

Sub-Project ID - 128

Volume II

Program Based Research Grant (PBRG)

Sub-Project Completion Report on Collection, Conservation and Characterization of Important Plant Genetic Resources

Sub-Project Duration
February 2018 to February 2022

Coordinating Organization
Crops Division
Bangladesh Agricultural Research Council



Project Implementation Unit
National Agricultural Technology Program-Phase II Project
BANGLADESH AGRICULTURAL RESEARCH COUNCIL

New Airport Road, Farmgate, Dhaka-1215, Bangladesh

www.barc.gov.bd

Program Based Research Grant (PBRG)

Sub-project Completion Report

on

Collection, Conservation and Characterization of Important Plant Genetic Resources

Implementing Organization

1. Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute
2. Genetic Resources and Seed Division, Bangladesh Rice Research Institute
3. Genetic Resources and Seed Division, Bangladesh Jute Research Institute
4. Breeding Division, Bangladesh Sugarcrop Research Institute
5. Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture
6. Cotton Development Board
7. Bangladesh Sericulture Research and Training Institute
8. Department of Horticulture, Bangladesh Agricultural University



Project Implementation Unit

National Agricultural Technology Program-Phase II Project
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

December 2021

Citation:

Chowdhury, M.A.Z., M.N. Islam, M.A. Rahim, M. Khalequzzaman, M.A. Salam, M.M. Islam, M. Shamsunnahar, M.R. Islam, M.M. Hussain, S.N. Begum, M.A. Rahman, S. M.M. Hossain, M.M.A. Ali, F. Ahmed, M.A. Alim, M.H. Rahman, M.M. Hossain, M.H. Rashid, M.A. Hossain, M.S. Uddin, R.A. Chanda, E.S.M.H. Rashid, M.Z. Islam, A.K.M.S. Hossain, M.M. Ahmed, K.M.R. Karim, F. Yasmine, M.K. Islam, M.A.B. Siddique, M.S. Hossain, S. Rahman, Q.M. Ahmed and A.C. Manidas. 2021. Collection, Conservation and Characterization of Important Plant Genetic Resources: Sub-Project Completion Report: Vol. II: 405-768.

Compiled and Edited by:

Md. Aziz Zilani Chowdhury, *PhD*
Md. Amjad Hossain, *PhD*
Md. Shamsher Ali, *PhD*
Amal Chandra Manidas, *MS*

Reviewed by:

Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka - 1215
Bangladesh

Acknowledgement

The execution of PBRG sub-project has successfully been completed by BARC, BARI, BRRI, BJRI, BSRI, BINA, CDB, BSRTI and BAU using the research fund of WB, IFAD and GoB through Ministry of Agriculture. We would like to acknowledge to the World Bank for arranging the research fund and supervising the PBRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP-2 in respect of field implementation of the sub-project in multiple sites. Preparing the sub-project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who have made it possible, deserve appreciation. Our thanks are due to the Director, PIU-BARC, NATP-2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

Published: December 2021

ISBN Number: 978-984-35-1485-1

Cover Design: Mohammad Nazmul Islam

Graphics Designer, Agriculture Information Centre, BARC

Printed by: College Gate Binding & Printing,

1/7, College Gate, Mohammadpur, Dhaka-1207

Contributors

Institute with Activities	Contributor	Position in the Sub-project
BARC (Coordination)	Dr. Md. Aziz Zilani Chowdhury	Coordinator
	Dr. Md. Abdus Salam	Principal Investigator (February 2018 to May 2020)
	Dr. Shah Md. Monir Hossain	Principal Investigator
	Dr. Md. Harunur Rashid	Co- Principal Investigator (February 2018 to May 2020)
BARI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Nazirul Islam	Principal Investigator (February 2018 to January 2020)
	Dr. Mosammat Shamsunnahar	Principal Investigator (February 2020 to October 2021)
	Dr. Md. Shalim Uddin	Co-Principal Investigator
	Dr. Rozina Afroz Chanda	Co-Principal Investigator
	Dr. Sajia Rahman	Co-Principal Investigator
	Quazi Maruf Ahmed	Co-Principal Investigator
BRRI (Collection, Conservation, Documentation and Characterization)	Dr. Mohammad Khalequzzaman	Principal Investigator
	Dr. Ebna Syod Md. Harunur Rashid	Co-Principal Investigator
	Dr. Mohammad Zahidul Islam	Co-Principal Investigator
	Md. Abu Bakar Siddique	Co-Principal Investigator
BJRI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Mahboob Hussain	Principal Investigator (February 2018 to July 2018)
	Md. Rafiqul Islam	Principal Investigator (August 2018 to October 2021)
	Dr. A.K.M. Shahadat Hossain	Co-Principal Investigator
BSRI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Anisur Rahman	Principal Investigator
	Md. Mostake Ahmed	Co-Principal Investigator
	K.M. Rezaul Karim	Co-Principal Investigator
BINA (Collection, Conservation, Documentation and Characterization)	Dr. Mirza Mofazzal Islam	Principal Investigator (February 2018 to March 2020)
	Dr. Shamsun Nahar Begum	Principal Investigator (April 2020 to October 2021)
	Dr. Fahmina Yasmine	Co-Principal Investigator
CDB (Characterization)	M M Abed Ali	Principal Investigator
	Dr. Md. Kamrul Islam	Co-Principal Investigator
BSRTI (Characterization)	Faruque Ahmed	Principal Investigator (February 2018 to July 2018)
	Md. Abdul Alim	Principal Investigator (August 2018 to October 2021)
	Md. Shakhawat Hossain	Co- Principal Investigator
BAU (Collection, Conservation, Documentation and Characterization)	Prof. Dr. M. A. Rahim	Principal Investigator
	Prof. Dr. Md. Habibur Rahman	Co-Principal Investigator
	Prof. Dr. Md. Mokter Hossain	Co-Principal Investigator

Abbreviation and Acronyms

AFLP	: Amplified Fragment Length Polymorphism
ANOVA	: Analysis of Variance
ARS	: Agricultural Research Station
BARC	: Bangladesh Agricultural Research Council
BARI	: Bangladesh Agricultural Research Institute
BAU	: Bangladesh Agricultural University
BBS	: Bangladesh Bureau of Statistics
BI	: Bioversity International
BINA	: Bangladesh Institute of Nuclear Agriculture
BJRI	: Bangladesh Jute Research Institute
BRRRI	: Bangladesh Rice Research Institute
BSPC	: Breeder Seed Production Centre
BSRI	: Bangladesh Sugarcrop Research Institute
BSRTI	: Bangladesh Sericulture Research and Training Institute
CBD	: Convention on Biological Diversity
CDB	: Cotton Development Board
Co-PI	: Co-Principal Investigator
CTAB	: Cetyl trimethylammonium bromide
CV	: Coefficient of Variation
DAE	: Department of Agricultural Extension
DNA	: Deoxyribonucleic Acid
DUS	: Distinctness, Uniformity, Stability
EC	: Executive Chairman
EDTA	: Ethylenediamine tetraacetic acid
FRG	: Fertilizer Recommendation Guide
FSRD	: Farming System Research and Development
GI	: Geographical Indication
GIS	: Geographic Information System
GO	: Government Organization
GoB	: Government of Bangladesh
GPC	: Germplasm Centre
GPS	: Geographical Positioning System
GRSD	: Genetic Resources and Seed Division
GT	: Genotype by Trait
HARS	: Hill Agriculture Research Station
HRC	: Horticulture Research Centre
HYV	: High Yielding Variety
IBPGR	: International Board for Plant Genetic Resources
IFAD	: International Fund for Agricultural Development
IPGRI	: International Plant Genetic Resources Institute

IPR	:	Intellectual Property Rights
JAF	:	Jute and Allied Fibre
LoA	:	Letter of Agreement
NARS	:	National Agricultural Research System
NATP	:	National Agricultural Technology Program
NBPGR	:	National Bureau of Plant Genetic Resources
NGO	:	Non-Government Organization
NTSYS	:	Numerical Taxonomy System
OFRD	:	On-Farm Research Division
ORC	:	Oilseed Research Centre
PBD	:	Plant Breeding Division
PBRG	:	Program Based Research Grant
PC	:	Principal Component
PCA	:	Principal Component Analysis
PCR	:	Sub-project Completion Report
PCR	:	Polymerase Chain Reaction
PGR	:	Plant Genetic Resources
PGRC	:	Plant Genetic Resources Centre
PGRFA	:	Plant Genetic Resources for Food and Agriculture
PI	:	Principal Investigator
PIC	:	Polymorphism information Content
PIU	:	Project Implementation Unit
PMU	:	Project Management Unit
PRA	:	Participatory Resource Appraisal
RAPD	:	Random Amplified Polymorphic DNA
RARS	:	Regional Agricultural Research Station
RCBD	:	Randomized Complete Block Design
SAHN	:	Sequential agglomerative hierarchical non-overlapping
SAU	:	Sher-e-Bangla Agricultural University
SD	:	Standard Deviation
SDG	:	Sustainable Development Goal
SDS	:	Self-Directed Search
SE	:	Standard Error
SSR	:	Single Sequence Repeat
TSS	:	Total Soluble Solids
USA	:	United States of America
WB	:	World Bank

Table of Contents

Sl. No.	Subject	Page No.
1.	Title page	i
2.	Citation, Acknowledgement	ii
3.	Contributors	iii
4.	Abbreviation and Acronyms	iv
5.	Table of Contents	vi
6.	List of tables	vii
7.	List of figures	xi
8.	Executive Summary	xiv
9.	Methodology in brief	405
	Bangladesh Agricultural Research Institute	405
	Bangladesh Jute Research Institute	423
	Bangladesh Sugarcrop Research Institute	426
	Bangladesh Institute of Nuclear Agriculture	431
10.	Results and Discussion	443
	Bangladesh Agricultural Research Institute	443
	Bangladesh Jute Research Institute	605
	Bangladesh Sugarcrop Research Institute	666
	Bangladesh Institute of Nuclear Agriculture	686
11.	Research Highlights	752
	Bangladesh Agricultural Research Institute	752
	Bangladesh Jute Research Institute	761
	Bangladesh Sugarcrop Research Institute	765
	Bangladesh Institute of Nuclear Agriculture	767

List of tables

Table	Title	Page
25	List of mustard germplasm used for molecular characterization	419
25a	List of test primers	420
26	DUS descriptor of sugarcane used for morphological characterization	428
27	Collection of germplasm from different districts in Bangladesh, January 2018 - December 2020	444
28	List of collected germplasm of different crops, January 2018 - December 2020	444
29	Passport information of collected germplasm, January 2018 - December 2020	445
30	Qualitative variation in different characters of pumpkin germplasm	524
31	Quantitative variation in different descriptors of pumpkin germplasm	525
32	Qualitative characters of pumpkin germplasm	529
33	Quantitative characters of pumpkin germplasm	532
34	Qualitative variation in different descriptors of cucumber germplasm	534
35	Quantitative variation in different descriptors of cucumber germplasm	537
36	Variability in growth and foliage characters of brinjal germplasm	539
37	Variability in qualitative fruit characters of brinjal germplasm	540
38	Quantitative descriptors of brinjal germplasm	540
39	Qualitative traits of brinjal germplasm	550
40	Qualitative variations in bitter gourd germplasm	556
41	Quantitative variations in bitter gourd germplasm	560
42	Qualitative characters of bitter gourd germplasm	560
43	Quantitative characters of bitter gourd germplasm	562
44	Qualitative and quantitative characters of black cumin	564
45	Qualitative and quantitative characters of fenugreek	565
46	Qualitative variations in brinjal germplasm	566
47	Quantitative variations in brinjal germplasm	568
48	Quantitative characters of brinjal germplasm	568
49	Qualitative characters of brinjal germplasm	569
50	Qualitative variation in mungbean germplasm	570
51	Quantitative variation in mungbean germplasm	572
52	Qualitative information of mungbean germplasm	572
53	Quantitative information of mungbean germplasm	574
54	Qualitative variation in bottle gourd germplasm	577

Table	Title	Page
55	Quantitative variation in bottle gourd germplasm	581
56	Qualitative information of bottle gourd germplasm	582
57	Quantitative information of bottle gourd germplasm	587
58	Qualitative variations in amaranth germplasm	594
59	Qualitative characters of amaranth germplasm	595
60	Quantitative variations in amaranth germplasm	597
61	Quantitative characters of amaranth germplasm	597
62	Qualitative characters of guava germplasm	600
62a	Quantitative characters of guava germplasm	600
63	Variability of simple sequence repeat marker used for rapeseed-mustard genotypes genetic analysis	603
64	List of collected jute germplasm, November 2018 to December 2020	605
65	District wise jute germplasm collection status	605
66	Passport in formation of jute germplasm	607
67	Conservation status of JAF germplasm collected under PBRG-PGR sub-project	614
68	Qualitative variation in different characters of jute germplasm, 2018	615
69	Quantitative variation in different descriptors of jute germplasm, 2018	616
70	Qualitative characters of deshi jute germplasm, 2018	616
71	Quantitative characters of deshi jute germplasm, 2018	617
72	Qualitative variation in different characters of deshi jute (<i>C. capsularis</i>) germplasm, 2020	627
73	Quantitative variation in different descriptors of deshi jute (<i>C. capsularis</i>) germplasm, 2020	628
74	Qualitative characters of deshi jute (<i>C. capsularis</i>) germplasm, 2020	628
75	Quantitative characters of deshi jute (<i>C. capsularis</i>) germplasm, 2020	629
76	Qualitative variation in different characters of tossa jute germplasm, 2020	633
77	Qualitative characters of tossa jute germplasm	634
78	Quantitative characters of tossa jute germplasm	634
79	Quantitative variation of tossa jute germplasm	635
80	List of jute germplasm with origin	639
81	SSR primers used for diversity analysis of jute germplasm	640
82	Summary of genetic variation for major alleles	643
83	Allele frequency of 14 polymorphic markers for test jute germplasm	644
84	Allele size of monomorphic primers for test jute germplasm	645

Table	Title	Page
85	Nei's (1983) genetic distance among jute germplasm	646
86	List of jute germplasm with origin	648
87	SSR primers used for diversity analysis of jute germplasm	649
88	Summary of genetic variation for major alleles	652
89	Allele frequency of 18 polymorphic markers for jute germplasm	653
90	Amplified allele size of monomorphic primers for jute germplasm	654
91	Nei's (1983) genetic distance among 22 jute germplasm	655
92	List of jute germplasm with origin	657
93	SSR primers used for diversity analysis of jute germplasm	658
94	Summary of genetic variation for major alleles	660
95	Allele size and frequency of 16 polymorphic markers	661
96	Allele size of monomorphic primers for jute germplasm	662
97	Nei's (1983) genetic distance among jute germplasm	663
98	List of sugarcane germplasm collected from different districts in Bangladesh, 2018-2020	668
99	Passport information of sugarcane germplasm collected under PBRG-PGR sub-project	668
100	Conservation status of collected sugarcane germplasm, 2018-2020	677
101	List of germplasm characterized morphologically, 2018-20	678
102	Morphological traits of sugarcane germplasm as per DUS descriptor	680
103	Analysis of variance for 12 characters of sugarcane germplasm	682
104	Clustering of sugarcane germplasm using mean of 12 quantitative characters	683
105	Differences among four clusters of sugarcane germplasm for mean performance of 12 quantitative characters	683
106	Principal component analysis of 12 quantitative characters in sugarcane germplasm	685
107	District wise germplasm collection status of target crops	686
108	Passport information of collected rice (<i>Oryzae sativa</i>) germplasm	687
109	Passport information of collected spices, chilli (<i>Capsicum frutescens</i> L.), ginger (<i>Zingiber officinale</i>) and turmeric (<i>Curcuma longa</i>) germplasm	706
110	Passport information of collected bitter gourd (<i>Momordica charantia</i>), eggplant (<i>Solanum melongena</i>) white gourd (<i>Benincasa hispida</i>), sweet gourd (<i>Cucurbita moschata</i>), bottle gourd (<i>Lagenaria siceraria</i>) and sponge gourd (<i>Luffa aegyptiaca</i>) germplasm	707
111	Passport information of collected french bean (<i>Phaseolus vulgaris</i>) and hyacinth bean (<i>Lablab purpureus</i>) germplasm	710
112	Passport information of collected groundnut (<i>Arachis hypogaea</i>), mustard (<i>Brassica sp.</i>) and blackgram (<i>Vigna mungo</i>) germplasm	710

Table	Title	Page
113	List of test rice germplasm	712
114	Characterization of rice germplasm based on qualitative characters, T. Aman, 2019	713
115	Variability in test rice germplasm considering 10 quantitative characters, Boro, 2018-19	716
116	List of test rice germplasm	719
117	Characterization of rice germplasm based on qualitative characters, T. Aman, 2019	720
118	Variability in test rice germplasm in quantitative characters, T. Aman, 2019	724
119	Distribution of germplasm in different non-hierarchical clusters of rice germplasm	725
120	Qualitative descriptors of chilli germplasm	726
121	Quantitative descriptors of chilli germplasm	729
122	List of sesame germplasm used in this study	730
123	Qualitative descriptors for individual sesame germplasm	731
124	Quantitative variation in different descriptors of sesame germplasm	733
125	Distribution of germplasm in different non-hierarchical clusters of sesame	733
126	Quantitative characters of sesame germplasm	736
127	List of test peanut germplasm	738
128	Qualitative descriptors for test peanut germplasm	739
129	Quantitative variation in different descriptors of peanut germplasm	740
130	List of test rice germplasm used for molecular characterization	741
131	List of simple sequence repeat (SSR) markers	742
132	Allele number, frequency, genetic diversity and PIC of 83 rice landraces screened with nine micro-satellite markers	743
133	Conservation status of germplasm collected under PBRG-PGR sub-project	747

List of figures

Figure	Title	Page
19	Grid map of Bangladesh showing targeted collection sites	406
20	Field view and pheromone trap	411
21	Field view of amaranth germplasm characterization (A) and classes of amaranth (B)	417
22	Homepage of created database for administrators and users	421
23	Data entry/data modification forms for the users	422
24	Passport data entry form	422
25	Germplasm collection sites on map	424
26	Targeted areas for sugarcane germplasm collection	427
27	Bangladesh GIS map showing Sub-project areas	431
28	Bangladesh GIS map showing targeted areas to be explored for germplasm collection	432
29	Grid map of Bangladesh showing exploration sites	443
30	Variation in pumpkin fruit ridge	526
31	Variation in pumpkin fruit shape	527
32	Variation in fruit skin pattern of pumpkin	527
33	Variation in leaf of pumpkin	527
34	Peduncle shape of pumpkin	527
35	Stem characters of pumpkin	528
36	Variation in matured fruit skin color of pumpkin	528
37	Diversity in fruit shape of cucumber germplasm	535
38	Shape of leaf (orbicular) and stem (angular) with pubescence	536
39	Variation in fruit skin color at table maturity stage	536
40	Variation in fruit skin color at matured stage	537
41	GIS mapping of collected brinjal germplasm	538
42	Species richness of collected brinjal germplasm in Bangladesh map using Shannon diversity index	538
43	Distinctness among test brinjal germplasm	555
44	Plant growth habit of test bitter gourd germplasm	557
45	Tendrill branching habit of test bitter gourd germplasm	558
46	Leaf size of bitter gourd germplasm	558
47	Fruit shape of bitter gourd germplasm	558
48	Nature of tubercles and fruit surface of test bitter gourd germplasm	559
49	Blossom-end fruit shape of bitter gourd germplasm	559

Figure	Title	Page
50	Seed skin luster of bitter gourd germplasm	559
51	Flowering stage and different plant parts of black cumin	564
52	Different plant parts of fenugreek	565
53	Terminal leaflet shape (Deltoid and ovate) of mungbean germplasm	571
54	Calyx and corolla color of mungbean (Calyx: green and corolla: yellow)	571
55	Seed color of mungbean (Deep green and deep brown)	571
56	Stem pubescence and stem shape, leaf margin and leaf shape and variation in calyx, ovary and flower color of bottle gourd	578
57	Fruit shape of bottle gourd germplasm	579
58	Matured fruit skin color of bottle gourd	580
59	Early vigor of amaranth germplasm	592
60	Growth habit of amaranth germplasm	592
61	Inflorescence color of test amaranth germplasm	593
62	Inflorescence spininess (A), stem shape (B) and stem color (C) of test amaranth germplasm	593
63	Inflorescence shape of test amaranth germplasm	593
64	Microsatellite profiles of 25 rapeseed-mustard genotypes; primer Na12-A02 and OI12A04	601
64a	UPGMA cluster analysis and relationship among 25 mustard germplasm based on alleles generated by SSR markers	603
65	Bangladesh GIS map demonstrating explored areas	606
66	Germplasm collection from Dashiachora Sitmohol Phulbari, Kurigram	612
67	Germplasm collection from different places of Bangladesh	613
68	Different plant parts of deshi jute (<i>C. capsularis</i>) germplasm, 2018	618
69	Different plant parts of deshi jute (<i>C. capsularis</i>) germplasm, 2020	630
70	Different plant parts of tossa jute germplasm, 2020	636
71	DNA profile of the jute germplasm with the SSR marker JMBD148 (A), JMBD563 (B) and JMBD598 (C)	642
72	UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among jute germplasm based alleles detected by microsatellite markers	647
73	DNA profile of jute germplasm with SSR marker, JMBD880(A), MJM1401(B), JMBD756(C) and JMBD721 (D)	651
74	UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among jute germplasm based on alleles detected by microsatellite markers	656
75	DNA profile of jute germplasm with SSR marker, MJM1401	660

Figure	Title	Page
76	UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among test jute germplasm based on alleles detected by microsatellite markers	664
77	Lab activities for molecular characterization	665
78	Bangladesh map showing explored districts (20)	666
79	Bangladesh map showing 31 upazilas	667
80	Sugarcane germplasm collection from Chittagong Hill Tracts	676
81	Sugarcane germplasm collection from southern part of Bangladesh	676
82	Sugarcane germplasm collection from Sylhet region	676
83	Dendrogram based on mean performance of variables in test sugarcane germplasm	684
84	Genotype by trait (GT) biplot of sugarcane germplasm	685
85	Collecting seeds from farmers and seed agency and recording passport data	686
86	Collecting seeds from farmer's seed store and house	688
87	Leaf sheath color, ligule color and shape, lemma color, awn variation, grain color and length of rice germplasm	717
88	Stem anthocyanin color, attitude of flag leaf and culm of rice germplasm	718
89	Hierarchical cluster analysis using UPGMA among test rice germplasm	724
90	Hierarchical cluster analysis using UPGMA among test sesame germplasm	735
91	Primer survey of two rice landraces	744
92	DNA profile of 83 rice landraces with marker, RM493	744
93	DNA profile of 83 rice landraces with marker, RM262	745
94	An UPGMA dendrogram showing genetic relationships among 83 rice landraces based on alleles detected by nine micro-satellite markers	746

Executive Summary

Plant genetic resources are the most valuable and essential basic raw materials for crop improvement providing biological basis for world food security supporting livelihoods. Cultivated varieties, obsolete varieties, primitive cultivars (landraces), wild and weedy species, near relatives of cultivated species etc. are considered as component plant genetic resources. Bangladesh is characterized by a mixture of tropical and sub-tropical environments offering congenial growing condition for numerous agri-horticultural crops. It is bestowed with immense agro-biodiversity and rich diversity of landraces, traditional/farmers' varieties in several agri-horticultural crops with a good number of timber and medicinal plants which are indigenous to the country. The diverse 30 agro-ecological regions of the country have sustained rich genetic resources of crop plants. Collection and conservation of the plant genetic diversity is essential for present and future human well-being. Adoption of modern agriculture, destruction of habitat, aggression of local and overseas private seed companies and other reasons have caused high genetic erosion in the country. With a view to collect, characterize (morphological and molecular), conserve and documentation of important plant genetic resources including Geographical Indication (GI) crops, landraces and released varieties for establishing 'Intellectual Property Rights (IPR)' a coordinated sub-project titled "Collection, Conservation and Characterization of Important Plant Genetic Resources" (ID: 128) has been implemented by seven NARS institutes viz. BARI, BRRI, BJRI, BSRI, BINA, CDB, BSRTI and one University viz. BAU. As coordinating organization, BARC arranged meeting, inception, training and review workshops. It also monitored and evaluated technical activities at field and laboratory levels as well as edited and compiled reports (half yearly, annual and sub-project completion reports) submitted by implementing organizations. Participating organizations collected germplasm from target areas following appropriate procedures and the germplasm were conserved preliminary in active/short term storage and were characterized following standard descriptors for respective crops.

In total 1184 germplasm of different crops were collected by implementing institutes where BARI collected 600 (Cereals -14, Pulses-39, Oilseeds-26, Vegetables-455, Spices-36, Fruits-14, Medicinal plants-12 and Other crops - 4), BRRI collected 247 rice, BJRI collected 35 (*Corchorus capsularis*-23, *Corchorus olitorius*-9 and *Hibiscus sabdariffa*-3), BSRI collected 68 sugarcane, BINA collected 199 (Rice-151, Chilli-5, Turmeric-2, Ginger-2, Bitter gourd-3, Brinjal-9, White gourd-3, Sweet gourd-3, Bottle gourd-1, Sponge gourd-1, Okra -3, Bean -8, Groundnut-4, Mustard-1, Sesame-2 and Black gram -1) and BAU collected 35 Yam germplasm during sub-project tenure.

In total 1936 germplasm were characterized morphologically under the sub-project among which BARI has characterized 844 (Pumkin-64, Cucumber-26, Brinjal-284, Bitter gourd-48, Mungbean-97, Bottle gourd-223, Amaranthus-80 and Guava -22), BRRI characterized 264 rice (T. aman-120, Boro-96, Aus -48), BJRI characterized 97 jute (Deshi jute-62 and Tossa jute-35), BSRI characterized 51 sugarcane, BINA characterized 141 (Rice-73, Sesame-30, Groundnut-33 and Chilli-5), CDB characterized 343 cotton, BSRTI characterized 60 mulberry and BAU characterized 136 (Banana-60, Aroids-45 and 31 Yam) germplasm during the project period.

Molecular characterization of 526 germplasm of different crops has been completed by the implementing organizations. Twenty five mustard germplasm were characterized by BARI, whereas 216 rice (T. Aman-120; Boro-48 and Aus-48) and 66 jute germplasm were characterized by BRRI and BJRI, respectively. Likewise, BINA and BAU characterized 83 rice and 136 (Banana-60, Aroids-45 and Yam-31) germplasm, respectively.

All the germplasm comprised of orthodox seeds collected by BARI, BRRI, BINA and BJRI have been conserved in short term storage/active collection in the respective institutes. After completion of necessary procedures the seeds will be conserved in the base collection/long term preservation units. Recalcitrant seed germplasm collected by BARI, BSRI and BAU have been conserved in field gene bank of corresponding organizations.

An outstanding achievement of the sub-project came out with the release of 15 varieties (Banana-5, Aroids-4 and Yam-5 and chewing type sugarcane variety-1) by BAU and BSRI, respectively. All the released varieties are supposed to bring a positive impact in nutrition improvement of the farming community as the varieties are known as potent source of various health promoting stuffs. However previously collected germplasm were also been evaluated under the sub-project. Five research articles (BAU-4; BARI-1) are published and six are under process (BRRI-2, BJRI-1, BINA-2 and BSRI-1) from the results of this research.

10. Methodology in brief:

10.3. Bangladesh Agricultural Research Institute

To fulfill the objectives of the sub-project a series of experiments and activities were conducted. Germplasm were collected from 69 upazilas of 12 AEZs of Bangladesh which were covered by six Regional Agricultural Research Stations (RARs), one Hill Agriculture Research Station (HARS) and one (1) Farming System Research and Development (FSRD) Site of On-Farm Research Division (OFRD) of Bangladesh Agricultural Research Institute (BARI). Regional stations were: (1) Jashore, (2) Ishwardi, Pabna, (3) Rahmatpur, Barishal, (4) Hathazair, Chattogram and (6) Burirhat, Rangpur; Hill Agriculture Research Station was Khagrachari; FSRD site was Kapasia, Gazipur (Fig. 19). Activity wise methodologies are stated below.

10.3.1. Exploration and Collection of Plant Genetic Resources

Fourteen (14) collecting missions were made for collection of different crops' germplasm (vegetables, cereals, oilseeds, pulses, spices, fruits and medicinal plants) from different regions of Bangladesh. Eleven teams such as NSR, SU, NRI, MRI, NSR, NQR, SN, SNQR, SAA, SSR and NQ were formed comprising 1-3 scientists in each team. Each expedition was conducted 2 to 6 days. Upazila wise collection sites are presented in Fig.19. Number of samples of a crop were depleted on the extent and availability of varieties observed during collection. The teams were equipped with plastic carton, GPS, compass, digital camera, hand lens, envelop, knife, scissors, drying sheet, pencil, stapler etc. Germplasm of target crops were collected from farmers' field/house/threshing floor and market especially from floating seed traders (Arora, 1991). Local extension services and scientists of BARI assisted the team in exploring the crops. Collector's number and date were recorded during collection. Name of crop species along with English, Bangla, local and cultivar name were recorded. Name of donor with ethnic group, village, union, upazila/thana, district, latitude and longitude were noted. Type of soil, topography, sample status, sample source, habitat, frequency, type of materials, cultural practices, season, sole or mixed with, sample type, sampling method, insect and disease, agronomic score and plant characteristics were documented. Passport Data Form was developed to record passport information. The samples were registered in Germplasm Collection Register after collection and conserved in medium term conservation unit following appropriate procedure. At least 2-4 sites in each region were sampled for collecting germplasm. A grid map of Bangladesh was used for demarcating the survey area and collection sites (Fig. 19). Germplasm were collected directly from the farmers during farm and home visiting. Collected germplasm are in progress of characterization in the PGRC, Gazipur research field. Data relating to passport and characterization are documenting in both hard copy and computerized data base system. Open-source programming tool MySQL has been used to develop database application software. Three Participatory Rural Appraisal (PRA) survey were conducted in the communities for documenting farmer's perception on conservation and utilization of plant genetic resources including the GI characters (if any).

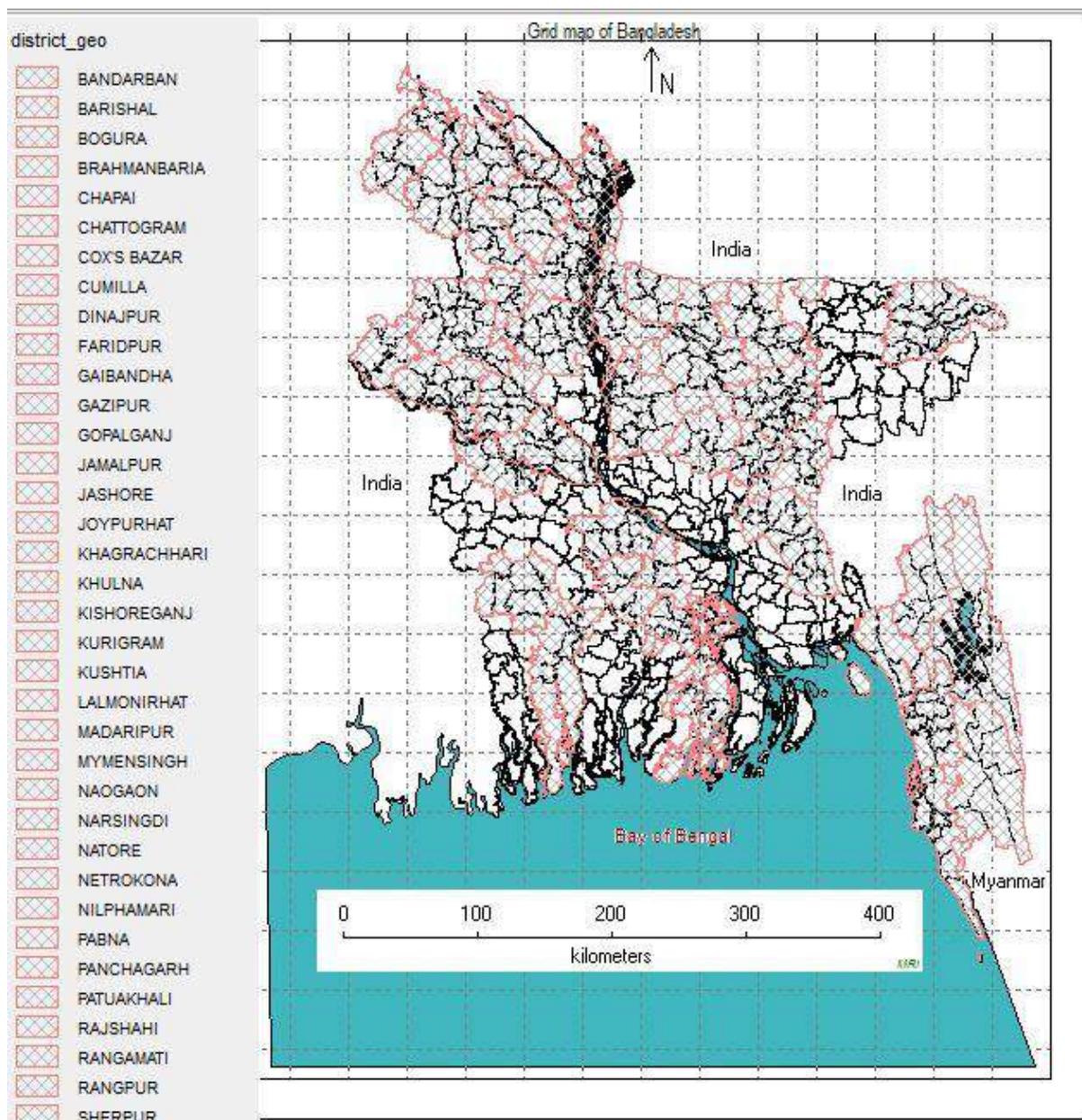


Fig. 19. Grid map of Bangladesh showing targeted collection sites

10.3.2. Morphological Characterization of Pumpkin Germplasm

The experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during winter 2017-18. Sixty-four (64) germplasm of pumpkin were sown in the plastic pot on 16 November, 2017. Plant spacing was 2x2 m and unit plot size was 3 x 4 m. The seedlings were transplanted on 10 December 2017. The recommended doses of manure and fertilizers such as 5 ton/ha cow dung, 100 kg N, 48 kg P, 80 kg K, 28 kg S, 3 kg Zn and 2.1 kg/ha B in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc-sulphate and boric acid were applied in the experimental field (FRG, 2012). The full doses of cow dung, TSP, MP, gypsum, zinc-sulphate and boric acid were applied during pit preparation before one week of transplanting. The urea was applied in the four installments as top dressing at 15, 35, 55 and 75 days after transplanting. Normal cultivation techniques and intercultural operations were followed to have a good crop.

Pheromone trap was used for insect control. Thirty-three observations on qualitative (21) and quantitative (12) characters were recorded as per Minimal Descriptors of Agri-Horticultural Crops. Part II (Srivastava, 2001). Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated.

Descriptor and descriptor states of Pumpkin

A. Qualitative descriptor

1. Early plant vigor: 3 Poor, 5 Good, 7 Very good, 99 Others
2. Plant growth habit: 3 Short viny, 5 Medium viny, 7 Long viny, 99 Others
3. Stem pubescence density: 1 Smooth, 2 Pubescence, 99 Others
4. Stem shape: 1 Rounded, 2 Angular, 99 Others
5. Tendril: 0 Absent, 1 Present
6. Tendril type: 1 Coiled, 2 Straight, 99 Others
7. Tendril branching: 1 Unbranched, 2 Branched, 99 Others
8. Leaf margin: 1 Entire, 2 Serrate, 3 Multifid, 99 Others
9. Leaf shape: 1 Cordate, 2 Oblong, 3 Ovate, 4 Obovate, 5 Orbicular, 99 Others
10. Leaf size: 3 Small, 5 Medium, 7 Large, 99 Others
11. Leaf pubescence density: 0 No hairs, 3 Sparse, 5 Intermediate, 7 Dense, 99 Others
12. Color of leaf spot: 3= Silver
13. Sex type: 1 Monoecious, 2 Gynomonoecious, 3 Andromonoecious, 4 Androgynomonoecious, 5 Hermaphrodite, 6 Androecious, 99 Others
14. Peduncle shape: 1 Nearly, cylindrical, 2 Smoothly grooved, 3 Angular grooved, 99 Others
15. Fruit shape: 1 Globular (round), 2 Flattened, 3 Disk, 4 Cylindrical, 5 Elliptical (oval), 6 Acorn/Heart shaped, 7 Pyriform, 8 Dumbbell, 9 Elongate form, 10 Terbinate superior, 11 Crowned, 12 Terbinate inferior, 13 Curved, 14 Crooked neck, 99 Others
16. Mature fruit skin color: 1 Creamish, 2 Yellowish, 3 Green, 4 Red, 99 Others
17. Fruit skin pattern: 1 Uniform, 2 Mottled, 3 Striped, 99 Others
18. Stem end fruit shape: 1 Depressed, 2 Pointed, 3 Flattened, 4 Rounded, 99 Others
19. Blossom end fruit shape: 1 Depressed, 2 Pointed, 3 Flattened, 4 Rounded, 99 Others
20. Fruit ridge shape: 1 Superficial, 2 Rounded/Grooved, 3 Intermediate, 4 Deep grooved, 5 Narrowly winged, 99 Others
21. Mature flesh color: 1 Yellow, 2 Deep yellow, 3 Orange, 99 Others

B. Quantitative descriptor

1. Number of primary branches: Data were recorded as average of same 10 plants at the end of flowering stage. The branch that arises from the main vine/stem is known as primary branch.
2. Days to 1st male flower: Data were recorded at first appearance of male flower.
3. Days to 1st Female flower: Data were recorded at first appearance of female flower.
4. Nodal position of 1st male flower: Nodal position where the first male flower was appeared.
5. Nodal position of 1st female flower: Nodal position where the first female flower was appeared.
6. Number of ridges per fruit: Data were recorded in cross section at full maturity stage.
7. Flesh thickness (cm): Data were recorded as average of same 5-10 fruits at marketable stage.
8. Fruit length (cm): Data were recorded as average of 5-10 random fruits at marketable stage.

9. Fruit breadth (cm): Data were recorded as average of same 5-10 fruits at marketable stage.
10. Fruit weight (kg): Average fruit weight of five fruits per accession.
11. Number of fruits per plant: Data were recorded as total number of fruits in each picking.
12. TSS (Brix) %: Pulp tissues of pumpkin were cut into small pieces and measured by Brix meter. Data were recorded in percentage.

10.3.3. Characterization of Landraces of Cucumber

The experiment was conducted at the Plant Genetic Resources Centre Farm, BARI, Gazipur during the period from March to June, 2019. Twenty-six accessions of cucumber were included in this study. Among them eighteen accessions seed were finally harvested. Some of plant has died due to excessive rain just after transplanting of seedling. The materials collected from different parts of Bangladesh. The experiment was laid out in a non-replicated design. One accession represented one treatment, with two plants. The unit plot size was 2 m x 2 m maintaining 0.5 m between the plots. Treatments were randomly assigned to different plots of each block separately. After final land preparation, the bed was raised about 30 cm from the ground level. The cucumber seeds of different accessions dibbled in the pot on 12 March 2019. The seedlings were transferred to the field on 10 April, 2019. Necessary intercultural operations were done throughout the cropping season for proper growth and development of the plant. Trail was made with bamboo and plastic wire for proper growth and development of the cucumber plants. Harvesting of mature fruits continued up to end of June, 2019. Data were collected on qualitative and quantitative characters following descriptor and data were analyzed to find out the variable characters among associations of Cucumber.

Descriptor and descriptor states of Cucumber:

A. Qualitative descriptor

1. Plant growth type: 1 Indeterminate and 2 Determinate
2. Leaf intensity of green color: 1 Light, 2 Medium and 3 Dark
3. Tendril presence: 1 Presence and 0 Absence
4. Stem end fruit shape at table maturity stage: 1 Necked, 2 Acute and 3 Obtuse
5. Blossom end fruit shape at table maturity stage: 1 Flat and 2 Deep raised
6. Fruit skin texture at table maturity stage: 1 Smooth and 3 Rough
7. Fruit shape at table maturity stage: 1 Oblong, 2 Oval, 3 Ellipsoid and 4 Blossom end
8. Fruit skin color at table maturity stage: 1 Light green, 2 Yellowish green and 3 Green
9. Fruit skin color at mature harvest stage: 1 Brown and 2 Yellow

B. Quantitative descriptor:

1. Internode length (cm) at fruiting stage: Average of 10 internode length
2. Leaf length (cm) at fully developed leaves: Average of 10 fully developed leaf length
3. Leaf width (cm) at fully developed leaves: Average of 10 fully developed leaf width
4. Days to staminate flower: Days to produce male flower after sowing
5. Days to pistilate flower: Days to produce female flower after sowing
6. Fruit length (cm) at edible stage: Average of five fruit length.
7. Fruit width (cm) at edible maturity stage: Average of five fruit length.
8. No. fruit per plant: Average of fruits number per plant
9. 100 seed weight (g): Measured 100 seed weight after drying
10. Days to mature fruit harvest: Days to harvest mature fruit

10.3.4. Characterization of Brinjal Germplasm

The experiment was conducted in the experimental field of Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI), Gazipur during winter 2018-19. A total of 240 accession and four check varieties were used in this experiment. Direct seeding was done in the well-prepared seed beds on 14th November, 2018. Thirty-eight days aged seedlings were transplanted in the prepared pits of main experimental field on 28th December 2018. The plot size was 3x2.1 m². Each germplasm was planted in a plot of three rows. Row to row and plant to plant distance was 70x60 cm. The experimental design used in the study was Augmented Randomized Complete Block Design (Augmented RCBD) with four check varieties and 12 blocks. All check varieties received 12 replications, giving a total of 284 experimental plots. Fertilizer doses were 10 ton/ha Cowdung, 210 kg/ha Urea, 33 kg/ha TSP, 200 kg/ha MP and 5 kg/ha Borax (Mondal *et al.*, 2011). The full doses of Cow-dung, TSP and Borax were applied during land preparation before one week of transplanting. Urea and MP were applied in the three equal splits at 15, 35 and 50 days after transplanting. Weeding and mulching were done four times at 25 days' interval starting from mid-December. Individual net was used per plot to avoid the cross pollination. Sevin 75 WP @ 0.1 g/pit, Sumithion 60 EC @ 2.5 ml/L and Vertimac 18 EC @ 1.2 ml/L were sprayed for controlling insect and mite, respectively. The Data were recorded as per the descriptor developed by IBPGR, 1990.

1. Accession number: This number serves as a unique identifier for accession and is assigned by the curators/gene bank scientist when an accession is entered into his collection. Once assigned this number should never be assigned to another accession in the collection. Even if an accession is lost, its assigned number is still not available for re-use. 'BD' letter has been used before the number to identify the accession that comes from the PGRC, BARI, Gazipur, Bangladesh.

2. Collector's number: Original number assigned by collector of the sample normally composed of the name or initials of the collector(s) followed by a number. This item is essential for identifying duplicates in different collections.

Descriptor and descriptor states of Brinjal

A. Qualitative descriptor

1. Plant growth habit: 3- Upright, 5- Intermediate, 7- Prostrate
2. Leaf blade lobing: 3- Weak, 5- Intermediate 7- Strong, 9- Very strong
3. Leaf blade tip angle: 1-very acute (>15 cm), 3-acute (~45 cm), 5-intermediate (~75 cm), 7-obtuse (~110 cm)
4. Leaf prickles: 0- None, 5- Intermediate (6-10), 7 -Many (11-20), 9- Very many (>20)
5. Leaf hairs: 1-Very few (<20), 3- Few (20-50), 5- Intermediate (50-100)
6. Corolla color: 5-pale violet, 7-light violet, 9-bluish violet
7. Calyx color (to be recorded at flowering stage): 1 Green, 2 Light purple, 3 Dark purple, 99 other
8. Calyx spininess (to be recorded at flowering stage): 3 Smooth, 5 Medium thorny, 7 High thorny, 99 Others
9. Fruit calyx prickles: 0 None, 1 Few (1-5), 2 Many (>5), 99 Others
10. Fruit color distribution: 1 Uniform, 3 Mottled, 5 Irregular striped, 7 Regular striped, 99 Others
11. Fruit curvature: 1 None, 3 Slightly curved, 5 Curved, 7 Snake shaped, 8 Sickle shaped, 9 U shaped, 99 Others
12. Fruit apex shape: 3 Prostrate, 5 Rounded, 7 Depressed, 99 Others

13. Fruit cross section: Data were recorded at near maturity stage.
14. Fruit color at ripening: 1 Milky white, 2 Green, 3 Deep yellow, 4 Fire red, 5 Scarlet red, 6 Lilac red, 7 Purple, 8 Purple black, 9 Black, 10 Light purple, 99 Others
15. Fruit flesh density: 1 Very loose (spongy), 3 Loose (crumbly), 5 Medium compact, 7 Compact, 9 Very compact, 99 Others
16. Fruit position: 3 Pendent, 5 Semi pendent, 7 Erect, 99 Others
17. Seed color: 1 White, 2 Light yellow, 3 Grey yellow, 4 Brownish yellow, 5 Brown, 6 Brown black, 7 Black, 99 Others
18. Seed size: 3 Small, 5 Intermediate, 7 Large, 99 Others

B. Quantitative descriptor

1. Leaf blade length (cm): Averages of five mature leaf length were measured.
2. Leaf blade width (cm): Averages of five mature leaf width were measured.
3. Fruit length (cm): Fruit length was measured from the neck region to blossom end at mature stage.
4. Fruit width (cm): Fruit width was measured by slide calipers, placing in the middle position of the fruits.
5. 100 seed wt.: Data recorded as the weight of 100 mature and dry seeds.
6. Plant height (cm): Averages of five plant height of individual germplasm were measured.
7. Days to 50% flowering: Days required to 50% of the flowers to open.
8. Number of fruits per plant: The sum of the total fruit harvested at different date was divided by number of plants to get number of fruits per plant.
9. Yield per plant (g): The sum of the total fruit weight at different date was divided by number of plants to get yield (average) per plant.

10.3.5. Characterization of Landraces of Bitter Gourd

The experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during summer 2018-19. Forty-six germplasm along with two check varieties of bitter gourd were used in this study. Passport data of germplasm used in this experiment are given in Table 26. Two seeds were sown in each plastic pot (6 cm in diameter approximately) on 14 March 2019. Pits of 40x 40 x40 cm were prepared 10 days before transplanting the seedlings in the main field. Plant spacing was 2x2 m and unit plot size was 3 x 4 m with two replications. The seedlings were transplanted on 31 March 2019. The plants were given support of 4 m height bamboo stick. Two plants were used for each germplasm. The recommended doses of manure and fertilizers such as 5 ton/ha decomposed cow dung, 100 kg N, 40 kg P, 60 kg K, 20 kg S and 1.5 kg/ha B in the form of urea, triple super phosphate, muriate of potash, gypsum and boric acid were applied in the experimental field (FRG, 2012). The full doses of cow dung, TSP, MP, gypsum and boric acid were applied during pit preparation before one week of transplanting. The urea was applied in the three installments as side dressing at 20, 40 and 60 days after transplanting. Normal cultivation techniques and intercultural operations were followed to have a good crop. Pheromone traps were used for controlling insects (Fig. 20). Data were recorded as per NBPGR (2001) descriptors for bitter gourd. Nevertheless, selection was done based on total fruiting period and yield for future use.



Fig. 20. Field view and pheromone trap

Descriptors and descriptor states of Bitter gourd

A. Qualitative descriptors

1. Classes of bitter gourd: 1 Uchche and 2 Korolla
2. Early plant vigor: 3 Poor, 5 Good and 7 Very good
3. Plant growth habit: 3 Short viny, 5 Medium viny and 7 Long viny
4. Stem pubescence: 0 Absent and 1 Present
5. Stem shape: 1 Rounded and 2 Angular
6. Twining tendency: 0 None, 3 Slight, 5 Intermediate and 7 Pronounced
7. Tendril branching: 1 Unifid, 2 Bifid and 3 Multifid
8. Leaf margin: 1 Entire, 2 Serrate and 3 Multifid
9. Leaf shape: 1 Ovate, 2 Obovate, 3 Cordate, 4 Oblong, 5 Reniform and 6 Orbicular
10. Leaf size: 3 Small 5 Medium 7 Large
11. Leaf pubescence: 0 No hairs, 3 Sparse, 5 Intermediate and 7 Dense
12. Sex type: 1 Monoecious, 2 Gynomonocious, 3 Andromonoecious, 4 Hermaphrodite, 5 Androecious and 99 Others
13. Flower color: 1 White, 2 Light yellow, 3 Yellow and 4 Deep
14. Fruit shape: 1 Spindle, 2 Elliptical, 3 Oblong, 4 Long cylindrical, 5 Top shaped and 6 Globular
15. Fruit surface: 1 Smoot, 2 Light tubercle and 3 Deep tubercle
16. Nature of tubercles: 3 Sparse, 5 Medium and 7 Dense
17. Blossom-end fruit shape: 1 Blunt and 2 Acute
18. Fruit skin color: 4 Light green, 5 Green and 6 Dark green
19. Fruit skin luster: 3 Matt, 5 Intermediate and 7 Glossy
20. Fruit bitterness: 3 Mild, 5 Moderate and 7 Strong
21. Seediness: 3 Low, 5 Medium and 7 High
22. Seed luster: 3 Matt, 5 Intermediate and 7 Glossy

B. Quantitative Descriptors

1. Internode length (cm): Data were recorded as average of distance between 4th and 5th node on 2 plants at full foliage stage.
2. Petiole length (cm): Data were recorded as average of 5 random leaves in the middle region of the vine at full foliage stage.
3. Days to 50% flowering: No. of days required from sowing date to the date when at least 50% of the plants show first female flower open.
4. Sex ratio: Data were recorded as ratio of male flowers to female flowers on a plant at flowering stage.
5. Peduncle length (cm): Data were recorded as average of 5 random fruits at marketable stage.
6. Vine length (cm): Data were measured at peak fruiting stage from ground level to the tip of main stem on 2 plants.
7. Number of primary branches: Data were recorded as average of 2 plants at the end of flowering stage.
8. Days to first fruit harvest: Data were recorded as number of days from date of sowing to the date of first marketable fruit harvest.
9. Days to last fruit harvest: Data were recorded as number of days from date of sowing to the date of last marketable fruit harvest.
10. Number of marketable fruit harvest: Data were recorded as total number of fruit pickings.
11. Number of fruits per plants: Data were recorded as average of 2 plants.
12. Yield of marketable fruits per plant (g): Data were recorded as average of cumulative yield of all pickings in 2 plants.
13. Fruit weight (g): Data were calculated on the basis of fruit yield and number of fruits per plant.
14. Fruit length (cm): Data were recorded as average of 5 random fruits at marketable stage.
15. Fruit width (cm): Recorded as average of same 5 fruits at marketable stage.
16. Number of seeds per fruit: Data were recorded as average of 5 randomly selected mature fruits.
17. 100 seed weight (g): Data were measured as average weight of 100 randomly dry seeds.

10.3.6. Regeneration of Black Cumin and Fenugreek Germplasm

The regeneration and characterization program of different crops was performed at the experimental field of PGRC, BARI, Gazipur during 2018-19. All germplasm of different crops was sown in winter season. The plot having the size 3 x 2 m maintaining a space of 30 x 10 cm and seed harvest was done. The required land for all the selected crops was prepared finely with special care and the crops were fertilized with recommended dose (Mondal *et al.*, 2011). After harvesting, the seeds were properly dried and cleaned to ensure seed quality for the conservation.

10.3.7. Characterization of Brinjal Germplasm (Set-II)

The experiment was conducted at the Regional Plant Genetic Resources Center, RARS, Ishwardi, Pabna during 2019-2020. The experiment involves thirty-six brinjal accessions. Main field was prepared 10 days before transplanting the seedlings. The recommended doses of manure and fertilizers such as 5-ton ha⁻¹ cow dung, 120 kg N, 36 kg P, 90 Kg K, 15 kg S and 2.0. kg ha⁻¹ Zn in the form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate (monohydrate), respectively were applied in the experimental field (FRG, 2018). The full doses of cowdung, TSP, gypsum and zinc sulphate were applied during land preparation before one week of transplanting. Urea and MP were applied in the three equal splits at 21,35 and 50 days after transplanting as ring method around the plant followed by irrigation (105) days interval during dry season. The experiment was conducted in a non-replicated design. The unit plot size was 3 m X 2 m and 9 plants were accommodated in a plot with a plant spacing of 75 cm apart and row to row distance of 100 cm (excluding 50 cm drain). The seedlings were transplanted on 19 October, 2019. The plants were given support of 1 m height bamboo sticks. Admire (0.5 ml per liter) was applied for controlling aphids. Twenty-five observations on qualitative (12) and quantitative (13) characteristics were classified into descriptor state as per Descriptors for Eggplant (IBPGR, 1990). Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated.

Passport Descriptors

1. Accession number: This number serves as a unique identifier for accession and is assigned by the curators/gene bank scientist when an accession is entered into his collection. Once assigned this number should never be assigned to another accession in the collection. Even if an accession is lost, its assigned number is still not available for re-use. 'BD' letter has been used before the number to identify the accession that comes from the PGRC, BARI, Gazipur, Bangladesh.

Descriptor states of brinjal

A. Qualitative characteristics

1. Cotyledon color: 3 Green, 5 Light violet and 7 Violet
2. Plant growth habit: 3 Upright, 5 Intermediate and 7 Prostrate
3. Leaf blade lobing: 3 Weak, 5 Intermediate 7 Strong and 9 Very strong
4. Leaf blade tip angle: 1 Very acute (>15 cm), 3 Acute (~45 cm), 5 Intermediate (~75 cm) and 7 Obtuse (~110 cm)
5. Number of leaf prickles: Number of leaf prickles on upper surface of the leaf 0 None, 5 Intermediate (6-10), 7 Many (11-20) and 9 Very many (>20)
6. Leaf hairs: Number of hairs per mm² on lower surface of the leaf 1 Very few (<20), 3 Few (20-50) and 5 Intermediate (50-100)
7. Corolla color: 5 Pale violet, 7 Light violet and 9 Bluish violet
8. Fruit curvature: 1 None (fruit straight), 3 Slightly, 5 Curved and 7- Snake shaped
9. Fruit shape: 5 About 1/2 way from base to tip and 7 About 3/4 way from base to tip
10. Fruit apex shape: 3 Protruded, 5 Rounded and 7 Depressed
11. Fruit color at commercial ripeness: 1 Green, 2 Milk white, 5 Scarlet red, 6 Lilac grey, 7 Purple, 8 Purple Back and 9 Black
12. Fruit color distribution at commercial ripeness: 1 Uniform, 3 Mottled, 5 Netted and 7 Striped

B. Quantitative characteristics

1. Days to first flowering: Number of days required from planting to first opening of the flower. 3 Early (<91 days), 5 Optimum (91-105 days) and 7 Late (>105 days)
2. Days to 1st edible fruiting stage: Number of days required from planting to first edible fruiting. 3 Early (<121 days), 5 Optimum (121-130 days), 7 Late (>130 days)
3. Plant height (cm): Data were recorded on 5 randomly selected plants at edible fruiting stage, 3 Short (~30 cm), 5 intermediate (~60cm) and 7 Tall (61-100cm)
4. Plant breadth (cm): Data were recorded on 5 randomly selected plants at edible fruiting stage, 7 Broad (61-90cm) and 9 Very broad (91-105 cm)
5. Number of primary branches: Mean number of primary branches was measured on 5 randomly selected plants. 3 Weak (3-5) and 5 Intermediate (6-10)
6. Leaf blade length (cm): Data were recorded at vegetative stage. 3 Short (<10cm), 5 Intermediate (11-20 cm) and 7 long (21-30 cm)
7. Leaf blade width (cm): Data were recorded at vegetative stage. 3 Narrow (<5cm), 5 Intermediate (5-10 cm) and 7- Wide (11-15 cm)
8. Fruit length (cm): From base of calyx to tip of fruit: 1 Very short (<1 cm), 3 Short (3-5cm), 5 Intermediate (6-10cm), 7 Long (11-20cm) and 9 Very long (>20cm)
9. Fruit breadth (cm): Diameter at broadest part: 3 Small (2-3cm), 5 Intermediate (4-5cm), 7 Large (6-10cm) and 9 Very large (>10cm)
10. Number of fruits per plant: Mean number of edible fruits was measured on 10 randomly selected fruit. 1 Very low (<7), 3 Low (7-12), 5 Intermediate (13-18), 7 High (19-24) and 9 Very high (>25)
11. Fruit weight (g): Mean weight of edible fruit was measured on 10 randomly selected fruit. 3 Low (<30g), 5 Intermediate (30-60g) and 7 High (>60g)
12. Fruit weight per plant (kg): Mean weight of edible fruit was measured on 10 randomly selected fruit. 100-seed weight (g): Mean weight of 100 randomly selected seeds after sun drying. High (>0.40 g)

10.3.8. Characterization of Mungbean Germplasm

The experiment was carried out with 91 germplasm of mung bean with 6 check varieties at Plant Genetic Resources Centre, BARI, Gazipur during kharif 2020. The seeds were directly sown in prepared land dated on 08 March, 2020. The distance between line to line and accessions to accession was 30 cm and 50 cm in Augmented design with 6 check varieties. Measurement was performed on five individual plants of each accession. Optimum cultural practices were followed mung bean production system. Data were recorded in qualitative and quantitative traits as per pulse descriptor on International Board for Plant Genetic Resources (IBPGR).

Descriptors and Descriptor states

A. Qualitative characters

1. Hypocotyl color (Data were recorded at seedling stage): 1 Green
2. Epicotyl color (Data were recorded at seedling stage): 1 Light green
3. Growth habit (Data were recorded at vegetative stage): 1 Erect
4. Growth pattern (Data were record when the first pod change color): 2 Determinate

5. Terminal leaflet shape (Data were recorded at vegetative stage): 1 Deltoid and 2 Ovate
6. Terminal leaflet length (Data were recorded for the leaf at fourth node): 1 Small (<10 cm)
7. Leaf pubescence (Data were recorded for the leaf at fourth node): 1 Glabrous
8. Leaf color (Data were recorded at 50% flowering stage): 2 Green
9. Petiole color (Data were recorded at 50% flowering stage): 2 Greenish purple
10. Petiole length (Data were recorded for the leaf at fourth node): 1 Short (<12 cm) and 2 Medium (12-18 cm)
11. Raceme position (Data were recorded when the first pod change color): 1 Mostly above canopy and 2 Intermediate
12. Calyx color (Data were recorded when the first pod change color): 1 Green
13. Corolla color (Data were recorded at full blossom at about 8-10 a.m.): 1 Yellow
14. Pod color at immature stage (Data were recorded at fruiting stage): 2 Deep green
15. Pod color at mature stage (Data were record at maturity stage): 4 Black
16. Leafiness (Data were recorded at 50% flowering stage): 1 Sparse, 5 Medium and 9 Abundant
17. Seed color (Data were recorded after harvest of seed): 1 Deep green and 2 Deep brown

B. Quantitative characters

1. Days to germination: This was recorded in days from sowing to seed germination
2. Days to 1st flowering: This was noted from date of sowing of seeds to 1st flowering
3. Days to 50% flowering: This was noted from date of sowing to 50 % plants with flowering
4. Number of primary branches per plant: Number of branches from base level per plant
5. Plant height (cm): Plant height was measured in centimeter from ground level to tip of main axis of the plant.
6. Number of pods per plant: Number of pods per plant was counted on five randomly selected plants and averaged.
7. Pod length (cm): Length of pod was measured in centimeter. Mean length of five pods from each plant was considered and averaged.
8. Number of seeds per pod: Seeds of five pods from each plant were counted and averaged.
9. 100 seed weight (g): The test weight of 100 counted seeds was recorded in grams for individual germplasm
10. Seed yield per plant (g): The selected plants were harvested, threshed and winnowed separately.

10.3.9. Characterization of Bottle gourd Germplasm

The experiment was conducted at the Plant Genetic Resources Center, BARI, Joydebpur, Gazipur during 2019-2020. Two hundred eighteen (218) accessions of bottle gourd collected from different districts and five (5) check varieties were taken in this study. The seeds were sown in poly bags on 13 November, 2019. After 15 days, the seedlings were transplanted in prepared pits in the field. Lay out: Pit to pit and line to line distance was 4m X 4m. The experiment was conducted in Augmented design with 5 check varieties.

Fertilizer: When land was prepared the following fertilizers and manure were mixed in each pit, Cow dung-10kg, Urea- 50g, TSP-200g and MP-150g, Gypsum-75g. In vegetative stage, 20g Urea with water was sprayed per pit. Normal cultivation techniques, intercultural operations and irrigations were followed to grow the crop. Observations were recorded on eighteen (19) qualitative and fifteen (15) quantitative traits as per IBPGR Cucurbitaceae descriptor.

Descriptors and descriptor states

A. Qualitative characters

1. Early plant vigor: 3 Poor, 5 Good, 7 Very good and 99 Others
2. Plant growth habit: 3 Short viny, 5 Medium viny, 7 Long viny and 99 Others
3. Stem Pubescence: 0 Absent, 3 Sparse, 5 Medium, 7 Dense and 99 Others
4. Stem shape: 1 Rounded, 2 Angular and 99 Others
5. Tendril: 0 Absent and 1 Present
6. Tendril type: 1 Coiled, 2 Straight and 99 Others
7. Tendril branching: 1 Unbranched and 2 Branched
8. Leaf margin: 1 Entire, 2 Serrate, 3 Multifid and 99 Others
9. Leaf shape: 1 Cordate, 2 Oblong, 3 Ovate, 4 Obovate, 5 Orbicular, 6 Reniform, 99 Others
10. Leaf size: 3 Small, 5 Medium, 7 Large and 99 Others
11. Leaf pubescence nature: 3 Soft, 5 Intermediate, 7 Hard and 99 Others
12. Calyx color: 1 Green
13. Leaf pubescence density: 0 No hairs, 3 Sparse, 5 Intermediate, 7 Dense, 99 Others
14. Sex type: 1 Monoecious, 2 Gynomonoecious, 3 Andromonoecious, 4 Androgynomonoecious, 5 Hermaphrodite, 6 Androecious and 99 Others
15. Flower color: 1 White, 2 Cream and 99 Others
16. Fruit shape: 1 Elliptical, 2 Elongate, 3 Pyriform, 4 Oblong, 5 Club shaped, 6 Top shaped, 7 Globular, 8 Dumbbell shaped, 9 Kamandal shaped, 10 Lengthened cylindrical and 99 Others
17. Matured fruit skin color: 1 Light green, 2 Green, 3 Dark green, 4 Patchy green and 99 Others
18. Fruit pubescence: 0 Absent and 1 Present
19. Fruit pubescence density: 3 Low, 5 Medium, 7 High and 99 Others

B. Quantitative characters

1. Days to seed germination: Data were recorded in days from sowing to seed germination
2. Internode length (cm): Data were recorded the distance between 4th and 5th node in random 5 plants at full foliage stage
3. Petiole length (cm): Data were recorded as average of 5 random leaves in the middle region of the vine at full foliage stage
4. Days to 1st flowering: Data were recorded as number of days from sowing date to the date when the first flower open
5. Nodal position of 1st female flower: Data were recorded the nodal position where the first female flower open
6. Days to 1st male flower: Data were recorded as number of days from sowing date to the date when the first male flower open

7. Nodal position of 1st male flower: Data were recorded the nodal position where the first male flower open
8. Peduncle length (cm): Data were recorded as average of 5 random fruit at edible stage
9. Days to edible fruit: Data were recorded as number of days from sowing date to the date of edible fruiting stage
10. Fruit length (cm): Data were recorded as average of 5 random fruits at matured stage
11. Fruit width (cm) Data were recorded as average of 5 random fruits at matured stage
12. Fruit weight at matured stage (kg): Data were recorded as average weight of 5 random fruits in centimeter at matured stage
13. 1000 seed wt. (g): Data were recorded as average weight of 1000 random dry seeds (g)
14. Number of fruits per plant: Data were recorded of the number of fruits per plant in edible stage
15. Yield per plant (kg): Data were recorded for total fruit yield per plant in edible stage

10.3.10. Characterization of Amaranth Germplasm

The experiment was conducted in augmented block design at the Plant Genetic Resources Centre of BARI, Gazipur during winter 2019-20. Eighty accessions of amaranth were considered in this study. Line sowing was done on 2 rows in 3m long plot maintaining 15 cm plant spacing. Row to row distance was 50 cm and plot to plot distance was 100 cm (Fig. 21). The seeds were sown on 09 December 2019. Chemical fertilizers such as urea 250 kg/ha, TSP 100 kg/ha, MoP 150 kg/ha and gypsum 75 kg/ha were applied (FRG, 2018). The half quantity of urea and all TSP, MoP and gypsum were applied during land preparation. Urea was applied in two equal installments at 25 and 45 days after sowing. Sevin 20 WP was applied periodically in early stage to control ants. Normal cultivation techniques and intercultural operations were followed to have a good crop. Data were recorded as per NBPGR (2001) descriptors for Amaranth. However, under the pandemic status of the world due to COVID-19 some of the parameters stated in the descriptor were not possible to execute.



Fig. 21. Amaranth germplasm characterization (A) and classes of amaranth (B).

Descriptors and descriptor states of characterization

A. Qualitative descriptor

1. Classes: 1 Leaf amaranth, 2 Stem amaranth and 3 Grain amaranth
2. Early plant vigor: 1 Poor, 2 Good and 3 Very good
3. Plant growth habit: 1 Erect, 2 Spreading and 3 Drooping
4. Leaf color: 5 Green, 10 Reddish green, 11 Red and 12 Dark red

5. Inflorescence color: 3 Yellowish orange, 8 Purple, 9 Red, 10 Reddish green and 11 Green
6. Inflorescence compactness: 3 Lax, 5 Intermediate and 7 Dense
7. Stem color: 5 Red, 6 Reddish green and 8 Green
8. Stem surface: 1 Smooth and 2 ridged
9. Inflorescence shape: 1 Globose, 2 Semi drooping, 3 Completely drooping and 4 Straight
10. Inflorescence spininess: 1 Smooth, 2 Glabrous, 3 Prickly and 4 Spiny
11. Seed shattering: 3 Low (%), 5 Intermediate (10-50%) and 7 High (>50%)
12. Seed color: 2 Creamish, 5 Red and 7 Black

B. Quantitative Descriptors

1. Number of days to germination: Data were counted from the sowing date to the day when 50% of seeds in a row germinated.
2. Leaf length (cm): Data were recorded on fully grown leaf at the heading stage.
3. Petiole length (cm): Data were recorded at heading stage.
4. Number of days to 50% flowering: Data were counted from the sowing date to the day when 50% of plants in a row flowered.
5. Number of branches per plant: Data were counted as number of branches on the main stem (average of 5 random plants).
6. Plant height (cm): Data were measured from ground level to the highest tip of inflorescence.
7. Lateral spikelet length (cm): Data were recorded on longest lateral spikelet.
8. Inflorescence length (cm): Data were recorded at maturity time (average of 5 random plants).
9. Seed yield per plant (g): Data were recorded as weight of fully dried seeds per plant (average of 5 randomly selected plants).
10. 1000 seed weight (g): Data were recorded as weight of thousand random seeds in grams (average of 5 random plants).

10.3.11. Characterization of Guava Germplasm

The study was conducted in the fruit orchard of Agricultural Research Station (ARS), Pahartali, Chattogram and Regional Agricultural Research Station (RARS), Hathazari, Chattogram during 2019-20. About 22 diverse guava germplasm were included in the experiment. The Data were recorded as per the descriptors for guava.

Descriptor states of characterization

A. Qualitative descriptor

1. Leaf shape: 2 Oblong, lanceolate and 3 Elliptical
2. Mature leaf Color: 1 pale green and 2 green
3. Fruit shape: 2 Globose, 3 Pear shape and 4 Oblong
4. Fruit surface: 1 Smooth, 2 Bumpy and 3 Ridge
5. Fruit skin color: 3 Yellow white and 4 Greenish white
6. Pulp color: 1 White, 2 Creamy white, 3 greenish white and 6 light red
7. Pulp texture: 1 Very soft, 3 Soft and 5 Medium hard
8. Pulp flavor: 3 Mild and 5 Moderate

9. Fruit taste: 3 Less sweet, 5 Medium sweet and 7 Highly sweet
10. Seediness: 0 Seedless, 3 Low, 5 Medium and 7 High
11. Seed hardness: 3 soft, 5 intermediate and 7 hard

B. Quantitative Descriptors

1. Plant height (m)
2. Base girth (cm)
3. No. of branch
4. Canopy (N-S)
5. Canopy (E-W)
6. Fruit diameter (cm)
7. Fruit length (cm)
8. TSS (%)
9. Fruit weight (g)
10. Yield/ plant (kg)

Data were recorded like Plant height (m), Base girth (cm), NO. of branch, Canopy (N-S), Canopy (E-W), Leaf shape, Mature leaf Color, Fruit shape, Fruit surface, Fruit dia (cm), Fruit length (cm), Fruit weight (g), Fruit skin color, Pulp color, Pulp texture, Pulp flavor, Fruit taste, TSS, Seediness, Seed hardness and Yield/ plant (kg).

10.3.12. Molecular Characterization of Rapeseed-Mustard Germplasm using SSR Markers

Plant sample and extraction of genomic DNA

The study “molecular characterization of rapeseed-mustard germplasm using SSR markers” was carried out at the Molecular Biology Lab., PGRC, BARI, Gazipur. In total 25 rapeseed-mustard germplasm (seven varieties, nine land races/local cultivars and nine advance lines are used as test materials (Table 25). Total genomic DNA was purified from young fresh leaf tissues following Sodium Dodecyl Sulphate (SDS) extraction (phenol: chloroform: isoamyl alcohol (25:24:1,v/v/v)). DNA quality was checked by electrophoresis and quantified using a spectrophotometer (Spectronic[®] Genesis[™], New York, USA).

Table 25. List of mustard germplasm used for molecular characterization

Sl. No.	Genotypes	Species	Source	Status	Sl No	Genotypes	Species	Source	Status
1	BD-6952	<i>B. rapa</i>	PGRC, BARI	TC	14	BD-10108	<i>B. napus</i>	PGRC, BARI	TC
2	BD-6957	<i>B. juncea</i>	PGRC, BARI	TC	15	BD-10115	<i>B. juncea</i>	PGRC, BARI	TC
3	BD-7104	<i>B. juncea</i>	PGRC, BARI	TC	16	JBC-05117	<i>B. rapa</i>	ORC, BARI	AL
4	BD-7115	<i>B. rapa</i>	PGRC, BARI	TC	17	BARI Sarisha-10	<i>B. juncea</i>	ORC, BARI	RV
5	BD-10111	<i>B. rapa</i>	PGRC, BARI	TC	18	BARI Sarisha-11	<i>B. juncea</i>	ORC, BARI	RV
6	BD-10112	<i>B. rapa</i>	PGRC, BARI	TC	19	BARI Sarisha-16	<i>B. juncea</i>	ORC, BARI	RV
7	Nap-0564	<i>B. napus</i>	ORC, BARI	AL	20	SAU-01	<i>B. juncea</i>	SAU, Dhaka	RV
8	Jun-536	<i>B. juncea</i>	ORC, BARI	AL	21	Nap-0567	<i>B. napus</i>	ORC, BARI	AL
9	BJDH-12	<i>B. juncea</i>	ORC, BARI	AL	22	Tori-7	<i>B. rapa</i>	ORC, BARI	RV
10	BARI sarisha-8	<i>B. napus</i>	ORC, BARI	RV	23	BD-7114	<i>B. rapa</i>	PGRC, BARI	TC
11	BARI sarisha-13	<i>B. napus</i>	ORC, BARI	RV	24	BD-9343	<i>B. rapa</i>	PGRC, BARI	TC
12	BD-6950	<i>B. juncea</i>	PGRC, BARI	TC	25	BD-9348	<i>B. rapa</i>	PGRC, BARI	TC
13	BD-6958	<i>B. rapa</i>	PGRC, BARI	TC					

PGRC: Plant Genetic Resources Centre; BARI: Bangladesh Agricultural Research Institute; ORC: Oil Seed Research Centre, SAU: Sher-e-Bangla Agricultural University; TC: Traditional cultivar; AL: Advance Line; RV: Released Variety

Selection of Simple Sequence Repeats (SSR) primers

In total 15 SSR primers were employed for diversity analysis and among the primers 10 were polymorphic (Table 25a). Diversity analysis was performed following Turi *et al.*, 2012 with minor modifications. PCR reactions were carried out in 10µl volume containing 5X Green GoTaq® Reaction Buffer (Promega, USA) (15 mM MgCl₂, 1.25 U Taq DNA polymerase, 0.4 mM each of the dNTPs, 10 µM forward and reverse primers and 50 ng template DNA). The mixtures were prepared at 0°C and transferred to the thermal cycler. The reaction was carried out in Mastercycler® nexus Gradient thermal cycler (Eppendorf, Germany). Amplified products were stored at 4°C until further use. The reproducibility of the amplified products was checked twice for each primer.

Thermal profiles for SSR markers

Step	Temperature (°C)	Time	No. of cycle
Initial	94	3 min	1
Denaturation	94	1 min	35
Annealing	50-54	1 min	
Primer elongation	72	1 min	
Final extension	72	10 mins	1

Table 25a. List of test primers

Sl.	Locus	Forward Primer	Reverse Primer	Motif type	Ann.T.	Exp. Size (bp)
1.	Ol11-C02	gcattgcaatctgttggtc	cgttccatacagatcgtaagac	di GT/CA	54°C	132
2.	Ra2E07	attgctgagattggctcagg	cctacacttgcgatcttcacc	di GA/CT	54°C	152
3.	Ra2-F11	tgaactagggtttccagcc	cttcaccatggtttgcctc	di GA/CT	52°C	240
4.	Na12D04	acggagtgatgatgggtctc	cctcaatgaaactgaaatgtgt g	di GT/CA	52°C	241
5.	Ni3G04b	atactgggataggtgtgcg	catgtggcaatcctacattac	di GA/CT	54°C	123
6.	Ol12A04	tggttaagtaactgtggtggc	agagttcgcatactctggagc	di GA/CT	54°C	144
7.	Na10-D03	atgattgccttgaaatgcc	gatgaaacaataacctgagacacac	di GT/CA	52°C	158
8.	Na12-A02	agccttgttctttcaacg	agtgaatcgatgatctcgcc	di GA/CT	54°C	190
9.	Na12-E01	attccatgactccattgtc	aaatccttctctctgtcg	di GA/CT	54°C	244
10	Ni4-B10	gtccttgagaaactccaccg	ccgatcccatttctaacc	di GA/CT	54°C	194

Electrophoretic separation and visualization of amplified products

Amplified products were electrophoresed on a 5% denaturing polyacrylamide gel containing 19:1 acrylamide: bis-acrylamide, 10X TBE buffer, 10% APS and ultrapure Temed. Electrophoresis was done using the Triple Wide Mini-Vertical Electrophoresis System, MGV-202-33 (CBS Scientific, USA) using cooling system (Julabo, Germany). After electrophoresis, separation the gel was stained with ethidium bromide (0.1%) and the individual bands were scored for analysis.

Scoring and analysis of microsatellite data

SSR markers were scored as co-dominant, so homozygous and heterozygous genotypes could be distinguished in individual plants. The bands representing particular alleles at the microsatellite loci were scored manually and designated as A, B, C, etc. from the top to the bottom of the gel. The genotypes of different individuals were hypothetically scored as AA, BB, CC, etc. for homozygous or as AB, AC, BC etc. for heterozygous. A single genotypic data matrix was constructed for all loci. This was used to estimate polymorphic loci, genetic variation (Nei's gene diversity, Shannon's information index), gene distance and construct a UPGMA dendrogram using computer program POPGENE (Version 1.31) POPGENE (Version 1.31) (Yeh *et al.*, 1999).

The polymorphism information content (PIC) of the SSR used or gene diversity value was calculated as $PIC = 1 - \sum f_{ij}^2$; where f_{ij} is the frequency of the i th allele for the j th SSR locus (Anderson *et al.* 1993). The software DNA FRAG version 3.03 was used to estimate allelic length (Nash, 1991).

10.3.13. Database Development and Data Entry for Germplasm Documentation

Building the system

1. Listing of required information
2. Building empty structures of database files/tables
3. Setup links between different database files
4. Developing screen forms for entering, modifying searching and deleting data
5. Developing report for information retrieval

Building of screen form

- Background information of PGRC, genebank, objectives, requirements of each management procedure, identification of descriptor occurring with the germplasm and data formats analyzed thoroughly
- Passport data, characterization data, evaluation data, distribution and management data selected
- Designing of landing page with general information, purpose of the genebank, guidelines and information/services obtained
- Forms for data entry, data modification, distribution of germplasm and related management procedures designed
- Open-source programming tools *php-MySQL*, *CSS*, *Java script* adopted for designing homepage, data entry/editing forms (Fig. 22).



Fig. 22. Homepage of created database for administrators and users

10.3.14. Development of Mobile Applications for PGR Passport Information Collection

Description of Technical Area:

A. Developing Tools(s):

- (i) Framework: Flutter (A Google Product. Most recently introduced and most sophisticated cross platform customize smart phone application developing technology.)
- (ii) Language: DART (A Google Product)
- (iii) Database: Firebase (A Cloud based Data Storage)
- (iv) UI/UX: Adobe XD (An Adobe Corporation Product)

B. Why we use these tool(s):

Since Google ruled over the time in the field of Technology World that's why we have been selected a Google product "Flutter". It is cross platform compatible single code base which support simultaneously Android device and iOS devices.

C. Apps Name: BARI PGR Passport App

D. Apps Feature:

- (i) Fully Automated
- (ii) Cloud based database
- (iii) Dual language supported

10.4. Bangladesh Jute Research Institute

10.4.1. Germplasm collection

Effort of genetic exploration of JAF crops has been made from Chattogram, Khulna, Rangpur and Barishal Divisions. Collection mission was made in Rangpur, Kurigram, Nilphamary, Panchagarh, Dinajpur, Bogura, Cumilla, Patuakhali, Barguna and Barishal districts during February 2018 to November 2020. The collection program was mission oriented, targeting season and location specific and involving different GO, NGO and private sector personnel. A grid map of Bangladesh was used for the demarcating survey area and collecting sites. Germplasm were collected from the farmers and seed store of collecting sites (Fig. 25). Collected germplasm were processed and characterized in the Manikganj Research Station. Useful information was gathered from local Agricultural Officers, forest officers and community leaders, which facilitated collection programme. Jute and allied fibre (JAF) germplasm were collected from 20 upazilas of Kurigram, Nilphamari, Panchagarh, Dinajpur, Bogura, Rangpur, Patuakhali, Barisal, Barguna and Cumilla districts. Collectors explored the target areas and the selected germplasm were recorded with passport information as per prescribed passport data form during germplasm collection. Seven collection teams were made for this purpose comprising one to two members in each team.

Collection team for collecting of germplasm

Collector's code	Collection team
RS	Md. Rafiqul Islam & Dr. A. K. M. Shahadat Hossain
AS	Dr. Md. Ayub Khan & Dr. A. K. M. Shahadat Hossain
ACK	Dr. Md. Ayub Khan & Dr. Chandan Kumar Saha
FM	Dr. Abul Fazal Mollah
FMN	Dr. Abul Fazal Mollah & Noor A Alam
TZ	Md. Tipu Sultan & Md. Zahidul Islam.
TP	Md. Tipu Sultan & Md. Parvez Howlader

The teams were equipped with GPS apps, compass apps, digital camera, envelop, knife, scissors, ball pen, pencil, stapler etc. Targeted farmers for collection of germplasm were located with the help of field level workers of Department of Agricultural Extension (DAE) and other research personnel of different research institutes. Each expedition was conducted 2 to 5 days. At least 2-4 sites in each region were sampled for collecting Jute germplasm.

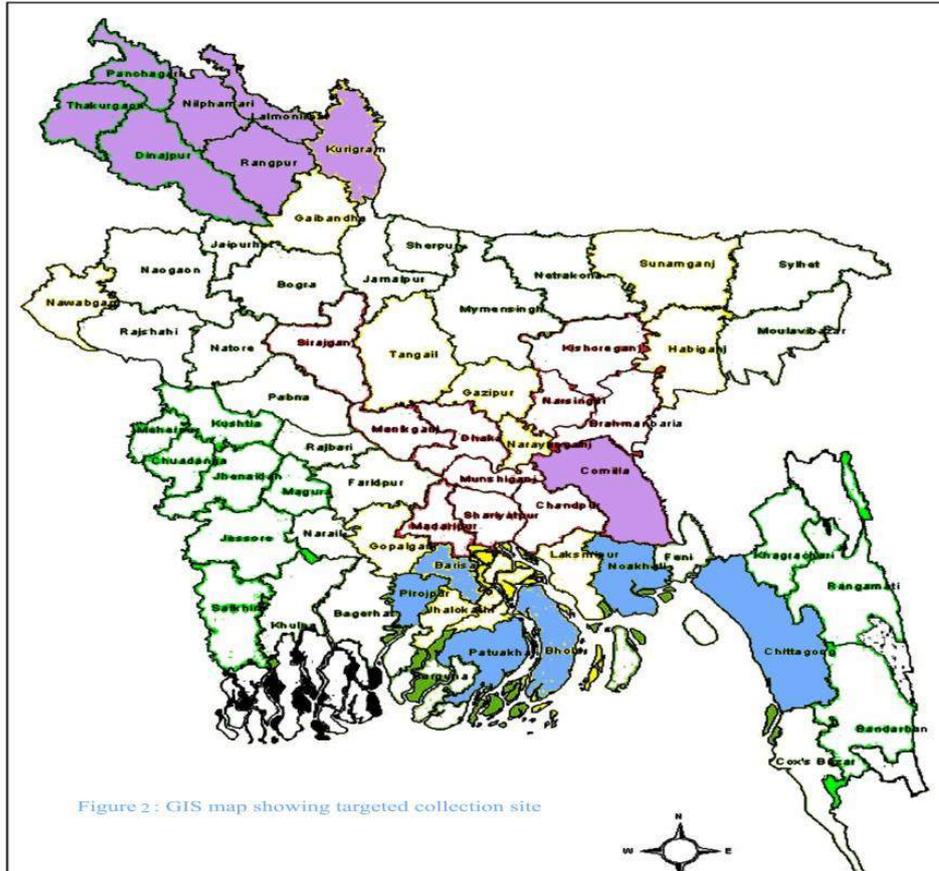


Figure 2: GIS map showing targeted collection site

Fig. 25. Germplasm collection sites on map

10.4.2. Conservation

BJRI has to conserve 90 jute and allied fibre germplasm collected from target areas and seed received from different sources. The collected germplasm were cleaned, processed, dried and conserved in short term storage room of BJRI Gene Bank at Manilmia Avenue, Dhaka. The collected JAF germplasm samples were registered in conservation book immediately after collection (February 2018 to November 2020). Each sample was assigned a registration number according to the source of acquisition and passport information. The collected germplasm have so far been conserved in short term storage as an active collection.

10.4.3. Morphological Characterization

BJRI has characterized 90 germplasm of JAF crops at morphological level. A total of 27 deshi jute germplasm were characterized at morphological level during 2019. In the year of 2020, thirty five deshi jute and thirty five tossa jute germplasm were also characterized at the Jute Agriculture Experimentation Centre, Jagir, Manikganj by two separate experiment.

Single row of 4 m length for each germplasm was maintained. Row to row distance was 30 cm and about 5-6 cm between plants. The plot was fertilized with recommended doses of cow dung (5 ton/hac), 100 kg/hac urea, 25kg/h TSP and 45 kg/hac Murate of Potash respectively. The whole amount of TSP, MP and half of urea were applied at final land preparation. The remaining half urea was applied in the equal installments of the 1st (20 days after sowing) and final (45 days after sowing) weeding. Appropriate control measures were taken for insect pests, diseases and weeds as and when necessary. Data on six qualitative and 15 quantitative traits were recorded according to standard descriptors of jute.

A. Qualitative descriptor

1. Stem color: 1 Green, 2 Red and 99 Others (light red)
2. Leaf shape: 1 Ovate, 2 Ovate-lanceolate, 3 Lanceolate, 4 Elliptical, 5 Cordate and 6 Other (specify).
3. Leaf lamina color: 1 Green, 2 Red and 99 Others (light red)
4. Leaf vein color: 1 Green, 2 Red and 99 Others (light red)
5. Petiole color: 1 Green, 2 Red and 99 Others (light red)
6. Stipule: 0 Absent and Present 1
7. Stipule color: 1 Green, 2 Red and 99 Others (light red)

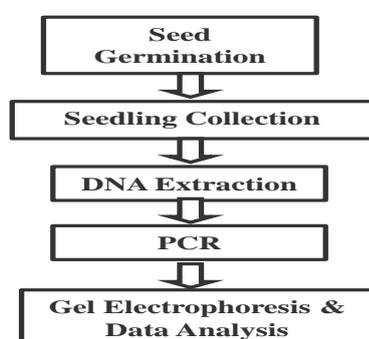
B. Quantitative descriptor

1. Plant technical height (cm): The height of the main stem measured from soil level to the point of forking at pre bud stage.
2. Node no. : Total number of nodes on main stem from soil surface to technical height at harvest time.
3. Stem diameter basal (mm): Measured as close to soil surface as possible using slide calipers at harvest time.
4. Stem diameter Middle (mm): Measured at midpoint between base and top at harvest time.
5. Stem diameter top (mm): Measured at the point of forking i.e. at technical height at harvest time.
6. Basal core diameter (mm): Measured at same position as base diameter but after removal of outer bark to expose core (stick) at harvest time.
7. Dry fibre wt. (g): Average of all 10 plants after defoliation, retting, fibre extraction and drying of fibre.
8. Dry stick wt. (g): Average of all 10 plants After defoliation, retting, fibre extraction and drying of core (stick).
9. Branch habit: 0-Non-branchingno Growth of axillary bud, 1- Very weak, 3-Weak, 5-Intermediate, 7-Strong, 9-Very Strong.
10. Leaf angle: The angle between the stem and the line connecting; the base and the centre of midrib of the leaf at pre-bud stage Measure the 10 leaves starting from the 6th leaf from top of main stem (i.e. ignore first 5 leaves). 1 for 0-20⁰ ...erect, 2 for 21-40⁰..., 3 for 41-60⁰.... intermediate, 4 for 61-80⁰..., 5 for 81-100⁰....horizontal, 6 for 101-120⁰..., 7 for 121-140⁰...descending, 8 for 141-160⁰..., 9 for 161-180⁰...drooping.
11. Leaf length (cm): Average maximum length of 10 starting from the 6th leaf from top of main stem (i.e. ignore first 5 leaves) at pre-bud stage.

12. Leaf width (cm): Average maximum width of 10 starting from the 6th leaf from top of main stem (i.e. ignore first 5 leaves) at pre-bud stage.
13. Petiole length: Measurement in mm. using same 10 leaves at pre-bud stage.
14. Leaf area (sq. cm): Average area of 10 leaves from the 6th leaf from the top of stem. Calculate from length and maximum breadth or use leaf area at pre-bud stage.

10.4.4. Molecular Characterization

A total of 66 jute germplasm including 15 varieties have been characterized at molecular level using SSR primers. DNA was extracted from 4 days old seedlings using modified mini preparation CTAB method. Electrophoresis was conducted with 8% Polyacrylamide gel in vertical gel electrophoresis system. 1kb⁺ DNA ladder was used for allele scoring. Gel documentation system was used for visualization of DNA bands. Three software were used for Data analysis. Molecular weight for each amplified allele was measured in base pair using Alpha Ease FC 4.0. The summery statistics including the number of alleles per locus, major allele frequency, genetic diversity, polymorphism information content values were determined using Power Marker version 3.25. NTSYS-pc was used to construct dendrograms showing relationship among the genotypes.



10.5. Bangladesh Sugarcrop Research Institute

10.5.1. Germplasm collection

Local germplasm were collected from 31 upazilas of 20 districts of Bangladesh. The collection program was mission oriented, targeting season and location specific and involving different GO, NGO and private sector personnel. For collection, especial emphasis was given on remote areas like hilly, coastal and beel/haor areas. Three collecting mission were made for collection of sugarcane germplasm. On the other hand, short visit and personal communication was also practiced for germplasm collection. Sugarcane germplasm were collected from 31 upazilas of 20 districts. The teams were equipped with GPS apps, compass apps, digital camera, envelop, knife, scissors, ball pen, pencil, stapler etc. Targeted farmers for collection of germplasm were located with the help of field level workers of Department of Agricultural Extension (DAE) and other research personnel of different research institutes. Collector's name, number and date were recorded during collection. Name of crop species along with English, Bengali, local and cultivar name were recorded. Name of donor with ethnic group, village, union, upazila, district, latitude and longitude were noted. A 'Passport Data Form' having passport information was filled up during germplasm collection. Planned areas for collection are shown in Fig. 26.

Collector's no.: Original number assigned by collector of the sample normally composed of the name or initials of the collectors followed by a number. The item is essential for identifying duplicates in different collections.

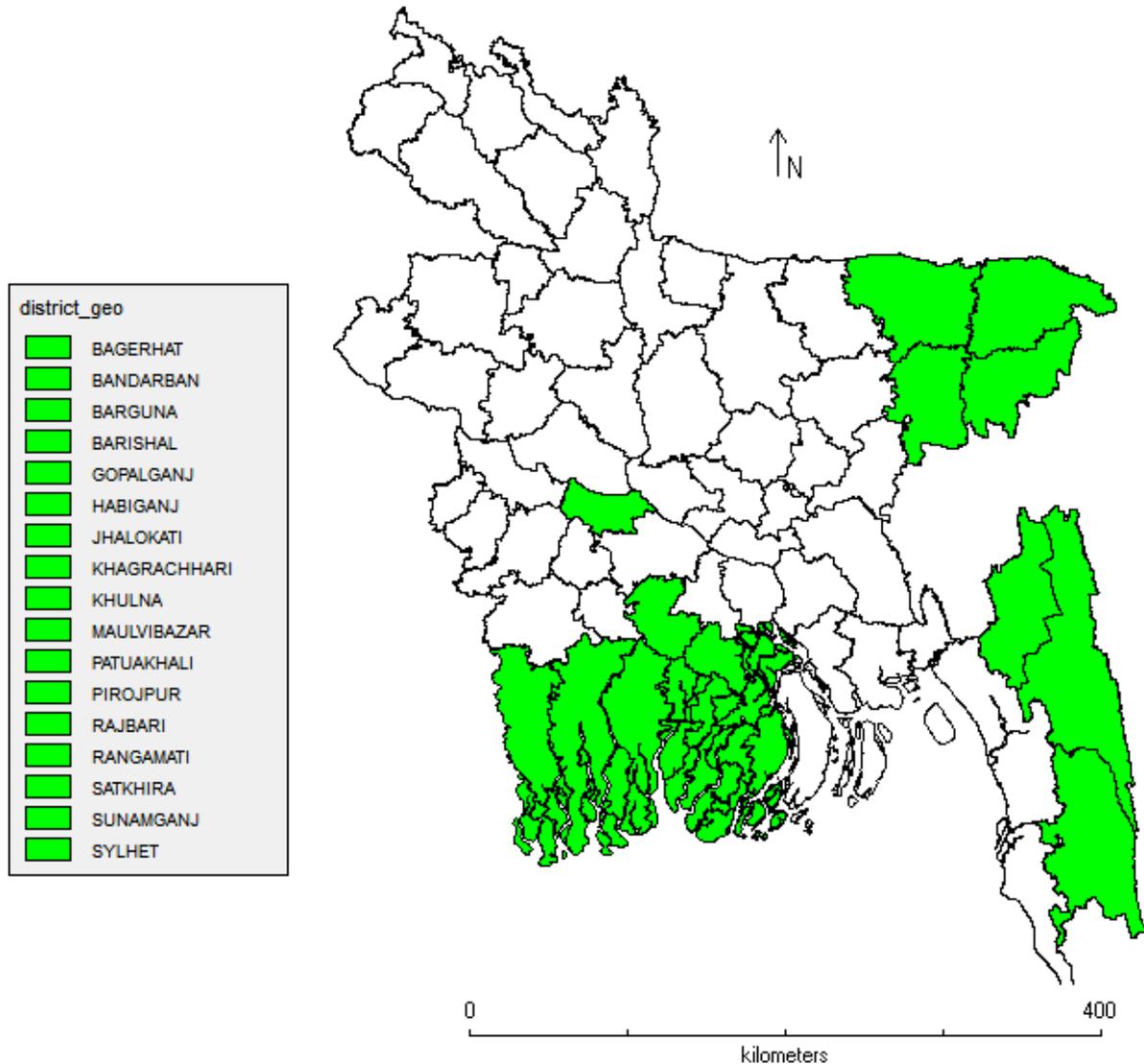


Fig. 26. Targeted areas for sugarcane germplasm collection

10.5.2. Conservation of collected germplasm

The collected germplasm were treated with carbendazim fungicide @1g/L and planted in BSRI germplasm bank just after collection during January 2018 to October 2020. After characterization it was conserved at field gene bank of BSRI, Ishurdi, Pabna.

10.5.3. Morphological characterization

Morphological data of 51 germplasm were taken according to the DUS descriptor of sugarcane. Thirty seven parameters were considered to find out the distinctness among the germplasm. Growth parameters were measured at 8-10 months of plant age and the maturity parameters were taken at 12 months. Genotypes were grouped according to character stated (Table 26).

Table 26. DUS descriptor of sugarcane used for morphological characterization

SI No.	Characteristic	State	Note	Stage of observation (days)
1.	Plant: Growth habit	Erect	1	210-240
		Semi-erect	2	
2.	Plant: Adherence of leaf sheath	Weak (self de-trashing)	3	270-300
		Medium (semi clasping)	5	
		Strong (tight clasping)	7	
3.	Plant: Number of millable canes (NMC) per stool	Low (<3.0)	3	300-360
		Medium (3.0 – 5.0)	5	
		High (5.1 – 7.0)	7	
		Very high (>7.0)	9	
4.	Plant: Leaf carriage	Open	1	210-240
		Compact	2	
5.	Plant: Intensity of green color of leaf canopy	Light	3	210-240
		Medium	5	
		Dark	7	
6.	Plant: Cane height (from the base to the TVD leaf)	Short (<1.75 m)	3	300-360
		Medium (1.75-3.0 m)	5	
		Tall (>3.0 m m)	7	
7.	Internode: Diameter	Thin (<2.2 cm)	3	270-300
		Medium (2.2 – 3.0 cm)	5	
		Thick (>3.0 cm)	7	
8.	Internode: Shape	Cylindrical	1	270-300
		Tumescant	2	
		Bobbin shaped	3	
		Conoidal	4	
		Obconoidal	5	
		Curved	6	
9.	Internode: Cross- section	Round	1	300-360
		Oval	2	
10.	Internode: Colour (Exposed to sun)	Green yellow group (RHS 1)	1	270-300
		Yellow green group (RHS 144-154)	2	
		Yellow group (RHS 3-13, 22)	3	
		Greyed group (RHS 160-182, 184, 199)	4	
		Brown group (RHS 200)	5	
		Purple group (RHS 59-65, 77)	6	
11.	Internode: Colour (Not exposed to sun)	Green (RHS 138-143)	1	270-300
		Green yellow (RHS 1)	2	
		Green white (RHS 157)	3	
		Yellow (RHS 2-11)	4	
		Yellow green (RHS 145 - 154)	5	
		Yellow white (RHS 158)	6	
		Orange white (RHS 159)	7	
		Greyed green (RHS 193)	8	
		Greyed yellow (RHS 160)	9	
12.	Internode: Split/growth crack	Absent	1	270-300
		Present	9	
13.	Internode: Alignment	Straight	1	270-300
		Zigzag	9	
14.	Internode: Appearance (rind surface)	Smooth	1	270-300
		Corky patches only	2	
		Ivory marks only	3	
		Corky patches and ivory marks present	4	
15.	Internode: Pithiness	Absent	1	300-360
		Present	9	
16.	Internode: Waxiness	Absent	1	270-300
		Light	3	
		Medium	5	
		Heavy	7	

SI No.	Characteristic	State	Note	Stage of observation (days)
17.	Node: Width of root band	Narrow (< 6mm) Medium (6-8mm) Broad (> 8mm)	3 5 7	270-300
18.	Node: Bud shape	Triangular-pointed Oval Obovate, Pentagonal, Rhomboid, Round Ovate Rectangular Beaked	1 2 3 4 5 6 7 8 9	270-300
19.	Node: Bud prominence	Flat Bulging	1 9	270-300
20.	Node: Depth of bud groove	Absent Shallow Medium Deep	1 3 4 5	270-300
21.	Node: Size of bud (Measured from base of bud to the tip)	Small (6 mm or less), Medium (6-9 mm), Large (9 mm or more)	3 5 7	270-300
22.	Node: Bud tip position in relation to growth ring	Clearly below growth ring Touching the ring Clearly above growth ring	1 3 5	270-300
23.	Node: Pubescence on the bud	Absent Present	1 9	270-300
24.	Node: Bud cushion (Space between bud base and leaf scar)	Absent Present	1 9	270-300
25.	Node: Growth ring appearance	Weak (Not swollen) Strong (Swollen)	1 9	270-300
26.	Node: Root primordial arrangement	One row Two rows Three rows Four rows Irregular	1 2 3 4 5	
27.	Leaf sheath: Number of hairs (groups 57)	Absent Few Many	1 3 5	210-240
28.	Leaf sheath: Distribution of hairs	Absent Only dorsal Lateral and dorsal	1 3 5	210-240
29.	Leaf sheath: Shape of ligule	Strap-shaped Deltoid Crescent-shaped Bow-shaped	1 2 3 4	210-240
30.	Leaf sheath: Shape of inner auricle	Sloping transitional Straight transitional Ascending transitional Deltoid Dentoid Unciform Calciform lanceolate Falcate	1 2 3 4 5 6 7 8 9	210-240
31.	Leaf sheath: Shape of outer auricle	Sloping transitional Straight transitional Ascending transitional Deltoid Dentoid Unciform	1 2 3 4 5 6	210-240

SI No.	Characteristic	State	Note	Stage of observation (days)
		Calcareform lanceolate Falcate	7 8 9	
32.	Leaf sheath: Colour of dewlap	Greenish-yellow Yellow Yellowish-green Brown Purple	1 2 3 4 5	210-240
33.	Leaf blade: Curvature	Erect to tip Curved near tip Bent near tip Curved near middle	1 2 3 4	210-240
34.	Leaf blade: width at the longitudinal midpoint	Narrow (< 3.0 cm) Medium (3.0-5.0 cm) Broad (>5.0 cm)	3 5 7	210-240
35.	Leaf blade: Serration of margin	Absent Present	1 9	210-240
36.	Cane top: Waxiness	Absent Weak Medium Strong	1 3 4 5	210-240
37.	Special feature: (If any)	-	-	-

10.5.4. Molecular characterization

DNA extraction: Total genomic DNA of 51 sugarcane genotypes were extracted from shoot apical meristems as per the method described by Aljanabi *et al.* (1999) with some modification. DNA of each genotype was quantified using spectrophotometer and quality were judge by running the DNA in 1 percent agarose gel with known standards. All the DNA samples were diluted uniformly to have a final concentration of 20ng/ μ l.

SSR analysis: Screening of polymorphic SSR primer pairs were practiced. For PCR amplification, a final volume of 20 μ l are used containing: 5 μ l of genomic DNA (20ng/ μ l), 2 μ l of 10X enzyme buffer, 2.4 μ l of MgCl₂ (25mM), 0.4 μ l of dNTP (10mM), 0.1 μ l of Taq DNA polymerase (5U/ μ l) and 0.5 μ l of both forward and reverse primer (10 μ M). All PCR reactions were performed on thermal cycler with PCR profile: Initial denaturation at 94°C for 4 minutes, followed by 34 cycles each of which consisted of 2 minutes denaturation at 94°C, 2 minutes annealing at respective annealing temperature and 1 minute extension at 72°C, then a final extension at 72°C for 5 minutes. The amplified products were then mixed with equal volume of loading dye, denatured at 95°C for 5 minutes and 3.6 μ l were run on a denaturing 5% polyacrylamide (20:1) gel with 1x TBE buffer at 70W (100mA). Electrophoresis times varied according to size and act of different primers amplified fragment accordingly (2-3 hrs). Then the gel was stained with silver nitrate followed by visual observation on light tray.

10.6. Bangladesh Institute of Nuclear Agriculture

10.6.1. Germplasm Collection

BINA was assigned to collect local rice, oilseeds, pulses, spices and vegetables germplasm from Mymensingh, Tangail and Sylhet regions (Fig. 27 & 28). Germplasm were collected from farmer's field, farm house, seed market and NGO. Eleven teams such as MM, SB, F, ST, M, MI, SA, H, MK, I and A were formed comprising one member in each team. Each expedition was conducted for 1- 4 days. The teams were equipped with ice box, plastic carton, GPS, compass, digital camera, hand lens, envelope, knife, scissors, drying sheet, pencil, stapler etc. Germplasm of target crops were collected from farmers' field/farm store/threshing floor and market especially from floating seed traders. Targeted farmers for collection of specific germplasm were located with the help of field level worker of the Department of Agricultural Extension (DAE) and direct contact. Collector's name, number and date were recorded during collection. Name of crop species along with English, Bangla, local and cultivar name were recorded. Name of donor with ethnic group, village, union, upazila/thana, district, latitude and longitude were noted. Type of soil, topography, sample status, sample source, habitat, frequency, type of materials, cultural practices, season, sole or mixed with, sample type, sampling method, insect and disease, agronomic score and plant characteristics were noted. A 'Passport Data Form' having passport information was filled up during germplasm collection. The samples were registered in conservation book immediately after collection and conserved in short term conservation storage of following appropriate procedure.



Fig. 27. Bangladesh GIS map showing Sub-project Areas

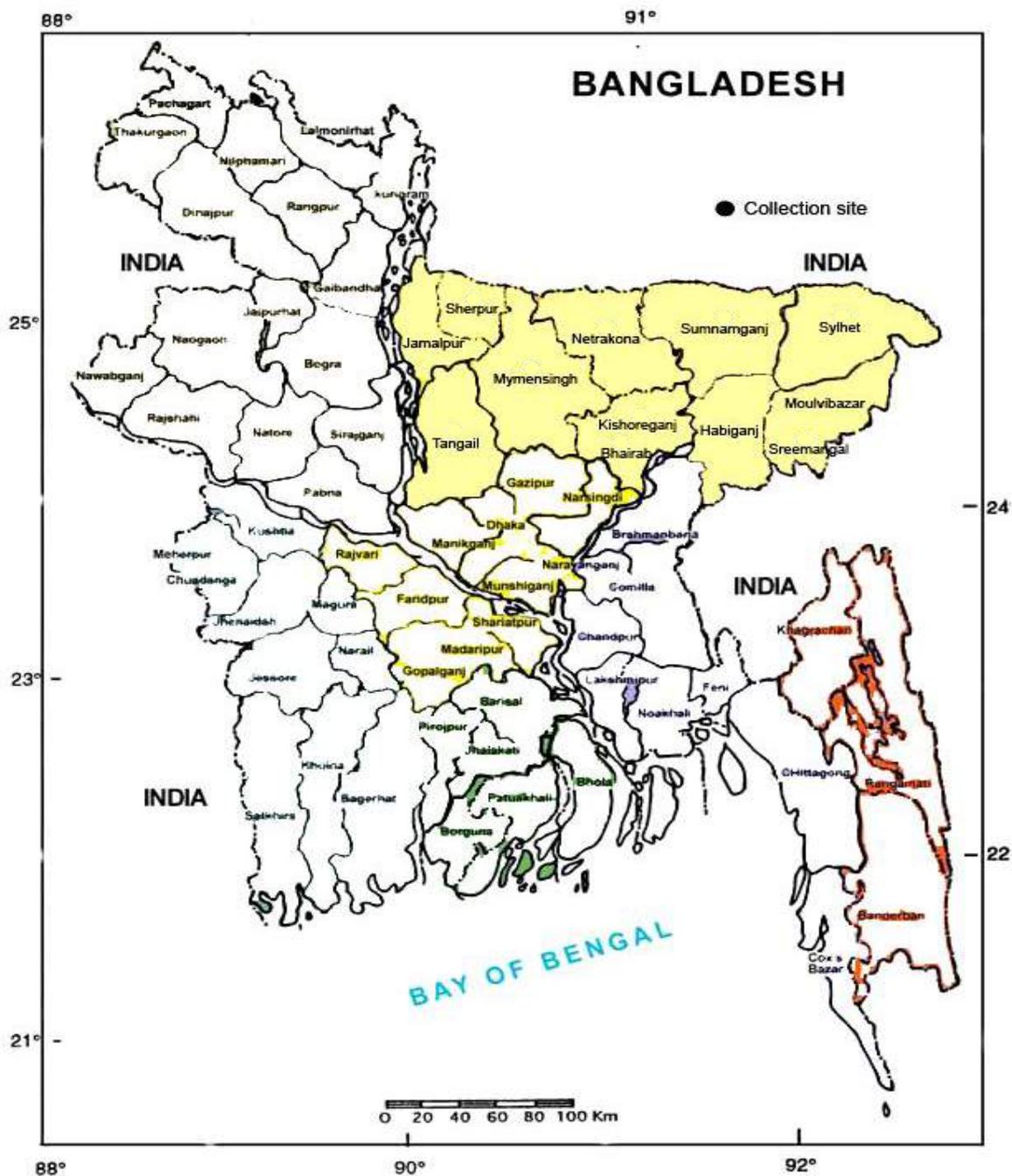


Fig. 28. Bangladesh GIS map showing targeted areas to be explored for germplasm collection

10.6.2. Morphological Characterization

A total of 143 germplasm of different crops have been characterized at morphological level during February 2018 to December 2020. Seventy three rice germplasm, five chilli, 33 peanut, 30 sesame and 2 bitter ground germplasm have been characterized during the period of 2018 to 2020.

10.6.2.1. Morphological characterization of local landraces of *Aman* rice collected from Mymensingh region during 2018:

The experiment was carried out during the period from July to December 2018. In this study, 31 rice germplasm were used as plant materials. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Unit plot size was 2m× 3m. The seeds were soaked in water for 24 hours. Then it was incubated in moist cloth sacks for 48 hours for quick germination. The pre-germinated seeds were sown in seedbed on 5 July, 2018. When the seedlings were 25 day old, one seedling hill⁻¹ was transplanted to the main plot on 01 August, 2018. Spacing between hills and rows were 15 and 20 cm, respectively. Basal dose of TSP and MP at the rate of 45kg and 25kg per hectare was applied. After transplanting the recommended dose of Urea (160kg/ha) was top dressed at three growth stages of rice. Irrigation and drainage were done as per requirement. The crop was kept weed free throughout the growth period. Insects and fungal attacks were negligible. Different germplasm attained their maturity at different times. Harvesting was done when 80% of the plant population of each plot reached to maturity and harvesting was done from 21 November to 08 December, 2018. Data of rice germplasm were recorded according to the “Rice Germplasm Descriptors and Evaluation Form” (BRRI-2018). The germplasm were agro-morphologically characterized on the basis of 31 qualitative and 10 quantitative traits of rice as per “Descriptors and descriptor states of characterization for Rice”.

Descriptors and descriptor states of characterization for Rice

Qualitative descriptor (31)

1. Blade pubescence: 1 = glabrous, 2 = Intermediate and 3= pubescent.
2. Blade colour: 1 = pale green, 2 = green, 3 = dark green, 4 = purple tips, 5 = purple margins, 6 = purple blotch and 7 = purple
3. Leaf sheath anthocyanin colour: 1 = absent and 9 = Present.
4. Basal leaf sheath colour: 1 = green, 2 = purple lines 3 = light purple and 4 = purple.
5. Leaf angle: 1 = erect, 5 = horizontal and 9 = drooping
6. Flag leaf angle: 1 = erect, 3 = semi erect, 5 = horizontal and 7 = descending.
7. Ligule colour: 1 = white, 2 = purple line and 3 = purple.
8. Ligule shape: 1 = acute to acuminate, 2 = 2-cleft and 3 = truncate.
9. Collar colour: 1 = pale green, 2 = green and 3 = purple.
10. Auricle colour: 1 = pale green and 2 = purple.
11. Culm anthocyanin colour: 1 = absent and 9 = present.
12. Culm angle: 1 = erect, 3 = intermediate, 5 = open, 7 = spreading and 9 = procumbent.
13. Internode colour: 1 = green, 2 = light gold, 3 = purple lines and 4 = purple.
14. Culm strength: 1 = strong, 3 = moderately strong, 5 = intermediate, 7 = weak and 9 = very weak.
15. Panicle type: 1 = compact, 5 = intermediate and 9 = open.
16. Secondary branching: 0 = absent, 1 = light, 2 = heavy and 3 = clustered.
17. Panicle exertion: 1 = enclosed, 3 = partly exerted, 5 = just exerted, 7 = moderately well exerted and 9 = well exerted.
18. Panicle axis: 1 = straight and 2 = droopy.
19. Shattering: 1= very low 3 = low, 5 = moderate, 7 = high and 9 = very high.

20. Threshability: 1 = difficult, 3 = moderately difficult, 5 = intermediate, 7 = loose and 9 = easy.
21. Awn distribution: 0 = none (awnless), 1 = tip only, 2 = upper quarter only, 3 = upper half only, 4 = upper three-quarters only and 5 = whole length.
22. Awn color: 1 = straw, 2 = gold, 3 = brown (tawny), 4 = red, 5 = purple and 6 = black.
23. Apiculus colour: 1 = white, 2 = straw, 3 = brown (tawny), 4 = green, 5 = red, 6 = red apex, 7 = purple, 8 = purple apex and 9 = black.
24. Stigma colour: 1 = white, 2 = light green, 3 = yellow, 4 = light purple and 5 = purple.
25. Lemma and palea colour: 0 = straw, 1 = gold and gold furrows on straw background, 2 = brown spots on straw, 3 = brown furrows on straw, 4 = brown (tawny), 5 = reddish to light purple, 6 = purple spots on straw, 7 = purple furrows on straw, 8 = purple, 9 = black and 10 = white.
26. Lemma and palea pubescence: 1 = glabrous, 2 = hairs on lemma keel, 3 = hairs on upper portion, 4 = short hairs and 5 = long hairs (velvety).
27. Sterile lemma colour: 1 = straw, 2 = gold, 3 = red and 4 = purple.
28. Seed coat (bran) colour: 1 = white, 2 = light brown, 3 = speckled brown, 4 = brown, 5 = red, 6 = variable purple and 7 = purple.
29. Endosperm type: 1 = non-glutinous (non-waxy), 2 = glutinous (waxy) and 3 = indeterminate.
30. Decorticated grain scent (aroma): 0 = non-scented, 1 = lightly scented and 2 = scented.
31. Leaf senescence: 1 = very early, 3 = early, 5 = intermediate (one leaf still green at harvest), 7 = late and slow and 9 = very late.

Quantitative descriptor (21)

1. Seedling height (cm): Mean length of 15 randomly selected seedlings was measured at 5- leaf stage, approximately 20-25 days after seeding.
2. Ligule length (mm): Mean length of 15 randomly selected ligules was measured after anthesis.
3. Leaf blade length (cm): Mean length of 15 randomly selected leaf blades was measured at early reproductive stage.
4. Leaf blade width (cm): Mean width of 15 randomly selected leaf blades was measured at early reproductive stage.
5. Culm diameter (mm): Mean diameter of 15 randomly selected culms (from mother tillers in the lowest internode) was measured at reproductive stage.
6. Total tiller number: Mean tiller number of 15 randomly selected hills was measured after flowering.
7. Effective tiller number: Mean number of effective tiller was measured on 15 randomly selected hills at early ripening stage.
8. Culm length (cm): Mean length of 15 randomly selected culms was measured after flowering,
9. Panicle length (cm): Mean length of 15 randomly selected Panicles was measured at dough stage.
10. Plant height (cm): Addition of the mean of culm length and panicle length.

11. Days to 50% flowering: Number of days required from seeding days to 50% opening of the flowers.
12. Days to maturity: Number of days required from seeding to days of 80% panicle matured.
13. Number of filled grain per panicle: Mean number of filled grain/panicle was measured on 15 panicles.
14. Number of unfilled grain per panicle: Mean number of unfilled grain/panicle was measured on 15 panicles.
15. 1000 grain weight (g): Mean weight of 1000 randomly selected seeds (grains) was measured after sun drying.
16. Grain length (mm): Mean length of 15 randomly selected grains was measured after sun drying.
17. Grain width (mm): Mean width of 15 randomly selected grains was measured after sun drying.
18. Decorticated grain length (mm): Mean length of 15 randomly selected dehulling grains was measured before milling.
19. Decorticated grain width (mm): Mean width of 15 randomly selected dehulling grains was measured before milling.
20. Decorticated grain L/W ratio: Mean length and width ratio of 15 randomly selected de-hulled grains.
21. Yield (g/hill): Mean weight of grains of 10 randomly selected hills after threshing and drying (at 14% moisture content).

10.6.2.2. Morphological Characterization of rice landraces during Aman 2019 season

The experiment was carried out during the period from July to December 2019. In this study, 42 rice germplasm were used as plant materials. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Unit plot size was 2m× 3m. The seeds were soaked in water for 24 hours. Then it was incubated in moist cloth sacks for 48 hours for quick germination. The pre-germinated seeds were sown in seedbed on 14 July, 2019. When the seedlings were 25 days old, one seedling hill⁻¹ was transplanted to the main plot on 09 August, 2019. Spacing between hills and rows were 15 and 20 cm, respectively. Basal dose of TSP and MP at the rate of 45kg and 25kg per hectare was applied. After transplanting, the recommended dose of Urea, 160 kg per hectare was top dressed at three growth stages of rice. Irrigation and drainage were done as per requirement. The crop was kept weed free throughout the growth period. Insects and fungal attacks were negligible. Different germplasm attained their maturity at different times. Harvesting was done when 80% of the plant population of each plot reached to maturity and harvesting was done from 20 October to 05 November, 2019. The experimental plots were visited frequently and as per schedule, required data were collected. A data record book was used for keeping records of data related to the identification of the germplasm. Data on 31 qualitative and 10 quantitative traits were recorded on individual plant basis from 5 randomly selected plants as per BRR descriptor (2018).

10.6.2.3. Morphological characterization of chilli germplasm

A total of 5 local chilli germplasm have been characterized at morphological level during winter 2018-19 season. The genetically pure and physically healthy seeds of these germplasm were collected from the Horticulture Division, BINA. They have collected these germplasm from local area of Mymensingh. The experiment was set at BINA Head

Quarters Farm, Mymensingh. Data were recorded from experimental field according to IBPGR (1995) descriptor and evaluation form. Out of 63 observations, 43 qualitative and 20 quantitative characters were recorded. The seed beds were prepared by mixing vermicompost. Seeds were sown on 28 September 2018 in separate bed uniformly at a depth of 2-3 cm. Out of forty two-days old uniform growth and healthy seedlings were transplanted on 10 November 2018 in the pots at the evening and immediately after transplanting light irrigation were given. The pots were 17 cm × 30 cm with small holes to drain excess water. After transplanting subsequent irrigations were provided as and when required for growth and development of plants. Three random competitive plants per variety were selected; tagged and recorded data for quantitative and qualitative characters.

Descriptors and descriptor states of characterization for Chilli

A. Qualitative descriptor

1. Hypocotyl colour: 1 = White, 2 = Green and 3 = Purple
2. Hypocotyl pubescence: 3 = Sparse, 5 = Intermediate and 7 = Dense
3. Cotyledonous leaf colour: 1 = Light green, 2 = Green, 3 = Dark green, 4 = Light purple, 5 = Purple, 6 = Dark purple, 7 = Variegated, 8 = Yellow and 9 = Other
4. Cotyledonous leaf shape: 1 = Deltoid, 2 = Ovate, 3 = Lanceolate and 4 = Elong-deltoid
5. Stem colour: 1 = Green, 2 = Green with purple stripes, 3 = Purple and 4 = Other
6. Nodanthocyanin (whole plant): 1 = Green, 3 = Light purple, 5 = Purple and 7 = Dark purple
7. Stem shape: 1 = Cylindrical, 2 = Angled and 3 = Flattened
8. Stem pubescence: 3 = Sparse, 5 = Intermediate and 7 = Dense
9. Plant growth habit: 3 = Prostrate, 5 = Intermediate (compact), 7 = Erect, and 9 = Other
10. Branching habit: 3 = Sparse, 5 = Intermediate, 7 = Dense
11. Tillering: 3 = Sparse, 5 = Intermediate and 7 = Dense
12. Leaf density: 3 = Sparse, 5 = Intermediate and 7 = Dense
13. Leaf colour: 1 = Yellow, 2 = Light green, 3 = Green, 4 = Dark green, 5 = Light purple, 6 = Purple, 7 = Variegated and 8 = Other
14. Leaf shape: 1 = Deltoid, 2 = Ovate and 3 = Lanceolate
15. Lamina margin: 1 = Entire, 2 = Undulate and 3 = Ciliate
16. Leaf pubescence 3 = Sparse, 5 = Intermediate and 7 = Dense
17. Days to flowering: Number of days from sowing/transplanting until 50% of plants has at least one open flower
18. Number of flowers per axil: 1 = One, 2 = Two, 3 = Three or more and 4 = Many
19. Flower position: 3 = Pendant, 5 = Intermediate, 7 = Erect
20. Corolla colour: 1 = White, 2 = Light yellow, 3 = Yellow, 4 = Yellow-green, 5 = Purple with white base, 6 = White with purple base, 7 = White with purple margin, 8 = Purple and 9 = Other
21. Corolla spot colour: 1 = White, 2 = Yellow, 3 = Green-yellow, 4 = Green, 5 = Purple and 6 = Other
22. Corolla shape: 1 = Rotate, 2 = Campanulate and 3 = Other
23. Anther colour: 1 = White, 2 = Yellow, 3 = Pale blue, 4 = Blue, 5 = Purple and 6 = Other

24. Filament colour: 1 = White, 2 = Yellow, 3 = Green, 4 = Blue, 5 = Light purple, 6 = Purple and 7 = Other
25. Stigma exertion: 3 = Inserted, 5 = Same level and 7 = Exserted
26. Male sterility: 0 = absent and 1 = Present
27. Calyx Pigmentation: 0 = Absent and 1 = Present
28. Calyx margin: 1 = Entire, 2 = Intermediate, 3 = Dentate and 4 = Other
29. Calyx annular constriction: 0 = Absent and 1 = Present
30. Anthocyanin spots or stripes: 0 = Absent and 1 = Present
31. Fruit colour at intermediate stage: 1 = White, 2 = Yellow, 3 = Green, 4 = Orange, 5 = Purple, 6 = Deep purple and 7 = other
32. Fruit set: 3 = Low, 5 = Intermediate and 7 = High
33. Fruit colour at mature stage: 1 = White, 2 = Lemon-yellow, 3 = Pale orange-yellow, 4 = Orange-yellow, 5 = Pale orange, 6 = Orange, 7 = Light red, 8 = Red, 9 = Dark red, 10 = Purple, 11 = Brown, 12 = Black and 13 = Other
34. Fruit shape: 1 = Elongate, 2 = Almost round, 3 = Triangular, 4 = Campanulate, 5 = Blocky and 6 = Other.
35. Fruit shape at pedicel attachment: 1 = Acute, 2 = Obtuse, 3 = Truncate, 4 = Cordate and 5 = Lobate
36. Neck at base of fruit: 0 = absent and 1 = Present
37. Fruit shape at blossom end: Average of 10 fruits. 1 = Pointed, 2 = Blunt, 3 = Sunken, 4 = Sunken and pointed and 5 = other
38. Fruit blossom end appendage: 0 = absent and 1 = Present
39. Fruit cross-sectional corrugation: 3 = Slightly corrugated, 5 = Intermediate and 7 = Corrugated
40. Fruit surface: 1 = Smooth, 2 = Semiwrinkled and 3 = Wrinkled
41. Seed colour: 1 = Straw (deep yellow), 2 = Brown, 3 = Black and 4 = others
42. Seed surface: 1 = Smooth, 2 = Rough and 3 = Wrinkled
43. Seed size: 3 = Small, 5 = Intermediate and 7 = Large

B. Quantitative descriptor

1. Cotyledonous leaf length (mm): Average of 10 cotyledonous leaves
2. Cotyledonous leaf width (mm): Average of 10 cotyledonous leaves
3. Plant height (cm): Recorded when in 50% of the plants the first fruit has begun to ripen. 1 = <25, 2 = 25-45, 3 = 46-65, 4 = 66-85 and 5 = >85
4. Plant canopy width (cm): Measured immediately after first harvest, at the widest point
5. Stem length (cm): Height to first bifurcation. Measured immediately after first harvest
6. Stem diameter (cm): Measured in the middle part to first bifurcation, immediately after first harvest
7. Mature leaf length (cm):
8. Mature leaf width (cm): Measured on the widest part of the leaf
9. Days to flowering: Number of days from sowing/transplanting until 50% of plants have at least one open flower

10. Corolla length (cm): Average of 10 petals of dissected corolla. 1 = <15, 2 = 1.5-2.5, 3 = >25
11. Anther length (mm): Average anther length of 10 representative flowers selected from different plants. Observed immediately at anthesis
12. Filament length (mm): Average filament length of 10 representative flowers selected from different plants. Observed immediately at anthesis
13. Days to fruiting : Number of days from transplanting until 50% of the plants bear mature fruits at the first and second bifurcation
14. Fruit bearing period (d): Number of days from first fruit set to last fruit formation
15. Fruit length (cm): Average fruit length of 10 ripe fruits of the second harvest
16. Fruit width (cm): Measured at the widest point. Average fruit width of 10 ripe fruits of the second harvest
17. Fruit weight (g): Average fruit weight of 10 ripe fruits of the second harvest
18. Seed diameter (mm): The maximum diameter of 10 seeds to two decimal places
19. 1000 seed weight (g)
20. Number of seeds per fruit: Average of at least 10 fruits selected from 10 random plants 1 = <20, 2 = 20-50 and 3 =>50

10.6.2.4. Morphological characterization of bitter gourd germplasm

Characterization of two germplasm of bitter gourd is being evaluated in this rabi season 2018. The purity and germination percentage were determined as 100 and 80, respectively. The genetically pure and physically healthy seeds of these germplasm were collected from the Horticulture Division, BINA. They have collected these germplasm from local area of Mymensingh. Seeds were sown in the plastic pot and healthy and vigorous seedlings of one month old were selected for transplanting in the main land. The seedlings were removed carefully from the small plastic pots by avoiding any injuries and were sown one seedling per pit in the evening time. Slight watering was provided after transplantation. Mechanical support was provided to the growing plants by dhaincha sticks to keep them erect and support the plant before flowering. The vines were tied with thin rope with the dhaincha sticks. A bamboo pandal (macha) was then prepared and allowed the vine to creep on the pandal. Fruits were picked on the basis of maturity, size, colour and age being determined for the purpose of consumption as the fruit grew rapidly and soon get beyond the marketable stage, frequent picking was done throughout the harvesting period. Fruits were picked with sharp knife and care was taken to avoid injury of the vine. Now the plants of bitter gourd are in harvesting stage. Data were recorded following IBPGR descriptors for bitter gourd.

10.6.2.5. Characterization of sesame germplasm

An experiment was conducted on Sesame at Genetic and Pant Breeding Experimental field of Bangladesh Agricultural University (BAU), Mymensingh, during March 2020 to July 2020. In this study, 30 sesame germplasm including three BINA varieties Binatil-2, Binatil-3 and Binatil-4 and two landraces Kalotil and Sadatil were used as plant materials. The germplasm were collected from Plant Genetic Resources Centre (PGRC), BARI, Joydebpur, Gazipur. Three sesame varieties of BINA and two landraces have collected from Plant Breeding Division, BINA, Mymensingh.

Thirty-eight observations on qualitative (22) and quantitative (16) characters were recorded as per Descriptors for Sesame (*Sesamum indicum*), the International Plant Genetic Resources Institute (IPGRI), 1985.

Descriptors and descriptor states of characterization for sesame

A. Qualitative descriptor

1. Plant growth type: 1 = Indeterminate and 2 = Determinate
2. Plant growth habit: 1 = Prostrate, 2 = Semi-erect and 3 = Erect
3. Stem hairiness: 0 = Glabrous, 3 = Weak, 5 = Medium and 7 = Strong
4. Branching pattern : 0 = Non branching, 1 = Basal branching, 2 = Top branching and 3 = Others
5. Leaf color: 1 = green, 2 = green with yellowish cast, : 3 = green with blue-grey cast, 5 = green with purple cast and 99 = Others
6. Leaf hairiness: 0 = Glabrous (hair absent), 3 = Weak or sparse, 5 = Medium, and 7 = Strong or profuse
7. Leaf shape: 1 = Linear, 2 = Lanceolate, 3 = Elliptic, 4 = Ovate, 5 = Narrowly cordate, 99 = Other
8. Basal leaf margin : 1 = Entire, 2 = Serrate, 3 = Dentate
9. Lobe incision of basal leaf : 0 = Absent (leaf entire), 3 = Weak and 5 = Medium
10. Leaf angle to main stem: 1 = Acute (<90°), 2 = Horizontal (90°), 3 = Drooping (>90°)
11. Petiole Color: 1 = Green, 2 = Greenish purple, 3 =Purple, 4 = Pink and 99 = Other
12. Petiole hairiness : 0 = Glabrous (hair absent), 3 = Weak or sparse, 5 = Medium and 7 = Strong or profuse
13. Number of flowers per axil : 1 = One and 2 = More than one
14. Extra floral nectar development : 1 = Rudimentary, 2 = Small, 3 = Medium and 4 = Large
15. Number of locules per capsule: 1 = Four, 2 = Six and 3 = Eight
16. Bicarpellate capsule shape: 1 = Tapered at apex, 2 = Narrow oblong, 3 = Broad oblong, 4 = Square
17. Capsule arrangement : 1 = Monocapsular and 2 = Multicapsular
18. Capsule hairiness : 0 = Glabrous (hair absent), 3 = Weak or sparse, 5 = Medium, 7 = Strong or profuse
19. Shape of capsule hair: 1 = Short and straight, 2 = Medium and straight, 3 = Long and bent
20. Colour of dry capsules : 1 = Green, 2 = Straw/yellow, 3 = Brown/tan and 4 =Purple
21. Type of capsule beak : 1 = Short, 2 = Long, 3 = Curved, 4 = Cleft and 99 = Other
22. Seed coat colour : 1 = White, 2 = Cream, 3 = Beige, 4 = Light brown, 5 = Medium brown, 6 = Dark brown, 7 = Brick red, 8 = Tan, 9 = Olive, 10 = Grey, 11 = Dull black, 12 = Bright black and 99 = Other

B. Quantitative descriptor of sesame

1. Plant height (cm): Measured at flower initiation on the main stem from the ground level up to the apex
2. Number of primary branches
3. Internodes length (cm): Measured as an average of 10 internode distances on the same stalk, with five replicate branches from the same plant
4. Length of basal leaf (cm): Mean length of five leaves from the basal portion of the main stem
5. Width of basal leaf (cm): Mean width of five leaves from the basal portion of the main stem
6. Length of top leaf (cm): Mean length of five leaves from the top of the main stem
7. Width of top leaf (cm): Mean width measured at the widest point of five leaves from the top of the main stem (five cm below the apex)
8. Petiole length of basal leaf (cm): Mean of five leaves from the basal portion of the main stem
9. Petiole length of top leaf (cm): Mean of five leaves from the top of the main stem
10. Days to 50% flowering : Number of days from sowing or first irrigation until 50% of the plants in a row initiate flowering
11. Number of capsules per plant : Mean of five randomly selected plants
12. Mean capsule length (mm): Measured on five randomly selected capsules from the middle of main stem, each from a different plant at physiological maturity
13. Mean capsule width (mm): Measured on five randomly selected capsules from the middle of main stem, each from a different plant at physiological maturity
14. Seeds per capsule : Mean number of seeds from five randomly selected capsules from five different plants taken from the middle of the main stem
15. 100-seed weight (g): Weight in grams of 100 random seeds taken from the bulk harvest
16. Seed yield per plant (g): Average seed yield from five randomly selected plants

10.6.2.6. Characterization of peanut germplasm

An experiment was conducted on peanut at Agronomy Experimental field of Bangladesh Agricultural University (BAU), Mymensingh, during March 2020 to July 2020. In this study, 33 peanut germplasm including one BINA variety Binachinabadam-4, and one BARI variety BARIbadam-9 were used as plant materials. The germplasm were collected from Oilseed Research Centre (ORC), BARI, Joydebpur, Gazipur. Two peanut varieties of BINA and BARI were collected from Plant Breeding Division, BINA, Mymensingh. Twenty five observations on qualitative (16) and quantitative (9) characters were recorded as per Descriptors for peanut (*Arachis hypogaea*), the International Plant Genetic Resources Institute (IPGRI), 1985.

Descriptors and descriptor states of characterization for groundnut

A. Qualitative descriptor

1. Plant growth habit: 1 = Procumbent-1, 2 = Procumbent-2, 3 = Decumbent-1, 4 = Dcumbent-2, 5 = Procumbent-3 and 6= Erect
2. Branching pattern: 1 = Alternate, 2= Sequential, 3 = Irregular with flowers on main stem, 4 = Irregular without flowers on main stem and 5 = others
3. Stem pigmentation: 0 = Absent and 1 = Present
4. Stem surface: 1 = Glabrous, 3 = Sub-glabrous, 5 = moderately hairy, 7 = Very hairy and 9 = Woolly
5. Peg pigmentation: 0 = Absent and 1 = present
6. Leaf color : 1 = yellow/yellow green, 2 = Light green, 3 = Green, 4 = Dark green, 5 = Bluish green and 6 = others
7. Leaflet shape: 1 = Cuneate, 2 = Obcuneate, 3 = Elliptic, 4 = Oblong-elliptic, 5 = Narrow-elliptic, 6 = wide-elliptic, 7 = Suborbicular, 8 = orbicular, 9 = ovate, 10 = Obovate, 11 = Oblong, 12 = Oblong–lanceolate, 13 = Lanceolate, 14 = linear-lanceolate and 15 = Others
8. Leaflet surface: 1 = Almost glabrous on both surface), 2 = Almost glabrous above, hairs below, 3 = Almost glabrous above hairs and/or bristles below, 4 = Almost glabrous below, hairs above, 5= Almost glabrous below, hairs and bristles above, 6 = Hairs on both surfaces, without bristles 7 = Hairs on both surfaces, with bristles at least on one surface, 8= Woolly without bristles , 9 = Woolly with bristles at least on one surface and 10 = Others
9. Leaflet margin: 1 = Entire, 2 = Hairy, 3 = Wavy and 4 = Others
10. Leaflet tip: 1 = Obtuse, 2 = Acute, 3 = Mucronate and 4 = others
11. Number of seeds per pod: 1 = 2-1, 2= 2-3-1/2-1-3, 3= 3-2-1/3-1-2 and 10 = Others
12. Pod beak: 0= Absent, 1 = Slight, 5 = Moderate, 7 = Prominent and 9 = very prominent
13. Pod constriction: 0 = None, 3 = Slight, 5 = Moderate, 7 = Deep, 9 = very deep
14. Pod reticulation: 0 = None, 3 = Slight, 5 = Moderate, 7 = Prominent and 9 = very prominent
15. Seed color: 1 = One color and 2 = Variegated
16. Primary seed color: 1 = white, 2 = Off –white, 3 = Yellow, 4 = Very pale tan, 5 = Pale tan, 6 = Light tan, 7 = Tan, 8 = Dark tan, 9 = Greyed orange, 10 = rose, 11 = Salmon, 12 = Light red, 13 = Red, 14 = Dark red, 15 = Purplish red, 16 = Light purple, 17 = Purple, 18 = Dark purple, 19 = Very dark purple and 20 = Others

B. Quantitative descriptor

1. Height of main stem (cm): Measured from cotyledonary axil up to terminal bud, recorded 60-85 days after emergence
2. Plant width or spread (cm): Measured as widest point, from branch tip to tip. Recorded 45-60 days after emergence
3. Leaflet length (mm): Measured on the third leaf, apical leaflet, of the main stem when fully expanded
4. Leaflet width (mm): Measured on the third leaf, fully expanded apical leaflet, of the main stem. At its widest point

5. Pod length (mm): Mean of 10 mature pods
6. Pod width (mm): Mean of 10 mature pods measured at the widest point
7. Seed length (mm): Average of 10 mature seeds
8. Seed width (mm): Measured at the midpoint, average of 10 mature seeds
9. Yield/plant (g):

10.6.3. Genetic Diversity Analysis of Rice Landraces using SSR Markers

A total of 83 rice germplasm have been characterized at molecular level using SSR markers during February 2018 to November 2020. The molecular work was done at Molecular Laboratory of Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Total genomic DNA was extracted from young leaves of three-week-old plants following the simple and modified protocol of Zheng *et al.*, 1995. PCR analysis was performed in 12.5 µl reaction sample containing 5-25 ng of DNA template, 1.25 µl of MgCl₂ free 10X PCR buffer (100 mM Tris-HCl pH 9.0 at 25°C, 500 mM KCl, 0.1% Triton® X-100 and H₂O), 1.5 µl of 25 mM MgCl₂, 0.25 µl of 10mM dNTP, 0.25 µl of 5 U/µl Taq polymerase enzyme, 0.625 µl each of 10 µM forward and reverse primers using a MJ Research single 96-well thermal cycler. The mixture was overlaid with one drop of mineral oil to prevent evaporation. After initial denaturation for five minutes at 94°C, each cycle comprised one min denaturation at 94°C, one min annealing at 55°C, and two min extension at 72°C with a final extension for seven min at 72°C at the end of 35 cycles. The PCR products were mixed with bromophenol blue gel loading dye and were analyzed by electrophoresis on 8% polyacrylamide gel using mini vertical polyacrylamide gels for high throughput manual genotyping (CBS Scientific Co. Inc., CA, USA). 2.5 µl of amplification products were resolved by running gel in 1×TBE buffer for 2-2.5 hrs depending upon the allele size at around 75 volts and 180 mA current. The gels were stained in 0.5 mg/ml ethidium bromide and were documented using UVPRO (Uvipro Platinum, EU) gel documentation unit. Microsatellite or simple sequence repeat (SSR) markers were used for DNA analysis (Temnykh *et al.*, 2001; McCouch *et al.*, 2002).

10.6.4. Conservation

BINA had collected 199 germplasm of different crops during 2018-2020. Collected germplasm were multiplied at BINA headquarter, Mymensingh in respective season (February 2018 to December 2020) and preserved in mid and short term storage room at BINA. After multiplication seeds of collected germplasm we carefully cleaned of each germplasm. Removal of any debris, and low quality, infested or infected seeds of a different species can also be considered. We processed collected or harvested germplasm material is as soon as possible to avoid unnecessary losses or decrease in longevity For Safe conservation demands, we had determined the germination percentage. After a sufficient number of good qualities for a given accession have been cleaned, dried, tested, and weighed or counted, the seeds will be placed in a container and hermetically sealed for subsequent storage. All the seeds of a given accession are packaged in one container, especially when large glass or metal containers are used; alternatively sub-samples, each adequately representing the genetic diversity of that accession for later use, are packaged in separate containers. The latter procedure has the advantage that the removal of one sub-sample will not affect the other sub-samples, and its removal is quick and easy, thus facilitating the use of the germplasm. If sub-samples are used, it must be decided whether sub-samples of the same accession are stored in both the base and active collections, which might have different storage conditions and locations.

11. Results and Discussion:

11.3. Bangladesh Agricultural Research Institute

11.3.1. Exploration and Collection of Plant Genetic Resources during January 2018 - December 2020

A total of 600 germplasm of 66 crops were collected from 69 upazilas of 30 districts (Fig. 29 and Table 27). Among them, 14 germplasm from cereals (barley, foxtail millet and wheat), 39 pulses (black gram, black pea, cowpea, field pea, grass pea, lentil, mung bean, pigeon pea and white pea), 26 oilseeds (linseed, mustard, safflower and sesame), 36 spices (black cumin, chilli, coriander, fennel, fenugreek, garlic, onion and turmeric), 455 vegetables (amabashashak, amaranth, ash gourd, babar shak, bitter gourd, bottle gourd, brinjal, chinese mellow, country bean, cucumber, french bean, indian spinach, jute leaf, kang kong, kidney bean, okra, potato, pumpkin, radish, red amaranth, ridge gourd, roselle, snake gourd, spinach, sponge gourd, sword bean, teasel gourd, turnip, yam and yard-long bean), 14 fruits (banana, custard apple, musk melon and papaya), 12 medicinal and 04 other germplasm (indigo and sesbania) (Table 27). Details of passport data with photograph of collected germplasm are presented in Table 28.

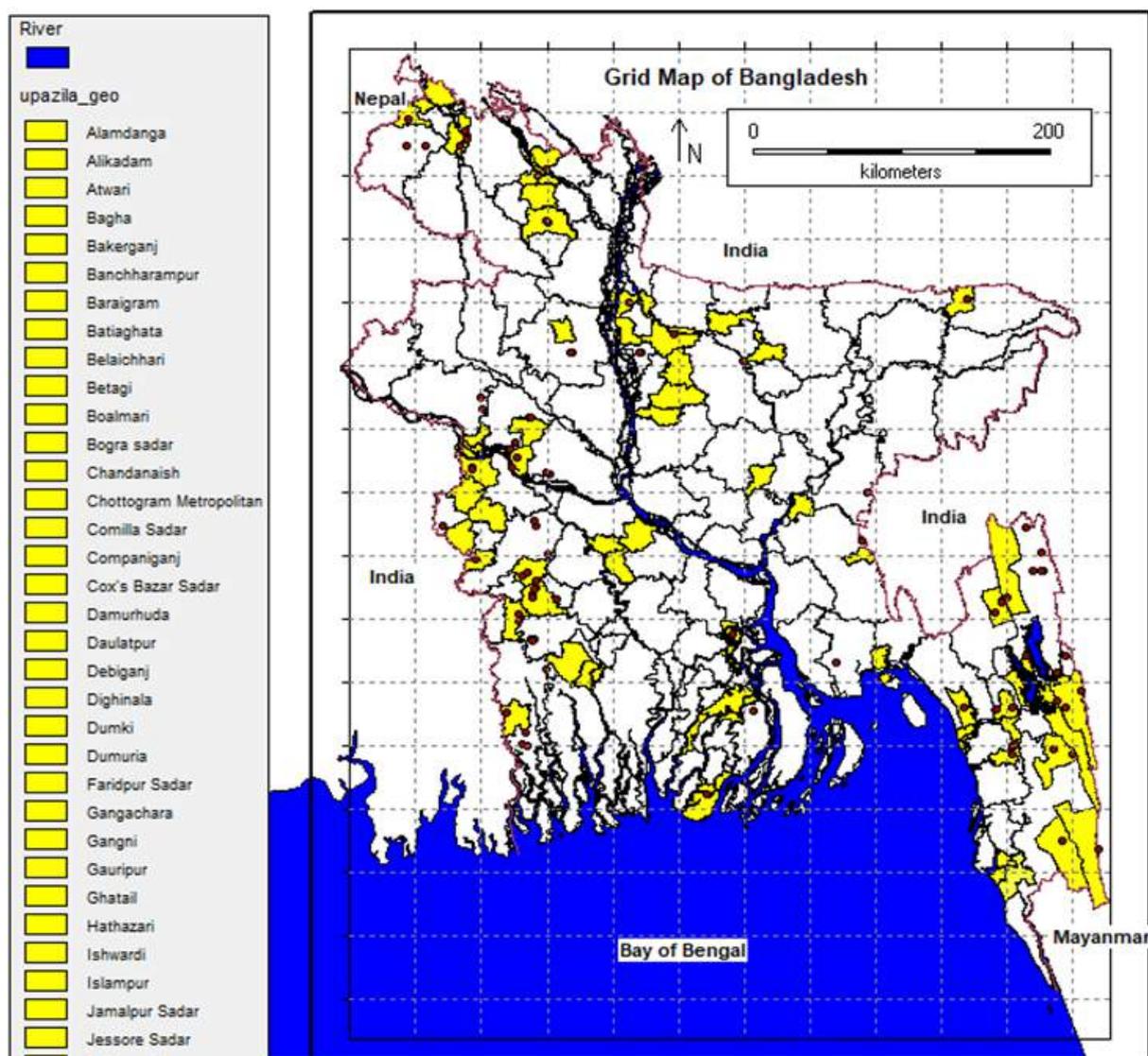


Fig. 29. Grid map of Bangladesh showing exploration sites

Table 27. Collection of germplasm from different districts in Bangladesh, January 2018 - December 2020

District*	No. of upazila explored	No. of germplasm collected							Total
		Cereal	Pulse	Oilseed	Vegetable	Spice	Fruit	Other	
Bandarban	3	5	2	2	48	5	4	2	68
Barishal	1		1		15			Medicinal =12 (from different locations)	16
Chattogram	6		1		61	3	4		69
Cox's Bazar	2		6		1				7
Cumilla	3				1				1
Faridpur	5	2	15	16	24	16	1	1	75
Jamalpur	3				36	1	2		39
Jashore	4				15				15
Jhinaidah	1				9		1		10
Khulna	5			1	16				17
Lalmonirhat	1				1				1
Mymensingh	1				1				1
Noakhali	2				3				3
Pabna	2			3	65		2		70
Panchagarh	2	2	1		24	3		1	31
Patuakhali	4		9	2	72	2			85
Satkhira	4	1	4		53	4			62
Thakurgao	2	4		2	10	2			18
Total	51	14	39	26	455	36	14	16	588+12

*Other explored districts but not mentioned in the table are: Borguna (1), Chuadanga (3), Khagrachari (2), Meherpur (2), Natore (2), Rangamati (3), Rangpur (2), Tangail (3).

Table 28. List of collected germplasm of different crops, January 2018 - December 2020

Sl. No.	Crop name	No. of germplasm	Sl. No.	Crop name	No. of germplasm
1	Different <i>shak</i>	6	18	Custard apple	2
2	Amaranth	30	19	Fennel	2
3	Ash gourd	19	20	Fenugreek	3
4	Taro	4	21	Field pea	5
5	Banana	1	22	Foxtail millet	6
6	Barley	1	23	French bean	6
7	Bitter gourd	12	24	Garlic	1
8	Black cumin	4	25	Grass pea	9
9	Black gram	2	26	Indian spinach	7
10	Black pea	1	27	Indigo	1
11	Bottle gourd	32	28	Jute leaf	4
12	Brinjal	76	29	Kangkong	4
13	Chinese mallow	5	30	Kidney bean	1
14	Coriander	11	31	Lentil	4
15	Country bean	75	32	Linseed	1
16	Cowpea	8	33	Mung bean	6
17	Cucumber	14	34	Musk melon	5

Table 28. Cont'd

Sl. No.	Crop name	No. of germplasm	Sl. No.	Crop name	No. of germplasm
35	Mustard	13	51	Spinach	14
36	Okra	16	52	Sponge gourd	16
37	Onion	2	53	Sword bean	3
38	Papaya	6	54	Teasle gourd	3
39	Pigeon pea	3	55	Turmeric	4
40	Potato	1	56	Turnip	1
41	Pumpkin	28	57	Wheat	1
42	Radish	6	58	White pea	1
43	Red amaranth	23	59	Yam	5
44	Red chilli	13	60	Yard long bean	24
45	Ridge gourd	13	61	Carrot	1
46	Roselle	1	62	Yam bean	1
47	Safflower	1	63	Broom corn	2
48	Sesame	7	64	Maize	3
49	Sesbania	1	65	Coffee	1
50	Snake gourd	7	66	Medicinal	12
Total = 600					

Table 29. Passport information of collected germplasm, January 2018 - December 2020

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Field pea (<i>Pisum sativum</i>)					
1	NRI-100	Motor Kalai/ Rainfed/ Rabi season	Name: Idris Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23 ⁰ 33'35.41" E-89 ⁰ 50'1.33" 11-04-2019	
2	NRI-180	Motor Kalai/ Rainfed/ Rabi season	Name: Sumon Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89049'3.84" 12-04-2019	
3	NRI-204	Motor Kalai/ Rainfed/ Rabi season	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23035'56.39" E-89046'41.84" 12-04-2019	
4	SNQR-5	Deshi motor/ Irrigated/ Rabi	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	

Table 29 (Cont'd)

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
5	SNQR-60	Motorsuti/ Irrigated/ Rabi	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
Amaranth (<i>Amaranthus gangeticus</i>)					
1	NRI-164	Danta/ Broadcast/ Thinning	Name: Md. Akter Mondol Village: Parchar Union: Pourosova, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23°35'21.34" E-89°46'48.02" 12-04-2019	
2	NRI-196	Danta/ Broadcast/ Thinning	Name: Md. Saidul Molla Village: Macchorkourpur Union: 6 no. Macchor Upazila: Faridpur Sadar District: Faridpur	N-23°36'33.49" E-89°46'37.84" 12-04-2019	
3	NRI-245	Danta Broadcast/ Irrigated	Name: Sahana Begum Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'05.9" E-91°047'27.9" 20-04-2019	
4	NRI-246	Lal maresh (Danta)/ Broadcast/ Irrigated	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°048'25.2" 21-04-2019	
5	NRI-247	Sadamaresh (Danta)/ Broadcast/ Thinning	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°048'25.2" 21-04-2019	
6	NRI-268	Danta/ Broadcast/ Irrigated	Name: Md. Palash Molla Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
7	NRI-269	Danta/ Broadcast/ Irrigated	Name: Md. Palash Molla Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
8	NRI-286	Danta/ Broadcast/ Irrigated	Name: Shelina Khatun Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
9	NQR-15	Danta/ Broadcast/ Irrigated	Name: Nazimuddin Village: Sikdar para Union: Sonahar Upazila: Debiganj District: Panchagarh	N-26.05165 E-88.72736 13-11-2019	
10	NQR-22	Danta/ Broadcast/ Irrigated	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
11	NQ-48	Datashak/ Broadcast/ Thinning	Name: Md. Abdur Rob Village: Giadhat Union: Haibatpur Upazila: Sadar District: Jashore	N-23°11'40.9" E-89°19'25.7" 02-10-2019	
12	NQ-77	Datashak/ Broadcast/ Thinning	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
13	NQ-82	Datashak/ Broadcast/ Thinning	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
14	MRI-11	Aman Daunga (Data)/ Aman season	Name: Nikhil Ch. Howlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
15	MRI-20	Aman Data/ Aman season	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
16	MRI-27	Data/ Broadcast/ Thinning	Name: Razvanu Village: Itbaria Union: Itbaria Upazila: Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
17	MRI-41	Data (Lal)/ Broadcast/ Thinning	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
18	MRI-44	Data (Lal & Sada)/ Broadcast/ Thinning	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
19	MRI-54	Then theinashak (Data)/ Broadcast/ Kharif-I & II	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
20	MRI-88	Data (Daunga)/ In field/ Irrigated	Name: Mst. Sweety Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
21	NRI-26	Data (Shada)/ Broadcast/ Thinning	Name: Sobita Mistri Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
22	NRI-40	Data (Local)/ Broadcast/ Thinning	Name: Md. Moksed Fakir Village: Teligati Union: KUET (Aronggatha) Upazila: Aronggatha District: Khulna	13 September 2018 N-22°53'56.88" E-89°29'52.23"	
23	N-228	Sada Data Shak/ Broadcast/ Thinning	Name: Md. Shofi Village: Kobutorhat Union: Hathazari Upazila: Hathazari District: Chottogram	30 October 2018 N-22°50' E-91°85'	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
24	NSR-39	Data/ Broadcast/ Thinning	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
25	SNQR-7	Chotrovogdanta / Irrigated/ Kharif I, II and Rabi	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhainadah	N-23.36522 E-89.14153 13-10-2020	
26	SNQR-33	Patabahar data shak/ Irrigated/ Kharif I, II and Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
27	SNQR-37	Altabat damoshak/ Irrigated/ Kharif I, II and Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
28	SNQR-47	Chotrovongo data shak/ Irrigated/ Kharif I, II and Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
29	SNQR-55	Sada data/ Irrigated/ Kharif I, II and Rabi	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
30	SN-2	Bashpata Data/ Irrigated/ Rabi, Kharif	Name: Dr. Sohiful Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
Ash gourd (<i>Benincasa hispida</i>)					
1	NRI-194	Chalkumra/ Roof top platform	Name: Md. Saidul Islam Village: Macchorkourpur Union: 6 no. Macchor Upazila: Faridpur Sadar District: Faridpur	N-23°36'33.39" E-89°46'37.84" 12-04-2019	
2	NRI-250	Chalkumra/ Roof top platform	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
3	NRI-83	Chalkumra/ Roof top platform	Name: Promila Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur-S District: Faridpur	N-23034'26.4" E-89045'44.1" 10-04-2019	
4	NRI-271	Chalkumra/ Roof top platform	Name: Md. Palash Molla Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
5	NRI-282	Chalkumra/ Roof top platform	Name: JoliAker Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
6	NQR-33	Chalkumra/ Roof top platform	Name: Prodip Chandra Ray Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	
7	NQ-81	Chalkumra/ Roof top platform	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
8	MRI-7	Chalkumra/ Roof top platform	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
9	MRI-18	Chalkumra/ Roof top platform	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
10	MRI-21	Chalkumra/ Roof top platform	Name: A. Halim Matobbor Village: Itbaria Union: Itbaria Sadar Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
11	MRI-38	Chalkumra/ Roof top platform	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
12	MRI-59	Chalkumra/ Roof top platform	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
13	MRI-92	Chalkumra/ Roof top platform	Name: Yeasmin Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
14	NRI-8	Desi Chalkumra/ Roof top platform	Name: Ruidas Sordar Village: Mirzapur Union: Dumuria Upazila: Dumuria District: Khulna	12 September 2018 N-22°49'15.72" E-89°26'41.04"	
15	SNQR-42	Chalkumra/ Irrigated/ Kharif I, II	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
16	SNQR-62	Chalkumra/ Irrigated/ Kharif I	Name: Zakir Hossen Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
17	SAA-57	Jhum chalkumra/ Irrigated/ Kharif (Jhum)	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
Banana (<i>Musa sapientum</i>)					
1	NRI-217	Rustom kola (Gera sundori) Annual plant	Name: Md. Kamal Hossen Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'0" E-91°47'60" 20-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Barley (<i>Hordeum vulgare</i>)					
1	NRI-127	Job/ Field crop	Name: Jahid Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
Bitter gourd (<i>Momordica charantia</i>)					
1	NRI-249	Tit Korolla/ In field platform	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	
2	NRI-69	Usta/ In field platform	Name: Morzina Begum Village: Fursa Union: Kanaipur Upazila: Faridpur Sadar District: Faridpur	N-23°04'26.4" E-89°02'44.1" 10-04-2019	
3	NRI-277	Korolla/ In field platform	Name: Mst. Fahima Khatun Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
4	NRI-285	Korolla/ In field platform	Name: Shelina Begum Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
5	NQR-18	Korolla/ In field platform	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
6	NQR-47	Korolla/ In field platform	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
7	NQ-79	Korolla/ In field platform	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
8	SNQR-6	Ucche/ Irrigated/ Kharif I	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
9	SNQR-43	Ucche/ Irrigated/ Kharif I	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
10	SNQR-58	Ucche/ Irrigated/ Kharif I	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
11	SNQR-63	Korolla/ Irrigated/ Kharif I, II	Name: Shah Alam Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
12	SAA-54	Jhum korolla/ Irrigated/ Kharif (Jhum)	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
Black cumin (<i>Nigella sativa</i>)					
1	NRI-125	Kalijira/ Field/ Rabi	Name: Jahid Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NRI-147	Kalijira/ Field/ Rabi	Name: M. A. Kader Sheikh Village: Gobindopur Union: Pourosava, ward-10 Upazila: Faridpur Sadar District: Faridpur	N-23036'55.08" E-89048'50.04" 12-04-2019	
3	NRI-165	Kalajira/ Field/ Rabi	Name: Md. Akter Mondol Village: Parchar Union: Pourosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
4	NRI-195	Kalijira/ Field/ Rabi	Name: Md. Saidul Molla Village: Mocchor Kourpur Union: 6 no. Macchor Upazila: Faridpur Sadar District: Faridpur	N-23036'33.39" E-89046'37.84" 12-04-2019	
Black gram (<i>Vigna mungo</i>)					
1	NRI-41	Mashkolair Dai/ Field/ Kharif-II	Name: Tara Sheikh Village: Beparidangi Union: Dingir Char Upazila: Faridpur-Sadar District: Faridpur	N-23°35'28.61" E-89°49'53.68" 10-04-2019	
2	NRI-42	Mash kalai/ Field/ Kharif-II	Name: Dilip Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur-Sadar District: Faridpur	N-23°35'26.4" E-89°46'44.1" 10-04-2019	
Black pea (<i>Pisum sativum</i>)					
1	NRI-176	Kali motor/ Field	Name: Moslem Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23°36'38.39" E-89°49'3.84" 12-04-2019	
Bottle gourd (<i>Lagenaria siceraria</i>)					
1	NRI-181	Lau/ In jhar	Name: Sonailaa Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23°36'38.39" E-89°49'3.84" 12-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NRI-228	Lau/ In field	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
3	NRI-236	Lau/ Field	Name: Abdul Mannan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
4	NRI-254	Lau/ In jhar	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
5	NRI-280	Lau/ In jhar	Name: Joli Akter Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
6	NQR-13	Lau/ In jhar	Name: Rohima Begum Village: Sikdar para Union: Sonahar Upazila: Debiganj District: Panchagarh	N-26.05165 E-88.72736 13-11-2019	
7	NQR-31	Lau/ In jhar	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
8	NQR-32	Lau/ In jhar	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
9	NQR-46	Lau/ In jhar	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
10	NQ-42	Lau/ In jhar	Name: Md. Billal Village: Kullapara Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°20'39.6" E-89°06'39.0" 02-10-2019	
11	NQ-66	Lau/ In jhar	Name: Md. Asfaq Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
12	MRI-35	Lau/ In jhar	Name: Mizanur Rahman Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
13	MRI-40	Lau/ In jhar	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
14	MRI-64	Lau/ In jhar	Name: Md. Jahangir Hossen Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'24.54" E-90°7'11.79"	
15	MRI-70	Lau/ In jhar	Name: M. Joynal Abedin Kazi Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
16	MRI-85	Lau/ In <i>jhar</i>	Name: Mst. Sabikunnahar Village: Chilmari Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	
17	MRI-86	Lau/ In <i>jhar</i>	Name: Aleya Khatun Village: Banimordon Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	
18	MRI-87	Lau (Kadu)/ In <i>jhar</i>	Name: Yeasmin Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
19	NRI-3	Jharlau (Deshi)/ In <i>jhar</i>	Name: Purnandu Bishwas Village: Mirzapur Union: Dumuria Upazila: Dumuria District: Khulna	12 September 2018 N-22°44'15.72" E-89°26'41.04"	
20	NRI-19	Lau/ In <i>jhar</i>	Name: Kumkum Boiragi Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
21	NRI-22	Deshikodu (Lomba)/ In <i>jhar</i>	Name: Bila Mondol Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
22	NRI-37	Lau/ In <i>jhar</i>	Name: Palash Sardar Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
23	NSR-42	Lau/ In jhar	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
24	NSR-50	Lau/ In jhar	Name: Babul Mir Village: Kochua Union: Dapunia Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50.6" E-89°15'19.7"	
25	SNQR-39	Lau/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
26	SNQR-65	Lau/ Irrigated/ Rabi	Name: Zakir Hossen Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
27	SAA-14	Jhum lau/ Irrigated/ Jhum (Rabi)	Name: Tona Chakma Village: Kanglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°29'19" E-92°16'46" 22/12/2019	
28	SAA-27	Jhum lau/ Irrigated/ Rabi (Jhum)	Name: Bilas Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
29	SAA-42	Jhum lau/ Irrigated/ Rabi (Jhum)	Name: Dipali Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°11'07" E-92°01'56" 23/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Brinjal (<i>Solanum melongena</i>)					
1	NRI-130	Kata begun (sada)/ Home yard/ Year round	Name: Aklima Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-221	Futa begun/ Field/ Year round	Name: Md. Hanif Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
3	NRI-231	Futa begun (choto)/ Field/ Year round	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
4	NRI-232	Begun (Islampuri)/ Field/ Year round	Name: Abdul Mannan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
5	NRI-264	Futa begun/ Field/ Year round	Name: Md. Sultan Village: Dewannagar (West) Union: Hathazaripourosova Upazila: Hathazari District: Chattogram	N-22029'58.58" E-91048'0.53" 20-04-2019	
6	NRI-281	Begun/ Home yard/ Year round	Name: Joli Akter Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
7	NRI-291	Begun/ Home yard/ Year round	Name: Ruma Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
8	NQR-39	Tit begun (<i>Solanum trilobatum</i>)/ Wild	Name: Abdul Gofur Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgaon	N-26.17937 E-88.51668 14-11-2019	
9	NQ-50	Begun/ Field/ Year round	Name: Huzaifa Rahman Village: Berapatahalia Union: Pourasaba Upazila: Jamalpur Sadar District: Jamalpur	N-24°51'55.4" E-90°02'19.4" 17-10-2019	
10	NQ-53	Begun/ Home yard/ Year round	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
11	NQ-54	Begun/ Home yard/ Year round	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
12	NQ-67	Begun/ Home yard/ Year round	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
13	NQ-75	Begun/ Home yard/ Year round	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
14	NQ-87	Begun/ Home yard/ Year round	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	
15	MRI-22	Sada begun/ Home yard/ Year round	Name: Razvanu Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
16	MRI-100	Begun-(SMP-2)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
17	MRI-101	Begun-(SMP-3)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
18	MRI-102	Begun-(SMP-4)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
19	MRI-103	Begun-(SMP-5)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
20	MRI-104	Begun-(SMP-6)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
21	MRI-105	Begun-(SMP-9)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
22	MRI-106	Begun-(SMP-10)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
23	MRI-107	Begun-(SMP-12)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
24	MRI-108	Begun-(SMP-11)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
25	MRI-109	Begun-(SMP-14)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
26	MRI-110	Begun-(SMP-35)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
27	MRI-111	Begun-(SMP-43)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
28	MRI-112	Begun-(SMP-44)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
29	MRI-113	Begun-(SMP-47)/ Selected line	Name: Dr. M. M. Rahman Village: RHRS Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
30	MRI-114	Begun (Gol kata)/ Home yard	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	

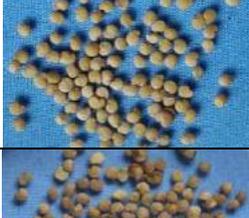
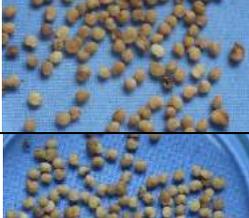
Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
31	MRI-115	Begun (2-16)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
32	MRI-116	Begun (4-2)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
33	MRI-117	Begun (4-3)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
34	MRI-118	Begun (4-4)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
35	MRI-119	Begun (6-1)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
36	MRI-120	Begun (6-2)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
37	MRI-121	Begun (6-3)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
38	MRI-122	Begun (6-4)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
39	MRI-123	Begun (7-3) Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
40	MRI-124	Begun (7-16)/ Selected line	Name: Md. Rezaul Karim Village: (SO, RHRS) Union: Lebukhali Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'50.62" E-90°20'19.52"	
41	N-215	Baigun/ Home yard/ Year round	Name: Md. Saiful Islam Village: Boiltoli bazar Union: Dohazari Upazila: Chandanaish District: Chattogram	29 October 2018 N-22°16' E-92°06'	
42	N-216	Begun (Deshi)/ Home yard/ Year round	Name: Azim Uddin Village: Dewan Nagar Union: Hathazari Upazila: Hathazari District: Chattogram	29 October 2018 N-22°50' E-91°85'	
43	N-217	Sada Tal Begun/ Home yard/ Year round	Name: Helal Uddin Village: Vatirtek Union: Sadar-6 Upazila: Choumohoni District: Noakhali	28 October 2018 N-22°94' E-91°11'	
44	N-218	Tal Begun Sobuj/ Home yard/ Year round	Name: Tofayel Ahamed Village: Purbo Solakia Sadar Union: Sadar-7 Upazila: Noakhali Sadar District: Noakhali	28 October 2018 N-22°94' E-91°11'	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
45	N-234	Owsodi Begun/ Jhum	Name: Piplu Rakhiyan Village: Bolipara (Nilgiri) Union: Bolipara Upazila: Thanchi District: Bandarban	29 October 2018 N-21°81' E-92°43'	
46	N-235	Choto Begun/ Jhum	Name: Piplu Rakhiyan Village: Bolipara (Nilgiri) Union: Bolipara Upazila: Thanchi District: Bandarban	29 October 2018 N-21°81' E-92°43'	
47	N-236	Begun/ Jhum	Name: Piplu Rakhiyan Village: Bolipara (Nilgiri) Union: Bolipara Upazila: Thanchi District: Bandarban	30 October 2018 N-21°81' E-92°43'	
48	N-237	Begun/ Jhum	Name: Sorot Marma Village: Laimipara (Nilgiri) Union: LaimiSadar Upazila: Thanchi District: Bandarban	29 October 2018 N-21°81' E-92°43'	
49	N-215	Baigun/ Field/ Year round	Name: Md. Saiful Islam Village: Boiltoli bazar Union: Dohazari Upazila: Chandanaish District: Chattogram	29 October 2018 N-22°16' E-92°06'	
50	NSR-2	Begun/ Home yard/ Year round	Name: Shopown Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
51	NSR-3	Begun/ Home yard/ Year round	Name: Shopown Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
52	NSR-4	Begun/ Home yard/ Year round	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
53	NSR-5	Begun/ Home yard/ Year round	Name: Shopown Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
54	NSR-6	Begun/ Home yard/ Year round	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
55	NSR-8	Begun/ Home yard/ Year round	Name: Shopown Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
56	NSR-9	Begun/ Home yard/ Year round	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
57	NSR-10	Begun/ Home yard/ Year round	Name: Kiron Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
58	NSR-11	Begun/ Home yard/ Year round	Name: Kiron Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
59	NSR-12	Begun/ Home yard/ Year round	Name: Kiron Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
60	NSR-13	Begun/ Home yard/ Year round	Name: Kiron Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
61	NSR-14	Begun/ Home yard/ Year round	Name: Al-Amin Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
62	NSR-15	Begun/ Home yard/ Year round	Name: Al-Amin Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
63	NSR-17	Begun/ Home yard/ Year round	Name: Al-Amin Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
64	NSR-18	Begun/ Home yard/ Year round	Name: Al-Amin Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
65	NSR-19	Begun/ Home yard/ Year round	Name: Al-Amin Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
66	NSR-20	Begun/ Home yard/ Year round	Name: Fotik Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
67	NSR-21	Begun/ Home yard/ Year round	Name: Fotik Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
68	NSR-22	Begun/ Home yard/ Year round	Name: Fotik Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
69	NSR-23	Begun/ Home yard/ Year round	Name: Fotik Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
70	NSR-24	Begun/ Home yard/ Year round	Name: Shahanur Rahman Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
71	NSR-26	Begun/ Home yard/ Year round	Name: Shahanur Rahman Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
72	NSR-27	Begun/ Home yard/ Year round	Name: Shahanur Rahman Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
73	NSR-28	Begun/ Home yard/ Year round	Name: Shahanur Rahman Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
74	SNQR-10	Begun/ Irrigated/ Kharif I, II	Name: Mohon Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.48153 E-89.26292 13-10-2020	
75	SAA-66	Jhum begun/ Irrigated/ Kharif	Name: Sukiron Chakma Village: TUS (NGO) Union: Milenpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
76	SAA-68	Laffa begun/ Irrigated/ Kharif	Name: Jamal Uddin Village: Mohamoni Union: Rai-Pouroshova Upazila: Ramghar District: Khagrachari	N-22.9565669 E-91.7763169 24-12-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
77	SN-1	Bagun/ Irrigated/ Kharif	Name: Dr. Sohikul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
Chilli (<i>Capsicum frutescens</i>)					
1	NRI-220	Hathazari Morich/ Kharif	Name: Md. Salauddin Village: West Mirzapur Union: Mirzapur Upazila: Hathazari District: Chattogram	N-22°33'26.9" E-91°46'30.7" 20-04-2019	
2	NRI-225	Halda Morich/ kharif	Name: Md. Hasan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
3	NRI-243	DhennaMorich/ Home yard/ kharif	Name: Sahana Begum Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	
4	NQR-38	Jira morich/ Home yard	Name: Norul Islam Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	
5	NQ-64	Morich/ Field	Name: Md. Asfaq Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
6	SNQR-31	Bombay morich/ Irrigated/ Biennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
7	SNQR-53	Bullet jhal/ Irrigated/ Annual	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
8	SAA-02	Chikonmorich/ Rainfed/ Rabi	Name: Tona Chakma Village: Kanglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°29'19" E-92°16'46" 22/12/2019	
9	SAA-03	Chotomorich/ Rainfed/ Rabi	Name: Anil Tripura Village: Kanglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°29'19" E-92°16'46" 22/12/2019	
10	SAA-36	Jhum morich/ Irrigated/ Rabi (Jhum)	Name: Mokshedor Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
11	SN-4	Pola morich/ Irrigated/ Rabi	Name: Md. Ruhul Amin Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
12	SN-5	Boltumorich/ Irrigated/ Rabi	Name: Dr. Sohidul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22°56'2.22" E-89°9'45.9" 04-03-2020	
13	SN-6	Patakandimorich/ Irrigated/ Rabi	Name: Dr. Sohidul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
Coriander (<i>Coriandrum sativum</i>)					
1	NRI-104	Dhonia soz/ Field/ Rabi	Name: Idris Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NRI-158	Dhonia soz/ Field/ Rabi	Name: Md. Humayun Mondol Village: Parchar Union: Pourosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
3	NRI-159	Dhonia soz/ Field/ Rabi	Name: Md. Akter Mondol Village: Parchar Union: Pourosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
4	NRI-172	Dhonia soz/ Field/ Rabi	Name: Moslem Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89049'3.84" 12-04-2019	
5	NRI-188	Dhonia soz/ Field/ Rabi	Name: Ahmmed Ali Sheikh Village: Char Noshipur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89049'3.84" 12-04-2019	
6	NRI-197	Dhonia soz/ Field/ Rabi	Name: Md. Saidul Molla Village: Macchorkourpur Union: 6 no. Macchor Upazila: Faridpur Sadar District: Faridpur	N-23036'33.49" E-89046'37.84" 12-04-2019	
7	NQR-8	Dhonia/ Field/ Rabi	Name: Aminul Islam Raju Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
8	NQR-28	Dhonia/ Field/ Rabi	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
9	NQR-45	Dhonia/ Field/ Rabi	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
10	MRI-9	Dhonia/ Field/ Rabi	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
11	MRI-65	Dhonia/ Field/ Rabi	Name: Md. Jahangir Hossen Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'24.54" E-90°7'11.79"	
Country bean (<i>Lablab purpureus</i>)					
1	NRI-132	Choita sim/ Hatikani sim/ <i>Jhar</i>	Name: Aklima Begum Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-133	Noladanga sim/ <i>Jhar</i>	Name: Aklima Begum Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
3	NRI-230	Jat sim/ <i>Jhar</i>	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
4	NRI-235	Jat sim/ <i>Jhar</i>	Name: Abdul Mannan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
5	NRI-238	Putichoi/ <i>Jhar</i>	Name: Orchona Chowdhury Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
6	NRI-239	Loittachoi/ <i>Jhar</i>	Name: Orchona Chowdhury Village: Alipur Union: Hathazari poursova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	
7	NRI-253	Lal putichoi/ <i>Jhar</i>	Name: Saymon Village: Dewan nagar Union: Hathazari poursova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
8	NRI-214	Nolusshi/ <i>Jhar</i>	Name: Nazrul Matobbar Village: Aruakandi Union: Gatti Upazila: Nagar Kanda (Salta) District: Faridpur	N-23029'10.48" E-89048'57.5" 13-04-2019	
9	NRI-267	Seem/ <i>Jhar</i>	Name: Moriom Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
10	NRI-275	Seem/ <i>Jhar</i>	Name: Md. Afzal Village: PramanikVaroimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
11	NRI-283	Seem/ <i>Jhar</i>	Name: Jihad Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
12	NRI-284	Ghikanchon/ <i>Jhar</i>	Name: Shelina Begum Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
13	NQR-6	Seem/ Jhar	Name: Aminul Islam Raju Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
14	NQR-7	Seem/ Jhar	Name: Aminul Islam Raju Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
15	NQR-9	Seem/ Jhar	Name: Aminul Islam Raju Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
16	NQR-34	Seem/ Jhar	Name: Prodip Chandra Roy Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	
17	NQR-48	Seem/ Jhar	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
18	NQ-43	Sheem/ Jhar	Name: Md. Billal Village: Kullapara Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°20'39.6" E-89°06'39.0" 02-10-2019	
19	NQ-45	Shim/ Jhar	Name: Md. Billal Village: Kullapara Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°20'39.6" E-89°06'39.0" 02-10-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
20	NQ-46	Shim/ <i>Jhar</i>	Name: Md. Abdur Rob Village: Giadhat Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°11'40.9" E-89°19'25.7" 02-10-2019	
21	NQ-59	Sheem/ <i>Jhar</i>	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
22	NQ-62	Sheem/ <i>Jhar</i>	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
23	NQ-84	Sheem/ <i>Jhar</i>	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	
24	MRI-1	Kartik jali sim/ <i>Jhar</i>	Name: Borun Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.756" E-90°25'13.17"	
25	MRI-13	Sim (Soto)/ <i>Jhar</i>	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
26	MRI-14	Sim (Soto,Green)/ <i>Jhar</i>	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
27	MRI-15	Kartik sim/ <i>Jhar</i>	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22 ⁰ 26'3.8" E-90 ⁰ 25'13.17"	
28	MRI-16	Tepa sim/ <i>Jhar</i>	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22 ⁰ 26'3.8" E-90 ⁰ 25'13.17"	
29	MRI-32	Koromza (Chotoussi)/ <i>Jhar</i>	Name: Md. Ruhul Amin Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
30	MRI-34	Kartik sim (Utro)/ <i>Jhar</i>	Name: Mizanur Rahman Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
31	MRI-45	Kartik jal sim/ <i>Jhar</i>	Name: Md. Abdul Haque Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
32	MRI-60	Ussi/ <i>Jhar</i>	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21 ⁰ 50'23.79" E-90 ⁰ 7'12.54"	
33	MRI-78	Sim/ <i>Jhar</i>	Name: Feroza Begum Village: Banimordon Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22 ⁰ 57'39.65" E-90 ⁰ 21'54.47"	
34	MRI-79	Sim/ <i>Jhar</i>	Name: Feroza Begum Village: Banimordon Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22 ⁰ 57'39.65" E-90 ⁰ 21'54.47"	
35	MRI-99	Sim/ <i>Jhar</i>	Name: Md. Al-Amin Village: BoroLaxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23 ⁰ 01'38.6" E-90 ⁰ 22'15.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
36	NRI-5	Chepta sim/ <i>Jhar</i>	Name: Sonchoy Boiragi Village: Mirzapur Union: Dumuria Upazila: Dumuria District: Khulna	12 September 2018 N-22°49'15.72" E-89°26'41.04"	
37	NRI-18	Karthik shailchapta shim/ <i>Jhar</i>	Name: Monoronjon Ganguli Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
38	NRI-33	Sim/ <i>Jhar</i>	Name: Md. Moktar Sheikh Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
39	N-249	Sitakundo Sim/ <i>Jhum</i>	Name: Md. Samad Hossen Village: Kumira Union: Sitakunda Upazila: Sitatunga District: Chattogram	29 October 2018 N-22°50' E-91°71'	
40	N-252	Khaissa Sim/ <i>Jhum</i>	Name: Md. Nazim Uddin Village: Murgirhat Union: Hathazari Upazila: Hathazari District: Chattogram	29 October 2018 N-22°50' E-91°71'	
41	N-255	Sim (Khaissa)/ <i>Jhum</i>	Name: Abu Musa Village: Dewanhat Union: Dohazari Upazila: Chandanaish District: Chattogram	30 October 2018 N-22°17' E-92°07'	
42	NSR-31	Shim/ <i>Jhar</i>	Name: Shapon Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	
43	NSR-32	Shim/ <i>Jhar</i>	Name: Shapon Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24°4.4'65" E-89°4.10'34"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
44	NSR-33	Shim/ Jhar	Name: Shapon Ali Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
45	NSR-34	Shim/ Jhar	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
46	NSR-35	Shim/ Jhar	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
47	NSR-36	Shim/ Jhar	Name: Amirul Islam Village: Char Mir Kamal Union: Solimpur Upazila: Ishwardi District: Pabna	02 October 2018 N-24 ⁰ 4.4'65" E-89 ⁰ 4.10'34"	
48	NSR-45	Shim/ Jhar	Name: Rafique Sharker Village: Dashuria Union: Dashuria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23 ⁰ 59' E-89 ⁰ 16'20"	
49	SNQR-4	Rohimsheem/ Irrigated/ Rabi	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
50	SNQR-14	Sadanoikoshshe em/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
51	SNQR-15	Jamaikolisheem / Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
52	SNQR-16	Kori sheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
53	SNQR-17	Borokoromjhas heem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
54	SNQR-18	Delpatsheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
55	SNQR-19	Lal sheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
56	SNQR-20	Sobuznolkoshsh eem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
57	SNQR-21	Sadanolkoshshe em/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
58	SNQR-22	Chotokorisheem / Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
59	SNQR-23	Ghitokanchansheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
60	SNQR-24	Patra katrikasheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
61	SNQR-25	Lal koromjhasheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
62	SNQR-26	Motor sheem/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
63	SNQR-69	Ghee kanchonsheem/ Irrigated/ Rabi	Name: Shah Alam Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
64	SAA-45	Jhum sheem/ Irrigated/ Rabi (Jhum)	Name: Dipali Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichari District: Rangamati	N-23°11'07" E-92°01.56" 23/12/2019	
65	SAA-61	Korenghasheem/ Irrigated/ Rabi	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
66	SAA-64	Jarkallosheem/ Irrigated/ Rabi	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
67	SSQR-1	Lombu/Gochish eem/ Irrigated/ Rabi	Name: Md. Abdul Based Village: Daktarpara Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.756514 E-89.413862 25-09-2020	
68	SSQR-2	Cotisheem/ Irrigated/ Rabi	Name: Md. Abdul Mojid Village: Brikushtia Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.753970 E-89.406835 25-09-2020	
69	SSQR-3	China sheem/ Irrigated/ Rabi	Name: Md. Abdul Mojid Village: Brikushtia Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.753970 E-89.406835 25-09-2020	
70	SSQR-4	Deshilalsheem/ Irrigated/ Rabi	Name: Md. Abdul Mojid Village: Brikushtia Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.753970 E-89.406835 25-09-2020	
71	SSQR-5	Jossorisheem/ Irrigated/ Rabi	Name: Md. Romjan Ali Village: Doripara Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.756514 E-89.413862 25-09-2020	
72	SSQR-6	Pantisheem/ Irrigated/ Rabi	Name: Md. Faridul Alam Village: Brikushtia Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.753970 E-89.406835 25-09-2020	
73	SSQR-7	Tepa sheem/ Irrigated/ Rabi	Name: Md. Motahar Ali Village: Daktarpara Union: Cupinagar Upazila: Sajahanpur District: Bogura	N-24.756514 E-89.413862 25-09-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Cucumber (<i>Cucumis sativus</i>)					
1	NRI-222	Kheera/ Macha/ Kharif	Name: Md. Hanif Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'12.5" E-91°47'42.0" 20-04-2019	
2	NRI-223	Sosha/ Macha/ Kharif	Name: Md. Hanif Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'12.5" E-91°47'42.0" 20-04-2019	
3	NRI-274	Sosha/ Macha/ Kharif	Name: Md. Afzal Pramanik Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
4	NRI-295	Sosha/ Macha/ Kharif	Name: Mojibor Rahman Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
5	MRI-5	Borososha/ Macha/ Kharif	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
6	MRI-29	Sosha/ Macha/ Kharif	Name: A. Halim Matobbor Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
7	MRI-56	Sosha/ Macha/ Kharif	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
8	MRI-75	Morma/ Macha/ Kharif	Name: M. Joynal Abedin Kazi Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
9	NSR-44	Sosha/ Macha/ Kharif	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
10	SNQR-1	Deshikhira/ Irrigated/ Kharif I	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
11	SNQR-30	Sosha/ Irrigated/ Kharif I, II	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
12	SAA-25	Marfa/ Irrigated/ Kharif	Name: Bibika Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
13	SAA-51	Jhum marfa/ Irrigated/ Kharif (Jhum)	Name: Chandrakishor Tripura Village: 6 Mile, Perachora Union: Baghaichori Upazila: Baghaichori District: Rangamati	N-23°10'34" E-92°01'38" 23/12/2019	
14	SAA-60	Marfa/ Irrigated/ Kharif	Name: Sukiron Chakma Village: TUS (NGO) Union: Milenpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
Bullock's heart (<i>Annona reticulata</i>)					
1	NRI-216	Ata/ Perennial	Name: Enamul Kabir Village: Berbori Union: Fulhori Upazila: Shoilkupa District: Jhinaidha	N-23°41'0.83" E-89°14'45.4" 13-04-2019	
2	SAA-62	Sharifa (Atisamila)/ Rainfed/ Perennial	Name: Sukiron Chakma Village: TUS (NGO) Union: Milenpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Fennel (<i>Foeniculum vulgare</i>)					
1	NRI-117	Guemuri (Mouri)/ Field/ Rabi	Name: Moriam Akter Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NQR-19	Mouri/ Field/ Rabi	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
Fenugreek (<i>Trigonella foenum-graecum</i>)					
1	NRI-108	Methi/ Field/ Rabi	Name: Shahid Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-167	Methi/ Field/ Rabi	Name: Md. Akter Mondol Village: Parchar Union: Pourosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23°35'21.34" E-89°46'48.02" 12-04-2019	
3	NRI-185	Methi/ Field/ Rabi	Name: Jalil Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23°36'38.39" E-89°49'3.84" 12-04-2019	
Garlic (<i>Allium sativum</i>)					
1	NRI-135	Rosun/ Field/ Rabi	Name: Aklima Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
Grass pea (<i>Lathyrus sativus</i>)					
1	NRI-106	Khesari/ Rely crop with boro rice/ Rabi	Name: Idris Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NRI-154	Khesari/ Rely crop with boro rice/ Rabi	Name: Razia Anwar Village: Gobindopur Union: Pourosava, ward-10 Upazila: Faridpur Sadar District: Faridpur	N-23036'55.08" E-89048'50.04" 12-04-2019	
3	NRI-156	Khesari/ Rely crop with boro rice/ Rabi	Name: M. Humayun Mondol Village: Parchar Union: Pourosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
4	NRI-207	Khesari/ Rely crop with boro rice/ Rabi	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23035'36.39" E-89046'41.84" 12-04-2019	
5	MRI-37	Khesari/ Rely crop with boro rice/ Rabi	Name: Mizanur Rahman Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
6	MRI-49	Khesari/ Rely crop with boro rice/ Rabi	Name: Md. Shanu Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
7	MRI-67	Khesari/ Rely crop with boro rice/ Rabi	Name: Israt Jahan Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21 ⁰ 50'24.54" E-90 ⁰ 7'11.79"	
8	MRI-91	Khesari/ Rely crop with boro rice/ Rabi	Name: Yeamin Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23 ⁰ 01'38.6" E-90 ⁰ 22'15.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
9	SNQR-46	Kheshari/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
Indian spinach (<i>Basella alba</i>)					
1	NRI-103	Puishak/ <i>Macha</i>	Name: Idris Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-206	Puishak/ <i>Macha</i>	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23035'36.39" E-89046'41.84" 12-04-2019	
3	NRI-261	Puishak/ <i>Macha</i>	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
4	NQR-21	Puishak/ <i>Macha</i>	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
5	NQ-88	Puishak/ <i>Macha</i>	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	
6	SNQR-9	Puishak/ Irrigated/ Kharif I, II and Rabi	Name: Mohon Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.48153 E-89.26292 13-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
7	SNQR-66	Puishak/ Irrigated/ Kharif I, II	Name: Zakir Hossen Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
Jute (<i>Corchorus olitorius</i>)					
1	NRI-137	Amoinnasada pat/ Aman season/ Field	Name: Rustom Khan Village: Piarpur Union: Koijuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	N-231	Pat shak/ Kharif-II	Name: Afsar Miah Village: Roktipara Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-91°85'	
3	SAA-59	Pat shak (Naris)/ Rainfed/ Kharif	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23°06'29" E-91°59'23" 24/12/2019	
Kangkong (<i>Ipomoea aquatica</i>)					
1	NRI-262	Kolmishak/ Wetland	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	
2	NSR-75	Kolmishak/ Wetland	Name: Md. A. Aziz Village: Raddershar Union: Kakina Upazila: Kaligonj District: Lalmonirhat	14 January 2019 N-25°54'18.6" E-89°15'27.2"	
3	SNQR-40	Math kolmi/ Irrigated/ Kharif I, II and Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Lentil (<i>Lens esculenta</i>)					
1	NRI-118	Mosur dal/ Rabi/ Field	Name: Kaiyum Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-166	Mosur dal/ Rabi/ Field	Name: Md. AkterMondol Village: Parchar Union: Pourosova, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 11-04-2019	
3	NRI-200	Mosur dal/ Rabi/ Field	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89046'41.84" 11-04-2019	
4	NQR-17	Mosur dal/ Rabi/ Field	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
Linseed (<i>Linum usitatissimum</i>)					
1	NRI-144	Moishna/ Kharif-II/ Field	Name: Md. Firoz Khan Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
Okra (<i>Abelmoschus esculentus</i>)					
1	NRI-161	Vendi/ Kharif/ Home yard	Name: Md. AkterMondol Village: Parchar Union: Pourosova, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23°35'21.34" E-89°46'48.02" 12-04-2019	
2	NRI-192	Vendi/ Kharif/ Home yard	Name: Ahmmed Ali Sheikh Village: Char Noshipur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23038'34.39" E-89047'22.84" 12-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
3	NRI-240	Vendi/ Kharif/ Field	Name: Orchona Chowdhury Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	
4	NRI-259	Vendi/ Kharif/ Field	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
5	NRI-289	Vendi/ Kharif/ Home yard	Name: Shelina Begum Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
6	NQR-20	Vendi/ Kharif/ Home yard	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
7	NQR-40	Dherosh/ Kharif/ Home yard	Name: Munni Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
8	NQ-52	Dherosh/ Kharif/ Home yard	Name: Huzaifa Rahman Village: Berapatahalia Union: Pourasaba Upazila: Jamalpur Sadar District: Jamalpur	N-24°51'55.4" E-90°02'19.4" 17-10-2019	
9	NQ-61	Dherosh/ Kharif/ Home yard	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
10	NQ-80	Derosh/ Kharif/ Home yard	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
11	MRI-69	Vandi (Derosh)/ Kharif/ Home yard	Name: Md. Kamal Hossen Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
12	NRI-17	Vendi/ Kharif/ Home yard	Name: Shankar Mondol Village: Bosurabad Union: 2, No, Bosurabad Upazila: Botiaghata District: Khulna	13 September 2018 N-22°43'28.31" E-89°29'52.01"	
13	N-230	Vendi/ Kharif/ Home yard	Name: Saiful Alam Village: Boiltoli bazar Union: Dohazari Upazila: Chandanaih District: Chattogram	29 October 2018 N-22°31' E-92°06'	
14	SNQR-44	Dherosh/ Irrigated/ Kharif I, II	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
15	SAA-21	Jhum derosh/ Irrigated/ Kharif (Jhum)	Name: Sumon Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
16	SAA-52	Jhum dherosh/ Irrigated/ Kharif (Jhum)	Name: Chandrakishor Tripura Village: 6 Mile, Perachora Union: Baghaichori Upazila: Baghaichori District: Rangamati	N-23°10'34" E-92°01'38" 23/12/2019	
Onion (<i>Allium cepa</i>)					
1	NRI-153	Taherpuripeyaz/ Rabi/ Field	Name: Razia Anwar Village: Gobindopur Union: Pourosova, ward-10 Upazila: Faridpur Sadar District: Faridpur	N-23°36'55.08" E-89°48'50.04" 12-04-2019	
2	NRI-134	Taherpuripeyaz/ Rabi/ Field	Name: Aklima Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
Papaya (<i>Carica papaya</i>)					
1	NRI-234	Pepe/ Perennial/ Home yard	Name: Abdul Mannan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'12.5" E-91°47'42.0" 20-04-2019	

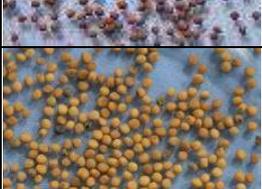
Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NRI-242	Pepe/ Perennial/ Home yard	Name: Orchona Chowdhury Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	
3	NRI-265	Pepe/ Perennial/ Home yard	Name: Md. Hasan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
4	NRI-73	Pepe/ Perennial/ Home yard	Name: Shuvankar Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur sadar District: Faridpur	N-23034'26.4" E-89045'44.1" 10-04-2019	
5	NRI-273	Pepe/ Perennial/ Home yard	Name: Hasem Ali Pramanik Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
6	SAA-46	Pepe/ Rainfed/ Annual	Name: Dipali Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°11'07" E-92°01.56" 23/12/2019	
Pigeon pea (<i>Cajanus cajan</i>)					
1	NRI-257	Arol/ Perennial/ Road side	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	
2	NRI-57	Orol/ Perennial/ Home yard	Name: M. A. Rashid Khan Village: Fursa Union: Kanaipur Upazila: Faridpur-Sadar District: Faridpur	N-23043'26.4" E-89028'44.1" 10-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
3	SAA-40	Jhum Arhar/ Rainfed/ Annual	Name: Moten Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
Pumpkin (<i>Cucurbita moschata</i>)					
1	NRI-131	Misti kumra/ Macha/ Rabi	Name: Aklima Begum Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-241	Misti kumra/ Field/ Rabi	Name: Orchona Chowdhury Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'05.9" E-91047'27.9" 20-04-2019	
3	NRI-260	Misti kumra/ Field/ Rabi	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
4	NRI-272	Misti kumra/ Macha/ Rabi	Name: Hasem Ali Pramanik Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
5	NRI-276	Misti kumra/ Macha/ Rabi	Name: Mst. Fahima Khatun Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
6	NQ-44	Misti kumra/ Macha/ Rabi	Name: Md. Billal Village: Kullapara Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°20'39.6" E-89°06'39.0" 02-10-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
7	NQ-58	Misti kumra/ Field/ Rabi	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
8	NQ-71	Misti kumra/ Field/ Rabi	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
9	MRI-6	Misti kumra/ <i>Macha</i> / Rabi	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
10	MRI-39	Misti kumra/ <i>Macha</i> / Rabi	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
11	MRI-51	Misti kumra/ <i>Macha</i> / Rabi	Name: Aleya Khatun Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
12	MRI-61	Misti kumra/ <i>Macha</i> / Rabi	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
13	MRI-72	Misti kumra/ <i>Macha</i> / Rabi	Name: M. Joynal Abedin Kazi Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
14	MRI-76	Misti kumra/ <i>Macha</i> / Rabi	Name: Feroza Begum Village: Banimordon Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	
15	MRI-80	Misti kumra/ <i>Macha</i> / Rabi	Name: Md. Rafiqul Islam Village: Banimordon Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	
16	MRI-83	Misti kumra/ <i>Macha</i> / Rabi	Name: Mst. Sabikunnahar Village: Chilmari Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	
17	MRI-89	Misti kumra/ <i>Macha</i> / Rabi	Name: Yeasmin Village: BoroLaxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
18	NRI-38	Misti kumra (Majari)/ <i>Macha</i> / Rabi	Name: Palash Sardar Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
19	NSR-38	Misti kumra/ <i>Macha</i> / Rabi	Name: Gazimia Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
20	SNQR-11	Deshimisti kumra/ Irrigated/ Rabi, Kharif I	Name: Mohon Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhainadah	N-23.48153 E-89.26292 13-10-2020	
21	SNQR-48	Misti kumra/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
22	SNQR-61	Misti kumra/ Irrigated/ Rabi	Name: Zakir Hossen Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
23	SAA-04	Jhum kumro/ Irrigated/ Jhum	Name: Anil Tripura Village: KanglakPahar Union: Sajek Upazila: Baghaichori District Rangamati	N-23°29'19" E-92°16'46" 22/12/2019	
24	SAA-05	Sumoroi (mistikumra)/ Rainfed	Name: Binoma Tripura Village: Kanglak Pahar Union: Sajek Upazila: Baghaichori District Rangamati	N-23°29'19" E-92°16'46" 22/12/2019	
25	SN-8	Misti kumra/ Irrigated/ Rabi	Name: Dr. Sohidul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District Jashore	N-22.933543 E-89.166874 04-03-2020	
Mustard (<i>Brassica rapa/juncea</i>)					
1	NRI-111	Choitasorisha (Rai)/ Rabi/ Field	Name: Shahid Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-136	Choitasorisha (Rai)/ Rabi/ Field	Name: Rustom Khan Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23033'35.41" E-89050'1.33" 11-04-2019	
3	NRI-149	Choitasorisha (Rai)/ Rabi/ Field	Name: M. A. Kader Sheikh Village: Gobindopur Union: Pourosova, ward-10 Upazila: Faridpur Sadar District: Faridpur	N-23036'55.08" E-89048'50.04" 12-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	NRI-155	Choitasorisha (Rai)/ Rabi/ Field	Name: Md. Humayun Mondol Village: Parchar Union: Poulosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
5	NRI-174	Choitasorisha (Rai)/ Rabi/ Field	Name: Moslem Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89049'3.84" 12-04-2019	
6	NRI-184	Choitasorisha (Rai)/ Rabi/ Field	Name: Jalil Jomoddar Village: Duldi, Gobindopur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89049'3.84" 12-04-2019	
7	NRI-190	Choitasorisha (Rai)/ Rabi/ Field	Name: Ahmmed Ali Sheikh Village: Char Noshipur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23038'34.39" E-89047'22.84" 12-04-2019	
8	NRI-199	Choitasorisha (Rai)/ Rabi/ Field	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23036'38.39" E-89046'41.84" 12-04-2019	
9	NQR-50	Sorisha/ Rabi/ Field	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
10	MRI-30	Sorisha/ Rabi/ Field	Name: Md. Ruhul Amin Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22 ⁰ 22'2.58" E-90 ⁰ 17'15.8"	
11	NSR-46	Sorisha/ Rabi/ Field	Name: Gazi Mia Village: Char Shahapur Union: Shahapur Upazila: Ishwardi District: Pabna	03 October 2018 N-24 ⁰ 4.4'72" E-89 ⁰ 4.13'34"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
12	NSR-54	Sorisha/ Rabi/ Field	Name: Hazrat Ali Village: Char Shahapur Union: Shahapur Upazila: Ishwardi District: Pabna	03 October 2018 N-24°4.4'72" E-89°4.13'34"	
13	NSR-55	Maghishorisha/ Rabi/ Field	Name: Samim Village: Char Shahapur Union: Shahapur Upazila: Ishwardi District: Pabna	03 October 2018 N-24°4.4'72" E-89°4.13'34"	
Red amaranth (<i>Amaranthus tricolor</i>)					
1	NRI-163	Lal shak/ Year round/ Home yard	Name: Md. AkterMondol Village: Parchar Union: Pourosova, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23°35'21.34" E-89°46'48.02" 12-04-2019	
2	NRI-202	Lal shak/ Year round/ Home yard	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23035'56.39" E-89046'41.84" 12-04-2019	
3	NRI-248	Lal shak/ Year round/ Home yard	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
4	NQR-11	Lal shak/ Year round/ Home yard	Name: Aminul Islam Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
5	NQR-25	Lal shak/ Year round/ Home yard	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
6	NQ-47	Lal shak/ Year round/ Home yard	Name: Md. Abdur Rob Village: Giadhat Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°11'40.9" E-89°19'25.7" 02-10-2019	
7	NQ-55	Lal shak/ Year round/ Home yard	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
8	NQ-57	Lal shak/ Year round/ Home yard	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
9	NQ-63	Lal shak/ Year round/ Home yard	Name: Md. Asfaq Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
10	NQ-74	Lal shak/ Year round/ Home yard	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
11	NQ-85	Lal shak/ Year round/ Home yard	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	
12	MRI-2	Lal shak/ Year round/ Home yard	Name: BorunHawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.756" E-90°25'13.17"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
13	MRI-10	Lal shak/ Year round/ Home yard	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
14	MRI-33	Lal shak/ Year round/ Home yard	Name: Md. Ruhul Amin Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
15	MRI-36	Lal shak/ Year round/ Home yard	Name: Mizanur Rahman Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
16	MRI-42	Lal shak/ Year round/ Home yard	Name: Md. Habibur Rahman Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
17	MRI-46	Lal shak/ Year round/ Home yard	Name: Md. Abdul Haque Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
18	MRI-53	Lal shak/ Year round/ Home yard	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
19	MRI-71	Lal shak/ Year round/ Home yard	Name: M. Joynal Abedin Kazi Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	

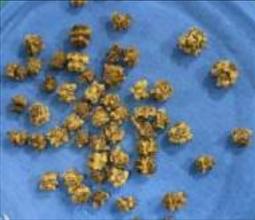
Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
20	NRI-23	Lal shak/ Year round/ Home yard	Name: Smiriti Mistri Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
21	SNQR-49	Lal shak/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
22	SNQR-57	Lal shak/ Irrigated/ Kharif I, II and Rabi	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
23	SN-3	Lal Taktok Shak/ Irrigated/ Rabi, Kharif	Name: Dr. Sohidul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
Ridge gourd (<i>Luffa acutangular</i>)					
1	NRI-255	Jhinga/ Kharif/ Home yard-on other tree plants	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	
2	MRI-57	Jhinga/ Kharif/ Home yard-on other tree plants	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
3	MRI-98	Jhinga/ Kharif/ Home yard-on other tree plants	Name: Yeasmin Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
4	NRI-256	Jhinga (wild)	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
5	NRI-294	Jhinga/ Kharif/ Home yard-on other tree plants	Name: M. Rahman Mollik Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
6	NRI-301	Jhinga/ Kharif/ Home yard-on other tree plants	Name: Abdus Sattar Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
7	NQR-5	Torui/ (wild type)	Name: Larzina Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
8	NQ-78	Zhinga/ Kharif/ Home yard-on other tree plants	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
9	SNQR-8	Jhinga/ Rainfed/ Kharif I	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
10	SNQR-41	Jhinga/ Irrigated/ Rabi, Kharif I	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
11	SAA-23	Jhum jinga/ Rainfed/ Kharif (Jhum)	Name: Bibika Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
12	SAA-43	Jhum jhinga/ Irrigated/ Kharif (Jhum)	Name: Gourangha Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 11'07" E-92 ⁰ 01.56" 23/12/2019	
13	SN-7	Jhinga/ Rainfed/ Kharif	Name: Dr. Sohidul Islam Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
Roselle (<i>Hibiscus sabdariffa</i>)					
1	NRI-252	Tok pata/ Year round/ Home yard	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22 ⁰ 30'07.8" E-91 ⁰ 48'25.2" 21-04-2019	
Safflower (<i>Carthamus tinctorius</i>)					
1	NRI-143	Kusumful/ Rabi/ Field	Name: Md. Firoz Khan Village: Piarpur Union: Kojuri Upazila: Faridpur Sadar District: Faridpur	N-23 ⁰ 33'35.41" E-89 ⁰ 50'1.33" 11-04-2019	
Sesame (<i>Sesamum indicum</i>)					
1	NRI-169	Kalotil/ Kharif/ Field	Name: Sohid Mondol Village: Parchar Union: Pourosova, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23 ⁰ 35'21.34" E-89 ⁰ 46'48.02" 12-04-2019	
2	NRI-64	Kalotil/ Kharif/ Field	Name: Dilip Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur Sadar District: Faridpur	N-23034'26.4" E-89045'44.1" 10-04-2019	
3	NQR-37	Krishnotil/ Kharif/ Field	Name: Md. Abdul Kadir Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	MRI-31	Til/ Kharif/ Field	Name: Md. Ruhul Amin Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
5	NRI-13	Lal til/ Kharif/ Field	Name: Shankar Mondol Village: Bosurabad Union: 2, No, Bosurabad Upazila: Botiaghata District: Khulna	13 September 2018 N-22°43'28.31" E-89°29'52.01"	
6	SAA-28	Gaichatil/ Rainfed/ Kharif	Name: Polmani Chakma Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
7	SAA-34	Til (sada)/ Rainfed/ Kharif	Name: Bibika Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
Sesbania (<i>Sesbania sesban</i>)					
1	NRI-193	Dhaincha/ Field/ Kharif-II	Name: Ahammed Ali Sheikh Village: Char Noshipur Union: Ambikapur Upazila: Faridpur Sadar District: Faridpur	N-23°38'34.39" E-89°47'22.84" 12-04-2019	
Snake gourd (<i>Trichosanthes cucumerin</i>)					
1	NRI-219	Chichinga/ <i>Macha</i> / Kharif	Name: Md. Sultan Village: Dewannagar (West) Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°29'58.58" E-91°48'0.53" 20-04-2019	
2	NRI-258	Koinda/ <i>Macha</i> / Kharif	Name: Saymon Village: Dewannagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'07.8" E-91°48'25.2" 21-04-2019	
3	NRI-270	Cicinga/ <i>Macha</i> / Kharif	Name: Md. Palash Molla Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	NRI-287	Cicinga/ Macha/ Kharif	Name: Shelina Begum Village: Varoimari (Sordarpara) Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
5	NRI-292	Cicinga/ Macha/ Kharif	Name: Nurjahan Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
	SNQR-34	Kusicicinga/ Irrigated/ Kharif I, II	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
	SAA-41	Jhum cicinga/ Irrigated/ Kharif (jhum)	Name: Moten Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
Spinach (<i>Spinacia oleracea</i>)					
1	NRI-121	Palongshak/ Rabi/ Field	Name: Kaiyum Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	
2	NRI-160	Palongshak/ Rabi/ Field	Name: Md. Akter Mondol Village: Parchar Union: Poulosava, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23035'21.34" E-89046'48.02" 12-04-2019	
3	NRI-205	Palongshak/ Rabi/ Field	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23035'56.39" E-89046'41.84" 11-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	NQR-26	Palongshak/ Rabi/ Field	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
5	NQ-60	Palongshak/ Rabi/ Field	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
6	NQ-68	Palongshak/ Rabi/ Field	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
7	NRI-24	Palongshak (Shada)/ Rabi/ Field	Name: Smiriti Mistri Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
8	NRI-29	Palongshak/ Rabi/ Field	Name: Ullasini Rai Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
9	N-205	Palongshak/ Rabi/ Field	Name: Alamgir Hossen Village: Dhormopur Union: Sadar-7 Upazila: Choumohoni District: Noakhali	28 October 2018 N-22°94' E-91°11'	
10	N-247	Khor Palong/ Rabi/ Field	Name: Md. Shoti Village: Kobutorhat Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-91°85'	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
11	N-250	Palongshak/ Rabi/ Field	Name: Maruf Hossen Village: Haidgaon Union: Haidgaon Upazila: Potiya District: Chattogram	29 October 2018 N-22°31' E-91°97'	
12	N-251	Khor Palong/ Rabi/ Field	Name: Md. Naim Village: Foteabad Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-91°85'	
13	SNQR-28	Palongshak/ Irrigated/ Rabi, Kharif I	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
14	SNQR-56	Palongshak/ Irrigated/ Rabi	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
Sponge gourd (<i>Luffa aegyptiaca</i>)					
1	NRI-208	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Md. Siddique Sheikh Village: Bahirdah Union: Macchor Upazila: Faridpur Sadar District: Faridpur	N-23°35'36.39" E-89°46'41.84" 12-04-2019	
2	NRI-224	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Md. Hasan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
3	NRI-229	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	NRI-233	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Abdul Mannan Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'12.5" E-91047'42.0" 20-04-2019	
5	NRI-251	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22030'07.8" E-91048'25.2" 21-04-2019	
6	NRI-88	Dhundul (Polla)/ Wild relatives	Name: Md. Abdur Rashid Village: Fursa Union: Kanaipur Upazila: Faridpur Sadar District: Faridpur	N-23043'26.4" E-89028'44.1" 10-04-2019	
7	NQR-4	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Larzina Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
8	NQR-36	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Prodip Chandra Ray Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	
9	NQ-76	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Md. Nazmul Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°44'54.2" E-89°49'41.8" 18-10-2019	
10	MRI-82	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Intiaz Begum Village: Chilmari Union: Nazirpur Upazila: Muladi District: Barishal	13 October 2018 N-22°57'39.65" E-90°21'54.47"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
11	NRI-20	Polla (Dhundul)/ Kharif	Name: Kumkum boiragi Village: Kochubunia (Jolma) Union: Chokrakhali Upazila: Botiaghata District: Khulna	13 September 2018 N-22°44'50.82" E-89°31'49.42"	
12	NSR-41	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
13	SU-27	Dhundol/ Kharif/ Home yard-on other tree plants	Name: Alamgir Village: Sutiakhali Union: Kawatkhali Upazila: Mymensingh Sadar District: Mymensingh	30 October 2018 N-24°41'51.5" E-90°27'14.1"	
14	SNQR-51	Monakobij (Dhundol)/ Irrigated/ Rabi, Kharif I	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
15	SNQR-64	Dhundol/ Irrigated/ Kharif I, II	Name: Zakir Hossen Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
16	SNQR-67	Dhundol/ Irrigated/ Kharif I	Name: Shah Alam Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
Teasle gourd (<i>Momordica dioica</i>)					
1	NRI-218	Korol (Kakrol)/ Field/ Vegetative reproduction	Name: Md. Ibrahim Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	22°30'0" E-91°47'60" 20-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	NQ-70	Kakrol/ Kharif/ Home yard	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
3	NQ-86	Kakrol/ Kharif/ Home yard	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	
Turmeric (<i>Curcuma longa</i>)					
1	NRI-43	Holud/ Rabi/ Field	Name: Ajoy Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur Sadar District: Faridpur	N-23°35'26.4" E-89°46'44.1" 10-04-2019	
2	NRI-44	Adagatiholud/ Rabi/ Field	Name: Dilip Das Village: Velabaj Union: Krisnonagor Upazila: Faridpur Sadar District: Faridpur	N-23°35'26.4" E-89°46'44.1" 10-04-2019	
3	NRI-138	Sonamukhholud / Rabi/ Field	Name: Abdul Kader Khan Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'2.2" E-89°49'34.64" 11-04-2019	
4	SAA-31	Jhum halud/ Rainfed/ Annual (Jhum)	Name: Polmani Chakma Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
Wheat (<i>Triticum aestivum</i>)					
1	NRI-162	Gom/ Rabi/ Field	Name: Md. Akter Mondol Village: Parchar Union: Pourosaba, ward-03 Upazila: Faridpur Sadar District: Faridpur	N-23°35'21.34" E-89°46'48.02" 12-04-2019	
White pea (<i>Phaseolus vulgaris</i>)					
1	NRI-110	Dabri/ Rabi	Name: Shahid Sheikh Village: Piarpur Union: Kojjuri Upazila: Faridpur Sadar District: Faridpur	N-23°33'35.41" E-89°50'1.33" 11-04-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Yard-long bean (<i>Vigna unguiculate</i>)					
1	NRI-226	Borboti (sada)/ Rabi/ <i>Macha</i>	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'12.5" E-91°47'42.0" 20-04-2019	
2	NRI-227	Borboti (kalo)/ Rabi/ <i>Macha</i>	Name: Nuruzzaman Village: Sujanagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°30'12.5" E-91°47'42.0" 20-04-2019	
3	NRI-237	Borboti/ Rabi/ <i>Macha</i>	Name: Orchona Chowdhury Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°03'05.9" E-91°04'27.9" 20-04-2019	
4	NRI-244	Borboti/ Rabi/ <i>Macha</i>	Name: Sahana Begum Village: Alipur Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°03'05.9" E-91°04'27.9" 20-04-2019	
5	NRI-263	Borboti/ Rabi/ <i>Macha</i>	Name: Saymon Village: Dewan nagar Union: Hathazari pourosova Upazila: Hathazari District: Chattogram	N-22°03'07.8" E-91°04'25.2" 21-04-2019	
6	NRI-266	Borboti/ Rabi/ <i>Macha</i>	Name: Moriom Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	
7	NRI-278	Borboti/ Rabi/ <i>Macha</i>	Name: Mst. Fahima Khatun Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 11-07-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
8	NQR-30	Borboti/ Rabi/ <i>Macha</i>	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
9	MRI-19	Borboti/ Rabi/ <i>Macha</i>	Name: Md. Belal Hossen Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
10	MRI-68	Borboti/ Rabi/ <i>Macha</i>	Name: Hasina Begum Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'24.54" E-90°7'11.79"	
11	MRI-73	Borboti/ Rabi/ <i>Macha</i>	Name: M. Joynal Abedin Kazi Village: Tarikata Union: Dulassor Upazila: Mohipur District: Patuakhali	12 October 2018 N-21°51'26.9" E-90°07'31.6"	
12	MRI-96	Barboti (Borkudi) Rabi/ <i>Macha</i>	Name: Yeasmin Village: Boro Laxmipur Union: Safipur Upazila: Muladi District: Barishal	14 October 2018 N-23°01'38.6" E-90°22'15.6"	
13	N-207	Lal Borboti/ Rabi/ <i>Macha</i>	Name: Asgar Chowdhury Village: Chowdhuri Hat Union: Hathazari Upazila: Hathazari District: Chottogram	29 October 2018 N-22°44' E-91°82'	
14	N-208	SobujBorboti/ Rabi/ <i>Macha</i>	Name: Md. Saiful Islam Village: Boiltoli Bazar Union: Dohazari Upazila: Chandanaish District: Chattogram	29 October 2018 N-22°16' E-92°06'	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
15	N-209	SadaBorboti/ Rabi/ Macha	Name: Sozib Chowdhury Village: Chowdhuri Hat Union: Foteabad Upazila: Hathazari District: Chattogram	30 October 2018 N-22°44' E-91°81'	
16	N-243	Borboti/ Rabi/ Macha	Name: Piplu Rakhiyan Village: Khansama Chori Union: Khansama Upazila: Rowangchori District: Bandarban	30 October 2018 N-22°13' E-92°28'	
17	SNQR-59	Borboti/ Irrigated/ Rabi	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
18	SNQR-68	Borboti (Sonai)/ Irrigated/ Rabi	Name: Shah Alam Village: Varashimla Union: Varashimla Upazila: Kaliganj District: Satkhira	N-22.48083 E-89.01310 15-10-2020	
19	SAA-22	Jhum borboti (lal)/ Irrigated/ Rabi (Jhum)	Name: Bibika Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
20	SAA-35	Jhum borboti/ Irrigated/ Rabi (Jhum)	Name: Moten Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23°12'10" E-92°03'58" 23/12/2019	
21	SAA-44	Jhum borboti/ Irrigated/ Rabi (Jhum)	Name: Dipali Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°11'07" E-92°01.56" 23/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
22	SAA-50	Jhum borboti/ Irrigated/ Rabi (Jhum)	Name: Chandrakishor Tripura Village: 6 Mile, Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23°10'34" E-92°01'38" 23/12/2019	
Mung bean (<i>Vigna radiata</i>)					
1	MRI-3	Sona mug/ Kharif-I/ Field	Name: Chintahoron Hawlader Village: Uttor Muradia Union: Muradia Upazila: Dumki District: Patuakhali	08 October 2018 N-22°26'3.8" E-90°25'13.17"	
2	MRI-48	Sona mug (Chotodail)/ Kharif-I/ Field	Name: Md. Shanu Fakir Village: Itbaria Union: Itbaria Upazila: Patuakhali Sadar District: Patuakhali	09 October 2018 N-22°22'2.58" E-90°17'15.8"	
3	MRI-62	Mugdai/ Kharif-I/ Field	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	
4	MRI-66	Sonamug/ Kharif-I/ Field	Name: Israt Jahan Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'24.54" E-90°7'11.79"	
5	SU-22	Sona mug/ Kharif-I/ Field	Name: Sumon Village: Union: Tala Upazila: Tala District: Sathkhira	30 October 2018 N-22°45'02" E-89°15'29.1"	
6	SNQR-45	Choita mug dal/ Irrigated/ Kharif I	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
Cowpea (<i>Vigna unguiculata</i>)					
1	MRI-55	Feludal (Plane dail)/ Rabi/ Field	Name: Md. Al-Amin Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'23.79" E-90°7'12.54"	

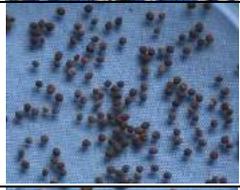
Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	MRI-63	Feludail/ Rabi/ Field	Name: Israt Jahan Village: Fashipara Union: Lotachapli Upazila: Kolapara District: Patuakhali	11 October 2018 N-21°50'24.54" E-90°7'11.79"	
3	SU-32	Felon/ Rabi/ Field	Name: Md. Azam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
4	SU-33	Felon/ Rabi/ Field	Name: Md. Azam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
5	SU-34	Felon/ Rabi/ Field	Name: Md. Kamrul Islam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
6	SU-35	Felon/ Rabi/ Field	Name: Md. Kamrul Islam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
7	SU-36	Felon/ Rabi/ Field	Name: Md. Kamrul Islam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
8	SU-37	Felon/ Rabi/ Field	Name: Md. Kamrul Islam Village: Tarabonna Union: Tarabonna Upazila: Cox's bazar Sadar District: Cox's bazaar	12 November 2018 N-22°30'46.0" E-91°47'47.4"	
French bean (<i>Phaseolus vulgaris</i>)					
1	N-212	Khaissa Sim/ Rabi/ Field	Name: Md. Shofi Village: Kobutorhat Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-91°85'	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	N-213	KhaissaForash Sim/ Rabi/ Field	Name: Azim Uddin Village: Dewan Nagar Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-91°85'	
3	N-245	Forasi Sim/ Rabi/ Field	Name: Rohim Mia Village: Hasan Dondi Union: Dohazari Upazila: Chandanaish District: Chattogram	30 October 2018 N-22°13' E-92°06'	
4	N-257	Forasi Sim (Golapi)/ Rabi/ Field	Name: Md. Shofi Village: Kobutorhat Union: Hathazari Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-92°85'	
5	N-258	Khassia Sim/ Rabi/ Field	Name: Ciru Mia Village: Foteabad Union: Chowdhrihat Upazila: Hathazari District: Chattogram	30 October 2018 N-22°50' E-92°85'	
6	N-259	ForasiKhassia/ Rabi/ Field	Name: Memaling Rakhiyan Village: Kodomtoli Union: Kodomtoli Upazila: Ali Kadam District: Bandarban	30 October 2018 N-22°33' E-91°82'	
7	N-195	Kidney bean/ Rabi/ Field	Name: Dr. Zakir Hossain Village: Doriadawlat Union: Doriadawlat Upazila: Bancharampur District: Cumilla	21 September 2018 N-23°48'43.2" E-90°47'52.8"	
Amaboshashak					
1	N-199	Amaboshashak/ Rabi/ Field	Name: Waser Hossain Village: Srirampur Union: Tripura Upazila: Shoilkupa District: Jhinaidha	29 November 2018 N-23°41'4.09" E-89°10'41.02"	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Sword bean (<i>Canavalia gladiata</i>)					
1	NSR-48	Katari shim/ Rabi/ Field yard-on other tree plants	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
2	SNQR-2	Kola sheem/ Rainfed/ Rabi season	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
3	SNQR-13	Borokola sim/ Irrigated/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
Potato (<i>Solanum tuberosum</i>)					
1	NSR-40	Kishor alu/ Rabi/ Field	Name: Sujon Ali Village: Salgaria Union: Salgaria Upazila: Pabna Sadar District: Pabna	03 October 2018 N-23°59'50" E-89°15'19.7"	
Musk melon (<i>Cucumis melo</i>)					
1	NRI-290	Bangi/ Kharif-I/ Field	Name: Ruma Village: Varoimari Union: Solimpur Upazila: Ishwardi District: Pabna	24°8'40.67"N 89°2'22.96"E 12-07-2019	
2	NQ-56	Bangi/ Kharif-I/ Field	Name: Md. Shahin Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
3	NQ-83	Bangi/ Kharif-I/ Field	Name: Md. Kamrul Village: Shankarpur Union: Noapara Upazila: Islampur District: Jamalpur	N-25°04'21.3" E-89°45'49.6" 19-10-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
4	SAA-47	Jhum cinal/ Irrigated/ Kharif	Name: Gouranga Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 11'07" E-92 ⁰ 01.56" 23/12/2019	
5	SAA-58	Jhum cinal/ Irrigated/ Kharif	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23 ⁰ 06'29" E-91 ⁰ 59'23" 24/12/2019	
Indigo (<i>Indigofera tinctorial</i>)					
1	NQR-1	Neel/ Rabi/ Field	Name: Dr. M. Mohi Uddin Village: BSPC Union: BSPC Upazila: Debiganj District: Panchagarh	N-26.09899 E-88.767254 12-11-2019	
Chinese mallow (<i>Malva verticillate</i>)					
1	NQR-2	Lafashak/ Year round/ Field/ Home yard	Name: Moniruzzaman Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
2	NQR-14	Lafashak/ Year round/ Field/ Home yard	Name: Rohima Begum Village: Sikdar para Union: Sonahar Upazila: Debiganj District: Panchagarh	N-26.05165 E-88.72736 13-11-2019	
3	NQR-16	Lafashak/ Year round/ Field/ Home yard	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
4	NQR-41	Lafashak/ Year round/ Field/ Home yard	Name: Longkeshor Ray Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
5	NQR-49	Lafashak/ Year round/ Field/ Home yard	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Foxtail Millet (<i>Setaria italica</i>)					
1	NQR-3	Kawoon/ Rabi/ Field	Name: Md. Fazal Haque Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
2	NQR-23	Kawoon/ Rabi/ Field	Name: Abdus Salam Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
3	NQR-35	Kawoon/ Rabi/ Field	Name: Prodip Ch. Day Village: Danga para Union: Balrampur Upazila: Mulani District: Thakurgao	N-26.19113 E-88.51921 14-11-2019	
4	NQR-42	Kawoon/ Rabi/ Field	Name: Md. Robiul Islam Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
5	NQR-43	Kawoon/ Rabi/ Field	Name: Md. Probar Hossen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
6	NQR-44	Kawoon/ Rabi/ Field	Name: Nogen Village: Boal Danga Union: Rongian Bazar Upazila: Debipur District: Thakurgao	N-26.17937 E-88.51668 14-11-2019	
Different leafy vegetables					
1	NQR-10	Babar shak/ Year round/ Field/ Home yard	Name: Moniruzzaman Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
2	NQR-29	Babar shak/ Year round/ Field/ Home yard	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
3	SNQR-3	Veto shak/ Irrigated/ Kharif II, Rabi	Name: Lovlu Village: Arpara Union: Shidnagar Upazila: Kaliganj District: Jhinaidah	N-23.36522 E-89.14153 13-10-2020	
4	SAA-63	Raishak/ Irrigated/ Year round	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23 ⁰⁶ '29" E-91 ⁰⁵⁹ '23" 24/12/2019	
5	SAA-69	Katarongshak/ Irrigated/ Year round	Name: BARI sub-station Village: HARS Union: Khagrachari Upazila: Khagrachari Sadar District: Khagrachari	N-23.10885 E-92.00031 24-12-2019	
Yam (<i>Dioscorea bulbifera</i>)					
1	NQR-12	Gozalu/ Annual/ Home yard-on other tree plants	Name: Lutu Village: Burujerdanga Union: 3 no. Debiganj Upazila: Debiganj District: Panchagarh	N-26.14964 E-88.75745 12-11-2019	
2	SAA-33	Jhum alu/ Irrigated/ Rabi	Name: Moten Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰¹² '10" E-92 ⁰⁰³ '58" 23/12/2019	
3	SN-9	KhamoChupni (Mete alu)/ Rainfed/ Annual	Name: Saburon Nessa Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
4	SN-10	Dil Alu (Mete alu)/ Rainfed/ Annual	Name: Saburon Nessa Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	
5	SN-11	Altapata (Mete alu)/ Rainfed/ Annual	Name: Saburon Nessa Village: Tripurapur Union: Chaluahati Upazila: Monirampur District: Jashore	N-22.933543 E-89.166874 04-03-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Radish (<i>Raphanus sativus</i>)					
1	NQR-24	Mula/ Rabi/ Field/ Line sowing	Name: Abdul Malek Village: Atwari Bazar Union: Atwari Upazila: Atwari District: Panchagarh	N-26.24106 E-88.40820 13-11-2019	
2	NQ-51	Mula/ Rabi/ Field/ Line sowing	Name: Huzaifa Rahman Village: Berapatahalia Union: Pourasaba Upazila: Jamalpur Sadar District: Jamalpur	N-24°51'55.4" E-90°02'19.4" 17-10-2019	
3	NQ-65	Mula/ Rabi/ Field/ Line sowing	Name: Md. Asfaq Village: Kharkaria Union: Rangachua Upazila: Jamalpur Sadar District: Jamalpur	N-24°52'06.7" E-90°02'17.8" 17-10-2019	
4	NQ-69	Mula/ Rabi/ Field/ Line sowing	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
5	NQ-72	Mula/ Rabi/ Field/ Line sowing	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
6	NQ-73	Mula/ Rabi/ Field/ Line sowing	Name: Hossain Village: Karnibari Union: Karnibari Upazila: Sarishabari District: Jamalpur	N-24°45'14.7" E-89°49'50.3" 18-10-2019	
German Turnip (<i>Brassica oleracea L. var. gongylodes</i>)					
1	NQ-48	Olkopi/ Rabi/ Field/ Line sowing	Name: Md. Abdur Rob Village: Giadhat Union: Haibatpur Upazila: Jashore Sadar District: Jashore	N-23°11'40.9" E-89°19'25.7" 02-10-2019	
Medicinal plants					
1	SNQR-27	Cakondo/ Rainfed/ Rabi	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
2	SNQR-29	Bishallakoroni/ Rainfed/ Perennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
3	SNQR-32	Bautulsi/ Rainfed/ Perennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
4	SAA-30	Tulsi/ Rainfed/ Annual	Name: Mayadhan Chakma Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	
5	SNQR-35	Ombolmodhu/ Rainfed/ Perennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
6	SNQR-36	Tokma dana/ Rainfed/ Perennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
7	SNQR-38	Pithegorafol/ Rainfed/ Perennial	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
8	SNQR-50	Dupri ful/ Rainfed/ Annual	Name: Arpana Rani Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.272624 E-89.136888 14-10-2020	
9	SNQR-52	Bokful/ Rainfed/ Perennial	Name: Gonesh Ch. Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
10	SAA-56	Tetfulgula/	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23 ⁰ 06'29" E-91 ⁰ 59'23" 24/12/2019	
11	SAA-65	Hugibigol	Name: Sukiron Chakma Village: TUS (NGO) Union: Milonpur Upazila: Khagrachari Sadar District: Khagrachari	N-23 ⁰ 06'29" E-91 ⁰ 59'23" 24/12/2019	
Carrot (<i>Daucus carota</i>)					
1	SNQR-54	Gajhor/ Irrigated/ Rabi, Kharif I	Name: Gonesh Ch.Mondol Village: Dhumghat Union: Ishwaripur Upazila: Shamnagar District: Satkhira	N-22.27883 E-89.11263 14-10-2020	
Coffee (<i>Coffea arabica</i>)					
1	SAA-01	Coffee/ Perennial	Name: Tonachakma Village: Konglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 29'19" E-92 ⁰ 16'46" 22/12/2019	
Taro (<i>Colocasia esculenta</i>)					
1	SAA-06	Naricalkachu/ Rainfed/ Annual	Name: Raju Sinha Village: Konglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 29'19" E-92 ⁰ 16'46" 22/12/2019	
2	SAA-07	Mukhikachu/ Rainfed/ Annual	Name: Raju Sinha Village: Kanglak Pahar Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 29'19" E-92 ⁰ 16'46" 22/12/2019	
3	SAA-29	Gurikachu/ Rainfed/ Kharif	Name: Mayadhan Chakma Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	
4	SAA-38	Mukhikachu/ Rainfed/ Kharif	Name: Aben Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	

Sl. #	Collector's No.	Local/cultivar name/cultural practice	Donor's name and address	Geographic location and date	Photograph
Yam bean (<i>Pachyrrhizus tuberosa</i>)					
1	SAA-32	Shak alu/ Irrigated/ annual	Name: Polmani Chakma Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	
Broom corn (<i>Sorghum bicolor</i>)					
1	SAA-37	Sorghum (kalo)/ Irrigated/ Rabi	Name: Aben Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	
2	SAA-39	Sorghum (sada)/ Irrigated/ Rabi	Name: Bibika Tripura Village: Rashiknagar Union: Marung Upazila: Dighinala District: Khagrachari	N-23 ⁰ 12'10" E-92 ⁰ 03'58" 23/12/2019	
Maize (<i>Zea mays</i>)					
1	SAA-48	Jhum vutta (kalo)/ Irrigated/ Rabi (Jhum)	Name: Gourangha Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 11'07" E-92 ⁰ 01.56" 23/12/2019	
2	SAA-49	Jhum vutta (sada)/ Irrigated/ Rabi (Jhum)	Name: Dipali Tripura Village: 8 Mile Perachora Union: Sajek Upazila: Bagharichori District: Rangamati	N-23 ⁰ 11'07" E-92 ⁰ 01.56" 23/12/2019	
3	SAA-53	Jhum vutta / Irrigated/ Rabi (Jhum)	Name: Chandrakishor Tripura Village: 6 Mile, Perachora Union: Sajek Upazila: Baghaichori District: Rangamati	N-23 ⁰ 10'34" E-92 ⁰ 01'38" 23/12/2019	

Conclusion

Primitive cultivars/landraces and wild relatives of agri-horticultural crops are still available in less accessible areas of the country, which are also endangered. Massive collection mission is essential to rescue these invaluable landraces and wild relatives.

11.3.2. Characterization of Pumpkin Germplasm

Qualitative character

Qualitative variations of different characters of pumpkin are presented below (Table 30). In plant character, early plant vigor and plant growth habit showed the variability among the germplasm. In vegetative stage 51.56% germplasm performed good for early plant vigor and 48.44% was very good. Good plant growth habit of 54.69% germplasm and 45.31% very good were observed. In leaf character, there are some variations observed on leaf size. Small, medium and large three types of leaf size were found, most of them (59.38%) were medium leaf size. Based on the fruit the variations (Fig. 31) were observed on mature fruit skin color, fruit skin pattern, stem end fruit shape, blossom end fruit shape, fruit ridge shape and matured fruit flesh color. The maximum variations were obtained on mature fruit skin color and fruit shape. Different types of fruit shape were found among the germplasm like globular (53.13%), flattened (21.88%), oblong blocky (10.94%) and elliptical (14.06%). The maximum variation of mature fruit skin color was observed creamish (4.69%) yellowish (4.69%) green (6.25%) deep brown (3.13%) brown (34.38%) brown with green (25.00%) yellow with green (21.88%) (Fig. 32). Most of the germplasm (82.81%) expressed mottled fruit skin pattern and rest of them (17.19%) uniform. Whereas 89.06% depressed and 9.38% flattened and 1.56% pointed both stem end fruit shape and blossom end fruit shape were observed. Superficial 4.69%, intermediate 70.31% and deep grooved 25% fruit ridge shape were found. Flesh color of mature fruits was orange in 70.31% germplasm and yellow in 29.69%. All germplasm showed dense stem pubescence density and angular stem shape. The tendril was present and coiled type tendril with branching for all germplasm. In case of leaf, undulated leaf margin, cordate leaf shape, silver color of leaf spot was found. Monoecious sex type and angular grooved peduncle shape were observed.

Table 30. Qualitative variation in different characters of pumpkin germplasm

Descriptor	Descriptor state	No. of acc.	Percent (%) of acc.
Early plant vigor	Good	33	51.56
	Very good	31	48.44
Plant growth habit	Good	35	54.69
	Very good	29	45.31
Stem pubescence density	Dense	64	100.00
Stem shape	Angular	64	100.00
Tendril	Present	64	100.00
Tendril type	Coiled	64	100.00
Tendril branching	Branched	64	100.00
Leaf margin	Undulated	70	109.38
Leaf shape	Cordate	64	100.00
Leaf size	Small	12	18.75
	Medium	38	59.38
	Large	14	21.88
Leaf pubescence density	Dense	64	100.00
Color of leaf spot	Silver	64	100.00
Sex type	Monoecious	64	100.00
Peduncle shape	Angular grooved	64	100.00
Fruit shape	Globular	34	53.13
	Flattened	14	21.88
	Oblong blocky	7	10.94
	Elliptical	9	14.06

Table 30. Cont'd

Descriptor	Descriptor state	No. of acc.	Percent (%) of acc.
Mature fruit skin color	Creamish	3	4.69
	Yellowish	3	4.69
	Green	4	6.25
	Deep brown	2	3.13
	Brown	22	34.38
	Brown with green	16	25.00
	Yellow with green	14	21.88
Fruit skin pattern	Uniform	11	17.19
	Mottled	53	82.81
Stem end fruit shape	Depressed	57	89.06
	Flattened	6	9.38
	Pointed	1	1.56
Blossom end fruit shape	Depressed	57	89.06
	Flattened	6	9.38
	Pointed	1	1.56
Fruit ridge shape	Superficial	3	4.69
	Intermediate	45	70.31
	Deep grooved	16	25.00
Mature flesh color	Yellow	19	29.69
	Orange	45	70.31

Quantitative character

Range, mean, standard deviation and coefficient of variation of different quantitative characters of pumpkin have been presented in Table 31. The range of number of primary branches was found 2 to 4 and average number of ridges per fruit 11.16. On an average, days to 1st male flower were 76.84 and days to 1st female flower were 80.66. The average flesh thickness 3.36 cm and number of fruits per plant 5.56 was observed. The range of fruit length 10 to 30.50 cm and fruit breadth 13.75 to 52.00 cm were identified. On an average, fruit weight was 2.99 kg. Among the germplasm average TSS (Brix) 5.92% was recorded. The maximum coefficient of variation was obtained for number of fruits per plant 41.25% followed by fruit weight in kg 34.53% and nodal position of 1st male flower 33.67%. The minimum CV was found for days to 1st male flower (10.38%). Percent of coefficient of variation indicated the variability among the germplasm comparing within the characters. The promising germplasm were selected based on sweetness of fruit on brix % like AHI-63 (10% TSS), RAI-87 (10% TSS), RAI-254 (10% TSS), RAI-279 (8% TSS) and AC-512 (8% TSS).

Table 31. Quantitative variation in different descriptors of pumpkin germplasm

Character	Range	Mean	SD	CV (%)
Number of primary branches	2.00- 4.00	2.70	0.61	22.53
Days to 1 st male flower	49.00-92.00	76.84	7.98	10.38
Days to 1 st female flower	56.00-94.00	80.66	8.73	10.82
Nodal position of 1st male flower	2.00-10.00	3.42	1.15	33.67
Nodal position of 1st female flower	2.00-19.00	12.42	3.97	31.97
Number of ridges per fruit	5.50-17.20	11.16	2.46	22.05
Flesh thickness (cm)	2.25-4.50	3.36	0.52	15.43
Fruit length (cm)	10.00-30.50	18.36	4.91	26.76
Fruit breadth (cm)	13.75-52.00	19.74	4.89	24.78
Fruit weight (kg)	1.14-5.43	2.99	1.03	34.53
Number of fruits per plant	2.00-12.00	5.56	2.29	41.25
TSS (Brix) %	4.00-10.00	5.92	1.48	25.07

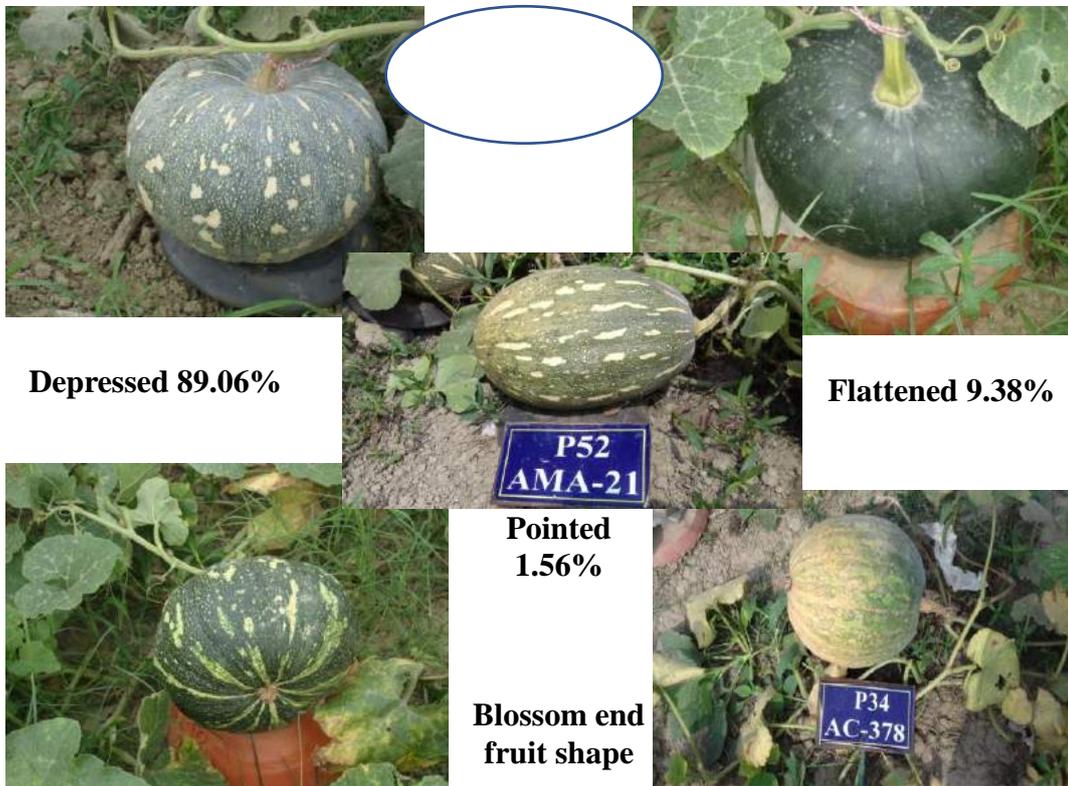
Conclusion

The genetic variability of 64 germplasm of pumpkin was estimated using of qualitative and quantitative characters. Eight germplasm were selected based on the sweetness of fruit and yield per plant for future utilization.



Superficial: 4.69%
Intermediate: 70.31%
Deep Grooved: 25.00%

Fig. 30. Variation in pumpkin fruit ridge



Depressed 89.06%

Flattened 9.38%

Pointed
1.56%

Blossom end
fruit shape

Fig. 31. Variation in pumpkin fruit shape



Globular



Flattened



Oblong blocky



Elliptical

Cont'd Fig. 31. variation in pumpkin fruit shape



Fig. 32. Variation in fruit skin pattern of pummkin



Fig. 33. Variation in leaf of pumpkin



Fig. 34. Peduncle shape of pumpkin



Fig. 35. Stem characters of pumpkin



Green 6.25%



Brown with green 25%



Creamish 4.69%



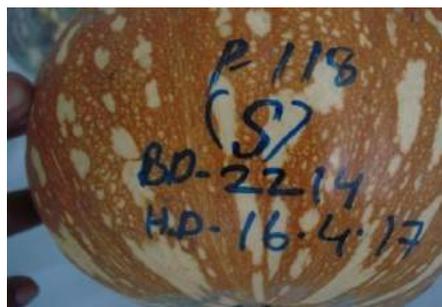
Yellow with green 21.88%



Deep Brown 30.13%



Yellow 4.69%



Brown 34.38%

Fig. 36. Variation in matured fruit skin color of pumpkin

Table 32. Qualitative characters of pumpkin germplasm

Coll. No.	Early plant vigor	Plant growth habit	Stem pubescence density	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	Leaf size	Leaf pubescence density	Color of leaf spot	Sex type
1	2	3	4	5	6	7	8	9	10	11	12	13	14
AHI-63	7	7	2	2	1	1	2	4	1	5	7	3	1
AHI-121	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-87	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-139	3	5	2	2	1	1	2	4	1	5	7	3	1
RAI-151	3	5	2	2	1	1	2	4	1	5	7	3	1
RAI-178	5	7	2	2	1	1	2	4	1	5	7	3	1
RAI-195	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-196	7	7	2	2	1	1	2	4	1	7	7	3	1
RAI-211	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-254	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-268	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-278	5	5	2	2	1	1	2	4	1	5	7	3	1
RAI-279	3	5	2	2	1	1	2	4	1	5	7	3	1
SA-39	3	5	2	2	1	1	2	4	1	3	7	3	1
M-54	3	5	2	2	1	1	2	4	1	5	7	3	1
AR-182	3	3	2	2	1	1	2	4	1	3	7	3	1
AR-221	5	5	2	2	1	1	2	4	1	5	7	3	1
AR-238	5	3	2	2	1	1	2	4	1	3	7	3	1
AR-257	3	3	2	2	1	1	2	4	1	3	7	3	1
AC-13	7	7	2	2	1	1	2	4	1	7	7	3	1
AC-15	7	7	2	2	1	1	2	4	1	7	7	3	1
AC-22	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-62	3	3	2	2	1	1	2	4	1	3	7	3	1
AC-73	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-90	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-107	3	3	2	2	1	1	2	4	1	3	7	3	1
AC-136	7	7	2	2	1	1	2	4	1	7	7	3	1
AC-192	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-225	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-253	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-258	7	7	2	2	1	1	2	4	1	5	7	3	1
AC-263	7	5	2	2	1	1	2	4	1	5	7	3	1
AC-345	5	5	2	2	1	1	2	4	1	3	7	3	1
AC-378	5	5	2	2	1	1	2	4	1	7	7	3	1
AC-428	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-447	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-448	5	5	2	2	1	1	2	4	1	5	7	3	1
AC-465	7	7	2	2	1	1	2	4	1	5	7	3	1
AC-469	5	5	2	2	1	1	2	4	1	3	7	3	1
AC-512	7	7	2	2	1	1	2	4	1	5	7	3	1
RAI-224	7	7	2	2	1	1	2	4	1	7	7	3	1
MAH-10	7	3	2	2	1	1	2	4	1	5	7	3	1
MAH-24	5	3	2	2	1	1	2	4	1	3	7	3	1
MAH-44	7	5	2	2	1	1	2	4	1	3	7	3	1

Table 32. Cont'd

Coll. No.	Early plant vigor	Plant growth habit	Stem pubescence density	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	Leaf size	Leaf pubescence density	Color of leaf spot	Sex type
MAH-50	5	5	2	2	1	1	2	4	1	7	7	3	1
MAH-60	5	5	2	2	1	1	2	4	1	7	7	3	1
ATR-1	7	7	2	2	1	1	2	4	1	7	7	3	1
ATR-2	3	3	2	2	1	1	2	4	1	5	7	3	1
ATR-7	3	3	2	2	1	1	2	4	1	5	7	3	1
ATR-28	5	5	2	2	1	1	2	4	1	7	7	3	1
ATR-45	7	7	2	2	1	1	2	4	1	5	7	3	1
AMA-21	7	7	2	2	1	1	2	4	1	5	7	3	1
AMA-24	5	5	2	2	1	1	2	4	1	3	7	3	1
AMA-33	5	5	2	2	1	1	2	4	1	3	7	3	1
AMA-42	5	5	2	2	1	1	2	4	1	5	7	3	1
AMA-47	7	7	2	2	1	1	2	4	1	7	7	3	1
AMA-76	5	5	2	2	1	1	2	4	1	5	7	3	1
AMA-84	7	7	2	2	1	1	2	4	1	7	7	3	1
AMA-85	5	5	2	2	1	1	2	4	1	5	7	3	1
AMA-106	5	5	2	2	1	1	2	4	1	5	7	3	1
AMA-124	5	5	2	2	1	1	2	4	1	5	7	3	1
AMA-146	7	7	2	2	1	1	2	4	1	7	7	3	1
AMA-160	7	7	2	2	1	1	2	4	1	7	7	3	1
AC-332	5	5	2	2	1	1	2	4	1	5	7	3	1

Table 32. Qualitative characters of pumpkin germplasm (cont'd)

Coll. No.	Peduncle shape	Fruit shape	Mature fruit skin color	Fruit skin pattern	Stem end fruit shape	Blossom end fruit shape	Fruit ridge shape	Mature flesh color
1	15	16	17	18	19	20	21	22
AHI-63	3	1	5	1	1	1	3	3
AHI-121	3	5	6	2	3	3	3	3
RAI-87	3	5	1	2	3	3	3	3
RAI-139	3	2	1	2	1	1	3	3
RAI-151	3	1	1	2	1	1	3	3
RAI-178	3	1	6	2	1	1	3	1
RAI-195	3	5	7	1	3	3	3	3
RAI-196	3	2	2	2	1	1	3	1
RAI-211	3	1	7	2	1	1	3	3
RAI-254	3	1	7	1	3	3	3	3
RAI-268	3	1	8	2	1	1	3	1
RAI-278	3	5	7	2	1	1	3	1
RAI-279	3	1	7	2	1	1	3	1
SA-39	3	1	5	2	1	1	3	3
M-54	3	1	6	2	1	1	3	3
AR-182	3	1	6	2	1	1	3	3
AR-221	3	1	6	2	1	1	3	3

Table 32. Cont'd

Coll. No.	Peduncle shape	Fruit shape	Mature fruit skin color	Fruit skin pattern	Stem end fruit shape	Blossom end fruit shape	Fruit ridge shape	Mature flesh color
AR-238	3	1	8	2	1	1	3	1
AR-257	3	1	6	1	3	3	3	1
AC-13	3	1	7	1	3	3	3	1
AC-15	3	1	6	2	3	3	1	1
AC-22	3	4	3	2	1	1	1	3
AC-62	3	1	7	2	1	1	3	3
AC-73	3	1	8	2	1	1	3	3
AC-90	3	1	7	2	1	1	3	1
AC-107	3	5	7	2	3	3	1	3
AC-136	3	2	3	2	1	1	4	1
AC-192	3	1	3	2	3	3	3	3
AC-225	3	5	7	2	3	3	3	1
AC-253	3	1	6	2	1	1	3	3
AC-258	3	1	6	2	1	1	3	3
AC-263	3	1	8	2	1	1	3	3
AC-345	3	1	6	2	1	1	1	3
AC-378	3	4	7	2	3	3	1	3
AC-428	3	1	6	2	3	3	1	3
AC-447	3	1	8	2	1	1	3	3
AC-448	3	2	6	2	1	1	3	3
AC-465	3	4	6	2	3	3	3	3
AC-469	3	1	3	2	1	1	3	3
AC-512	3	1	8	2	1	1	3	3
RAI-224	3	1	6	2	1	1	1	1
MAH-10	3	4	2	2	3	3	3	3
MAH-24	3	1	8	1	1	1	1	3
MAH-44	3	5	8	2	3	3	3	3
MAH-50	3	1	8	2	1	1	4	3
MAH-60	3	5	8	1	1	1	4	1
ATR-1	3	4	8	2	3	3	4	1
ATR-2	3	1	6	2	1	1	1	1
ATR-7	3	9	8	2	3	3	3	1
ATR-28	3	1	6	2	1	1	3	3
ATR-45	3	2	6	2	1	1	3	3
AMA-21	3	1	7	2	1	1	3	3
AMA-24	3	1	8	2	1	1	3	3
AMA-33	3	2	7	2	1	1	3	3
AMA-42	3	4	8	2	3	3	3	3
AMA-47	3	1	7	2	1	1	3	3
AMA-76	3	9	6	1	3	3	3	3
AMA-84	3	1	6	1	3	3	3	3
AMA-85	3	1	6	2	3	3	3	3
AMA-106	3	5	7	2	3	3	3	3
AMA-124	3	4	6	1	3	3	3	1
AMA-146	3	4	6	1	3	3	3	3
AMA-160	3	2	7	2	3	3	4	3
AC-332	3	2	2	2	1	1	3	1

Table 33. Quantitative characters of pumpkin germplasm

Coll. No.	No. of primary branches/ plant	Days to 1 st male flower	D/ 1 st Female flower	Nodal position of 1st male flower	Nodal position of 1st female flower	No. of ridges /fruit	Flesh thickness (cm)	Fruit length (cm)	Fruit breath (cm)	Fruit weight (kg)	No. of fruit /plant	TSS (Brix) %
1	2	3	4	5	6	7	8	9	10	11	12	13
AHI-63	3	73	71	3	18	15.60	4.00	11.00	22.80	2.82	11	10
AHI-121	3	78	71	4	13	9.80	3.50	10.00	17.20	1.81	5	9
RAI-87	2	71	74	4	16	11.80	3.20	15.00	20.60	2.69	8	10
RAI-139	3	72	74	4	15	11.00	3.75	15.00	21.20	3.15	5	7
RAI-151	3	71	75	4	15	12.00	2.88	13.80	19.20	2.52	6	7
RAI-178	3	62	59	4	12	10.60	2.25	10.20	13.80	1.14	3	9
RAI-195	3	72	69	2	17	11.60	4.00	19.80	21.80	4.08	5	5
RAI-196	2	70	72	2	2	12.40	3.00	16.20	18.40	2.63	7	5
RAI-211	2	73	73	3	16	12.40	3.67	19.80	17.60	2.92	3	6
RAI-254	3	70	73	2	16	7.80	3.70	17.00	20.60	3.36	6	10
RAI-268	4	64	73	3	13	9.00	3.60	18.20	22.60	4.17	4	7
RAI-278	2	59	56	4	16	14.80	2.40	14.20	19.80	2.20	4	7
RAI-279	3	72	75	5	13	17.20	3.60	12.40	21.20	2.77	6	8
SA-39	2	75	69	3	16	11.00	3.25	14.50	23.25	3.90	4	7
M-54	3	81	89	3	12	16.67	3.75	10.67	18.67	2.11	4	7
AR-182	2	76	79	3	16	10.80	3.50	20.80	20.40	3.84	3	5
AR-221	3	76	90	4	12	15.80	3.00	10.50	17.60	1.74	9	7
AR-238	2	86	84	3	13	12.80	3.30	22.40	18.00	3.45	6	6
AR-257	3	84	84	3	13	13.00	4.00	20.00	16.60	3.16	5	7
AC-13	3	82	78	4	14	8.00	3.66	26.60	13.75	3.35	3	4
AC-15	3	78	80	3	12	8.60	3.00	25.60	14.60	2.87	5	4
AC-22	2	77	85	3	14	11.60	3.00	19.80	16.20	2.84	6	5
AC-62	3	79	84	3	19	12.20	3.84	16.60	17.00	2.54	8	5
AC-73	3	85	75	4	15	11.40	2.80	14.80	17.40	2.27	10	5
AC-90	2	77	75	2	12	9.00	2.70	13.00	15.40	1.52	2	4
AC-107	2	83	75	3	4	9.00	3.25	25.75	19.75	4.04	6	5
AC-136	3	77	80	3	4	12.50	3.00	23.50	18.50	3.04	3	6
AC-192	3	81	86	3	17	12.80	2.88	12.60	16.80	2.02	9	5
AC-225	3	77	81	3	16	9.40	2.70	13.80	17.40	2.38	9	5
AC-253	3	76	78	4	10	11.00	3.75	23.00	19.60	4.27	3	7
AC-258	3	78	84	3	12	8.60	3.00	12.60	16.60	1.34	9	5
AC-263	2	92	86	3	13	13.75	2.50	19.50	19.25	3.47	7	7
AC-345	2	78	90	5	12	10.67	3.00	20.00	19.67	2.73	3	6
AC-378	2	75	75	3	8	9.00	3.00	18.10	21.00	3.60	5	5
AC-428	3	75	75	3	13	11.00	3.40	23.00	19.80	3.60	3	6
AC-447	3	77	80	4	18	11.00	4.00	16.40	24.00	3.64	3	6
AC-448	2	75	75	4	13	7.50	3.17	17.50	24.00	3.96	5	6
AC-465	2	82	82	4	12	10.25	3.00	16.80	22.40	3.96	5	7
AC-469	3	75	72	3	6	13.00	4.50	17.80	22.40	3.92	4	6
AC-512	2	78	92	4	16	14.00	2.50	15.00	20.50	2.60	6	8
RAI-224	4	49	75	4	9	11.67	4.00	28.00	22.67	5.43	4	5
MAH-10	2	78	93	2	11	16.00	3.33	20.80	22.80	3.75	4	5

Table 33. Cont'd

Coll. No.	No. of primary branches/ plant	Days to 1 st male flower	D/ 1 st Female flower	Nodal position of 1 st male flower	Nodal position of 1 st female flower	No. of ridges /fruit	Flesh thickness (cm)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (kg)	No. of fruit /plant	TSS (Brix) %
MAH-24	2	78	80	3	18	10.40	2.33	21.60	19.20	2.88	7	5
MAH-44	2	78	79	3	14	9.20	3.67	15.20	16.20	1.66	12	4
MAH-50	3	71	91	3	13	8.20	3.20	16.80	18.80	2.36	8	5
MAH-60	3	78	91	4	12	5.50	4.20	30.50	22.50	4.90	7	5
ATR-1	2	74	81	3	14	9.25	3.50	22.75	18.25	3.94	4	5
ATR-2	2	71	77	4	12	10.20	4.50	23.80	15.60	3.07	6	6
ATR-7	3	71	75	2	13	10.67	3.25	16.33	18.33	2.52	4	7
ATR-28	2	71	77	6	7	15.00	3.00	14.50	23.00	3.77	4	5
ATR-45	3	71	75	3	15	11.20	3.60	14.40	17.60	2.39	11	5
AMA-21	3	91	90	10	8	9.60	3.00	27.20	16.60	3.00	7	5
AMA-24	3	92	92	5	12	10.20	2.75	15.40	17.00	2.15	5	4
AMA-33	4	73	91	3	12	8.40	3.40	20.00	16.20	2.59	7	5
AMA-42	3	78	91	3	14	10.20	3.60	22.00	18.00	3.04	8	4
AMA-47	4	76	91	3	13	7.00	4.00	27.50	20.50	4.56	7	5
AMA-76	2	72	77	3	16	14.60	3.25	16.40	22.00	3.28	6	5
AMA-84	3	72	76	3	10	14.00	3.25	20.50	16.50	3.42	5	5
AMA-85	2	77	93	3	12	10.40	3.33	24.80	16.20	2.85	4	6
AMA-106	3	91	93	3	13	8.40	4.50	15.80	19.60	2.96	3	6
AMA-124	3	91	94	2	3	10.00	3.56	16.54	18.53	3.24	4	6
AMA-146	3	91	94	3	3	10.60	3.54	25.00	52.00	3.25	3	5
AMA-160	3	91	94	3	3	10.20	3.67	15.00	23.40	4.07	5	5
AC-332	4	91	94	4	14	13.33	3.46	21.00	24.33	4.80	3	5

11.3.3. Characterization of Landraces of Cucumber

Qualitative descriptor

Plant growth was indeterminate type and tendril was present in all studied accessions (Table 34 and Fig. 35-38). Stem color was dark green in six accession but rest (12 accessions) showed light green color stem. Medium green colored leaves were present in 6 accessions, whereas light green colored leaves were showed in twelve accessions. No variation was found in leaf shape, tendril presence, leaf margin among all accessions. Stem end fruit shape was obtuse in most accessions (13) followed by acute (5) and blossom end fruit shape was flat among all accessions. Fruit skin texture at edible stage was smooth (18) in all accessions. Maximum number of accessions (14 accessions) showed oblong fruit shape while oval (4 accessions) fruit shape was also found among the accessions. Fruit skin color at edible stage was light green (13 accessions) followed by dark green (5 accessions). Maximum fruit skin color at fully ripening stage was brown (14) followed by yellow (4).

Table 34. Qualitative variation in different descriptors of Cucumber germplasm

Name of descriptor	Descriptor state	No. of germplasm
Plant growth type	Indeterminate	18
Stem color	Light green	12
	Dark green	06
Leaf intensity of green color	Light green	12
	Medium green	06
Leaf shape	Orbicular	18
Stem end fruit shape	Necked	0
	Acute	05
	Obtuse	13
Blossom end fruit shape	Flat	18
	Deep raised	0
	Blossom end tapered	0
Fruit shape	Oblong	14
	Oval	4
	Ellipsoid	0
	Blossom end tapered	0
Fruit skin color at table maturity	Light green	13
	Dark green	5
Fruit skin color at maturity	Brown	14
	Yellow	4
Seed color	Creamy	21

Quantitative descriptor

Range, mean, standard deviation and coefficient of variations are shown in Table 35. Low to medium variabilities among the germplasm was recorded for the quantitative characters studied. Highest variation (19.85%) was observed in fruit length closely followed by number of fruits per plant (18.71%). Internode length varied from 4.94 to 9.92 cm with an average of 7.816 cm with an average of 7.816 cm (CV- 16.01%). Variations among the germplasm in respect of length and width of leaves were medium (CV- 11.03 and 14.00, respectively). Fruit length ranged from 15.66 cm to 30.74 cm with an average of 20.33 cm. Number of fruits per plant showed medium variability, which ranged from 3.50 to 7.50 averaging 5.03. Days to staminate flower and pistillate flower ranged from 48 to 66 days and 56 to 73 days after sowing, respectively. The germplasm RAI -68 takes more duration to produce staminate and pistillate flower. Days to fruit at edible stage varied from 73 to 85 days after sowing. On an average, internode length, leaf blade length and leaf blade width were 7.81, 14.57 and 17.79 cm, respectively. Average fruit length and fruit width were 20.33 and 6.47 cm. The highest fruit length was recorded from RAI- 117 (30.74 cm) followed by RAI-116 (29.06 cm). The smallest fruit was obtained from AR-273 (15.66 cm). The highest fruit width was recorded from BD-4242 (8.42 cm) followed by RAI- 116 (8.12 cm) and the lowest fruit width was obtained from IAH-273 (5.08 cm). Number of fruit per plant at edible stage/ was ranged from 3.5 to 7.5. Maximum number fruits per plant were obtained from RAI- 209 and minimum number of fruits per plant was recorded from IAH-331. 100- Seed weight ranged from 2.96 to 3.48 gm. The highest coefficient of variation was found in fruit length (19.85 %) followed by fruit width (14.46%) and number of fruits per plant (18.71%). Coefficient of variation was also high in internode length (16.01). 100 seed weight showed the lowest (4.71%) coefficient of variation.



Fig. 37. Diversity in fruit shape of cucumber germplasm



Fig. 37. Diversity in fruit shape of cucumber germplasm (Cont'd)



Fig. 38. Shape of leaf (orbicular) and stem (angular) with pubescence



Fig. 39. Variation in fruit skin color at table maturity stage



Fig. 40. Variation in fruit skin color at matured stage

Table 35. Quantitative variation in different descriptors of cucumber germplasm

Descriptor	Range	Mean	Sd	CV (%)
Internode length	4.94-9.92	7.816	1.251	16.01
Leaf length (cm)	11.55-17.1	14.57	1.609	11.03
Leaf width (cm)	12.99-23.37	17.79	2.492	14.00
Fruit length	15.66-30.74	20.33	4.03	19.85
Fruit width (cm)	5.08-8.42	6.47	0.936	14.46
No. of fruit/pl	3.5-7.5	5.03	0.993	18.71
100 seed wt.	2.96-3.48	3.19	0.150	4.71
Days to staminate flower	48-66	56.76	5.048	8.89
Days to pistilate flower	56-73	65.09	5.356	8.22
Days to harvest	73-85	79.09	4.999	6.32

Conclusion

Variability showed in qualitative quantitative characters It was shown that, although morphological diversity was found among the accession but would be necessary to investigate genetic diversity based on the molecular analysis using accessions collected more widely.

11.3.4. Characterization of Brinjal Germplasm

The brinjal germplasm collected districts and GIS position presented in Bangladesh map (Fig. 41), color filled polygon indicate collected districts and blue point indicate the collected sample GIS positions (Fig. 42). The collected germplasm covered 36 districts of the country. Maximum richness of brinjal germplasm was found in Pabna district followed by Chattogram and Gazipur.

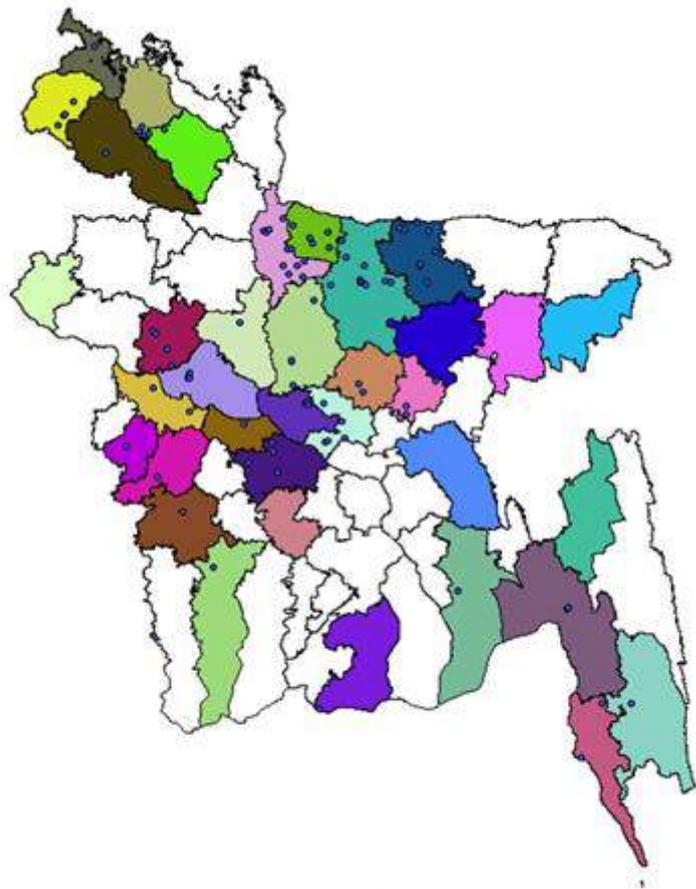


Fig. 41. GIS mapping of collected brinjal germplasm

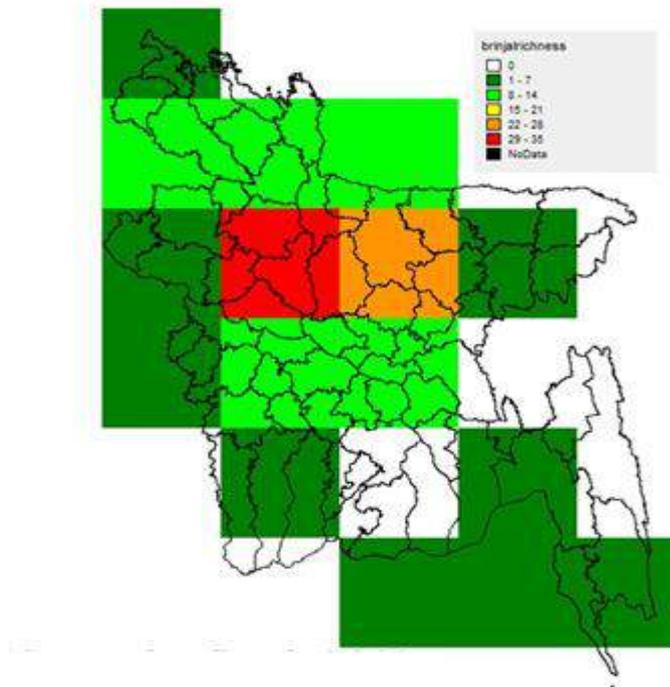


Fig. 42. Species richness of collected brinjal germplasm in Bangladesh map by using Shannon diversity index

A. Qualitative characters

A total of 18 qualitative characters were evaluated to know the variability of the studied germplasm (Table 36 & 37). All the characters showed distinct variation among the germplasm except leaf hairs, corolla color, fruit cross section and fruit position. The maximum variation observed in overall leaf prickles, fruit calyx prickles, fruit color at ripening and fruit flesh density.

Variability in growth and foliage

All the characters studied related to plant growth habit and foliage showed distinct variation among the germplasm except leaf hairs and corolla color (Table 35 & 36). Plant growth habit was observed in upright (67.6%), intermediate (10.2%) and prostrate only 22.1%). Leaf prickles were found in maximum variation such as very few (18.0%), few (33.6%), intermediate (42.6%), many (4.1%) and very many (1.6%) in studied germplasm. The Leaf blade tip angles were also exhibited as four categories such as Very acute (2.5%), Acute (23.8%), Intermediate (53.7%) and Obtuse (20.1%). Leaf hairs and corolla color showed no variation. Leaf blade lobing exhibited four categories such as Weak (60.2%), Intermediate (22.5%), Strong (16.4%), and Very strong (0.8%). All leaf hairs were observed as 'very many' type and corolla color was light violet (99.2%) and dark violet (0.8%).

Table 36. Variability in growth and foliage characters of brinjal germplasm

Name of descriptor	Descriptor state	No. of germplasm	Frequency (%)
Plant growth habit	Upright	165	67.6
	Intermediate	25	10.2
	Prostrate	54	22.1
Leaf blade lobing	Weak	147	60.2
	Intermediate	55	22.5
	Strong	40	16.4
	Very strong	2	0.8
Leaf blade tip angle	Very acute	6	2.5
	Acute	58	23.8
	Intermediate	131	53.7
	Obtuse	49	20.1
Leaf prickles	Very few	44	18.0
	Few	82	33.6
	Intermediate	104	42.6
	Many	10	4.1
	Very many	4	1.6
Leaf hairs	Very many	244	100.0
Corolla color	Light violet	242	99.2
	Dark violet	2	0.8
Leaf blade lobing	Weak	147	60.2
	Intermediate	55	22.5
	Strong	40	16.4
	Very strong	2	0.8

Variability in fruit characters

All the characters studied related to fruit of brinjal showed distinct variation among the germplasm (Fig. 43) except fruit position (Table 37). The maximum variation was found in 'fruit color at ripening stage'. Six categories fruit color at ripening such as milky white (0.4%), lilac grey (4.9%), Purple (19.7%), green with mottled at the distal end (29.5%), and Green with yellowish stripe (41.8%) and purple with light green at the distal end (3.7%) were observed. The next higher variation was found in 'fruit flesh density'. Very loose (spongy), loose (crumbly), average density, dense and very dense type of fruit flesh density was found where majority of the germplasm exhibited average density type. On the other hand, fruit calyx prickles were found as

very few (1.6%), few (13.9%), intermediate (36.5%), many (23.0%) and very many (25.0%). Fruit color distribution was exhibited as Uniform (50.8%), mottled (13.1%), netted (16.8%) and striped (27.9%). Fruit curvature was none (straight) in 50.8% of the germplasm 21.3% of the germplasm showed curved and 27.9% showed slightly curved fruit. Fruit apexes were exhibited as two categories such as rounded (40.28%) and depressed (59.72%).

Table 37. Variability in qualitative fruit characters of brinjal germplasm

Name of descriptor	Descriptor state	No. of germplasm	% of germplasm
Fruit calyx prickles	Very few	4	1.6
	Few	34	13.9
	Intermediate	89	36.5
	Many	56	23.0
	Very many	61	25.0
Fruit color distribution	Uniform	36	14.8
	Mottled	32	13.1
	Netted	41	16.8
	Striped	135	55.3
Fruit curvature	None (fruit straight)	124	50.8
	Slightly curved	68	27.9
	Curved	52	21.3
Fruit apex shape	Rounded	96	39.3
	Depressed	148	60.7
Fruit cross section	Circular (no groove)	72	29.5
Fruit color at ripening	Milky white	1	0.4
	Lilac grey	12	4.9
	Purple	48	19.7
	Green with mottled at the distal end	72	29.5
	Green with yellowish stripe	102	41.8
	Purple with light green at the distal end	9	3.7
Fruit flesh density	Very loose (spongy)	112	45.9
	Loose (Crumbly)	64	26.2
	Average density	43	17.6
	Dense	17	7.0
	Very dense	8	3.3
Fruit position	Pendant	244	100.0

Table 38. Quantitative descriptors of brinjal gerplasm

Coll./Acc. #	DF	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
AC-172	73.56	3.77	14.76	75.76	444.2	375.69	2.29
AC-212	74.56	4.97	11.76	85.4	465.5	385.69	2.6
AC-240	72.56	4.87	11.42	71.74	480.1	496.99	2.07
AC-258	74.81	4.13	10.6	65.11	390.97	393.16	2.6
AC-285	73.56	6.63	12.09	168.4	435.3	342.39	2.62
AC-396	75.81	3.46	8.93	43.44	270.87	350.26	2.51
AC-47	77.81	5.13	7.6	86.44	476.87	390.26	2.26
AH-41	75.31	2.97	19.97	111.67	602.02	558.04	3.75
AHI-101	74.31	5.3	11.63	122.67	407.72	319.34	2.54
AHI-102	76.31	4.63	10.3	115	358.92	309.94	2.34
AHI-124	76.06	4.88	7.59	33.15	244.15	218.09	2.42
AM-10	75.81	5.67	5.55	84.07	285.9	337.29	1.9
AM-10111	77.06	6.88	7.59	11.15	367.05	236.29	2.9
AMA-294	75.06	5.75	16.55	97.07	308.37	378.09	2.48

Coll./Acc. #	DFP	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
AMA-302	75.31	4.92	9.39	91.15	438.75	401.49	2.27
AMA-312	77.06	3.42	13.89	56.4	388.37	219.79	2.65
AMA-368	74.81	4.84	10.55	96.41	437.5	465.29	3.44
AMA-410	73.31	3.63	13.63	89.33	301.12	250.94	1.92
ATR-12	74.81	3.51	10.22	81.74	544.8	211.39	0.89
BARI-1	75.06	4.42	9.22	50.4	352.97	234.49	2.54
BARI-10	74.06	3.75	9.22	58.73	201.17	309.39	2.49
BARI-4	73.81	3.34	10.22	96.07	380.9	267.09	1.1
BARI-5	73.81	6.34	8.55	138.07	325.1	274.69	1.58
BARI-6	75.81	6.67	8.22	95.74	534.4	439.99	1.9
BARI-7	73.81	2.44	10.55	50.41	563.3	564.29	2.29
BARI-8	73.81	3.01	15.89	70.74	577.8	444.19	1.94
BARI-9	74.81	5.01	6.22	109.07	357.6	303.29	1.72
BARI-BT-1	74.5	3.37	7.84	49.29	229.23	189.58	1.25
BARI-BT-2	74.75	3.53	9.37	50.98	246.15	217.35	1.37
BARI-BT-3	75	5.45	6.34	94.67	247.97	139.67	1.03
BARI-BT-4	75	7.5	8.17	142.66	365.05	327.75	2.21
BD—2705	74.06	2.62	7.07	31.96	450.25	288.14	2.99
BD-10154	73.56	3.03	14.76	57.07	390.3	324.59	1.73
BD-10156	74.56	2.97	12.42	48.73	297	225.69	1.43
BD-10157	74.81	5.18	8.51	46.67	239.05	337.14	2.86
BD-10158	74.81	3.51	20.18	41	209.15	213.14	1.28
BD-10171	74.56	5.23	6.09	113.07	640.8	501.39	4.29
BD-10176	73.56	3.3	7.42	34.07	317.9	283.49	1.44
BD-10178	75.81	3.51	11.85	63.34	292.25	319.24	1.85
BD-10187	74.81	3.35	8.51	41.67	310.05	319.94	2.74
BD-10188	74.81	4.18	8.18	72	309.15	334.94	2.16
BD-10190	74.56	3.75	9.8	69.77	592.57	458.66	4.47
BD-10191	74.56	4.75	10.13	112.1	464.67	446.26	3.89
BD-10192	74.56	6.42	9.13	137.1	380.87	403.96	2.06
BD-10193	74.56	2.42	5.47	18.1	525.27	547.16	3.18
BD-10194	74.56	4.09	6.47	42.44	427.97	403.26	2.92
BD-10195	74.56	4.42	10.8	78.44	410.47	446.26	2.35
BD-2645	75.06	3.55	14.8	82.41	509.45	342.34	3.06
BD-2646	74.06	5.22	6.3	83.86	505.35	494.74	3.28
BD-2649	76.06	4.21	7.26	59.15	392.25	355.39	4.09
BD-2650	75.56	5.33	4.72	94.48	380.32	425.99	2.08
BD-2651	75.56	3	10.05	75.15	328.12	282.39	2.06
BD-2652	75.06	2.88	12.59	33.48	379.05	397.79	2.69
BD-2653	73.06	3.55	8.13	46.6	228.45	229.04	1.13
BD-2657	74.06	3.55	6.63	40.52	365.45	203.64	2.16
BD-2658	75.06	2.89	3.97	37.66	394.55	267.04	2.29
BD-2662	75.56	2.77	10.05	45.81	621.42	411.09	1.78
BD-2663	76.06	4.55	8.63	66.75	92.15	30.34	0.47
BD-2664	75.56	3.17	10.39	86.81	222.22	239.19	2.88
BD-2665	75.06	2.89	9.63	70.95	404.95	285.34	2.38
BD-2669	74.56	7	6.05	85.15	219.32	321.09	2.88
BD-2672	76.56	3.67	12.05	82.48	380.42	319.09	2.49
BD-2673	75.56	3.67	8.05	50.15	225.92	333.79	1.77
BD-2674	76.06	4.55	12.63	88.44	250.95	195.64	1.39
BD-2675	75.06	2.52	11.47	67.29	230.65	156.54	1.37
BD-2677	75.56	5	7.05	75.48	382.02	282.39	1.14
BD-2678	74.06	3.55	6.97	40.66	352.45	250.14	1.76
BD-2680	74.56	3.67	5.05	54.81	362.92	245.79	1.33
BD-2681	74.81	2.68	8.51	32.67	207.05	130.94	3.66
BD-2682	74.06	2.89	7.3	43.88	259.05	127.64	0.99

Table 38. Cont'd

Coll./Acc. #	DFF	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
BD-2683	74.06	2.72	12.8	65.2	429.95	316.24	2.13
BD-2685	76.56	3	15.05	76.15	468.22	446.39	3.08
BD-2686	75.81	3.01	14.85	63	546.05	319.24	1.97
BD-2687	74.06	2.42	15.97	50.55	548.95	404.24	3.36
BD-2694	74.06	3.92	14.13	99.41	543.25	430.34	3.37
BD-2695	75.06	2.25	7.4	31.96	135.85	83.24	0.83
BD-2702	75.81	3.85	4.85	38	306.05	188.64	1.18
BD-2703	74.81	3.51	7.51	27.34	265.05	185.64	2.71
BD-2707	80.06	3.55	6.59	43.15	389.15	331.39	3.13
BD-2708	76.06	2.05	10.59	20.48	191.35	336.29	4.12
BD-2710	75.06	2.88	5.26	11.15	473.25	320.39	3.32
BD-2711	76.06	2.65	6.8	36.63	404.25	258.34	2.07
BD-2715	75.06	3.65	9.13	52.29	259.25	195.94	1.25
BD-2716	74.81	3.18	12.18	49.67	238.85	178.24	2.41
BD-2721	74.81	5.18	7.51	96.67	492.35	528.04	2
BD-2724	74.81	2.35	6.51	23.67	126.45	133.74	3.66
BD-2725	74.81	6.51	7.51	86.34	132.15	168.84	1.97
BD-2728	74.06	5.21	6.92	60.48	471.05	425.39	3.12
BD-2731	75.06	4.72	6.47	80.4	436.65	305.64	2.01
BD-2732	74.06	2.62	8.67	44.62	395.75	254.34	1.99
BD-2733	74.06	2.55	5.93	34.1	548.95	366.86	3.58
BD-2735	73.06	2.72	12.6	63.39	619.35	451.56	3.43
BD-2740	73.81	3.85	6.18	45	567.05	382.64	3.46
BD-2746	75.81	4.85	5.85	68	309.15	276.04	2.05
BD-2748	73.81	4.85	6.85	71.34	269.15	257.64	3.33
BD-2749	75.06	2.65	3.6	10.05	294.75	190.66	1.51
BD-2751	75.06	4.22	4.26	76.79	481.45	357.76	2.92
BD-2753	75.06	4.88	6.26	70.86	417.95	274.66	2.48
BD-2754	75.06	4.72	7.26	74.3	500.05	371.46	2.85
BD-2755	73.81	5.51	7.51	85.34	238.85	327.34	2.71
BD-2756	73.81	4.85	6.85	38.34	262.05	180.94	2.31
BD-2757	74.06	5.22	6.26	86.2	400.85	285.96	1.94
BD-2762	75.06	2.38	10.59	32.15	323.25	397.39	4.19
BD-2763	76.06	5.88	7.92	47.15	352.05	430.69	2.11
BD-2764	74.06	4.38	6.1	81.43	388.75	307.16	2.49
BD-2766	75.06	4.88	6.93	85.97	632.75	531.56	4.23
BD-2770	77.06	3.88	5.6	64.63	426.75	342.86	1.96
BD-2773	74.06	3.21	4.59	24.82	374.05	405.69	3.08
BD-2774	75.06	4.22	4.6	43.55	420.65	287.36	1.98
BD-2775	74.06	4.22	4.6	53.77	404.25	272.26	2.05
BD-2776	75.81	3.51	8.18	55.67	306.15	224.74	1.49
BD-2783	74.81	3.68	9.18	45	289.25	210.64	2.71
BD-2789	74.81	3.46	6.93	37.77	358.97	292.46	2.57
BD-2790	74.81	6.13	6.93	65.11	401.87	403.46	3.17
BD-2791	75.81	3.79	5.26	27.11	388.77	348.66	2.13
BD-2792	73.81	3.46	8.6	55.77	229.97	294.16	3
BD-2796	74.06	3.48	7.6	44.9	530.95	424.16	2.99
BD-2797	74.06	2.05	5.5	14.54	385.15	235.56	2.17
BD-2805	75.06	4.55	6.93	76.65	298.55	349.36	1.8
BD-2807	74.06	4.55	6.6	102.79	461.15	366.86	2.38
BD-2808	75.81	2.46	12.26	35.44	357.87	342.16	2.56
BD-2809	74.81	3.79	7.26	81.11	405.77	302.56	2.81
BD-2820	74.06	4.55	7.6	93.1	396.85	282.86	1.3
BD-2822	74.81	3.79	7.26	31.44	332.07	282.16	2.16

Table 38. Cont'd

Coll./Acc. #	DFE	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
BD-2825	74.81	4.13	6.6	42.44	222.97	352.36	2.33
BD-2826	79.06	5.88	7.92	38.15	348.55	368.09	3.4
BD-2827	80.06	4.88	7.92	33.15	400.05	336.29	2.99
BD-2830	74.06	3.88	6.46	76.43	467.75	426.56	2.52
BD-2832	73.06	3.88	13.26	67.1	594.55	446.66	3.15
BD-2840	73.81	2.46	6.26	37.77	232.07	322.96	1.84
BD-2842	75.06	3.55	8.26	88.43	437.15	313.76	2.56
BD-7314	74.56	5.3	7.76	68.74	306.5	302.39	1.86
BD-7319	74.56	4.3	8.76	74.4	390.7	316.59	2.62
BD-7320	74.81	2.46	22.93	57.44	242.87	307.66	2
BD-7321	74.81	3.46	10.93	70.77	262.77	255.46	1.78
BD-7324	73.81	2.39	14.26	38.44	357.07	274.16	2.68
BD-7327	74.81	4.89	7.6	66.44	696.07	323.96	2.57
BD-7328	74.56	2.03	13.52	26.76	307	271.69	2.02
BD-7332	72.56	2.57	9.42	27.4	340.1	268.69	2.17
BD-7333	73.56	4.73	7.69	40.74	392.4	290.39	2.04
BD-7335	73.56	4.3	13.76	103.07	575.7	537.49	2.97
BD-9530	72.56	3.97	3.76	26.07	216.2	142.89	1.27
BD-9531	77.06	4.71	8.26	78.15	422.75	335.19	2.91
BD-9532	73.56	3.3	3.09	25.4	116.3	93.49	0.75
BD-9535	74.56	4.3	5.09	35.07	166.4	140.09	1.08
BD-9537	75.06	3.88	5.26	30.82	265.85	260.99	2.54
BD-9538	75.06	3.55	3.92	13.48	397.15	264.09	2.26
BD-9540	74.81	2.29	12.93	39.11	298.97	348.66	2.51
BD-9542	73.81	4.79	6.26	44.77	397.97	372.86	3.11
BD-9543	74.81	2.79	8.93	81.44	332.87	363.26	4.03
BD-9545	75.81	2.29	7.93	26.11	367.97	288.36	2.29
BD-9546	74.56	3.4	11.76	73.07	402.5	279.69	2.43
BD-9547	74.56	3.07	4.69	22.74	146.1	105.59	0.72
BD-9548	73.56	2.73	16.26	53.26	279.8	216.09	1.25
BD-9549	75.31	4.25	5.39	87.79	499.95	342.79	2.05
IAH-39	75.31	6.63	8.63	103.67	415.32	378.54	2.93
K-10	75.31	4.92	10.72	56.82	552.25	530.09	3.63
K-11	76.06	4.42	7.55	57.4	415.07	257.19	1.68
K-12	76.31	7.25	8.39	125.49	511.85	476.99	2.99
K-13	74.06	5.75	7.55	103.07	434.37	215.59	1.76
K-15	74.06	3.75	10.89	58.07	384.77	268.09	1.82
K-16	75.06	6.42	7.55	95.07	308.77	279.79	1.91
K-17	75.06	5.75	7.72	119.4	348.07	299.19	2.64
K-18	74.31	4.25	16.05	115.49	574.95	502.39	3.8
K-19	75.31	4.92	5.39	118.15	468.95	406.49	2.88
K-20	75.31	6.59	7.39	149.49	411.15	292.39	2.11
K-21	75.06	4.75	9.22	68.73	399.47	217.79	3.43
K-22	77.06	3.42	21.89	74.4	410.17	286.59	2.65
K-23	75.06	3.42	8.22	61.07	329.27	281.39	2.29
K-26	76.06	5.09	6.55	51.07	351.37	265.79	2.34
K-27	75.31	6.25	6.05	124.82	522.65	471.79	3.17
K-28	74.31	5.59	7.05	95.49	615.75	388.49	3.73
K-29	73.31	5.92	8.05	77.82	656.75	535.69	4.45
K-30	75.31	5.25	9.05	118.32	579.15	443.39	3.47
K-32	75.06	5.42	8.22	72.73	308.37	244.49	2.35
K-33	74.31	5.59	7.05	127.82	472.95	406.69	2.67
K-34	75.31	3.59	10.05	53.15	661.15	563.49	4.33
K-35	73.31	4.59	9.05	76.82	500.95	393.49	3.04

Table 38. Cont'd

Coll./Acc. #	DFE	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
K-36	74.31	3.92	8.72	114.49	458.75	318.99	3.51
K-37	75.31	4.3	13.3	118	339.12	236.74	1.78
K-38	74.31	6.3	6.97	131.67	360.72	265.54	1.57
K-39	76.31	4.63	7.63	103	286.22	157.04	1.59
K-40	75.31	5.97	10.3	108.67	345.12	240.64	2.28
K-42	75.31	4.3	13.3	104.23	355.72	252.24	2.04
K-45	75.31	4.3	10.3	92.67	363.02	223.74	1.85
K-47	76.06	5.75	9.22	119.07	451.17	271.69	3.02
KASI-46	75.56	5.67	6.39	76.81	568.62	282.39	1.72
KASI-98	75.56	5.07	6.05	68.81	583.02	388.39	3.13
KASI-99	74.31	4.97	4.97	69.67	256.82	153.64	1.77
M-02	75.56	5.67	6.39	37.48	192.82	379.79	2.3
MTR-7	74.06	5.09	7.22	93.07	300.07	254.69	3.34
NIR-04	75.56	6.53	7.45	50.48	238.22	366.39	2.16
NIR-62	75.56	2.67	4.72	13.48	449.72	275.09	1.56
NSR-10	74.56	4.75	9.8	103.77	580.37	525.86	2.91
NSR-11	74.56	3.42	5.8	43.1	516.37	460.26	3.49
NSR-12	74.56	3.09	12.13	83.44	615.67	498.86	4.46
NSR-13	74.56	2.42	7.47	31.77	347.37	275.16	1.98
NSR-14	76.31	6.63	9.3	125	504.52	426.64	3.3
NSR-15	75.31	5.63	10.3	100.67	548.02	464.64	3.03
NSR-16	74.31	4.97	9.97	93	386.62	337.54	2.69
NSR-17	74.56	4.09	7.8	77.44	536.57	480.76	3.64
NSR-18	74.81	5.01	7.55	66.07	421.4	307.49	2.68
NSR-19	73.81	5.34	8.89	108.07	509.1	373.09	2.32
NSR-2	74.06	5.09	10.22	100.4	440.17	360.09	1.93
NSR-2.1	76.31	5.97	12.63	120.33	522.92	345.54	2.98
NSR-20	77.31	7.3	8.63	125	615.72	530.04	5.02
NSR-21	75.06	5.09	6.89	68.07	212.07	191.19	2.32
NSR-22	75.81	6.34	7.22	148.41	468.2	319.49	3.22
NSR-23	74.81	4.67	11.89	87.41	350.2	315.79	2.21
NSR-24	74.81	8.34	7.22	156.74	404.6	323.99	2.34
NSR-25	75.81	2.67	19.22	76.74	331.9	311.39	1.9
NSR-26	74.81	7.01	9.22	212.07	408.2	345.89	2.72
NSR-27	73.81	5.01	7.89	102.74	256	236.89	1.75
NSR-28	74.56	6	7.05	74.48	327.22	260.69	1.12
NSR-29	75.56	4.67	11.39	100.15	418.62	266.39	1.33
NSR-3	74.81	4.67	7.22	127.07	255.3	288.39	1.37
NSR-30	75.56	5.5	8.05	102.48	383.62	345.09	1.96
NSR-4	75.31	7.63	12.3	229.67	346.32	277.84	2.75
NSR-5	75.31	5.3	12.97	162.67	300.92	305.64	1.99
NSR-53	74.56	6.53	7.45	127.15	436.02	332.89	1.44
NSR-6	75.81	5.01	8.55	121.74	628.6	506.19	3.73
NSR-7	75.31	7.3	9.63	100.33	498.02	432.64	3.12
NSR-8	74.56	6.75	8.47	91.77	543.97	434.76	4.71
NSR-9	74.81	6.34	8.55	107.41	429.1	396.39	2.66
RAI-150	74.31	4.59	4.39	62.49	459.95	310.79	1.81
RAI-216	74.31	4.75	4.39	88.49	417.65	277.59	1.84
RAI-219	75.31	4.65	4.55	52.64	299.05	210.39	1.87
RAI-230	76.56	5	5.05	73.48	382.12	305.09	1.43
RAI-81	74.31	4.59	5.39	95.82	394.65	263.69	1.86
RAI-99	70.31	4.59	5.05	93.15	563.75	402.09	3.02
SU-1	80.06	3.88	4.26	11.82	422.15	372.39	2.64
SU-3	80.06	5.18	7.92	55.15	379.05	315.09	3.24

Table 38. Cont'd

Coll./Acc. #	DFE	FD	FL	FW	LA	LACal	LDW
1	2	3	4	5	6	7	8
SU-88	76.06	6.55	8.26	20.82	336.35	355.39	3.12
TRMR-102	74.56	2.42	21.8	57.77	487.57	425.86	3.04
TT-102	75.56	2.42	9.8	61.77	555.57	480.16	4.32
TT-103	74.56	3.09	5.13	14.77	371.57	446.26	3.33
TT-105	76.06	4.88	6.59	31.15	386.35	311.39	2.42
TT-136	75.56	4.42	7.8	99.77	771.37	656.16	5.28
TT-169	75.56	4.09	7.13	99.35	684.77	680.26	6.14
TT-176	75.56	4.42	6.47	65.1	730.17	694.06	5.86
TT-200	74.56	3.42	12.47	75.1	275.87	264.06	1.96
TT-27	75.06	3.92	9.89	69.4	449.37	181.39	2.34
TT-58	75.06	5.75	6.05	86.4	364.37	376.09	2.9
TT-64	74.56	3.42	9.47	28.1	392.87	470.76	3.08

Table 38. Quantitative descriptors of brinjal germplasm (Cont'd)

Coll./Acc.#	LL	LW	PFI	PH	PSI	SPAD	TF	TS	YPP
1	9	10	11	12	13	14	15	16	17
AC-172	30.2	12.52	40.47	134.85	5	71.74	37.51	26.73	3.96
AC-212	30.2	12.85	34.67	139.85	5	65.44	24.79	26.73	2.83
AC-240	31.53	15.85	25.07	127.85	12.5	55.94	37.51	30.73	3.76
AC-258	26.29	15.09	9.14	99.35	2.17	49.21	19.07	87.73	2.18
AC-285	26.2	13.18	9.67	119.85	12	59.84	29.88	31.73	6.64
AC-396	25.62	13.76	50.84	101.35	2.6	48.31	6.36	77.73	0.55
AC-47	24.95	15.76	0.84	103.35	6	46.71	6.36	95.73	1.21
AH-41	37.29	13.85	7.59	108.35	8.89	54.79	6.36	37.23	1.21
AHI-101	25.62	11.85	32.59	113.35	14.29	58.89	6.36	20.23	1.38
AHI-102	25.62	11.51	74.29	113.35	22.22	54.49	3.81	37.23	0.85
AHI-124	23.2	9.35	59.67	87.1	4.35	56.44	14.62	49.73	1
AM-10	25.79	13.18	70.12	102.6	16.67	53.39	11.44	39.23	1.33
AM-10111	24.54	9.68	9.67	100.1	6.67	56.04	19.71	48.73	0.84
AMA-294	27.7	13.43	87.59	106.1	5	50.39	13.99	88.98	1.67
AMA-302	29.78	14.02	23.42	97.6	7.69	51.39	16.53	32.23	2.31
AMA-312	24.04	9.1	24.29	94.1	4.17	55.29	16.53	80.98	1.08
AMA-368	30.79	15.18	78.42	106.6	6.67	56.99	13.99	39.23	1.78
AMA-410	20.62	11.85	32.59	98.35	3.64	56.79	16.53	47.23	2.13
ATR-12	19.79	10.85	78.42	117.6	8	61.99	13.99	34.23	1.56
BARI-1	21.7	10.76	62.09	90.1	7.29	50.09	29.24	104.98	1.77
BARI-10	23.37	13.1	53.09	85.1	9.52	52.29	29.24	50.98	2.12
BARI-4	24.12	11.18	3.42	102.6	6.6e-14	50.79	16.53	64.23	2.09
BARI-5	22.79	12.18	17.72	93.6	12.5	56.49	21.62	49.23	3.84
BARI-6	30.45	14.52	53.42	99.6	5	54.29	13.99	49.23	1.77
BARI-7	36.45	15.52	3.42	101.6	5.2e-14	58.49	13.99	54.23	1.08
BARI-8	28.79	15.52	70.12	109.6	4.1e-14	55.19	19.07	44.23	1.83
BARI-9	24.45	12.52	78.42	101.6	-2.8e-14	54.39	13.99	49.23	1.98
BARI-BT-1	18.5	10.17	5.35	96.67	8.9e-15	57	16.53	63	1.43
BARI-BT-2	21.08	10.17	22.22	72	-3.8e-14	56.03	17.8	31.75	1.32
BARI-BT-3	17.56	7.89	11.1	114.92	4e-14	52.87	22.89	23.67	3.22
BARI-BT-4	24.67	13.17	1.7e-13	109.83	1.6e-14	57.15	19.07	28.5	3.87
BD--2705	23.7	11.93	20.12	116.6	3	56.99	29.24	92.48	1.01
BD-10154	26.87	12.18	36.97	109.85	5.56	52.44	32.42	78.73	2.6
BD-10156	23.2	9.85	71.17	117.85	10.71	56.34	37.51	34.73	2.62
BD-10157	24.78	13.27	29.67	99.85	16	51.74	24.79	39.98	1.65
BD-10158	18.12	11.93	91.47	114.85	5.81	58.84	27.34	75.98	1.58
BD-10171	37.2	13.52	38.27	109.85	8.33	60.04	22.25	30.73	3.24
BD-10176	24.87	11.52	55.17	106.85	20.83	55.84	32.42	30.73	1.64

Table 38. Cont'd

Coll. /Acc.#	LL	LW	PFI	PH	PSI	SPAD	TF	TS	YPP
1	9	10	11	12	13	14	15	16	17
BD-10178	26.78	11.6	36.37	117.85	-2.3e-14	56.74	37.51	69.98	3.48
BD-10187	25.45	12.27	42.97	111.85	13.16	53.94	29.88	27.98	1.77
BD-10188	22.45	14.6	36.37	99.85	-2.3e-14	53.34	37.51	73.98	3.98
BD-10190	32.37	14.43	22.09	99.6	8	53.76	9.54	18.23	1.19
BD-10191	30.03	15.09	24.99	109.6	4.44	54.86	14.62	38.23	2.97
BD-10192	28.37	14.43	-17.91	103.6	7.5	62.06	9.54	33.23	2.48
BD-10193	34.7	16.09	2.09	113.6	7.14	49.46	9.54	35.23	0.21
BD-10194	27.03	15.09	15.39	102.6	9.09	58.76	4.45	15.23	0.23
BD-10195	29.37	15.43	2.09	118.6	5	60.96	9.54	33.23	1.36
BD-2645	26.37	12.6	15.92	101.6	4.49	54.09	19.07	81.48	2.27
BD-2646	31.04	15.27	3.42	99.6	6.06	51.99	13.99	25.48	1.28
BD-2649	29.87	12.35	20.77	110.1	2.44	54.84	27.34	85.73	2.75
BD-2650	35.7	12.26	57.59	99.1	-4.3e-14	57.79	11.44	55.98	1.56
BD-2651	23.7	11.93	82.59	99.1	-2.6e-14	48.49	11.44	55.98	1.26
BD-2652	29.54	14.02	42.97	104.1	2.63	51.94	12.08	79.73	0.83
BD-2653	20.37	11.27	92.32	111.6	3.08	55.79	21.62	57.48	1.3
BD-2657	23.7	8.6	14.52	111.6	4.44	57.89	21.62	37.48	1.09
BD-2658	23.37	11.27	3.42	116.6	2.22	51.19	16.53	37.48	0.81
BD-2662	28.03	14.93	67.59	115.1	11.9	48.99	13.99	47.98	1.01
BD-2663	10.37	5.27	15.92	87.6	2.3e-14	54.49	19.07	34.48	1.79
BD-2664	18.7	12.6	27.59	99.1	10	65.99	26.7	45.98	3.56
BD-2665	20.7	13.6	103.42	116.6	8.9e-15	57.79	6.36	52.48	0.82
BD-2669	19.03	16.93	7.59	97.1	6	52.99	31.79	55.98	4.19
BD-2672	23.03	13.93	24.29	109.1	6.12	54.19	16.53	54.98	2.05
BD-2673	23.03	14.6	36.19	109.1	4.44	51.89	19.07	95.98	1.52
BD-2674	21.37	9.27	3.42	121.6	1.61	52.89	6.36	54.48	1.02
BD-2675	17.7	9.27	83.42	104.6	2.5e-14	59.99	11.44	52.48	1.19
BD-2677	23.03	12.26	47.59	99.1	10	53.39	13.99	55.98	1.58
BD-2678	22.04	11.27	86.72	111.6	-1.1e-14	51.29	13.99	57.48	0.79
BD-2680	20.36	11.93	74.29	105.1	22.22	51.19	16.53	50.98	1.41
BD-2681	13.45	10.6	67.97	113.85	8.89	63.54	29.88	34.98	1.36
BD-2682	17.37	7.93	103.42	106.6	4.6e-14	56.79	6.36	32.48	0.51
BD-2683	28.04	10.93	46.32	151.6	4.44	55.19	16.53	37.48	1.55
BD-2685	32.03	14.26	32.59	119.1	6.67	51.89	11.44	35.98	1.28
BD-2686	26.78	11.6	9.67	117.85	3.85	57.54	32.42	41.98	2.99
BD-2687	30.04	12.93	83.42	171.6	7.27	51.19	24.16	47.48	1.58
BD-2694	28.37	14.6	28.42	116.6	-1.9e-14	58.39	29.24	20.48	4.11
BD-2695	15.7	6.27	25.62	91.6	8.8e-14	59.79	21.62	69.48	0.8
BD-2702	21.45	8.93	9.67	99.85	5.26	57.04	14.62	27.98	0.75
BD-2703	20.45	9.27	9.67	85.85	8	52.84	14.62	39.98	0.5
BD-2707	25.54	13.35	9.67	110.1	3.33	59.04	19.71	63.73	1.57
BD-2708	23.54	14.68	42.97	98.1	2.22	48.74	19.71	93.73	1.05
BD-2710	22.87	14.35	23.97	103.1	3.33	45.04	22.25	93.73	0.93
BD-2711	24.04	10.6	40.92	131.6	2.11	47.29	39.42	87.48	1.58
BD-2715	20.04	9.93	103.42	121.6	16.3	56.69	6.36	84.48	0.61
BD-2716	20.45	8.93	38.27	97.85	3.23	56.64	17.17	51.98	1.2
BD-2721	33.78	14.93	42.97	99.85	8.89	50.74	14.62	34.98	2.09
BD-2724	14.12	10.27	84.67	103.85	3.33	52.54	9.54	49.98	0.24
BD-2725	16.12	10.93	9.67	109.85	3.03	58.44	17.17	55.98	2.18
BD-2728	28.87	15.35	38.27	100.1	2.44	51.24	22.25	85.73	2.24
BD-2731	25.7	11.6	78.42	101.6	2.4e-14	63.39	8.9	62.48	1.18
BD-2732	22.37	11.27	103.42	94.6	5	50.39	39.42	92.48	2.07
BD-2733	25.87	14.02	-19.98	99.85	-1.4e-14	52.31	6.36	51.48	0.49
BD-2735	29.87	15.02	80.02	112.85	6.25	55.61	6.36	43.48	0.67

Table 38. Cont'd

Coll. /Acc.#	LL	LW	PFI	PH	PSI	SPAD	TF	TS	YPP
1	9	10	11	12	13	14	15	16	17
BD-2740	35.45	10.27	59.67	101.85	5.77	56.94	9.54	41.98	0.57
BD-2746	24.12	11.27	9.67	99.85	7.27	53.04	6.99	44.98	0.66
BD-2748	21.45	11.93	69.67	99.85	6.35	48.44	12.08	52.98	1.24
BD-2749	20.54	9.02	80.02	101.85	1.6e-14	52.31	3.81	58.48	-0.42
BD-2751	25.2	14.02	80.02	112.85	-2.9e-14	64.81	-1.27	37.48	-0.06
BD-2753	24.54	11.02	-19.98	104.85	2.63	52.31	6.36	33.48	0.81
BD-2754	26.2	14.02	40.02	109.85	2.7e-14	60.51	6.36	27.48	0.88
BD-2755	24.12	13.27	69.67	99.85	4.35	52.84	12.08	35.98	1.51
BD-2756	21.45	8.6	9.67	103.85	3.17	57.64	12.08	52.98	0.61
BD-2757	21.54	13.02	0.02	122.85	5.3e-15	50.81	19.07	30.48	2.92
BD-2762	25.2	16.35	59.67	110.1	3.57	48.44	14.62	59.73	0.98
BD-2763	26.87	16.68	89.67	99.1	2	55.64	17.17	103.73	1.44
BD-2764	23.2	13.02	-19.98	132.85	4.3e-14	50.21	19.07	30.48	2.74
BD-2766	34.54	15.35	80.02	117.85	10	54.71	-1.27	15.48	0.01
BD-2770	23.54	14.35	60.02	132.85	5.56	61.31	6.36	31.48	0.69
BD-2773	26.87	15.68	42.97	94.1	2.38	48.74	27.34	87.73	1.57
BD-2774	24.2	11.68	0.02	98.85	7.14	48.31	31.79	37.48	2.3
BD-2775	22.87	11.68	25.52	132.85	14.29	54.91	21.62	30.48	1.92
BD-2776	24.12	9.27	76.37	106.85	5.26	52.64	6.99	27.98	0.52
BD-2783	17.45	12.27	9.67	103.85	3.08	50.24	4.45	54.98	0.23
BD-2789	22.29	13.09	42.54	101.35	2.7e-15	51.01	11.44	58.73	0.77
BD-2790	25.29	16.09	25.84	97.35	8	49.01	6.36	45.73	0.88
BD-2791	24.29	14.43	0.84	101.35	5.56	47.01	6.36	49.73	0.3
BD-2792	18.95	15.43	18.74	103.35	-1.6e-14	56.41	13.99	47.73	1.41
BD-2796	26.2	16.02	-4.58	117.85	2.38	56.21	26.7	37.48	1.96
BD-2797	20.87	11.02	60.02	92.85	2.9e-14	52.11	6.36	37.48	-0.26
BD-2805	25.2	13.68	17.52	98.85	5.71	56.31	13.99	30.48	1.9
BD-2807	27.2	13.35	55.02	96.85	10	55.51	13.99	15.48	2.7
BD-2808	21.29	16.09	9.14	113.35	5.45	53.11	11.44	50.73	0.72
BD-2809	21.95	13.76	31.44	105.35	12.31	52.21	19.07	60.73	2.73
BD-2820	24.54	11.35	63.32	112.85	8	48.71	8.9	20.48	1.63
BD-2822	23.29	12.09	31.44	101.35	7.69	54.61	19.07	60.73	1.02
BD-2825	21.95	16.09	39.44	100.35	5.26	52.21	24.16	71.73	1.74
BD-2826	26.54	14.35	59.67	97.1	2.7	53.24	14.62	77.73	1.07
BD-2827	23.54	14.68	59.67	100.1	4.29	54.74	19.71	73.73	1.34
BD-2830	27.54	15.35	40.02	107.85	16	53.81	19.07	20.48	2.55
BD-2832	29.54	15.02	46.72	122.85	15	50.31	8.9	15.48	1.03
BD-2840	19.62	16.43	5.84	94.35	12.5	54.21	21.62	43.73	1.39
BD-2842	22.54	13.68	24.42	97.85	10	55.31	16.53	15.48	2.64
BD-7314	23.2	13.18	92.97	96.85	6.25	56.84	19.71	38.73	1.8
BD-7319	25.53	12.52	87.47	104.85	12	61.04	27.34	31.73	2.77
BD-7320	21.29	14.43	-24.16	104.35	-4.4e-15	56.51	16.53	93.73	1.68
BD-7321	19.29	13.09	9.14	107.35	2.5e-14	59.01	19.07	55.73	2.37
BD-7324	21.95	12.43	25.84	114.35	1.2e-14	51.71	16.53	65.73	1.1
BD-7327	28.62	11.43	21.34	103.35	1.9e-14	49.11	24.16	57.73	2.75
BD-7328	23.2	11.85	101.37	99.85	4.6e-14	58.44	34.97	22.73	1.43
BD-7332	21.2	12.85	92.97	101.85	8.9e-15	52.74	34.97	31.73	1.46
BD-7333	26.2	11.18	98.57	89.85	4	51.94	27.34	31.73	1.61
BD-7335	35.53	15.18	76.37	99.85	11.11	72.14	12.08	42.73	1.42
BD-9530	17.87	8.18	59.67	85.85	14.29	53.74	19.71	27.73	0.82
BD-9531	25.2	13.68	76.37	103.1	2.86	51.64	19.71	73.73	2.37
BD-9532	13.53	7.18	82.37	59.85	10	51.14	32.42	26.73	1.27
BD-9535	17.53	8.18	98.57	114.85	12.5	59.54	27.34	30.73	1.42
BD-9537	22.54	11.68	76.37	98.1	2.22	57.04	19.71	93.73	1.29

Table 38. Cont'd

Coll. /Acc.#	LL	LW	PFI	PH	PSI	SPAD	TF	TS	YPP
1	9	10	11	12	13	14	15	16	17
BD-9538	23.54	11.35	59.67	88.1	2.38	51.04	14.62	87.73	0.7
BD-9540	24.29	14.43	65.84	101.35	1.52	53.21	21.62	61.73	1.44
BD-9542	23.29	16.09	-24.16	96.35	16.67	49.01	34.33	55.73	2.56
BD-9543	26.62	13.76	59.14	99.35	13.85	55.21	26.7	60.73	3.7
BD-9545	21.95	13.09	-1.96	100.35	15.91	52.21	19.07	39.73	0.84
BD-9546	23.87	11.85	109.67	109.85	5.56	62.34	19.71	42.73	1.9
BD-9547	14.53	7.52	82.37	89.85	4.17	64.44	32.42	30.73	1.16
BD-9548	21.53	10.18	17.97	118.85	8.33	56.94	34.97	30.73	2.64
BD-9549	25.78	13.68	26.52	119.6	8.33	48.59	36.87	42.23	4.9
IAH-39	29.95	11.85	47.59	104.35	8.33	47.39	8.9	16.23	1.46
K-10	30.78	18.02	3.42	109.6	6.67	56.69	31.79	21.23	2.93
K-11	23.7	10.76	37.59	98.1	13.33	61.59	26.7	53.98	1.87
K-12	31.11	16.02	3.42	114.6	30	60.59	34.33	26.23	6.29
K-13	22.04	9.76	49.29	97.1	2.88	53.29	31.79	112.98	4.35
K-15	28.04	9.43	7.59	108.1	4	53.89	26.7	108.98	1.9
K-16	25.7	10.76	24.29	98.1	7.14	56.89	16.53	64.98	1.97
K-17	21.04	14.1	47.59	96.1	4.84	53.29	13.99	70.98	2.1
K-18	29.11	18.02	3.42	107.6	24	50.99	34.33	31.23	5.84
K-19	29.45	14.35	3.42	116.6	15	52.49	31.79	26.23	5.51
K-20	23.45	12.68	3.42	125.6	5	54.69	39.42	26.23	6.53
K-21	18.04	12.1	34.89	98.1	3.13	55.79	29.24	104.98	2.54
K-22	21.7	13.1	32.59	101.1	5	57.89	21.62	68.98	2.01
K-23	19.37	14.43	90.89	95.1	5.45	58.29	31.79	63.98	2.42
K-26	20.7	12.76	7.59	102.1	4.55	56.49	13.99	52.98	0.79
K-27	30.11	16.35	3.42	106.6	15	57.59	26.7	26.23	4.84
K-28	26.78	15.02	23.42	109.6	15	54.89	41.96	26.23	6
K-29	31.11	18.02	3.42	111.6	22.22	62.29	34.33	24.23	4.11
K-30	29.45	15.68	20.12	118.6	15	53.99	34.33	26.23	5.97
K-32	24.04	10.1	7.59	108.1	3.23	56.59	26.7	70.98	2.46
K-33	28.11	15.02	13.42	119.6	15.38	54.89	29.24	32.23	5.43
K-34	32.78	18.02	16.72	114.6	8	57.09	41.96	31.23	3.58
K-35	27.78	14.68	3.42	106.6	10.71	57.39	31.79	34.23	3.77
K-36	25.11	13.02	36.72	98.6	11.43	62.69	11.44	41.23	1.88
K-37	21.95	10.51	7.59	108.35	13.64	48.69	26.7	14.23	4.7
K-38	22.29	11.51	32.59	101.35	10.71	55.29	6.36	20.23	1.51
K-39	18.29	8.85	7.59	108.35	15	53.39	1.27	12.23	0.34
K-40	21.62	10.85	7.59	104.35	14.29	61.39	3.81	13.23	0.78
K-42	21.29	11.51	7.59	101.35	10	51.49	3.81	22.23	0.72
K-45	20.29	10.85	7.59	113.35	9.52	49.99	8.9	13.23	1.25
K-47	21.7	12.43	54.29	108.1	1.52	55.59	39.42	74.98	6.36
KASI-46	23.03	12.26	37.59	99.1	13.33	49.09	26.7	35.98	3.18
KASI-98	27.03	14.6	32.59	93.1	16	58.79	11.44	30.98	1.17
KASI-99	18.62	8.51	27.59	88.35	15	53.99	8.9	12.23	0.81
M-02	27.7	13.93	20.09	107.1	8	48.99	21.62	30.98	1.34
MTR-7	26.7	9.43	24.29	87.1	8.33	51.69	31.79	68.98	3.89
NIR-04	26.03	14.26	7.59	94.1	12	54.59	24.16	30.98	1.96
NIR-62	23.03	11.93	47.59	85.1	7.14	58.39	13.99	33.98	0.39
NSR-10	30.7	17.43	-17.91	99.6	5	57.96	17.17	33.23	3.21
NSR-11	29.03	16.09	2.09	87.6	10	51.96	9.54	13.23	0.68
NSR-12	33.7	15.09	48.79	115.6	8	58.76	4.45	18.23	0.7
NSR-13	22.7	12.09	2.09	86.6	5.26	61.96	9.54	31.23	0.47
NSR-14	27.62	14.51	47.59	98.35	11.43	61.39	8.9	27.23	1.86
NSR-15	30.62	14.18	40.89	116.35	6.67	56.69	11.44	22.23	1.76
NSR-16	24.95	12.85	24.29	138.35	7.5	57.39	11.44	32.23	1.58

Table 38. Cont'd

Coll. /Acc.#	LL	LW	PFI	PH	PSI	SPAD	TF	TS	YPP
1	9	10	11	12	13	14	15	16	17
NSR-17	30.37	16.09	2.09	97.6	8	52.46	9.54	18.23	1.34
NSR-18	25.45	12.18	70.12	99.6	5.26	53.59	11.44	47.23	1.12
NSR-19	27.12	13.85	28.42	95.6	6.67	55.99	24.16	39.23	3.4
NSR-2	23.04	15.43	90.89	98.1	-1.6e-14	49.09	16.53	48.98	2.09
NSR-2.1	28.29	11.51	67.59	96.35	5	53.49	8.9	52.23	1.77
NSR-20	33.95	14.51	27.59	126.35	4.17	55.69	8.9	40.23	1.86
NSR-21	19.04	10.1	70.09	94.1	7.14	59.49	21.62	78.98	1.81
NSR-22	24.45	13.18	3.42	102.6	7.14	56.49	29.24	37.23	5.66
NSR-23	24.79	12.85	3.42	109.6	5.71	59.49	34.33	44.23	3.9
NSR-24	24.79	13.18	13.42	109.6	8	49.49	29.24	34.23	5.98
NSR-25	24.45	12.85	3.42	106.6	4	51.79	24.16	34.23	2.45
NSR-26	25.79	13.52	3.42	95.6	3.57	59.09	24.16	37.23	6.58
NSR-27	22.79	10.52	3.42	99.6	2.86	57.49	19.07	44.23	2.56
NSR-28	22.36	11.6	24.29	93.1	6.67	52.89	16.53	35.98	1.86
NSR-29	21.03	12.6	7.59	115.1	6.67	52.99	21.62	35.98	3.26
NSR-3	22.12	13.18	23.42	107.6	6.25	61.29	16.53	41.23	2.68
NSR-30	25.03	13.93	7.59	107.1	5.71	55.89	13.99	40.98	2.09
NSR-4	25.29	10.51	107.59	98.35	9.38	58.29	8.9	24.23	3.86
NSR-5	24.62	11.85	47.59	90.35	8	58.69	8.9	17.23	2.58
NSR-53	24.7	13.6	21.89	99.1	2.5	48.99	19.07	45.98	3.58
NSR-6	33.45	15.18	36.72	103.6	5.71	52.39	19.07	44.23	3
NSR-7	28.62	14.18	27.59	96.35	12	52.59	8.9	17.23	1.39
NSR-8	31.37	14.09	-3.61	103.6	14.29	49.46	14.62	21.23	2.43
NSR-9	28.79	13.85	3.42	97.6	4.44	65.29	24.16	54.23	3.38
RAI-150	25.78	12.35	24.82	99.6	12	56.69	39.42	31.23	3.88
RAI-216	24.11	11.68	11.72	124.6	20	52.49	34.33	21.23	4.6
RAI-219	17.11	12.02	23.42	118.6	8.9e-15	57.69	29.24	34.23	2.56
RAI-230	25.03	12.26	7.59	87.1	-8.9e-15	56.39	11.44	50.98	1.24
RAI-81	22.11	12.02	3.42	114.6	16.67	50.59	26.7	30.23	3.85
RAI-99	29.11	14.35	24.82	104.6	20	51.49	39.42	26.23	5.52
SU-1	23.54	16.35	9.67	100.1	4	57.14	14.62	53.73	0.67
SU-3	26.2	12.35	26.37	102.1	3.7	57.34	19.71	57.73	1.85
SU-88	27.54	13.35	9.67	100.1	6	50.14	24.79	53.73	1.31
TRMR-102	30.7	14.09	15.39	104.6	2.2e-14	53.36	12.08	11.23	1.24
TT-102	29.7	16.43	2.09	101.6	8.57	56.76	9.54	28.23	1.04
TT-103	29.37	15.43	32.09	95.6	3.33	58.16	6.99	23.23	0.03
TT-105	23.87	13.35	69.67	100.1	7.5	44.64	17.17	43.73	1.13
TT-136	31.7	21.09	-1.21	109.6	9.52	59.06	12.08	14.23	2.21
TT-169	32.37	21.43	2.09	106.6	11.11	55.26	9.54	11.23	1.76
TT-176	33.03	21.43	48.79	85.6	11.54	51.56	4.45	19.23	0.49
TT-200	23.03	11.43	-17.91	89.6	3.08	48.16	9.54	58.23	1.3
TT-27	19.37	9.43	35.39	104.1	3.33	58.59	47.05	68.98	4.22
TT-58	24.04	15.43	40.89	101.1	-8e-15	51.29	24.16	73.98	2.68
TT-64	31.03	15.43	-1.21	105.6	11.54	58.06	12.08	19.23	0.56

Table 39. Qualitative traits of brinjal germplasm

Coll./Acc. #	Plant Growth Habit	Corolla Color	Calyx Color	Calyx Spinniness	NSUL	NSDL	Fruit Color	Fruit Color Dist.	Fruit Curvature	Fruit Flesh Density	Fruit Shape	Fruits Apex shape	fruit color at maturity	Fruit calyx prickles	Leaf blade lobing	leaf blade tip angle	relative fruit calyx length
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
AC-172	3	5	3	3	0	0	9	1	1	5	5	3	2	0	5	3	5
AC-212	3	5	3	3	0	0	9	1	5	5	5	3	1	0	7	5	5
AC-240	3	5	3	3	0	0	1	3	1	5	5	5	3	0	7	5	5
AC-258	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	5	5
AC-285	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	5	5
AC-396	3	5	3	3	0	0	9	5	1	7	5	5	2	0	5	3	3
AC-47	3	5	3	3	0	0	9	1	1	5	5	3	2	0	5	7	5
AH-41	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	3	5
AHI-101	5	5	3	3	0	0	1	3	1	5	5	5	3	0	5	3	5
AHI-102	5	5	1	3	0	0	9	5	7	5	5	5	9	0	5	3	5
AHI-124	5	5	3	3	0	0				5	5	5	9	0	5	3	5
AM-10	7	5	3	3	0	0	1	5	3	5	5	3	3	0	5	5	5
AM-10111	3	5	3	3	0	0				5	5	3	4	0	5	7	5
AMA-294	3	5	3	5	0	0	9	3	1	5	5	3	4	0	5	7	5
AMA-302	3	5	3	3	0	0	1	3	1	5	5	3	3	0	7	7	5
AMA-312	3	5	3	3	0	0	1	3	1	7	5	3	1	0	5	3	5
AMA-368	3	5	3	3	0	0	1	1	1	7	5	5	3	0	7	5	5
AMA-410	7	5	3	3	0	0	1	3	1	5	5	5	2	0	7	5	5
ATR-12	3	5	3	3	0	0	1	7	5	5	5	3	3	0	5	5	5
BARI-1	3	5	3	3	9	7				5	5	3	3	0	7	5	
BARI-10	3	5	1	3	0	0	1	3	1	7	5	5	3	0	5	5	5
BARI-4	7	5	3	3	0	0	8	1	1	7	5	5	9	0	7	5	7
BARI-5	3	5	3	3	0	0	1	1	1	7	5	5	3	0	3	3	3
BARI-6	3	5	1	3	0	0	9	1	5	5	5	3	2	0	5	5	5
BARI-7	3	5	3	3	0	0				5	5	5	3	0	5	5	
BARI-8	3	5	3	3	0	0	1	1	1	5	5	5	3	0	3	3	5
BARI-9	5	5	3	3	0	0				5	5	3	3	0	7	5	5
BARI-BT-1	5	7	3	3	0	0	1	1	1	5	5	3	3	0	5	3	3
BARI-BT-2	5	5	3	3	0	0	6	1	1	7	5	3	3	0	3	3	5
BARI-BT-3	3	5	3	3	0	0	1	1	1	7	5	5	3	0	5	3	5
BARI-BT-4	3	5	1	3	0	0	1	7	1	5	5	5	3	0	7	5	7
BD—2705	3	5	3	3	0	0	6	7	3	7	5	3	3	0	5	3	5
BD-10154	3	5	3	3	0	0	1	1	1	5	5	7	3	0	5	3	5
BD-10156	3	5	3	3	0	0	9	1	7	5	5	5	2	0	7	5	5
BD-10157	3	5	3	3	0	0	1	3	1	5	5	3	3	0	5	5	3
BD-10158	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
BD-10171	5	5	3	3	0	0	1	5	1	5	5	7	3	0	5	5	3
BD-10176	3	5	3	3	0	0	1	1	1	5	5	3	3	0	5	5	5
BD-10178	7	5	3	3	0	0	9	5	1	5	5	5	3	0	7	5	5
BD-10187	3	5	3	3	0	0	1	3	1	7	5	5	3	0	5	5	5
BD-10188	7	5	3	3	0	0	9	1	1	7	5	5	2	0	5	5	5
BD-10190	3	1	1	3	0	0	1	5	1	7	5	5	3	0	7	5	5
BD-10191	7	5	1	7	7	9	1	5	5	5	5	3	3	5	7	5	3
BD-10192	3	5	3	3	0	0	1	3	1	5	5	5	4	0	7	5	7
BD-10193	5	5	3	3	0	0	9	1	3	5	5	3	9	0	5	5	3
BD-10194	3	5	3	3	0	0	6	1	1	7	5	5	2	0	5	7	5
BD-10195	3	7	3	3	0	0	1	1	2	5	5	3	2	0	5	5	3
BD-2645	3	5	1	5	10	9	1	1	2	5	5	3	3	0			

Table 39. Cont'd

Coll./Acc. #	Plant Growth Habit	Corolla Color	Calyx Color	Calyx Spininess	NSUL	NSDL	Fruit Color	Fruit Color Dist.	Fruit Curvature	Fruit Flesh Density	Fruit Shape	Fruits Apex shape	fruit color at maturity	Fruit calyx prickles	Leaf blade lobing	leaf blade tip angle	relative fruit calyx length
BD-2646	3	5	3	3	0	0	1	5	3	5	5	3	3	0	5	5	5
BD-2649	3	5	1	3	0	0	1	5	3	7	5	3	3	0	7	5	
BD-2650	3	5	3	3	0	0	1	1	3	5	5	3	3	0	5	5	5
BD-2651	3	5	3	3	0	0	9	1	1	5	5	5	3	0	5	5	3
BD-2652	7	5	3	3	0	0		1						0	5	1	5
BD-2653	3	5	3	3	9	8	1		1	5	5	7	2	0	7	1	
BD-2657	3	5	1	3	0	0	6	1	1	5	1	3	2	0	5	1	5
BD-2658	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	7	5
BD-2662	7	5	3	3	0	0	6	7	1	5	5	3	1	0	5	3	5
BD-2663	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	7
BD-2664	3	7	3	3	0	0	1	7	3	7	5	3	2	0	7	3	3
BD-2665	5	5	3	3	0	0	9	5	1	5	5	3	2	0	5	5	5
BD-2669	3	5	1	3	0	0	9	1	1	5	5	3	3	0	5	5	5
BD-2672	3	5	3	3	0	0	9	1	8	5	5	3	2	0	7	5	5
BD-2673	3	5	1	3	0	0	1	1	1	5	5	5	2	0	3	5	7
BD-2674	7	5	3	3	0	0	1	5	1	7	5	3	2	0	5	5	5
BD-2675	3	5	3	3	0	0	1	1	1	7	5	5	3	0	5	5	5
BD-2677	3	5	3	3	0	0	9	5	1	7	5	3	2	0	5	3	5
BD-2678	5	5	3	3	0	0	6	5	1	5	5	5	2	0	5	5	5
BD-2680	7	5	3	3	0	0	1	1	5	5	5	3	2		5	5	7
BD-2681	7	5	3	3	0	0	1	7	5	5	5	3	2	0	5	3	5
BD-2682	3	5	3	3	0	0	9	3	3	5	5	3		0	7	7	5
BD-2683	3	5	3	3	0	0	1	1	1	5	5	3	3	0	7	5	7
BD-2685	3	5	3	3	0	0	6	1	3	5	5	5	1	0	5	7	5
BD-2686	3	7	3	3	0	0	1	3	5	5	5	3	1	0	7	5	5
BD-2687	3	5	1	3	0	0	6	3	1	7	5	3	2	0	5	3	3
BD-2694	7	5	3	3	0	0	1	7	3	5	1	5	3	0	5	3	5
BD-2695	3	5	3	3	0	0	6	1	1	7	5	5	2	0	7	5	5
BD-2702	7	5	3	3	0	0	9	1	1	5	5	3	2	0	5	5	7
BD-2703	7	5	3	3	0	0	1	3	1	5	5	3	3	0	5	1	7
BD-2707	3	5	3	3	0	0	9	3	5	5	5	3	2	0	5	5	7
BD-2708	3	5	3	3	0	0	1	3	1	5	5	3	3	0	5	3	5
BD-2710	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	7	5
BD-2711	7	5	3	3	0	0	9	3	3	5	5	3	2	0	7	7	5
BD-2715	3	5	3	3	0	0	1	3	1	7	5	5	2	0	5	3	5
BD-2716	3	5	3	3	0	0	1	1	1	7	5	5	3	0	5	5	5
BD-2721	7	5	1	3	0	0	1	5	1	5	5	5	3	0	5	5	5
BD-2724	7	5	3	3	0	0	1	1	1	7	5	5	3	0	5	5	5
BD-2725	3	5	1	5	0	0	1	5	1	5	5	5	3	1	7	7	3
BD-2728	7	5	1	3	0	0	1	7	1	7	5	5	3	0	5	5	5
BD-2731	3	5	1	5	0	0	1	7	5	5	5	5	3	0	5	5	5
BD-2732	7	5	3	3	0	0	1	1			5			0	5	5	5
BD-2733	3	5	1	7	10	9							3		7	5	
BD-2735	3	5	2	3	0	0	9	1	1	7	5	5	3	0	3	3	5
BD-2740	3	5	3	3	0	0	1	5	1	5	5	5	3	0	5	7	5
BD-2746	3	5	1	3	0	0	1	5	1	5	5	5	3	0	5	9	5
BD-2748	5	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
BD-2749	3	5	2	3	0	0	1	7	1	7	5	5	3	0	1	1	3
BD-2751	3	5	3	3	0	0	1	1		7	5	7	2	0	3	1	5

Table 39. Cont'd

Coll./Acc. #	Plant Growth Habit	Corolla Color	Calyx Color	Calyx Spininess	NSUL	NSDL	Fruit Color	Fruit Color Dist.	Fruit Curvature	Fruit Flesh Density	Fruit Shape	Fruits Apex shape	fruit color at maturity	Fruit calyx prickles	Leaf blade lobing	leaf blade tip angle	relative fruit calyx length
BD-2753	3	5	3	3	0	0				7	5	7	2	0	5	1	
BD-2754	3	5	3	3	0	0	1	7	1	7	5	7	2	0	5	3	5
BD-2755	5	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	5
BD-2756	3	5	3	3	0	0	1	5	1	7	5	5	3	0	7	3	5
BD-2757	3	5	3	3	0	0	1	5	1	7	5	5	3	0	7	5	3
BD-2762	3	5	3	3	0	0				7	5	5	3	0	5	5	5
BD-2763	3	5	3	3	0	0	1	5	1	7	5	5	3	0	5	5	5
BD-2764	3	5	3	3	0	0	1	5	1	7	5	5	3	0	3	3	5
BD-2766	3	5	1	5	0	0	1	7	1	5	5	5	3	0	5	5	5
BD-2770	5	5	2	3	0	0	1	5	1	5	5	5	3	0	5	5	7
BD-2773	5	5	3	3	0	0	6	5	1	7	5	5	2	0	3	3	3
BD-2774	7	5	3	3	0	0	1	5	1	5	5	5	3	0	7	5	5
BD-2775	3	5	2	3	0	0	6	5	1	7	5	5	9	0	5	3	5
BD-2776	3	5	3	3	0	0	1	7	1	5	5	3	3	0	7	5	5
BD-2783	3	5	1	5	4	2	6	5	1	5	5	5	3	0	5	3	5
BD-2789	7	5	3	3	0	0	1	3	1	5	5	7	3	0	5	3	5
BD-2790	3	5	3	3	0	0	2	1	1	5	5	5	3	0	7	5	5
BD-2791	3	5	1	7	12	10	9	1	1	5	5	5	3	3	7	5	5
BD-2792	7	5	3	3	0	0	1	1	5	7	5	3	3	0	5	5	7
BD-2796	3	5	3	3	0	0	6	1	1	7	5	3	2	0	7	3	5
BD-2797	7	5	3	3	0	0	1	1	5	5	5	3	3	0	5	7	5
BD-2805	7	7	3	3	0	0	1	7	1	7	5	5	3	0	3	3	5
BD-2807	3	5	3	3	0	0	1	5	1	7	5	5	3	0	7	5	5
BD-2808	3	5	3	3	0	0	1	7	1	5	5	5	3	0	5	5	5
BD-2809	3	5	3	3	0	0	9	5	1	5	5	5	2	0	5	3	5
BD-2820	3	5	3	3	0	0	6	7	1	7	5	3	2	0	3	3	5
BD-2822	3	5	1	7	14	10				5	5	5	2	0	7	7	5
BD-2825	3	5	3	5	0	0	9	3	1	5	5	5	2	0	5	5	5
BD-2826	3	5	3	3	0	0				5	5	3	3	0	5	5	
BD-2827	3	5	1	5	4	3				5	5	3	3	0	7	3	
BD-2830	7	5	2	3	0	0	1	5	3	5	5	3	3	0	7	5	5
BD-2832	3	5	3	7	10	7	1	3	1	5	5	5	3	0	7	5	5
BD-2840	7	5	3	3	0	0	9	1	8	5	5	3	2	0	5	5	5
BD-2842	3	5	3	3	0	0	1	1	1	5	5	5	2	0	5	3	5
BD-7314	3	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	5
BD-7319	3	5	1	3	0	0	1	7	8	5	5	3	3	0	7	3	5
BD-7320	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	7
BD-7321	7	5	3	3	0	0	1	5	1	5	5	3	3	0	5	5	5
BD-7324	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	3	5
BD-7327	3	5	3	3	0	0	9	3	3	5	5	3	3	0	7	5	5
BD-7328	7	5	3	3	0	0	1	7	1	5	5	5	3	0	5	3	5
BD-7332	7	5	3	3	0	0	1	1	1	5	5	3	3	0	3	1	5
BD-7333	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	3	5
BD-7335	3	5	3	5	0	0	1	1	1	7	5	5	3	0	7	1	5
BD-9530	7	5	3	3	0	0	1	5	1	7	5	5	4	0	5	5	3
BD-9531	3	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	5
BD-9532	7	5	3	3	0	0	1	5	1	5	5	5	3	0	3	3	3
BD-9535	3	5	3	3	0	0	9	5	1	7	5	5	9	0	5	5	3
BD-9537	7	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	3
BD-9538	7	5	3	3	0	0	1	5	3	5	5	3	1	0	5	5	3
BD-9540	3	5	3	3	0	0	1	3	1	5	5	5	3	0	5	5	7

Table 39. Cont'd

Coll./Acc. #	Plant Growth Habit	Corolla Color	Calyx Color	Calyx Spininess	NSUL	NSDL	Fruit Color	Fruit Color Dist.	Fruit Curvature	Fruit Flesh Density	Fruit Shape	Fruits Apex shape	fruit color at maturity	Fruit calyx prickles	Leaf blade lobing	leaf blade tip angle	relative fruit calyx length
BD-9542	3	5	3	3	0	0	1	5	1	5	5	5	3	0	7	7	5
BD-9543	3	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	5
BD-9545	3	5	3	3	0	0	1	1	1	5	5	3	3	0	3	3	5
BD-9546	3	5	3	3	0	0	1	7	5	5	5	3	3	0	7	5	5
BD-9547	7	5	2	3	0	0	1	1	1	7	5	5	3	0	5	5	5
BD-9548	3	5	3	3	0	0	1	7	1	7	5	5	3	0	5	3	5
BD-9549	5	5	3	3	0	0	1	1	8	5	5	3	3	0	3	5	3
IAH-39	3	5	3	3	0	0	1	7	1	5	5	5	3	0	7	3	
K-10	3	5	1	5	10	9	1	7	1	5	5	5	3	0	7	3	
K-11	3	5	1	3	0	0	1	7	1	5	5	5	3	0	7	5	
K-12	3	5	1	3	0	0	1	7	1	5	5	5	3	0	7	3	7
K-13	3	5	3	5	0	0	1	5	1	5	5	5	3	1	5	5	3
K-15	5	5	1	3	0	0	1	1	1	5	5	5	3	0	3	3	5
K-16	3	5	1	3	0	0	1	5	1	5	5	3	3	0	7	5	3
K-17	3	5	1	3	0	0	1	5	1	7	5	5	3	0	7	5	3
K-18	3	5	3	3	4	3	1	1	1	5	5	5	3	0	7	5	5
K-19	7	5	1	3	0	0	9	1	5	7	5	3	2	3	7	3	5
K-20	3	5	3	3	0	0	1	1	1	7	5	5	3	0	7	3	5
K-21	3	5	3	3	0	0	1	1	1	7	5	7	3	0	5	5	7
K-22	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
K-23	7	5	3	3	0	0	1	1	8	7	5	3	9	0	5	5	5
K-26	3	5	3	3	0	0				5	5	5	3	0	5	5	5
K-27	7	5	3	3	0	0	1	5	1	5	5	5	3	0	5	3	3
K-28	5	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
K-29	3	5	1	5	0	0	1	7	1	7	5	5	3	0	7	5	5
K-30	3	5	2	5	0	0	1	1	1	5	5	5	3	0	5	5	5
K-32	3	5	3	3	0	0	6	1	1	7	5	5	2	0	5	7	5
K-33	3	5	1	3	0	0	6	7	1	7	5	3	3	0	5	3	5
K-34	7	5	1	3	0	0								0	5	5	
K-35	3	5	1	7	0	0	1	3	1	5	5	5	1	0	7	5	5
K-36	3	5	1	3	0	0	9	7	1	5	5	3	3	0	5	3	7
K-37	3	5	2	3	0	0	1	3	1	7	5	5	3	0	5	3	7
K-38	5	5	1	7	11	10	1	5	1	5	5	5	3	3	5	3	5
K-39	3	5	3	3	0	0	9	1	1	5	5	5	3	0	5	3	5
K-40	3	5	3	3	0	0								0	7	5	
K-42	3	5	3	3	0	0	9	3	1	7	5	3	2	0	7	5	5
K-45	3	5	3	3	0	0	9	1	1	5	5	5	9	0	5	5	7
K-47	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
KASI-46	7	5	1	3	0	0	2	5	1	5	5	5	3	0	5	7	5
KASI-98	3	5	1	7	12	9	1	1	1	5	5	3	3	3	7	5	5
KASI-99	3	5	3	5	0	0	9	3	1	5	5	3	4	0	7	5	3
M-02	3	5	1	3	0	0	6	1	1	7	5	5	8		3	3	5
MTR-7	3	5	3	3	0	0								0	7	5	
NIR-04	3	5	1	3	0	0	1	5	1	5	5	5	3		7	5	5
NIR-62	7	5	3	3	0	0	2	5	1	5	5	5	3	0	3	3	5
NSR-10	7	5	1	3	0	0	1	1	1	5	5	5	2	0	7	3	5
NSR-11	7	5	3	3	0	0	1	3	1	5	5	3	3	0	7	5	5
NSR-12	3	5	3	3	0	0	6	1	1	7	5	5	2	0	5	5	7
NSR-13	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	7
NSR-14	3	5	1	7	6	2								0	7	5	
NSR-15	3	5	3	3	0	0	1	1	3	5	5	5	3	0	5	7	5

Table 39. Cont'd

Coll./Acc. #	Plant Growth Habit	Corolla Color	Calyx Color	Calyx Spininess	NSUL	NSDL	Fruit Color	Fruit Color Dist.	Fruit Curvature	Fruit Flesh Density	Fruit Shape	Fruits Apex shape	fruit color at maturity	Fruit calyx prickles	Leaf blade lobing	leaf blade tip angle relative	fruit calyx length
NSR-16	3	5	1	3	0	0	1	7	1	5	5	5	3	0	7	3	5
NSR-17	7	5	3	3	0	0	6	7	1	7	5	5	2	0	5	5	5
NSR-18	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	7	5
NSR-19	3	5	1	3	0	0	1	5	1	5	5	5	3	0	7	5	5
NSR-2	7	5	3	3	0	0	1	7	1	5	5	7	3	0	5	5	5
NSR-2.1	3	5	1	3	0	0	1	1	1	5	5	5	3	0	5	3	5
NSR-20	3	5	1	3	0	0	1	5	1	7	5	5	3	0	5	5	5
NSR-21	3	5	3	5	3	2	1	1	1	7	5	7	3	3	7	5	5
NSR-22	7	5	1	3	0	0	9	5	1	5	5	5	2	0	5	5	3
NSR-23	5	5	3	3	0	0	9	3	1	7	5	3	9	0	5	5	5
NSR-24	5	5	3	3	0	0	9	1	1	7	5	3	9	0	7	7	7
NSR-25	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	5	7
NSR-26	7	7	1	7	18	10	9	5	1	5	5	5	2	5	7	5	5
NSR-27	3	5	3	3	0	0	1	3	1	5	5	5	3	0	5	7	5
NSR-28	3	5	3	3	0	0	1	5	1	5	5	5	3	0	7	5	3
NSR-29	3	5	3	3	0	0	1	1	1	7	5	5	3	0	5	3	5
NSR-3	3	5	3	3	0	0	1	3	1	7	5	5	3	0	7	7	5
NSR-30	3	5	1	3	0	0	1	5	1	5	5	5	3	0	5	5	5
NSR-4	3	5	1	3	0	0	1	5	1	5	5	5	3	0	7	5	3
NSR-5	7	5	3	3	0	0	6	1	1	7	5	5	3	0	7	5	5
NSR-53	7	5	1	5	0	0	1	5	1	5	5	5	3	0	5	5	5
NSR-6	3	5	3	3	0	0	1	1	1	5	5	5	3	0	7	5	5
NSR-7	3	5	1	3	0	0	6	1	1	5	5	5	2	0	5	3	5
NSR-8	7	5	1	5	15	12				5	5	5	2	0	7	5	
NSR-9	3	5	1	7	14	13	1	5	1	5	5	5	3	0	5	5	5
RAI-150	5	5	2	3	0	0	9	5	1	7	5	5	9	0	3	3	3
RAI-216	3	5	2	3	0	0	1	5	1	5	5	5	3	0	5	5	5
RAI-219	5	5	2	3	0	0	9	5	1	5	5	3	9	0	7	7	5
RAI-230	3	5	3	3	0	0	8	5	1	5	5	3	2	0	5	3	3
RAI-81	7	5	3	3	0	0	1	1	1	7	5	5	3	0	7	5	3
RAI-99	3	5	2	3	0	0	1	5	1	7	5	5	3	0	5	3	3
SU-1	5	5	3	3	0	0				5	5	5	2	0	5	5	
SU-3	3	5	3	3	0	0	9	3	1	5	5	5	2	0	7	5	5
SU-88	3	5	3	3	0	0	9	3	1	5	5	5	2	0	5	5	5
TRMR-102	3	5	3	3	0	0	9	1	1	5	5	5	1	0	5	3	5
TT-102	3	5	3	3	0	0	2	3	1	5	5	5	3	0	7	3	5
TT-103	3	5	3	7	14	9	6	1	1	7	5	5	3	0	3	3	7
TT-105	3	5	3	3	0	0				7	5	5	3	0	3	3	7
TT-136	5	5	3	3	0	0	1	3	1	5	5	5	3	0	7	7	5
TT-169	3	5	3	3	0	0	1	1	1	5	5	5	3	0	5	5	5
TT-176	3	5	3	3	0	0	6	1	1	7	5	5	3	0	5	5	5
TT-200	7	5	3	3	0	0	9	1	3	5	5	3	9	0	5	3	7
TT-27	3	5	3	3	0	0	1	3	1	7	5	5	3	0	5	3	5
TT-58	5	5	3	3	0	0	1	5	1	5	5	5	3	0	5	5	3
TT-64	3	5	1	3	0	0	9	1	5	5	5	3	1	0	7	3	5



Fig. 43. Distinctness among test brinjal germplasm

Conclusion

A wide variation was observed in the collected brinjal germplasm. Most of the qualitative characters showed distinct variation among the germplasm. Qualitatively the maximum variation was observed in leaf prickles, fruit calyx prickles, fruit color at ripening and fruit flesh density. Quantitatively highest variation was observed in fruit length which was followed by 100 seed weight and yield per plant. The overall performance of the genotypes indicated that the genotypes NSR-10, NSR-8 and AH-101 had higher yield potentiality. Therefore, selection of these genotypes might play a significant role for future breeding program.

11.3.5. Characterization of Landraces of Bitter Gourd Germplasm

A. Qualitative Descriptors

Qualitative characters of different germplasm of bitter gourd are presented in Table 40. All germplasm was classified as *Korolla* (100%) (Table 40). Poor (15.22%), good (23.91%) and very good (60.87%) early plant vigor were observed among the germplasm. Short viny (6.52%), medium viny (36.96%) and long viny (56.52%) plant growth habit were found (Fig. 44). Stem pubescence was present in 45 germplasm (97.83%) and absent in only 1 germplasm (2.17%). Moreover, all germplasm has angular stem shape. Twining tendency of studied germplasm was intermediate (52.17%) and pronounced (47.83%). Maximum (80.43%) germplasm showed unifold and only (19.57%) germplasm showed bifid tendril branching (Fig. 44). However, all germplasm showed serrate leaf margin. In case of leaf shape, ovate and cordate shape was found in 4.35% germplasm of each, and supreme percentage of germplasm (91.30%) showed reniform leaf shape. Small (2.17%), medium (52.17%) and large 45.65% leaf size was found among the germplasm (Fig. 46). Leaf pubescence was sparse, intermediate and dense in 21.74%, 30.43% and 47.83% germplasm respectively. Nevertheless, Monoecious sex type was found in entire germplasm. Among the germplasm 23.91%, 45.65% and 30.43% showed correspondingly light yellow, yellow and deep yellow color flower. While considering fruit shape, spindle shaped was highest in 40 germplasm (86.96%), long cylindrical, top shaped and globular (4.35%) each fruit shape (Fig. 47) along with smooth only 2.17%, light tubercle 34.78% and deep tubercle 63.04% fruit surface occurred among the germplasm. Nature of tubercles were observed as sparse (17.39%), medium and dense (41.30%) each (Fig. 48). Blunt (39.13%) and acute (60.87%) blossom-end fruit shape were found (Fig. 49). Fruit skin color such as white was found in least number of germplasm (2.17%), while maximum germplasm has light green (34.78%) skin, as well green (39.13%) and dark green (23.91%) were exhibited among the germplasm. Fruit skin luster showed intermediate (45.65%), followed by glossy (36.96%) and matt in (17.39%) germplasm. Amid the germplasm fruit bitterness was mild in 26.09%, moderate in 45.65% and strong in 28.26%. Twenty-five (54.35%) germplasm had glossy seed luster, while intermediate and matt was in 13 (28.26%) and 8 (17.39%) germplasm singly (Fig. 50). Low (17.39%), medium and high (41.30%) seediness occurred among the germplasm. The qualitative descriptors for individual germplasm are presented in Table 41.

Table 40. Qualitative variations in bitter gourd germplasm

Name of Descriptor	Descriptor state	No. of germplasm	Percentage (%)
Classes	Uchche	0	0
	Korolla	46	100
Early plant vigor	Poor	7	15.22
	Good	11	23.91
	Very good	28	60.87
Plant growth habit	Short viny	3	6.52
	Medium viny	17	36.96
	Long viny	26	56.52
Stem pubescence	Absent	1	2.17
	Present	45	97.83
Stem shape	Angular	46	100
Twining tendency	Slight	0	0
	Intermediate	24	52.17
	Pronounced	22	47.83
Tendril branching	Unifold	37	80.43
	Bifold	9	19.57
Leaf margin	Serrate	46	100
Leaf shape	Ovate	2	4.35
	Cordate	2	4.35
	Orbicular	42	91.30

Table 40. Cont'd

Name of Descriptor	Descriptor state	No. of germplasm	Percentage (%)
Leaf size	Small	1	2.17
	Medium	24	52.17
	Large	21	45.65
Leaf pubescence	Sparse	10	21.74
	Intermediate	14	30.43
	Dense	22	47.83
Sex type	Monoecious	46	100
Flower color	Light yellow	11	23.91
	Yellow	21	45.65
	Deep yellow	14	30.43
Fruit shape	Spindle	40	86.96
	Long cylindrical	2	4.35
	Top shaped	2	4.35
	Globular	2	4.35
Fruit surface	Smooth	1	2.17
	Light tubercle	16	34.78
	Deep tubercle	29	63.04
Nature of tubercles	Sparse	8	17.39
	Medium	19	41.30
	Dense	19	41.30
Blossom-end fruit shape	Blunt	18	39.13
	Acute	28	60.87
Fruit skin color	White	1	2.17
	Light green	16	34.78
	Green	18	39.13
	Dark green	11	23.91
Fruit skin luster	Matt	8	17.39
	Intermediate	21	45.65
	Glossy	17	36.96
Fruit bitterness	Mild	12	26.09
	Moderate	21	45.65
	Strong	13	28.26
Seediness	Low	8	17.39
	Medium	19	41.30
	High	19	41.30
Seed luster	Matt	8	17.39
	Intermediate	13	28.26
	Glossy	25	54.35

**Fig. 44. Plant growth habit of test bitter gourd germplasm**



Unifid
(83.87%)

Bifid
(16.13%)

Fig. 45. Tendril branching habit of test bitter gourd germplasm



Small
(9.68%)

Medium
(56.45%)

Large
(33.87%)

Fig. 46. Leaf size of bitter gourd germplasm.



Spindle
(66.13%)

Long cylindrical
(4.84%)

Globular
(25.81%)

Top shaped
(3.22%)

Fig. 47. Fruit shape of bitter gourd germplasm



Fig. 48. Nature of tubercles and fruit surface of test bitter gourd germplasm



Fig. 49. Blossom-end fruit shape of bitter gourd germplasm

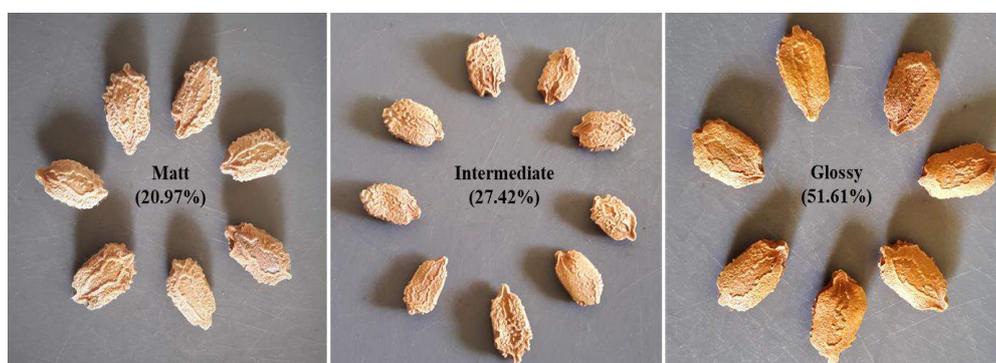


Fig. 50. Seed skin luster of bitter gourd germplasm.

B. Quantitative Descriptor

Range, mean, standard deviation and coefficient of variation for quantitative characters are shown in Table 41. Days to germinations varied from 4 to 15 days with mean 6.04. Internode length ranged from 4.44 to 9.4 cm. On an average, petiole length was 5.73 cm. Days to 50% plant flowering female flower ranged from 40 to 61. Moreover, Peduncle length ranged from 2.1 to 9.2 cm. Vine length showed an average of 250 cm, which oscillated from 170-342 cm. However, number of primary branches ranged from 20-45. On an average, days to first fruit harvest and last fruit harvest was 56.48 and 88.15 accordingly. Number of fruits per plant fluctuated from 9-38 with mean 20.85. Besides, weight of 5 marketable fruits ranged from 15-950 g. However, fruit length and fruit width ranged from 4 to 23.3 and 2.96 to 6.62 cm respectively. Averagely, number of seeds per fruit was 12.59. 100-seed weight ranged from 9.2 to 23.24 g. The highest CV was found in fruit weight (53.21%) and the lowest CV was found in days to last fruit harvest (5.35%). The quantitative descriptors for individual germplasm are presented in Table 43. Hereafter, some promising bitter gourd germplasm were selected based on two different criteria. Firstly, while considering total fruiting period AC-204 showed the

longest duration (49 days), followed by, AC-282 (43 days), AC-502 (42 days), AHI-85 (40 days) and AHI-30 (39 days). Secondly, taking the yield factor in mind AHI-85 was the best performer, about 5.5 kg/plant. Subsequent best yielders were, TRMR-13 (5.4 kg/plant), IA-13 (about 4.4 kg/plant), AHI-28 (3.6 kg/plant) and TRMR-63 (about 3.4 kg/plant). Overall, linking both factor AHI-85 is the most latent one among studied germplasm.

Table 41. Quantitative variations in bitter gourd germplasm

Parameter	Range	Mean	SD	CV (%)
Days to germination	4-15	6.04	2.56	42.29
Internode length (cm)	4.44-9.4	7.10	1.36	19.15
Petiole length (cm)	2.56-9.9	5.73	1.78	31.13
Days to 50% flowering	40-61	49.67	3.72	7.50
Peduncle length (cm)	2.1-9.2	4.89	1.41	28.85
Vine length (cm)	170-342	250.00	38.24	15.30
Number of primary branches	20-45	32.57	5.56	17.06
Days to first fruit harvest	42-70	56.48	5.68	10.06
Days to last fruit harvest	78-97	88.15	4.71	5.35
No. of fruits per plant	9-38	20.85	8.08	38.76
Fruit weight (g) (5)	15-950	413.17	219.83	53.21
Fruit length (cm)	4-23.3	14.30	3.86	26.98
Fruit width (cm)	2.96-6.62	5.12	0.80	15.62
No. of seed(s) per fruit	5.2-19.4	12.59	3.35	26.65
100 seed weight (g)	9.2-23.24	17.24	2.57	14.93

Table 42. Qualitative characters of bitter gourd germplasm

Coll. No.	Class	Early plant vigor	Plant growth habit	Stem pubescence	Stem shape	Twining tendency	Tendrils branching	Leaf margin	Leaf shape	Leaf size	Leaf pubescence
1	2	3	4	5	6	7	8	9	10	11	12
AC-204	2	7	7	1	2	7	1	2	5	5	5
AC-255	2	5	5	1	2	5	2	2	1	7	3
AC-282	2	3	3	1	2	5	2	2	5	5	5
AC-287	2	7	7	1	2	7	1	2	5	5	7
AC-296	2	5	7	1	2	5	1	2	5	7	5
AC-301	2	7	7	1	2	7	1	2	5	5	3
AC-307	2	7	5	1	2	5	1	2	5	5	7
AC-346	2	7	7	1	2	7	1	2	5	5	7
AC-404	2	7	5	1	2	5	2	2	5	5	7
AC-476	2	7	7	1	2	5	1	2	1	5	7
AC-502	2	7	5	1	2	7	2	2	5	5	3
AR-18	2	3	5	1	2	7	1	2	5	5	3
AR-181	2	7	7	1	2	7	1	2	5	5	7
AR-263	2	3	5	1	2	7	1	2	5	5	3
RC-18	2	7	7	1	2	7	2	2	5	7	7
RC-26	2	7	7	1	2	5	1	2	5	5	3
RC-96	2	5	7	1	2	5	1	2	5	7	7
RC-143	2	7	7	1	2	5	1	2	5	5	7
AHM-138	2	3	5	1	2	7	1	2	5	7	5
RAI-12	2	5	5	1	2	5	1	2	5	7	5
RAI-32	2	7	7	1	2	5	1	2	5	5	5
RAI-173	2	7	7	1	2	7	2	2	5	7	7
ZA-02	2	5	3	0	2	5	1	2	5	3	3

Table 42. Cont'd

Coll. No.	Class	Early plant vigor	Plant growth habit	Stem pubescence	Stem shape	Twining tendency	Tendrils branching	Leaf margin	Leaf shape	Leaf size	Leaf pubescence
ZS-24	2	5	5	1	2	7	1	2	5	7	7
TT-40	2	7	7	1	2	5	1	2	5	7	5
N-23	2	7	5	1	2	7	1	2	5	7	7
N-98	2	7	7	1	2	7	1	2	5	7	7
N-112	2	7	5	1	2	7	1	2	5	5	5
N-130	2	7	7	1	2	7	1	2	3	5	3
IA-13	2	5	5	1	2	5	1	2	5	5	7
IA-55	2	7	7	1	2	7	1	2	5	5	5
AHI-28	2	7	7	1	2	5	1	2	5	7	7
AHI-30	2	5	7	1	2	5	1	2	5	5	7
AHI-85	2	7	7	1	2	7	1	2	5	7	7
AHI-98	2	7	7	1	2	7	1	2	5	7	7
AHI-112	2	3	5	1	2	5	1	2	3	7	7
AHI-115	2	3	5	1	2	7	1	2	5	5	5
AHI-122	2	5	5	1	2	7	1	2	5	7	7
ATR-42	2	3	5	1	2	5	1	2	5	5	5
TRMR-13	2	7	7	1	2	5	1	2	5	5	3
TRMR-63	2	7	7	1	2	5	1	2	5	7	5
NRI-36	2	5	5	1	2	7	1	2	5	7	3
AC-18	2	5	5	1	2	5	1	2	5	5	3
AC-185	2	5	5	1	2	5	2	2	5	7	5
MRI-26	2	7	7	1	2	5	2	2	5	7	7
A-05	2	7	7	1	2	5	2	2	5	7	7
BARI Korolla-2	2	7	5	1	2	5	1	2	5	5	5
BARI Korolla-3	2	7	5	1	2	5	1	2	5	5	5

Table 42. Qualitative characters of bitter melon germplasm (Cont'd)

Collector's No.	Sex type	Flower color	Fruit shape	Fruit surface	Nature of tubercles	Blossom-end fruit shape	Fruit skin color	Fruit skin luster	Fruit bitterness	Seediness	Seed luster
1	13	14	15	16	17	18	19	20	21	22	23
AC-204	1	4	1	3	7	2	5	5	5	7	3
AC-255	1	4	1	2	7	2	6	5	5	7	7
AC-282	1	4	1	3	7	2	5	3	7	5	7
AC-287	1	2	1	3	7	1	5	5	3	5	7
AC-296	1	2	1	3	5	2	4	5	5	7	7
AC-301	1	4	1	3	7	1	5	7	5	3	7
AC-307	1	2	1	3	5	2	4	5	3	5	5
AC-346	1	2	1	3	7	2	5	7	3	5	5
AC-404	1	4	1	3	5	1	4	7	5	5	7
AC-476	1	2	1	3	7	2	6	5	5	5	7
AC-502	1	2	1	3	5	2	6	5	7	3	3
AR-18	1	3	1	3	7	2	5	7	5	3	5
AR-181	1	2	1	3	5	2	5	7	5	3	3
AR-263	1	2	4	2	5	2	4	5	5	5	7
RC-18	1	4	1	2	5	2	4	7	3	5	3
RC-26	1	3	1	3	5	2	5	5	7	7	5
RC-96	1	4	1	3	7	2	5	7	5	5	7

Table 42. Cont'd

Collector's No.	Sex type	Flower color	Fruit shape	Fruit surface	Nature of tubercles	Blossom-end fruit shape	Fruit skin color	Fruit skin luster	Fruit bitterness	Seediness	Seed luster
RC-143	1	3	1	3	3	2	5	7	5	5	7
AHM-138	1	3	1	3	7	1	6	3	7	7	7
RAI-12	1	4	1	2	7	2	6	3	5	5	5
RAI-32	1	4	1	3	7	2	4	3	5	7	5
RAI-173	1	3	1	3	5	1	6	5	5	7	5
ZA-02	1	3	5	2	3	2	5	3	7	3	7
ZS-24	1	4	1	3	7	1	5	5	3	5	3
TT-40	1	3	1	3	7	2	5	3	5	7	3
N-23	1	2	4	1	5	1	4	7	3	5	3
N-98	1	4	1	2	5	2	5	5	5	7	7
N-112	1	2	1	3	5	1	5	5	3	7	5
N-130	1	4	5	2	5	1	4	5	7	7	7
IA-13	1	3	1	3	7	1	6	5	3	7	7
IA-55	1	3	1	3	5	2	5	5	5	5	5
AHI-28	1	3	1	3	7	2	4	5	3	7	7
AHI-30	1	3	1	3	7	2	5	7	3	7	5
AHI-85	1	3	1	3	7	1	6	7	5	7	7
AHI-98	1	4	1	3	3	2	1	7	7	5	5
AHI-112	1	4	1	3	5	2	4	7	5	7	7
AHI-115	1	2	1	2	5	1	4	5	5	3	7
AHI-122	1	3	1	2	5	2	6	5	5	5	7
ATR-42	1	3	1	2	5	1	4	5	7	5	7
TRMR-13	1	3	1	2	5	1	4	7	3	7	7
TRMR-63	1	3	1	3	7	1	6	7	5	7	5
NRI-36	1	3	1	2	3	2	4	3	7	5	7
AC-18	1	2	1	3	3	2	4	5	7	5	7
AC-185	1	3	1	2	5	1	4	3	7	5	7
MRI-26	1	3	4	2	3	1	4	7	7	3	7
A-05	1	3	1	2	3	1	5	5	3	7	3
BARI Korolla-2	1	3	1	2	5	2	5	5	5	3	5
BARI Korolla-3	1	2	1	2	7	1	4	5	5	3	7

Table 43. Quantitative characters of different germplasm of bitter gourd

Collector's No.	Days to germination	Internode length (cm)	Petiole length (cm)	Days to 50% flowering	Sex ratio (M/F)	Peduncle length (cm)	Vine length (cm)	No. of primary branches	Days to first fruit harvest	Days to last fruit harvest	No. of fruits/plant	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	No. of seeds/fruit	100 seed wt (g)
AC-204	5	6.8	8.54	54	10/7	6.5	225	30	44	93	28	580	16.2	4.9	16	18.1
AC-255	4	7.76	7.2	55	10/5	6.9	226	29	55	89	18	500	9.84	4.64	9.6	20.5
AC-282	5	6.12	6.3	58	10/2	3.1	225	40	50	93	9	100	6.1	3.5	12.8	13.2
AC-287	5	7.2	5.3	50	10/8	4.8	250	37	52	88	21	173	13.6	5.2	11.2	19.1
AC-296	4	8.9	7.804	51	10/8	4.1	230	35	55	91	28	290	12.5	4.7	9	16.8
AC-301	5	8.9	6.2	50	10/7	4.6	265	30	56	93	26	460	14.3	5.7	8.8	18.42
AC-307	4	7.2	5.7	51	10/2	3.9	210	35	52	89	18	160	10.9	4.8	14	15.47
AC-346	5	7.2	6.5	50	10/8	5	265	32	63	88	26	172	12.7	4.4	10.6	13.82
AC-404	4	6.48	4.58	51	10/10	4.4	260	30	61	86	27	500	13.8	5.26	11	18.2
AC-476	5	8.02	5.46	50	7/10	5	170	20	59	84	17	370	12.8	4.3	9.8	21.6
AC-502	5	7.22	5.96	50	10/5	4.4	220	35	51	93	18	252	9.1	4	8.8	14.7
AR-18	10	6.06	2.66	43	10/10	4	225	35	59	83	16	300	14.4	4.7	9.6	22.32
AR-181	10	6.26	5.98	45	10/5	6.4	170	25	49	79	21	399	18.7	4.8	9.6	17.5

Collector's No.	Days to germination	Internode length (cm)	Petiole length (cm)	Days to 50% flowering	Sex ratio (M/F)	Peduncle length (cm)	Vine length (cm)	No. of primary branches	Days to first fruit harvest	Days to last fruit harvest	No. of fruits/plant	Fruit weight (g)	Fruit length (cm)	Fruit width (cm)	No. of seeds/fruit	100 seed wt (g)
AR-263	6	8.12	4.26	49	5/10	3.6	220	30	51	83	9	420	19.7	5.9	10.4	14.9
RC-18	5	9.28	3.74	50	10/5	3.5	240	25	59	84	12	210	14.9	4.8	18.6	16.91
RC-26	4	6.54	4.18	49	5/10	3.8	250	27	55	89	31	147	16.06	6.18	15	16.9
RC-96	5	7.68	5.54	50	10/5	4.5	230	35	59	88	14	260	18.2	5.9	8.6	19.5
RC-143	5	7.44	5.6	50	5/10	5.8	235	25	51	88	22	680	14.6	5.6	10	15.3
AHM-138	6	4.54	4.7	49	10/10	4.2	227	26	53	87	13	730	12.8	6	16	19.2
RAI-12	5	7.7	9.3	50	10/10	5.6	290	39	59	93	12	410	17.3	5.5	11.2	16.2
RAI-32	5	7.4	9.7	50	10/7	5	288	28	58	84	14	157	22	5.96	10	16.2
RAI-173	5	8.4	7.5	48	10/5	3.9	247	36	54	89	36	450	17.82	5.76	15.4	17.5
ZA-02	6	4.4	6.8	47	10/10	2.1	170	24	51	88	20	15	4	2.96	5.2	9.2
ZS-24	4	4.7	5.04	51	10/5	4.4	220	32	62	97	13	820	15.3	5.5	9.6	18.2
TT-40	10	6.04	5.46	43	10/10	3	247	34	57	79	28	64	15.12	6.14	19.2	17.5
N-23	5	8.7	8.56	50	10/10	3.64	325	30	59	93	21	602	18.8	5.2	9.2	16.2
N-98	4	4.86	7.06	51	10/5	3.9	290	29	55	92	23	520	15.9	4.9	16.2	18.8
N-112	5	6.26	9.9	46	5/10	2.3	240	25	55	92	17	147	11.4	4.6	12.8	16.36
N-130	4	6.6	3.6	49	5/10	3.8	260	35	52	86	11	147	9	3.5	13.2	14.2
IA-13	15	7.84	6.9	40	10/5	9.2	325	44	42	78	21	950	15.3	4.6	15.4	17.8
IA-55	6	6.06	5.36	49	10/5	6	245	33	62	92	27	84	13.5	5.3	11.2	18.3
AHI-28	4	5.88	3.86	51	10/5	5.6	280	45	62	94	36	500	13.5	5.4	19.4	18.1
AHI-30	5	7.76	3.88	50	5/10	4.9	255	37	54	93	32	352	12.4	5.3	15	14.4
AHI-85	10	6.44	6.44	45	10/10	6.5	342	45	48	88	38	720	13.1	5.7	19	18.5
AHI-98	5	9.04	6.68	49	10/5	6.3	325	38	59	81	30	320	11.3	5.1	12.4	19.2
AHI-112	4	8.98	5	61	10/5	7.3	315	32	59	92	26	600	16.1	6.1	18.2	17.2
AHI-115	10	7.82	5.08	55	10/2	3.4	240	35	58	79	12	590	10.5	4.2	11.4	17.27
AHI-122	4	8.12	4.76	55	10/10	5.9	250	32	64	94	9	550	13.7	4.7	10.6	15.8
ATR-42	10	4.46	3.24	49	10/10	6.6	235	36	59	88	15	510	14.74	6.62	13.6	17.3
TRMR-13	4	9.4	4.02	51	7/10	3.9	255	33	66	89	36	750	16.5	6.44	15.4	15.75
TRMR-63	10	8.58	5.8	45	10/10	5	290	34	66	83	28	590	11.5	4.9	14.6	21.4
NRI-36	10	5.32	2.56	45	5/10	4.2	253	32	58	88	14	500	19.2	6.1	11.2	15.1
AC-18	6	6.72	3.44	53	5/10	5.8	242	35	63	87	22	512	12.1	5.24	14.8	18.1
AC-185	4	7.96	4.22	49	5/10	5.3	240	28	70	94	14	420	21.5	4.5	8.8	19.5
MRI-26	10	7.92	7.5	49	5/10	5.8	238	27	59	83	11	523	23.3	5.5	12	13.4
A-05	6	5.6	5.5	49	10/10	7	250	39	53	91	19	500	11.9	4.3	14.6	23.24
BARI Korolla-2	7	4.1	7.6	44	7/10	8.6	225	28	67	72	32	700	14.3	5.9	7.8	17.6
BARI Korolla-3	7	4.9	6.2	44	10/4	3.9	260	30	68	84	27	705	12.7	5.9	10.2	26.6

Conclusion

Forty-six bitter melon germplasm showed variation in qualitative and quantitative characters. The maximum coefficient of variations was in fruit weight and minimum in days to last fruit harvest. Also, among all few germplasm were selected based on total fruiting period and yield, where AHI-85 was certainly a good one.

11.3.6. Regeneration of Black Cumin and Fenugreek Germplasm

Black cumin

The qualitative and quantitative characters of thirty-two germplasm of black cumin carried out in this program have been shown in Table 44. Green color leaves with lobed margin were noticed in all germplasm. The flower color was violet mixed with white. All the germplasm exhibited straw

color fruit and black color seeds at matured stage (Fig. 42). Hundred seed weight ranged from 0.34 to 0.60 g and the maximum seed weights 175.19 g obtained by BD-10864.



Fig. 51. Flowering stage and different plant parts of black cumin

Table 44. Qualitative and quantitative characters of black cumin

Coll. No.	Leaf color	Leaf margin	Petal color	Mature fruit color	Seed color	100 seed weight(g)	Total seed weight (g)
AC-19	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.34	41.37
AC-25	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.60	66.32
AC-115	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.322	103.3
AC-266	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.32	100.55
AC-318	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.28	140.08
AC-327	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.291	45.53
AC-377	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.28	150.16
AC-77	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.34	152.44
AC-99	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.27	90.4
AC-115	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.38	70.33
SA-20	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.36	47.29
SA-32	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.34	160.52
AHM-119	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.39	88.88
AHM-167	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.41	120.76
AHM-350	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.43	68.32
AHM-364	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.42	85.2
IA-33	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.38	59.3
RAI-34	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.44	160.2
IAH-93	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.42	150.11

Coll. No.	Leaf color	Leaf margin	Petal color	Mature fruit color	Seed color	100 seed weight(g)	Total seed weight (g)
AR-210	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.43	64.64
BD-4516	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.41	18.5
BD-10320	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.37	104.8
BD-10861	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.36	130.8
BD-10862	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.35	115.16
BD-10863	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.42	77.32
BD-10864	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.29	175.19
BD-11211	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.44	95.53
BD-11212	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.42	68.57
BD-11213	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.32	42.06
BD-11214	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.28	23.52
BD-11215	Green	Lobed	Mixed (Violet with white and light green color)	Straw color	Black	0.39	49.69
BD-11216	Green	Lobed	Mixed	Straw color	Black	0.45	47.62

Fenugreek

The qualitative and quantitative characters of thirty-nine germplasm of fenugreek carried out under this program have been shown in Table 45. Green color leaves noticed in all germplasm. All the germplasm exhibited green color fruit and brown color seeds at matured stage (Fig. 43). The maximum seed weight 5000 g obtained by AC-122.

Table 45. Qualitative and quantitative characters of fenugreek

Acc. No.	Leaflet color	Leaf pubescence	Immature pod color	Matured pod color	Seed coat color	Total seed weight (g)
BD-8521	Green	Absent	Green	Straw	Brown	80.2
BD-8538	Green	Absent	Green	Straw	Brown	120
BD-8539	Green	Absent	Green	Straw	Brown	2000
AHM-137	Green	Absent	Green	Straw	Brown	45
AHM-135	Green	Absent	Green	Straw	Brown	105
AC--265	Green	Absent	Green	Straw	Brown	82
AC-330	Green	Absent	Green	Straw	Brown	260
RAI-250	Green	Absent	Green	Straw	Brown	95
AC-122	Green	Absent	Green	Straw	Brown	5000



Fig. 52. Different plant parts of fenugreek

11.3.7. Characterization of Brinjal Germplasm (Set-II)

Qualitative characteristics

Qualitative characteristics of 36 brinjal accessions are presented in Table 46. Cotyledon color was green for 22 accessions (61.11%), light violet for 9 accessions (25.00%), purple for 5 accessions (13.89%). Plant growth habit was upright for 20 accessions, intermediate for 5 accessions (17.94%) and strong for 11 accessions (30.56%). Leaf blade lobing was weak for 4 accessions (11.11%), intermediate for 12 accessions (33.33%) and strong for 17 accessions (47.22%) and very strong for 3 accessions (8.33%). Leaf blade tip angle was very acute for 5 accessions (13.89%), acute for 12 accessions (33.33%), intermediate for 18 accessions (50.00%) and obtuse for 1 accession (2.78%). Number of leaf prickles was none for 27 accessions (75.00%), intermediate for 3 accessions (8.33%), many for 5 accessions (13.89%) and very many for 1 accession (2.78%). Number of leaf hairs was very few for 17 accessions (47.22%), few for 15 accessions (41.67%) and intermediate for 4 accessions (11.11%). Corolla color was pale violet for 12 accessions (33.33%), light violet for 14 accessions (38.89%) and bluish violet for 10 accessions (27.78%). Fruit curvature was straight for 26 accessions (72.22%), slightly curved for 2 accessions (5.56%), curved for 5 accessions (13.89%) and snake shaped for 3 accessions (8.33%). Fruit shape was about half way from base to tip for 6 accessions (16.67%) and about three-quarter way from base to tip for 30 accessions (83.33%). Fruit apex shape was protruded for 23 accessions (63.89%), rounded for 12 accessions (33.33%) and depressed for 1 accession (2.78%). Fruit color was Green for 13 accessions (36.11%), milk white for 5 accessions (13.89%), scarlet red for 2 accessions (5.56%), lilac grey for 3 accessions (8.33%), purple for 8 accessions (22.22%), purple black for 3 accessions (8.33%) and black for 2 accessions (5.56%). Fruit color distribution was uniform for 8 accessions (22.22%), mottled for 3 accessions (8.33%), netted for 8 accessions (22.22%) and striped for 17 accessions (47.22%) were observed. The individual data of each accession is shown in Table 49.

Table 46. Qualitative variations in brinjal germplasm

Sl.#	Descriptor	Descriptor state	No. acc.	% of acc.
1	Cotyledon color	Green	22	61.11
		Light violet	9	25.00
		Violet	5	13.89
2	Plant growth habit	Upright	20	55.56
		Intermediate	5	13.89
		Strong	11	30.56
3	Leaf blade lobing	Weak	4	11.11
		Intermediate	12	33.33
		Strong	17	47.22
		Very strong	3	8.33
4	Leaf blade tip angle	Very acute	5	13.89
		Acute	12	33.33
		Intermediate	18	50.00
		Obtuse	1	2.78
5	Number of leaf prickles	None	27	75.00
		Intermediate	3	8.33
		Many	5	13.89
		Very many	1	2.78
6	Number of leaf hairs	Very few	17	47.22
		Few	15	41.67
		Intermediate	4	11.11
7	Corolla color	Pale violet	12	33.33
		Light violet	14	38.89
		Bluish violet	10	27.78

Sl.#	Descriptor	Descriptor state	No. acc.	% of acc.
8	Fruit curvature	Straight	26	72.22
		Slightly curved	2	5.56
		Curved	5	13.89
		Snake shaped	3	8.33
9	Fruit shape	About half way from base to tip	6	16.67
		About three quarter way from base to tip	30	83.33
10	Fruit apex shape	Protruded	23	63.89
		Rounded	12	33.33
		Depressed	1	2.78
11	Fruit color	Green	13	36.11
		Milk white	5	13.89
		Scarlet red	2	5.56
		Lilac grey	3	8.33
		Purple	8	22.22
		Purple Back	3	8.33
		Black	2	5.56
12	Fruit color distribution	Uniform	8	22.22
		Mottled	3	8.33
		Netted	8	22.22
		Striped	17	47.22

Quantitative characteristics

Quantitative characteristics of 36 brinjal accessions are presented in the Table 47. Days to first flowering, days to first edible fruiting stage, number of fruits per plant, 100-seed weight, seed yield per plant differed among the accessions. The first flower initiation was noticed in SM Ish-017 (82 days). Days to first flowering varied from 82.00 to 101.00, 17 accessions were early (82.00 to 87 days) and rest 19 accessions were optimum (91.00 to 101.00 days). Five accessions attained first edible fruiting stage within 100 to 115 days while 18 accessions first edible fruiting stage were within 116 to 120 days and the rest accessions 1st edible fruiting stage were within 125 to 132 days. Plant height varied from 62.50 cm to 106.50 cm, 18 accessions were short (62.50 to 79 cm), the 14 accessions were intermediate (80.50 to 99.50 cm) and rest 3 accessions were tall (102.50 to 106.50 cm). Plant breadth varied from 47.50 to 133.50 cm, 17 accessions were broad (47.50 to 90 cm) and rest 19 accessions were very broad (90.50 to 133.50 cm). Number of primary branches varied from 3.40 to 8.70cm, 21 accessions were weak (3.40 to 5.60 cm) and rest 15 accessions were intermediate (6.40 to 8.70cm). Leaf blade length varied from 12.30 to 24.20 cm, 22 accessions were intermediate (12.30 to 18.60 cm) and rest 14 accessions were long (21.20 to 24.20 cm). Leaf blade width varied from 7.40 to 13.60 cm, 16 accessions were intermediate (7.40 to 10.50 cm) and rest 20 accessions were wide (11.10 to 13.60 cm). Fruit length varied from 9.30 to 29.10 cm, 4 accessions were intermediate (9.30 to 10.75 cm), 25 accessions were long (11.25 to 19.60 cm) and rest 7 accessions were very long (20.30 to 29.10 cm) were observed. Number of fruits per plant varied from 9.00 to 46.00, 3 accessions were low (9.00 to 11.20), 9 accessions were intermediate (15.20 to 18.20), 8 accessions were high (19.00 to 23.00.) and rest 16 accessions were very high (24.10 to 46.00) were observed. Fruit weight per fruit varied from 77.65 to 266.38 g, the accessions were produced high fruit weight (>60g). The highest fruit weight per plant was found from SM Ish-015 (5.38 kg per plant) and lowest was found from SM Ish-032 (2.09 kg per plant). 100 seed weight varied from 1.10 to 4.30 g, the 100 seed weight of all the brinjal accessions were observed high. The individual data of each accession is shown in Table 48.

Table 47. Quantitative variations in brinjal germplasm

Characteristics	Range	Mean	SD	CV (%)
Days to first flowering	82.00-101.00	89.33	5.12	5.71
Days to first edible fruiting stage	102.00-132.00	114.86	7.73	6.73
Plant height (cm)	62.50-106.50	82.47	11.59	14.05
Plant breadth (cm)	47.50-133.50	92.50	14.81	16.02
Number of primary branches	3.40-8.70	5.87	1.22	20.90
Leaf blade length (cm)	12.30-24.20	18.43	3.60	19.56
Leaf blade width (cm)	7.40-13.60	11.18	1.72	15.45
Fruit length (cm)	9.30-29.10	17.34	7.89	45.53
Fruit breadth (cm)	2.80-10.55	7.31	1.59	21.84
Number of fruits per plant	9.00-46.00	21.56	7.40	34.35
Fruit weight (g)	77.65-266.38	190	41.78	21.97
Fruit weight per plant (kg)	2.06-5.38	3.87	0.83	21.56
100-seed weight (g)	1.10-4.30	3.10	1.18	38.30

Conclusion

Variations among 36 brinjal accessions were observed in different qualitative characteristics. The accessions SM Ish-001, SM Ish-015, SM Ish-018, SM Ish-010, SM Ish-011, SM Ish-012, SM Ish-024 and SM Ish-027 germplasm gave high edible fruit weight per fruit and per plant (4.77 to 5.38 kg) and it may be considered as better accessions. These accessions may be used in brinjal improvement program.

Table 48. Quantitative characters of brinjal germplasm

Acc. No.	Days to first flowering	Days to 1st edible fruiting stage	Plant height (cm)	Plant breadth (cm)	Number of primary branches	Leaf blade length (cm)	Leaf blade width (cm)	Fruit length (cm)	Fruit breadth (cm)	Number of fruits per plant	Fruit weight (g)	Fruit weight /plant (kg)	100 seed weight (g)
SM Ish-001	87	120	94.50	119.00	4.40	23.40	13.10	11.60	9.10	9.40	266.38	2.50	4.10
SM Ish-002	91	116	78.50	92.50	5.50	17.50	11.50	16.80	8.50	17.40	185.17	3.22	3.20
SM Ish-003	85	125	83.00	93.00	5.40	16.90	10.50	17.85	6.75	22.20	182.07	4.04	3.10
SM Ish-004	92	132	97.00	90.50	5.60	22.40	13.10	11.25	7.70	9.00	228.44	2.06	4.30
SM Ish-005	87	107	74.00	99.50	4.40	16.70	10.20	15.00	7.65	18.20	189.01	3.44	2.10
SM Ish-006	92	120	83.50	97.00	4.50	23.10	12.60	10.75	7.60	21.00	164.00	3.44	2.10
SM Ish-007	92	115	78.50	89.50	4.50	17.60	12.20	10.20	7.35	25.60	178.05	4.56	2.20
SM Ish-008	93	114	106.50	96.00	4.40	15.60	11.10	21.20	5.45	25.00	166.48	4.16	4.10
SM Ish-009	91	120	91.50	96.00	4.60	14.90	9.52	15.30	8.90	17.40	258.74	4.50	4.30
SM Ish-010	101	120	99.50	83.00	6.60	18.20	10.50	13.90	10.55	22.00	226.36	4.98	2.10
SM Ish-011	84	105	90.00	90.50	6.50	23.30	13.20	12.25	8.30	29.20	167.12	4.88	3.30
SM Ish-012	85	118	87.50	99.00	5.60	18.60	10.30	18.25	6.15	27.80	171.80	4.78	1.40
SM Ish-013	93	125	105.00	123.50	6.70	22.60	13.30	13.50	4.60	22.80	169.47	3.86	4.10
SM Ish-014	85	106	91.00	88.00	7.80	17.80	12.10	29.10	2.80	46.00	77.65	3.57	4.30
SM Ish-015	86	105	90.00	90.00	4.60	21.90	12.40	16.75	6.00	24.20	222.31	5.38	5.20
SM Ish-016	84	105	71.00	90.00	5.60	17.60	12.30	12.25	7.25	23.00	170.61	3.92	1.20
SM Ish-017	82	102	80.50	133.50	5.40	16.30	10.20	10.70	9.90	19.40	174.74	3.39	2.00
SM Ish-018	91	111	72.50	86.00	6.50	16.40	10.30	9.30	7.20	19.00	251.05	4.77	4.10
SM Ish-019	84	115	98.50	87.50	4.50	14.30	9.50	12.40	8.30	29.60	147.64	4.37	2.20
SM Ish-020	93	119	70.00	81.50	6.70	22.10	13.10	17.50	8.00	16.40	239.51	3.93	4.10
SM Ish-021	85	102	78.00	104.50	6.40	21.30	12.90	23.70	3.40	19.40	183.71	3.56	4.30

Acc. No.	Days to first flowering	Days to 1st edible fruiting stage	Plant height (cm)	Plant breadth (cm)	Number of primary branches	Leaf blade length (cm)	Leaf blade width (cm)	Fruit length (cm)	Fruit breadth (cm)	Number of fruits per plant	Fruit weight (g)	Fruit weight /plant (kg)	100 seed weight (g)
SM Ish-022	87	105	102.50	114.00	6.50	23.40	13.20	12.20	8.15	40.80	105.78	4.32	4.10
SM Ish-023	91	120	78.50	81.50	5.60	24.20	13.60	17.70	6.70	24.40	185.41	4.52	3.30
SM Ish-024	86	115	79.00	95.00	8.70	16.50	10.10	18.75	6.25	27.60	131.45	3.63	4.20
SM Ish-025	93	116	81.50	91.00	6.50	21.60	12.40	16.90	8.10	26.00	194.23	5.05	4.10
SM Ish-026	84	119	62.50	90.00	8.60	16.30	10.10	20.70	8.00	15.80	198.23	3.13	4.30
SM Ish-027	97	120	88.50	100.00	5.50	21.20	11.90	21.10	6.30	21.20	233.49	4.95	3.20
SM Ish-028	96	120	66.00	86.50	5.60	22.30	11.50	11.65	9.15	24.40	168.44	4.11	2.10
SM Ish-029	92	119	79.00	85.50	5.60	12.30	7.50	19.60	7.85	15.20	231.58	3.52	4.10
SM Ish-030	93	120	78.50	99.00	6.60	15.60	11.20	17.25	7.85	16.40	235.37	3.86	2.20
SM Ish-031	84	103	75.00	81.00	7.60	22.10	13.20	13.80	6.70	19.20	248.96	4.78	2.30
SM Ish-032	101	120	66.00	47.50	7.50	14.30	9.20	20.30	6.60	11.20	186.43	2.09	2.10
SM Ish-033	87	100	75.50	86.00	5.40	12.30	7.40	22.45	6.60	18.20	181.76	3.31	1.20
SM Ish-034	87	116	77.00	85.50	5.50	14.50	8.90	17.25	6.95	19.40	150.82	2.93	1.10
SM Ish-035	100	120	69.00	66.00	6.70	15.20	10.20	14.60	8.00	17.20	165.70	2.85	1.20
BARI Begun-6	93	120	70.80	91.50	3.40	13.40	8.20	16.30	8.80	15.40	206.49	3.18	4.30
SD	5.13	7.73	11.59	14.82	1.23	3.61	1.73	7.90	1.60	7.41	41.78	0.84	1.19
CV%	5.71	6.73	14.05	16.02	20.90	19.56	15.46	45.54	21.85	34.36	21.97	21.56	38.31

Table 49. Qualitative characters of brinjal germplasm

Acc. No.	Cotyledon color	Plant growth habit	Leaf blade lobing	Leaf blade tip angle	Number of leaf prickles	Number of leaf hairs	Corolla color	Fruit curvature	Fruit shape	Fruit apex shape	Fruit color	Fruit color distribution
SM Ish-001	5	7	5	5	7	5	5	1	7	5	2	1
SM Ish-002	7	3	3	3	9	5	9	1	7	7	6	7
SM Ish-003	3	5	5	5	0	1	9	1	7	3	1	7
SM Ish-004	3	3	7	5	0	1	7	1	7	5	1	7
SM Ish-005	7	3	3	3	0	1	9	1	7	5	7	5
SM Ish-006	7	3	5	5	7	5	5	1	7	3	8	7
SM Ish-007	5	5	9	5	7	3	5	1	7	5	7	1
SM Ish-008	3	3	5	3	7	3	7	7	7	5	9	1
SM Ish-009	3	7	7	5	5	1	5	5	7	3	2	1
SM Ish-010	3	7	7	3	0	1	5	1	7	3	1	7
SM Ish-011	5	5	3	1	5	3	9	1	7	5	2	7
SM Ish-012	3	7	5	3	0	3	7	1	7	5	2	5
SM Ish-013	5	3	7	1	0	3	9	3	7	3	2	5
SM Ish-014	5	3	5	1	0	3	9	7	7	3	7	1
SM Ish-015	5	3	7	1	0	1	9	5	7	3	9	5
SM Ish-016	7	5	3	3	0	1	7	1	7	3	7	7
SM Ish-017	3	3	5	3	0	1	7	1	7	3	5	5
SM Ish-018	3	3	7	5	0	3	5	1	7	3	1	7
SM Ish-019	3	7	5	5	5	3	7	1	7	5	1	7
SM Ish-020	3	7	7	5	0	3	7	1	7	5	1	7
SM Ish-021	7	3	5	3	0	3	5	1	7	3	5	5
SM Ish-022	5	3	7	1	0	3	9	7	7	3	7	1

Acc. No.	Cotyledon color	Plant growth habit	Leaf blade lobing	Leaf blade tip angle	Number of leaf prickles	Number of leaf hairs	Corolla color	Fruit curvature	Fruit shape	Fruit apex shape	Fruit color	Fruit color distribution
SM Ish-023	3	7	7	5	0	3	7	1	7	5	1	7
SM Ish-024	3	5	5	5	0	3	7	5	5	3	6	5
SM Ish-025	3	7	7	5	0	1	9	1	7	5	1	7
SM Ish-026	5	3	7	3	0	1	7	1	5	3	7	3
SM Ish-027	3	3	7	7	0	1	5	5	5	3	1	7
SM Ish-028	3	3	7	5	0	3	5	1	7	3	8	1
SM Ish-029	3	3	5	5	7	5	7	1	7	5	1	3
SM Ish-030	3	3	7	5	0	1	5	1	5	3	1	7
SM Ish-031	3	7	9	5	0	1	9	1	7	3	1	7
SM Ish-032	3	3	7	5	0	1	7	1	7	3	1	7
SM Ish-033	3	7	7	3	0	1	7	5	7	3	7	1
SM Ish-034	3	7	7	3	0	1	7	3	5	3	8	3
SM Ish-035	5	3	9	5	0	3	5	1	7	3	6	7
BARI Begun-6	3	3	5	3	0	1	5	1	5	3	7	5

11.3.8. Characterization of Mungbean Germplasm

A. Qualitative character

The data were recorded of ninety-one germplasm and six check varieties of mung bean which are presented in Table 50. The germplasm under study did not vary for hypocotyle colour, epicotyle colour, growth habit, growth pattern, terminal leaflet length, leaf pubescence, leaf colour, petiole colour, calyx colour, corolla colour, pod colour at immature stage, and pod colour at mature stage. Hundred percent germplasm exhibited same states for respective descriptors. Among the 97 germplasm, variation was found for terminal leaflet shape, petiole length, raceme position, leafiness, and seed color. Terminal leaflet shape was deltoid in 63.92% and ovate in 36.08% germplasm. Short (<12cm) petiole length was observed in 58.76% germplasm while rest of the germplasm (41.24% had medium petiole length (12-18 cm). Raceme position such as mostly above canopy (50.82%) and intermediate (49.48%) were observed. Sparse (43.96%), medium (58.56%) and abundant (8.79%) leafiness were exhibited among the germplasm.

Table 50. Qualitative variation in mungbean germplasm

Character	Descriptor state	No. of acc.	Frequency (%)
Hypocotyl color	Green	97	100
Epicotyl color	Light green	97	100
Growth habit	Erect	97	100
Growth pattern	Determinate	97	100
Terminal leaflet shape	Deltoid	62	63.92
	Ovate	35	36.08
Terminal leaflet length	Small (<10cm)	97	100
Leaf pubescence	Glabrous	97	100
Leaf color	Green	97	100
Petiole color	Greenish purple	97	100
Petiole length	Short (<12cm)	57	58.76
	Medium (12-18cm)	40	41.24
Raceme position	Mostly above canopy	49	50.82
	Intermediate	48	49.48
Calyx color	Green	97	100
Corolla color	Yellow	97	100

Character	Descriptor state	No. of acc.	Frequency (%)
Pod color at immature stage	Deep green	97	100
Pod color at mature stage	Black	97	100
Leafiness	Sparse	40	43.96
	Medium	57	58.76
	Abundant	8	8.79
Seed color	Deep green	93	95.88
	Deep brown	4	4.12



Fig. 53. Terminal leaflet shape (Deltoid and ovate)



Fig. 54. Calyx and corolla color of mungbean (Calyx: green and corolla: yellow)



Fig. 55. Seed color of mungbean (Deep green and deep brown)

B. Quantitative characters

The variable data were recorded as per IBPGR descriptor. Means and standard error (SE), standard deviations (SD), minimum (Min), maximum (Max), skewness and kurtosis are summarized in Table 51. The maximum range of yield/plant was 5.75 to 338.24 g followed by number of pods per plant was 3.24 to 85.46 and mean 24. 25. In plant height, mean was 40.97 cm and range, 22.50 to 73.70 cm, in number of seed per pod range 10.52 to 35.30 and mean 22.37. The maximum coefficient of variation 92.68% was obtained from yield per plant followed 69.91% no. of pod/plant 26.69%, no. of primary branches/plant, 25.40% 100 seed weight. The frequency distribution observed higher on number of seed per pod and medium on days to 1st flowering and yield per plant.

Table 51. Quantitative variation in mungbean germplasm

Trait	Range		Mean	SE	SD	CV (%)
	Min	Max				
Days to germination	1.75	5.17	3.64	0.08	0.74	12.36
Days to 5 leaves	10.47	16.31	13.27	0.14	1.33	6.29
No. of primary branches/plant	0.56	5.09	2.16	0.06	0.63	13.81
Days to 1 st flowering	14.81	19.97	17.03	0.13	1.25	4.08
Days to 50% flowering	4.25	64.25	49.76	0.76	7.48	5.81
Plant height (cm)	22.5	73.7	40.97	0.99	9.69	5.97
Pod length (cm)	5.59	8.43	6.97	0.06	0.57	0.76
Pod breath (cm)	0.36	0.66	0.49	0.01	0.06	10.05
No. of pod /plant	3.24	85.46	24.25	1.74	17.09	5.36
No. of seed /pod	10.52	35.3	22.37	0.51	4.99	0.09
100 seed wt. (g)	1.24	5.48	2.78	0.08	0.76	7.36
Yield /plant (g)	5.75	338.24	103.36	9.57	93.73	23.53

Table 52. Qualitative information of mungbean germplasm

Acc. No.	Hypocotyl color	Epicotyl color	Growth habit	Growth Pattern	Terminal leaflet shape	Terminal leaflet length	Leaf pubescence	Leaf color	Petiole color	Petiole length	Raceme position	Calyx color	Corolla color	pod color at immature stage	Pod color at mature stage	Leafiness	Seed color
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BD-6874	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	5	1
BD-6875	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	5	1
BD-6876	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	5	1
BD-6877	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	5	1
BD-6878	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-6879	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-6880	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-6881	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	5	1
BD-6882	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6884	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	1	1
BD-6885	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6886	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6887	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-6888	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1

Table 52. Cont'd

Acc. No.	Hypocotyl color	Epicotyl color	Growth habit	Growth Pattern	Terminal leaflet shape	Terminal leaflet length	Leaf pubescence	Leaf color	Petiole color	Petiole length	Raceme position	Calyx color	Corolla color	pod color at immature stage	Pod color at mature stage	Leafiness	Seed color
BD-6889	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6890	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-6891	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6892	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-6893	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	1	1
BD-6894	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	1	1
BD-6896	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6897	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6898	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6899	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-6900	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	1	1
BD-6902	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	1	1
BD-6903	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	5	1
BD-6904	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6905	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-6907	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-6908	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-6909	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	5	1
BD-6910	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	9	1
BD-6911	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-6912	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	1	1
BD-6916	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	9	1
BD-6917	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	5	1
BD-6918	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	5	1
BD-6920	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	1	1
BD-6922	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	5	2
BD-6923	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6924	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	1	2
BD-6925	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	1	1
BD-6926	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-6927	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-6928	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-6934	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	1	1
BD-6935	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6936	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	1	1
BD-6937	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-6941	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-9743	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	1	1
BD-9706	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-9707	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-9835	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-9836	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	9	1
BD-9837	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-10022	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	1	1
BD-10023	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	9	1
BD-10024	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	9	1
BD-10026	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	9	1
BD-10028	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-10029	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1

Table 52. Cont'd

Acc. No.	Hypocotyl color	Epicotyl color	Growth habit	Growth Pattern	Terminal leaflet shape	Terminal leaflet length	Leaf pubescence	Leaf color	Petiole color	Petiole length	Raceme position	Calyx color	Corolla color	pod color at immature stage	Pod color at mature stage	Leafiness	Seed color
BD-10030	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	1	1
BD-10031	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	5	1
BD-10032	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	5	1
BD-10324	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-10353	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-10503	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-10504	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-10584	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	1	1
BD-10585	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	1	1
BD-10586	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	1
BD-10587	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-10588	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	5	1
BD-10589	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	1	1
BD-10590	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-10591	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	1	1
BD-10733	1	1	1	2	2	1	1	2	2	2	2	1	1	2	4	5	1
BD-10734	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	1	1
BD-10735	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	1	1
BD-10736	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	1	1
BD-10739	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BD-10740	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	1	2
BD-10741	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	1	2
BD-10742	1	1	1	2	2	1	1	2	2	1	2	1	1	2	4	5	1
BD-10743	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-10744	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	1	1
BD-10745	1	1	1	2	1	1	1	2	2	1	2	1	1	2	4	5	1
BD-10746	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BD-10747	1	1	1	2	1	1	1	2	2	1	1	1	1	2	4	5	1
BARI-2	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	5	1
BARI-3	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	9	1
BARI-4	1	1	1	2	1	1	1	2	2	2	2	1	1	2	4	5	1
BARI-5	1	1	1	2	2	1	1	2	2	2	1	1	1	2	4	1	1
BARI-6	1	1	1	2	2	1	1	2	2	1	1	1	1	2	4	9	1
BARI-7	1	1	1	2	1	1	1	2	2	2	1	1	1	2	4	5	1

Table 53. Quantitative information of mungbean germplasm

Acc. No.	Days to germination	Days to 5 leaves	No. of Primary branch/plants	Days to 1 st flower	Days to 50 % flowering	Plant height (cm)	Pod length (cm)	Pod breadth (cm)	Pod per plant	No. of seed/pod	100 seed wt. (g)	Yield per plant (g)
1	2	3	4	5	6	7	8	9	10	11	12	13
BD-6874	3	12	5.0	15	4	38.8	6.42	0.42	21.36	14.3	2.34	74.88
BD-6875	4	12	3.2	16	51	31.2	6.44	0.44	21.52	21.1	2.05	74.06
BD-6876	3	14	2.6	17	59	37.2	7.06	0.48	10.88	21.9	2.36	65.58
BD-6877	3	13	2.4	16	51	31.8	5.80	0.44	13.33	19.7	2.53	22.98
BD-6878	4	14	3.0	18	45	35.0	6.86	0.42	8.71	19.0	2.14	13.04
BD-6879	3	14	2.8	17	53	34.0	6.72	0.44	15.00	21.0	2.14	34.37

Acc. No.	Days to germination	Days to 5 leaves	No. of Primary branch/plants	Days to 1 st flower	Days to 50 % flowering	Plant height (cm)	Pod length (cm)	Pod breadth (cm)	Pod per plant	No. of seed/pod	100 seed wt. (g)	Yield per plant (g)
1	2	3	4	5	6	7	8	9	10	11	12	13
BD-6880	4	15	2.6	19	51	32.6	6.66	0.42	19.33	21.5	2.30	32.44
BD-6881	4	13	3.0	17	61	31.6	6.16	0.44	11.21	21.2	2.26	24.79
BD-6882	4	14	2.6	18	50	36.4	6.24	0.36	11.54	20.4	2.29	49.15
BD-6884	3	12	2.6	15	51	43.2	7.20	0.46	18.92	22.6	3.12	57.13
BD-6885	4	15	2.2	19	51	31.0	6.54	0.42	35.40	23.9	2.60	27.98
BD-6886	5	14	2.6	19	51	37.0	6.74	0.42	18.25	22.1	1.92	70.69
BD-6887	4	14	2.6	18	51	37.0	6.66	0.46	19.47	22.1	2.23	67.70
BD-6888	3	13	2.4	16	51	41.4	7.94	0.64	13.13	21.7	4.81	36.02
BD-6889	3	15	2.6	18	51	33.2	6.76	0.50	6.47	19.3	3.27	24.76
BD-6890	3	14	1.6	17	51	33.4	6.26	0.46	12.35	20.1	2.77	43.90
BD-6891	4	12	2.0	16	50	35.6	7.34	0.48	18.75	21.4	3.90	36.39
BD-6892	3	12	1.8	15	48	39.8	7.14	0.46	19.72	21.7	2.78	81.88
BD-6893	4	14	2.2	18	48	42.4	6.48	0.42	30.00	24.2	2.37	111.82
BD-6894	3	15	1.8	18	48	37.0	6.92	0.42	13.89	20.7	2.64	65.92
BD-6896	4	12	1.6	16	50	34.8	7.14	0.44	7.92	22.2	2.82	21.73
BD-6897	3	15	2.0	18	57	42.6	7.82	0.48	9.29	23.7	2.98	40.09
BD-6898	3	14	2.8	17	59	48.6	6.96	0.44	20.71	23.2	2.49	54.61
BD-6899	4	16	2.4	20	45	46.0	6.72	0.42	20.53	23.3	2.72	63.75
BD-6900	4	12	2.2	16	48	48.4	7.40	0.46	21.18	26.4	2.84	105.83
BD-6902	4	13	3.0	17	58	54.6	7.26	0.48	9.73	21.5	2.91	27.02
BD-6903	3	12	2.8	15	55	54.2	7.42	0.46	9.00	22.7	3.14	32.62
BD-6904	3	12	1.6	15	52	44.4	7.50	0.44	6.64	19.2	2.35	42.52
BD-6905	3	14	3.2	17	59	43.6	7.50	0.48	12.86	23.4	3.26	54.73
BD-6907	4	12	2.4	16	51	33.6	6.78	0.44	19.14	22.7	1.98	76.33
BD-6908	4	14	2.4	18	57	29.4	7.30	0.46	14.00	21.8	2.05	43.95
BD-6909	4	12	2.0	16	59	44.8	7.16	0.44	12.94	22.6	2.06	38.86
BD-6910	4	13	2.0	17	54	39.0	6.52	0.46	22.56	23.2	3.29	65.72
BD-6911	3	14	2.2	17	57	35.0	6.58	0.44	27.00	24.9	1.89	38.32
BD-6912	4	15	2.2	19	61	35.2	6.70	0.46	10.55	19.1	2.60	36.47
BD-6916	3	12	3.0	15	58	36.8	6.18	0.52	3.75	19.0	2.58	32.54
BD-6917	4	13	2.2	17	57	41.4	6.36	0.54	19.23	21.2	3.78	26.53
BD-6918	3	12	2.4	15	51	30.8	6.94	0.38	18.89	21.7	2.38	44.97
BD-6920	3	12	2.0	15	55	33.4	6.72	0.44	8.44	19.3	2.55	32.12
BD-6922	4	12	2.0	16	56	36.6	7.22	0.50	10.42	20.1	2.70	29.55
BD-6923	4	13	2.0	17	64	39.8	7.00	0.54	25.65	21.8	2.90	41.25
BD-6924	4	12	2.0	16	59	28.8	6.80	0.44	4.29	16.4	2.53	48.57
BD-6925	3	13	2.0	16	47	37.8	7.22	0.58	14.00	17.2	3.40	43.48
BD-6926	3	13	2.2	16	51	37.2	6.46	0.58	41.52	10.55	3.32	340.56
BD-6927	3	12	2.2	15	49	36.0	6.55	0.60	38.06	10.54	3.51	345.30
BD-6928	3	13	2.6	16	55	29.0	6.53	0.59	40.45	10.55	3.38	289.98
BD-6934	3	13	2.0	16	49	31.0	6.42	0.42	21.36	14.3	2.34	74.88
BD-6935	3	15	2.0	18	56	28.6	6.44	0.44	21.52	21.1	2.05	74.06
BD-6936	4	12	1.6	16	59	22.8	7.06	0.48	10.88	21.9	2.36	65.58
BD-6937	4	13	2.0	17	41	28.6	5.80	0.44	13.33	19.7	2.53	22.98
BD-6941	3	12	2.4	15	33	33.2	6.86	0.42	8.71	19.0	2.14	13.04
BD-9743	4	13	1.6	17	40	29.4	6.72	0.44	15.00	21.0	2.14	34.37
BD-9706	3	14	1.4	17	41	29.2	6.66	0.42	19.33	21.5	2.30	32.44
BD-9707	4	13	1.4	17	51	36.2	6.16	0.44	11.21	21.2	2.26	24.79
BD-9835	4	13	1.8	17	45	28.6	6.24	0.36	11.54	20.4	2.29	49.15
BD-9836	4	12	1.8	16	46	32.4	7.20	0.46	18.92	22.6	3.12	57.13

Table 53. Cont'd

Acc. No.	Days to germination	Days to 5 leaves	No. of Primary branch/plants	Days to 1 st flower	Days to 50 % flowering	Plant height (cm)	Pod length (cm)	Pod breadth (cm)	Pod per plant	No. of seed/pod	100 seed wt. (g)	Yield per plant (g)
BD-9837	3	12	2.6	15	45	43.6	6.54	0.42	35.40	23.9	2.60	27.98
BD-10022	3	12	2.6	15	52	44.2	6.74	0.42	18.25	22.1	1.92	70.69
BD-10023	4	13	1.8	17	46	37.6	6.66	0.46	19.47	22.1	2.23	67.70
BD-10024	4	13	1.4	17	47	41.4	7.94	0.64	13.13	21.7	4.81	36.02
BD-10026	4	13	2.6	17	48	40.0	6.76	0.50	6.47	19.3	3.27	24.76
BD-10028	4	14	1.4	18	49	36.6	6.26	0.46	12.35	20.1	2.77	43.90
BD-10029	3	14	1.2	17	45	74.0	7.34	0.48	18.75	21.4	3.90	36.39
BD-10030	4	13	2.6	17	45	57.8	7.14	0.46	19.72	21.7	2.78	81.88
BD-10031	4	14	1.6	18	61	65.0	6.48	0.42	30.00	24.2	2.37	111.82
BD-10032	4	15	3.2	19	48.2	62.8	6.92	0.42	13.89	20.7	2.64	65.92
BD-10324	4	15	2.0	19	48	56.6	6.62	0.46	23.53	21.9	2.82	89.67
BD-10353	3	14	1.8	17	50	52.2	7.14	0.44	7.92	22.2	2.82	21.73
BD-10503	4	12	1.4	16	41	47.2	7.82	0.48	9.29	23.7	2.98	40.09
BD-10504	4	15	1.6	19	56	46.2	6.96	0.44	20.71	23.2	2.49	54.61
BD-10584	3	14	1.8	17	49	51.6	6.72	0.42	20.53	23.3	2.72	63.75
BD-10585	4	12	1.4	16	42	50.2	7.40	0.46	21.18	26.4	2.84	105.83
BD-10586	4	13	1.2	17	40	47.0	6.74	0.48	12.95	24.1	2.81	40.89
BD-10587	4	14	2.2	18	42	59.4	7.26	0.48	9.73	21.5	2.91	27.02
BD-10588	4	14	1.4	18	40	58.4	7.42	0.46	9.00	22.7	3.14	32.62
BD-10589	3	15	1.8	18	40	49.0	7.50	0.44	6.64	19.2	2.35	42.52
BD-10590	4	13	1.0	17	41	51.4	7.42	0.44	10.64	20.5	2.19	34.56
BD-10591	4	14	1.8	18	45	60.4	7.50	0.48	12.86	23.4	3.26	54.73
BD-10733	3	15	1.4	18	45	52.2	6.78	0.44	19.14	22.7	1.98	76.33
BD-10734	4	13	2.2	17	47	45.2	7.30	0.46	14.00	21.8	2.05	43.95
BD-10735	4	12	1.4	16	48	45.4	7.16	0.44	12.94	22.6	2.06	38.86
BD-10736	4	13	1.6	17	50	52.6	6.52	0.46	22.56	23.2	3.29	65.72
BD-10739	4	13	2.6	17	57	43.4	6.58	0.44	27.00	24.9	1.89	38.32
BD-10740	3	14	2.8	17	47	53.2	6.70	0.46	10.55	19.1	2.60	36.47
BD-10741	3	14	2.6	17	56	43.6	6.78	0.48	13.33	20.7	2.60	28.65
BD-10742	4	14	2.4	18	55	46.8	6.74	0.42	24.40	23.4	2.32	38.97
BD-10743	4	13	2.2	17	53	43.0	6.88	0.44	10.23	23.1	3.07	21.70
BD-10744	4	13	2.4	17	50	41.4	6.18	0.52	3.75	19.0	2.58	32.54
BD-10745	4	14	2.0	18	47	36.4	6.36	0.54	19.23	21.2	3.78	26.53
BD-10746	4	15	2.8	19	53	53.6	6.94	0.38	18.89	21.7	2.38	44.97
BD-10747	4	15	2.4	19	53	46.8	6.90	0.50	19.75	21.2	2.40	33.44
BARI-2	5	12	2.2	18	53	31.35	6.72	0.44	8.44	19.3	2.55	32.12
BARI-3	4	14	2.4	19	50	29.7	6.86	0.52	24.50	21.3	2.55	85.24
BARI-4	4	13	1.8	17	47	34.71	7.22	0.50	10.42	20.1	2.70	29.55
BARI-5	5	12	2.0	18	45	36.49	7.00	0.54	25.65	21.8	2.90	41.25
BARI-6	4	14	1.6	19	51	33.06	6.80	0.44	4.29	16.4	2.53	48.57
BARI-7	5	14	2.4	18	45	33.49	7.22	0.58	14.00	17.2	3.40	43.48

11.9. Characterization of Bottle Gourd Germplasm

In bottle gourd, qualitative and quantitative traits were studied. Some characters showed pronounced variability as described below:

A. Qualitative Characters

Nineteen (19) qualitative characters were studied for 223 germplasm of bottle gourd (Table 54). These accessions showed variations under individual character. The Maximum variation was observed in fruit shape such as Globular, Oblong blocky, Pyriform, Dumbbell, Elongate form, Curved and Crooked neck. Among the total germplasm (223 acc.) 8.97% globular (20

acc.), 4.04% Oblong blocky (9 acc.), 62.78% pyriform (140 acc.), 0.456% Dumbbell (1 acc.), 15.70% elongate form (35 acc.), 0.456% curved (1 acc.) and 7.62% crooked neck (17 acc) followed by matured fruit skin color such as creamish, yellowish and green. These were 39.46% creamish (88 acc.), 56.95% yellowish (127 acc.), 3.59% green (8 acc.). Early plant vigor viz. poor 23.32% in 52 acc., good 46.19% in 103 acc. and very good 30.49% in 68 acc. were found. Variation was observed on leaf margin, 93.29% germplasm showed entire margin and 6.73% germplasm showed serrate leaf margin. No variability was observed on plant growth habit, stem pubescence, stem shape, tendril, tendril type, tendril branching, leaf shape, leaf pubescence density, calyx color, leaf pubescence density, sex type, flower color, fruit pubescence and fruit pubescence density (Table 54).

Table 54. Qualitative variation in bottle gourd germplasm

Character	Descriptor state	No. of germplasm	Variation (%)
Early plant vigor	Poor	52	23.32
	Good	103	46.19
	Very good	68	30.49
Plant growth habit	Light green	223	100
Stem pubescence	Dense	223	100
Stem shape	Angular	223	100
Tendril	Present	223	100
Tendril type	Coiled	223	100
Tendril branching	Branched	223	100
Leaf margin	Entire	208	93.27
	Serrate	15	6.73
Leaf shape	Cordate	223	100
Leaf size	Small	16	7.17
	Medium	142	63.68
	Large	65	100
Leaf pubescence nature	Intermediate	223	100
Calyx color	Green	223	100
Leaf pubescence density	Dense	223	100
Sex type	Monoecious	223	100
Corolla color	White	223	100
Fruit shape	Globular	20	8.97
	Oblong blocky	9	4.04
	Pyriform	140	62.78
	Dumbbell	1	0.45
	Elongate form	35	15.70
	Curved	1	0.45
	Crooked neck	17	7.62
Matured fruit skin color	Creamish	88	39.46
	Yellowish	127	56.95
	Green	8	3.59
Fruit pubescence	Present	223	100
Fruit pubescence density	Intermediate	223	100



Stem pubescence and shape



Variation in calyx



Variation in leaf margin and shape



Ovary shape and flower color of bottle gourd

Fig. 56. Stem pubescence and stem shape, leaf margin and leaf shape and variation in calyx, ovary and flower color of bottle gourd



Globular



Oblong blocky shape



Pyriform shape



Dumb bell shape



Curved shape

Fig. 57. Fruit shape of bottle gourd



Elongate form shape



Crooked neck shape

Cont'd Fig. 57. Friut shape of bottle gourd



Creamish



Yellowish



Green

Fig. 58. Matured friut skin color of bottle gourd

B. Quantitative Characters

All (223 germplasm) germplasm relating to fifteen (15) important quantitative traits showed variations on different traits. Range, mean, standard deviation (SD) and percent of coefficient of variation (CV %) indicated their comparative performances on different characters. The mean value was observed in case of yield per plant was 26.26 kg, days to edible fruit was 125.73 days, days to 1st male flower was 96.00 days, days to 1st female flower was 98.35 days. The range of number of fruits per plant was 1 to 7, fruit weight at matured stage was 1.28 to 15.64 kg, days to edible fruit was 108.77 to 140.17 days and yield per plant was 1.92 to 55.98 kg. The highest standard deviation (SD) was found in 1000 seed weight (49.49) and the lowest in number of fruits per plant (1.75). The maximum coefficient of variation was obtained on petiole length (84.38%) followed by yield per plant (41.40%) (Table 55). Percent of coefficient of variation indicated the variability among the germplasm comparing within the characters. The frequency distribution was high for days to edible fruit and yield per plant.

Table 55. Quantitative variation in bottle gourd germplasm

Trait	Range		Mean	SE	SD	CV (%)
	Min	Max				
Days to seed germination	7.2	19	11.67	0.18	2.72	24.58
Internode length (cm)	6.4	19.2	11.98	0.15	2.26	19.11
Petiole length (cm)	7.86	190.86	14.30	0.81	12.02	84.38
Days to 1 st female flowering	80.67	111.67	98.35	0.44	6.5	6.72
Nodal position of 1st female flower	3.72	17.34	10.08	0.18	2.68	26.63
Days to 1st male flower	80.3	127.3	96.00	0.75	11.21	11.31
Nodal position of 1st male flower	3.37	28.37	13.92	0.28	4.12	29.92
Peduncle length (cm)	7.55	20.42	13.22	0.16	2.38	17.33
Days to edible fruit	108.77	140.17	125.73	0.45	6.71	5.31
Fruit length (cm)	13.84	96.84	41.57	0.83	12.32	29.75
Fruit width (cm)	11.44	33.09	17.89	0.25	3.79	21.12
Fruit weight at matured stage (kg)	1.28	15.64	8.75	0.16	2.44	28.19
1000 seed wt. (g)	51.24	431.24	252.29	3.33	49.49	19.57
Number of fruits per plant	1.00	7.00	3.23	0.12	1.75	30.98
Yield per plant (kg)	1.92	55.98	26.26	0.73	10.78	41.40

Table 56. Qualitative information of bottle gourd germplasm

Acc. No.	Early plant vigor	Plant growth habit	Stem Pubescence	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	leaf size	Leaf pubescence nature	Leaf pubescence density	Sex type	Flower color	Fruit shape	Fruit skin Color	Fruit pubescence	Fruit pubescence density
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
BD-375	3	3	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-376	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	3	1	5
BD-380	7	5	7	2	1	1	2	1	1	3	5	7	1	1	13	1	1	5
BD-382	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-383	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-384	7	3	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-389	7	5	7	2	1	1	2	1	1	7	5	7	1	1	1	2	1	5
BD-390	5	7	7	2	1	1	2	1	1	7	5	7	1	1	1	1	1	5
BD-391	5	5	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-394	5	7	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-397	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-398	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-403	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-404	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-405	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-407	3	5	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-408	7	7	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
BD-412	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-416	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-419	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-423	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-424	5	7	7	2	1	1	2	1	1	3	5	7	1	1	9	1	1	5
BD-425	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-426	5	7	7	2	1	1	2	1	1	7	5	7	1	1	9	1	1	5
BD-428	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-432	3	5	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BD-435	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-438	5	5	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BD-441	5	7	7	2	1	1	2	1	1	5	5	7	1	1	4	1	1	5
BD-442	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-445	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-448	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-449	7	7	7	2	1	1	2	1	1	5	5	7	1	1	8	2	1	5
BD-450	3	7	7	2	1	1	2	1	1	5	5	7	1	1	9	G	1	5
BD-452	7	7	7	2	1	1	2	1	1	5	5	7	1	1	9	G	1	5
BD-453	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	G	1	5
BD-454	5	5	7	2	1	1	2	1	1	3	5	7	1	1	7	G	1	5
BD-455	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	G	1	5
BD-456	5	5	7	2	1	1	2	1	1	5	5	7	1	1	14	1	1	5
BD-457	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-458	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-459	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-460	5	5	7	2	1	1	2	2	1	5	5	7	1	1	7	2	1	5
BD-463	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-4525	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4527	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4528	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5

Table 56. Cont'd

Acc. No.	Early plant vigor	Plant growth habit	Stem Pubescence	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	leaf size	Leaf pubescence nature	Leaf pubescence density	Sex type	Flower color	Fruit shape	Fruit skin Color	Fruit pubescence	Fruit pubescence density
BD-4531	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4533	7	7	7	2	1	1	2	1	1	5	5	7	1	1	4	1	1	5
BD-4537	5	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4539	5	3	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-4540	3	3	7	2	1	1	2	1	1	5	5	7	1	1	7	3	1	5
BD-4542	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4543	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4548	3	3	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
BD-4549	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4550	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4551	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-4552	7	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4553	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4554	7	5	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-4555	5	7	7	2	1	1	2	1	2	5	5	7	1	1	7	2	1	5
BD-4556	7	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4557	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4558	5	5	7	2	1	1	2	1	1	7	5	7	1	1	1	2	1	5
BD-4561	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4562	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4563	5	3	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-4564	5	7	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-4565	5	5	7	2	1	1	2	1	2	5	5	7	1	1	9	1	1	5
BD-4566	3	3	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-4567	3	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4568	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4569	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4570	3	7	7	2	1	1	2	1	1	7	5	7	1	1	14	1	1	5
BD-4571	5	7	7	2	1	1	2	1	1	7	5	7	1	1	1	1	1	5
BD-4572	3	7	7	2	1	1	2	1	1	7	5	7	1	1	14	2	1	5
BD-4573	5	7	7	2	1	1	2	2	1	5	5	7	1	1	4	2	1	5
BD-4574	5	3	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4575	3	3	7	2	1	1	2	1	1	7	5	7	1	1	1	1	1	5
BD-4576	7	5	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-4577	7	7	7	2	1	1	2	1	1	7	5	7	1	1	4	1	1	5
BD-4578	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4579	5	5	7	2	1	1	2	2	1	5	5	7	1	1	1	1	1	5
BD-4580	3	3	7	2	1	1	2	2	1	5	5	7	1	1	7	2	1	5
BD-4581	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4582	5	7	7	2	1	1	2	2	1	5	5	7	1	1	14	2	1	5
BD-4583	7	7	7	2	1	1	2	1	1	7	5	7	1	1	14	2	1	5
BD-4584	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-4585	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-4597	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4598	5	7	7	2	1	1	2	2	1	7	5	7	1	1	7	2	1	5
BD-4599	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4600	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-4602	5	5	7	2	1	1	2	1	1	7	5	7	1	1	4	2	1	5
BD-4603	5	5	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5

Table 56. Cont'd

Acc. No.	Early plant vigor	Plant growth habit	Stem Pubescence	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	leaf size	Leaf pubescence nature	Leaf pubescence density	Sex type	Flower color	Fruit shape	Fruit skin Color	Fruit pubescence	Fruit pubescence density
BD-4604	3	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8935	5	3	7	2	1	1	2	1	1	7	5	7	1	1	4	1	1	5
BD-8936	3	3	7	2	1	1	2	1	1	3	5	7	1	1	4	2	1	5
BD-8939	3	5	7	2	1	1	2	2	1	5	5	7	1	1	7	2	1	5
BD-8940	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-8942	7	7	7	2	1	1	2	1	1	3	5	7	1	1	9	1	1	5
BD-8943	5	7	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-8944	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8945	5	5	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BD-8946	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8947	5	7	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BD-8949	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8950	3	7	7	2	1	1	2	2	1	5	5	7	1	1	7	2	1	5
BD-8952	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-8954	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8955	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8956	7	5	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BD-8957	7	5	7	2	1	1	2	1	1	3	5	7	1	1	9	1	1	5
BD-8958	7	3	7	2	1	1	2	1	1	3	5	7	1	1	9	2	1	5
BD-8959	7	5	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-8960	7	7	7	2	1	1	2	2	1	5	5	7	1	1	14	2	1	5
BD-8961	7	7	7	2	1	1	2	2	1	5	5	7	1	1	7	1	1	5
BD-8962	7	7	7	2	1	1	2	2	1	5	5	7	1	1	1	1	1	5
BD-8963	7	7	7	2	1	1	2	2	1	5	5	7	1	1	7	1	1	5
BD-8964	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
BD-8965	5	7	7	2	1	1	2	1	1	7	5	7	1	1	9	1	1	5
BD-8966	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-8968	7	7	7	2	1	1	2	2	1	7	5	7	1	1	7	1	1	5
BD-8971	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-8972	7	5	7	2	1	1	2	2	1	5	5	7	1	1	14	1	1	5
BD-8973	5	7	7	2	1	1	2	1	1	7	5	7	1	1	9	1	1	5
BD-8974	7	7	7	2	1	1	2	1	1	3	5	7	1	1	4	2	1	5
BD-8975	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-8976	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
BD-8977	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-8978	5	5	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5
BD-8985	7	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-8988	3	7	7	2	1	1	2	1	1	5	5	7	1	1	1	1	1	5
BD-9617	3	7	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5
BD-9618	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-9620	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
BD-9621	5	5	7	2	1	1	2	1	1	3	5	7	1	1	7	1	1	5
BD-9624	3	7	7	2	1	1	2	1	1	3	5	7	1	1	7	2	1	5
BD-9625	5	7	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
BD-9630	7	5	7	2	1	1	2	1	1	5	5	7	1	1	1	2	1	5
BD-9635	5	7	7	2	1	1	2	1	1	5	5	7	1	1	14	1	1	5
BD-9637	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-9638	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-9641	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5

Table 56. Cont'd

Acc. No.	Early plant vigor	Plant growth habit	Stem Pubescence	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	leaf size	Leaf pubescence nature	Leaf pubescence density	Sex type	Flower color	Fruit shape	Fruit skin Color	Fruit pubescence	Fruit pubescence density
BD-9648	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	1	1	5
BD-9740	3	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
BD-9844	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-10327	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-10545	5	5	7	2	1	1	2	1	1	5	5	7	1	1	1	2	1	5
BD-10547	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-10548	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-10549	7	7	7	2	1	1	2	2	1	7	5	7	1	1	7	2	1	5
BD-10556	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BD-11453	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
BD-11454	5	5	7	2	1	1	2	1	1	3	5	7	1	1	7	2	1	5
BD-9958	5	3	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
BARI-1	7	5	7	2	1	1	2	1	1	3	5	7	1	1	9	2	1	5
BARI-2	7	5	7	2	1	1	2	1	1	5	5	7	1	1	4	1	1	5
BARI-3	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
BARI-4	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
BARI-5	7	5	7	2	1	1	2	1	1	5	5	7	1	1	14	3	1	5
AC-16	5	3	7	2	1	1	2	1	1	3	5	7	1	1	1	1	1	5
AC-34	5	5	7	2	1	1	2	1	1	3	5	7	1	1	7	2	1	5
AC-41	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	3	1	5
AC-76	7	5	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
AC-93	7	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AC-101	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AC-106	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AC-121	3	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
AC-139	7	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AC-216	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AC-246	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AC-297	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	3	1	5
AC-302	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AC-334	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AC-349	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AC-405	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
AC-414	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AC-494	5	3	7	2	1	1	2	1	1	3	5	7	1	1	7	2	1	5
AHM-01	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AHM-23	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
AHM-157	7	5	7	2	1	1	2	1	1	5	5	7	1	1	7	3	1	5
AHM-168	7	5	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5
RAI-01	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
RAI-11	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
RAI-15	5	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
RAI-62	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
AH-16	7	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
AH-23	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	3	1	5
IA-02	7	5	7	2	1	1	2	1	1	7	5	7	1	1	9	3	1	5
IA-03	7	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
IA-04	3	7	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5
IA-26	3	5	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5

Table 56. Cont'd

Acc. No.	Early plant vigor	Plant growth habit	Stem Pubescence	Stem shape	Tendrils	Tendrils type	Tendrils branching	Leaf margin	Leaf shape	leaf size	Leaf pubescence nature	Leaf pubescence density	Sex type	Flower color	Fruit shape	Fruit skin Color	Fruit pubescence	Fruit pubescence density
IA-45	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
IA-54	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
IA-61	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
IA-73	7	5	7	2	1	1	2	1	1	5	5	7	1	1	9	2	1	5
IA-74	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
AMA-319	5	7	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
AMA-340	3	5	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
AMA-387	3	5	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
AMA-418	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AM-13	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AM-14	3	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
AM-51	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
MAH-31	3	5	7	2	1	1	2	1	1	7	5	7	1	1	9	2	1	5
MAH-111	3	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
RC-25	3	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
RC-91	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
RC-141	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
RC-147	5	7	7	2	1	1	2	1	1	5	5	7	1	1	14	2	1	5
RC-158	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
MTR-82	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
RC-58	3	3	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
KMR-300	5	3	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
M-49	5	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
RC-163	7	5	7	2	1	1	2	1	1	7	5	7	1	1	7	2	1	5
R-246	5	5	7	2	1	1	2	1	1	5	5	7	1	1	9	1	1	5
KASI-54	5	5	7	2	1	1	2	1	1	5	5	7	1	1	1	2	1	5
TR-11	5	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5
ZS-09	5	5	7	2	1	1	2	1	1	5	5	7	1	1	7	1	1	5
B-33	7	7	7	2	1	1	2	1	1	5	5	7	1	1	7	2	1	5

Table 57. Quantitative information of bottle gourd germplasm

Acc. no.	Days to seed germination	Internode length (cm)	Petiole length (cm)	Days to 1 st female flower	Nodal position of 1 st female flower	Days to 1 st male flower	Nodal position of 1 st male flower	Peduncle length (cm)	Days to seed germination	Fruit length (cm)	Fruit width (cm)	Fruit weight at matured stage (kg)	1000 seed wt. (g)	Number of fruits per plant	Yield per plant (kg)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
BD-375	10	15.4	7.8	99	6	119	10	13.80	132	30.50	20.50	10.23	220.0	4	40.93
BD-376	10	13.6	8.2	94	9	109	11	11.00	124	56.50	19.00	12.73	290.0	4	50.93
BD-380	11	11.8	8	111	5	90	5	12.80	112	96.50	14.00	8.20	217.5	3	24.60
BD-382	11	12	11.2	102	8	84	11	12.00	140	35.50	17.00	8.43	320.0	4	33.73
BD-383	12	15.6	10.8	101	7	109	13	16.80	132	36.67	14.00	5.98	222.5	4	23.90
BD-384	10	10.4	11.8	88	9	103	18	10.50	120	35.00	23.50	13.03	250.0	4	52.13
BD-389	10	14.6	12	94	9	103	9	9.25	125	21.20	22.00	7.37	300.0	4	29.47
BD-390	12	14.8	14.2	103	15	112	22	16.80	125	23.50	27.50	13.67	275.0	3	41.00
BD-391	10	12.6	14.2	106	11	127	28	14.25	140	19.67	19.00	7.20	101.0	4	28.80
BD-394	9	14.8	14.2	96	10	109	14	12.20	125	23.50	21.50	10.20	280.0	3	30.60
BD-397	12	12.2	14.2	99	11	109	19	15.25	132	23.00	25.00	11.33	240.0	4	45.33
BD-398	11	12	15.2	96	12	109	16	14.00	126	24.67	24.33	10.38	265.0	2	20.77
BD-403	11	11.8	14	96	11	104	16	17.00	119	26.33	27.67	12.09	265.0	3	36.28
BD-404	13	11	13.4	99	11	112	9	16.67	127	17.87	18.55	6.61	267.5	4	26.44
BD-405	11	11.6	13.8	99	10	112	16	13.67	132	17.87	18.33	6.51	85.0	2	13.02
BD-407	11	11.6	13.2	96	12	84	17	16.50	127	50.50	17.50	10.83	295.0	3	32.50
BD-408	9	12	13.8	94	14	106	14	14.00	125	42.20	15.20	6.83	282.5	4	27.33
BD-412	12	14.8	14.2	109	11	109	17	20.00	140	36.67	14.00	5.98	235.0	4	23.90
BD-416	12	13.2	13.2	99	14	107	21	15.00	129	33.00	26.67	11.47	235.0	3	34.40
BD-419	12	14	13.2	94	7	107	16	13.33	140	27.00	19.00	12.05	215.0	3	36.15
BD-423	14	13	14.4	94	8	104	13	9.60	125	33.25	19.00	7.38	285.0	3	22.14
BD-424	9	11.2	14.2	91	6	104	14	11.00	121	36.00	13.50	6.27	252.5	2	12.53
BD-425	11	16	16	105	8	117	15	14.50	134	39.00	18.00	10.07	330.0	2	20.13
BD-426	15	13.4	13.6	96	9	110	16	16.67	127	53.50	14.00	7.87	216.0	4	31.47
BD-428	10	13.4	12.6	103	13	119	14	13.50	132	32.00	26.67	11.67	225.0	3	35.01
BD-432	15	10.6	12.6	98	4	108	13	10.75	132	42.00	16.00	10.20	185.0	4	40.80
BD-435	12	12	12.6	98	5	110	15	12.50	134	33.00	18.00	9.17	215.0	2	18.33
BD-438	15	12	10	95	7	112	16	16.00	130	33.00	26.77	11.67	235.0	4	46.68
BD-441	11	14	190.4	94	9	105	13	14.50	131	33.00	17.00	10.20	257.5	1	10.20
BD-442	15	14.6	9.2	94	8	104	11	10.40	132	34.00	26.78	11.68	278.0	4	46.72
BD-445	11	10.2	8.6	93	8	107	10	19.00	132	46.50	18.00	10.33	287.5	3	31.00
BD-448	12	15.6	7.4	92	8	81	11	13.25	132	33.00	25.00	15.20	215.0	3	45.60
BD-449	12	14.4	12.2	95	14	104	8	13.40	117	46.40	16.40	7.60	275.0	3	22.80
BD-450	9	10	12.4	95	9	83	10	12.80	131	44.50	15.00	8.13	277.5	2	16.27
BD-452	12	9.8	10.4	92	9	83	13	13.00	138	46.67	15.33	6.96	282.5	2	13.92
BD-453	15	13.8	11.2	99	9	83	21	12.75	132	39.67	15.00	7.79	275.0	1	7.79
BD-454	13	18.8	10	107	8	95	23	14.25	132	54.22	15.50	6.65	218.0	3	19.95
BD-455	11	8.2	8.4	105	9	83	18	11.00	134	53.25	14.50	6.48	266.5	2	12.96
BD-456	14	13	11.4	91	5	83	14	13.25	123	42.00	17.00	10.52	200.0	4	42.08
BD-457	12	8.4	13.2	96	10	81	13	17.50	127	48.50	17.50	10.57	271.0	3	31.70
BD-458	16	12	11.4	99	11	83	14	13.67	129	40.00	16.00	10.20	50.00	2	20.40
BD-459	12	12.8	11.6	95	8	82	11	10.33	140	51.67	15.67	7.97	210.0	4	31.87
BD-460	12	11.8	10.8	99	7	84	16	16.00	129	32.67	15.47	6.84	229.0	4	27.36
BD-463	18	11.6	13.2	109	15	84	18	14.50	131	40.50	14.50	7.67	285.0	4	30.67
BD-4525	10	14.2	12.2	87	8	102	23	11.00	124	39.00	18.00	12.35	270.0	4	49.40
BD-4527	12	15.6	12	95	14	83	16	8.60	131	34.67	16.33	7.06	275.0	4	28.23

Table 57. Cont'd

Acc. no.	Days to seed germination	Internode length (cm)	Petiole length (cm)	Days to 1 st female flower	Nodal position of 1 st female flower	Days to 1 st male flower	Nodal position of 1 st male flower	Peduncle length (cm)	Days to seed germination	Fruit length (cm)	Fruit width (cm)	Fruit weight at matured stage (kg)	1000 seed wt. (g)	Number of fruits per plant	Yield per plant (kg)
BD-4528	10	8.6	10.2	96	13	81	17	13.25	131	45.33	15.33	6.83	237.5	3	20.50
BD-4531	12	12.4	12.4	92	11	81	18	14.00	131	48.33	16.33	8.31	320.0	3	24.93
BD-4533	9	11.8	12.6	94	10	103	23	12.00	115	51.00	17.00	11.65	270.0	1	11.65
BD-4537	10	11.8	13.4	102	14	111	13	12.50	131	32.67	15.33	6.96	211.0	1	6.96
BD-4539	11	10.6	12.4	95	11	81	17	13.50	128	39.67	19.33	8.51	255.0	3	25.53
BD-4540	12	14	11.4	99	9	81	19	13.25	128	39.67	15.00	7.79	225.0	4	31.15
BD-4542	11	9.4	11	99	16	82	14	14.50	129	54.00	18.00	10.60	285.0	5	53.00
BD-4543	9	11.2	13.2	106	11	109	9	15.00	130	49.00	16.00	9.00	330.0	3	27.00
BD-4548	9	14.2	12	94	10	104	15	11.33	128	52.00	18.00	9.45	235.0	4	37.80
BD-4549	12	7.6	12.2	106	13	109	21	10.40	130	51.00	17.00	9.30	225.0	4	37.20
BD-4550	11	7.8	12.6	100	13	81	10	13.50	131	41.50	14.00	7.03	230.0	3	21.10
BD-4551	12	13.4	13.4	92	10	104	14	13.25	119	41.00	11.50	5.47	252.5	4	21.87
BD-4552	13	11.2	12.6	93	10	104	14	13.50	118	21.67	14.33	5.03	221.5	3	15.10
BD-4553	12	12.6	13	106	12	107	16	12.00	134	25.67	32.00	13.43	267.5	4	53.70
BD-4554	12	10.6	10.6	96	17	108	15	9.67	121	31.00	14.00	8.40	197.5	4	33.60
BD-4555	12	11.4	13.6	91	9	81	10	10.33	123	42.33	18.00	10.43	320.0	3	31.28
BD-4556	9	11.8	13.8	94	15	104	20	15.00	127	49.33	17.00	9.13	277.5	2	18.25
BD-4557	12	11.8	12.8	105	14	105	17	12.67	127	51.67	15.67	7.97	272.5	2	15.93
BD-4558	9	10.6	14	102	15	104	15	12.60	128	20.33	20.67	7.97	270.0	3	23.90
BD-4561	12	8.4	14	95	14	82	7	13.00	125	38.00	21.50	12.27	430.0	2	24.53
BD-4562	11	10.8	14	102	13	81	11	11.00	129	45.00	17.75	8.05	325.0	4	32.20
BD-4563	11	10.8	13.6	104	9	84	10	16.33	125	25.00	25.00	11.73	275.0	2	23.47
BD-4564	10	11.2	13.8	96	11	81	12	10.67	126	22.33	22.33	10.21	247.5	4	40.83
BD-4565	10	8.6	13.8	106	10	81	8	12.00	121	40.50	12.50	6.03	269.0	3	18.10
BD-4566	11	11.4	12	95	9	81	16	8.33	123	55.67	18.67	9.32	270.0	3	27.95
BD-4567	15	13	14	105	13	82	16	12.75	129	31.00	18.50	8.70	210.0	2	17.40
BD-4568	11	14.4	14.8	103	14	109	13	10.50	124	54.00	15.00	6.42	365.0	2	12.84
BD-4569	13	11	13.6	104	11	111	10	9.75	129	40.67	17.33	7.43	249.0	3	22.30
BD-4570	15	15.8	14.2	83	12	94	23	10.00	139	51.00	20.00	11.97	66.00	3	35.90
BD-4571	13	11.2	12.8	102	9	81	12	10.00	129	30.00	19.50	9.17	262.5	4	36.67
BD-4572	15	12.8	15	105	9	81	10	10.33	131	42.50	13.50	6.57	250.0	4	26.27
BD-4573	12	12.2	16	103	10	105	6	13.00	129	31.00	18.50	8.70	242.5	4	34.80
BD-4574	18	8.8	14.4	94	11	103	13	14.00	122	51.00	20.00	11.97	257.5	4	47.87
BD-4575	12	10.6	14	105	10	82	14	11.00	129	18.50	20.50	9.57	240.0	3	28.70
BD-4576	12	14.6	14	90	7	103	16	16.25	118	19.50	23.50	7.96	270.0	2	15.92
BD-4577	17	13.8	10.8	93	9	81	18	13.00	127	35.50	17.50	9.53	235.0	4	38.13
BD-4578	12	12.6	13.6	95	9	105	14	9.50	121	28.00	20.00	10.63	250.0	4	42.53
BD-4579	16	12.2	14	105	10	82	8	13.50	117	21.50	24.50	11.83	305.0	2	23.67
BD-4580	14	10.4	13.2	88	6	105	14	12.00	132	25.00	25.00	12.47	260.0	2	24.93
BD-4581	14	9.8	13	95	11	104	21	12.50	123	46.00	22.00	14.23	320.0	3	42.70
BD-4582	15	12.2	12.2	103	18	108	8	11.00	125	55.00	16.00	10.15	242.0	3	30.45
BD-4583	12	11.2	14.2	94	11	104	18	13.00	132	57.00	17.00	10.13	345.0	3	30.40
BD-4584	15	10.6	14	104	13	106	15	11.50	125	51.00	20.00	11.97	287.5	3	35.90
BD-4585	12	9.4	15.2	102	11	108	12	14.50	132	34.00	26.50	12.40	260.0	3	37.20
BD-4597	8	7	14.2	95	13	105	7	14.33	117	58.00	18.00	10.40	290.0	2	20.80
BD-4598	11	11.6	13.6	103	11	83	16	10.00	129	47.00	15.00	7.97	290.0	2	15.93
BD-4599	11	14.4	14	106	8	83	16	12.00	127	44.50	20.50	12.60	340.0	1	12.60
BD-4600	9	11.8	14.6	102	14	82	9	12.00	132	46.00	17.00	9.33	290.0	4	37.33

Table 57. Cont'd

Acc. no.	Days to seed germination	Internode length (cm)	Petiole length (cm)	Days to 1 st female flower	Nodal position of 1 st female flower	Days to 1 st male flower	Nodal position of 1 st male flower	Peduncle length (cm)	Days to seed germination	Fruit length (cm)	Fruit width (cm)	Fruit weight at matured stage (kg)	1000 seed wt. (g)	Number of fruits per plant	Yield per plant (kg)
BD-4602	11	10.6	14.4	92	11	105	17	11.75	118	43.67	17.67	8.57	255.0	5	42.83
BD-4603	11	8.4	14	94	8	106	15	15.00	120	20.33	21.33	8.76	280.0	2	17.52
BD-4604	11	15	14	98	5	111	16	11.00	132	54.50	13.50	8.60	270.0	1	8.60
BD-8935	12	11	13.6	87	5	104	4	13.00	119	25.00	18.50	7.47	190.0	3	22.40
BD-8936	16	10	15	104	8	91	16	10.50	119	42.00	15.00	9.00	222.0	3	27.00
BD-8939	16	14.4	14.6	105	6	95	22	12.67	119	43.00	14.00	8.45	242.0	3	25.35
BD-8940	16	9.4	15	95	11	105	14	13.50	119	22.67	24.67	10.57	257.5	3	31.70
BD-8942	9	12	15.4	88	6	103	14	12.00	118	89.33	17.67	10.97	300.0	2	21.93
BD-8943	11	11.8	15.4	98	11	103	8	12.00	128	16.50	29.00	14.00	330.0	2	28.00
BD-8944	9	9.8	15	105	9	82	15	10.67	129	14.50	18.00	7.47	215.0	3	22.40
BD-8945	9	13.2	15	95	11	104	16	12.25	131	49.50	16.00	8.33	224.0	2	16.67
BD-8946	12	13.8	15.2	100	10	81	15	12.33	130	57.00	16.00	9.67	347.5	3	29.00
BD-8947	9	13.8	15.4	95	11	102	7	13.50	116	53.50	13.00	6.57	277.5	2	13.13
BD-8949	11	8.6	14	94	9	82	16	10.33	130	44.67	15.33	7.21	257.5	3	21.63
BD-8950	16	12	13.2	100	11	105	10	13.67	124	42.50	21.50	12.00	250.0	2	24.00
BD-8952	11	13.4	14.6	95	10	81	16	12.50	122	46.50	15.00	8.63	240.0	3	25.90
BD-8954	9	16.8	15.6	95	11	104	7	15.67	123	50.67	19.00	9.70	295.0	2	19.40
BD-8955	14	11.8	15.8	95	13	104	11	10.00	124	44.00	14.50	7.20	60.00	3	21.60
BD-8956	9	13.2	16.2	87	7	102	9	16.00	138	50.00	17.50	11.07	260.0	1	11.07
BD-8957	9	13.2	14	81	9	105	21	11.67	119	40.50	16.00	8.57	340.0	3	25.70
BD-8958	12	14.2	16.2	83	10	91	13	13.00	138	34.00	16.00	5.60	280.0	4	22.40
BD-8959	8	15	14.4	91	11	91	12	11.75	136	43.00	14.00	8.45	216.0	2	16.90
BD-8960	9	12.6	12	94	12	81	13	10.33	125	42.00	12.50	6.00	195.0	5	30.00
BD-8961	12	12.4	13.6	95	15	81	12	14.00	130	69.35	14.45	8.73	235.0	2	17.47
BD-8962	8	11.6	16	92	10	100	14	11.75	114	21.50	22.00	10.20	275.0	4	40.80
BD-8963	8	10.2	16.2	94	13	104	18	12.25	123	19.50	18.50	8.23	220.0	3	24.70
BD-8964	9	9.4	17	94	11	104	19	13.50	128	69.33	14.33	8.73	290.0	3	26.20
BD-8965	9	13	16	91	7	82	12	15.50	127	52.00	20.00	10.93	310.0	3	32.80
BD-8966	10	11.2	13.6	93	11	103	15	11.00	117	54.50	15.50	6.80	300.0	4	27.20
BD-8968	9	7	14.6	98	12	82	13	13.33	131	43.00	18.50	8.57	200.0	4	34.27
BD-8971	12	12.4	14.6	95	8	104	14	14.00	121	48.00	18.00	10.80	330.0	4	43.20
BD-8972	9	9	14.6	88	7	104	15	13.75	118	55.33	19.67	10.84	345.0	4	43.37
BD-8973	9	8.4	14.6	95	10	103	7	12.33	118	47.50	17.50	10.40	270.0	2	20.80
BD-8974	9	8.6	13.8	92	11	104	11	13.25	111	38.33	15.67	8.27	240.0	1	8.27
BD-8975	8	11.2	14.2	84	6	90	10	13.25	119	42.60	17.60	7.46	272.5	3	22.38
BD-8976	8	10.4	13	92	11	103	17	14.20	119	43.50	17.50	9.00	160.0	1	9.00
BD-8977	12	8	13.4	96	8	81	19	15.33	130	53.25	18.50	9.16	285.0	1	9.16
BD-8978	12	9	14.2	92	9	105	14	9.25	121	42.50	19.50	9.90	267.5	4	39.60
BD-8985	16	8.2	13.6	95	10	106	11	14.00	121	65.00	16.33	9.18	285.0	2	18.37
BD-8988	16	11.8	13.6	99	11	91	17	14.75	130	16.50	18.50	7.67	230.0	2	15.33
BD-9617	11	13	13	90	7	105	19	14.75	122	50.00	21.50	13.10	257.5	2	26.20
BD-9618	12	6.2	14	95	9	103	10	13.20	127	39.00	20.50	8.30	285.0	3	24.90
BD-9620	9	8.8	13.2	94	12	104	16	13.00	124	62.00	17.50	10.00	280.0	3	30.00
BD-9621	12	13	13.8	103	14	84	21	13.00	130	47.00	20.50	11.13	285.0	3	33.40
BD-9624	12	13.4	12.4	106	12	107	17	11.50	121	41.50	11.50	5.27	142.0	4	21.07
BD-9625	9	8.6	13.6	87	8	97	13	11.75	112	42.60	15.20	6.27	265.0	4	25.07
BD-9630	9	9.2	12	92	9	95	9	17.50	131	33.00	32.00	4.20	242.0	4	16.80
BD-9635	11	9	12.4	92	10	106	17	14.25	124	40.00	11.00	6.65	245.0	4	26.60

Table 57. Cont'd

Acc. no.	Days to seed germination	Internode length (cm)	Petiole length (cm)	Days to 1 st female flower	Nodal position of 1 st female flower	Days to 1 st male flower	Nodal position of 1 st male flower	Peduncle length (cm)	Days to seed germination	Fruit length (cm)	Fruit width (cm)	Fruit weight at matured stage (kg)	1000 seed wt. (g)	Number of fruits per plant	Yield per plant (kg)
BD-9637	15	14.4	13	104	11	108	18	14.00	132	46.00	16.50	9.03	235.0	2	18.07
BD-9638	11	13.4	13	95	10	108	14	17.67	129	22.50	19.50	6.46	277.5	2	12.92
BD-9641	11	15	14.2	83	4	106	14	13.75	123	38.33	15.00	6.35	145.0	3	19.05
BD-9648	14	12.8	11.4	92	8	104	16	11.50	125	55.00	12.00	8.00	218.0	3	24.00
BD-9740	18	12.2	12.8	106	7	107	15	13.25	127	32.33	12.00	4.30	152.0	4	17.20
BD-9844	7	13.4	13.6	95	11	106	10	15.00	134	43.00	14.00	6.93	222.5	4	27.73
BD-10327	12	10.2	14	86	5	86	4	12.67	110	22.00	21.00	11.55	265.0	4	46.20
BD-10545	8	12.8	12.4	103	14	104	12	15.00	132	29.00	13.00	7.25	252.0	4	29.00
BD-10547	8	12.6	14.4	94	9	105	10	16.25	125	45.00	17.00	2.45	232.0	4	9.80
BD-10548	11	12.6	14.2	94	10	104	8	12.25	122	51.00	20.00	3.21	257.5	4	12.84
BD-10549	7	11.8	13.6	94	9	106	11	14.75	123	45.75	16.00	6.10	230.0	4	24.40
BD-10556	11	12.6	13.4	94	10	105	14	16.25	123	42.00	15.50	8.20	335.0	2	16.40
BD-11453	8	10.6	13.2	95	8	105	10	12.20	129	59.00	20.50	13.23	232.5	3	39.70
BD-11454	8	7.4	13	86	6	87	8	13.75	117	34.00	18.50	8.17	240.0	2	16.33
BD-9958	8	14.6	14.8	95	9	105	11	9.60	129	39.75	12.50	4.54	220.0	4	18.16
BARI-1	8	10.6	13.6	92	6	104	9	9.00	129	41.00	12.00	5.03	227.5	2	10.07
BARI-2	8	10.2	14.4	95	9	83	10	11.40	129	21.00	16.50	7.63	202.5	4	30.53
BARI-3	11	10.4	15.2	99	10	104	16	12.80	127	43.00	16.00	10.75	290.0	3	32.25
BARI-4	14	13.8	17	94	7	100	6	13.80	127	55.00	15.00	6.44	290.0	4	25.76
BARI-5	12	7.8	12.4	96	7	82	9	12.60	126	42.00	15.00	9.20	266.0	2	18.40
AC-16	10	10.8	14	92	9	105	11	9.60	119	21.00	21.00	7.93	275.0	4	31.70
AC-34	11	12.6	10.4	91	9	102	10	7.75	129	44.33	13.67	6.39	300.0	2	12.78
AC-41	9	7.8	12.8	86	10	100	7	12.40	119	42.50	17.50	9.73	285.0	4	38.93
AC-76	16	13.8	13.2	94	12	106	23	19.00	126	44.25	13.50	4.82	220.0	2	9.64
AC-93	9	14.6	13.4	87	8	88	9	14.00	109	31.67	20.33	8.56	227.5	4	34.23
AC-101	11	12.8	13.2	94	9	95	12	16.00	135	50.00	19.00	3.50	217.5	2	7.00
AC-106	17	12.2	12.4	103	11	106	13	13.00	123	36.67	17.67	8.74	287.5	4	34.97
AC-121	18	12.4	13	95	7	105	16	16.25	123	44.00	18.00	9.20	272.5	4	36.80
AC-139	11	12.4	13.2	87	7	107	10	14.00	125	49.50	18.50	9.83	245.0	1	9.83
AC-216	18	12.8	13	95	8	109	16	16.00	135	55.00	18.50	11.97	275.0	4	47.87
AC-246	10	10.4	13.2	86	6	106	9	12.50	120	32.67	16.67	6.62	267.0	2	13.23
AC-297	18	7	13.4	92	9	100	14	9.60	116	60.00	12.00	1.24	195.0	2	2.48
AC-302	10	14.4	14	95	11	109	21	16.00	124	31.00	19.33	7.88	255.0	2	15.77
AC-334	14	9.4	14.2	91	10	87	7	10.00	116	39.00	14.00	6.15	205.0	3	18.45
AC-349	9	11.4	14.2	92	11	102	9	16.00	116	45.00	17.50	9.00	220.0	3	27.00
AC-405	16	14.6	14.2	107	9	83	14	10.00	127	40.00	15.00	2.45	212.0	1	2.45
AC-414	11	17.4	14.2	89	9	106	10	11.00	116	38.25	16.00	8.60	280.0	3	25.80
AC-494	8	13	13.8	106	4	84	8	12.00	114	45.75	15.75	5.95	215.0	3	17.85
AHM-01	8	12	13.2	87	9	95	12	12.75	111	46.00	15.50	7.63	260.0	3	22.90
AHM-23	8	10.6	14	96	12	104	17	16.50	120	46.00	20.00	8.00	200.0	4	32.00
AHM-157	8	13	13.6	86	7	87	6	13.75	109	29.80	20.00	6.87	250.0	3	20.60
AHM-168	8	15	13.4	87	8	109	18	12.00	127	51.33	18.00	8.25	320.0	3	24.75
RAI-01	8	13.2	14.2	94	13	104	14	11.33	116	41.00	12.00	5.97	190.0	4	23.87
RAI-11	8	9	13.8	104	11	106	13	9.00	127	52.00	15.50	7.67	232.5	3	23.00
RAI-15	8	12.6	13	86	7	91	7	11.00	119	55.50	18.50	9.80	230.0	5	49.00
RAI-62	8	12.2	13.2	82	6	91	11	14.00	109	39.67	16.33	8.98	285.0	4	35.93
AH-16	8	13.2	13.8	92	13	106	13	19.00	121	60.50	18.50	10.37	275.0	3	31.10
AH-23	8	8.2	14	94	7	102	9	13.00	120	42.00	19.00	7.00	315.0	4	28.00

Table 57. Cont'd

Acc. no.	Days to seed germination	Internode length (cm)	Petiole length (cm)	Days to 1 st female flower	Nodal position of 1 st female flower	Days to 1 st male flower	Nodal position of 1 st male flower	Peduncle length (cm)	Days to seed germination	Fruit length (cm)	Fruit width (cm)	Fruit weight at matured stage (kg)	1000 seed wt. (g)	Number of fruits per plant	Yield per plant (kg)
IA-02	8	9.2	13.2	92	15	106	14	14.00	119	57.00	17.00	9.83	265.0	4	39.33
IA-03	8	12.2	14	82	8	91	12	14.00	109	33.50	18.00	8.90	322.5	2	17.80
IA-04	8	7.6	12.8	95	9	106	13	13.33	119	40.00	17.00	9.47	252.5	4	37.87
IA-26	7	11.2	14.6	92	12	105	12	9.20	116	44.50	16.50	8.17	225.0	2	16.33
IA-45	8	7.8	14.2	92	11	106	20	12.75	131	42.00	17.00	4.00	257.5	4	16.00
IA-54	8	12.8	14	93	7	106	17	16.33	127	48.00	19.00	5.00	250.0	4	20.00
IA-61	7	13.6	13.6	81	6	91	11	13.25	110	61.00	16.25	8.03	290.0	4	32.12
IA-73	8	9	12	84	11	92	13	16.00	117	38.50	17.00	7.83	200.0	2	15.67
IA-74	8	9.4	13.2	92	8	104	17	17.20	134	29.67	15.00	6.18	185.0	4	24.70
AMA-319	8	14.8	14.6	84	10	107	16	14.00	119	49.67	14.75	6.87	185.0	4	27.48
AMA-340	9	9.2	14.6	106	9	83	14	14.75	134	50.33	17.00	8.95	260.0	2	17.90
AMA-387	9	12.4	14	107	11	104	13	11.80	120	40.33	16.00	6.95	275.0	4	27.80
AMA-418	14	13.2	13.6	107	13	83	16	17.00	132	28.33	24.33	9.78	290.0	2	19.57
AM-13	12	12.6	14.6	97	13	107	16	11.00	127	35.00	11.67	4.07	205.0	4	16.27
AM-14	12	12	14.6	104	13	108	16	12.00	128	52.00	13.00	3.20	292.5	4	12.80
AM-51	16	14.8	14.2	97	13	109	13	11.33	129	50.00	14.00	8.95	200.0	2	17.90
MAH-31	12	9.4	11.2	106	11	83	18	11.67	130	35.00	19.00	6.00	260.0	4	24.00
MAH-111	15	15.2	15.6	104	15	82	14	12.00	129	47.67	14.00	5.60	225.0	3	16.80
RC-25	15	10.4	13.6	106	7	90	19	13.00	135	59.00	15.00	10.05	210.0	2	20.10
RC-91	16	12.4	11	106	11	83	14	9.50	129	41.00	17.00	9.07	235.0	3	27.20
RC-141	16	12	12.8	96	11	82	15	8.75	129	40.00	12.67	5.09	190.0	3	15.28
RC-147	14	10.8	13.2	106	13	83	11	11.00	129	32.00	17.33	7.38	285.0	2	14.77
RC-158	17	10.2	13.8	95	10	82	17	12.00	120	53.50	18.00	10.30	210.0	3	30.90
MTR-82	14	16.4	13.8	95	8	84	11	13.00	122	42.00	18.00	4.00	200.0	3	12.00
RC-58	18	14.4	14	104	10	104	13	11.00	130	53.50	16.50	8.33	220.0	4	33.33
KMR-300	18	13	13.8	107	11	89	21	12.50	124	38.67	13.67	5.67	265.0	3	17.00
M-49	18	13	13.8	109	16	91	18	16.00	136	39.67	17.00	8.15	240.0	3	24.45
RC-163	14	14	14.8	95	10	108	16	15.60	123	44.50	16.50	8.77	257.5	2	17.53
R-246	11	13.8	14	96	8	105	14	17.00	123	42.50	18.50	10.80	240.0	3	32.40
KASI-54	18	15	12.2	104	11	109	9	16.00	129	22.00	23.67	14.43	225.0	4	57.73
TR-11	15	7.8	13.6	106	9	83	14	15.67	121	27.00	26.33	12.46	300.0	3	37.38
ZS-09	12	10.2	13.4	96	7	108	14	15.50	124	52.25	17.75	8.61	280.0	3	25.83
B-33	9	8.8	14.4	87	5	88	10	14.67	129	61.33	14.33	7.03	215.0	3	21.10

Conclusion

Based on the study, characterization and identification of 34 qualitative and quantitative traits of 218 germplasm and 5 check varieties were performed a wide variation. Finally, the seeds are preserved as active and base collections for future utilization.

11.3.9. Characterization of Amaranth Germplasm

A. Qualitative Descriptors

Qualitative characters of different accessions of amaranth are presented in Table 58. After sowing, plants were emerged at varied speed of growth as poor (31.25% accessions), good (37.5%) and very good (31.25%) (Fig. 59). On the basis of leaf, stem and grain quality, the whole accessions were classified as leaf, stem and grain amaranth. Among them, 57.5% accessions were identified as leaf amaranth, 26.25% accessions were identified as stem amaranth and the rest 16.25% were classified as grain amaranth.. Most of the accessions grew up erectly (77.5%), some showed spreading (21.25%) type of growth habit and only one accession with drooping attitude (1.25%) (Fig. 60). Among the accessions, 17.5% had green colored leaves, 16.25% had reddish green leaves, 6.25% had red colored leaves and 60% had dark red colored leaves. Furthermore, the accessions were flashed with different colored inflorescence such as yellowish orange (1.25%), purple (5%), red (3.75%), reddish green (61.25%) and green (28.75%) (Fig. 61). However, inflorescence compactness was more or less equally intermediate (52.5%) and dense (47.5%) type. Whereas, maximum (72.5%) accessions showed red color stem, only a few (6.25%) exhibited reddish green color stem and rest (21.25%) of the accessions showed green color stem (Fig. 62C). Nevertheless, all (98.75%) but one accessions demonstrated ridged stem surface and one (1.25%) had smooth stem surface (Fig. 62B). Globose (6.25%), semi drooping (28.75%), completely drooping (15%) and straight (50%) shaped inflorescence was observed among the accessions (Fig. 63). Where, inflorescence spininess attitude was smooth (65%), prickly (22.5%) and spiny (12.5%) (Fig. 62A). Low seed shattering character was found in 30% accession, intermediate type was observed in 13.75%, but more than half (56.25%) accessions had high seed shattering character. Finally, half of the accessions (50%) showed black colored seed, red colored seed was observed in 48.75% accessions and only one (1.25%) gave greenish colored seed. The qualitative descriptors for individual germplasm are presented in Table 58.



Fig. 59. Early vigor of amaranth germplasm



Fig. 60. Growth habit of amaranth germplasm



Fig. 61. Inflorescence color of test amaranth germplasm

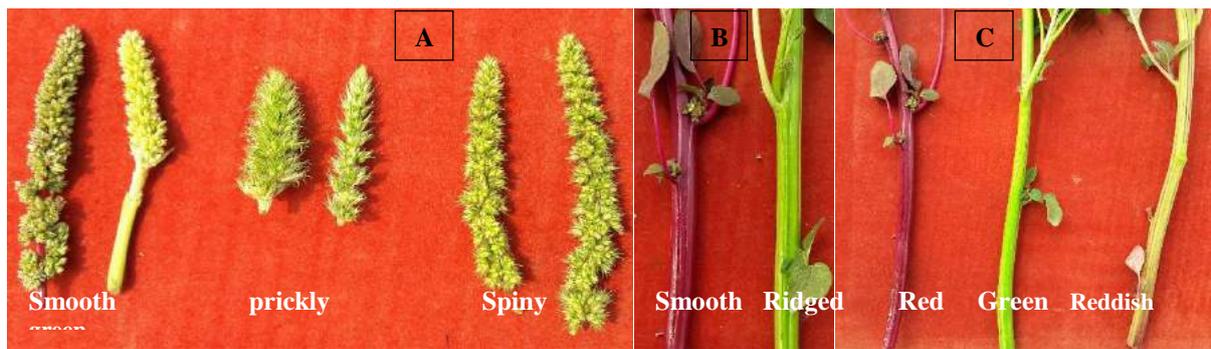


Fig. 62. Inflorescence spininess (A), stem shape (B) and stem color (C) of test amaranth germplasm



Fig. 63. Inflorescence shape of test amaranth germplasm

Table 58. Qualitative variations in amaranth germplasm

Name of Descriptor	Descriptor state	No. of germplasm	Percentage (%)
Classes	1 Leaf amaranth	46	57.5
	2 Stem amaranth	21	26.25
	3 Grain amaranth	13	16.25
Early plant vigor	1 Poor	25	31.25
	2 Good	30	37.5
	3 Very good	25	31.25
Plant growth habit	1 Erect	62	77.5
	2 Spreading	17	21.25
	3 Drooping	1	1.25
Leaf color	5 Green	14	17.5
	10 Reddish green	13	16.25
	11 Red	5	6.25
	12 Dark red	48	60
Inflorescence color	3 Yellowish orange	1	1.25
	8 Purple	4	5
	9 Red	3	3.75
	10 Reddish green	49	61.25
	11 Green	23	28.75
Inflorescence compactness	3 Lax	0	0
	5 Intermediate	42	52.5
	7 Dense	38	47.5
Stem color	5 Red	58	72.5
	6 Reddish green	5	6.25
	8 Green	17	21.25
Stem surface	1 Smooth	1	1.25
	2 Ridged	79	98.75
Inflorescence shape	1 Globose	5	6.25
	2 Semi drooping	23	28.75
	3 Completely drooping	12	15
	4 Straight	40	50
Inflorescence spininess	1 Smooth	52	65
	2 Glabrous	0	0
	3 Prickly	18	22.5
	4 Spiny	10	12.5
Seed shattering	3 Low (%)	24	30
	5 Intermediate (10-50%)	11	13.75
	7 High (>50%)	45	56.25
Seed color	2 Greenish	1	1.25
	5 Red	39	48.75
	7 Black	40	50

Table 59. Qualitative characters of amaranth germplasm

Accession no.	Class	Early plant vigor	Plant growth habit	Leaf color	Inflorescence color	Inflorescence compactness	Stem color	Stem surface	Inflorescence shape	Inflorescence spininess	Seed shattering	Seed color
1	2	3	4	5	6	7	8	9	10	11	12	13
BD-2461	2	1	1	10	9	5	5	1	4	3	3	7
BD-2466	2	1	1	10	9	7	5	2	4	3	3	7
BD-2470	1	1	1	12	9	7	5	2	4	3	3	7
BD-2510	1	2	1	12	10	5	5	2	4	3	3	7
BD-2923	1	1	2	12	10	5	5	2	4	3	3	7
BD-2925	1	2	1	10	10	5	5	2	4	1	7	5
BD-2926	3	1	2	5	11	7	8	2	3	3	5	7
BD-2928	1	3	1	12	11	5	5	2	4	1	7	5
BD-2930	1	1	1	12	10	5	5	2	4	1	7	5
BD-2931	1	1	1	12	10	5	5	2	4	1	7	5
BD-2932	1	2	1	12	10	5	5	2	4	1	7	5
BD-2933	1	2	1	12	10	5	5	2	4	1	7	5
BD-2934	1	1	1	12	10	5	5	2	4	1	7	5
BD-2935	1	2	1	10	10	5	5	2	4	1	7	5
BD-2936	1	1	1	12	10	5	5	2	4	1	7	5
BD-2940	1	1	1	12	10	5	5	2	4	1	3	7
BD-2942	1	2	1	12	10	5	5	2	4	1	7	5
BD-2944	1	1	1	12	10	5	5	2	4	1	3	7
BD-2946	1	1	1	12	10	5	5	2	4	1	3	7
BD-2947	1	3	1	12	10	5	5	2	4	1	3	7
BD-2951	3	3	1	5	11	7	8	2	4	3	5	7
BD-2952	2	2	2	12	10	5	5	2	4	1	7	5
BD-2953	1	2	1	12	10	5	5	2	4	1	3	7
BD-2956	1	1	1	12	10	5	5	2	4	1	7	5
BD-2957	1	1	1	12	10	5	5	2	4	1	7	5
BD-2958	1	1	1	12	10	5	5	2	4	1	7	5
BD-2959	1	1	1	12	10	5	5	2	4	1	7	5
BD-2961	1	3	1	12	10	5	5	2	4	1	7	5
BD-2964	1	2	1	12	10	5	5	2	4	1	7	5
BD-2966	1	1	1	12	10	5	5	2	4	1	7	5
BD-2968	2	1	2	10	11	7	8	2	4	3	3	7
BD-2969	1	1	1	12	10	5	5	2	2	1	7	5
BD-7382	3	2	1	10	11	7	8	2	3	4	7	7
BD-7383	3	2	1	10	11	7	8	2	3	4	7	7
BD-7385	3	2	1	10	11	7	8	2	3	4	5	7
BD-7389	3	2	1	10	11	7	8	2	3	4	7	7
BD-7392	2	2	1	5	11	5	8	2	4	4	5	7
BD-7400	1	3	1	12	10	5	5	2	2	1	7	5
BD-7403	1	2	1	12	10	7	5	2	2	1	7	5
BD-7406	2	2	3	12	10	5	5	2	2	1	7	5
BD-7411	2	2	2	12	10	5	5	2	2	1	3	5
BD-8066	3	2	1	5	11	7	8	2	4	3	5	7
BD-8069	3	2	1	5	3	5	8	2	1	1	7	2
BD-8260	2	2	1	10	11	7	8	2	3	4	5	7
BD-8263	2	3	1	12	10	7	5	2	4	4	3	7
BD-8303	2	3	2	5	10	7	5	2	4	4	3	7
BD-8312	2	3	1	5	11	7	8	2	2	3	5	7
BD-8313	2	3	1	5	11	7	8	2	2	3	3	7
BD-8316	2	2	2	5	10	7	5	2	4	4	5	7

Table 59. Cont'd

Accession no.	Class	Early plant vigor	Plant growth habit	Leaf color	Inflorescence color	Inflorescence compactness	Stem color	Stem surface	Inflorescence shape	Inflorescence spinniness	Seed shattering	Seed color
BD-8322	1	1	1	12	10	5	5	2	3	1	7	5
BD-8325	3	1	1	12	11	7	8	2	2	3	7	7
BD-8326	3	3	1	10	11	7	8	2	3	3	7	7
BD-8482	3	3	1	11	8	7	6	2	1	3	3	7
BD-9004	1	2	1	12	11	5	5	2	4	1	7	5
BD-9789	2	2	2	5	10	7	5	2	4	4	7	7
BD-9790	1	3	1	12	10	5	5	2	3	1	7	5
BD-9795	1	3	1	12	10	5	5	2	2	1	7	5
BD-9797	1	2	1	12	10	7	5	2	3	1	7	5
BD-9802	1	1	2	11	8	7	6	2	1	3	7	7
BD-9806	1	3	1	12	10	7	5	2	2	1	7	5
BD-9811	2	2	2	5	10	7	5	2	2	1	3	7
BD-9812	2	2	2	5	10	7	5	2	2	1	5	7
BD-9815	1	2	1	12	10	5	5	2	2	1	7	5
BD-9820	3	2	2	5	11	7	8	2	4	3	5	7
BD-9822	2	1	2	12	10	7	5	2	2	1	3	7
BD-9825	1	3	1	12	10	5	5	2	4	1	7	5
BD-9826	3	1	2	5	11	7	8	2	3	1	3	7
BD-9941	2	3	2	11	8	7	6	2	1	3	5	7
BD-9942	2	3	2	11	8	7	6	2	1	3	3	7
BD-10206	1	2	1	12	10	7	5	2	3	1	7	5
BD-10207	1	3	1	12	11	7	5	2	2	1	7	5
BD-10212	2	3	2	10	10	7	5	2	2	1	7	7
BD-10215	1	3	1	12	11	7	5	2	2	1	7	7
BD-10223	1	1	1	12	10	7	5	2	2	1	7	5
BD-10463	1	2	1	11	11	5	5	2	2	1	3	5
BD-10465	1	3	1	12	10	5	5	2	2	1	3	5
BD-10466	1	3	1	12	11	5	5	2	2	1	7	5
BD-10470	1	3	1	12	10	7	5	2	2	1	3	5
BD-11539	1	3	1	12	11	7	5	2	4	1	7	5
BARI Danta-1	2	3	1	10	10	5	6	2	2	1	3	7

B. Quantitative Descriptor

Range, mean, standard deviation and coefficient of variation of different quantitative characters of amaranth have been summarized in Table 60. Where, days to germination varied from 6 to 31 with a mean value of 14.94. On an average, leaf length and petiole length were 11.40 and 6.06 cm, respectively. Number of days to 50% flowering ranged from 50 to 79. In addition, number of branches per plant ranged from 3 to 15 with an average of 8.90. Mean plant height was 98.45 cm, where it ranged from 26 to 153 cm. Moreover, lateral spikelet length and inflorescence length ranged from 2.5 to 22.6 cm and 4.3 to 28.6 cm, correspondingly. On the one hand, average seed yield per plant was 9.11 g, on the other hand, mean of 1000 seed weight was 0.83 g. However, highest standard deviation (SD) was found 23.22 for plant height and lowest was 0.14 for 1000 seed weight. Finally, CV% was highest in case of seed yield per plant (68.21%), which indicates wide distinction amid accessions regarding this character, and the lowest was found in number of days to 50% flowering (13.41%), suggesting lower dispersion from mean value. The quantitative descriptors for specific germplasm are shown in Table 61.

Table 60. Quantitative variations in amaranth germplasm

Character	Range		Mean	SD	CV (%)
	Minimum	Maximum			
Days to germination	6	31	14.94	6.52	43.62
Leaf length (cm)	3.5	19.34	11.40	2.89	25.36
Petiole length (cm)	2.3	10.2	6.06	1.66	27.39
Number of days to 50% flowering	50	79	60.05	8.05	13.41
Number of branches per plant	3	15	8.90	2.71	30.41
Plant height (cm)	26	153	98.45	23.22	23.58
Lateral spikelet length (cm)	2.5	22.6	8.24	4.34	52.66
Inflorescence length (cm)	4.3	28.6	13.53	4.69	34.68
Seed yield per plant (g)	1	35	9.11	6.22	68.21
1000 seed weight (g)	0.61	1.2	0.83	0.14	16.67

Table 61. Quantitative characters of amaranth germplasm

Accession no.	Days to germination	Leaf length (cm)	Petiole length (cm)	Number of days to 50% flowering	Number of branches per plant	Plant height (cm)	Lateral spikelet length (cm)	Inflorescence length (cm)	Seed yield per plant (g)	1000 seed weight (g)
BD-2461	8	15.22	4.22	72	8	90	5.6	17.5	4	0.77
BD-2466	31	4.52	2.44	77	5	91	3.2	7.6	3	0.91
BD-2470	11	12.2	4.9	76	3	85	5	9	8	1
BD-2510	12	9.24	5.8	77	8	85	4.5	11.3	1	0.96
BD-2923	17	11.46	5.14	55	7	95	13.5	19.2	4	0.91
BD-2925	17	11.5	7	55	9	95	3.5	13.5	5	1
BD-2926	12	9.8	5.1	58	12	94	7.5	14.5	5	0.65
BD-2928	12	12.7	6.7	55	9	107	8.2	11.5	6	0.81
BD-2930	19	13.3	7	55	6	112	4.2	12.5	8	1
BD-2931	19	9.6	5.6	55	8	83	5.1	13.5	9	0.81
BD-2932	19	13.6	7.3	55	9	113	5.6	13.5	4	0.76
BD-2933	17	13.2	7.3	55	10	107	5.3	12.9	4	0.92
BD-2934	27	19.34	5.02	62	10	121	6.5	9.5	20	0.83
BD-2935	19	13.5	8.5	55	8	119	7.2	9.1	4	0.64
BD-2936	25	11.8	5.7	55	12	100	7.5	7.2	10	0.77
BD-2940	19	13.5	8.5	55	12	130	9.6	10.2	3	0.67
BD-2942	12	10.5	6	55	8	97	7.5	17.8	7	1
BD-2944	23	16.1	6.5	55	11	103	10.5	10.5	4	0.91
BD-2946	17	10.6	7.5	55	8	100	3.8	11.7	6	0.63
BD-2947	7	8.4	5.6	55	9	111	8.3	12.1	15	1
BD-2951	7	9.5	5.4	76	5	62	6	12	8	0.66
BD-2952	19	10.4	7.3	62	3	70	6.5	13	3	1
BD-2953	12	10.3	7.1	55	9	97	8.9	15.3	4	0.71
BD-2956	23	18.4	7	58	8	128	7.3	14.3	7	0.73
BD-2957	17	13.6	7	58	10	114	6.2	13.5	10	0.96
BD-2958	27	11.7	6.4	58	8	107	7.2	14.3	12	0.87
BD-2959	27	14.2	6.7	58	11	86	5.4	17.5	3	0.67
BD-2961	12	11.5	6	55	4	106	9.5	14.5	10	0.61

Table 61. Cont'd

Accession no.	Days to germination	Leaf length (cm)	Petiole length (cm)	Number of days to 50% flowering	Number of branches per plant	Plant height (cm)	Lateral spikelet length (cm)	Inflorescence length (cm)	Seed yield per plant (g)	1000 seed weight (g)
BD-2964	12	12.4	7.8	58	8	99	3.5	11.2	4	0.72
BD-2966	27	14.3	4.1	64	11	94	5.6	13.9	14	0.83
BD-2968	20	9.84	4.18	78	8	85	4.5	10.5	4	0.66
BD-2969	27	10.8	7.4	62	13	70	9.5	15.6	2	0.71
BD-7382	12	7.2	5.2	52	8	84	5.2	19.9	16	0.91
BD-7383	12	8	5.2	52	7	67	13.2	17.6	19	1.2
BD-7385	12	10	6.4	52	9	94	6.3	18.3	12	1
BD-7389	12	7.2	5	52	10	77	8.2	15.2	10	1
BD-7392	7	14.54	4.28	79	10	130	18.5	16.5	15	1
BD-7400	7	10.9	7.1	55	8	96	9.3	13.5	9	1
BD-7403	20	9	6	55	15	96	5.4	12.5	10	0.69
BD-7406	12	16.64	5.16	55	11	132	22.6	12.3	12	1
BD-7411	12	15.26	5.08	62	5	127	4.5	21.2	10	1
BD-8066	12	6.34	4.24	62	14	153	14.2	17.1	14	1
BD-8069	7	16.8	10.2	66	7	130	5.3	4.3	20	1.2
BD-8260	7	15.24	3.36	78	8	123	7.5	23.2	20	0.83
BD-8263	7	12	3.88	78	8	112	14.5	11.5	5	0.75
BD-8303	7	11.28	3.28	78	10	73	7.6	17.4	4	0.82
BD-8312	7	11.1	3.42	78	8	117	12.5	15.5	12	0.92
BD-8313	7	8.76	3.36	78	9	135	7.8	8.5	10	0.69
BD-8316	13	11.92	3.02	55	15	98	2.5	15.5	25	0.96
BD-8322	16	11	7.4	62	13	82	14.5	17.3	3	0.76
BD-8325	16	8.84	4.026	58	7	53	10.5	28.6	35	0.84
BD-8326	7	7.3	5.7	51	10	64	22.4	6.9	10	0.63
BD-8482	17	16.9	8.2	58	10	105	13.5	22.9	3	0.76
BD-9004	17	11.2	7.6	55	15	85	4.5	10.5	7	0.71
BD-9789	19	9.4	5.62	55	12	105	18.6	20.2	9	0.79
BD-9790	12	11.4	8.1	58	13	107	6.5	7.5	7	0.82
BD-9795	13	11.1	7.6	55	8	111	4.5	21.5	15	0.69
BD-9797	19	11	7.1	55	10	113	7.6	16.9	10	0.71
BD-9802	27	6.9	3.42	62	9	98	18.6	16.5	6	0.76
BD-9806	12	9	6.3	55	8	103	5.7	15.5	7	0.72
BD-9811	27	11.9	5.02	66	8	126	8.2	12.2	25	0.92
BD-9812	13	12.9	8.3	66	7	65	6	14	11	0.63
BD-9815	19	13.7	9	55	6	94	4.5	17.5	9	0.92
BD-9820	17	10.6	6.58	66	8	75	7	8	3	1
BD-9822	19	9.5	4.5	55	5	79	8.5	7.5	10	0.73
BD-9825	17	10.5	7.5	58	12	108	8.5	12.3	16	0.89
BD-9826	27	10.5	7.5	62	6	114	17.5	21.5	6	1

Table 61. Cont'd

Accession no.	Days to germination	Leaf length (cm)	Petiole length (cm)	Number of days to 50% flowering	Number of branches per plant	Plant height (cm)	Lateral spikelet length (cm)	Inflorescence length (cm)	Seed yield per plant (g)	1000 seed weight (g)
BD-9941	7	9.5	5.4	55	4	54	8.5	12.5	8	0.74
BD-9942	7	11.5	6.8	55	10	32	6.5	10	5	0.91
BD-10206	7	12.3	9	55	11	97	11	14.5	9	0.63
BD-10207	12	10	6.2	55	7	103	8	19	14	0.81
BD-10212	12	14	7.5	62	11	102	13	10	13	0.63
BD-10215	13	10.5	8	62	12	92	5	9.5	12	0.9
BD-10223	24	8.5	5	55	10	96	4	5.2	3	0.83
BD-10463	12	3.5	2.3	62	4	26	7.5	9.5	3	0.69
BD-10465	9	12.5	6.5	55	5	127	6	6.2	7	0.81
BD-10466	9	11.5	7.5	55	7	135	4	5.4	3	0.72
BD-10470	10	9.5	5.5	55	9	130	5	5.2	4	0.89
BD-11539	7	10.6	8	55	11	115	8.5	16.6	20	0.9
BARI Danta-1	6	15.6	5.4	50	10	80	7.5	11	2	1

Conclusion

Based on the phenotypic appearance and performance in the field condition few accessions can be recommended as top-notch genotypes for future study. For instance, leaf amaranth: BD-2961, BD-9790, BD-9795 and BD-9825; stem amaranth: BD-9822, BD-9941 and BD-9942.

11.3.10. Characterization of Guava Germplasm

Qualitative character

Qualitative traits of guava are presented in Table 62. Leaf shape varied from oblong lanceolate (2) to elliptical (3). Among the accession 50% was found oblong lanceolate and 50% was found elliptical leaf shape guava germplasm. The maximum variation was observed in pulp color and seediness in guava fruits. Four types of pulp color were found among the germplasm. White colored guava was found 31.81%, creamy white 45.45%, greenish white 18.18% and light red 4.54%. Fruit seediness was found in four types in among the germplasm. Seedless guava was found 4.54%, which our desired trait and high seed also found 4.54%, low seed was observed 36.36% and 54.54% was observed medium number of seed. If crossed low seeded or seedless guava genotypes with high seed containing genotypes got maximum variation in seediness for selection good quality guava variety.

Quantitative character

The pattern of 10 quantitative traits of guava is presented in Table 62a. The highest coefficient variation (%) was observed in yield per plant (94.04%) followed by individual fruit weight (68.59%). Plant height ranged from 2.38 to 6.20 m with an average 3.58 m. Base girth ranged from 28.00 to 81.00 cm with an average of 47.79 cm. Fruit weight ranged from 55.0-362.0 g with average 101.92 g and yield per plant ranged from 12.53 to 126.70 kg with average 26.54 kg (Table 62). The genotypes BARI Peyara 4 (126.70 kg per plant), BARI Peyara 2 (66.00 kg per plant), PG Pah 07 (34.65 kg per plant), PG Hat 012 (27.50 kg per plant) and PG Hat 017 (26.25 kg per plant) selected as a higher yielder than other genotypes.

Table 62. Qualitative characters of guava gerplasm

Acc.	Leaf shape	Mature leaf Color	Fruit shape	Fruit surface	Fruit skin color	Pulp color	Pulp flavor	Fruit taste	Pulp flavor	Seed hardness	Seediness
BARI Peyara 2	2	1	2	1	4	1	5	3	3	7	5
BARI Peyara 4	2	1	4	2	4	1	5	3	3	0	0
PG Pah 01	3	2	2	1	3	3	3	3	5	3	3
PG Pah 02	3	2	2	1	3	2	1	5	5	7	5
PG Pah 03	2	1	2	1	3	2	3	3	5	7	3
PG Pah 04	2	1	2	2	4	2	3	3	3	5	5
PG Pah 05	3	2	3	2	4	6	5	3	5	7	7
PG Pah 06	2	1	2	2	4	2	3	3	5	5	5
PG Pah 07	2	1	3	3	4	1	3	3	5	5	5
PG Hat 004	2	1	3	1	3	1	3	3	5	3	3
PG Hat 009	2	2	2	2	4	2	3	3	7	3	5
PG Hat 010	3	2	3	3	3	1	3	3	5	3	5
PG Hat 011	2	1	2	2	3	1	5	3	7	5	5
PG Hat 012	2	1	2	2	3	1	5	3	7	5	5
PG Hat 013	3	2	2	2	3	2	5	3	7	5	5
PG Hat 014	3	1	4	3	4	2	3	3	7	5	3
PG Hat 015	3	2	3	2	4	2	3	3	7	5	3
PG Hat 016	3	2	4	1	4	2	3	3	7	7	3
PG Hat 017	3	2	2	1	4	3	5	3	7	3	5
PG Hat 018	3	2	3	2	3	3	3	3	5	3	5
PG Hat 019	2	1	4	2	3	2	5	5	7	5	3
PG Hat 020	3	1	2	3	4	3	3	3	7	3	3

Table 62a. Quantitative characters of guava gerplasm

Acc.	Plant height (m)	Base girth (cm)	No. of branch	Canopy (N-S)	Canopy (E-W)	Fruit dia. (cm)	Fruit length (cm)	TSS (%)	Fruit weight (g)	Yield/plant (kg)
BARI Peyara 2	5.3	44.0	2.3	6.1	6.6	7.4	7.8	5.4	250.0	66.0
BARI Peyara 4	3.6	37.3	3.0	4.1	4.6	8.6	10.3	4.5	362.0	126.7
PG Pah 01	4.0	35.0	4.0	4.7	7.1	6.1	4.9	8.9	79.0	15.8
PG Pah 02	3.5	28.0	4.0	5.1	4.9	6.6	5.5	9.4	89.0	22.3
PG Pah 03	3.6	35.0	4.0	5.3	4.9	6.8	4.8	6.5	87.0	21.8
PG Pah 04	2.9	38.0	3.0	4.2	3.6	6.4	5.3	9.9	84.0	16.8
PG Pah 05	2.9	30.0	2.0	2.8	3.4	5.5	6.0	8.7	89.5	12.5
PG Pah 06	4.2	28.0	3.0	3.1	6.3	5.2	5.5	8.7	83.3	16.7
PG Pah 07	3.9	70.0	5.0	6.1	4.6	6.0	6.7	10.0	115.5	34.7
PG Hat 004	4.2	67.0	3.0	6.2	5.9	4.8	5.5	10.1	60.0	15.0
PG Hat 009	5.2	28.0	5.0	5.0	5.1	6.5	4.5	12.4	75.0	18.8
PG Hat 010	4.7	35.0	5.0	5.2	5.0	6.0	5.0	10.7	80.0	20.0
PG Hat 011	3.3	49.0	6.0	5.0	4.7	5.3	5.0	10.9	80.0	20.0
PG Hat 012	4.9	48.0	4.0	6.1	5.9	5.7	5.9	11.6	110.0	27.5
PG Hat 013	3.2	45.0	5.0	5.5	5.2	5.0	5.5	12.3	85.0	21.3
PG Hat 014	2.9	55.0	5.0	4.2	4.0	4.8	5.5	12.0	70.0	17.5
PG Hat 015	2.6	65.0	6.0	4.0	4.3	5.2	4.8	13.0	75.0	18.8

Acc.	Plant height (m)	Base girth (cm)	No. of branch	Canopy (N-S)	Canopy (E-W)	Fruit dia. (cm)	Fruit length (cm)	TSS (%)	Fruit weight (g)	Yield/plant (kg)
PG Hat 016	2.9	81.0	7.0	3.3	3.5	5.3	5.2	13.6	80.0	20.0
PG Hat 017	3.1	70.0	5.0	4.2	4.4	5.6	5.8	11.8	105.0	26.3
PG Hat 018	5.2	65.0	3.0	4.5	4.3	4.9	4.0	10.1	60.0	15.0
PG Hat 019	2.4	50.0	4.0	3.0	3.1	5.0	4.3	11.1	68.0	17.0
PG Hat 020	6.2	48.0	5.0	7.0	6.5	4.0	4.4	11.4	55.0	13.8
Mean	3.85	47.79	4.24	4.75	4.89	5.75	5.54	10.13	101.92	26.54
S. Error	0.22	3.39	0.27	0.24	0.24	0.22	0.29	0.50	14.90	5.32
Minimum	2.38	28.00	2.00	2.80	3.10	4.00	4.00	4.52	55.00	12.53
Maximum	6.20	81.00	7.00	7.00	7.10	8.63	10.30	13.60	362.00	126.70
CV (%)	26.82	33.30	30.21	24.15	22.55	17.72	24.33	68.59	23.21	94.04

Molecular Characterization of Germplasm and Landraces

11.3.11. Molecular Characterization of Rapeseed-Mustard Germplasm using SSR Marker

According to DNA amplification patterns, all ten SSR markers used in this analysis were found to be polymorphic. Two typical SSR profiles are shown in Fig. 64. After studying 10 SSR loci for the 25 rapeseed-mustard genotypes, 34 alleles were amplified with an average 3.40 allele per locus, which is higher than that of effective number of alleles (2.50). Among the primers, the highest rates were produced by Na10-D03 and Na12-A02, which produced 5 bands, whereas the least number of bands (2) were generated by primers Ra2E07, Na12D04 and Ni3G04b. Variation of allele sizes ranged from 98 to 293 bp for the locus Ni3G04b and Na12D04, respectively. The locus Ni3G04b had the smallest (98-108 bp) and Na12D04 had the largest fragments (275-293 bp). Thus, markers with different fragment length (for example, Na12D04 versus Ni2-B02) can be used concurrently (Turi *et al.*, 2012).

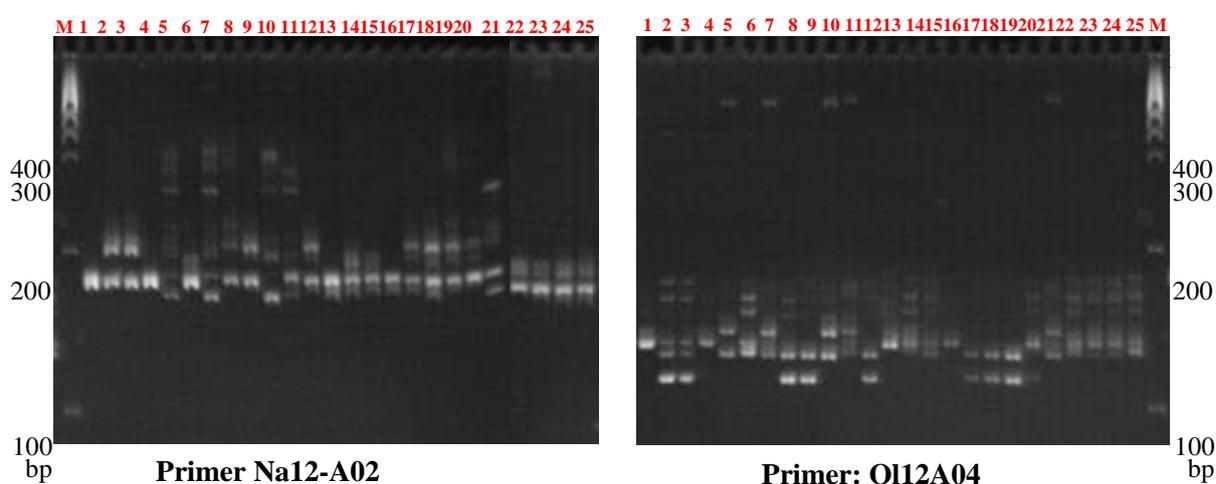


Fig. 64. Microsatellite profiles of 25 rapeseed-mustard genotypes; primer Na12-A02 and OI12A04

Average observed heterozygosity of SSR markers is 0.321, ranging between 0.000 and 0.522. The second locus of the marker 12-E01 showed the highest heterozygosity (0.522). Markers Ni3G04b was not heterozygote (Table 63). The values of expected heterozygosity (H_e) for each SSR locus, considering all test genotypes, are always higher than the observed heterozygosity (average $H_e=0.575$), indicating high of homozygosity.

Polymorphic information content (PIC) is regarded as one of the important features of the molecular markers used to evaluate the differentiation ability of the markers (Junjian *et al.*, 2002). We have PIC values ranging from 0.211 (Ra2E07) to 0.737 (Na10-D03) (Table 63). The di-nucleotide marker, Na10-D03 with GT/CA and OI12A04 with GA/CT repeated sequence showed higher PIC as compared to other di-nucleotide makers (Ra2E07, Na12D04 and Ni3G04b). This may be attributed to the higher mutation rate of di-nucleotide repeated sequence (Molla *et al.* 2010 and Vigoruroux *et al.*, 2005). Similar results have been reported by some researchers (Heckenberger *et al.*, 2002; Agrama and Tuinstra, 2003; Vaz Patto *et al.*, 2004; Moghaddam *et al.* 2009). The amount of PIC is a function of allele number and frequency. Thus, markers with more alleles had larger PIC. For example, Na10-D03 representing largest number of alleles (5) had the highest PIC (0.735). Average PIC of all SSR markers was 0.560 indicating the ability of utilized markers to differentiate the mustard genotypes. SSR markers with *B. rapa* origin showed lower PIC (0.439) as compared to the rest (0.594). Turi *et al.* (2012) also obtained lower PIC with markers from *B. rapa* origin. This is probably is an the indication of lower genetic variation existing in the A genome.

Genetic differentiation (F_{st}) values were found ranging from 0.532 to 1.000 with an average of 0.752 and gene flow (N_m) values ranged from 0.000 to 0.228 with an average of 0.082 (Table 63). It is observed comparatively that higher level of genetic differentiation and lower level of gene flow values in 25 rapeseed-mustard genotypes, an indicative of diverse genotypes. The loci Ra2E07 and OI12A04 have highest (0.88) and lowest (0.36) frequency of the predominant allele, respectively. The average frequency of the predominant allele was 0.561 (Table 63). Low frequency of the predominant allele reveals suitable allelic distribution among the rapeseed genotypes (Priolli *et al.*, 2002). Furthermore, SSR markers with the higher number of alleles per locus, showed the lowest frequency of the predominant allele. Thus, markers with lower frequency of the predominant allele have more differentiating ability than others (Moghaddam *et al.*, 2009).

A similarity matrix based on the proportion of shared SSR fragments was used to establish the level of relatedness among the various collected mustard genotypes. Pair-wise estimates of similarity ranged from 0.069 to 1.000 and the average similarity among all 25 accessions was 0.45. Genotypes BD-10111 and Nap-0564; Jun-536 and BJDH-12 and BARI Sarisha-10 and BARI Sarisha-16 had the highest similarity index of 100%. This was followed by 96% similarity between two genotypes BD-7114 and BD-9343. The lowest similarity (6.90%) was observed between BD-10111 and BD-9343; Nap-0564 and BD-9343 and BARI Sarisha-13 and BD-9343 (Fig.64b). These results were further strengthened by the earlier findings Das *et al.*, 1999; Cansian and Echeverrigaray, 2000 and Turi *et al.*, 2012.

Table 63. Variability of simple sequence repeat marker used for rapeseed-mustard genotypes genetic analysis

Locus	na	Allele sizes (bp)	ne	MAF	Ho	He	Fst	Nm*	PIC
OI11-C02	3	116, 126, 1133	2.000	0.667	0.333	0.522	0.910	0.025	0.500
Ra2E07	2	104, 1115	1.268	0.880	0.160	0.216	0.621	0.152	0.211
Ra2-F11	4	188, 207, 237, 263	2.998	0.480	0.240	0.680	0.820	0.055	0.666
Na12D04	2	275, 293	1.950	0.580	0.200	0.497	0.795	0.065	0.487
Ni3G04b	2	98, 108	1.899	0.615	0.000	0.492	1.000	0.000	0.473
OI12A04	4	118, 126, 136, 138	3.342	0.360	0.480	0.715	0.658	0.130	0.701
Na10-D03	5	119, 129, 133, 137, 145	3.799	0.400	0.520	0.752	0.647	0.136	0.737
Na12-A02	5	161, 172, 178, 189, 201	2.197	0.640	0.520	0.556	0.523	0.228	0.545
Na12-E01	4	198, 209, 229, 244	3.067	0.457	0.522	0.689	0.669	0.124	0.674
Ni4-B10	3	163, 172, 180	2.558	0.529	0.235	0.628	0.902	0.027	0.609
Mean	3.40	-	2.508	0.561	0.321	0.575	0.752	0.082	0.560

Na: Observed number of alleles, ne: Effective number of alleles, MAF: Major allele frequency Ho: Observed Heterozygosity, He Expected heterozygosity, Fst: Genetic differentiation, Nm: Gene flow estimated from Fst = 0.25(1 - Fst)/Fst, PIC: Polymorphic Information Content

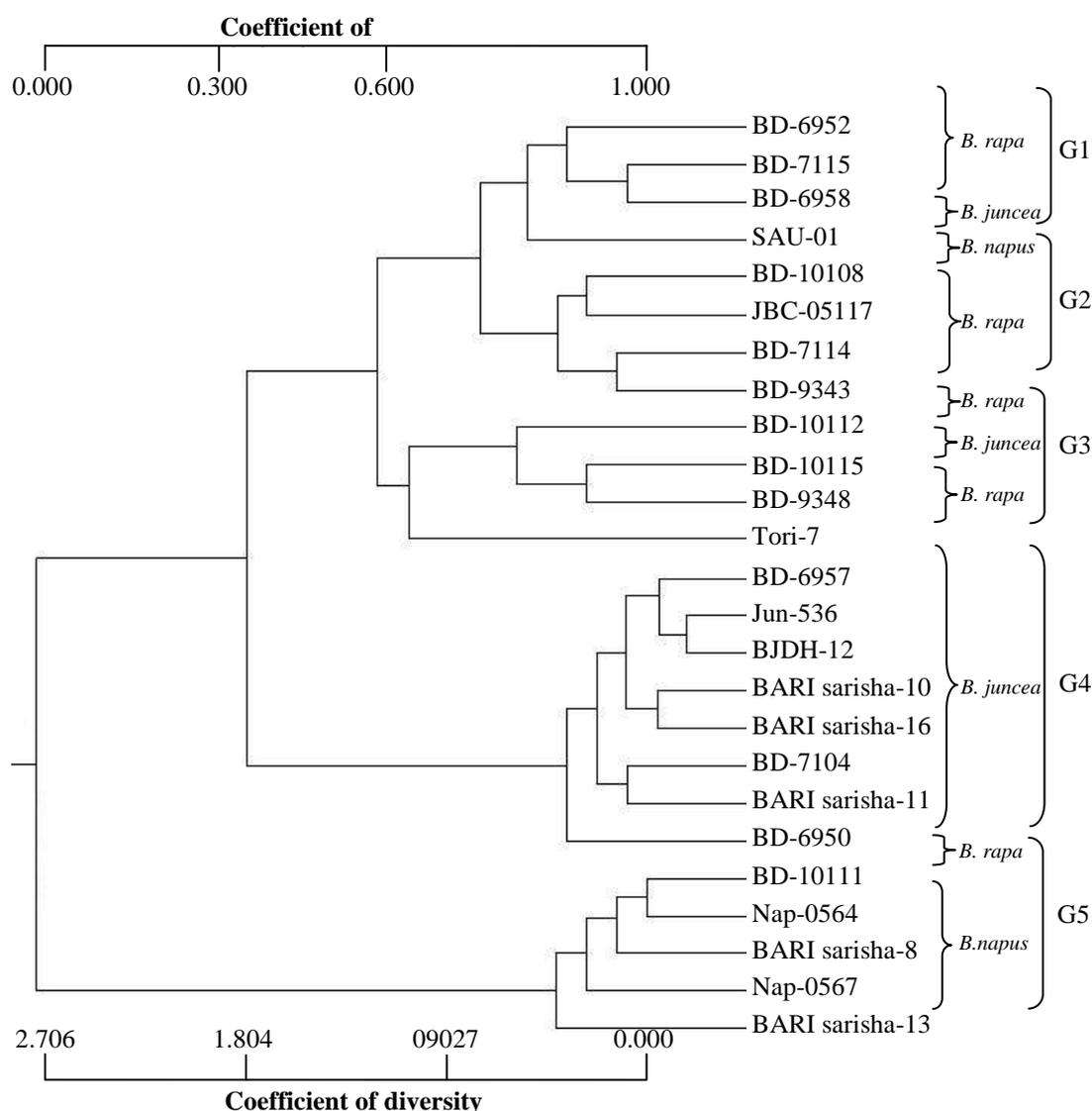


Fig. 64a. UPGMA cluster analysis and relationship among 25 mustard germplasm based on alleles generated by SSR markers.

On the basis of cluster study, the total genotypes were distributed into two main clusters (I and II). Main cluster I was further sub-divided into four sub-groups (Fig. 64a) comprising *B. rapa* and *B. juncea* and also one genotype of *B. napus*, while in cluster II four among the five genotypes belongs to *B. napus* and one (BD-10111) to *B. rapa*. These findings suggested that there is less variations among *B. napus* and *B. juncea* genotypes and also some kind of similarity among *B. rapa* genotypes. The genotypes of *B. rapa* have a distinct status in the dendrogram, because there might have effect of geographical variation.

As discussed above, genotypes belonging to different subspecies but were collected from the same region were more similar to each other than genotypes of the same species but of different location. Zhao *et al.*, (2005) made the same observation as they studied various morphotypes of *B. rapa* using AFLP markers. This confirms that geographic affinity would contribute to the similarity between genotypes (Ren *et al.*, 1995).

Conclusion

Genetic diversity was found among the test rapeseed-mustard genotypes. Higher ratio of genetic diversity was obtained in *B. rapa* accessions than in *B. napus* and *B. juncea* genotypes. The possible reason for high genetic variation in *B. rapa* is the local adaptability desirable. Information on genetic distances based on microsatellite markers shall be employed in creating variation using distinct genotypes.

11.4. Bangladesh Jute Research Institute

11.4.1. Germplasm collection

The collection mission was made to Rangpur, Kurigram, Nilphamari, Panchagarh and Dinajpur districts of Rangpur Division; Bogura district of Rajshahi division; Cumilla district of Chattogram division and Patuakhali, Barguna and Barishal districts of Barishal division during February 2018 to November 2020 (Fig. 65, 66 & 67). A total of 35 germplasm were collected from farmers' field, road side, stores and market place (Table 64). Samples were collected as seeds and fruits from individual plant or population along with sufficient passport information. The collected samples were registered and conserved in active collection for further activities (Mostofa, 2001). Out of 35 germplasm 23 *Corchorus capsularis*, 9 *C. olitorius* and 3 were *Hibiscus sabdariffa* (Table 65). Passport information of collected germplasm of jute (*Corchorus spp.*) with photographs is shown in table 66.

Table 64. List of collected jute germplasm, November 2018 to December 2020

Sl. no.	Crops name	Scientific name	Deshi pat	Tossa pat	Kenaf	Mesta
1	Pat	<i>Corchoruscapsularis</i>	23	-	-	-
2	Pat	<i>Corchorusolitorius</i>		9	-	-
3	Kenaf	<i>Hibiscus cannabinus</i>	-	-	-	-
4	Mesta	<i>Hibiscus sabdariffa</i>	-	-	-	3
Sub Total			23	9	0	3
Grand Total			35			

Table 65. District wise jute germplasm collection status

Name of District	No. of Upazilas explored	Number of germplasm collected				
		Deshi pat	Tossa pat	Kenaf	Mesta	Total
Kurigram	3	4	-	-	-	4
Nilphamari	2	2	2	-	-	4
Panchagarh	2	4	-	-	-	4
Dinajpur	5	4	2	-	-	6
Bogura	1	4	1	-	-	5
Rangpur	3	3	-	-	-	3
Patuakhali	1	2	2	-	1	5
Barisal	2	-	2	-	-	2
Cumilla	1	-	-	-	2	2
Total	20	23	9	-	3	35

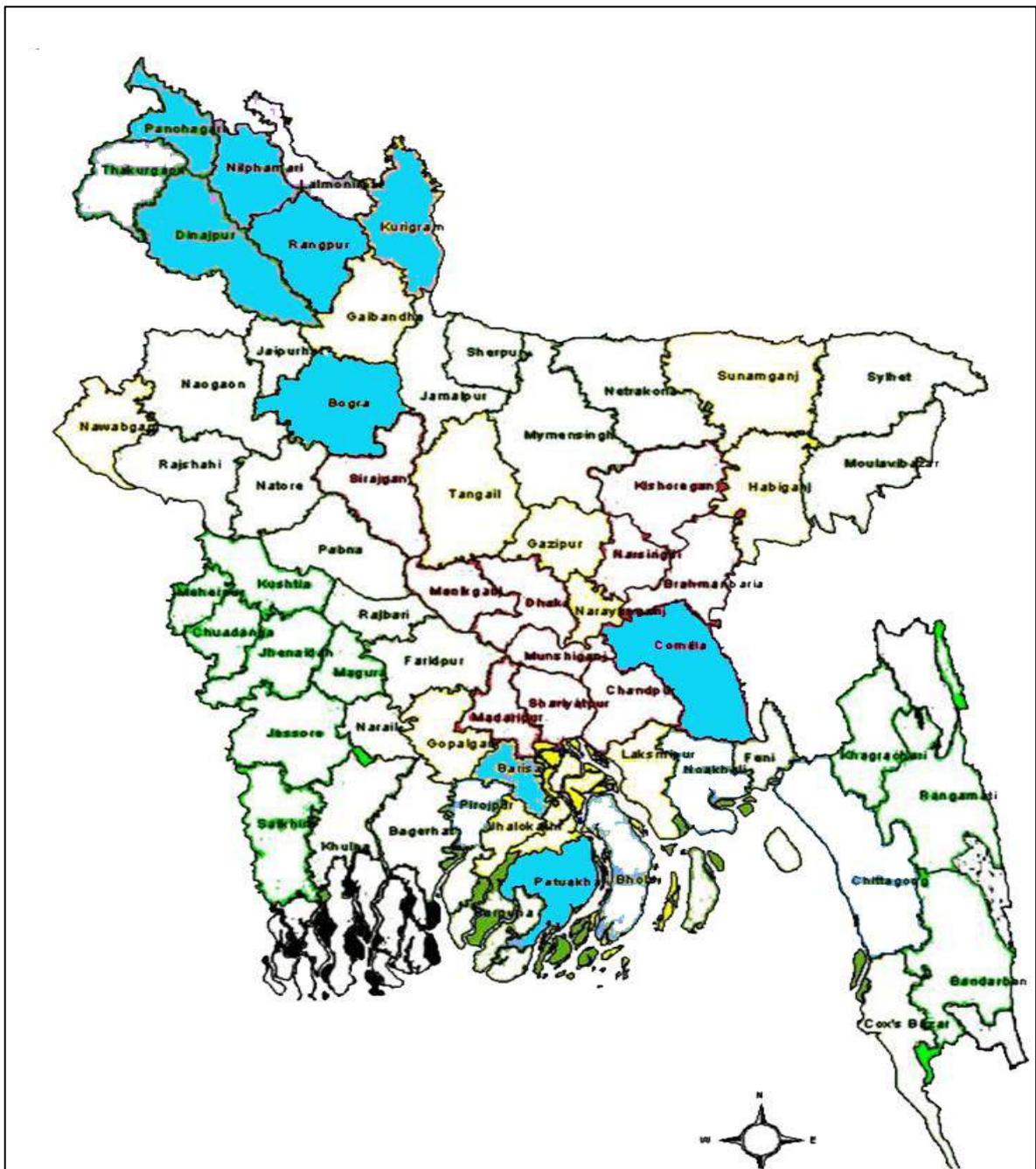
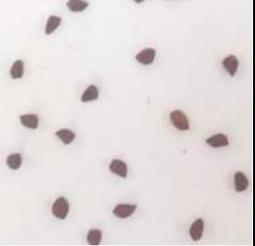


Fig. 65. Bangladesh GIS map demonstrating explored areas

Table 66. Passport information of jute germplasm

Sl. no.	Collector's no.	Local/Cultivar name/cultural practice	Donor's Name & address	Geographic location and date	Photograph
1	RS-1	Mera Shak Used as vegetable	Md. Moksedul Village: Kabir Mahmud Thana: Fulbari District: Kurigram	N-25 ⁰ 57.210 E-89 ⁰ 33.518 15-11-2018	
2	RS-2	Mera Shak	Abdul Malek Village: Rash mela Thana: Fulbari District: Kurigram	N-25 ⁰ 57.210 E-89 ⁰ 33.518 15-11-2018	
3	RS-3	Chera Pat	Haji Guljar Hossain Village: Tookar Bazar Thana: Fulbari District: Kurigram	N-25 ⁰ 57.210 E-89 ⁰ 33.518 15-11-2018	
4	RS-4	Mera Shak Vegetable type	Md. Abed Ali Village: Japurvita Thana: Kurigram Sadar District: Kurigram	N-23 ⁰ 51.916 E-90 ⁰ 16.213 15-11-2018	
5	AS-2	Deshi pat	Md. Mahbubur Rahman Village: Domarrailget Thana: Domer District: Nilphamari	N-26 ⁰ 6.620 E-88 ⁰ 49.682 16-11-2018	
6	AS-4	DeshiSada	Md. Aminul Islam Village: Domar railgate Thana: Domer District: Nilphamari	N-26 ⁰ 6.620 E-88 ⁰ 49.682 16-11-2018	
7	ACK-1	Jati pat	Shonali Rani Village: Kazi Para Thana: Boda District: Panchagarh	N-25 ⁰ 44.088 E-89 ⁰ 15.104 16-11-2018	

Sl. no.	Collector's no.	Local/Cultivar name/cultural practice	Donor's Name & address	Geographic location and date	Photograph
8	ACK-2	Jati pat	Shree Omapatho Village: Shahed Para Thana: Boda District: Panchagarh	N-25 ⁰ 44.088 E-89 ⁰ 15.104 16-11-2018	
9	ACK-3	Jati pat	AbdusShamad Thana: Panchagarh Sadar District: Panchagarh	N-26 ⁰ 20.357 E-89 ⁰ 15.104 16-11-2018	
10	FM-1	Jati pat	Julfikar Ali Vhutto Thana: Panchagarh Sadar District: Panchagarh	N-26 ⁰ 20.357 E-89 ⁰ 15.104 16-11-2018	
11	AS-5	Deshi pat	Sree Birendro Nath Goash Village: Pannagor Thana: Birgonj District: Dinajpur	N-26 ⁰ 2.447 E-89 ⁰ 36.793 16-11-2018	
12	AS-6	Deshi pat	Sree Birendro Nath Goash Village: Pannagor Thana: Birgonj District: Dinajpur	N-26 ⁰ 2.447 E-89 ⁰ 36.793 16-11-2018	
13	AS-7	Deshi pat	Md. Amirul Islam Village: Doshmile Thana: Kaharul District: Dinajpur	N-25 ⁰ 48.182 E-88 ⁰ 39.37 16-11-2018	
14	AS-9	Tita pat	Md. Aynul Village: Ranir Bandor Thana: Chirirbandar District: Dinajpur	N-25 ⁰ 39.622 E-88 ⁰ 46.794 16-11-2018	

Sl. no.	Collector's no.	Local/Cultivar name/cultural practice	Donor's Name & address	Geographic location and date	Photograph
15	RS-5	Mera	Md. Zablul Tareq Village: Dhawakola Thana: Bogura Sadar District: Bogura	N-24 ⁰ 50.561 E-89 ⁰ 22.596 17-11-2018	
16	RS-6	Birol	Md. Zablul Tareq Village: Dhawakola Thana: Bogura Sadar District: Bogura	N-24 ⁰ 50.561 E-89 ⁰ 22.596 17-11-2018	
17	RS-7	Birol	Md. Zablul Tareq Village: Dhawakola Thana: Bogura Sadar District: Bogura	N-24 ⁰ 50.561 E-89 ⁰ 22.596 17-11-2018	
18	RS-8	Birol Vegetable type	Md. Zablul Tareq Village: Dhawakola Thana: Bogura Sadar District: Bogura	N-24 ⁰ 50.561 E-89 ⁰ 22.596 17-11-2018	
19	FMN-1	Megnal	Mir Hasan Mithu Village: Ubragir Kuthir Thana: Mithapukur District: Rangpur	N-25 ⁰ 34.133 E-89 ⁰ 16.413 23-11-2018	
20	FMN-2	Cherashak	Abdus Salam Village: Muradpur Thana: Nobabgong District: Rangpur	N-25 ⁰ 25.386 E-89 ⁰ 16.413 23-11-2018	
21	FZ-1	Deshi pat	Abul Fazal Mollah Village: Kamal kashna Thana: Rangpur Sadar District: Rangpur	N-25 ⁰ 45.410 E-89 ⁰ 4.283 23-11-2018	

Sl. no.	Collector's no.	Local/Cultivar name/cultural practice	Donor's Name & address	Geographic location and date	Photograph
22	RS-11	Pat	Md. Mosharrof Phokir Village: Umedpur Thana: Kolapara District: Patuakhali	N-21 ⁰ 59.985 E-90 ⁰ 13.524 17-12-2019	
23	RS-12	Deshi pat	Md. Mosharrof Phokir Village: Umedpur Thana: Kolapara District: Patuakhali	N-21 ⁰ 59.985 E-90 ⁰ 13.524 17-12-2019	
24	AS-1	Naila	Md. Mishudul Islam Village: Chiraviza Thana: Joldaka District: Nilphamari	N-23 ⁰ 51.916 E-90 ⁰ 16.213 16-11-2018	
25	AS-3	Naila	Md. Mahbubur Rahman Village: Domar railget Thana: Domer District: Nilphamari	N-26 ⁰ 6.620 E-88 ⁰ 49.682 16-11-2018	
26	AS-8	Mitha pat	Md. Aynul Village: Ranir Bandor Thana: Chirirbandar District: Dinajpur	N-25 ⁰ 39.622 E-88 ⁰ 46.794 16-11-2018	
27	AS-10	Mitha pat	Md. Aynul Village: Ranir Bandor Thana: Chirirbandar District: Dinajpur	N-25 ⁰ 39.622 E-88 ⁰ 46.794 16-11-2018	
28	TZ-1	Nobin pat	Moshrrrof Hossain Thana: Borguna Sadar District: Borguna	N-22 ⁰ 9.254 E-90 ⁰ 7.022	

Sl. no.	Collector's no.	Local/Cultivar name/cultural practice	Donor's Name & address	Geographic location and date	Photograph
29	TP-1	Tossa pat	Moshrrrof Hossain Village: Gutia Bazar Thana: Uzirpur District: Barishal	N-22 ⁰ 49.364 E-90 ⁰ 15.248 17-12-2019	
30	TP-2	Tossa pat	Md. Nuruzzaman Village: Chakhar Bazar Thana: Banari Para District: Barishal	N-22 ⁰ 47.164 E-90 ⁰ 9.902 18-12-2019	
31	TP-3	Tossa pat	Shohraf Farazi Village: Kolapara Bazar Thana: Kolapara District: Patuakhali	N-22 ⁰ 47.164 E-90 ⁰ 9.902 18-12-2019	
32	RS-13	Pat	Md. Alom Shordar Village: Mowdubi Thana: Kolapara District: Patuakhali	N -22 ⁰ 47.164 E-90 ⁰ 9.902 18-12-2019	
33	RS-9	Chukur	A.K.M. Shahadat Village: Gangkanda Thana: Daudkandi District: Cumilla	N-23 ⁰ 31.106 E-90 ⁰ 42.654 17-11-2018	
34	RS-10		A.K.M. Shahadat Village: Gangkanda Thana: Daudkandi District: Cumilla	N-23 ⁰ 31.106 E-90 ⁰ 42.654 17-11-2018	
35	RS-14	Mesta	DulalKazi (Seed Dealer) Village: Baintola Thana: Kolapara District: Patuakhali	N-22 ⁰ 47.164 E-90 ⁰ 9.902 18-12-2019	



Fig. 66. Germplasm collection from Dashiachora Sitmohol, Phulbari, Kurigram



Fig. 67. Germplasm collection from different places of Bangladesh

11.4.2. Conservation of collected germplasm

Global initiative for collection and conservation of plant genetic resources (PGR) are focused for ensuring the future adaptability of cultivars and wild populations by preserving data and traits. Plant genetic resources can be conserved both *in-situ* and *ex-situ*. Jute & allied fibre (JAF) germplasm are conserved by *ex-situ* in BJRI. This sub-project has to conserve 35 jute and allied fibre germplasm collected from target areas and seed received from different sources (Table 64). The collected JAF germplasm samples were registered in conservation book by specific registration number. Among them, 32% germplasm found in respect of 20-30% germination rate. Same 32% germplasm also showed 40-60% germination rate. 70-80% germination rate covered for 8% of total conserved germplasm. 90% and 100% germination rate measured in the 17% and 11% conserved material respectively. Moisture content 7-9% was found among the conserved germplasm. The conserved seed quantity varied sharply 3-120 g of different collected genetic materials. The collected germplasm have so far been conserved in short-term storage as an active collection is shown in table 67.

Table 67. Conservation status of jute and allied fibre (JAF) germplasm collected under PBRG-PGR sub-project

Sl.no	Local/cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
Deshi Jute							
1.	Mera Shak	RS-1	112	8	90	05.08.2020	5317
2.	Mera Shak	RS-2	90	8	90	05.08.2020	5318
3.	Chera Pat	RS-3	48	7	100	05.08.2020	5319
4.	Mera Shak vegetable	RS-4	52	7	60	05.08.2020	5320
5.	Deshi pat	AS-2	03	8	50	05.08.2020	5321
6.	Deshi Sada	AS-4	90	8	80	05.08.2020	5322
7.	Jati pat	ACK-1	06	7	90	05.08.2020	5323
8.	Jati pat	ACK-2	09	8	20	05.08.2020	5324
9.	Jati pat	ACK-3	86	7	90	05.08.2020	5325
10.	Jati pat	FM-1	22	7	20	05.08.2020	5326
11.	Deshi pat	AS-5	62	8	40	05.08.2020	5327
12.	Deshi pat	AS-6	05	7	50	05.08.2020	5328
13.	Deshi pat	AS-7	33	8	30	05.08.2020	5329
14.	Tita pat	AS-9	29	7	40	05.08.2020	5330
15.	Mera	RS-5	13	8	90	05.08.2020	5331
16.	Birol	RS-6	20	7	100	05.08.2020	5332
17.	Birol	RS-7	20	8	60	05.08.2020	5333
18.	Birol Vegetable type	RS-8	03	8	100	05.08.2020	5334
19.	Megnal	FMN-1	67	7	60	05.08.2020	5335
20.	Cherashak	FMN-2	103	8	100	05.08.2020	5336
21.	Deshi pat	FZ-1	57	7	90	05.08.2020	5337
22.	Pat	RS-11	46	8	70	05.08.2020	5338
23.	Deshi pat	RS-12	36	8	60	05.08.2020	5339
Tossa Jute							
24.	Naila	AS-1	45	7	30	06.08.2020	5340
25.	Naila	AS-3	46	7	20	06.08.2020	5341
26.	Mitha pat	AS-8	25	7	30	06.08.2020	5342
27.	Mitha pat	AS-10	30	8	40	06.08.2020	5343
28.	Nobin pat	TZ-1	29	7	80	06.08.2020	5344
29.	Tossa pat	TP-1	05	8	50	06.08.2020	5345
30.	Tossa pat	TP-2	07	8	30	06.08.2020	5356
31.	Tossa pat	TP-3	12	7	20	06.08.2020	5347
32.	Pat	RS-13	24	8	40	06.08.2020	5348
Mesta (<i>Hibiscus Subdarifa</i>)							
33.	Chukur	RS-9	10	9	30	06.08.2020	5349
34.	Mesta	RS-10	12	9	25	06.08.2020	5350
35.	Mesta	RS-14	120	9	30	06.08.2020	5351

11.4.3. Characterization of Deshi Jute (*Corchorus capsularis*) germplasm during 2018 season

Qualitative variations of different characters in 27 deshi jute germplasm are shown in table 68 & 70. Wide range of variation was found in plant stem color. Green stem (44%), red (30%) and light red (26%) stem color were found among the germplasm. Green leaf color was found in most of the germplasm except two (Collector's no RS-6 & RS-7), which were light red in color. Leaf vein color was green in 16 genotypes and rest was light red in color. Light red (48%), green (26%) and red color (26%) petiole were found among the germplasm. Stipule was present in all germplasm with green (52%), light red (37%) and 11% red in color. 48% germplasm were non-branched habit with lanceolate leaves, 30% germplasm have same percentage for weak and intermediate branching habit and the other 22% germplasm were equally considered for very weak and strong in branching habit.

Quantitative variations of 15 characters were shown in table 69. Range, mean, standard deviation and co-efficient of variations of quantitative characters were calculated (Table 71). The highest leaf length was found in acc. no. 742 (17.76 cm) followed by Collector's no. ACK-3 (16.34 cm) and Acc. no. 4894 (16.26 cm). In case of leaf width the highest was 11.28 cm in acc. no. 3311. Leaf area ranged from 13.94 cm²-75.11cm² with an average 42.10 cm². Petiole length was highest in Collector's no. AS-4 (12.38 cm) followed by acc. no. 890 (11.78 cm). The technical height was found highest in Collector's no. AS-6 (352.5 cm) while the lowest was 120 cm in Collector's no. AS-9. Number of nodes per plant ranged from 35-74 with an average 54.85. The highest base diameter (39.30 mm) was observed in Collector's no. AS-5 followed by 23.05 mm in Collector's no. AS-6 and 21.81 mm (acc. no. 742 and Collector's no. AS-4). Germplasm stem mid diameter ranged from 5.23 mm to 20.58 mm in Collector's no. RS-2 and Collector's no. RS-5, respectively. The highest top diameter (5.09 mm) was found in acc. no. 4894 whereas the lowest was in Collector's no. RS-2 (3.18 mm). Basal core diameter was highest (19.45 mm) in Collector's no. AS-6 followed by Collector's no. AS-4 (18.20 mm) and acc. no.742 (17.89 mm). Dry fibre and stick weight was highest in acc. no. 742 which was 21.8 g and 53.4 g, respectively. Merha red (Collector's no. RS-4) and Birol red (Collector's no. RS-8) two wild germplasm collected from Kurigram and Bogura are used as vegetable in that region round the year though their fibre yield is low (5.1 g, 5.8 g). These two germplasm contained more vitamins, minerals and indicated their importance for vegetable (Tareq *et al.* 2019). Therefore, Merha red and Birol red can be identified for vegetable purpose and acc. no. 742 for fibre and stick purpose.

Table 68. Qualitative variation in different characters of jute germplasm, 2018

Character	Descriptor state	No. of germplasm	Frequency (%)
Stem color	Green	12	44
	Red	8	30
	Light red	7	26
Leaf color	Green	25	93
	Light red	2	7
Vein color	Green	16	59
	Light red	11	41
Petiole color	Green	7	26
	Red	7	26
	Light red	13	48
Stipule color	Green	14	52
	Red	3	11
	Light red	10	37

Table 69. Quantitative variation in different descriptors of deshi jute germplasm, 2018

Name of descriptor	Range	Mean	SD	CV (%)
Technical height (cm)	120-352.5	231.77	67.66	29.19
Node number (no.)	35-74	54.85	12.20	22.24
Plant base diameter (mm)	8.8-39.3	15.66	6.47	41.32
Mid-diameter (mm)	5.23-20.58	9.61	3.25	33.86
Top diameter (mm)	3.18-5.09	4.03	0.60	14.86
Basal core diameter(mm)	7-19.45	12.04	3.98	33.10
Dry fibre weight (g)	1.3-21.8	8.41	6.35	75.58
Dry stick weight (g)	7.9-53.4	24.34	14.22	58.43
Leaf length (cm)	9.6-17.76	13.62	2.27	16.72
Leaf width(cm)	2.62-11.28	5.37	1.87	34.96
Petiole length (mm)	2.78-12.38	6.00	2.01	33.61
Leaf area (cm ²)	13.94-75.11	42.10	18.25	43.34

Table 70. Qualitative characters of deshi jute germplasm, 2018

Collector's no.	Stem Color (1) (g/lr/r)	Stem Color (2) (g/lr/r)	Leaf lemina Color (g/lr/r)	Leaf vein Color (g/lr/r)	Petiole Color (g/lr/r)	Stipule (+ / 0)	Stipule Color (g/lr/r)
RS-1	2	2	1	99	2	1	2
RS-2	1	1	1	1	99	1	1
RS-3	2	2	1	99	2	1	2
RS-4	2	2	1	99	2	1	99
Acc. 841	1	1	1	1	1	1	1
AS-2	1	1	1	1	1	1	1
Acc. 742	1	1	1	1	1	1	1
AS-4	99	99	1	1	99	1	1
ACK-1	99	99	1	1	99	1	1
ACK-2	2	2	1	1	2	1	99
ACK-3	1	1	1	1	99	1	1
FM-1	2	2	1	99	2	1	99
AS-5	99	99	1	1	99	1	1
AS-6	99	99	1	1	99	1	1
AS-7	1	1	1	1	1	1	1
Acc.890	1	1	1	1	1	1	1
AS-9	1	1	1	1	1	1	1
Acc. 4894	1	1	1	1	1	1	1
RS-5	99	99	1	99	99	1	99
RS-6	1	1	99	99	99	1	99
RS-7	1	1	99	99	99	1	99
RS-8	2	2	1	99	2	1	2
Acc. 3311	99	99	1	99	99	1	1
Acc. 5134	99	99	1	99	99	1	99
FMN-1	1	1	1	1	99	1	99
FMN-2	2	2	1	99	2	1	99
FZ-1	2	2	1	1	99	1	99

Table 71. Quantitative characters of deshi jute germplasm, 2018

Collector's no.	Tech ht (cm)	Nodes (no.)	Base dia. (mm)	Mid dia. (mm)	Top dia. (mm)	Basal Core dia.(mm)	Dry fibre wt./plant. (g)	Dry stick wt./plant (g)	Branchabit(0-9)	Leafangle(1-9)	Leaflength(cm)	Leaf width(cm)	Petiolelength(mm)	Leaf area (cm ²)	Leaf shape (1-6)
RS-1	204.0	48	14.41	9.45	4.10	11.97	5.0	11.42	5	5	12.90	3.90	4.48	30.10	3
RS-2	167.2	42	9.68	5.23	3.18	7.65	5.1	11.4	1	5	11.48	4.58	5.54	33.75	3
RS-3	207.5	52	15.48	9.70	4.10	12.77	5.6	28.2	5	5	12.14	4.06	4.92	30.10	3
RS-4	174.0	40	9.80	6.75	3.49	7.50	1.8	8.9	0	5	9.60	4.00	4.78	29.34	2
Acc. 841	235.5	55	14.40	9.05	5.08	10.50	8.4	16.4	0	5	14.88	5.82	6.04	55.98	2
AS-2	170.0	35	8.80	6.00	4.00	7.00	5.0	12.5	3	5	10.00	4.50	5.00	25.80	2
Acc. 742	340.0	70	21.81	11.58	5.09	17.89	21.8	53.4	0	5	17.76	7.36	6.70	75.07	2
AS-4	334.0	72	21.81	12.98	4.97	18.20	21.0	47.8	0	5	15.38	6.26	12.38	52.30	2
ACK-1	264.1	68	21.38	12.95	4.51	16.64	11.5	31.1	0	5	14.36	6.16	6.14	57.80	2
ACK-2	231.0	45	12.54	9.34	4.16	8.71	5.0	21.4	5	5	12.80	4.36	5.02	24.81	3
ACK-3	315.0	66	20.52	12.62	5.04	16.81	14.3	39.6	0	5	16.34	6.94	6.52	70.77	2
FM-1	217.5	46	12.69	8.31	4.16	10.47	4.1	17.2	5	5	12.54	4.62	4.96	28.24	3
AS-5	327.5	69	39.30	11.94	3.99	16.67	13.0	35.2	0	5	15.52	6.38	6.50	57.40	2
AS-6	352.5	74	23.05	12.88	4.83	19.45	19.4	51.2	0	5	15.70	6.40	6.66	63.84	2
AS-7	173.0	39	8.80	6.00	3.40	7.00	2.0	9.00	0	5	11.00	4.50	5.00	32.00	3
Acc.890	247.0	66	12.08	8.30	3.20	9.73	7.4	15.2	0	5	13.46	8.20	11.78	75.11	2
AS-9	120.0	38	10.00	8.00	4.00	8.00	1.5	8.0	3	5	11.50	2.62	6.5	28.5	3
Acc. 4894	231.0	74	11.00	7.02	3.45	8.89	6.2	14.0	0	5	16.26	7.46	5.96	63.54	2
RS-5	298.5	63	18.58	20.58	3.98	16.05	13.3	38.8	0	5	15.68	5.34	5.48	54.79	2
RS-6	148.5	44	10.13	6.10	3.21	7.92	1.3	7.9	7	5	11.88	2.62	2.78	14.75	3
RS-7	162.5	43	11.23	7.74	3.35	8.77	1.9	11.6	7	5	11.82	2.82	3.20	13.94	3
RS-8	200.0	52	14.36	9.05	3.74	11.35	5.8	23.0	7	5	14.20	4.08	5.00	28.62	3
Acc. 3311	125.6	47	13.60	8.22	4.20	10.25	1.7	12.2	3	5	9.62	11.28	6.80	41.98	6
Acc. 5134	282.0	70	16.78	8.20	3.90	13.28	19.10	31.0	0	5	14.30	5.22	5.34	30.50	3
FMN-1	244.0	45	17.04	12.44	4.44	14.20	9.5	37.0	3	5	16.14	5.68	6.56	37.55	3
FMN-2	194.5	57	13.60	7.42	3.36	10.34	4.2	25.0	1	5	14.68	4.20	5.84	27.06	3
FZ-1	291.5	61	20.13	11.66	4.14	17.07	12.2	38.8	1	5	16.04	5.74	6.36	53.30	2

Conclusion

A wide range of variation was found among the six qualitative characters such as stem color, leaf color, petiole color, leaf shape etc. Significant variations were also found among fifteen quantitative characters such as plant technical height, plant base diameter, dry fibre weight, dry stick weight etc. The maximum co-efficient of variation was in dry fibre weight (75.58%) and minimum in top diameter (14.86%) of plant. Three germplasm (acc. 742, RS-4 & RS-8) were identified as promising and can be used for varietal development program.

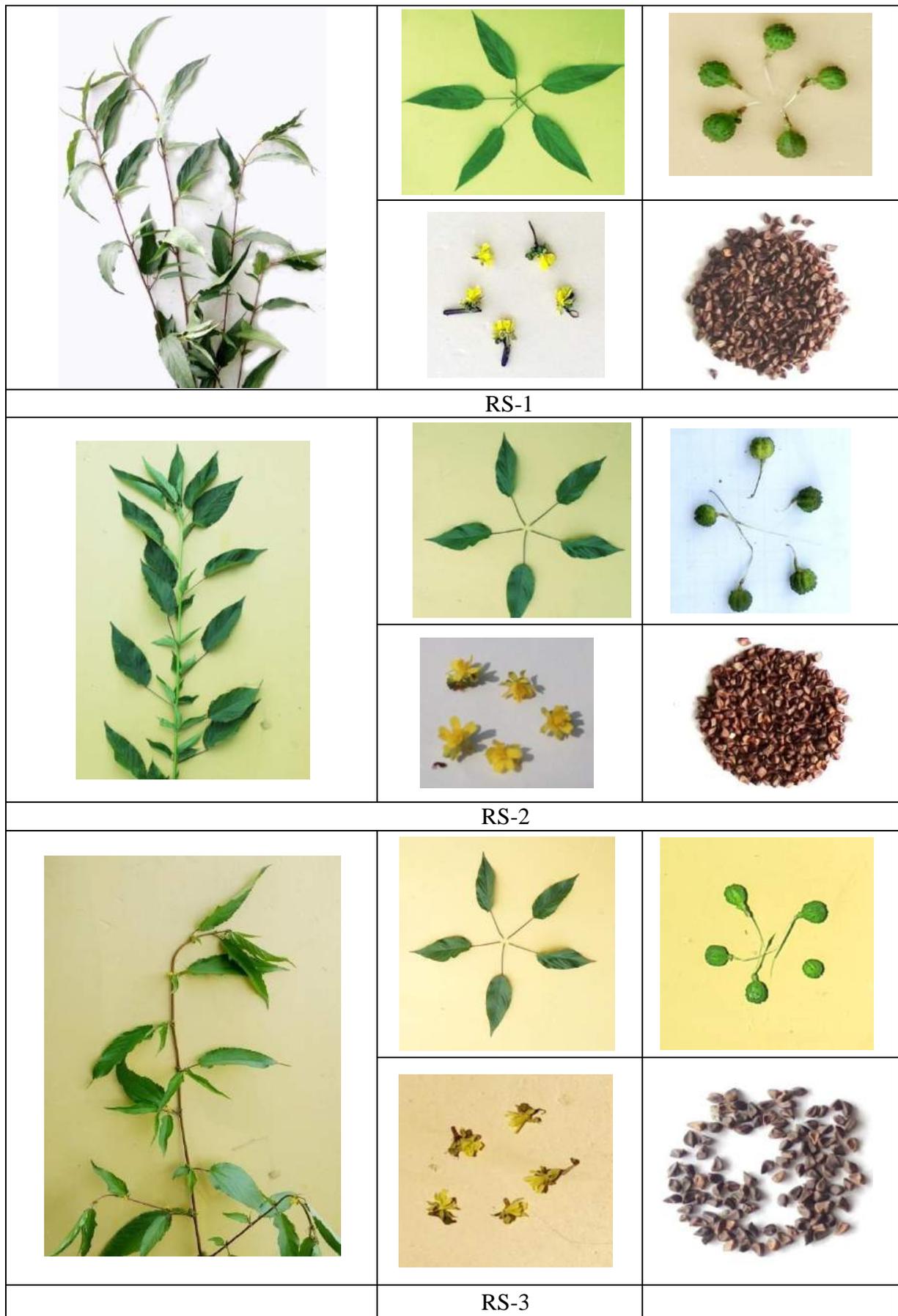
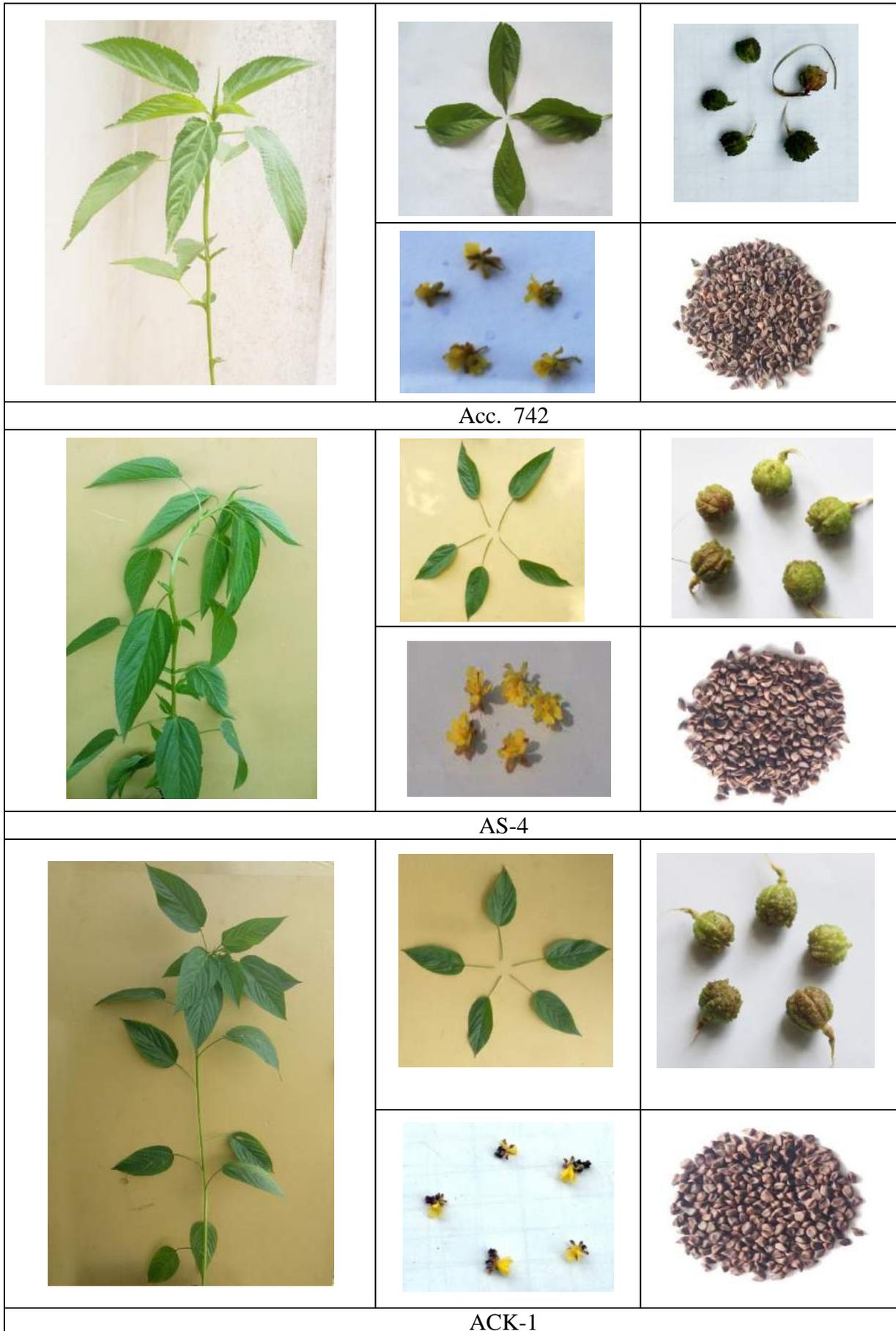


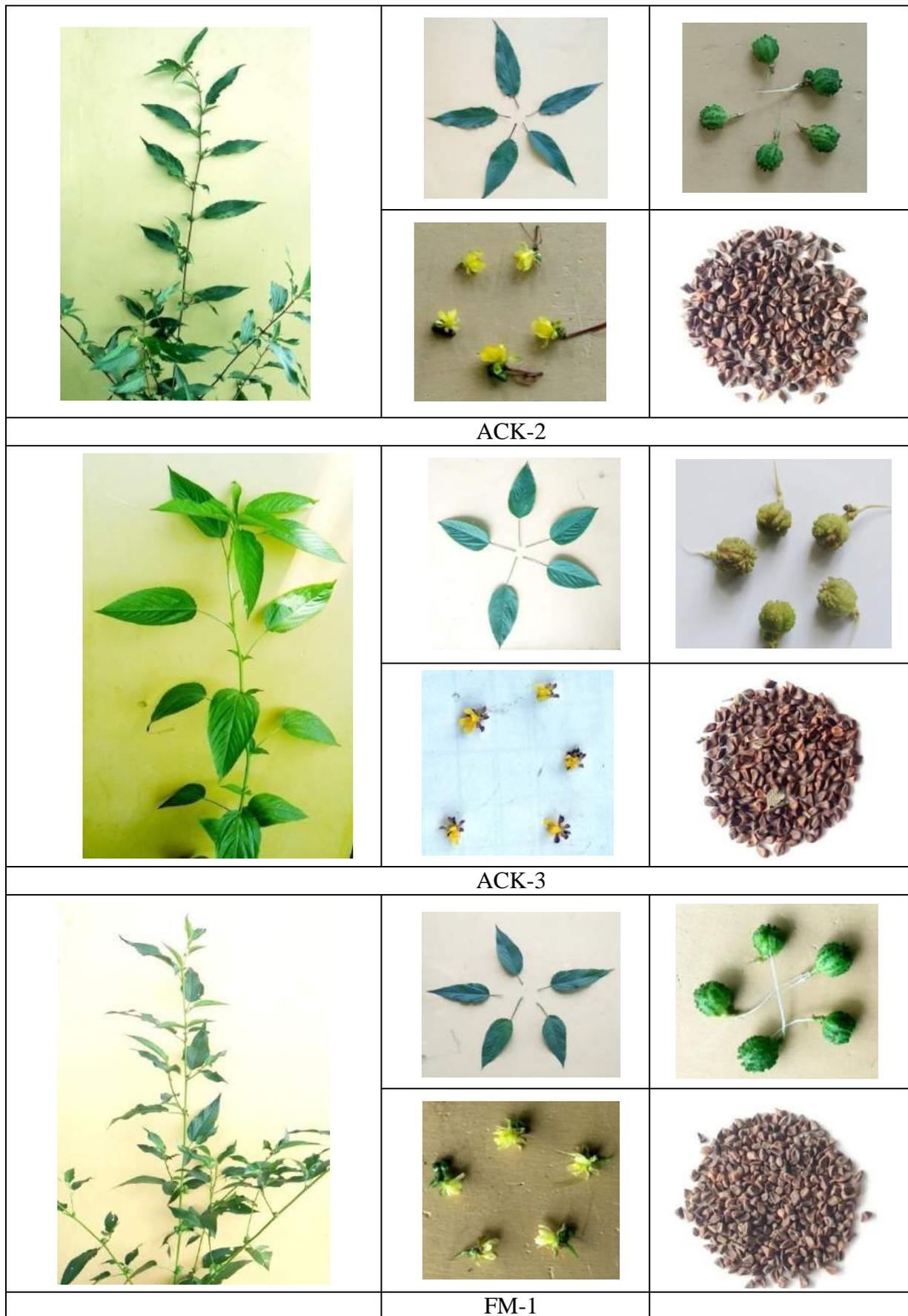
Fig. 68. Different plant parts of deshi jute, 2018



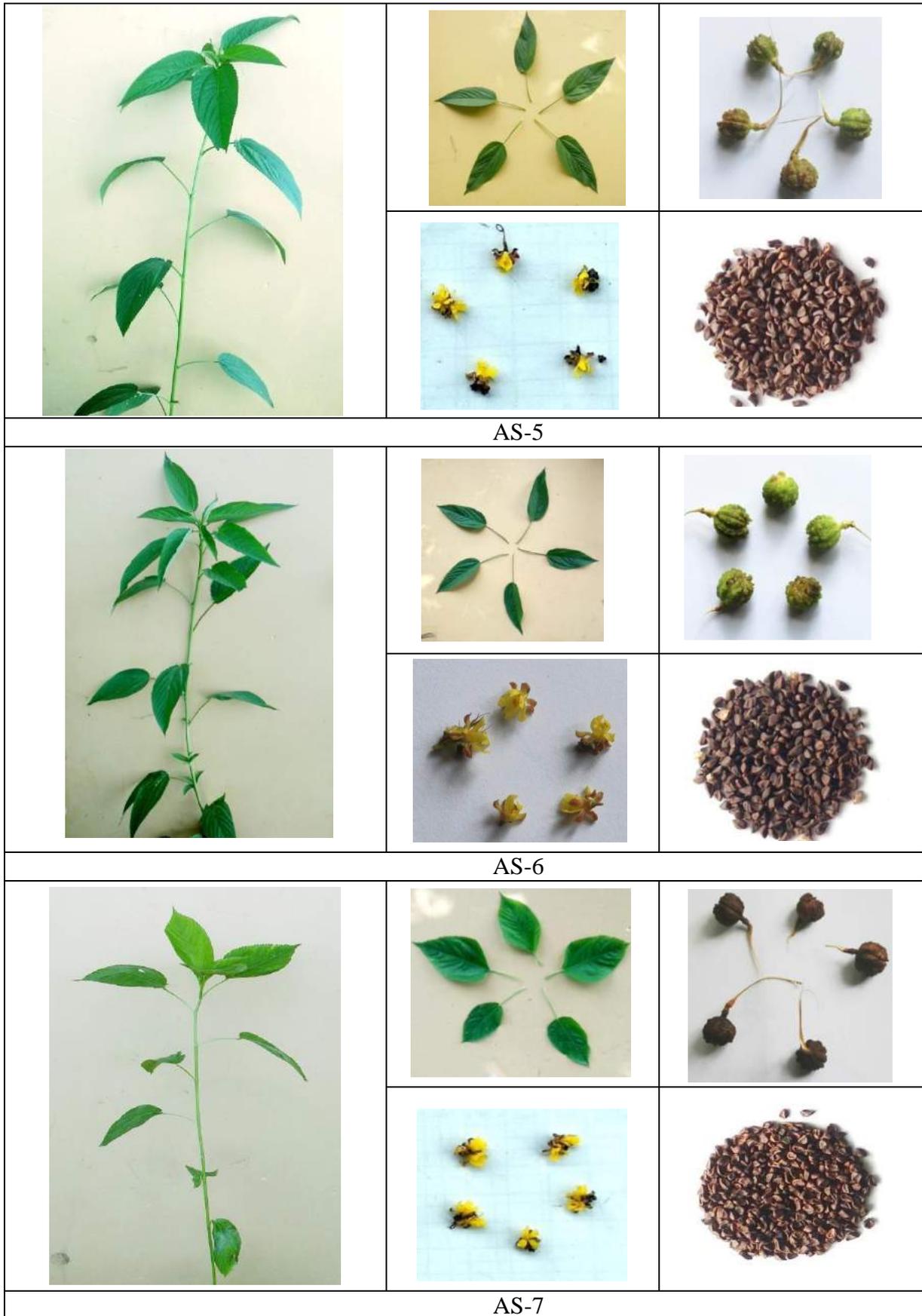
Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Acc. 890

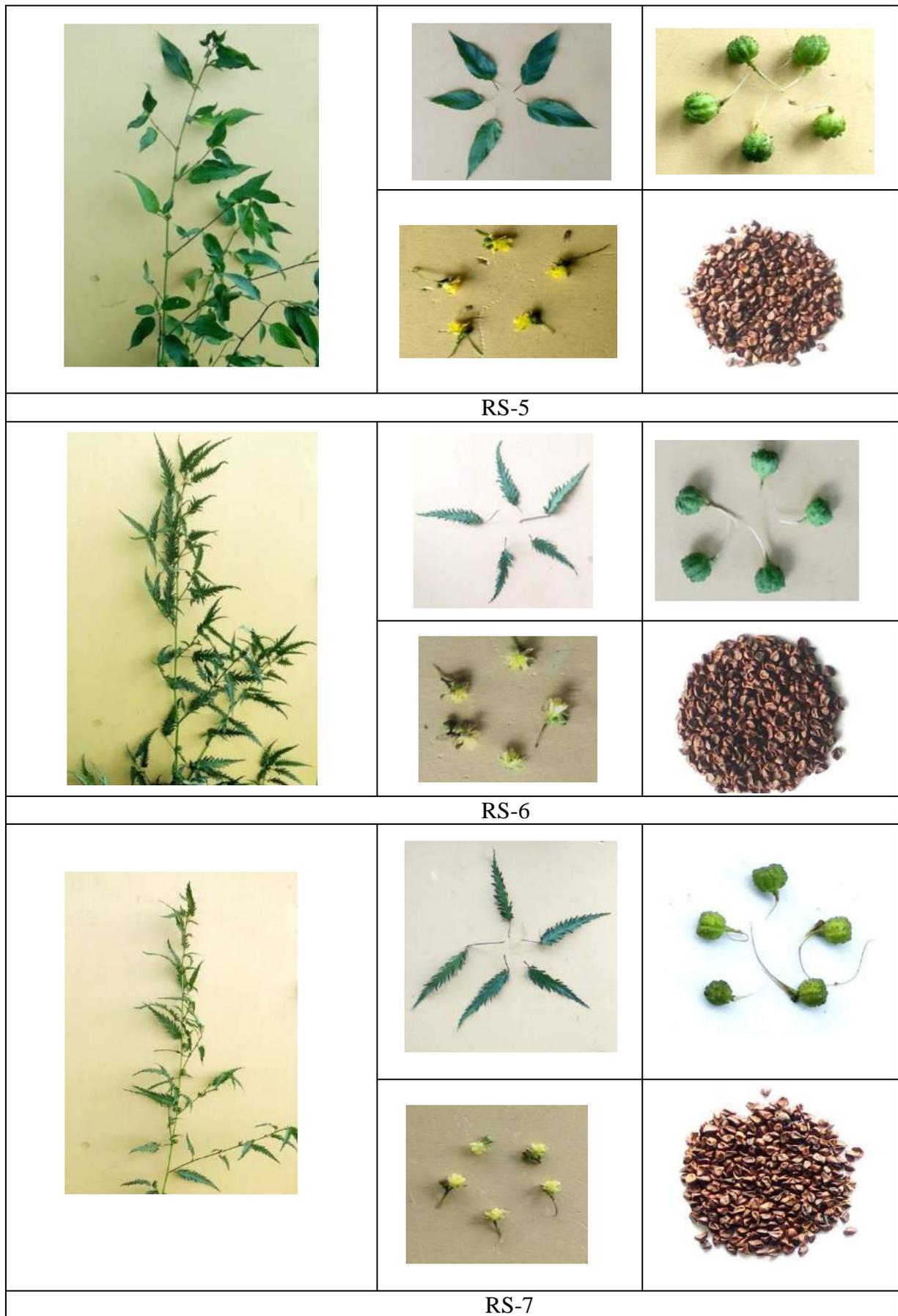


AS-9



Acc. 4894

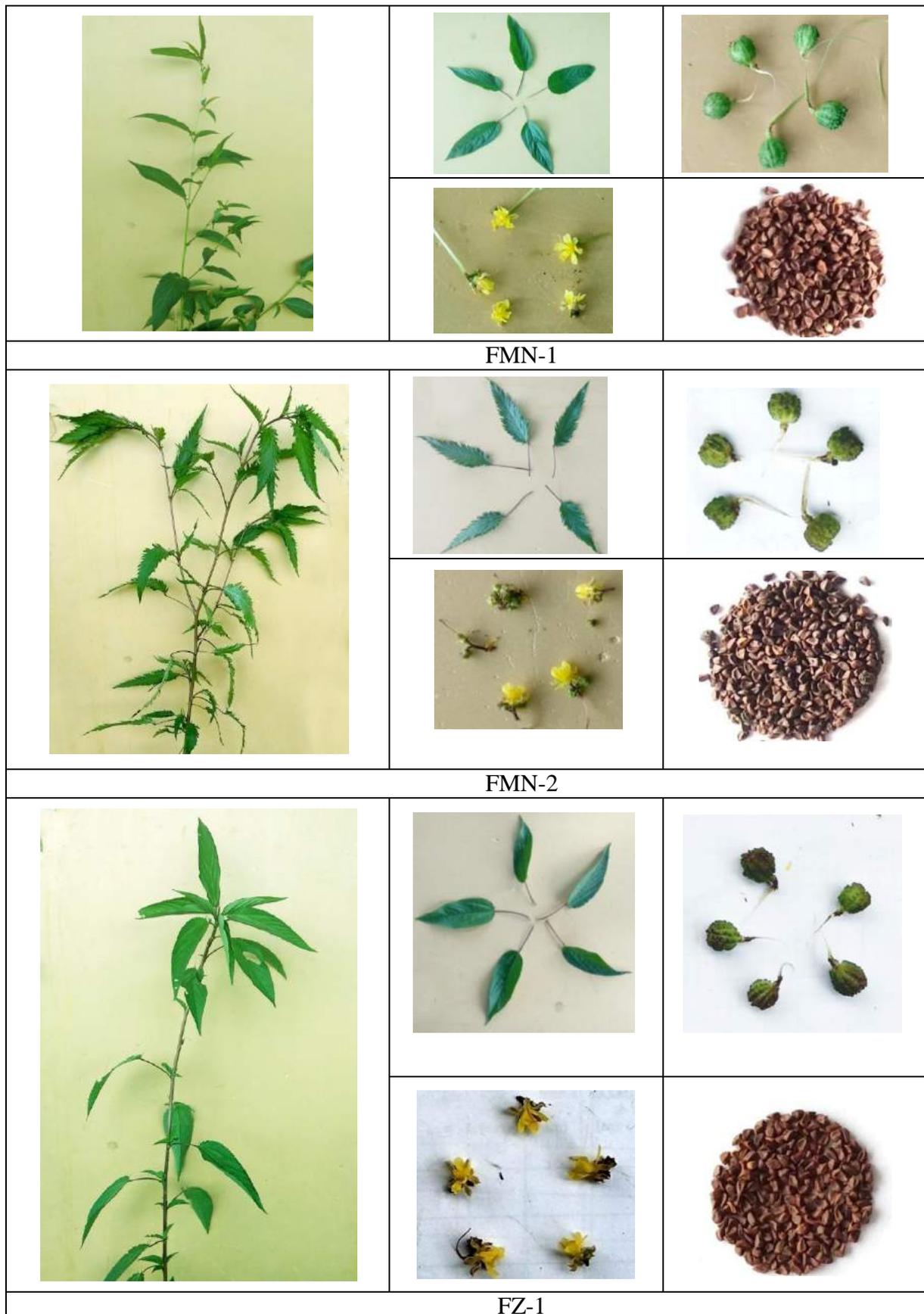
Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018



Cont'd. Fig. 68. Different plant parts of deshi jute, 2018

11.4.4. Characterization of Deshi Jute (*C. capsularis*) Germplasm, 2020

Qualitative variations of different characters in 35 germplasm are shown in table 72. Wide range of variation was found in plant stem color and stipule color. Green stem (71%), red (20%) and light red (9%) were found among the germplasm. Green leaf and leaf vein color was found in all the germplasm. Stipule was present in all germplasm with 66% green, 31% light red and 3% red color. Among them 83% germplasm were non-branched (Fig. 55 & 56).

Quantitative variations of 10 characters were shown in table 73 Range, mean, standard deviation and co-efficient of variations of quantitative characters were calculated. The maximum co-efficient of variation was in dry core weight (34.95%) followed by dry fibre weight (34.58%). The plant height was found highest in acc. no. 2023 (329 cm) followed by acc. no. 2122 (322 cm), acc. no. 2068 (318 cm), acc. no. 2020 (316 cm), acc. no. 2061 (315 cm) and acc. no. 2143 (312 cm) (Table. 75). Khatun and Sobhan (1992) studied the morphological characters of tossa jute germplasm and revealed that plant height and bark weight had great influence on fibre yield. The highest base diameter 24.58 mm was found in acc. no. 2023 followed by 23.40 mm in acc. no. 2061, 22.50 mm in acc. no. 2090, 21.94 mm in acc. no. 2096, 21.92 mm in acc. no. 2193, 21.72 mm in 2068 and 21.18 mm in acc. no. 2143. The highest leaf length was measured 18.60 cm in acc. no. 2167 followed by 17.54 cm in acc no. 2143 and 17.42 cm in acc. no. 2106. In case of leaf width, the highest was 7.82 cm in acc. no. 2122 followed by 2.74 cm in acc. no. 2192 & 2193. Petiole length was highest 9.12 cm in acc. no. 2122 followed by 8.62 cm in acc. no. 2192 and 8.46 cm in acc. no. 2189 while the lowest was 170 cm in acc. no. 2085. Number of nodes per plant ranged from 38-72 with an average 56.88. Dry stick weight was highest (50.40 g) in acc. no. 2061 followed by 49 g in acc. no. 2122, 46 g in acc. no. 2067 & 2090, 45.8 g in acc. no. 2193, 44.8 g in acc. no. 2106 and 44.6 g in acc. no. 2143 & 2083. Dry fibre weight was highest 20 g in acc. no. 2143 followed by 19.8 g in acc. no. 2061, 19.20 g in acc. no. 2122, 19 g in acc. no. 2090 and 18.2 g in acc. no. 2193. Significant differences for the all the characters with wide range of variability were found. Islam and Ahmed (2003) suggested that jute genotype variability is considered for crop improvement program. Based on the yield contributing characters acc. no. 2143, 2061, 2122, 2090 and 2193 can be used in this regard.

Table 72. Qualitative variation in different characters of deshi jute (*C. capsularis*) germplasm, 2020

Characters	Descriptorstate	No. of germplasm	Frequency (%)
Stem color	Green	25	71
	Red	7	20
	Light Red	3	9
Late stem color	Green	26	74
	Red	7	20
	Light red	2	6
Leaf lamina color	Green	35	100
Vein color	Green	35	100
Stipule color	Green	23	66
	Red	1	3
	Light red	11	31

Table 73. Quantitative variation in different descriptors of deshi jute (*C. capsularis*) germplasm, 2020

Name of descriptor	Range	Mean	SD	CV (%)
Plant height (cm)	170-329	283.31	36.52	12.89
Nodes per plant (no.)	38.40-71.40	56.88	9.31	16.37
Stem diameter (mm)	10.22-24.58	18.57	3.35	18.02
Leaf length (cm)	12.84-81.60	15.37	1.40	9.12
Leaf width (cm)	4.84-7.82	6.24	0.83	13.31
Petiole length (cm)	4-9.12	6.89	1.21	17.50
Dry fibre weight (g)/plant	2.8-20	13.31	4.60	34.58
Dry core weight (g)/plant	7.4-50.4	33.33	11.65	34.95

Table 74. Qualitative characters of deshi jute (*C. capsularis*) germplasm, 2020

Acc. No.	Stem Color (1)(g/lr/r)	Stem Color (2)(g/lr/r)	Leaf lemina Color (g/lr/r)	Leaf vein Color (g/lr/r)	Leaf shape	Stipule 0/1	Stipule color
2020	1	1	1	1	2	1	1
2023	99	1	1	1	3	1	99
2033	1	1	1	1	2	1	1
2339	1	1	1	1	2	1	1
2061	2	2	1	1	1	1	2
2063	2	2	1	1	2	1	99
2067	1	1	1	1	2	1	99
2068	1	1	1	1	2	1	1
2082	1	1	1	1	2	1	1
2083	1	1	1	1	2	1	1
2085	1	1	1	1	2	1	1
2090	2	2	1	1	2	1	99
2096	1	1	1	1	2	1	1
2106	1	1	1	1	2	1	1
2122	1	1	1	1	2	1	1
2123	1	1	1	1	2	1	1
2124	1	1	1	1	2	1	1
2141	2	2	1	1	2	1	99
2142	2	2	1	1	2	1	99
2143	1	1	1	1	2	1	1
2145	1	1	1	1	2	1	1
2146	2	2	1	1	2	1	99
2166	2	2	1	1	2	1	99
2167	99	99	1	1	2	1	99
2169	1	1	1	1	2	1	1
2170	1	1	1	1	2	1	1
2183	1	1	1	1	2	1	1
2186	1	1	1	1	2	1	1
2187	1	1	1	1	2	1	1
2188	1	1	1	1	2	1	1
2189	1	1	1	1	2	1	1
2192	99	99	1	1	2	1	99
2193	1	1	1	1	2	1	1
2200	1	1	1	1	2	1	1
7370	1	1	1	1	2	1	99

Table 75. Quantitative characters of deshi jute (*C. capsularis*) germplasm, 2020

Acc. No.	Plant height (cm)	Nodes per plant (no.)	Stem diameter (mm)	Leaf length (cm)	Leaf Width (cm)	Leaf angle	Petiole length (cm)	Branching habit	Dry fibre weight (g)/plant	Dry core (stick) wt. /plant (g)
2020	316	61.40	20.90	14.02	5.30	3.00	5.96	0	15.20	35.60
2023	329	63.40	24.58	13.22	4.96	3.00	5.22	0	15.80	42.80
2033	287	47.60	20.70	13.56	5.08	3.00	4.76	0	11.00	29.80
2339	233	48.80	14.62	14.74	5.58	3.00	6.50	0	9.00	28.00
2061	315	61.20	23.40	16.48	6.50	3.00	8.18	0	19.80	50.40
2063	232	50.80	18.26	13.36	5.50	3.00	6.30	0	14.20	38.00
2067	299	53.60	19.88	16.10	5.94	3.00	7.64	0	16.80	46.00
2068	318	71.40	21.72	15.26	5.80	3.00	6.46	0	17.20	38.80
2082	308	67.40	20.26	14.44	7.20	3.00	6.28	0	16.80	35.20
2083	289	49.60	20.60	14.86	6.54	3.00	5.76	0	15.20	44.60
2085	170	38.40	10.22	12.84	5.24	3.00	5.74	0	2.80	7.40
2090	304	61.60	22.50	16.20	6.18	4.00	5.94	0	19.00	46.00
2096	295	51.60	21.94	16.40	7.02	3.00	6.98	0	16.60	41.20
2106	291	49.40	19.92	17.42	6.34	4.00	7.26	0	16.80	44.80
2122	322	68.00	20.76	15.36	7.82	4.00	9.12	0	19.20	49.00
2123	202	40.40	11.08	13.38	5.30	3.00	6.48	0	4.00	9.40
2124	280	45.60	16.76	12.92	5.64	3.00	5.16	0	11.60	29.40
2141	290	53.60	16.84	16.11	5.62	3.00	7.16	0	12.20	30.80
2142	288	49.60	18.56	15.18	5.40	3.00	5.58	0	15.00	41.00
2143	312	62.80	21.18	17.54	4.84	4.00	7.96	0	20.00	44.60
2145	298	61.00	18.50	16.58	6.76	3.00	7.78	5	13.60	33.60
2146	307	66.40	18.82	16.34	6.16	4.00	7.82	0	13.80	33.60
2166	288	56.00	16.62	15.72	6.06	4.00	6.96	0	9.60	26.00
2167	305	69.80	19.50	18.60	6.74	4.00	8.08	0	16.20	40.60
2169	301	68.40	18.02	15.86	6.00	3.00	4.00	5	12.00	28.60
2170	219	41.80	12.82	13.70	6.08	3.00	6.62	0	4.00	9.40
2183	309	55.00	19.36	16.02	6.82	4.00	6.00	3	15.20	39.20
2186	290	68.20	19.70	15.10	7.20	4.00	7.78	3	14.20	32.60
2187	256	56.20	15.20	15.80	7.08	3.00	8.08	0	7.80	15.80
2188	250	58.80	15.48	15.28	6.98	4.00	8.18	0	7.40	14.60
2189	276	53.80	17.28	16.98	6.62	3.00	8.46	0	10.20	22.40
2192	300	70.00	19.56	16.98	7.74	3.00	8.62	5	14.80	33.00
2193	301	59.40	21.92	15.46	7.74	3.00	7.60	3	18.20	45.80
2200	236	43.60	13.16	14.90	7.08	3.00	6.70	0	6.60	22.60
7370	300	66.20	19.36	15.18	5.64	3.00	7.90	0	14.20	35.80

Conclusion

A wide range of variation was found among the qualitative characters such as stem color, stipule color, leaf shape etc. Significant variations were also found among ten quantitative characters such as plant height, stem diameter, dry fibre weight, dry stick weight etc. The maximum co-efficient of variation was in dry core weight (34.95%) and minimum in leaf length (9.12%). Some promising germplasm acc. no. 2143, 2061, 2122, 2090 and 2193 were selected.

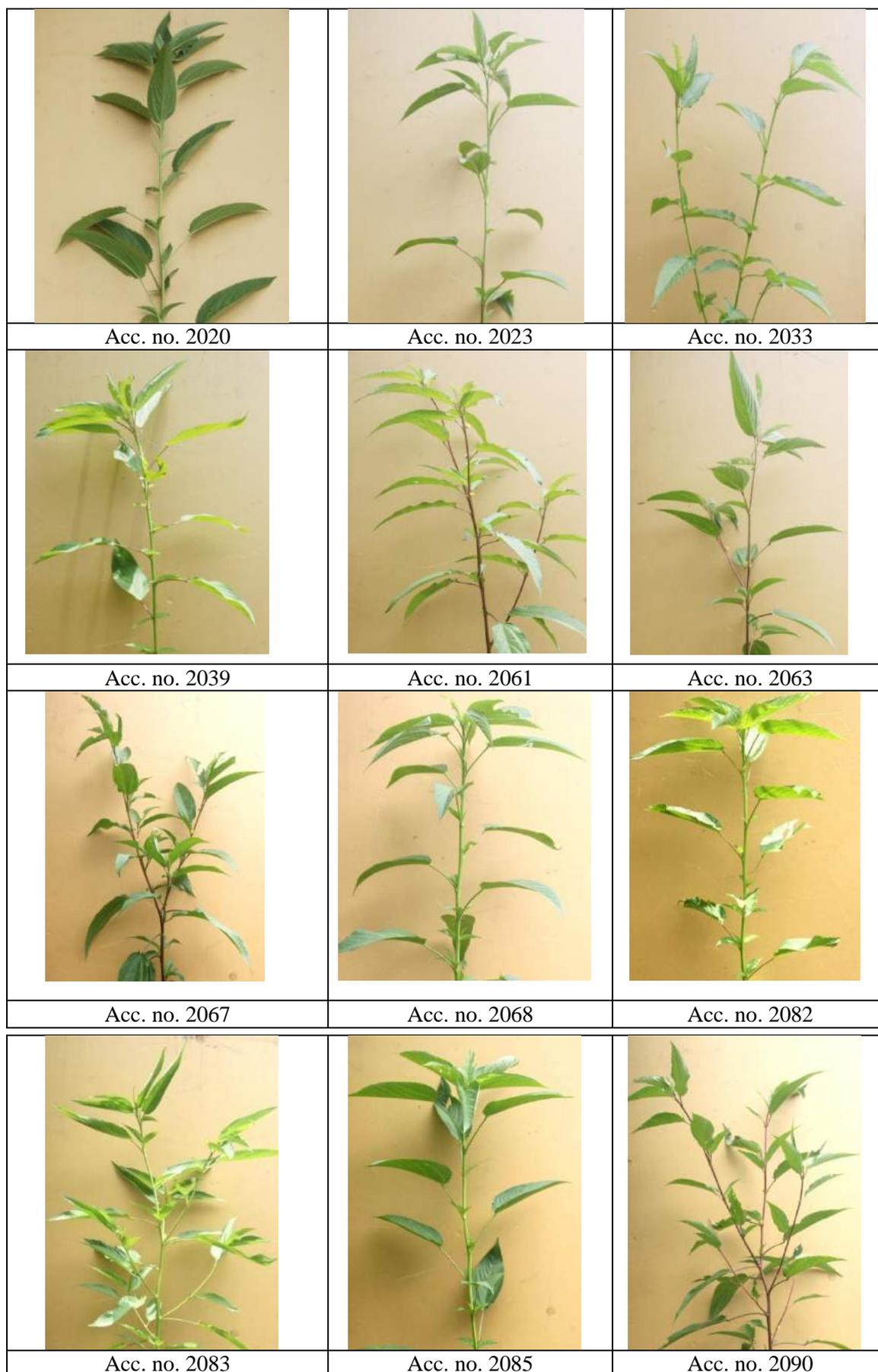


Fig. 69. Different plant parts of deshi jute (*C. capsularis*) germplasm, 2020

		
Acc. no. 2096	Acc. no. 2106	Acc. no. 2122
		
Acc. no. 2123	Acc. no. 2124	Acc. no. 2141
		
Acc. no. 2142	Acc. no. 2143	Acc. no. 2145
		
Acc. no. 2146	Acc. no. 2166	Acc. no. 2167

Cont'd. Fig. 69 Different plant parts of deshi jute (*C. capsularis*) germplasm, 2020

		
Acc. no. 2169	Acc. no. 2170	Acc. no. 2183
		
Acc. no. 2186	Acc. no. 2187	Acc. no. 2188
		
Acc. no. 2189	Acc. no. 2192	Acc. no. 2193
		
Acc. no. 2200	Acc. no. 7370	

Cont'd. Fig. 69. Different plant parts of deshi jute (*C. capsularis*) germplasm, 2020

11.4.5. Characterization of tossa jute (*Corchorus olitorius*) germplasm, 2020

Qualitative variations of different characters in 35 germplasm were shown in table 76 & 77. Wide range of variation was found in plant stem color. Green stem (74%) and red (26%) stem color were found among the germplasm. Green leaf and leaf vein color was found in all the germplasm. Stipule was present in all germplasm with 23% green, 5% light red and 7% red color. Among them 63% germplasm were non-branched (Fig. 70).

Quantitative variations of 10 characters were shown in table 78. Range, mean, standard deviation and co-efficient of variations of quantitative characters were calculated (Table 79). The maximum co-efficient of variation was in dry core weight (27.54%). The plant height was found highest in Robi 1 (350 cm) followed by acc. no. 5141 (308 cm), acc. no. 5144 (307 cm), acc. no. 4142 (301 cm), acc. no. 5163 (300 cm), acc. no. 5038 (299 cm), acc. no. 5145 (298 cm), acc. no. 4792 (292 cm) while the lowest was 206 cm in acc. no. 5122. Number of nodes per plant ranged from 36-76 with an average 56.44. Khatun and Sobhan (1992) studied the morphological characters of tossa jute germplasm and revealed that plant height and bark weight had great influence on fibre yield. The highest base diameter was 22 mm found in Robi-1 variety followed by 21.66 mm in acc.s no. 5163, 19.05 mm in acc. no. 5145, 18.86 mm in acc. no. 4794, 18.72 mm in acc. no. 4792, 18.55 mm in 5103 and 18.04 mm in acc. no. 5149. The highest leaf length was measured in acc. no. 5145 (16.85 cm) followed by acc no. 5141 (16.70 cm) and BJRI variety Robi-1 (16.68 cm). In case of leaf width, the highest was 7.34 cm in acc. no. 5141. The highest petiole length was calculated in acc. no.5141 (7.1 cm) followed by acc. no. 5142 (7.06 cm). Dry fibre weight was highest in Robi-1 (24.5 g) followed by 23.8 g in acc. no. 5123, 22 g in acc. no. 5121, 21.6 g in acc. no. 5038 & 5142, 20.8 g in acc. no. 4792 and 20.5 g in acc. no. 5163, 3854 & 5103. Dry stick weight was highest in acc. no. 5103 (60.75 g) which was even higher than check variety Robi-1 (Table 79). Considering yield contributing parameters, the acc. nos. 5038, 4792, 5163, 4851, 5145, 4794 and 5121 can be selected for crop improvement program.

Table 76. Qualitative variation in different characters of tossa jute germplasm, 2020

Character	Descriptor state	No. of germplasm	% of variation
Stem color	Green	26	74
	Red	9	26
Late stem color	Green	26	74
	Red	6	17
	Light red	3	9
Leaf color	Green	35	100
Vein color	Green	35	100
Stipule color	Green	23	66
	Red	7	20
	Light red	5	14

Table 77. Qualitative characters of tossa jute germplasm

Acc. No.	StemColor (1) (g/lr/r)	StemColor (2) (g/lr/r)	Leaf lemina Color (g/lr/r)	Leaf vein Color (g/lr/r)	Leaf shape	Stipule 0/1	Stipule color
3854	1	1	1	1	2	1	1
3855	1	1	1	1	2	1	1
3862	2	99	1	1	2	1	99
3875	1	1	1	1	1	1	1
3887	1	1	1	1	2	1	1
3888	1	1	1	1	2	1	1
4674	1	1	1	1	2	1	1
4742	1	1	1	1	2	1	1
4792	1	1	1	1	3	1	1
4794	2	2	1	1	2	1	2
4851	1	1	1	1	2	1	1
4870	1	1	1	1	3	1	1
5008	1	1	1	1	2	1	1
5041	1	1	1	1	2	1	2
5103	1	1	1	1	3	1	1
5108	2	2	1	1	2	1	99
5118	2	99	1	1	2	1	2
5120	2	2	1	1	2	1	2
5121	2	2	1	1	2	1	99
5122	1	1	1	1	2	1	1
5123	1	1	1	1	2	1	1
5038	1	1	1	1	2	1	1
5141	1	1	1	1	3	1	1
5142	1	1	1	1	2	1	1
Robi-1	2	2	1	1	2	1	2
5145	1	1	1	1	3	1	2
5146	1	1	1	1	2	1	1
5148	1	1	1	1	2	1	1
5149	1	1	1	1	2	1	1
5150	1	1	1	1	1	1	1
5160	2	99	1	1	2	1	99
5162	1	1	1	1	2	1	99
5163	1	1	1	1	2	1	1
5166	1	1	1	1	2	1	1
5144	2	2	1	1	2	1	2

Table 78. Quantitative characters of tossa jute germplasm

Acc. No.	Plant height (cm)	Nodes per plant (no.)	Stem dia. (mm)	Leaf length (cm)	Leaf Width (cm)	Leaf angle	Petiole length (cm)	Branching habit	Dry fibrewt (g)/plant	Dry core (stick) wt (g) /plant
3854	256	52.60	16.96	14.52	5.58	4	6.14	5	20.50	56.60
3855	269	57.80	14.96	15.00	6.66	4	6.74	1	13.60	30.80
3862	224	47.40	15.36	13.00	6.26	4	5.60	3	14.20	41.20
3875	220	38.80	17.00	12.86	6.16	4	5.12	0	12.80	47.00
3887	217	40.80	14.78	13.16	5.76	4	4.56	0	13.00	38.40
3888	213	41.60	15.50	12.60	5.66	3	5.46	0	12.20	39.80
4674	230	43.60	15.80	13.18	5.74	3	5.86	0	12.40	38.40
4742	244	58.80	15.68	12.98	6.90	4	6.18	0	14.40	25.00

Table 78. Cont'd.

Acc. No.	Plant height (cm)	Nodes per plant (no.)	Stem dia. (mm)	Leaf length (cm)	Leaf Width (cm)	Leaf angle	Petiole length (cm)	Branching habit	Dry fibrewt (g)/plant	Dry core (stick) wt (g) /plant
4792	292	64.40	18.72	14.68	5.82	4	6.90	3	20.80	48.60
4794	274	59.60	18.86	15.16	6.34	4	6.04	0	19.60	41.20
4851	290	55.60	17.02	15.42	6.32	4	6.58	0	20.00	45.00
4870	260	58.40	14.68	16.48	6.50	3	6.48	5	15.40	33.40
5008	212	36.20	14.44	15.60	6.30	3	5.70	0	9.60	26.40
5041	241	47.40	14.06	15.78	6.42	4	6.58	-	17.80	31.00
5103	248	41.50	18.55	15.30	6.30	4	60	0	20.50	60.75
5108	289	65.40	17.94	14.50	6.25	4	6.08	0	18.00	38.60
5118	258	64.00	15.50	14.94	6.10	4	60	0	14.60	29.00
5120	253	47.80	14.86	15.18	5.94	4	6.04	0	16.20	51.60
5121	280	6.40	15.94	15.82	6.46	4	6.80	0	22.00	56.50
5122	206	51.40	12.06	13.90	5.58	3	6.16	0	9.00	14.60
5123	255	58.00	14.98	15.74	6.34	4	6.24	1	23.80	46.00
5038	299	65.00	16.54	16.54	6.86	4	6.56	3	21.60	43.20
5141	308	76.00	15.62	16.70	7.34	4	7.10	5	20.00	49.40
5142	301	68.20	14.74	16.32	6.12	4	7.06	0	21.60	38.20
Robi-1	350	60.00	22.00	16.68	6.18	4	7.00	0	24.50	60.50
5145	298	68.00	19.05	16.85	6.70	4	6.75	0	20.00	57.50
5146	238	53.80	13.70	15.18	6.20	4	6.00	0	16.20	32.40
5148	255	53.00	10.95	14.50	6.65	4	5.65	5	11.50	29.15
5149	277	66.40	18.04	15.64	6.84	4	6.42	5	15.20	31.80
5150	252	59.60	16.96	12.50	5.96	3	5.66	0	17.80	34.80
5160	261	63.20	16.52	15.76	6.50	4	6.08	5	18.60	55.40
5162	259	59.30	17.80	15.92	6.54	4	6.22	3	20.30	50.00
5163	300	64.80	21.66	16.64	7.18	4	6.20	0	20.50	55.00
5166	291	58.00	13.70	16.26	6.34	4	5.78	0	14.60	29.20
5144	307	68.60	16.38	16.28	6.72	4	6.00	3	19.50	48.40

Table 79. Quantitative variation of tossa jute germplasm

Name of descriptor	Range	Mean	SD	CV(%)
Plant height (cm)	206-350	263.63	33.25	12.61
Nodes per plant (no.)	36.2-76	56.44	9.75	17.28
Stem diameter (mm)	10.95-22	16.21	2.31	14.23
Leaf length (cm)	12.5-16.85	15.07	1.32	8.74
Leaf width 9 (cm)	5.58-7.34	6.33	0.43	6.75
Petiole length (cm)	4.56-7.1	6.16	0.55	8.92
Dry fibre weight (g/plant)	9-24.5	17.21	4.01	23.30
Dry core weight	14.6-60.75	41.57	11.45	27.54

Conclusion

A wide range of variation was found among the seven qualitative characters such as stem color, Stipule color, leaf shape etc. Significant variations were also observed among the fifteen quantitative characters such as plant height, stem diameter, dry fibre weight, dry stick weight etc. The maximum co-efficient of variation was in dry core weight (27.54%) and minimum in leaf width (6.75%). The acc. no. 5038, 4792, 5163, 4851, 5145, 4794 and 5121 were identified as promising for varietal development program.

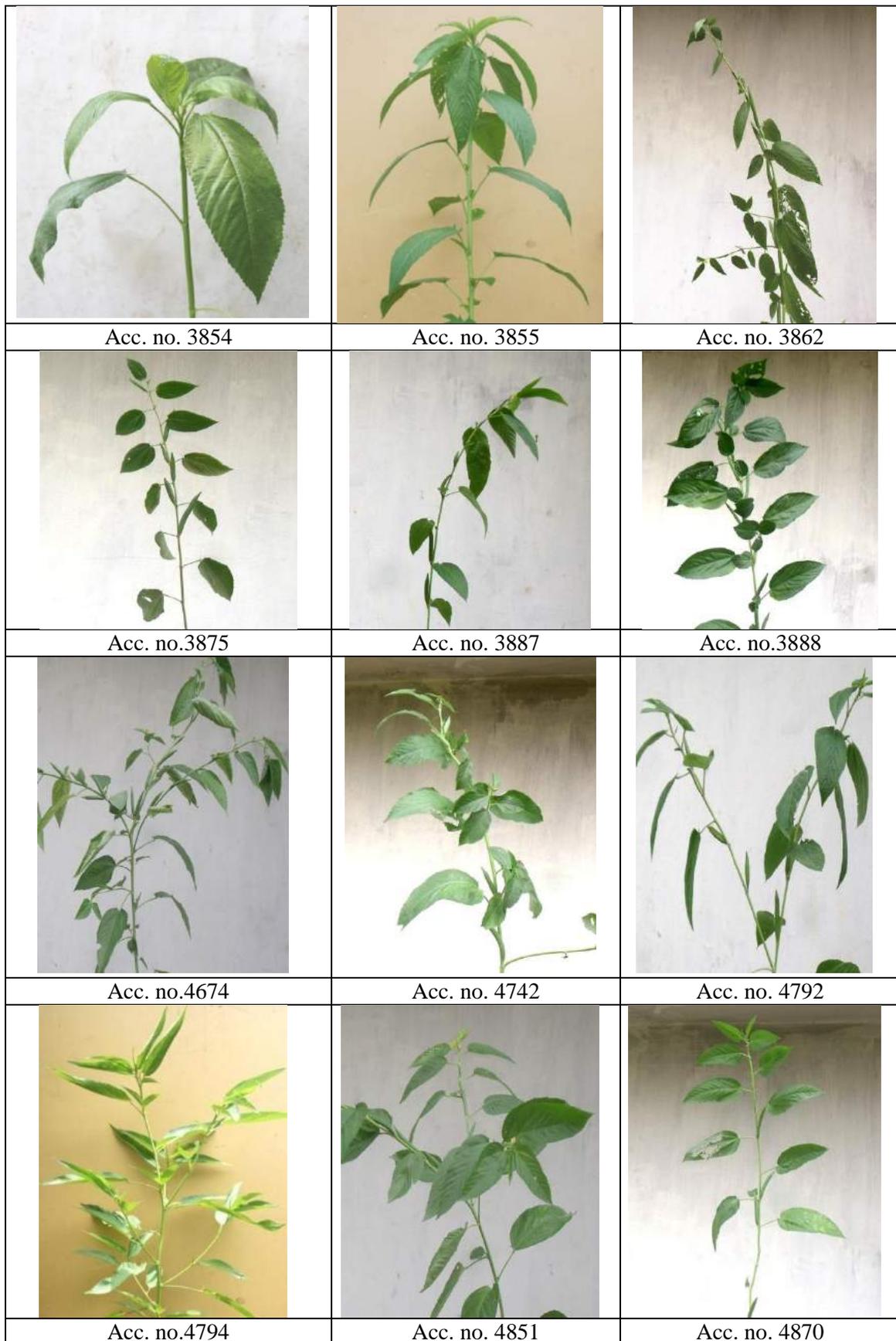
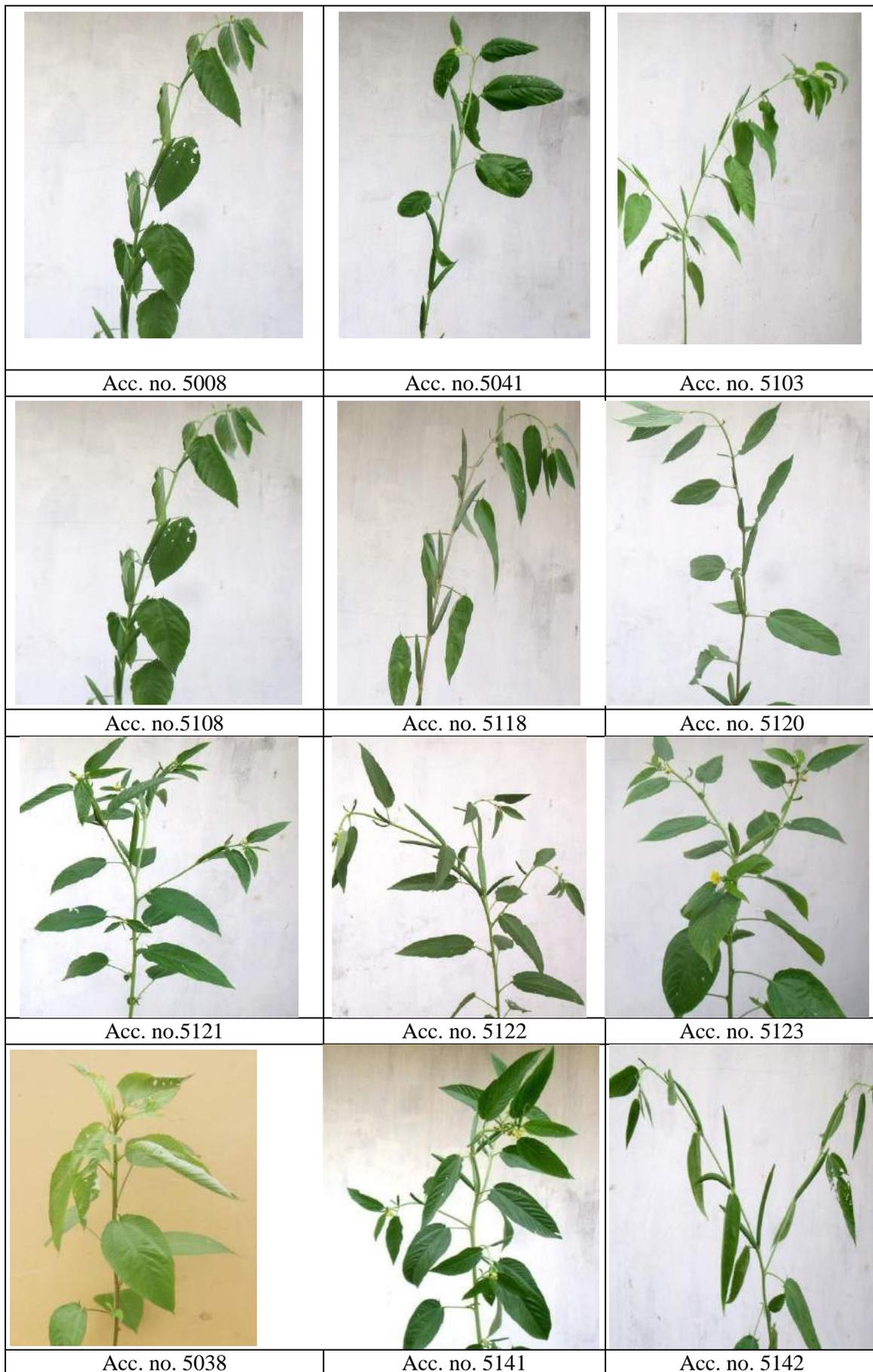
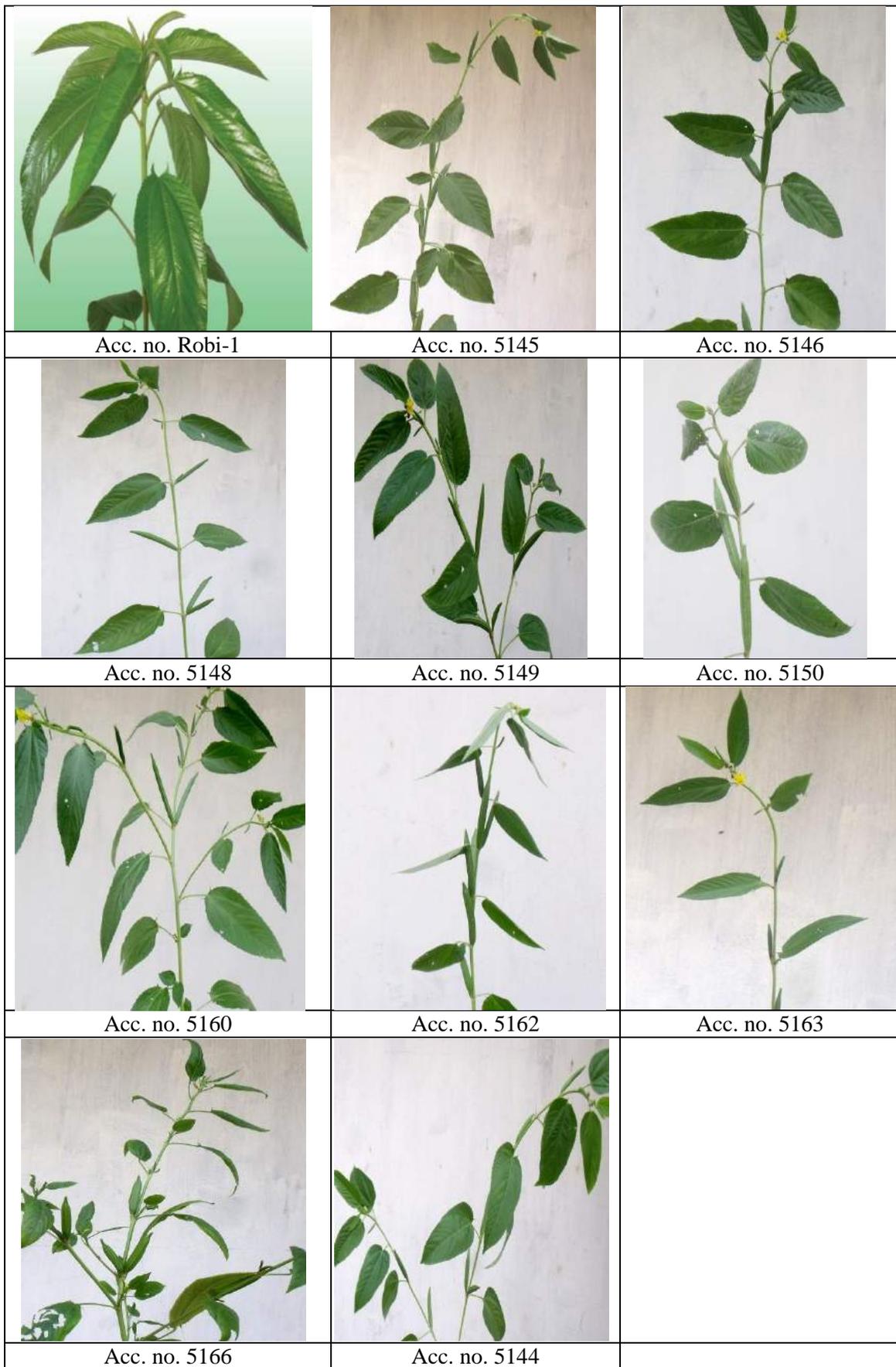


Fig. 70. Different plant parts of tossa jute germplasm, 2020



Cont'd. Fig. 70. Different plant parts of tossa jute germplasm, 2020



Cont'd. Fig. 70. Different plant parts of tossa jute germplasm, 2020

11.4.6. Molecular characterization of jute germplasm through DNA fingerprinting

Closely related cultivars with low genetic variability can't readily be distinguished by morphological traits like pigmentation pattern, leaf shape, stipule shape, seed coat color and so on that are very difficult to identify in jute and allied fibregermplasm characterization. DNA fingerprinting for cultivar or varietal identification has become an important tool for genetic identification in germplasm management and plant breeding. When planning of DNA fingerprinting, one of the most important decision is the marker system and molecular technique to be used. Various systems and their related techniques are currently available, and those are based on polymerase chain reaction (PCR). PCR based techniques or molecular markers such as Randomly Amplified Polymorphic DNA (RAPDs), Simple Sequence Repeats (SSRs) or microsatellites and Amplified Fragment Length Polymorphisms (AFLPs), have an apparent advantage as cultivar descriptors. SSRs have become a powerful and popular tool for determining unique genetic identity or fingerprint, and establishing genetic relatedness as well as diversity among various crop cultivars. The present piece of work is undertaken to develop genetic fingerprints and to estimate genetic relatedness of 22 jute germplasm using some SSR markers.

The jute genotypes (Table 80) studied in this experiment was collected from the Gene Bank of Bangladesh Jute Research Institute (BJRI).

Table 80. List of jute germplasm with origin

Sl. no.	Acc. o./Variety	Species	Country of Origin
1	O-5	<i>Corchorusolitorius</i>	BJRI Variety
2	O-9897	<i>C. olitorius</i>	BJRI Variety
3	O-72	<i>C. olitorius</i>	BJRI Variety
4	OM-1	<i>C. olitorius</i>	BJRI Variety
5	O-795	<i>C. olitorius</i>	BJRI Variety
6	A.1039	<i>C. olitorius</i>	Bangladesh
7	A.1234	<i>C. olitorius</i>	Bangladesh
8	A.1245	<i>C. olitorius</i>	Bangladesh
9	A.1338	<i>C. olitorius</i>	Philippine
10	A.1347	<i>C. olitorius</i>	Uganda
11	A.1480	<i>C. olitorius</i>	Srilanka
12	A.1362	<i>C. olitorius</i>	Bangladesh
13	CVL-1	<i>C. capsularis</i>	BJRI Variety
14	BJC7370	<i>C. capsularis</i>	BJRI Variety
15	BJC2197	<i>C. capsularis</i>	BJRI Variety
16	BDPS1	<i>C. capsularis</i>	BJRI Variety
17	A.552	<i>C. capsularis</i>	Bangladesh
18	A.568	<i>C. capsularis</i>	Bangladesh
19	A.628	<i>C. capsularis</i>	Bangladesh
20	A.646	<i>C. capsularis</i>	Bangladesh
21	A.4484	<i>C. capsularis</i>	Thailand
22	A.4618	<i>C. capsularis</i>	Brazil

The seeds were placed on wet blotting paper in petri dishes and kept in a dark place. DNA was isolated from 4 days old seedlings using the mini preparation CTAB method (Doyle and Doyle, 1987) with some modifications. Approximately 1.5g tissue was grinded to fine powder with mortar and pestle in liquid nitrogen and was taken in 2ml centrifuge tube and 1ml extraction buffer (2% CTAB, 1.4M NaCl, 20mM EDTA, 100mMTrisbase, 100mM β -mercaptoethanol, 2% Polyvinylpolypyrrolidon) was added. The centrifuge tubes were kept in water bath with 65°C for 10 minutes and then centrifuged with 13000rpm for 10 minutes. The supernatants were collected and transferred to fresh 1.5ml centrifuge tubes.

DNA was purified by Phenol: Chloroform: Isoamyl alcohol(25:24:1) and was precipitated using ice cold isopropanol in presence of 0.3 M sodium acetate. Finally DNA was pelleted and washed with 70% and 100% ethanol. The pellets were dried with vacuum freeze dryer and dissolved in 100µl TE buffer (10 mMTris-HCl, 1mM EDTA pH-8.0) and stored at -20°C. For making working solutions extracted DNA solutions were diluted to 10 times in new centrifuge tubes. A total of 33 SSR primers (Table 81) were used in this experiment.

Table 81. SSR primers used for diversity analysis of jute germplasm

Sl. No.	Primer		Sequence	Repeat Motif	Status
1	JMBD 142	Forward Primer	ATGAAATGGAGGTGCTACGG	(CGC)6	Not amplified
		Reverse Primer	CACTTCCTTCGACTTCTCCG		
2	JMBD 148	Forward Primer	ACCCACCAAGTTCATGCTTC	(CAT)5	Polymorphic
		Reverse Primer	GAAGGAAGTGAGCAAGCCAG		
3	JMBD 154	Forward Primer	ATCCACGCTCCAACATAAG	(TCA)5	Not amplified
		Reverse Primer	GAACAAACCCGCACTTGACT		
4	JMBD 166	Forward Primer	GCAGTTTGTGGTGATGGATG	(TTA)6	Polymorphic
		Reverse Primer	GCCTTAAAGTGCATACAGGAGG		
5	JMBD 238	Forward Primer	CACCGTGCAACTGCAAATAG	(GAA)6	Not amplified
		Reverse Primer	CTGTCTTCTCCTTCCGCTTG		
6	JMBD 423	Forward Primer	CACAGCCAAGCTGATGAGAA	(GAT)5	monomorphic
		Reverse Primer	CCTCACGCTCTGGAGACTTC		
7	JMBD 434	Forward Primer	TTGTGGGAGTAACAGGAGGG	(AAG)5	monomorphic
		Reverse Primer	GAGCTGATATTGGCGGTGTT		
8	JMBD 492	Forward Primer	AACCAAAGCACCACCACTTC	(ACC)5	monomorphic
		Reverse Primer	CGCTGACGACGATATCTTGA		
9	JMBD 563	Forward Primer	TGGGCTTGTAACCAAGGAAG	(GTA)5	Polymorphic
		Reverse Primer	CAAACAAATGTGCCATTCCA		
10	JMBD 598	Forward Primer	CCTAATTTCCACCACCAACG	(CTT)5	Polymorphic
		Reverse Primer	CGGGTTAAGGGTCTTGTGTA		
11	JMBD 616	Forward Primer	AGCATCCATTCTTCAGGTG	(CTT)5	monomorphic
		Reverse Primer	GTCATCTCGCTCTGCTCTCC		
12	JMBD 639	Forward Primer	TCATCCTCCACCTCCTCATC	(CAT)5	monomorphic
		Reverse Primer	CCTAACCTAATGCCACCCT		
13	JMBD 643	Forward Primer	TAATAACTGCGCCTTCGACC	(GCC)5	monomorphic
		Reverse Primer	GCTGTTGTGCTGCTGGTAA		
14	JMBD 709	Forward Primer	GTTGACCAGGCTTCTTCTGC	(ATC)5	Polymorphic
		Reverse Primer	CAAGCAGCAATCACAGCAAT		
15	JMBD 721	Forward Primer	CCCATCAAATTAGCCACAC	(TGT)5	Polymorphic
		Reverse Primer	CTCTCTCAAACCTGCCAAG		
16	JMBD 880	Forward Primer	GCTCCTACTTTCATTGAATGGC	(TCT)5	Polymorphic
		Reverse Primer	CCTGTTCTTGTGCTGCTGA		
17	JMBD 929	Forward Primer	ACCCTTTCCTTGGATTACGC	(GAA)5	monomorphic
		Reverse Primer	GCTTCTTCAATTCGCGAGAG		
18	JMBD 969	Forward Primer	ATTCTTGCATGGAAACGGAG	(AAT)5	Polymorphic
		Reverse Primer	CCTTTGTTTCATCTGCTGCAA		
19	JMBD 989	Forward Primer	GGAAGAGATCAGGCTCAACG	(GGA)5	Polymorphic
		Reverse Primer	GATCTCATTCCTTGCCAAA		

Table 81. Cont'd.

Sl. No.	Primer		Sequence	Repeat Motif	Status
20	JMBD 1150	Forward Primer	CGCTATCTCCTCTGCTCCTG	(TTC)6	monomorphic
		Reverse Primer	CATTTTCGACGATCGGATTCT		
21	JMBD 1579	Forward Primer	TCAATCTTCACCAGCAGCAG	(ACA)5	monomorphic
		Reverse Primer	GCCGTCTCCTATTTCCATGA		
22	JMBD 1667	Forward Primer	AGTTCACTTGGGATCGGTTG	(GTG)5	monomorphic
		Reverse Primer	GATAAAGCCACAGGAAGCCA		
23	JMBD 1774	Forward Primer	TCTTTCTGGTCCACCTTTGG	(GAG)5	monomorphic
		Reverse Primer	CTGGATTCGTCCACTCCCTA		
24	JMBD 1793	Forward Primer	TTCCGACTTCCGCAATAAAC	(TCT)5	monomorphic
		Reverse Primer	GTGTCGGACGAGGAAACT		
25	JMBD 1806	Forward Primer	TGAGTCACTTCTTGATGCCG	(GAT)5	Not amplified
		Reverse Primer	CTTGGCCTGGATAATAGGCA		
26	JMBD1824	Forward Primer	TTTACGAAACCTGCCACTCC	(GAA)5	Polymorphic
		Reverse Primer	CGCTCACAACCTCTTTCTCC		
27	JMBD 1912	Forward Primer	ACTACGTCCCGTCAGTCACC	(CTG)5	monomorphic
		Reverse Primer	GCACATTCTTCCGACCATCT		
28	JMBD 1950	Forward Primer	AGTGAACCTCCACAAATGCC	(AAC)6	Polymorphic
		Reverse Primer	GGCGAATTTCGAAATGGTAGA		
29	JMBD 2032	Forward Primer	AAAGCATTGGATCTTCGTGG	(TGA)5	Polymorphic
		Reverse Primer	GTTGCATACTGGTGCATTGG		
30	JMBD 2045	Forward Primer	GGACAGAAGTTCGAGCCAAG	(CGG)5	Polymorphic
		Reverse Primer	GTTTCCCACCAGTAGTCCGA		
31	JMBD 2047	Forward Primer	CATACAAATGCAGACGGTGG	(AAG)5	Not amplified
		Reverse Primer	GCTCTCCTTCATTTGGCTCA		
32	JMBD 2054	Forward Primer	TTGGGAAGCAAGATGGAAAC	(GAA)5	Not amplified
		Reverse Primer	CGCACTTCCACCCATCTTAT		
33	JMBD 2064	Forward Primer	ACGAGATGGATTCTGATGCC	(GAC)5	Polymorphic
		Reverse Primer	CTCCAGCTTTGCTTGGAAAC		

PCR was performed in 10 µl reactions containing around 25 ng of DNA template (3 µl DNA with 10X dilution factor), 1 µl 10X TB buffer (containing 200 mM Tris-HCl pH 8.3, 500 mM KCl), 1.35 µl 25 mM MgCl₂, 0.2 µl of 10 mM dNTP, 0.5 µl each of 10 µM forward and reverse primers and 0.1 µl of Taq DNA polymerase (5 U/µl) using thermal cycler (Chen *et al.*, 1997; Neeraja *et al.*, 2007). After initial denaturation for 5 min at 94°C, each cycle comprises 45 sec denaturation at 94°C, 45 sec annealing at 55°C, and 2 min extension at 72°C with a final extension for 7 min at 72°C at the end of 35 cycles. 2.5 µl of 10x loading buffer (Bromophenol Blue 0.4%, Xylene cyanol 0.4%, Glycerol 50%) was added to each PCR product.

PCR products were run on 8 % polyacrylamide gel following standard lab protocols. Vertical gel electrophoresis system with 24 well was used. Electrophoresis was conducted at 130 volt for 90 minutes. DNA ladder (1 kb plus) were electrophoresed alongside the PCR products. After completion of the electrophoresis the gel was stained in ethidium bromide solution for 25 minutes. Then the gel was rinsed carefully with the tap water and placed on gel documentation system for visualization of DNA bands and the images were taken and saved in computer.

Molecular weight for each amplified allele was measured in base pair using AlphaEaseFC 4.0 software. The allele frequency data from Power Marker version 3.25 (Liu and Muse, 2005) was used to export the data in binary format (allele presence = 1 and allele absence = 0) for analysis with NTSYS-pc version 2.2 (Rohlf, 2002). The summary statistics including the number of alleles per locus, major allele frequency, genetic diversity, polymorphism information content (PIC) values were determined using Power Marker version 3.25 (Liu and Muse, 2005).

A similarity matrix was calculated with the Simqual subprogram using the DICE coefficient, followed by cluster analysis with the SAHN subprogram using the UPGMA clustering method and implemented in NTSYS-pc to construct a dendrogram showing relationship among the genotypes.

Thirty-three primers were used and a total number of 52 loci were amplified by these SSR primers. Out of 33 primers 14 primers were found polymorphic for the germplasm and they amplified 39 loci. Thirteen primers were monomorphic for the germplasm and 6 primers did not amplify properly. The SSR profiles of 22 Jute accessions using SSR primers JMBD148, JMBD563 and JMBD598 are shown in Fig. 71 (A, B & C).

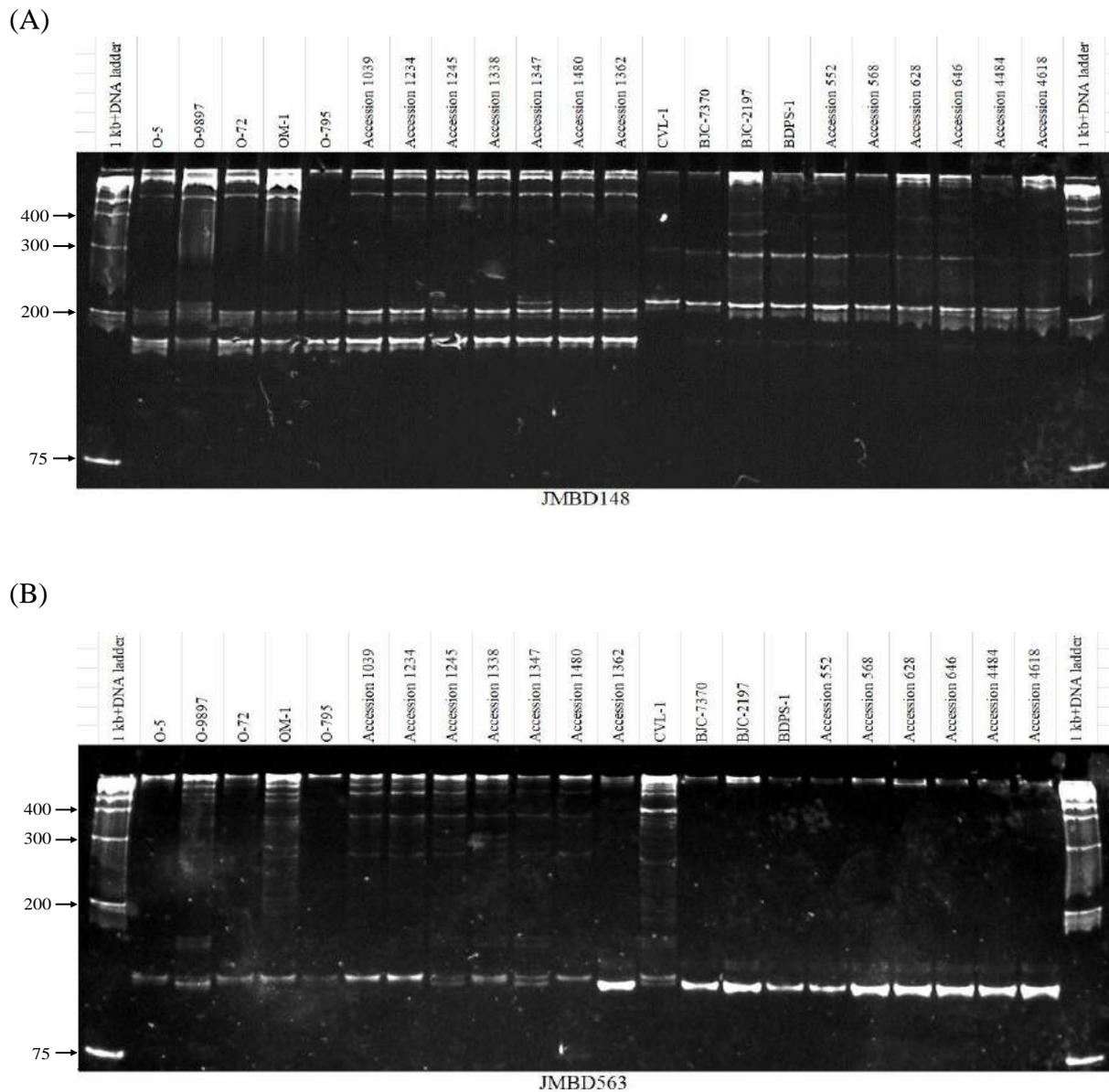
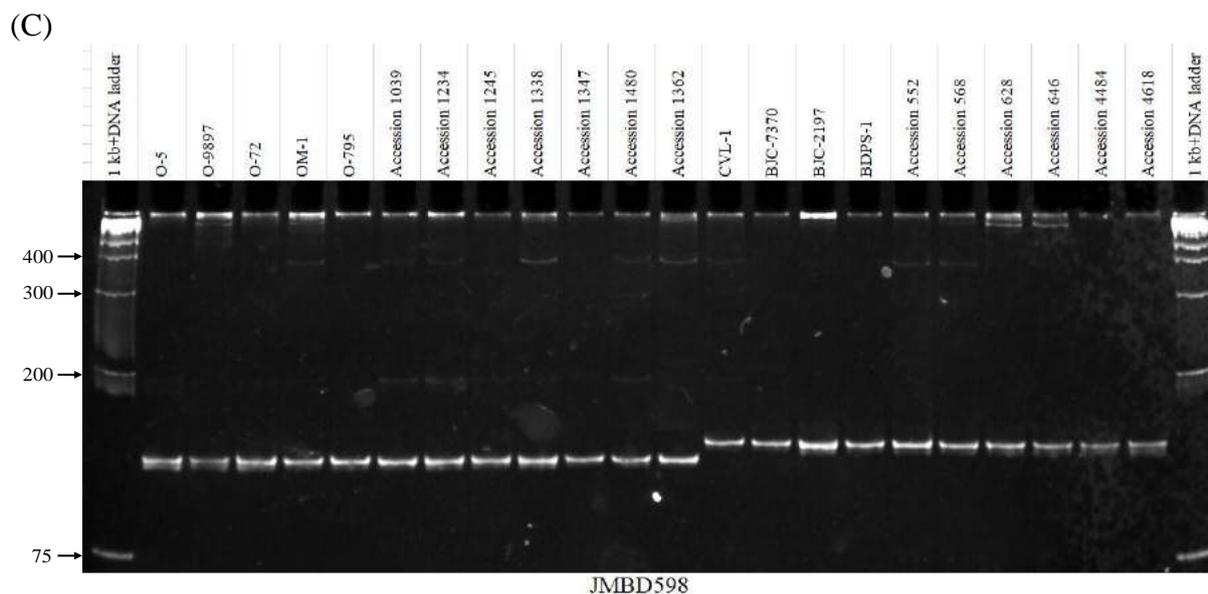


Fig. 71. DNA profile of jute germplasm with the SSR marker JMBD148 (A) and JMBD563 (B)



Cont'd. Fig. 71. DNA profile of jute germplasm with SSR marker, JMBD598(C)

Major allele frequency of 14 polymorphic primers and genetic diversity values are shown in table 82. The highest gene diversity value (0.685) and PIC (Polymorphism Information Content) value (0.635) were found for primer JMBD1824. The second highest gene diversity value (0.640) and PIC (Polymorphism Information Content) value (0.567) were found for primer JMBD563. The lowest gene diversity value (0.177) and Polymorphism Information Content (0.169) among the 14 primers were found for primer JMBD709. The result suggests that genetic variations exist among these jute germplasm. The overall gene diversity value and PIC value for all polymorphic primers were estimated as 0.507 and 0.413 respectively. The highest (0.90) major allele frequency was found for allele size 185bp for JMBD709 (Table 82 & 83).

Table 82. Summary of genetic variation for major alleles

Marker	SampleSize	No. of obs.	No. of Allele	Highest frequency allele		Gene Diversity	Polymorphism Information Content
				size (bp)	frequency		
JMBD148	22	22	3	168	0.50	0.541	0.436
JMBD 166	22	22	4	140	0.55	0.566	0.484
JMBD 563	22	22	3	111	0.45	0.640	0.567
JMBD 598	22	22	2	124	0.55	0.496	0.373
JMBD 709	22	21	3	185	0.90	0.177	0.169
JMBD 721	22	15	3	245	0.73	0.418	0.370
JMBD 880	22	20	3	195	0.50	0.545	0.441
JMBD 969	22	22	2	86	0.55	0.496	0.373
JMBD 989	22	16	2	185	0.56	0.492	0.371
JMBD 1824	22	20	5	305	0.45	0.685	0.635
JMBD 1950	22	18	3	293	0.50	0.549	0.448
JMBD 2032	22	22	2	170	0.55	0.496	0.373
JMBD 2045	22	22	2	220	0.55	0.496	0.373
JMBD 2064	22	21	2	225	0.52	0.499	0.374
Mean	22		3		0.56	0.507	0.413

The frequency and variance of all 39 allele from 14 polymorphic markers for twenty-two jute genotypes is presented in table 83. JMBD989₁₇₀ allele JMBD989₁₈₅ showed the highest variance for all 22 genotypes (Table 84).

Table 83. Allele frequency of 14 polymorphic markers for test jute germplasm

Sl no.	Marker	Allele Size (bp)	Frequency	Variance	SD
1	JMBD148	168	0.50	0.0114	0.107
2	JMBD148	172	0.05	0.0020	0.044
3	JMBD148	220	0.45	0.0113	0.106
4	JMBD166	135	0.36	0.0105	0.103
5	JMBD166	140	0.55	0.0113	0.106
6	JMBD166	145	0.05	0.0020	0.044
7	JMBD166	188	0.05	0.0020	0.044
8	JMBD563	111	0.45	0.0113	0.106
9	JMBD563	117	0.23	0.0080	0.089
10	JMBD563	124	0.32	0.0099	0.099
11	JMBD598	124	0.55	0.0113	0.106
12	JMBD598	137	0.45	0.0113	0.106
13	JMBD709	185	0.90	0.0041	0.064
14	JMBD709	190	0.05	0.0022	0.046
15	JMBD709	218	0.05	0.0022	0.046
16	JMBD721	236	0.07	0.0041	0.064
17	JMBD721	245	0.73	0.0130	0.114
18	JMBD721	253	0.20	0.0107	0.103
19	JMBD880	195	0.50	0.0125	0.112
20	JMBD880	205	0.05	0.0024	0.049
21	JMBD880	218	0.45	0.0124	0.111
22	JMBD969	86	0.55	0.0113	0.106
23	JMBD969	96	0.45	0.0113	0.106
24	JMBD989	170	0.44	0.0154	0.124
25	JMBD989	185	0.56	0.0154	0.124
26	JMBD1824	305	0.45	0.0124	0.111
27	JMBD1824	315	0.05	0.0024	0.049
28	JMBD1824	320	0.10	0.0045	0.067
29	JMBD1824	325	0.30	0.0105	0.102
30	JMBD1824	333	0.10	0.0045	0.067
31	JMBD1950	198	0.44	0.0137	0.117
32	JMBD1950	293	0.50	0.0139	0.118
33	JMBD1950	299	0.06	0.0029	0.054
34	JMBD2032	170	0.55	0.0113	0.106
35	JMBD2032	200	0.45	0.0113	0.106
36	JMBD2045	212	0.45	0.0113	0.106
37	JMBD2045	220	0.55	0.0113	0.106
38	JMBD2064	225	0.52	0.0119	0.109
39	JMBD2064	240	0.48	0.0119	0.109

Table 84. Allele size of monomorphic primers for test jute germplasm

Sl no.	Marker	Allele Size (bp)
1	JMBD423	203
2	JMBD434	205
3	JMBD492	270
4	JMBD616	380
5	JMBD639	210
6	JMBD643	250
7	JMBD929	315
8	JMBD1150	260
9	JMBD1579d	275
10	JMBD1667	295
11	JMBD1774	168
12	JMBD1793	180
13	JMBD1912	280

The values of pair wise Nei's genetic distance between accessions were computed from combined data for 14 SSR primers. The values were ranged from 0 to 1 (Table 85). BJRI tossa jute variety O-795 showed highest genetic distance value with accession no. 4484, 4618, 552, 568, 628, 646 and BJRI white jute varieties BJC-2197, BJC-7370, CVL-1 and BJRI Deshi Pat Sak-1. BJRI Deshi Pat Sak-1 showed highest genetic distance value with accession no. 1039, 1234, 1338, 1362, 1347 and BJRI tossa jute varieties O-72, O-5, O-9897 and O-795. Accession no. 1347 showed highest distance value with accession no. 552, 628 and BJRI white jute variety CVL-1, BJC-7370 and BJRI Deshi Pat Sak-1. As the primers used in this study were designed from tossa jute genome, 7 out of 10 germplasm viz. acc. nos. 4618, 552, 568, 628, 464 and varieties BJC-2197, BJC-7370 showed no genetic distance (genetic distance value 0) among them. Among the tossa jute germplasm, the highest genetic distance value (0.4) was found between accession no. 1039 and accession no. 1347. Among the *C. capsularis* germplasm, accession no. 4484 showed the highest genetic distance value (0.214) with varieties CVL-1 and BJRI Deshi Pat Shak-1

Table 85. Nei's (1983) genetic distance values among jute germplasm

	A1039	A1234	A1245	A1338	A1347	A1362	A1480	A4484	A4618	A552	A568	A628	A646	BDPS1	BJC2197	BJC7370	CVL-1	O-5	O-72	O-795	O-9897	
A1234	0.083																					
A1245	0.300	0.167																				
A1338	0.167	0.071	0.250																			
A1347	0.400	0.250	0.182	0.167																		
A1362	0.333	0.214	0.167	0.214	0.167																	
A1480	0.091	0.077	0.091	0.154	0.273	0.231																
A4484	0.917	0.857	0.750	0.857	0.917	0.857	0.769															
A4618	0.909	0.846	0.750	0.846	0.909	0.846	0.750	0.077														
A552	0.917	0.923	0.818	0.923	1	0.923	0.833	0.077	0													
A568	0.917	0.857	0.750	0.857	0.917	0.857	0.769	0.071	0	0												
A628	0.917	0.923	0.818	0.923	1	0.923	0.833	0.077	0	0	0											
A646	0.909	0.846	0.750	0.846	0.909	0.846	0.750	0.077	0	0	0	0										
BDPS1	1	1	0.917	1	1	1	0.923	0.214	0.154	0.077	0.143	0.077	0.154									
BJC2197	0.917	0.857	0.750	0.857	0.917	0.857	0.769	0.071	0	0	0	0	0	0.143								
BJC7370	0.909	0.923	0.833	0.923	1	0.923	0.833	0.154	0.077	0	0.077	0	0.077	0.077	0.077							
CVL-1	0.917	0.929	0.833	0.929	1	0.929	0.846	0.214	0.154	0.077	0.143	0.077	0.154	0.143	0.143	0.077						
O-5	0	0	0.222	0	0.222	0.182	0.091	0.909	0.900	0.909	0.909	0.909	0.900	1	0.909	0.900	0.909					
O-72	0.100	0	0.182	0.091	0.300	0.273	0.100	0.909	0.909	0.909	0.909	0.909	0.909	1	0.909	0.909	0.909	0				
O-795	0.333	0.200	0.200	0.200	0.111	0.200	0.333	1	1	1	1	1	1	1	1	1	1	0.222	0.200			
O-9897	0.250	0.214	0.250	0.286	0.333	0.286	0.308	0.929	0.923	0.923	0.929	0.923	0.923	1	0.929	0.923	0.929	0.182	0.182	0.200		
OM-1	0.167	0.154	0.364	0.154	0.364	0.231	0.250	0.846	0.833	0.846	0.846	0.846	0.833	0.923	0.846	0.833	0.846	0.091	0.182	0.300	0.308	

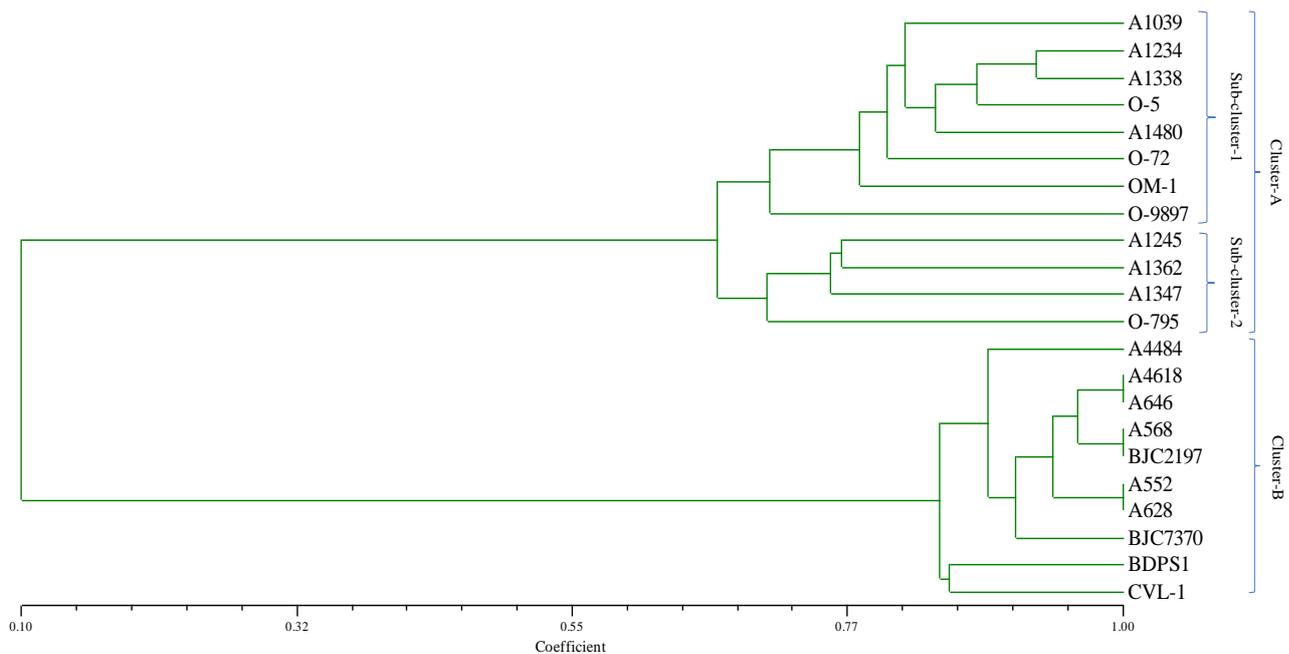


Fig. 72. UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among jute genotypes based alleles detected by microsatellite markers

Two species of jute, *Corchorus capsularis* and *C. olitorius* formed two main clusters in the dendrogram (Fig. 72). *C. olitorius* germplasm were divided in 2 sub-clusters. The dendrogram is based on Nei's (1983) genetic distance. Sub-Cluster 1 is comprised of accession no.1039, accession no.1234, accession no.1338, O-5, accession no.1480, O-72, OM-1 and O-9897. Sub-cluster 2 is comprised of accession no.1245, accession no.1362, accession no.1347 and O-795. Second main cluster cluster B is comprised of accession no. 4484, accession no. 4618, accession no. 646, accession no. 568, BJC-2197, accession no. 552, accession no. 628, BJC-7370 and BJRI deshi pat shak-1 and CVL-1.

Conclusion

The highest genetic distance value was found between germplasm from two different species of jute while no genetic distance was found among maximum white jute germplasm for the used primers. Among the tossa jute germplasm, highest genetic distance value was found between accession no. 1039 and accession no. 1347. In case of white jute, accession no. 4484 showed highest genetic distance with varieties CVL-1 and BJRI deshi pat shak-1. From the differences between the highest and the lowest value of genetic distance it was revealed that variability was existed among these 22 jute germplasm. It is hoped that, in future the present results will help breeders to make selection from the diverse accessions studied to use them as parents for crossing that are designed for breeding and for producing mapping populations, but more SSR primers should be used to find more genetic variation information among them.

11.7. Molecular characterization of jute germplasm through DNA fingerprinting

The jute genotypes (Table 86) studied in this experiment was collected from the Gene Bank of Bangladesh Jute Research Institute (BJRI). Among these germplasm, 12 are of deshi jute that are collected in the 2018-19 from Rangpur region of Bangladesh. There are 8 tossa jute accessions stored at the Gene Bank of BJRI. The rest 2 are deshi and tossa jute varieties of BJRI.

Table 86. List of jute germplasm with origin

Sl. no.	Accession Number/Collection no. (Collector's no.)/Variety	Species	Origin
1	Collection no. 1 (RS-1)	<i>C. capsularis</i>	Kurigram
2	Collection no. 9 (ACK-1)	<i>C. capsularis</i>	Panchegarh
3	Collection no. 11 (ACK-3)	<i>C. capsularis</i>	Panchegarh
4	Collection no. 12 (FM-1)	<i>C. capsularis</i>	Panchegarh
5	Collection no. 13 (AS-5)	<i>C. capsularis</i>	Dinajpur
6	Collection no. 19 (RS-5)	<i>C. capsularis</i>	Bogura
7	Collection no. 20 (RS-6)	<i>C. capsularis</i>	Bogura
8	Collection no. 21 (RS-7)	<i>C. capsularis</i>	Bogura
9	Collection no. 22 (RS-8)	<i>C. capsularis</i>	Bogura
10	Collection no. 25 (FMN-1)	<i>C. capsularis</i>	Rangpur
11	Collection no. 26 (FMN-2)	<i>C. capsularis</i>	Dinajpur
12	Collection no. 27 (FZ-1)	<i>C. capsularis</i>	Rangpur
13	BJRI deshi pat-6	<i>C. capsularis</i>	BJRI deshi jute variety
14	BJRI tossa pat-6	<i>C. olitorius</i>	BJRI tossa jute variety
15	Accession no. 1860	<i>C. olitorius</i>	BJRI Genebank
16	Accession no. 1402	<i>C. olitorius</i>	BJRI Genebank
17	Accession no. 1417	<i>C. olitorius</i>	BJRI Genebank
18	Accession no. 1460	<i>C. olitorius</i>	BJRI Genebank
19	Accession no. 2148	<i>C. olitorius</i>	BJRI Genebank
20	Accession no. 2345	<i>C. olitorius</i>	BJRI Genebank
21	Accession no. 2383	<i>C. olitorius</i>	BJRI Genebank
22	Accession no. 3227	<i>C. olitorius</i>	BJRI Genebank

The seeds were placed on wet blotting paper in petri dishes and kept in a dark place. DNA was isolated from 4 days old seedlings using the mini preparation CTAB method (Doyle and Doyle, 1987) with some modifications. Approximately 1.5g tissue was grinded to fine powder with mortar and pestle in liquid nitrogen and was taken in 2ml centrifuge tube and 1ml extraction buffer (2% CTAB, 1.4M NaCl, 20mM EDTA, 100mM Trisbase, 100mM β -mercaptoethanol, 2% Polyvinylpolypyrrolidon) was added. The centrifuge tubes were kept in water bath with 65°C for 10 minutes and then centrifuged with 13000rpm for 10 minutes. The supernatants were collected and transferred to fresh 1.5ml centrifuge tubes. DNA was purified by Phenol: Chloroform: Isoamyl alcohol (25:24:1) and was precipitated using ice cold isopropanol in presence of 0.3 M sodium acetate. Finally DNA was pelleted and washed with 70% and 100% ethanol. The pellets were dried with vacuum freeze dryer and dissolved in 100 μ l TE buffer (10 mM Tris-HCl, 1mM EDTA pH-8.0) and stored at -20°C. For making working solutions extracted DNA solutions were diluted to 10 times in new centrifuge tubes.

Table 87. SSR primers used for diversity analysis of jute germplasm

SI #	Primer		Sequence	Repeat Motif	Status
1	JMBD115	Forward Primer	TCGGACAAGATCAAGTGCAG	(CAT)5	Monomorphic
		Reverse Primer	TGGCCCTTCTGGAATGTAAG		
2	JMBD148	Forward Primer	ACCCACCAAGTTCATGCTTC	(CAT)5	Polymorphic
		Reverse Primer	GAAGGAAGTGAGCAAGCCAG		
3	JMBD154	Forward Primer	ATCCACGCCTCCAACATAAG	(TCA)5	Not amplified
		Reverse Primer	GAACAAACCCGCACTTGACT		
4	JMBD1579	Forward Primer	TCAATCTTACCAGCAGCAG	(ACA)5	Polymorphic
		Reverse Primer	GCCGTCTCTATTTCCATGA		
5	JMBD 166	Forward Primer	GCAGTTTGTGGTGTGGATG	(TTA)6	Monomorphic
		Reverse Primer	GCCTTAAAGTGCATACAGGAGG		
6	JMBD 1667	Forward Primer	AGTTCACCTGGGATCGGTTG	(GTG)5	Not amplified
		Reverse Primer	GATAAAGCCACAGGAAGCCA		
7	JMBD 1774	Forward Primer	TCTTTCTGGTCCACCTTTGG	(GAG)5	Monomorphic
		Reverse Primer	CTGGATTTCGTCCACTCCCTA		
8	JMBD1824	Forward Primer	TTTACGAAACCTGCCACTCC	(GAA)5	Polymorphic
		Reverse Primer	CGCTCACAACCTCTTTCTCC		
9	JMBD 1950	Forward Primer	AGTGAACCTCCACAAATGCC	(AAC)6	Monomorphic
		Reverse Primer	GGCGAATTCGAAATGGTAGA		
10	JMBD201	Forward Primer	GTTGTCCACATGAGAATGCG	(AAC)5	Monomorphic
		Reverse Primer	AAGGCAGCCATAAGAGCAA		
11	JMBD 2032	Forward Primer	AAAGCATTGGATCTTCGTGG	(TGA)5	Polymorphic
		Reverse Primer	GTTGCATACTGGTGCATTGG		
12	JMBD 2045	Forward Primer	GGACAGAAGTTCGAGCCAAG	(CGG)5	Polymorphic
		Reverse Primer	GTTTCCCACCAGTAGTCCGA		
13	JMBD 2064	Forward Primer	ACGAGATGGATTCTGATGCC	(GAC)5	Polymorphic
		Reverse Primer	CTCCAGCTTTGCTTGGAAAC		
14	JMBD 423	Forward Primer	CACAGCCAAGCTGATGAGAA	(GAT)5	Monomorphic
		Reverse Primer	CCTCACGCTCTGGAGACTTC		
15	JMBD 492	Forward Primer	AACCAAAGCACCACCCTTC	(ACC)5	Polymorphic
		Reverse Primer	CGCTGACGACGATATCTTGA		
16	JMBD563	Forward Primer	TGGGCTTGTAACCAAGGAAG	(GTA)5	Monomorphic
		Reverse Primer	CAAACAAATGTGCCATTCCA		
17	JMBD57	Forward Primer	CCTTCCAACCTCTAATGCCA	(CTC)6	Monomorphic
		Reverse Primer	CCGAGGGATCAGGATAGTCA		
18	JMBD594	Forward Primer	CCAACAATTCGCCATCTCT	(CTG)5	Polymorphic
		Reverse Primer	GAGGTGGTTTCGTTTGGAGAA		
19	JMBD 598	Forward Primer	CCTAATTTCCACCACCAACG	(CTT)5	Polymorphic
		Reverse Primer	CGGGTTAAGGGTCTTGTGTA		
20	JMBD613	Forward Primer	AACCCAACCTGCAGGAACATC	(GAA)6	Polymorphic
		Reverse Primer	TGCAAGGACTTGAGCTTGTG		
21	JMBD635	Forward Primer	CAAATGAAACACATGCCAG	(GAA)5	Polymorphic
		Reverse Primer	AAAGAAACAGCGAAGGCAA		
22	JMBD709	Forward Primer	GTTGACCAGGCTTCTTCTGC	(ATC)5	Monomorphic
		Reverse Primer	CAAGCAGCAATCACAGCAAT		
23	JMBD721	Forward Primer	CCCATCCAAATTAGCCACAC	(TGT)5	Polymorphic
		Reverse Primer	CTCTCTCCAAACTGCCCAAG		
24	JMBD756	Forward Primer	TGTTGTTGTTCCGGTTGAAA	(GCT)7	Polymorphic
		Reverse Primer	GCCAGCAGTTCAAAAACAT		
25	JMBD880	Forward Primer	GCTCCTACTTTTCAATGAATGGC	(TCT)5	Polymorphic
		Reverse Primer	CCTGTTCTTGTGCTGCTGA		
26	JMBD989	Forward Primer	GGAAGAGATCAGGCTCAACG	(GGA)5	Not amplified
		Reverse Primer	GATCTCATTCCCTTGCCAAA		

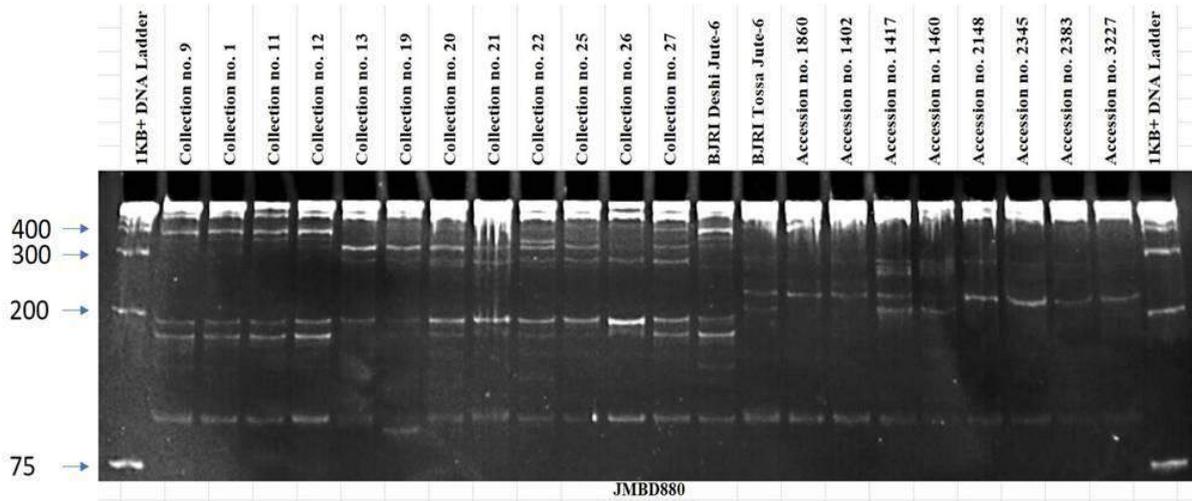
Cont'd. Table 87.

Sl #	Primer		Sequence	Repeat Motif	Status
27	TJMBD3	Forward Primer	TCGCGCTCCTTCGGTCTCCT		Monomorphic
		Reverse Primer	CGAACGGCCGGCGATTCTCA		
28	MJM1140	Forward Primer	GCTGTACCTGCCATCTTTT		Polymorphic
		Reverse Primer	TGCTTGCTGTTGCTGATAGG		
29	MJM1195	Forward Primer	GAGGCTGACAGCGAGTGTTA		Polymorphic
		Reverse Primer	CCTAAAACCCAGACGAACCA		
30	MJM1401	Forward Primer	CAG AAA CAA GTT CAA CAA CAT CA		Polymorphic
		Reverse Primer	GAC TCC TTG GTG GTG TCC TC		
31	MJM390	Forward Primer	AAA GCC GTG ACT GAG CTG TT		Monomorphic
		Reverse Primer	CTT TCT TCA CCG AGA GGT GC		
32	MJM562	Forward Primer	GAA GAA CAG GCG GTT GAC AT		Polymorphic
		Reverse Primer	CTT CCT TGG TTA CAA GCC CA		

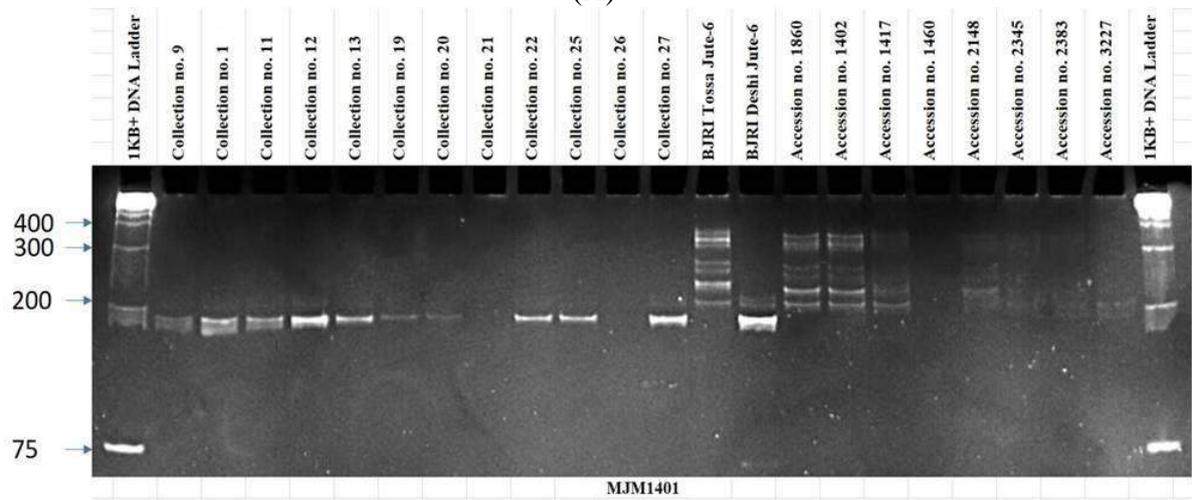
A total of 32 SSR primers (Table 87) were used in this experiment. PCR was performed in 10 µl reactions containing around 25 ng of DNA template (3 µl DNA with 10X dilution factor), 1 µl 10X TB buffer (containing 200 mM Tris-HCl pH 8.3, 500 mM KCl), 1.35 µl 25 mM MgCl₂, 0.2 µl of 10 mM dNTP, 0.5 µl each of 10 µM forward and reverse primers and 0.1 µl of Taq DNA polymerase (5 U/µl) using thermal cycler (Chen *et al.*, 1997; Neeraja *et al.*, 2007). After initial denaturation for 5 min at 94°C, each cycle comprises 45 sec denaturation at 94°C, 45 sec annealing at 55°C, and 2 min extension at 72°C with a final extension for 7 min at 72°C at the end of 35 cycles. 2.5 µl of 10x loading buffer (Bromophenol Blue 0.4%, Xylene cyanol 0.4%, Glycerol 50%) was added to each PCR product. PCR products were run on 8 % polyacrylamide gel following standard lab protocols. Vertical gel electrophoresis system with 24 wells was used. Electrophoresis was conducted at 130 volt for 90 minutes. DNA ladder (1 kb plus) were electrophoresed alongside the PCR products. After completion of the electrophoresis the gel was stained in ethidium bromide solution for 25 minutes. Then the gel was rinsed carefully with the tap water and placed on gel documentation system for visualization of DNA bands and the images were taken and saved in computer.

Molecular weight for each amplified allele was measured in base pair using Alpha Ease FC 4.0 software. The allele frequency data from Power Marker version 3.25 (Liu and Muse, 2005) was used to export the data in binary format (allele presence = 1 and allele absence = 0) for analysis with NTSYS-pc version 2.2 (Rohlf, 2002). The summary statistics including the number of alleles per locus, major allele frequency, genetic diversity, polymorphism information content (PIC) values were determined using Power Marker version 3.25 (Liu and Muse, 2005). A similarity matrix was calculated with the Simqual subprogram using the DICE coefficient, followed by cluster analysis with the SAHN subprogram using the UPGMA clustering method and implemented in NTSYS-pc to construct a dendrogram showing relationship among the genotypes.

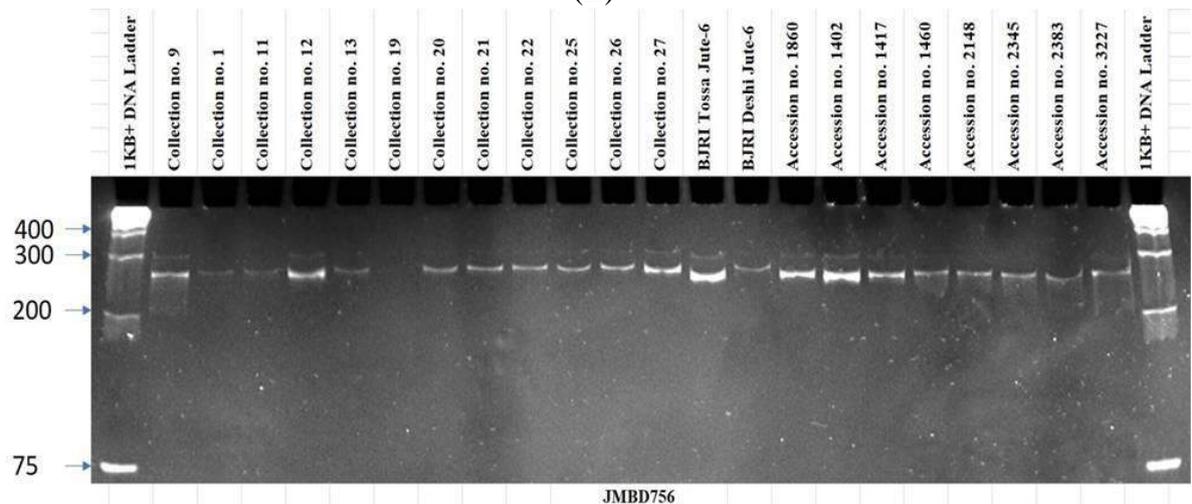
Thirty-two primers were used and a total number of 70 loci were amplified by these SSR primers. Out of 32 primers 18 primers were found polymorphic (Table 87) for the germplasm and they amplified 59 loci (Table 88). Eleven primers were monomorphic for the germplasm and 3 primers did not amplify properly. The SSR profiles of 22 jute accessions using SSR primers JMBD880, MJM1401, JMBD756 and JMBD721 are shown in Fig.73 (A, B, C & D). Major allele frequency of 18 polymorphic primers and genetic diversity values are shown in table 88.



(A)

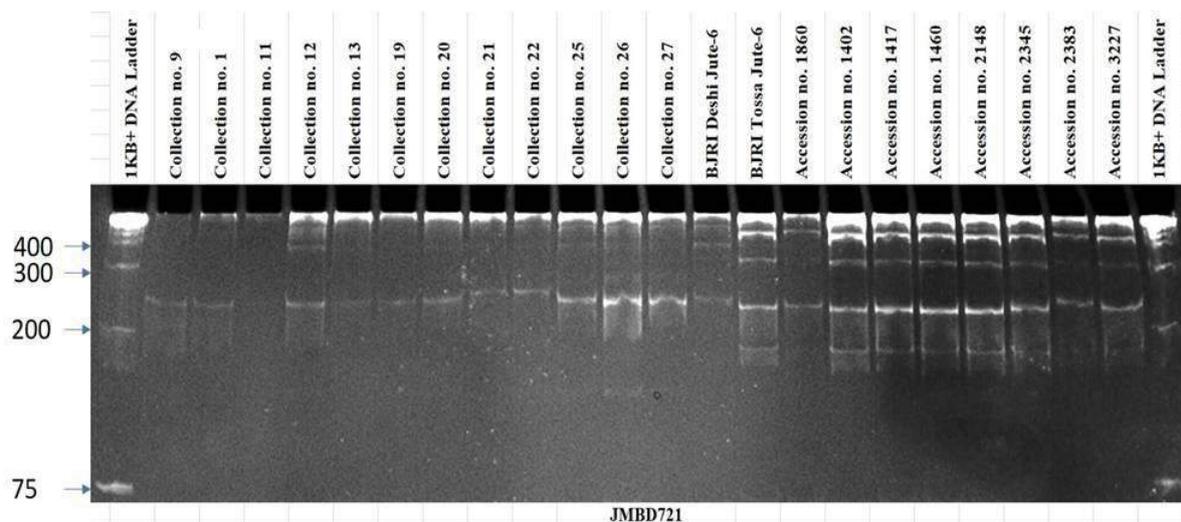


(B)



(C)

Fig. 73. DNA profile of jute germplasm with SSR marker, JMBD880 (A), MJM1401 (B) and JMBD756 (C)



Cont'd. Fig. 73. DNA profile of the jute germplasm with SSR marker JMBD721 (D)

Table 88. Summary of genetic variation for major alleles

Marker	Sample Size	No. of obs.	No. of Allele	Highest frequency allele		Gene Diversity	Polymorphism Information Content
				size (bp)	frequency		
JMBD148	22	22	2	220	0.591	0.483	0.367
JMBD1579	22	22	2	275	0.955	0.087	0.083
JMBD1824	22	21	5	335	0.381	0.726	0.679
JMBD2032	22	22	2	170	0.682	0.434	0.340
JMBD2045	22	22	2	220	0.955	0.087	0.083
JMBD2064	22	20	2	235	0.600	0.480	0.365
JMBD492	22	22	3	275	0.364	0.665	0.591
JMBD594	22	18	2	275	0.667	0.444	0.346
JMBD598	22	22	2	137	0.591	0.483	0.367
JMBD613	22	10	2	340	0.700	0.420	0.332
JMBD635	22	12	4	390	0.417	0.694	0.639
JMBD721	22	21	5	245	0.381	0.744	0.704
JMBD756	22	21	5	280	0.381	0.748	0.710
JMBD880	22	22	5	196	0.318	0.764	0.726
MJM1140	22	17	4	90	0.765	0.394	0.370
MJM1195	22	22	5	162	0.364	0.711	0.657
MJM1401	22	19	5	190	0.316	0.748	0.704
MJM562	22	22	2	252	0.591	0.483	0.367
Mean						0.519	0.452

The highest gene diversity value (0.764) and PIC (Polymorphism Information Content) value (0.726) were found for primer JMBD880. The second highest gene diversity value (0.748) was found for primer JMBD756 and MJM1401. The second highest PIC value (0.710) was found for primers JMBD756 and the third highest PIC value (0.704) was found for primers JMBD721 and MJM1401. The second highest gene diversity value (0.744) was found for primer JMBD721. The lowest gene diversity value (0.087) and PIC value (0.083) among the 18 polymorphic primers were found for primers JMBD1579 and JMBD2045.

The result suggests that genetic variations exist among these jute germplasm. The overall gene diversity value and PIC value for all polymorphic primers for major alleles were estimated as 0.519 and 0.452 respectively. The highest (0.955) Major Allele Frequency was found for allele size 275bp by JMBD1579 and allele size 220 by JMBD2045 (Table 89 & 90).

The frequency and variance of all 59 allele from 18 polymorphic markers for twenty-two jute genotypes is presented in table 89. JMBD613₃₄₀ allele JMBD613₃₄₅ showed the highest variance for all 22 genotypes (Table 89).

Table 89. Allele frequency of 18 polymorphic markers for jute germplasm

Sl. no	Marker	Allele Size (bp)	Frequency	Variance	SD
1	JMBD148	220	0.591	0.011	0.105
2	JMBD148	168	0.409	0.011	0.105
3	JMBD1579	275	0.955	0.002	0.044
4	JMBD1579	290	0.045	0.002	0.044
5	JMBD1824	335	0.381	0.011	0.106
6	JMBD1824	317	0.286	0.010	0.099
7	JMBD1824	308	0.190	0.007	0.086
8	JMBD1824	311	0.095	0.004	0.064
9	JMBD1824	330	0.048	0.002	0.046
10	JMBD2032	170	0.682	0.010	0.099
11	JMBD2032	200	0.318	0.010	0.099
12	JMBD2045	220	0.955	0.002	0.044
13	JMBD2045	225	0.045	0.002	0.044
14	JMBD2064	235	0.600	0.012	0.110
15	JMBD2064	240	0.400	0.012	0.110
16	JMBD492	275	0.364	0.011	0.103
17	JMBD492	280	0.318	0.010	0.099
18	JMBD492	300	0.318	0.010	0.099
19	JMBD594	275	0.667	0.012	0.111
20	JMBD594	280	0.333	0.012	0.111
21	JMBD598	137	0.591	0.011	0.105
22	JMBD598	124	0.409	0.011	0.105
23	JMBD613	340	0.700	0.021	0.145
24	JMBD613	345	0.300	0.021	0.145
25	JMBD635	390	0.417	0.020	0.142
26	JMBD635	370	0.250	0.016	0.125
27	JMBD635	400	0.250	0.016	0.125
28	JMBD635	380	0.083	0.006	0.080
29	JMBD721	245	0.381	0.011	0.106
30	JMBD721	253	0.238	0.009	0.093
31	JMBD721	235	0.190	0.007	0.086
32	JMBD721	168	0.095	0.004	0.064
33	JMBD721	240	0.095	0.004	0.064
34	JMBD756	280	0.381	0.011	0.106
35	JMBD756	290	0.238	0.009	0.093
36	JMBD756	275	0.143	0.006	0.076
37	JMBD756	285	0.143	0.006	0.076
38	JMBD756	270	0.095	0.004	0.064

Cont'd. Table 89.

Sl. no.	Marker	Allele Size (bp)	Frequency	Variance	SD
39	JMBD880	196	0.318	0.010	0.099
40	JMBD880	175	0.273	0.009	0.095
41	JMBD880	230	0.182	0.007	0.082
42	JMBD880	212	0.136	0.005	0.073
43	JMBD880	220	0.091	0.004	0.061
44	MJM1140	90	0.765	0.011	0.103
45	MJM1140	180	0.118	0.006	0.078
46	MJM1140	110	0.059	0.003	0.057
47	MJM1140	170	0.059	0.003	0.057
48	MJM1195	162	0.364	0.011	0.103
49	MJM1195	172	0.318	0.010	0.099
50	MJM1195	175	0.227	0.008	0.089
51	MJM1195	167	0.045	0.002	0.044
52	MJM1195	178	0.045	0.002	0.044
53	MJM1401	190	0.316	0.011	0.107
54	MJM1401	194	0.263	0.010	0.101
55	MJM1401	215	0.263	0.010	0.101
56	MJM1401	238	0.105	0.005	0.070
57	MJM1401	220	0.053	0.003	0.051
58	MJM562	252	0.591	0.011	0.105
59	MJM562	260	0.409	0.011	0.105

Table 90. Amplified allele size of monomorphic primers for jute germplasm

Sl no.	Marker	Allele Size (bp)
1	JMBD115	230
2	JMBD166	265
3	JMBD1774	165
4	JMBD1950	272
5	JMBD201	305
6	JMBD423	199
7	JMBD563	117
8	JMBD57	205
9	JMBD709	215
10	MJM390	70
11	TJMBD3	160

The values of pair wise Nei's genetic distance between accessions were computed from combined data for 29 SSR primers. The values were ranged from 0.04 to 0.609 (Table 91). BJRI tossa jute variety BJRI tossa jute-6 (O-3820) showed highest genetic distance value (0.609) with collection no. 20. The lowest genetic distance value (0.04) was found between collection numbers 21 and 22. Among the tossa jute germplasm, the highest genetic distance value (0.348) was found between BJRI tossa jute-6 (O-3820) and accession no. 3227. Tossa jute accessions 1417 and 2345 showed lowest genetic distance value (0.08) with tossa jute accessions 1402 and 2148 respectively. Among the deshi jute germplasm, collector's number 12 showed highest genetic distance (0.423) with collector's number 22.

Table 91. Nei's (1983) genetic distance among 22 jute germplasm

	Acc.1402	Acc.1417	Acc.1460	Acc.1860	Acc.2148	Acc.2345	Acc.2383	Acc.3227	BJC-83	Col.01	Col.11	Col.12	Col.13	Col.19	Col.20	Col.21	Col.22	Col.25	Col.26	Col.27	Col.9	
Acc.1417	0.080																					
Acc.1460	0.083	0.083																				
Acc.1860	0.125	0.174	0.136																			
Acc.2148	0.154	0.120	0.083	0.130																		
Acc.2345	0.240	0.167	0.130	0.174	0.080																	
Acc.2383	0.125	0.167	0.130	0.130	0.208	0.167																
Acc.3227	0.167	0.167	0.174	0.130	0.125	0.125	0.208															
BJC-83	0.500	0.458	0.478	0.478	0.480	0.458	0.435	0.435														
Col.01	0.500	0.435	0.409	0.455	0.417	0.435	0.455	0.409	0.240													
Col.11	0.500	0.476	0.450	0.455	0.500	0.500	0.476	0.476	0.217	0.125												
Col.12	0.538	0.458	0.522	0.500	0.520	0.500	0.478	0.478	0.269	0.160	0.125											
Col.13	0.542	0.522	0.500	0.435	0.542	0.542	0.478	0.522	0.333	0.217	0.130	0.240										
Col.19	0.545	0.550	0.526	0.429	0.571	0.571	0.500	0.550	0.318	0.304	0.273	0.348	0.091									
Col.20	0.520	0.565	0.500	0.565	0.583	0.583	0.522	0.565	0.250	0.333	0.250	0.400	0.240	0.136								
Col.21	0.500	0.545	0.500	0.545	0.565	0.565	0.500	0.545	0.261	0.261	0.217	0.333	0.208	0.190	0.120							
Col.22	0.538	0.565	0.500	0.583	0.583	0.583	0.522	0.565	0.320	0.360	0.320	0.423	0.280	0.174	0.077	0.040						
Col.25	0.591	0.571	0.550	0.524	0.591	0.591	0.571	0.571	0.273	0.348	0.273	0.391	0.217	0.091	0.087	0.136	0.087					
Col.26	0.500	0.524	0.476	0.545	0.545	0.545	0.476	0.524	0.261	0.261	0.217	0.333	0.174	0.190	0.083	0.042	0.080	0.095				
Col.27	0.577	0.565	0.500	0.478	0.542	0.522	0.545	0.500	0.160	0.240	0.167	0.308	0.292	0.273	0.200	0.250	0.231	0.182	0.208			
Col.9	0.481	0.400	0.375	0.417	0.385	0.400	0.417	0.375	0.296	0.077	0.125	0.148	0.240	0.261	0.320	0.292	0.346	0.304	0.292	0.308		
O-3820	0.308	0.250	0.217	0.217	0.320	0.333	0.261	0.348	0.538	0.500	0.500	0.560	0.478	0.476	0.609	0.545	0.583	0.524	0.545	0.583	0.462	

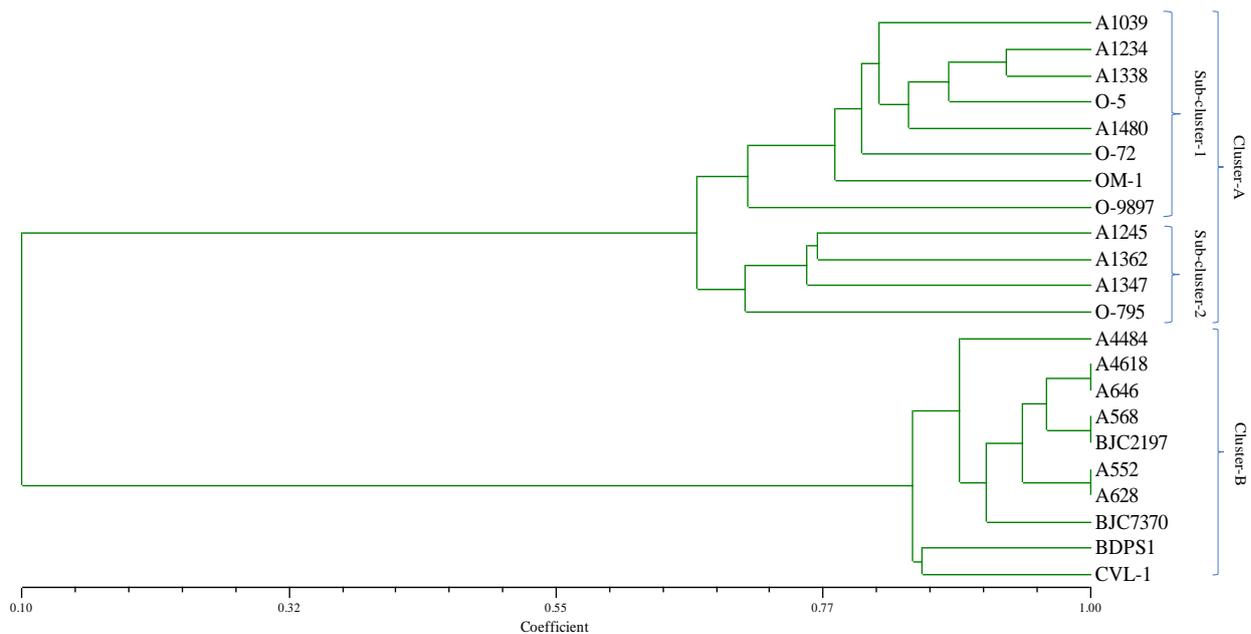


Fig. 74. UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among jute genotypes based on alleles detected by microsatellite markers

Two species of jute, *Corchorus capsularis* and *C. olitorius* formed two main clusters in the dendrogram (Fig. 74). Each germplasm Cluster was divided into 2 sub-clusters. The dendrogram is based on Nei's (1983) genetic distance. First sub-cluster of cluster 1 was comprised of tossa jute accessions that separated them from tossa jute variety BJRI tossa jute-6 (O-3820). First sub-cluster of cluster 2 was comprised of collector's numbers 27, 1, 9, 11, 12 and BJRI deshi jute-6 (BJC-83). Second sub-cluster of cluster 2 was comprised of collector's numbers 13, 19, 25, 20, 21, 22 and 26.

Conclusion

The highest genetic distance value was found between germplasm from two different species of jute for the used primers. BJRI tossa jute-6 variety showed highest genetic distance value with collection no 20, while collection numbers 21 and 22 showed the lowest genetic distance. From the differences between the highest and the lowest value of genetic distance it was revealed that high level of variability was existed among these 22 jute germplasm. It is hoped that, in future the present results will help breeders to make selection from the diverse accessions studied to use them as parents for crossing that are designed for breeding and for producing mapping populations, but more SSR primers should be used to find more genetic variation information among them.

11.8. Molecular characterization of jute germplasm through DNA fingerprinting

The jute genotypes (Table 92) studied in this experiment was collected from the Gene Bank of Bangladesh Jute Research Institute (BJRI). Among these germplasm, 7 are of deshi jute. There are 15 tossa jute germplasm including 2 new collections that were collected from southern region of Bangladesh. Four variety of BJRI were included in this study.

Table 92. List of jute germplasm with origin

Sl. no.	Acc./Collector's no./Variety	Species	Origin
1	Accession# 2025	<i>C. capsularis</i>	Brazil
2	Accession# 2022	<i>C. capsularis</i>	Brazil
3	Accession# 4616	<i>C. capsularis</i>	Brazil
4	Accession# 4617	<i>C. capsularis</i>	Brazil
5	Accession# 4374	<i>C. capsularis</i>	USA
6	BJRI Deshi Pat 9	<i>C. capsularis</i>	BJRI deshi jute variety
7	BJRI Deshi Pat 7	<i>C. capsularis</i>	BJRI deshi jute variety
8	BJRI Tossa Pat 7	<i>C. olitorius</i>	BJRI tossa jute variety
9	BJRI Tossa Pat 8	<i>C. olitorius</i>	BJRI tossa jute variety
10	Accession# 3809	<i>C. olitorius</i>	Kenya
11	Accession# 3815	<i>C. olitorius</i>	Kenya
12	Accession# 3726	<i>C. olitorius</i>	Kenya
13	Accession# 3755	<i>C. olitorius</i>	Kenya
14	Accession# 3782	<i>C. olitorius</i>	Kenya
15	Accession# 4254	<i>C. olitorius</i>	Tanzania
16	Accession# 4311	<i>C. olitorius</i>	Tanzania
17	Accession# 4323	<i>C. olitorius</i>	Tanzania
18	Accession# 4719	<i>C. olitorius</i>	USA
19	Collector's# TZ1	<i>C. olitorius</i>	BargunaSadar
20	Collector's# TP1	<i>C. olitorius</i>	Wazirpur, Barisal
21	Accession# 4158	<i>C. olitorius</i>	Kenya
22	Accession# 4575	<i>C. olitorius</i>	Nepal

The seeds were placed on wet blotting paper in petri dishes and kept in a dark place. DNA was isolated from 4 days old seedlings using the mini preparation CTAB method (Doyle and Doyle, 1987) with some modifications. Approximately 1.5 g tissue was grinded to fine powder with mortar and pestle in liquid nitrogen and was taken in 2 ml centrifuge tube and 1ml extraction buffer (2% CTAB, 1.4 M NaCl, 20 mM EDTA, 100mMTrisbase, 100 mM β -mercaptoethanol, 2% Polyvinylpolypyrrolidon) was added. The centrifuge tubes were centrifuged with 8500 \times g for 10 minutes. The supernatants were collected and transferred to fresh 1.5ml centrifuge tubes. DNA was purified by Phenol: Chloroform: Isoamyl alcohol (25:24:1) and was precipitated using ice cold isopropanol in presence of 0.3 M sodium acetate. Finally DNA was pelleted and washed with 70% and 100% ethanol. The pellets were dried with vacuum freeze dryer and dissolved in 100 μ l TE buffer (10 mMTris-HCl, 1 mM EDTA pH-8.0) and stored at -20°C. For making working solutions extracted DNA solutions were diluted to 10 times in new centrifuge tubes. A total of 31 SSR primers (Table 93) were used in this experiment.

Table 93. SSR primers used for diversity analysis of jute germplasm

Sl. no.	Primer		Sequence	Status
1	JMBD880	Forward Primer	GCTCCTACTTTCATTGAATGGC	Polymorphic
		Reverse Primer	CCTGTTCTTGTGCTGCTGA	
2	JMBD1404	Forward Primer	ATGGCTTCACCATCTCCTTG	Polymorphic
		Reverse Primer	CGGCAATTAGACCTGGTTGT	
3	JMBD148	Forward Primer	ACCCACCAAGTTCATGCTTC	Polymorphic
		Reverse Primer	GAAGGAAGTGAGCAAGCCAG	
4	JMBD201	Forward Primer	GTTGTCCACATGAGAATGCG	Polymorphic
		Reverse Primer	AAGGCAGCCATAAGAGCAAA	
5	JMBD563	Forward Primer	TGGGCTTGTAACCAAGGAAG	Polymorphic
		Reverse Primer	CAAACAAATGTGCCATTCCA	
6	JMBD598	Forward Primer	CCTAATTTCCACCACCAACG	Polymorphic
		Reverse Primer	CGGGTTAAGGGTCTTGTTGA	
7	JMBD1061	Forward Primer	TGTAGCCTGCATAGTGCCTG	Polymorphic
		Reverse Primer	CCCAAAGCAGACAACCTCAT	
8	JMBD1824	Forward Primer	TTTACGAAACCTGCCACTCC	Polymorphic
		Reverse Primer	CGCTCACAACCTCTTCTCC	
9	JMBD2032	Forward Primer	AAAGCATTGGATCTTCGTGG	Polymorphic
		Reverse Primer	GTTGCATACTGGTGCATTGG	
10	JMBD2045	Forward Primer	GGACAGAAGTTCGAGCCAAG	Polymorphic
		Reverse Primer	GTTTCCCACCAGTAGTCCGA	
11	JMBD2047	Forward Primer	CATACAAATGCAGACGGTGG	Polymorphic
		Reverse Primer	GCTCTCCTTCATTTGGCTCA	
12	JMBD2064	Forward Primer	ACGAGATGGATTCTGATGCC	Polymorphic
		Reverse Primer	CTCCAGCTTTGCTTGAAAC	
13	MJM1401	Forward Primer	CAGAAACAAGTTC AACAACATCA	Polymorphic
		Reverse Primer	GAC TCC TTG GTG GTG TCC TC	
14	MJM467	Forward Primer	CATGAATTGAGTGAGCATCCA	Polymorphic
		Reverse Primer	ATCTTCAAGCCCAAATATGCC	
15	MJM1140	Forward Primer	GCTGTACCTGCCATCTTTT	Polymorphic
		Reverse Primer	TGCTTGCTGTTGCTGATAGG	
16	MJM1195	Forward Primer	GAGGCTGACAGCGAGTGTTA	Polymorphic
		Reverse Primer	CCTAAAACCCAGACGAACCA	
17	JMBD492	Forward Primer	AACCAAAGCACCACCACTTC	Monomorphic
		Reverse Primer	CGCTGACGACGATATCTTGA	
18	JMBD635	Forward Primer	CCAAATGAAACACATGCCAG	Monomorphic
		Reverse Primer	AAAGAAACAGCGAAGGCAAA	
19	JMBD709	Forward Primer	GTTGACCAGGCTTCTTCTGC	Monomorphic
		Reverse Primer	CAAGCAGCAATCACAGCAAT	
20	MJM390	Forward Primer	AAA GCC GTG ACT GAG CTG TT	Monomorphic
		Reverse Primer	CTT TCT TCA CCG AGA GGT GC	
21	JMBD721	Forward Primer	CCCATCCAAATTAGCCACAC	Monomorphic
		Reverse Primer	CTCTCTCCAACTGCCCAAG	
22	JMBD1017	Forward Primer	AAAGGGAAGAAGCAGAAGGC	Monomorphic
		Reverse Primer	CAAGACGCTCGAATTGTTGA	
23	TJMBD3	Forward Primer	TCGCGCTCCTTCGGTCTCCT	Monomorphic
		Reverse Primer	CGAACGGCCGGCGATTCTCA	

Table 93. Cont'd

Sl. no	Primer		Sequence	Status
24	JMBD1579	Forward Primer	TCAATCTTCACCAGCAGCAG	Monomorphic
		Reverse Primer	GCCGTCTCCTATTTCCATGA	
25	JMBD1604	Forward Primer	ATCGAGTGGCTTCAAAGGTG	Monomorphic
		Reverse Primer	CTCGAGTGGAGTGTTTCGTCA	
26	MJM1305	Forward Primer	ACTACAAAAGACAGAGAAATAGGA AAA	Monomorphic
		Reverse Primer	ATGTGGGACCAAATTAATGC	
27	JMBD1496	Forward Primer	TACCTTTGGGCCAATCAGAG	Not amplified properly
		Reverse Primer	CGCCGTAGTATTGACTGGGT	
28	JMBD1497	Forward Primer	TGATCTGCTTGATGCTACCG	Not amplified properly
		Reverse Primer	GAATCCTCCATGCTTTCCAA	
29	JMBD1514	Forward Primer	TGAATCGGAGTAAGATCCCG	Not amplified properly
		Reverse Primer	CAAGAGAATGCGCCCTTTAG	
30	JMBD1343	Forward Primer	ACCAGTGAACCGCCAACACTAC	Not amplified properly
		Reverse Primer	CTAGAACCGGATCGGTCAGA	
31	JMBD1403	Forward Primer	GGATGGTGCTCGTATGAAGG	Not amplified properly
		Reverse Primer	GATTCTTTCAGGGTGTCCGA	

PCR was performed in 10 µl reactions containing around 25 ng of DNA template (3 µl DNA with 10X dilution factor), 1 µl 10X TB buffer (containing 200 mM Tris-HCl pH 8.3, 500 mM KCl), 1.35 µl 25 mM MgCl₂, 0.2 µl of 10 mM dNTP, 0.5 µl each of 10 µM forward and reverse primers and 0.1 µl of Taq DNA polymerase (5 U/µl) using thermal cycler (Chen *et al.*, 1997; Neeraja *et al.*, 2007). After initial denaturation for 5 min at 94°C, each cycle comprises 45 sec denaturation at 94°C, 45 sec annealing at 55°C, and 2 min extension at 72°C with a final extension for 7 min at 72°C at the end of 35 cycles. 2.5 µl of 10x loading buffer (Bromophenol Blue 0.4%, Xylene cyanol 0.4%, Glycerol 50%) was added to each PCR product. PCR products were run on 8 % polyacrylamide gel following standard lab protocols. Vertical gel electrophoresis system with 24 wells was used. Electrophoresis was conducted at 100 volt for 90 minutes. DNA ladder (1 kb plus) were electrophoresed alongside the PCR products. After completion of the electrophoresis the gel was stained in ethidium bromide solution for 25 minutes. Then the gel was rinsed carefully with the tap water and placed on gel documentation system for visualization of DNA bands and the images were taken and saved in computer (Fig. 75).

Molecular weight for each amplified allele was measured in base pair using AlphaEaseFC 4.0 software. The allele frequency data from Power Marker version 3.25 (Liu and Muse, 2005) was used to export the data in binary format (allele presence = 1 and allele absence = 0) for analysis with NTSYS-pc version 2.2 (Rohlf, 2002). The summary statistics including the number of alleles per locus, major allele frequency, genetic diversity, polymorphism information content (PIC) values were determined using Power Marker version 3.25. A similarity matrix was calculated with the Simqual subprogram using the DICE coefficient, followed by cluster analysis with the SAHN subprogram using the UPGMA clustering method and implemented in NTSYS-pc to construct a dendrogram showing relationship among the genotypes.

Thirty one SSR primers were used and a total number of 59 (Table 95 & 97) loci were amplified by these SSR primers. Out of 31 primers 16 primers were found polymorphic for the germplasm and they amplified 49 loci (Table 94). Ten primers were monomorphic for the germplasm and 5 primers did not amplify properly. The SSR profile of 22 jute accessions using SSR marker MJM1401 is shown in Fig. 62. Major allele frequency of 16 polymorphic primers and genetic diversity values are shown in table 94.

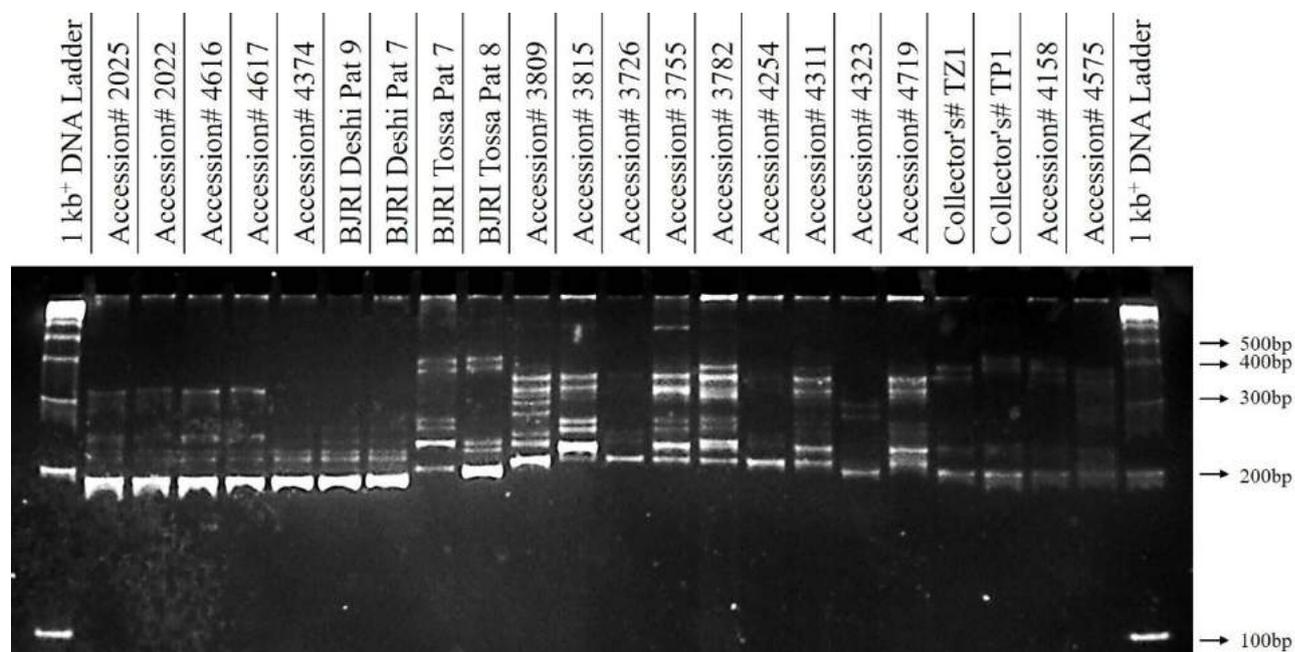


Fig. 75. DNA profile of jute germplasm with SSR marker, MJM1401

Table 94. Summary of genetic variation for major alleles

Marker	SampleSize	No. of obs.	No. of Allele	Highest frequency allele		Gene Diversity	Polymorphism Information Content
				size (bp)	frequency		
JMBD880	22	22	4	245	0.5	0.64	0.580
JMBD1404	22	21	3	310	0.467	0.608	0.527
JMBD148	22	21	2	185	0.667	0.444	0.346
JMBD201	22	22	3	300	0.727	0.417	0.360
JMBD563	22	22	3	150	0.5	0.574	0.484
JMBD598	22	22	2	150	0.682	0.434	0.340
JMBD1061	22	21	4	115	0.524	0.649	0.602
JMBD1824	22	22	3	340	0.682	0.483	0.434
JMBD2032	22	22	2	200	0.727	0.397	0.318
JMBD2045	22	22	4	170	0.409	0.69	0.633
JMBD2047	22	22	3	270	0.545	0.533	0.432
JMBD2064	22	20	3	250	0.5	0.58	0.492
MJM1401	22	22	5	235 & 210	0.318	0.719	0.666
MJM467	22	22	2	390	0.682	0.434	0.340
MJM1140	22	22	4	215	0.545	0.591	0.522
MJM1195	22	22	2	185	0.682	0.434	0.340

The highest number of allele (5) was found from primer MJM1401 for the studied germplasm. The highest gene diversity value (0.719) and PIC (Polymorphism Information Content) value (0.666) were also found from MJM1401. The second highest gene diversity value (0.69) and PIC value (0.633) was found for primer JMBD2045. Among the major alleles of the polymorphic primers the lowest gene diversity value (0.397) and PIC value (0.318) were found for JMBD2032. The result suggests that genetic variations exist among these jute germplasm. The highest (0.727) major allele frequency was found for allele size 300bp by JMBD201 and allele size 200 by JMBD2032 (Table-89 & 90). The frequency and variance of all 49 allele from 16 polymorphic markers for twenty-two jute genotypes is presented in Table 88. JMBD2064₂₅₀ allele showed the highest variance (0.013) for all 22 genotypes (Table 95). The size of amplified monomorphic allele primers for 22 jute germplasm is shown in table 96.

Table 95. Allele size and frequency of 16 polymorphic markers

Sl no.	Marker	Allele Size (bp)	Frequency	Variance	SD
1	JMBD880	210	0.273	0.009	0.095
2	JMBD880	215	0.045	0.002	0.044
3	JMBD880	235	0.182	0.007	0.082
4	JMBD880	245	0.500	0.011	0.107
5	JMBD1404	260	0.143	0.006	0.076
6	JMBD1404	290	0.381	0.011	0.106
7	JMBD1404	310	0.476	0.012	0.109
8	JMBD148	185	0.667	0.011	0.103
9	JMBD148	230	0.333	0.011	0.103
10	JMBD201	300	0.727	0.009	0.095
11	JMBD201	310	0.227	0.008	0.089
12	JMBD201	320	0.045	0.002	0.044
13	JMBD563	140	0.409	0.011	0.105
14	JMBD563	145	0.091	0.004	0.061
15	JMBD563	150	0.500	0.011	0.107
16	JMBD598	150	0.682	0.010	0.099
17	JMBD598	160	0.318	0.010	0.099
18	JMBD1061	115	0.524	0.012	0.109
19	JMBD1061	120	0.143	0.006	0.076
20	JMBD1061	140	0.143	0.006	0.076
21	JMBD1061	170	0.190	0.007	0.086
22	JMBD1824	315	0.182	0.007	0.082
23	JMBD1824	320	0.136	0.005	0.073
24	JMBD1824	340	0.682	0.010	0.099
25	JMBD2032	200	0.727	0.009	0.095
26	JMBD2032	225	0.273	0.009	0.095
27	JMBD2045	150	0.182	0.007	0.082
28	JMBD2045	160	0.091	0.004	0.061
29	JMBD2045	170	0.409	0.011	0.105
30	JMBD2045	240	0.318	0.010	0.099
31	JMBD2047	190	0.045	0.002	0.044
32	JMBD2047	210	0.409	0.011	0.105
33	JMBD2047	270	0.545	0.011	0.106
34	JMBD2064	230	0.100	0.005	0.067
35	JMBD2064	240	0.400	0.012	0.110
36	JMBD2064	250	0.500	0.013	0.112
37	MJM1401	210	0.318	0.010	0.099
38	MJM1401	220	0.273	0.009	0.095

Table 95. Cont'd

Sl no.	Marker	Allele Size (bp)	Frequency	Variance	SD
39	MJM1401	225	0.045	0.002	0.044
40	MJM1401	235	0.318	0.010	0.099
41	MJM1401	250	0.045	0.002	0.044
42	MJM467	360	0.318	0.010	0.099
43	MJM467	390	0.682	0.010	0.099
44	MJM1140	115	0.318	0.010	0.099
45	MJM1140	150	0.045	0.002	0.044
46	MJM1140	170	0.091	0.004	0.061
47	MJM1140	215	0.545	0.011	0.106
48	MJM1195	185	0.682	0.010	0.099
49	MJM1195	195	0.318	0.010	0.099

Table 96. Allele size of monomorphic primers for jute germplasm

Sl no.	Marker	Allele Size (bp)
1	JMBD492	290
2	JMBD635	260
3	JMBD709	240
4	MJM390	70
5	JMBD721	140
6	JMBD1017	195
7	TJMBD3	160
8	JMBD1579	285
9	JMBD1604	190
10	MJM1305	160

The values of pair wise Nei's genetic distance between accessions were computed from combined data for 16 polymorphic SSR primers. For the studied jute germplasm, the values were ranged from 0 to 1 (Table 97). Highest value (1) was found in between some deshi and tossa jute germplasm. It means that the genetic makeup of those germplasm from 2 different species have no or very negligible similarity. Deshi jute accession no. 2022 and 4616 showed no genetic difference for the used primers. May be the used primers were not polymorphic for them or they are genetically same or very much similar. Second lowest genetic distance (0.063) was also found among some deshi jute germplasm. Among deshi and tossa jute germplasm 2nd highest genetic distance was found 0.938. In case of tossa jute germplasm accession no. 3809 showed the highest genetic distance (0.533) with collector's no. TZ1. On the other hand tossa jute accessions 3782 and 3815 showed the lowest distance (0.063).

Table 97. Nei's (1983) genetic distance among jute germplasm

	Accession# 2022	Accession# 2025	Accession# 3726	Accession# 3755	Accession# 3782	Accession# 3809	Accession# 3815	Accession# 4158	Accession# 4254	Accession# 4311	Accession# 4323	Accession# 4374	Accession# 4575	Accession# 4616	Accession# 4617	Accession# 4719	BJRI Deshi Pat 7	BJRI Deshi Pat 9	BJRI Tossa Pat 7	BJRI Tossa Pat 8	Collector's# TP1
Accession# 2025	0.063																				
Accession# 3726	1.000	0.933																			
Accession# 3755	0.750	0.688	0.400																		
Accession# 3782	0.875	0.813	0.267	0.125																	
Accession# 3809	0.867	0.800	0.267	0.267	0.267																
Accession# 3815	0.875	0.813	0.333	0.188	0.063	0.333															
Accession# 4158	0.875	0.813	0.400	0.500	0.375	0.400	0.375														
Accession# 4254	0.875	0.813	0.267	0.188	0.125	0.333	0.188	0.438													
Accession# 4311	0.875	0.813	0.400	0.125	0.125	0.333	0.188	0.500	0.125												
Accession# 4323	1.000	0.938	0.200	0.375	0.250	0.400	0.250	0.250	0.313	0.375											
Accession# 4374	0.313	0.375	0.867	0.875	1.000	0.867	1.000	0.813	1.000	1.000	0.813										
Accession# 4575	0.933	0.867	0.357	0.467	0.400	0.286	0.400	0.200	0.467	0.467	0.267	0.867									
Accession# 4616	0.000	0.063	1.000	0.750	0.875	0.867	0.875	0.875	0.875	0.875	1.000	0.313	0.933								
Accession# 4617	0.063	0.125	1.000	0.750	0.875	0.867	0.875	0.875	0.875	0.875	1.000	0.375	0.933	0.063							
Accession# 4719	0.933	0.867	0.214	0.200	0.067	0.214	0.133	0.333	0.200	0.200	0.200	0.933	0.357	0.933	0.933						
BJRI Deshi Pat 7	0.313	0.375	0.933	0.813	0.938	0.867	0.938	0.938	1.000	0.938	0.938	0.125	1.000	0.313	0.375	0.933					
BJRI Deshi Pat 9	0.250	0.313	0.933	0.750	0.875	0.733	0.875	0.813	0.938	0.875	0.938	0.125	0.867	0.250	0.313	0.800	0.125				
BJRI Tossa Pat 7	1.000	0.938	0.333	0.375	0.313	0.467	0.313	0.375	0.375	0.313	0.188	0.875	0.333	1.000	1.000	0.267	1.000	0.938			
BJRI Tossa Pat 8	0.938	0.875	0.333	0.313	0.188	0.333	0.188	0.188	0.313	0.313	0.188	0.938	0.200	0.938	0.938	0.133	0.938	0.813	0.313		
Collector's# TP1	0.933	0.867	0.214	0.400	0.267	0.286	0.267	0.200	0.333	0.400	0.133	0.867	0.214	0.933	0.933	0.214	1.000	0.867	0.267	0.200	
Collector's# TZ1	1.000	0.938	0.333	0.500	0.438	0.533	0.438	0.250	0.500	0.438	0.188	0.813	0.267	1.000	1.000	0.400	0.938	0.938	0.250	0.250	0.200

Deshi jute

Tossa jute

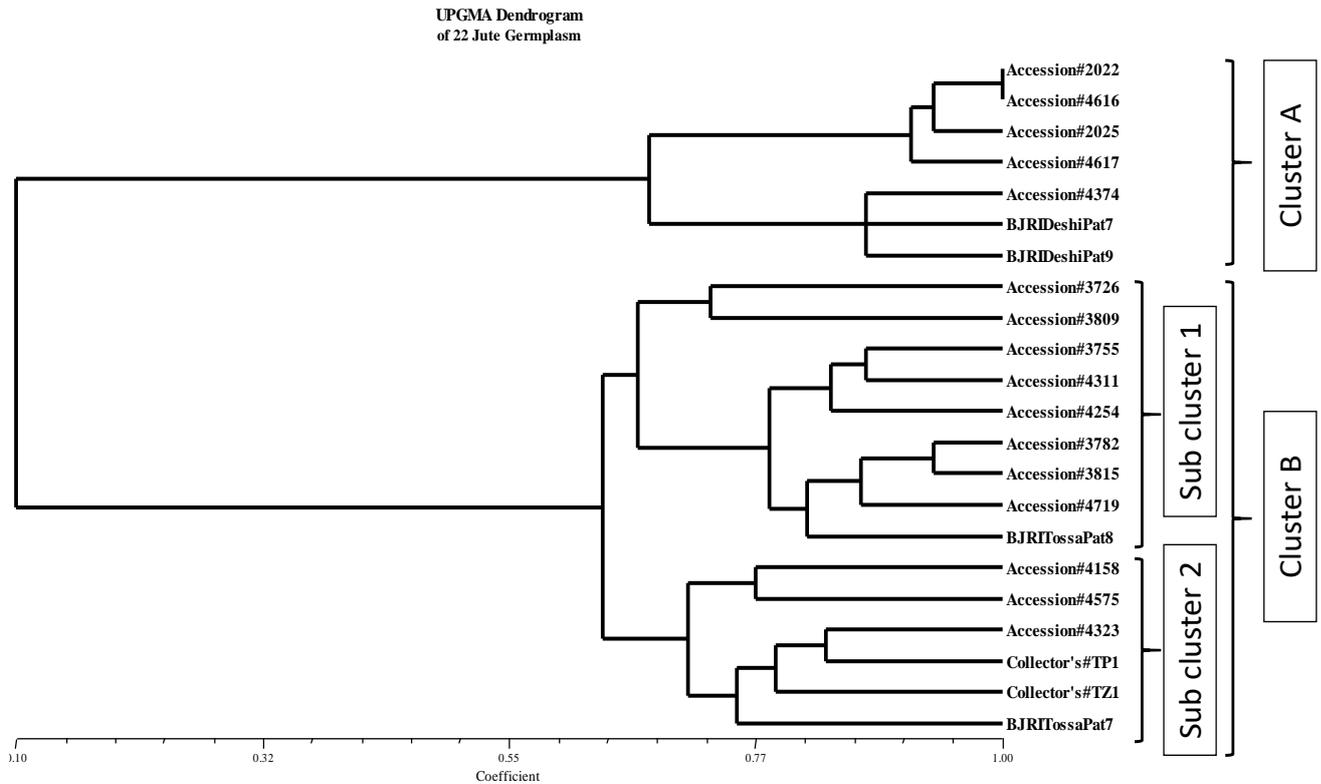


Fig. 76. UPGMA dendrogram showing Nei's genetic distance (Nei, 1983) among test jute germplasm based on alleles detected by microsatellite markers

Two species of jute, *Corchorus capsularis* and *C. olitorius* formed two clusters in the dendrogram (Fig. 76). Cluster of tossa jute were divided into 2 sub-clusters. The dendrogram is based on Nei's (1983) genetic distance. First sub-cluster of cluster B was comprised of tossa jute accession nos. 3726, 3809, 3755, 4311, 4254, 3782, 3815, 4719 and tossa jute variety BJRI Tossa Pat-8. Sub-cluster 2 of cluster B was comprised of accessions no. 4158, 4575, 4323; collector's no. TP1, TZ1 and variety BJRI Tossa Pat-7. BJRI Deshi Pat-7, BJRI Deshi Pat-9 and accession nos. 2022, 4616, 2025, 4617 and 4374 formed cluster A.

Conclusion

It is hoped that, in future the present results will help breeders to make selection from the diverse accessions studied to use them as parents for breeding and for producing mapping populations, but more SSR primers should be used to find more genetic variation information among them. For the used primers very little genetic distance was found for the deshi jute germplasm. So, more primer survey is needed for them. Tossa jute accessions showed decent genetic distance for the used primers which will be helpful for breeders to develop new high yielding variety.



Fig. 77. Lab activities for molecular characterization

11.5. Bangladesh Sugarcrop Research Institute

11.5.1. Germplasm collection

Three collecting missions were performed in south eastern hill districts of Bangladesh. In total 68 local sugarcane germplasm were collected from 31 upazilas of 20 districts of Bangladesh (Table 98, Fig. 78 & 79). In 2018, eleven germplasm were collected from Bandarban, Khagrachari and Rangamati districts by planned exploration and seven germplasm were collected from five districts through personal contact. In 2019, twenty three germplasm were collected from Bagerhat, Khulna, Patuakhali, Barishal, Borguna, and Rajbari districts. In 2020, twenty seven local germplasm were collected through an exploration trip in Sylhet, Sunamganj, Habiganj and Moulavibazar districts. The collected germplasm were maintained and conserved at BSRI germplasm bank with proper labelling. Passport information of the collected germplasm is shown in table 99.

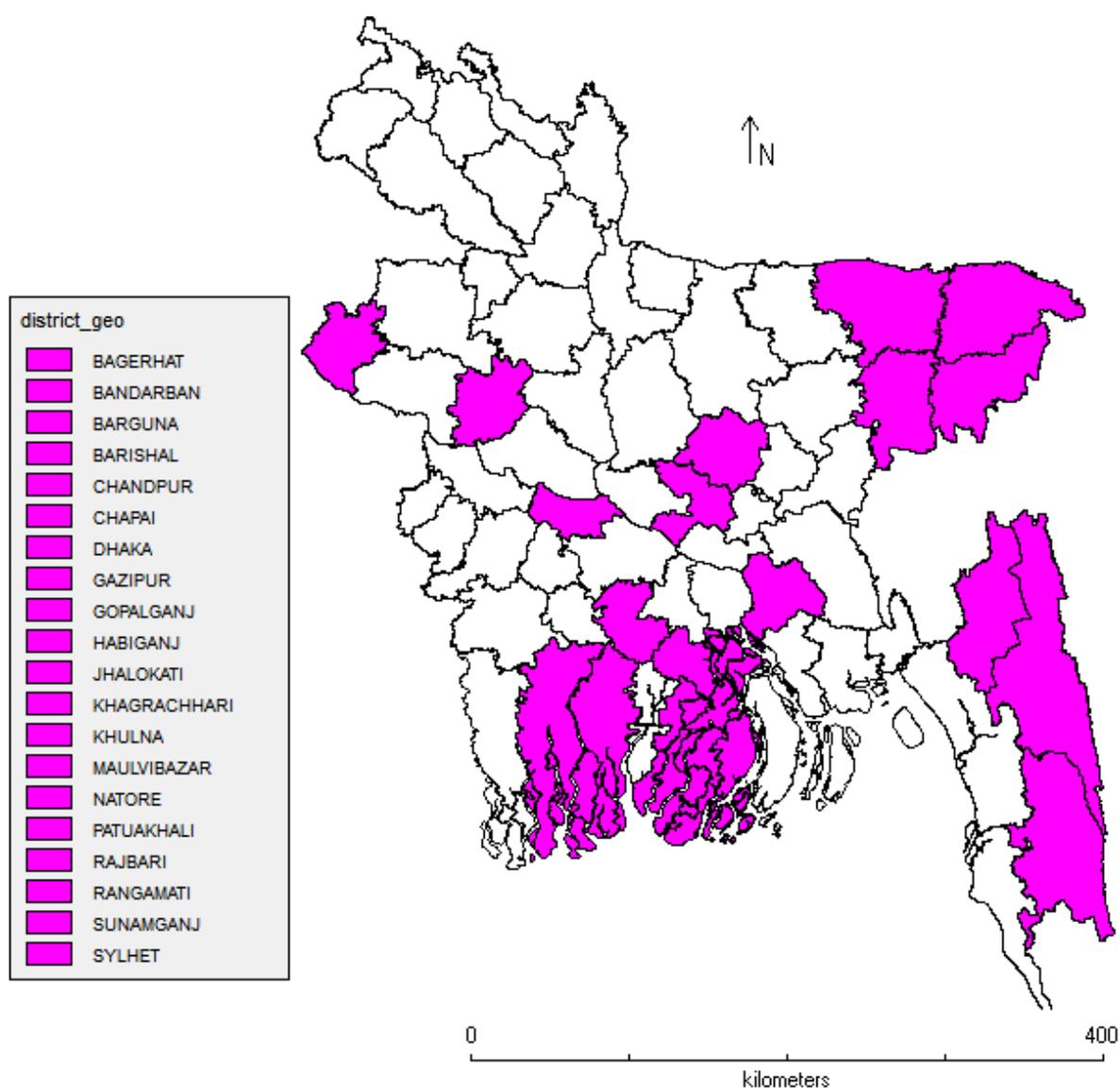


Fig. 78. Bangladesh map showing explored districts (20)

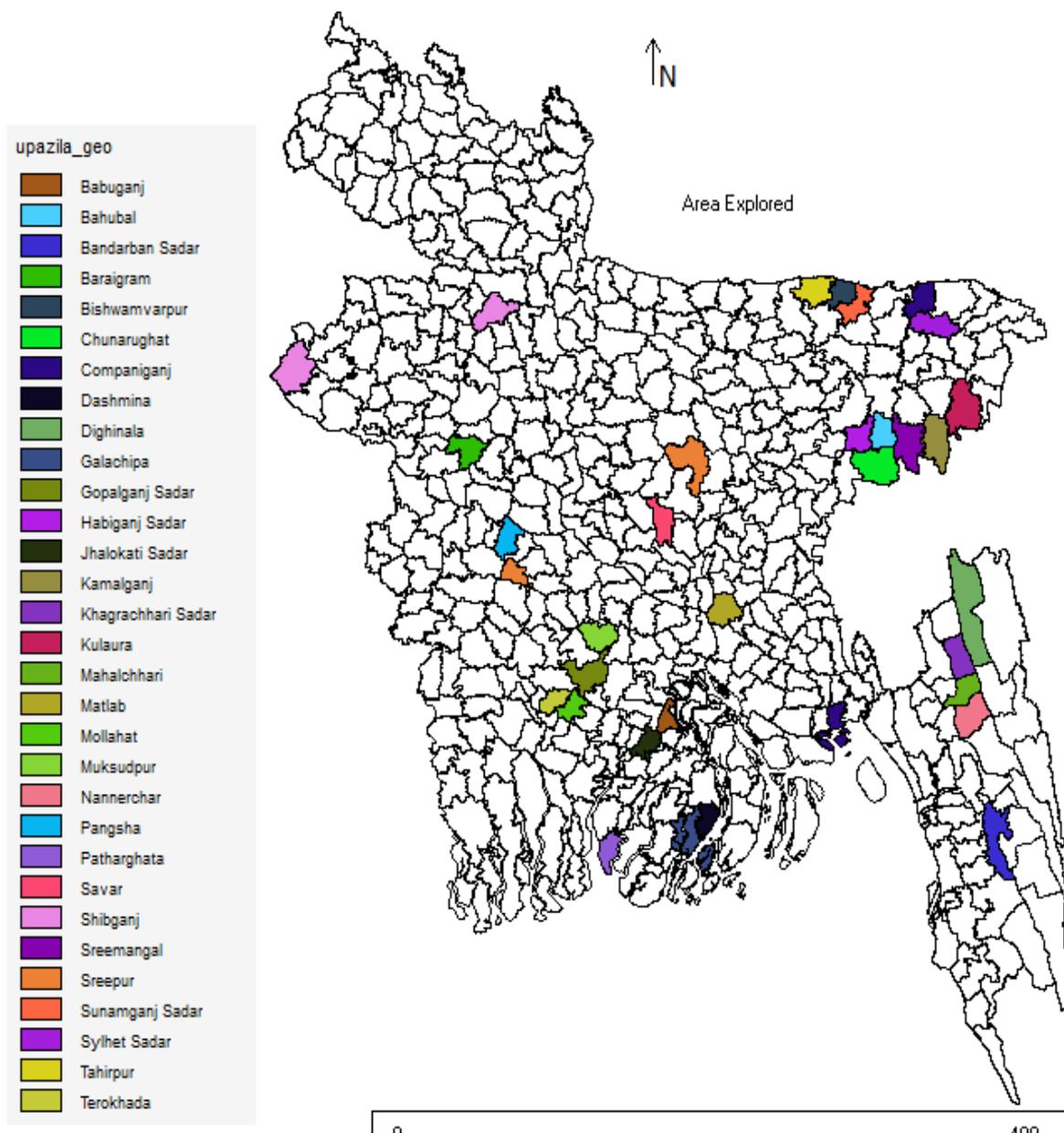


Fig. 79. Bangladesh map showing explored 31 upazilas

Out of 68 sugarcane germplasm under this sub-project 49 were chewing type, 17 were gur/sugar type and 2 were wild relatives. Maximum number of germplasm (9) were collected from Maulvibazar followed by Habiganj (8), Sunamganj (6), Borguna (5), Khagrachari (5) and Rajbari (5). Among the two wild relatives, one was collected from Sunamganj and another one from Sylhet. The districts from where maximum local cultivar/landraces were collected are mainly less accessible (situated in hilly, swamp and/or coastal regions). The results indicated that invaluable landraces and wild relatives of sugarcane are still available only in less accessible areas. Extensive collection explorations need to be made to these areas to rescue the endangered landraces from extinction and to minimize genetic erosion.

Table 98. List of sugarcane germplasm collected from different districts in Bangladesh, 2018-2020

District	No. of upazilas explored	No. of sugarcane germplasm collected			
		Chewing	Gur/Sugar	Wild	Total
1. Bagerhat	01	01	02	-	03
2. Bandarban	01	03	-	-	03
3. Barguna	01	04	01	-	05
4. Barishal	01	02	-	-	02
5. Chandpur	01	02	-	-	02
6. Chapainawabganj	01	01	-	-	01
7. Dhaka	01	01	-	-	01
8. Gazipur	01	01	-	-	01
9. Gopalganj	02	03	-	-	03
10. Habiganj	03	03	05	-	08
11. Jhalokati	01	01	-	-	01
12. Khagrachari	02	05	-	-	05
13. Khulna	01	-	02	-	02
14. Maulvibazar	03	07	02	-	09
15. Natore	01	01	-	-	01
16. Patuakhali	02	03	01	-	04
17. Rajbari	01	03	02	-	05
18. Rangamati	02	03	-	-	03
19. Sunamganj	03	03	02	01	06
20. Sylhet	02	02	-	01	03
Total	31	49	17	02	68

Table 99. Passport information of sugarcane germplasm collected under PBRG-PGR sub-project

SI No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
1	T-01	Modhumala (Chewing)	Md. Shahazaman Majhy Village: Baher char Upazila: Babugonj Dist.: Barishal	01.12.2018 90.633330°E 23.400000°N	
2	T-02	Misrimala (Chewing)	Md. Shahazaman Majhy Village: Baher char Upazila: Babugonj Dist.: Barishal	01.12.2018 90.633330°E 23.400000°N	
3	R-01	Babulal (Chewing)	Md. Kabirul Village: Mobarakpur Upazila: Shibgonj Dist.: Chapainobabgonj	17.08.2018 88.597868°E 24.365876°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
4	M-01	Chandpur Gandari-2 (Chewing)	Md. Tofazzal Hossain Village: Dubgi Upazila: Matlab Uttar Dist.: Chandpur	08.09.2018 90.706997°E 23.348592°N	
5	M-02	Tangail Gandari (Chewing)	Mozil Dhali Village: Dubgi Upazila: Matlab Uttar Dist.: Chandpur	08.09.2018 91.893042°E 21.480697°N	
6	T-03	Bonpara Gandari (Chewing)	Golam Rasul Village: Mohis Vanga Upazila: Boraigram Dist.: Natore	21.09.2018 88.95449°E 25.50309°N	
7	AK-01	Kalikushail-2 (Chewing)	Mukul Chakma Ward no. 7, Khagrachari town, Upazila: Khagrachari Sadar Dist.: Khagrachari	04.01.2018 92.38407°E 22.66881°N	
8	AK-02	Bulong Kushail (Chewing)	Jatin Bikash Chakma Vil: Baraitala Paikujhari, Upazila: Khagrachari Sadar Dist.: Khagrachari	04.01.2018 90.12402°E 22.14554°N	
9	AK-03	Juamati (Chewing)	Chaifou Marma Village: Gesimonipara, Upazila: Bandarban Sadar Dist.: Bandarban	05.01.2018 92.19167°E 22.23333°N	
10	AK-04	Churick (Chewing)	Daieu Murang Village: Emupara Upazila: Bandarban Sadar Dist.: Bandarban	05.01.2018 92.191673°E 22.23333°N	
11	AK-05	Khagra (Chewing)	Hafez Ahmod Modhyapara Bandarban town Upazila: Bandarban Sadar Dist.: Bandarban	06.01.2018 92.19167°E 22.23333°N	
12	AK-06	Black Rubi (Chewing)	Md. Anwarul Islam Raju Hero Nursery, Asulia, Upazila: Savar Dist.: Dhaka	30.07.2018 90.247872°E 23.838665°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
13	AR-01	Dhanopudi (Chewing)	Sohel Chakma Village: Pollin Headman Para Upazila: Dighinala Dist.: Khagrachari	28.01.2019 91.993922°E 23.116819°N	
14	AR-02	208 (Chewing)	Nirmol Chakma Village: Babu Chara Upazila: Dighinala Dist.: Khagrachari	28.01.2019 91.993922°E 23.116819°N	
15	AR-03	Domba Kusail (Chewing)	Ganolal Chakma Village: Beltoli Babu Chara Upazila: Dighinala Dist.: Khagrachari	28.01.2019 91.993922°E 23.116819°N	
16	AR-04	Ranga (Chewing)	Burigoda Village: Gatghor Para Upazila: Mohal Chari Dist.: Rangamati	29.01.2019 88.11521°E 25.00984°N	
17	AR-05	Rangakushail (Chewing)	Koltamoni Chakma Village: Toi Chakma Dosor Para Upazila: Naniachar Dist.: Rangamati	29.01.2019 88.95449°E 25.50309°N	
18	AR-06	Dhubo Kusail (Chewing)	Koltamoni Chakma Village: Toi Chakma Dosor Para Upazila: Naniachar Dist.: Rangamati	29.01.2019 88.95449°E 25.50309°N	
19	AMS-01	Chini Joba (Chewing)	Basudev Sarker Village: Astail Upazila: Mollarhat Dist.: Bagerhat	25.09.2019 89.80701°E 22.65906°N	
20	AMS-02	Nata Khail (Gur)	Badol Sarker Village: Astail Upazila: Mollarhat Dist.: Bagerhat	25.09.2019 89.80701°E 22.65906°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
21	AMS-03	Dabir Khail (Gur)	Basudev Sarker Village: Astail Upazila: Mollarhat Dist.: Bagerhat	25.09.2019 89.80701°E 22.65906°N	
22	AMS-04	Huley Khail (Gur)	Md. Osman Village: Dhankhali Upazila: Terokhada Dist.: Khulna	25.09.2019 89.55806°E 22.84193°N	
23	AMS-05	Humber Khail (Gur)	Md. Osman Village: Dhankhali Upazila: Terokhada Dist.: Khulna	25.09.2019 89.55806°E 22.84193°N	
24	AMS-06	Khagri-1 (Chewing)	Md. Selim Hawlader Village: Bodorpur Upazila: Golachipa Dist.: Patuakhali	27.09.2019 89.801933°E 23.583550°N	
25	AMS-07	Bash Ganderi (Gur)	Md. Selim Hawlader Village: Bodorpur Upazila: Golachipa Dist.: Patuakhali	27.09.2019 89.801933°E 23.583550°N	
26	AMS-08	Bareng/Bombay (Chewing)	Md. Masud Village: Kamarhaola Upazila: Golachipa Dist.: Patuakhali	27.09.2019 89.801933°E 23.583550°N	
27	AMS-09	Bash Fuli (Chewing)	Md. Oliul Hawlader Village: Dokkhin Rongopaldi Upazila: Dashmina Dist.: Patuakhali	27.09.2019 90.562203°E 22.283246°N	
28	AMS-10	Kazli (Chewing)	Md. Eusuf Village: Hoglapasa Munsirhat Upazila: Patharghata Dist.: Borguna	28.09.2019 90.365223°E 23.719198°N	
29	AMS-11	Turpin-Yellow (Chewing)	Md. Abdul Hakim Village: Gohorpur Upazila: Patharghata Dist.: Borguna	28.09.2019 90.365223°E 23.719198°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
30	AMS-12	Kalo Ganderi (Chewing)	Md. Habibor Rahman Village: Pouro ward-3 Upazila: Patharghata Dist.: Borguna	28.09.2019 90.365223°E 23.719198°N	
31	AMS-13	Ganderi (Chewing)	Md. Mojnu Sarif Village: Amratoli Kalmegha Upazila: Patharghata Dist.: Borguna	28.09.2019 90.365223°E 23.719198°N	
32	AMS-14	Jhati Kusail (Gur)	M. Abdur Rahman Munsif Village: Jaliaghata Kakchira Upazila: Patharghata Dist.: Borguna	28.09.2019 90.365223°E 23.719198°N	
33	AMS-15	Turpin- Green (Chewing)	Gopal Mistri Village: Simulesor Dogolchira Upazila: Jhalokathi Sadar Dist.: Jhalokathi	29.09.2019 90.191105°E 22.684365°N	
34	AMS-16	Huley Khail-2 (Chewing)	Milon Poddar Village: Ulpur Upazila: Gopalganj Sadar Dist.: Gopalganj	29.09.2019 78.75629°E 23.83797°N	
35	AMS-17	Lal Bareng (Chewing)	Md. Miraj Munsif Village: Tengrakhola Pour Upazila: Muksudpur Dist.: Gopalganj	30.09.2019 89.869677°E 23.314691°N	
36	AMS-18	Chini Chompa (Chewing)	Md. Firoj Molla Village: Komlapur Upazila: Muksudpur Dist.: Gopalganj	30.09.2019 89.869677°E 23.314691°N	
37	AMS-19	Hazarpeyara Lal-1 (Gur)	Md. Barek Pk. Village: Charafra Habaspur Upazila: Pangsha Dist.: Rajbari	01.10.2019 89.429207°E 23.788879°N	
38	AMS-20	Hazarpeyara Sada (Chewing)	Md. Barek Pk. Village: Charafra Habaspur Upazila: Pangsha Dist.: Rajbari	01.10.2019 89.429207°E 23.788879°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
39	AMs-21	Huley Joba-3 (Chewing)	Md. Berek Pk. Village: Charafra Habaspur Upazila: Pangsha Dist.: Rajbari	01.10.2019 89.429207°E 23.788879°N	
40	AMS-22	Sondesh Goja/ Sundori Joba (Chewing)	Md. Moizuddin Khan Village: Charpara Habaspur Upazila: Pangsha Dist.: Rajbari	01.10.2019 89.429207°E 23.788879°N	
41	AMS-23	Hazarpeyara Lal-2 (Gur)	Md. Moizuddin Khan Village: Charpara Habaspur Upazila: Pangsha Dist.: Rajbari	01.10.2019 89.429207°E 23.788879°N	
42	AMS-24	Dholbazari (Chewing)	Sri Anil Chandra Village: Bodnivanga Post: Maona Upazila: Sreepur Dist.: Gazipur	25.12.2019 90.365958°E 24.2127157°N	
43	AMS-25	Unknown (Chewing)	Md. Khosru Mian Village: West Pakuria Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
44	AMS-26	Unknown (Gur)	Md. KhosruMian Village: West Pakuria, Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
45	AMS-27	Unknown (Gur)	Md. Khosru Mian Village: West Pakuria, Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
46	AMS-28	Unknown (Gur)	Md. Abdun Noor Village: Kathuamara Union: Gazipur Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
47	AMS-29	Unknown (Gur)	Md. Abdun Noor Village: Kathuamara Union: Gazipur Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
48	AMS-30	Unknown (Gur)	Md. Abdun Noor Village: Kathuamara Union: Gazipur Upazila: Chunarughat Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
49	AMS-31	Manik Kushal (Chewing)	Abdus Salam Village: West Borochar Upazila: Sayestaganj Dist.: Habiganj	26.10.2020 91.4126358°E 24.385837°N	
50	AMS-32	Songso Kushal (Chewing)	Sri Dilip Chandra Paul Village: Mirpur Upazila: Bahubal Dist.: Habiganj	27.10.2020 91.4126358°E 24.385837°N	
51	AMS-33	Unknown (Chewing)	Md. Jahid Mian Village: Vunobir Upazila: Sreemangal Dist.: Moulvibazar	27.10.2020 91.725133°E 24.3105781°N	
52	AMS-34	Unknown (Chewing)	Md. Jahid Mian Village: Vunobir Upazila: Sreemangal Dist.: Moulvibazar	27.10.2020 91.725133°E 24.3105781°N	
53	AMS-35	Kalamanik (Chewing)	Md. Anowar Mian Village: Boilashir Union: Mirzapur Upazila: Sreemangal Dist.: Moulvibazar	27.10.2020 91.725133°E 24.3105781°N	
54	AMS-36	Unknown (Chewing)	Md. Anowar Mian Village: Boilashir Union: Mirzapur Upazila: Sreemangal Dist.: Moulvibazar	27.10.2020 91.725133°E 24.3105781°N	
55	AMS-37	Asami-1 (Chewing)	Md. Jamal Uddin Village: Boilashir Union: Mirzapur Upazila: Sreemangal Dist.: Moulavibazar	27.10.2020 91.725133°E 24.3105781°N	
56	AMS-38	Asami-2 (Gur)	Md. Harun Mian Village: West Bilerpar Kotarkona Union: Hazipur Upazila: Kulaura Dist.: Moulvibazar	27.10.2020 92.0340732°E 24.5226336°N	
57	AMS-39	Khagri-2 (Gur)	Md. Nazrul Islam Village: Shamsernagar Upazila: Komolganj Dist.: Moulvibazar	27.10.2020 92.0340732°E 24.5226336°N	
58	AMS-40	Unknown (Chewing)	Md. Sanowar Ali Village: Kotarkona Union: Hazipur Upazila: Kulaura Dist.: Moulvibazar	27.10.2020 92.0340732°E 24.5226336°N	

Sl No	Collector's No.	Cultivar/local name/cultural practice	Donor's name & Address	Geographical location and date	Photographs
59	AMS-41	Unknown (Chewing)	Md. Ismat Ali Village: Kotarkona Union: Hazipur Upazila: Kulaura Dist.: Moulvibazar	27.10.2020 92.0340732°E 24.5226336°N	
60	AMS-42	Kuair (Chewing)	Md. Sajib Ahmed Village: Borodeo Upazila: Companiganj Dist.: Sylhet	28.10.2020 91.81343079°E 25.08062377°N	
61	AMS-43	Wild-1 (Wild)	Md. Sajib Ahmed Village: Borodeo Upazila: Companiganj Dist.: Sylhet	28.10.2020 91.81343079°E 25.08062377°N	
62	AMS-44	Wild-2 (Wild)	Village: Lokhir par Union: Donpur Upazila: Biswvorpur Dist.: Sunamganj	29.10.2020 91.81343079°E 25.08062377°N	
63	AMS-45	Kutting (Gur)	Md. Abdus Sattar Mian Village: Lokhir par Union: Donpur Upazila: Biswvorpur Dist.: Sunamganj	29.10.2020 91.30943298°E 25.10052306°N	
64	AMS-46	Misridana (Chewing)	Md. Abdus Sattar Mian Village: Lokhir par Union: Donpur Upazila: Biswvorpur Dist.: Sunamganj	29.10.2020 91.30943298°E 25.10052306°N	
65	AMS-47	Tenai (Chewing)	Md. Abdus Sattar Mian Village: Lokhir par Union: Donpur Upazila: Biswvorpur Dist.: Sunamganj	29.10.2020 91.30943298°E 25.10052306°N	
66	AMS-48	Bata fuli (Chewing)	Md. Aminur Hossain Village: Laura gor Union: Bathaghat Upazila: Tahirpur Dist.: Sunamganj	29.10.2020 91.17622375°E 25.09430488°N	
67	AMS-49	Unknown (Chewing)	Md. Hanif Mian Village: Kanda para Union: Narayan tola Upazila: Sunamganj Sadar Dist.: Sunamganj	29.10.2020 91.43165588°E 25.09430488°N	
68	AMS-50	Unknown (Chewing)	Md. Sahjahan Village: Chalk gram Khadimnagar Upazila: Sylhet Sadar Dist.: Sylhet	30.10.2020 91.89376831°E 24.89141948°N	



Fig. 80. Sugarcane germplasm collection from Chittagong Hill Tracts



Fig. 81. Sugarcane germplasm collection from southern part of Bangladesh



Fig. 82. Sugarcane germplasm collection from Sylhet region

11.5.2. Germplasm conservation

The collected germplasm were evaluated at BSRI germplasm bank. Germplasm collected upto 2019 were evaluated and characterized using DUS descriptor of BSRI. Then these were conserved at field genebank of BSRI after putting an accession number (Table 100). Last year (2020) collections were planted upon treated with carbendazim fungicide @1g/L for evaluation. After evaluation and characterization the selected materials will be conserved at field genebank of BSRI.

Table 100. Conservation status of collected sugarcane germplasm, 2018-2020

Sl.	Collector's No.	Type of planting material	Planting site	Date of planting	Acc. No.
1.	T-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1520
2.	T-02	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1528
3.	R-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1521
4.	M-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1522
5.	M-02	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1524
6.	T-03	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1523
7.	AK-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1532
8.	AK-02	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1527
9.	AK-03	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1525
10.	AK-04	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1526
11.	AK-05	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1577
12.	AK-06	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1531
13.	AR-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1529
14.	AR-02	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1569
15.	AR-03	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1530
16.	AR-04	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1579
17.	AR-05	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1568
18.	AR-06	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1570
19.	AMS-01	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1533
20.	AMS-02	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1534
21.	AMS-03	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1535
22.	AMS-04	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1503
23.	AMS-05	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1536
24.	AMS-06	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1537
25.	AMS-07	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1538
26.	AMS-08	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1539
27.	AMS-09	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1540
28.	AMS-10	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1541
29.	AMS-11	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1542
30.	AMS-12	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1543
31.	AMS-13	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1544
32.	AMS-14	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1545
33.	AMS-15	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1546
34.	AMS-16	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1510
35.	AMS-17	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1547
36.	AMS-18	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1548
37.	AMS-19	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1549
38.	AMS-20	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1550
39.	AMS-21	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1551
40.	AMS-22	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1552
41.	AMS-23	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1553
42.	AMS-24	Two eyed sett	Block# D, Plot # 5	19.11.2020	BSRI-1554
43.	AMS-25	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
44.	AMS-26	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
45.	AMS-27	Two eyed sett	Block# D, Plot # 6	20.11.2020	-

Cont'd Table 100.

Sl.	Collector's No.	Type of planting material	Planting site	Date of planting	Acc. No.
46.	AMS-28	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
47.	AMS-29	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
48.	AMS-30	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
49.	AMS-31	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
50.	AMS-32	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
51.	AMS-33	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
52.	AMS-34	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
53.	AMS-35	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
54.	AMS-36	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
55.	AMS-37	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
56.	AMS-38	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
57.	AMS-39	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
58.	AMS-40	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
59.	AMS-41	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
60.	AMS-42	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
61.	AMS-43	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
62.	AMS-44	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
63.	AMS-45	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
64.	AMS-46	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
65.	AMS-47	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
66.	AMS-48	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
67.	AMS-49	Two eyed sett	Block# D, Plot # 6	20.11.2020	-
68.	AMS-50	Two eyed sett	Block# D, Plot # 6	20.11.2020	-

11.5.3. Morphological Characterization

A total of 51 sugarcane germplasm were characterized morphologically during 2nd and 3rd year of the sub-project period (Table 101). Thirty five germplasm were from new collection and rest sixteen from previous collection. In 2019, twenty eight sugarcane germplasm were characterized morphologically. In 2020, twenty three sugarcane germplasm were characterized morphologically and analyzed their diversity parameters together.

Table 101. List of germplasm characterized morphologically, 2018-20

Sl. No.	Cultivar /Local name	Acc. No.	Upazila	District
1	Kali kushal-1	BSRI-1504	Khagracharisadar	Khagrachari
2	Misridana	BSRI-1505	Babugonj	Barisal
3	Senegal	BSRI-1506	QS, Gazipur Sadar	Gazipur
4	Kaptai-3	BSRI-1507	Kaptai	Rangamati
5	Baskusal Kaptai	BSRI-1508	Kaptai	Rangamati
6	Turag	BSRI-1509	Shibgonj	Chapainobabgonj
7	Huleykhali-2	BSRI-1510	Terokhada	Khulna
8	CO 527	BSRI-1511	Kaliganj	Satkhira
9	Shung	BSRI-1512	Kalapara	Patuakhali
10	Q 69	BSRI-1513	Mohasthan	Bogura
11	Atkushail	BSRI-1514	Sadar	Rangamati
12	Raujan	BSRI-1515	Dighinala	Khagrachari

Cont'd Table 101.

Sl. No.	Cultivar /Local name	Acc. No.	Upazila	District
13	Chitra	BSRI-1516	QS, Gazipur Sadar	Gazipur
14	Kharki	BSRI-1517	Khagrachari sadar	Khagrachari
15	Malaysia	BSRI-1518	Kustia sadar	Kustia
16	Chorua	BSRI-1519	Sadar	Kurigram
17	Modhumala	BSRI-1520	Babugonj	Barishal
18	Babulal	BSRI-1521	Shibgonj	Chapainobabgonj
19	Chandpuri Gandary	BSRI-1522	Matlab Uttor	Chandpur
20	Bonpara Gandary	BSRI-1523	Boraigram	Natore
21	Tangail Gandary	BSRI-1524	Matlab Uttor	Chandpur
22	Juamoti	BSRI-1525	Bandarban Sadar	Bandarban
23	Cheuric	BSRI-1526	Bandarban Sadar	Bandarban
24	Bhulong	BSRI-1527	Khagrachari sadar	Khagrachari
25	Misrimala	BSRI-1528	Babugonj	Barisal
26	Dhonupodi	BSRI-1529	Dighinala	Khagrachari
27	Domba Kusail	BSRI-1530	Dighinala	Khagrachari
28	Black Ruby	BSRI-1531	Savar	Dhaka
29	Kali kushal-2	BSRI-1532	Khagrachari Sadar	Khagrachari
30	Chini Joba	BSRI-1533	Mollarhat	Bagerhat
31	Nata Khail	BSRI-1534	Mollarhat	Bagerhat
32	Dabir Khail	BSRI-1535	Mollarhat	Bagerhat
33	Humber Khail	BSRI-1536	Terokhada	Khulna
34	Khagri-1	BSRI-1537	Golachipa	Patuakhali
35	Bash Ganderi	BSRI-1538	Golachipa	Patuakhali
36	Bareng/Bombay	BSRI-1539	Golachipa	Patuakhali
37	Bash Fuli	BSRI-1540	Dashmina	Patuakhali
38	Kazli	BSRI-1541	Patharghata	Borguna
39	Turpin-Yellow	BSRI-1542	Patharghata	Borguna
40	Kalo Ganderi	BSRI-1543	Patharghata	Borguna
41	Ganderi	BSRI-1544	Patharghata	Borguna
42	Jhati Kusail	BSRI-1545	Patharghata	Borguna
43	Turpin- Green	BSRI-1546	Sadar	Jhalokathi
44	Lal Bareng	BSRI-1547	Muksudpur	Gopalganj
45	Chini Chompa	BSRI-1548	Muksudpur	Gopalganj
46	Hazarpeyara Lal-1	BSRI-1549	Pangsha	Rajbari
47	Hazarpeyara Sada	BSRI-1550	Pangsha	Rajbari
48	Huley Joba-3	BSRI-1551	Pangsha	Rajbari
49	Sondesh Goja	BSRI-1552	Pangsha	Rajbari
50	Hazarpeyara Lal-2	BSRI-1553	Pangsha	Rajbari
51	Dholbazari	BSRI-1554	Sreepur	Gazipur

Table 102. Morphological traits of sugarcane germplasm as per DUS descriptor

Sl. No.	Characteristic	Descriptor State	No of Germplasm	Frequency (%)
01	Plant: Growth habit	Erect	28	54.90
		Semi-erect	23	45.10
02	Plant: Adherence of leaf sheath	Weak (self de-trashing)	13	25.49
		Medium (semi clasping)	38	74.51
03	Plant: Number of millable canes (NMC) per stool	Low (<3.0)	4	7.84
		Medium (3.0 – 5.0)	19	37.25
		High (5.1 – 7.0)	28	54.90
04	Plant: Leaf carriage	Open	31	60.78
		Compact	20	39.22
05	Plant: Intensity of green color of leaf canopy	Light	14	27.45
		Medium	25	49.02
		Dark	12	23.53
06	Plant: Cane height	Medium (1.75-3.0 m)	22	15.69
		Tall (>3.0 m)	29	43.14
07	Internode: Diameter	Thin (<2.2 cm)	2	56.86
		Medium (2.2 – 3.0 cm)	37	3.92
		Thick (>3.0 cm)	12	72.55
08	Internode: Shape	Cylindrical	40	78.43
		Tumescent	6	11.76
		Bobbin shaped	2	3.92
		Conoidal	3	5.88
09	Internode: Cross- section	Round	51	100.00
10	Internode: Colour (Exposed to sun)	Green yellow group (RHS 1)	30	58.82
		Yellow green group (RHS 144-154)	8	15.69
		Yellow group (RHS 3-13, 22)	2	3.92
		Purple group (RHS 59-65, 77)	11	21.57
11	Internode: Colour (Not exposed to sun)	Green (RHS 138-143)	0	0.00
		Green yellow (RHS 1)	6	11.76
		Yellow (RHS 2-11)	28	54.90
		Yellow green (RHS 145 - 154)	2	3.92
		Yellow white (RHS 158)	3	5.88
		Greyed green (RHS 193)	2	3.92
		Greyed yellow (RHS 160)	10	19.61
12	Internode: Split/growth crack	Absent	39	76.47
		Present	12	23.53
13	Internode: Alignment	Straight	47	92.16
		Zigzag	4	7.84
14	Internode: Appearance (rind surface)	Smooth	22	43.14
		Corky patches only	12	23.53
	Internode: Appearance (rind surface)	Ivory marks only	3	5.88
		Corky patches and ivory marks	14	27.45
15	Internode: Pithiness	Absent	26	50.98
		Present	25	49.02
16	Internode: Waxiness	Absent	3	5.88
		Light	17	33.33
		Medium	27	52.94
		Heavy	4	7.84

Cont'd Table 102.

Sl. No.	Characteristic	Descriptor State	No of Germplasm	Frequency (%)
17	Node: Width of root band	Narrow (< 6mm)	6	3.6
		Medium (6-8mm)	23	11.76
		Broad (> 8mm)	22	45.10
18	Node: Bud shape	Round	18	43.14
		Ovate	33	35.29
19	Node: Bud prominence	Flat	7	64.71
		Bulging	44	13.73
20	Node: Depth of bud groove	Absent	27	78.43
		Shallow	7	52.94
		Medium	14	13.73
		Deep	3	27.45
21	Node: Size of bud	Medium (6-9 mm),	11	86.27
		Large (9 mm or more)	40	21.57
22	Node: Bud tip position in relation to growth ring	Clearly below growth ring	5	25.49
		Touching the ring	22	9.80
		Clearly above growth ring	24	43.14
23	Node: Pubescence on the bud	Absent	38	5.88
		Present	13	74.51
24	Node: Bud cushion (Space between bud base and leaf scar)	Absent	43	47.06
		Present	8	84.31
25	Node: Growth ring appearance	Weak (Not swollen)	39	76.47
		Strong (Swollen)	12	23.53
26	Node: Root primordial arrangement	One row	3	5.88
		Two rows	38	74.51
		Three rows	2	3.92
		Four rows	2	3.92
		Irregular	6	11.76
27	Leaf sheath: Number of hairs (groups 57)	Absent	5	9.80
		Few	16	31.37
		Many	30	58.82
28	Leaf sheath: Distribution of hairs	Absent	5	9.80
		Only dorsal	46	91.20
		Lateral and dorsal	0	0.00
29	Leaf sheath: Shape of ligule	Crescent-shaped	31	60.78
		Bow-shaped	20	39.22
30	Leaf sheath: Shape of inner auricle	Sloping transitional	9	17.65
		Straight transitional	12	23.53
		Ascending transitional	5	9.80
		Deltoid	7	13.73
		Unciform	3	5.88
		Lanceolate	15	29.41
31	Leaf sheath: Shape of outer auricle	Sloping transitional	8	15.69
		Straight transitional	14	27.45
		Ascending transitional	15	29.41
		Deltoid	6	11.76
		Dentoid	2	3.92
		Lanceolate	6	11.76

Cont'd Table 102.

Sl. No.	Characteristic	Descriptor State	No of Germplasm	Frequency (%)
32	Leaf sheath: Colour of dewlap	Greenish-yellow	15	29.41
		Yellowish-green	7	13.73
		Brown	10	19.61
		Purple	19	37.25
33	Leaf blade: Curvature	Erect to tip	19	37.25
		Curved near tip	4	7.84
		Bent near tip	7	13.73
		Curved near middle	21	41.18
34	Leaf blade: Width at the longitudinal mid point	Medium (3.0-5.0 cm)	23	45.10
		Broad (>5.0 cm)	28	54.90
35	Leaf blade: Serration of margin	Absent	4	7.84
		Present	47	92.16
36	Cane top: Waxiness	Weak	29	56.86
		Medium	22	43.14
37	Special Character (If any): Brix %	>20	18	35.29
		16-20	23	45.10
		<16	10	19.61

Table 103. Analysis of variance for 12 characters of sugarcane germplasm

SV	df	NMC	LLB	WLB	LB	WB	PH
Replication	2	0.05	2.3	0.005	0.055	0.008	136.0
Genotype	50	3.79***	1578.7***	4.78**	10.35**	4.28***	9472.0***
Residuals / Error	100	0.256	2.4	0.005	0.108	0.127	47
CV (%)		9.41	1.1	1.21	3.37	4.43	1.49

Table 103. Analysis of variance for 12 characters of sugarcane germplasm (Cont'd)

SV	df	SL	NI	IL	ID	SCW	BR
Replication	2	31.0	2.02	3.63***	0.0001	1.62***	0.251*
Genotype	50	8455.0***	40.84***	8.58***	0.62***	0.965***	23.21***
Residuals / Error	100	57	1.71	0.183	0.0079	0.0033	0.055
CV (%)		2.61	4.66	4.1	3.29	3.22	1.43

Note: SV = Source of variation, df = Degrees of freedom, NMC = Number of millable cane, LLB = Length of leaf blade (cm), WLB = Width of leaf blade (cm), LB = Length of bud (mm), WB = Width of bud (mm), PH = Plant height (cm), SL = Stalk length (cm), NI = Number of internode, IL = Internode length (cm), ID = Internode diameter (cm), SCW = Single cane weight (kg), BR = Brix percentage.

Cluster analysis

Cluster analysis for phenotypic traits showed a clear demarcation between sugarcane accessions. Cluster differences were observed by summarizing cluster means for the 12 quantitative traits. All the genotypes were clustered on the basis of agglomerative cluster analysis, where specifications were made based on Euclidean distance and grouping was made on average clustering method. Based on these traits, the accessions were grouped into four different clusters (Tables 104 & 105). The dendrogram divided the accessions into four different clusters consisting 11, 16, 18 and 6 genotypes respectively. Cluster analyses grouped genotypes with greater similarity for agronomic trait (Fig. 83), they did not necessarily include the genotypes from the same source of origin as well as collection site. In most of the germplasm resources lack of accessions between agronomic traits and origin has been reported (Ghafoor *et al.*, 2005 and Perera *et al.*, 2012). This information will be helpful to use in crop breeding through identification of parents. Crosses involving parents from these genetically divergent clusters are expected to manifest maximum heterosis and generate wide variability in genetic architecture. These are also likely to produce potential recombinants with desired traits (Singh and Singh, 1989).

Table 104. Clustering of sugarcane germplasm using mean of 12 quantitative characters

Cluster	No. of genotypes	Genotype
C ₁	11	4, 5, 7, 8, 9, 12, 13, 15, 19, 40 and 42
C ₂	16	2, 10, 14, 22, 24, 28, 29, 30, 31, 33, 34, 36, 38, 46, 49 and 50
C ₃	18	1, 3, 6, 11, 16, 17, 18, 20, 21, 23, 37, 39, 41, 43, 44, 47, 48 and 51
C ₄	6	25, 26, 27, 32, 35 and 45

Note: Number refers to number of genotypes

Table 105. Differences among four clusters of sugarcane germplasm for mean performance of 12 quantitative characters

Character	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Grand mean
Number of millable cane	6.37	5.03	5.25	4.86	5.38
Length of leaf blade (cm)	148.68	142.48	139.59	148.46	144.80
Width of leaf blade (cm)	6.16	5.86	5.41	5.52	5.74
Length of bud (mm)	9.11	10.07	9.47	10.75	9.85
Width of bud (mm)	7.53	8.87	7.66	7.87	7.98
Plant height (cm)	535.54	430.95	479.00	357.68	450.79
Stalk length (cm)	352.55	261.28	310.47	186.90	277.80
Number of Internode	29.95	28.87	27.87	22.85	27.39
Internode length (cm)	11.68	9.47	11.25	8.57	10.24
Internode dia (cm)	2.83	2.68	2.57	2.91	2.75
Single cane weight (kg)	2.19	1.63	1.71	1.66	1.80
Brix %	15.92	16.77	16.74	14.40	15.95

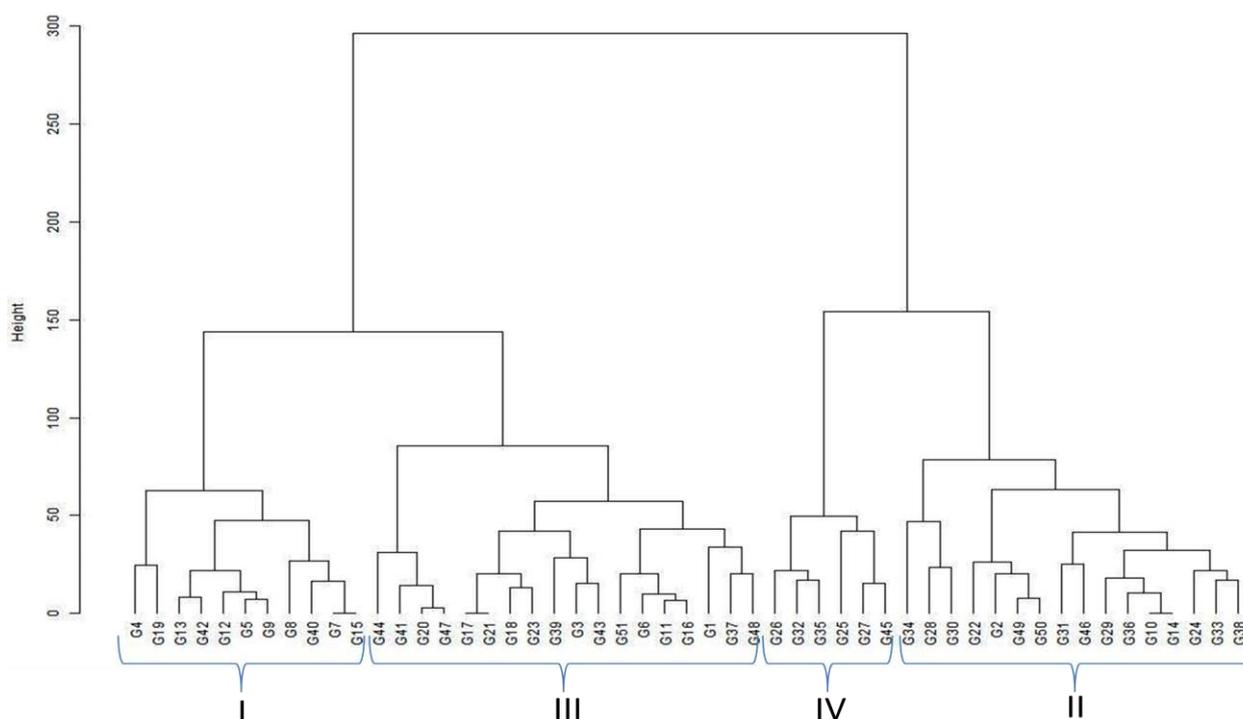


Fig. 83. Dendrogram based on mean performance of variables in test sugarcane germplasm

Principal component analysis

In the present study the PCA grouped the 12 phenotypic characters into 12 components, which accounted for the entire (100%) variability among the studied accessions (Table 106). As Chatfield *et al.* (1980) stated, components with an eigen value of less than one should be eliminated so that fewer components are dealt with. Furthermore, Hair *et al.* (1998) suggested that eigen values greater than one are considered significant and component loadings greater than ± 0.3 were considered to be meaningful. Hence, from this study, only the first four components which had eigen values greater than one and cumulatively explained about 76.5% of the total variation among the accessions were discussed. The first principal component (PC 1) alone explained 32.28% of the total variation. Characters which contributed more to the second PC accounted for 24.62% of the total variation. The third and fourth PC expressed 11.43% and 8.2% of the variation.

The first component of variation is mainly due to length of leaf blade (cm), width of leaf blade (cm), length of bud (mm), width of bud (mm), number of internode, internode dia (cm) and single cane weight (kg). Characters which contributed more to the second component are plant height (cm), stalk length (cm), number of internode and single cane weight (kg). The variation of third PC composed of length of bud (mm), width of bud (mm) and brix %. Number of millable cane, length of leaf blade (cm) and length of bud (mm) contribute to the variation in fourth PC.

11.6. Bangladesh Institute of Nuclear Agriculture

11.6.1. Germplasm Collection

One hundred and ninety nine local germplasm of different crops were collected from February, 2018 to December, 2020 (Figs. 85 & 86). During germplasm collection, passport data form was used for record preliminary data of the collected germplasm. Twenty eight expeditions were made for collection of rice, oilseeds, pulses, spices and vegetables germplasm from Mymensingh (including Tangail) and Sylhet regions of Bangladesh. The team members visited 38 upazilas of 10 districts viz. Mymensingh, Tangail, Sherpur, Jamalpur, Netrakona, Kishoreganj, Tangail, Sylhet, Habiganj and Sunamganj. Number of upazilas explored and number of germplasm collected from each district is shown in table 107. Passport information of collected germplasm of assigned crops is shown in tables 108-112.

Table 107. District wise germplasm collection status of target crops

Name of District	No. of Upazilas explored	Number of germplasm collected																
		Rice	Chilli	Bitter gourd	Egg-plant	Groundnut	Mustard	Sesame	Black gram	French bean	Hyacinth bean	White gourd	Sweet gourd	Bottle gourd	Sponge gourd	Turmeric	Ginger	Okra
Mymensingh	6	17	3	1	2	1		2									1	2
Netrokona	2	9	2															
Kishoreganj	2	8				3			1							1		
Jamalpur	4	5		2	2													
Sherpur	2	32			2													
Tangail	5	9			1							2	3	1	1	1	1	
Sylhet	5	7																
Sunamganj	8	64			2		1			1	7	1						1
Moulvibazar	1	2																
Habiganj	3	3																
Total	38	151	5	3	9	4	1	2	1	1	7	3	3	1	1	2	2	3

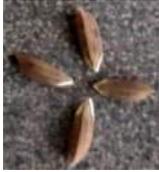


Fig. 85. Collecting seeds from farmers and seed agency and recording passport data



Fig. 86. Collecting seeds from farmer's seed store and house

Table 108. Passport information of collected rice (*Oryza sativa*) germplasm

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
1.	MM-01	Purabinni T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
2.	MM-04	Goati binni T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
3.	MM-05	Markabinni T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
4.	MM-06	Bishali binni-1 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
5.	FS-02	Bishalibinni-2 T. Aman	Md. Wasim Village : Shimultoli Upazila : Durgapur District : Netrokona	9 January 2019 N-25.12° E-90.68°	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
6.	MM-18	Shongbinni T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
7.	MM-19	Ledabinni T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
8.	MM-27	Dudhbinni T. Aman	Sentu hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
9.	M-02	Kashiabinni T. Aman	Md. Wasim Village : Shimultoli Upazila : Durgapur District : Netrokona	9 May 2018 25.12°N 90.68°E	
10.	MM-02	Malonchi Aman T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	01 June 2018 N- 25.14° E-90.19°	
11.	MM-03	Dhepa T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
12.	MM-07	Lal chinishail T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
13.	MM-11	Ranishail T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
14.	MM-13	Sentushail T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
15.	MM-23	Rupashail T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19°	
16.	FS-11	Chinisail T. Aman	Mohammad Ali Village : Nethpara Union : Kullagora Upazila : Durgapur District : Netrokona	09 May 2019 N-25.13° E-90.68°	
17.	FS-18	Chinisail-3 T. Aman	Rasel Mia Village: Dharmapasha Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	25 May 2019 24.900°N 91.016°E	
18.	FS-40	Moinashail T. Aman	Md. ALi Village : Dhapkai Union : Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.783°N 91.350°E	
19.	FM-35	Birushail T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	27 November 2019 25.06°N 91.44°E	
20.	FM-36	Laittashail T. Aman	Almas Ali Village:Kandigaon Union : Rongar chor Upazila: Sunamganj Sadar District : Sunamganj	27 November 2019 25.75°N 91.26°E	
21.	FM-37	Atonishail T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	27 November 2019 25.06°N 91.44°E	
22.	FM-38	Gandhishail T. Aman	Md. Shahjahan Village : Kandigaon Union : Dokkhinpara Upazila : Rongar chor District : Sunamganj	27 November 2019 25.75°N 91.26°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
23.	FM-39	Moinashail-2 T. Aman	Md. Abul Kashem Village : Buristhol Union : Mollapara Upazila: Sunamganj Sadar District : Sunamganj	27 November 2019 25.11°N 91.26°E	
24.	MM-08	Motamarang T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
25.	FI-01	Poshu shail/ Sylhetshail T. Aman	Ali Ahammad Village: Bristol Union: Mollapara Upazila: Shunamganj District: Shunamganj	20 July 2020 25.11°N 91.26°E	
26.	MSF-12	Dudhshail T. Aman	Abul Hoshen Village: Mushulli Union: Mushulli Upazila: Nandail District: Mymensingh	23 June 2020 25.08°N 90.538°E	
27.	MM-09	Sentu-16 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
28.	MM-10	Mery gold T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
29.	MM-12	Pairjaat T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
30.	MM-14	Chapal-2 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
31.	MM-16	Chapal-1 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
32.	MM-15	Sentu gold-12 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 25.14°N E- 90.19 °N	
33.	MM-17	Biroi-1 T. Aman	Sentu hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
34.	FS-06	Biroi-2 T. Aman	Ali Hossain Village : Ghosgao Union : Ghosgao Upazila : Dhobaura District : Mymensingh	23 June 2019 25.09°N 90.533°E	
35.	FS-27	Biroi dhan-1 T. Aman	Mokhlesh Village : Goatola Union : Goatola Upazila : Dhobaura District : Mymensingh	23 June 2019 25.091°N 90.533°E	
36.	FM-6	Biroi-3 T. Aman/ B. Aman	Md.Abul Kashem Village : Buristhol Union : Mollapara Upazila: Sunamganj Sadar District : Sunamganj	25November 2019 24.9000°N 91.0167°E	
37.	MM-20	Ful lota T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
38.	MM-21	Sentu-18 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
39.	MM-22	Sentu-19 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
40.	MM-24	Champamasuri T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
41.	MM-25	Sentu-17 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
42.	MM-26	Ful kainja T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
43.	MM-28	Soto shornolota T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
44.	MM-29	Sentu-15 T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
45.	MM-30	Gaindha T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 N-25.14° E-90.19 °	
46.	MM-31	Madhobilota T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 25.14°N E 90.19 °N	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
47.	MM-32	Lalmatia T. Aman	Sentu Hajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 25.14°N E 90.19 °N	
48.	H-01	Kalahapa Aus	Md. Abdul Gani Village: Kalitoli Union : Bhairab Upazila: Bhairab District: Kishoreganj	1 June 2018 25.14°N E- 90.19 °N	
49.	FA-01	Binnatoa Boro	Baten Mia Village: Kathgola Union : Khagdoho Upazila: Mymensingh Sadar District : Mymensingh	16 May 2019 24.43°N 90.79 °E	
50.	FA-02	Gourohati Boro	Baten Mia Village: Kathgola Union : Khagdoho Upazila: Mymensingh Sadar District : Mymensingh	16 May 2019 24.43°N 90.79 °E	
51.	FA-03	Begunbichi Aman	Baten Mia Village: Kathgola Union : Khagdoho Upazila: Mymensingh Sadar District : Mymensingh	16 May 2019 24.43°N 90.79 °E	
52.	FHS-01	Rati Boro (local Aromatic rice) Boro	Md. Abdul Latif Village : Chander chor Union : Gojaria Upazila : Bhairab District : Kishorganj	20 May 2019 25.09°N 90.53°E	
53.	FHS-02	Lafaya Boro	Md. Liton Village : Duoj Union : Duoj Upazila : Atpara District : Netrokona	16 May 2019 24.52°N 90.44 °E	
54.	FM-01	Chengri T. Aman	Md. Golam Azam Village: Saitola Union : Sreemangal Upazila: Sreemangal District: Moulvibazar	16 May 2019 24.31°N 91.73 °E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
55.	FM-02	Arai T. Aman	Md. Golam Azam Village: Saitola Union : Sreemangal Upazila: Sreemangal District: Moulvibazar	16 May 2019 24.31°N 91.73 °E	
56.	FMM-01	Laldinga Boro	Siddik Mia Village : Babigao Union : Surma Upazila : Sunamganj Sadar District : Sunamganj	16 May 2019 25.07°N 91.40 °E	
57.	FMM-02	Local (Boro)	Siddik Mia Village : Saidpur Union : Surma Upazila : Sunamganj District : Sunamganj	23 May 2019 24.90°N 91.02°E	
58.	FS-01	Lalkumri T. Aman	Md. Wasim Village : Shimultoli Union : Bakaljora Upazila : Durgapur District : Netrokona	9 January 2019 25.12°N 90.68°E	
59.	FS-03	Paijam T. Aman	Siddik mia Village : Terapur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 25.07°N 91.40 °E	
60.	FS-09	Lal paijam T. Aman	Baset Ali Village :Uttor Gamaritola Union : Gamaritola Upazila : Dhobaura District :Mymensingh	23 June 2019 25.0917°N 90.5333°E	
61.	FS-36	Paijam T. Aman	Taimur Ali Village : Dolua Union: Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.783°N 91.350°E	
62.	FS-41	Faijam T. Aman	Md. Ali Village: Dhapkai Union : Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.783°N 91.350°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
63.	FM-22	Desi pajjam T. Aman	Jainal Abedin Village : Laalpur Union : Mollapara Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.11°N 91.26°E	
64.	FM-25	Sada pajjam T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
65.	FM-26	Painjab T. Aman	Abul Kalam Village : Konagaon Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
66.	FS-04	Gobinda T. Aman	Abul Kalam Village : Bottola Union : Goatola Upazila : Dhobaura District : Mymensingh	23 June 2019 25.097°N 90.533°E	
67.	FS-05	Tulsimala T. Aman	Ali Hossain Village : Ghosgao Union : Ghosgao Upazila : Dhobaura District : Mymensingh	23 June 2019 25.091°N 90.533°E	
68.	FS-07	Chanmoni T. Aman	Baten Mia Village : Shimultoli Union : Bakaljora Upazila : Durgapur District : Netrokona	9 May 2019 25.12°N 90.68°E	
69.	FS-08	Hashemirri T. Aman	Hanif Mia Village : Arapara Union : Kullagora Upazila : Durgapur District : Netrokona	9 May 2019 25.120°N 90.687°E	
70.	FS-10	Boroabji T. Aman	Mohammad Ali Village : Arapara Union : Kullagora Upazila : Durgapur District : Netrokona	09 January 2019 25.1250°N 90.6875°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
71.	FS-12	Kalojira T. Aman	Mokhlesh Village : Goatola Union : Goatola Upazila : Dhobaura District : Mymensingh	23 June 2019 25.0917°N 90.5333°E	
72.	FM-19	Deshi kalojira T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila : Sunamganj Sadar District : Sunamganj	24November 2019 24.90°N 91.01°E	
73.	MSF-01	Kalijira T. Aman	Md. Ajim Uddin Village : Kushtia Union : Kushtia Upazila: Mymensingh Sadar District: Mymensingh	12 May 2020 25.0917°N 90.5333°E	
74.	FS-13	Bashiraj T. Aman	Motaleb Rahman Village : Chandigar Union : Chandigar Upazila : Durgapur District : Netrokona	9 May 2019 25.1250°N 90.6875°E	
75.	FS-14	Lombaail T. Aman	Motaleb Rahman Village : Chandigar Union : Chandigar Upazila : Durgapur District : Netrokona	9 May 2019 25.1250°N 90.6875°E	
76.	FS-15	Nagra T. Aman	Rasel Mia Village : Dharmapasha Union: Dharmapasha Sadar Upazila: Dharmapasha District : Sunamganj	25 May 2019 24.900°N 91.017°E	
77.	FS-16	Maloti T. Aman	Hashem Ali Village : Monjurabad Union : Golapganj Sadar Upazila : Golapganj District : Sylhet	25 May 2019 24°54'N 91°52'E	
78.	FS-17	Guamouri T. Aman	Rasel Mia Village : Dharmapasha Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	25 May 2019 24.900°N 91.016°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
79.	FS-19	Molaireti T. Aman	Rasel Mia Village : Dharmapasha Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	25 May 2019 24.900°N 91.016°E	
80.	FS-20	Putibirun T. Aman	Rasel Mia Village : Dharmapasha Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	25 May 2019 24.900°N 91.016°E	
81.	FM-13	Birun-1 T. Aman	Hafijul Islam Village : Puraton Gudigaon Union : Zahangirnogor Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25°66'N 91°44'E.	
82.	FM-14	Birun-2 T. Aman	Abul Kashem Village : Kandigaon Union : Rongarchor Upazila: Sunamganj Sadar District: Sunamganj	24November 2019 25°75'N 91°26'E.	
83.	FS-21	Kutimurar Birun T. Aman	Rasel Mia Village : Dharmapasha Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	25 May 2019 24.9000°N 91.0167°E	
84.	FS-24	Soragotobirun T. Aman	Wali ullah Village : Habibpur Union : Habibpur Upazila : Shalla District : Sunamganj	24 May 2019 24.900°N 91.016°E	
85.	FS-26	Ojana birun T. Aman	Aziz Rahman Village : Sukhaipur Union: Sukhair Rajpur Uttor Upazila : Dharmapasha District : Sunamganj	24 May 2019 24.90°N 91.016°E	
86.	FS-39	Kalobirun T. Aman	Md. ALi Village : Dhapkai Union : Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.7833°N 91.3500°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
87.	FS-42	Bedabirun T. Aman	Latifa Banu Village : Noagaon Union: Dharmapasha Sadar Upazila : Dharmapasha District : Sunamganj	24 May 2019 24.54°N 91.10°E	
88.	FM-08	Asamyo birun T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	25November 2019 24.9000°N 91.0167°E	
89.	FM-10	Laal birun T. Aman	Motiur Rahman Village : Rampur Union : Mannargaon Upazla : Sunamganj Sadar District : Sunamganj	25November 2019 25°04'N 91°24'E	
90.	FS-22	Guarchara-1 T. Aman	Rasel Mia Village : Dharmapasha Union : Dharmapasha Sadar Upazla : Dharmapasha District : Sunamganj	25 May 2019 24.9000°N 91.0167°E	
91.	FS-23	Chinigura-1 T. Aman	Rasel Mia Village : Mainpur Union : Surma Upazla: Sunamganj Sadar District : Sunamganj	23 May 2019 24.90°N 91.016°E	
92.	FM-18	Chinigura-2 T. Aman	Abul Kashem Village : Kandigaon Union : Rongarchor Upazila : Sunamganj Sadar District : Sunamganj	24 November 2019 25.75°N 91.26°E	
93.	MFS-21	Chiniguri T. Aman	Md. Jamir Uddin Village : Kumargata Union : Kumargata Upazila : Muktagacha District : Mymensingh	20 May 2020 25.091°N 90.533°E	
94.	M-23	Guabari T. Aman	Md. Jamir Uddin Village: Kumargata Union: Kumargata Upazila: Muktagacha District: Mymensingh	20 May 2020 25.091°N 90.533°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
95.	FS-25	Chakloshi T. Aman	Wali ullah Village : Habibpur Union : Habibpur Upazila : Shalla District : Sunamganj	24 May 2019 24.9000°N 91.0167°E	
96.	FM-15	Chaplash T. Aman	Abul Kashem Village : Kandigaon Union : Rongarchor Upazila: Sunamganj Sadar District: Sunamganj	24November 2019 25°75'N 91°26'E	
97.	FS-28	Mukta T. Aman	Wali Ullah Village : Habibpur Union : Habibpur Upazila : Shalla District : Sunamganj	24 May 2019 24.900°N 91.016°E	
98.	FS-29	Deshi-32 T. Aman	Wali Ullah Village : Habibpur Union : Habibpur Upazila : Shalla District : Sunamganj	24 May 2018 24.900°N 91.016°E	
99.	FS-30	Hashakalo T. Aman	Wali Ullah Village : Habibpur Union : Habibpur Upazila : Shalla District : Sunamganj	24 May 2019 24.900°N 91.016°E	
100.	FS-31	Shonajuri T. Aman	Keramot Ali Village : Bolorampur Union : Shalla Sadar Upazla : Shalla District : Sunamganj	24 May 2019 24.900°N 91.016°E	
101.	FS-32	Hasa sada T. Aman	Azmat Ali Village : Badaghat Union : Badaghat Upazila : Tahirpur District : Sunamganj	24 May 2019 24.900°N 91.016°E	
102.	FM-16	Chengermuri-1 T. Aman	Motuir Rahman Village : Rampur Union : Mannargaon Upazila : Doarbazar District : Sunamganj	24November 2019 25°65'N 91°26'E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
103.	FM-17	Chengermuri-2 T. Aman	Abul Kashem Village : Kandigaon Union : Rongarcho Upazila : Sunamganj Sadar District : Sunamganj	24November 2019 25.75°N 91.26°E	
104.	FS-34	Parbotjira T. Aman	Keramot Ali Village : Bolorampur Union : Shalla Sadar Upazila : Shalla District : Sunamganj	24 May 2019 24.900°N 91.016°E	
105.	FS-35	Noliguarchara T. Aman	Keramot Ali Village : Bolorampur Union : Shalla Sadar Upazila : Shalla District : Sunamganj	24 May 2019 24.9000°N 91.0167°E	
106.	FS-37	Laal cheng T. Aman	Taimur Ali Village : Dolua Union : Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.783°N 91.350°E	
107.	FS-38	Ailaguta T. Aman	Md. Akkas Village : Modhupur Union : Rajanogor Upazila : Dirai District : Sunamganj	25 May 2019 24.783°N 91.350°E	
108.	FM-3	Chollish (40) T. Aman	Md. Shahjahan Village : Kandigaon Union : Dokkhinpara Upazila : Rongarchor District : Sunamganj	27 November 2019 25.75°N 91.26°E	
109.	FM-4	Chechollish (46) T. Aman/ B. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	25 Novemer 2019 24.9000°N 91.0167°E	
110.	FM-5	Bolok T. Aman/ B. Aman	Md.Abul Kashem Village : Buristhol Union : Mollapara Upazila : Sunamganj Sadar District : Sunamganj	25November 2019 24.9000°N 91.0167°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
111.	FM-07	Abdul Halim dhan T. Aman/ B. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila : Sunamganj Sadar District : Sunamganj	25November 2019 24.9000°N 91.0167°E	
112.	FM-20	Deshi-32 T. Aman	Motiur Rahman Village : Rampur Union : Mannargaon Upazila: Sunamganj Sadar District : Sunamganj	24 November 2019 25.36°N 91.30°E	
113.	FM-22	Desi paijam T. Aman	Jainal Abedin Village : Laalpur Union: Mollapara Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.11°N 91.26°E	
114.	FM-23	Laal paijam T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
115.	FM-24	Dshi paijam-2 T. Aman	Montaj Ali Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	25November 2019 25.06°N 91.44°E	
116.	FFH-03	Sada paijam-2 T. Aman	Montaj ali Village : Muslimpur Union : Surma Upazila : Sunamganj Sadar District : Sunamganj	25November 2019 25.06°N 91.44°E	
117.	FFH-04	Painjab T. Aman	Abul Kalam Village : Konagaon Union : Surma Upazila : Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
118.	FM-27	Goarchara T. Aman	Abul Kashem Village : Kandigaon Union : Dokkhinpara Upazila : Rongar chor District : Sunamganj	24November 2019 25.75°N 91.26°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
119.	FM-28	Goarchara-2 T. Aman	Motiur Rahman Village : Rampur Union : Mannargaon Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
120.	FM-29	Khudbadal/ Chinigura T. Aman	Abul Kalam Village : Konagaon Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	24November 2019 25.06°N 91.44°E	
121.	FM-30	Kotkoti T. Aman	Abul Kashem Village : Kandigaon Union : Dokkhinpara Upazila : Rongar chor District : Sunamganj	24 November 2019 25.75°N 91.26°E	
122.	FM-31	Maloti T. Aman	Abul Kashem Village : Kandigaon Union : Dokkhinpara Upazila : Rongar chor District : Sunamganj	24 November 2019 25.75°N 91.26°E	
123.	FM-32	Maloti T. Aman	Chan Mia Village : Muslimpur Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	25 November 2019 25.06°N 91.44°E	
124.	FM-34	Murabadam T. Aman	Abul Kalam Village : Konagaon Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	27 November 2019 25.06°N 91.44°E	
125.	MSF-02	Jiradhan T. Aman	Abdul Motaleb Village : Charpakerdoho Union : Charpakerdoho Upazila : Madarganj District : Jamalpur	25 May 2020 24.88°N 89.76°E	
126.	MSF-03	Jirabuti T. Aman	Abdul Baset Village : Sidhuli Union : Sidhuli Upazila : Madarganj District : Jamalpur	25 May 2020 24.88°N 89.76°E	
127.	MSF-04	Rajbuti T. Aman	Zohurul Islam Village : Ganggail Union : Ganggail Upazila : Nandail District : Mymensingh	25 May 2020 24.56°N 90.69°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
128.	MSF-05	Chiniatob T. Aman	Shamsar Ali Village : Borogram Union : Borogram Upazila : Muktagacha District : Mymensingh	22 June 2020 24.76°N 90.25°E	
129.	MSF-06	Chini sakkhor T. Aman	Abdul Momen Village : Salla Union : Salla Upazila : Kalihati District : Tangail	20 May 2020 24.33°N 89.92°E	
130.	MSF-07	Shakkhor khora T. Aman	Main Uddin Village : Anaitara Union : Anaitara Upazila : Mirzapur District : Tangail	20 May 2020 25.13°N 82.56°E	
131.	MSF-08	Kaonkhir T. Aman	Md. Rubel Village : Bajgati Union : Bajgati Upazila : Nandail District : Mymensingh	26 May 2020 24.56°N 90.69°E	
132.	MSF-09	Khirshabuti T. Aman	Md. Chan Mian Village : Mogra Union : Mogra Upazila: TangailSadar District : Tangail	20 May 2020 24.26°N 89.86°E	
133.	MKF-01	Khirsapat T. Aman	Abdul Berek Village : Digpaith Union : Digpaith Upazila : Jamalpu Sadar District : Jamalpur	26 May 2020 24.92°N 89.94°E	
134.	MSF-10	Sadagura T. Aman	Zahir Uddin Village : Hadira Union : Hadira Upazila : Gopalpur District : Tangail	20 May 2020 24.56°N 89.92°E	
135.	MSF-11	Doiorgura T. Aman	Md. Rubel Village : Solimabad Union : Solimabad Upazila : Nagorpur District : Tangail	20 May 2020 24.05°N 89.87°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
136.	MSF-13	Chanmoni T. Aman	Abdul Latif Village : Mogra Union : Tangail Sadar Upazila : Mogra District : Tangail	20 May 2020 24.26°N 89.86°E	
137.	MSF-14	Ranjit T. Aman	Abdur Rashid Village : Latibabad Union : Latibabad Upazila : Kishoreganj Sadar District : Kishoreganj	22 June 2020 24.43°N 90.78°E	
138.	MSF-15	Sylhet balam T. Aman	Nabin Chandra Paul Village : Kandigaon Union : Kandigaon Upazila : Sylhet Sadar District : Sylhet	10 June 2020 24.96°N 91.81°E	
139.	MSF-16	Lalbalam T. Aman	Nabin Chandra Paul Village : Kandigaon Union : Kandigaon Upazila : Sadar, Sylhet District : Sylhet	10 June 2020 24.96°N 91.81°E	
140.	MSF-18	Shatta T. Aman	Abdul Baten Village : Goulabazar Union : Goulabazar Upazila : Balaganj District : Sylhet	10 June 2020 24.56°N 91.82°E	
141.	MSF-19	Hutra T. Aman	Mejbah Uddin Village : Bajitkhila Union : Bajitkhila Upazila: Sherpur Sadar District : Sherpur	25 May 2020 24.96°N 91.81°E	
142.	MSF-20	Ajanta T. Aman	Mobarak Hossen Village : Sadipur Union : Sadipur Upazila : Balaganj District : Sylhet	10 June 2020 24.65°N 91.82°E	
143.	MSF-17	Kasalath Boro	Md. Hashim Uddin Village : Karab Union : Karab Upazila : Lakhai District : Habiganj	12 June 2020 24.38°N 91.41°E	

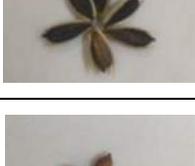
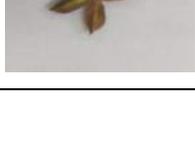
Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Ggeographical location and date	Photograph
144.	MKF-02	Halui T. Aman	Md. Rabin Village : Titpalla Union : Titpalla Upazila : Jamalpur Sadar District : Jamalpur	26 May 2020 24.90°N 89.95°E	
145.	FFH-07	Jagli Boro Boro	Mohammad Ali Village : Mokambari Union : Jointapur Upazila : Jointapur District : Sylhet	8November 2020 24°53 N 91°52 E	
146.	FFH-06	Baiyakauchi Boro	Kutub Mian Village : Satghori Union : Satbakh Upazila : Kanaighat District : Sylhet	8November 2020 24°53 N 91°52 E	
147.	FFH-09	Rata Boro Boro	Hanif Mian Village : Ranigaon Union : Ranigaon Upazila : Chunarughat District : Habiganj	7November 2020 24° 22 N 91° 24 E	
148.	FFH-08	Muraikka Boro	Hanif Mian Village : Noagaon Union : Mirpur Upazila : Bahubal District : Habiganj	7November 2020 24° 22 N 91° 24 E	
149.	FFH-05	Bayful Boro	Md.Abul Kashem Village : Buristhol Union : Mollapara Upazila: Sunamganj Sadar District : Sunamganj	25 November 2019 24.9000°N 91.0167°E	
150.	FFH-01	Ponkhiraj Aman	Ali Hossain Village : Ghosgao Union : Ghosgao Upazila : Dhobaura District : Mymensingh	23 June 2019 25.09°N 90.533°E	
151.	FFH-02	Thoa Aman	Ali Hossain Village : Ghosgao Union : Ghosgao Upazila : Dhobaura District : Mymensingh	23 June 2019 25.09°N 90.533°E	

Table 109. Passport information of collected spices, chilli (*Capsicum frutescens* L.), ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) germplasm

Sl. no.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
152.	S-01	Superhot master Rabi	Abdur Rahman Village: Sutiakhali Union: Boiara Upazila: Mymensingh Sadar District: Mymensingh	3 June 2018 25.14°N 90.19 °E	
153.	S-02	Balijhuri morich (Shyampur) Rabi	Md. Atab Uddin Village: Shyampur Union: Shyampur Upazila: Melandoho District: Jamalpur	18 October 2018 24.92° N 89.95 °E	
154.	S-03	Balijhuri (Kagmari) Rabi	Alom Mia Village: Jhaugora Union: Goalpara Upazila: Melandoho District: Jamalpur	2 March 2018 25.14°N 90.19 °E	
155.	S-04	Chata morich Rabi	Shah Alom Village: Sutiakhali Union: Boiara Upazila: Sadar District: Mymensingh	2 October 2018 25.45° N 90.24 °E	
156.	S-05	Ulto morich Rabi	Shah Alom Village: Sutiakhali Union: Boiara Upazila: Sadar District: Mymensingh	2 March 2018 25.45°N 90.24 °E	
157.	H-06	Turmeric (Local)	Abdul Gani Village : Bhairab Union : Bhairab Upazila : Bhairab District : Kishoreganj	19 October 2018 25.14°N 90.19 °E	
158.	FM-11	Ginger Haluaghat local Kharif	Abed Ali Village : Dhara Union : Dhara Upazila : Haluaghat District : Mymensingh	23 February 2019 25.0917°N 90.5333°E	

Sl. no.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
159.	FM-12	Ginger Modhupur local Kharif	Taimur Ali Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.900 0°N 91.0167°E	
160.	FM-13	Turmeric Modhupur local Kharif	Md. Abdul Latif Village : Golabari Union : Golabari Upazila : Madhupur District : Tangail	20 January 2019 24.9000°N 91.0167°E.	

Table 110. Passport information of collected bittergourd (*Momordica charantia*), eggplant (*Solanum melongena*), white gourd (*Benincasa hispida*), sweetgourd (*Cucurbita moschata*), bottle gourd (*Lagenaria siceraria*) and sponge gourd (*Luffa aegyptiaca*) germplasm

Sl. No.	Collector's No.	Cultivar/local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
161.	M-01	Matikorla Rabi	Rasel mia Village: Komorchor Union: Komorchor Upazila: Melandoho District: Jamalpur	19 October 2018 25.14°N 90.19 °E	
162.	M-02	Bolderusta	Rasel mia Village: Komorchor Union: Komorchor Upazila: Melandoho District: Jamalpur	19 October 2018 24.92° N -89.95 °E	
163.	F-1	Goj corolla	Ashrab Ali Village: Sitra Union: Sitra Upazila: Sadar District: Mymensingh	10 February 2020 24.78° N 90.3 5 °E	
164.	M-03	Taal Begun Rabi	Habibur Rahman Village: Belgacha Union : Belgacha Upazila : Islampur Dist. Jamalpur	28 October 2018 24.92° N 89.95 °E	

Sl. No.	Collector's No.	Cultivar/local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
165.	M-4	Local Begun (Norshingdi) Rabi	Habibur Rahman Village: Belgacha Union : Belgacha Upazila : Islampur Dist. Jamalpur	28 October 2018 25.14°N 90.19 E	
166.	M-5	Local Begun Rabi	Sentuhajang Village: Chatkeya Union: Noyabil Upazila: Nalitabari District: Sherpur	1 June 2018 25.14°N 90.19 E	
167.	FMI-01	Islampuri begun Rabi	Shajahan Village: Balijuri Union : Madarganj Upazila: Madarganj District: Jamalpur	1 July 2020 24.90° N 89.71° E	
168.	FMI-02	Gaforgaon Begun Rabi	Belal uddin Village : Datter bazar Union : Datter Bazar Upazila : Gaforgaon District : Mymensingh	15 July 2020 24.45° N 90.54° E	
169.	FMI-03	Jhumki begun Rabi	Al Amin Village: Madhupur Union: Madhupur Upazila: Madhupur District: Tangail	10 July 2020 24.26° N 86.64° E	
170.	FMI-04	Golbegun Rabi	Belal uddin Village: Datter bazar Union: Datter Bazar Upazila: Gaforgaon District: Mymensingh	15 July 2020 24.45° N 90.54° E	
171.	FMM-11	Singnath Rabi	Mobarak Village : Fenibil Union : Jahangirnagar Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
172.	FMM-12	Mohisasing Rabi	Chanmia Village : Fenibil Union : Jahangirnagar Upazila: Sunamganj Sadar District: Sunamganj	23 May 2019 24.9000°N 91.0167°E	

Sl. No.	Collector's No.	Cultivar/local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
173.	FMM-14	White gourd local (Sunamganj) Rabi	Ayesha Khatun Village : Muslimpur Union : Surma Upazila : Surma District : Sunamganj	23 February 2019 24.9000°N 91.0167°E	
174.	FM-03	White gourd Local (Vabokhali) Rabi	Shafikul Islam Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.9000°N 91.0167°E	
175.	FM-04	White gourd Local (Sinha) (Modhupur) Summer	Amzad Ali Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	
176.	FM-06	Sweet gourd / matilau Kharif	Amzad Ali Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	
177.	FM-07	Sweet gourd Local Modhupur Oron khola Kharif	Amzad Ali Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	
178.	FM-09	Sweet gourd Zolchotro lau/khet lau Kharif	Milton Kumar Village : Alokdia Union : Alokdia Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	
179.	FM-08	Bottle gourd Modhupur lau Kharif	Md. Helal Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	

Sl. No.	Collector's No.	Cultivar/local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
180.	FM-10	Spongegourd Sogorika Kharif	Mamun Sarkar Village : Oronkhola Union : Oronkhola Upazila : Madhupur District : Tangail	23 February 2019 24.6167°N 90.0250°E	
181.	FM-35	Okra Baromasi	Naeb Ali Village : Kustia Union : Kustia Upazila: Kustia Sadar District : ymensingh	23 February 2020 23.90°N 89.12°E	
182.	FM-36	Okra Local Sunamganj	Md. Rubel Village : Dhalagao Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	10 February 2020 24.45°N 90.54°E	
183.	FM-37	Okra Local Modhupur	Aiman Village : Tarati Union :Tarati Upazila: Muktagacha District: Mymnsingh	12 February 2020 24.42°N 90.51°E	

Table 111. Passport information of collected french bean (*Phaseolus vulgaris*) and hyacinth bean (*Lablab purpureus*) germplasm

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
184.	FMM-03	Forasi sim Rabi	Siddik Mia Village : Dhalagao Union : Surma Upazila: Sunamganj Sadar District: Sunamganj	23 May 2019 24.9000°N 91.0167°E	
185.	FMM-04	Khoilla sim Rabi	Abul Kalam Village : Haluargaon Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
186.	FMM-05	Sada nag Rabi	Asmani Village : Shologhor Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
187.	FMM-06	Ankhi sim Rabi	Abul Kalam Village : Haluargaon Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
188.	FMM-07	Hatir kani/ Goal gadda Rabi	Raghunath Village : Kalengarpar Union : Hatkhola Upazila : SylhetSadar District : Sylhet	23 May 2019 24.9000°N 91.0167°E	
189.	FMM-08	Kaikka sim Rabi	Asma Khatun Village : Shologhor Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
190.	FMM-09	Chitagaia sim Rabi	Abdul Momen Village : Bagmara Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
191.	FMM-10	Bampata sim Rabi	Asma Khatun Village : Shologhor Union : Surma Upazila: Sunamganj Sadar District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	

Table 112. Passport information of collected groundnut (*Arachis hypogaea*), mustard (*Brassica sp.*) and blackgram (*Vigna mungo*) germplasm

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
192.	H-02	Soto Elachibadam (Kharif)	Abdul Gani Village: Bhairab Union : Bhairab Upazila : Bhairab Dist. Kishoreganj	19 October 2018 25.14°N 90.19E	
193.	H-03	Boro Elachibadam (Kharif)	Abdul Gani Village: Bhairab Union : Bhairab Upazila : Bhairab Dist. Kishoreganj	19 October 2018 25.14°N 90.19E	
194.	H-04	Tridanabadam (Kharif)	Abdul Gani Village: Bhairab Union : Bhairab Upazila : Bhairab Dist. Kishoreganj	19 October 2018 25.14°N 90.19 °E	

Sl. No.	Collector's No.	Cultivar /local name/cultural practice	Donor's name and address	Geographical location and date	Photograph
195.	F-02	Khenkhen Kharif	Abdul Mazid Village: Ashtadhar Union : Ashtadhar Upazila : Sadar Dist. Mymensingh	10 February 2020 25.74°N 90.42 °E	
196.	FMM-13	Deshi sorisha Rabi	Shafikul Islam Village : Vati tahirpur Union: Tahirpur Sadar Upazila : Tahirpur District : Sunamganj	23 May 2019 24.9000°N 91.0167°E	
197.	F-03	Sadatil	Anwar Hossen Village : Rasulpur Union : Rasulpur Upazila : Gaforgaon District : Mymensingh	11 February 2020 25.64°N 90.40 °E	
198.	F-04	Kalotil	Abdul Muhit Village : Daogao Union : Daogao Upazila : Muktagacha District : Mymensingh	13 February 2020 24.76°N 90.25 °E	
199.	H-05	Mashkalai (Local) Rabi	Abdul Gani Village : Bhairab Union : Bhairab Upazila : Bhairab District : Kishoreganj	19 October 2018 25.14°N 90.19 °E	

MM = Mirza Mofazzal Islam, DG, BINA, SB = Shamsun Nahar Begum, PSO. PBD; F = Fahmina Yasmine, SSO, PBD; ST = Sadia Tasmin, SSO, HRD; M = Mehedi Hasan, SO, HRD; MI = Majharul Islam, SO, SSD; FH = Forhad Hossain, SO, Sunamganj, SA = Md. Shahjahan Ahmed, ASO, PBD; H = Md. Habibur Rahman Mridha SA-1, PBD and Md. Aktar Hossain, SA-2, PBD.

11.6.2. Morphological Characterization Local Landraces of Aman Rice Collected from Mymensingh Region during 2018

The experiment was carried out during the period from July to December 2018. In this study, 31 rice germplasm were used as plant materials. The list of the experimental materials along with their sources of collection is shown in Table 113.

Table 113. List of test rice germplasm

SL No.	Local name	Collector's number	SL No.	Local name	Collector's number
1	Gaindha	MM-30	17	Markabinni	MM-05
2	Purabinni	MM-01	18	Bishalibinni	MM-06
3	Fulkainja	MM-26	19	Goatibinni	MM-04
4	Rupashail	MM-23	20	Shongbinni	MM-18
5	Leda binni	MM-19	21	Sentu-18	MM-21
6	Biroi	MM-17	22	Fullota	MM-20
7	Chapal	MM-16	23	Mery gold	MM-10

SL No.	Local name	Collector's number	SL No.	Local name	Collector's number
8	Sentu-15	MM-29	24	Lalmatia	MM-32
9	Sentu-19	MM-22	25	Chapal-2	MM-14
10	Lalchinishail	MM-07	26	Sentu-6/ Madhobilota	MM-30
11	Dudhbinni	MM-27	27	Sentushail	MM-13
12	Champamashuri	MM-24	28	Sentu-17	MM-25
13	Chotosornolota	MM-28	29	Sentu-16	MM-09
14	Motamorang	MM-08	30	Ranishail	MM-11
15	Pairjaat	MM-12	31	Sentu-5/Malonchi	MM-02
16	Sentu gold	MM-15			

Characterization based on qualitative characters by DUS test

Thirty one rice germplasm were evaluated considering 31 qualitative and morphological traits to characterize the germplasm as per BRRRI descriptor (2018). All the germplasm scored exactly same for the traits such as blade pubescence, basal leaf sheath color, ligule shape, auricle color and decorticated grain and aroma (Table 114). Such result indicated that there was no variation for these traits among the studied germplasm. Differences were found in the germplasm studied for rest of the qualitative characteristics. A wide range of variation was found in all the germplasm for blade color, leaf angle, flag leaf angle, culm angle, internode color, culm strength, panicle exertion, shattering, thresh ability, apiculus color, stigma color, lemma and palea color, lemma and palea pubescence, sterile lemma color, seed coat color and leaf senescence.

Low to moderate variability was observed for leaf sheath, anthocyanin color, ligule color, collar color, culm anthocyanin color, panicle type, secondary branching, axis, and awn distribution, awn color and endosperm type.

Table 114. Characterization of rice germplasm based on qualitative characters, T. Aman, 2019

Sl. No.	Character	State of characters	No. of germplasm	Germplasm (serial no. in Table 113)	Frequency (%)
1	Blade Pubescence	Glabrous	31	All	100
2	Blade color	Pale green	1	3	9.68
		Green	21	1,2,4,6,7,10,11,12,15,16,17,20,21,22,24,25,26,27,29,30,31	67.74
		Dark green	8	5,8,9,13,14,18,19,23	25.81
3	Leaf sheath: Anthocyanin color	Absent	30	1,2,3,4,5,6,7,8,9,10,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31	96.77
		Present	1	11	3.23
4	Basal leaf sheath color	Green	31	All	100
5	Leaf angle	Erect	12	11,13,14,15,24,25,26,27,28,29, 30,31	38.71
		Horizontal	19	1,2,3,4,5,6,7,8,9,10,12,16,17,18,19,20,21,22,23	61.29
6	Flag leaf angle	Erect	16	3,4,8,9,13,14,18,19,24,25,26,27,28,29,30,31	51.61
		Semi-erect	15	1,2,5,6,7,10,11,12,15,16,17,20,21,22,23	48.39
7	Ligule color	White	25	1,3,5,6,7,8,10,12,13,15,16,17,18,19,21,22,23,24,25,26,27,28,29,30,31	80.65
		Purple lines	5	2,4,9,14,20	16.13
		Purple	1	11	3.23

Sl. No.	Character	State of characters	No. of germplasm	Germplasm (serial no. in Table 113)	Frequency (%)
8	Ligule shape	2-cleft	31	All	100
9	Collar color	Pale green	29	1,2,3,4,5,6,7,9,10,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31	93.55
		Green	1	8	3.23
		Purple	1	11	3.23
10	Auricle color	Pale green	31	All	100
11	Culm anthocyanin color	Absent	30	1,2,3,4,5,6,7,8,9,10,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31	96.77
		Present	1	11	3.23
12	Culm angle	Erect	17	4,5,8,9,12,13,16,19,22,24,25,26,27,28,29,30,31	54.84
		Intermediate	9	1,3,6,7,10,11,14,17,18,23	29.03
		Open	3	2,20,21	9.68
		Spreading	1	15,	3.23
13	Internode color	Green	19	2,3,4,5,8,9,11,12,14,15,16,18,20,22,23,24,27,29,30	61.29
		Light gold	12	1,6,7,10,13,17,19,21,31 25,26,28	38.71
14	Culm strength (lodging resistance)	Strong	1	18	3.23
		Moderately strong	10	5,6,8,9,16,20,25,26,29,30	32.26
		Intermediate	8	3,4,14,22,23,24,27,28	25.81
		Weak	11	1,2,7,10,11,12,13,15,17,21,31	35.48
		Very weak	1	19	3.23
15	Panicle type	Intermediate	27	1,3,4,5,7,8,9,10,11,12,13,14,15,16,17,18,20,21,22,23,24,25,26,28,29,30,31	87.10
		Open	4	2,6,19,27	12.90
16	Secondary branching	Absent	7	2,5,6,7,8,11,20	22.58
		Light	24	1,3,4,9,10,12,13,14,15,16,17,18,19,21,22,23,24,25,26,27,28,29,30,31	77.42
17	Panicle exertion	Partly exerted	8	5,12,13,16,22,25,26,28	25.81
		Just exerted	10	8,9,10,11,14,17,18,20,21,31	32.26
		Moderately well exerted	11	1,2,3,4,6,7,15,23,24,29,30	35.48
		Well exerted	2	19,27	
18	Axis	Straight	10	4,5,8,16,17,18,19,20,29,30	32.26
		Droopy	21	1,2,3,6,7,9,10,11,12,13,14,15,21,22,23,24,25,26,27,28,31	67.74
19	Shattering	Very low	20	2,4,5,14,15,16,17,18,19,21,22,23,24,25,26,27,28,29,30,31	64.52
		Low	8	1,3,6,9,11,12,13,20	25.81
		Moderate	3	7,8,10	9.68
20	Threshability	Difficult	1	19	3.23
		Moderately difficult	4	5,16,17,31	12.90
		Intermediate	18	1,2,3,4,6,9,11,12,13,14,15,21,22,23,26,28,29,30	58.07
		Loose	4	7,8,10,26	12.90
		Easy	4	18,20,24,27	12.90
21	Awn: distribution	None	25	1,2,4,6,7,8,9,10,11,12,13,14,15,16,17,21,22,23,24,25,26,27,28,29,31	80.65
		Tip only	4	3,5,20,30	12.90
		Upper quarter only	1	18	3.23
		Upper three-quarters only	1	19	3.23
		Whole length			0

Sl. No.	Character	State of characters	No. of germplasm	Germplasm (serial no. in Table 113)	Frequency (%)
22	Awn color	Straw	4	3,5,18,30	12.90
		Gold			0
		Brown (tawny)	2	19,20	6.45
23	Apiculus color	Straw	11	6,8,14,15,16,20,24,25,26,27,28	35.48
		Brown	14	1,3,4,7,9,10,12,13,21,22,23,29,30,31	45.16
		Red apex	2	18,19	6.45
		Purple	1	5	3.23
		Black	3	2,11,17	9.68
24	Stigma color	White	2	6,11	6.45
		Light green	2	2,7	6.45
		Yellow	22	1,3,4,8,9,12,13,14,16,17,19,21,22,23,24,25,26,27,28,29,30,31	70.97
		Light purple	2	5,10	6.45
		Purple	3	15,18,20	9.68
25	Lemma and palea color	Straw	6	12,25,26,27,28,30	19.36
		Gold & gold furrows on straw background	5	15,16,20,23,24	16.13
		Brown spots on straw	2	1,14,	6.45
		Brown furrows on straw	7	3,4,7,17,19,22,29	22.58
		Brown	4	6,8,13,21	12.90
		Reddish to light purple	2	9,31	6.45
		Purple	3	5,10,18	9.68
		Black	2	2,11	6.45
		White			
26	Lemma and palea pubescence	Glabrous	22	1,2,3,4,6,7,8,10,12,15,16,20,22,23,24,25,26,27,28,29,30,31	70.97
		Hairs on upper portion	3	17,19,21	9.68
		Short hairs	6	5,9,11,13,14,18	19.36
27	Sterile lemma color	Straw	14	1,2,3,4,6,13,16,22,23,24, 25,26,29, 30	45.16
		Gold	10	8,10,12,14,15,18,20,27,28,31	32.26
		Red	6	7,9,11,17,19,21,	19.35
		Purple	1	5	3.23
28	Seed coat (bran) color	White	20	2,3,4,5,7,8,9,12,13,14,15,16,17,18,21,22,23,29,30,31	64.52
		Light brown	5	11,19,26,27,28	16.13
		Speckled brown	1	25	3.23
		Brown	1	24	3.23
		Red			0
29	Endosperm type	Variable purple	3	6,10,20	9.68
		Non-glutinous (no waxy)	2	10,19	6.45
		Glutinous (waxy)	23	2,3,4,5,6,8,9,12,13,14,15,16,17,18,21,22,23,25,26,27,29,30,31	74.19
30	Decorticated grain: Scent (aroma)	Intermediate	6	1,7,11,20,24,28	19.36
		Non-scented	31		100
31	Leaf senescence	Very early	11	4,6,10,13,14,17,19,21, 25,26,31	35.48
		Early	2	7,12	6.45
		Intermediate	5	1,11,15,16,31	16.13
		Late and slow	8	3,8,9,18,20,22,24,30	25.81
		Very late	5	2,5,23,27,29	16.13

Characterization based on quantitative characters by DUS test

Range, mean, standard deviation (SD) and coefficient of variation (CV) of different quantitative characters of 31 T. Aman (2018) rice germplasm have been shown in Table 115. The range of plant height was found 71.33 cm to 134.67 cm. The tallest plant height was found in Ranishail (134.67 cm) whereas the shortest plant was recorded in Lalmatia germplasm (71.33 cm) and average plant height was 105.26 cm. The average days to 50% flowering were 109 and range was found as 97.67 to 118. Among the studied germplasm, the highest data for days to 50% flowering was recorded for Shongbinni (118 days) followed by Ledabinni and Ranishail (117.67 days) which exhibited late flowering whereas days 50% flowering was the lowest in Sentu-5 (97.67 days).

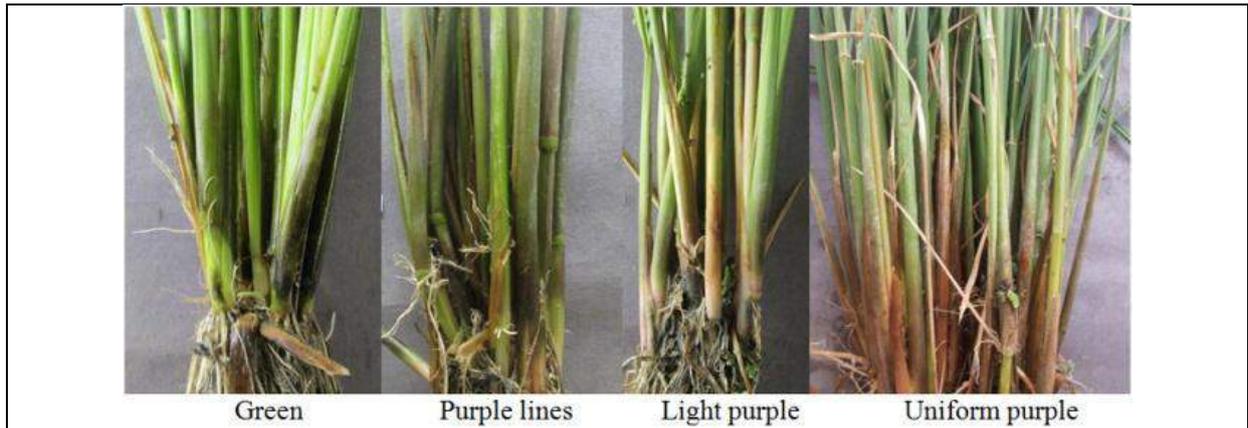
Days to maturity ranged from 135.33 to 151.33 days with the average of 145.62 days. Gaindha (151.33 days), Mery gold (151.33 days) and Ranishail (151.33 days) showed the maximum days to maturity whereas Sentu-17 showed the minimum days to maturity (135.33 days). Sentu-16 had the maximum number of total tillers hill⁻¹ (18.00) whereas Pairjaat had minimum number of total tillers hill⁻¹(8.67) with the average of 14.25. The CV% for number of effective tillers hill⁻¹ was 15.78%. Sentu-16 had the highest number of effective tillers hill⁻¹ (16.50) followed by Ranishail (16.33) whereas Fullota (5.33) had the lowest number of effective tillers hill⁻¹. Gaindha had the longest panicle (28.83 cm) whereas Rupashail (22.33 cm) had the shortest panicle (Fig.87).

The highest number of filled grains panicle⁻¹ was recorded for Ranishail (250.11) whereas, in Gaindha, the lowest number of filled grains panicle⁻¹ was recorded (70.03). Sentu-5 had the maximum number of unfilled grains panicle⁻¹ (66.67) and Purabinni had the minimum number of unfilled grains panicle⁻¹ (9.11). 1000-grain weight was marked the highest in Bishalibinni (31.42 g) followed by Fulkainja (28.13 g) whereas the lowest in Gaindha (9.38g). Among the studied rice germplasm, the highest grain yield was recorded in Sentu-16 (10.33 g) followed by Ranishail (10.17 g plant⁻¹) and lowest in Gaindha (4.91 g).

Table 115. Variability in test rice germplasm considering 10 quantitative characters, Boro, 2018-19

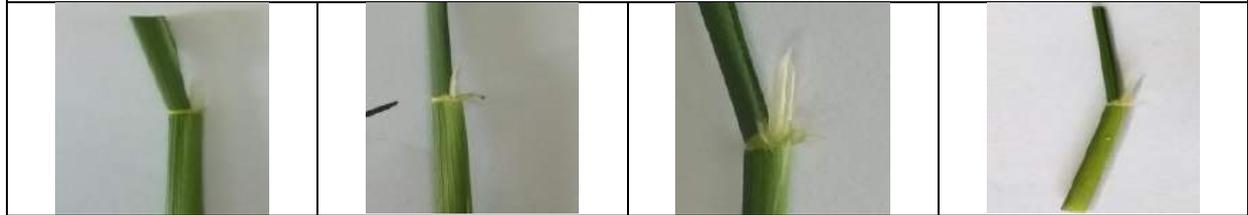
Character	Range	Mean	SD	CV (%)
Plant height (cm)	71.33- 134.67	105.26	18.44	17.52
Days to 50% flowering	97.67- 118	109.3	4.78	4.37
Days to 80% maturity	135.33-151.33	145.62	5.61	3.85
Number of total tillers hill ⁻¹	8.67- 18	14.25	2.25	15.78
Number of effective tillers hill ⁻¹	5.33 - 16.5	11.88	2.67	22.47
Panicle length (cm)	22.33 - 28.83	24.69	1.50	6.08
Number of filled grains panicle ⁻¹	70.03 - 250.11	173.01	40.93	23.66
Number of unfilled grains panicle ⁻¹	9.11-66.67	28.26	15.00	53.07
1000-grain weight (g)	9.38 - 31.42	19.33	5.02	25.99
Grain yield plant ⁻¹ (g)	4.91-10.33	8.42	1.15	13.64

Conclusion: The traits blade color, leaf angle, flag leaf angle, culm angle, internode color, culm strength, panicle exertion, shattering, thresh ability, apiculus color, stigma color, lemma and palea color, lemma and palea pubescence, sterile lemma color, seed coat color and leaf senescence were found as desired traits which could be used for further development of rice. Sentu-16 and Ranishail was the promising germplasm for higher yield and Sentu-17 was for short duration.

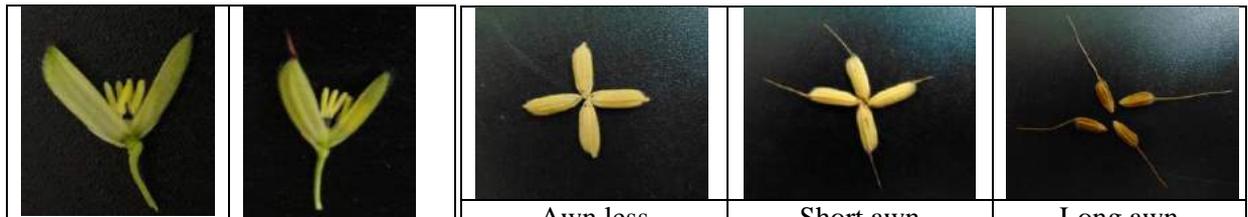


Green Purple lines Light purple Uniform purple

Basal leaf sheath color



Variation in ligule colour and shape



Absent

Present

Awn less

Short awn

Long awn

Lemma: anthocyanin colouration of apex

Variation in awn



White

Light brown

Light red

Red

Decorticated grain: color



Short

Medium

Long

Decorticated grain: length

Fig. 87. Leaf sheath color, ligule color and shape, lemma color, awn variation, grain color and length of rice germplasm

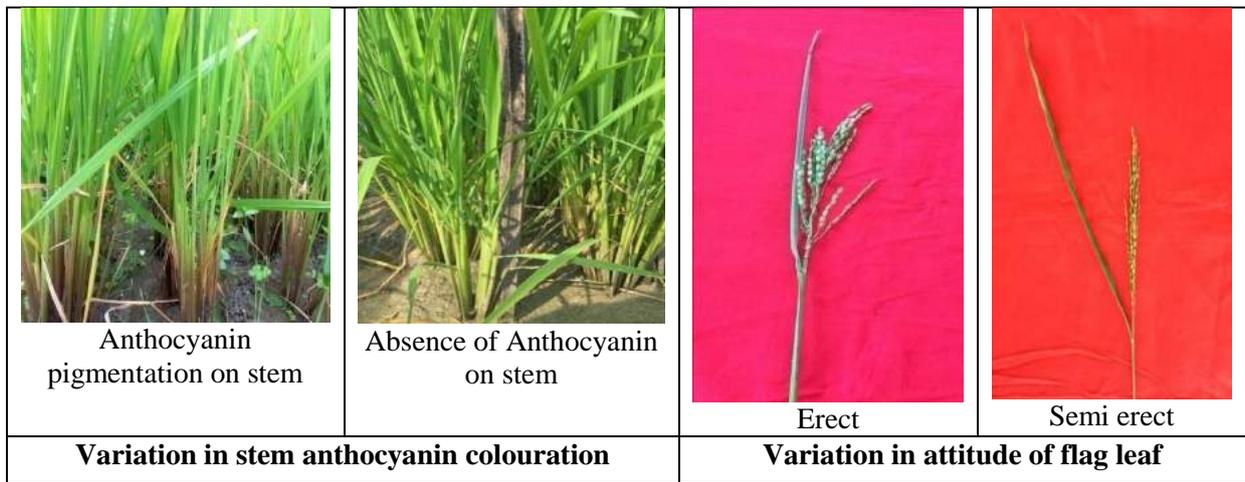


Fig. 87. Leaf sheath color, legule color and shape of rice germplasm (cont'd)

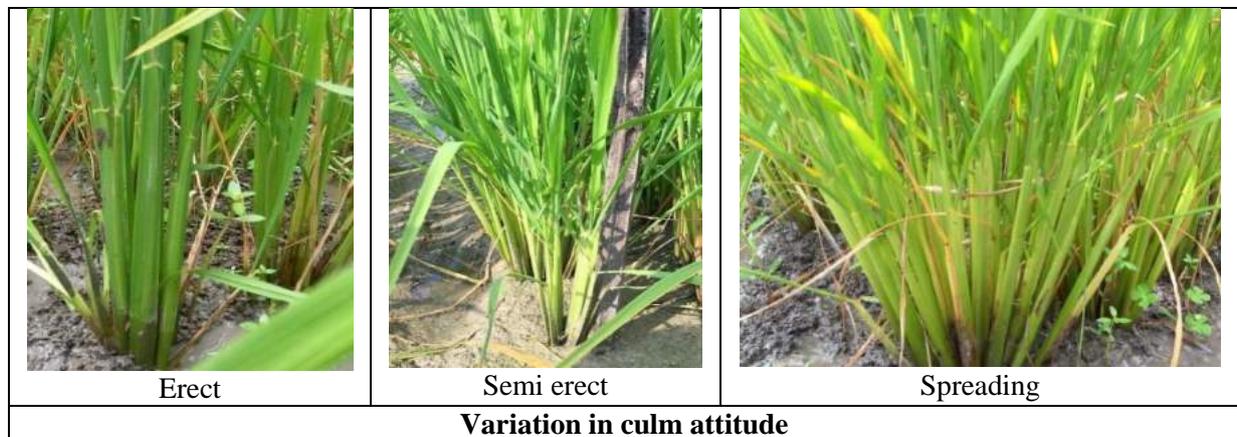


Fig. 88. Stem anthocyanin color, attitude of flag leaf and culm of rice germplasm

11.6.3. Morphological Characterization of Rice Landraces during Aman, 2019 Season

Continuous effort is needed to develop high yielding rice varieties to feed the ever increasing population. Therefore, study of morphological characterization of the germplasm is very much essential to find the desirable traits to use as potential breeding tool. In this regard, forty two rice germplasm were evaluated to assess the variation considering 10 quantitative and 31 qualitative traits under field condition during the period from July to December 2019 at the BINA Head Quarters Farm, Mymensingh following Randomized Complete Block Design (RCBD) with three replications. Qualitative characterization by DUS test revealed that a wide range of variation was observed among the studied germplasm for blade color, leaf angle, flag leaf angle, culm angle, internode color, culm strength, panicle exertion, axis, shattering, threshability, apiculus color, stigma color, lemma and palea color, lemma and palea pubescence, sterile lemma color, seed coat color and leaf senescence. Therefore, this study would be helpful for breeders and researchers to choose and identify the restoration and conservation of beneficial genes for crop improvement. The experiment was carried out during the period from July to December 2019. In this study, 42 rice germplasm were used as plant materials. The list of the experimental materials along with their sources of collection is shown in table 116.

Table 116. List of test rice germplasm

SL No.	Rice germplasm	Collector's number	SL No.	Rice germplasm	Collector's number
1	Ailagota	FS-38	22	Guar chara	FS-22
2	Kaijam	FS -36	23	Putibirun	FS-20
3	Kalobirun	FS-39	24	Guabari	M-23
4	Mukta	FS-28	25	Molairati	FS-19
5	Moinashail	FS-40	26	Guamouri	FS-17
6	Deshi-32	FS-29	27	Maloti	FS-16
7	Paijam	FS-03	28	Nagra	FS-15
8	Bedhabirun	FS-42	29	Lomba ail	FS-14
9	Chengermuri	FS-33	30	Bashiraj	FS-13
10	Parbotjira	FS-38	31	Kalojira	FS-12
11	Lalcheng	FS-37	32	Boroabji	FS-10
12	Hasakalo	FS-30	33	Lalpaijam	FS-09
13	Shonajuri	FS-31	34	Chinishail	FS-11
14	Noliguar chara	FS-35	35	Chinishail-3	FS-3
15	Hasa sada	FS-32	36	Hashemirri	FS-08
16	Birui dhan	FS-06	37	Chanmoni	FS-07
17	Ojanabirun	FS-26	38	Birui	FS-06
18	Soragotobirun	FS-24	39	Gobinda	FS-04
19	Chaklosh	FS-25	40	Sadapaijam	FS-03
20	Kutimurarbirun	FS-21	41	Kashiabinni	M-02
21	Chinigura-1	FS-23	42	Lalkumri	FS-01

Characterization based on qualitative characters by DUS test

A total of 42 rice land races were taken for DUS characterization using 37 characters which include 18 qualitative and seven quantitative characters as per BRRI descriptor (2018). The rice landraces undertaken for this study showed wide range of distinctiveness characters for all most all the morphological traits studied. Frequency distribution for all the characters under study was computed and qualitative and quantitative characters of different agronomic and morphological parameters are given in Table 117. Out of 42 germplasm studied, 90.48% germplasm didn't show anthocyanin coloration of apex while only 9.52% exhibited the anthocyanin colouration on leaf sheath. In case of blade pubescence 69.05% germplasm exhibited glabrous, 28.57% exhibited intermediate and only one germplasm had shown pubescent.

All most all the landraces were of green coloured basal leaf sheath, among the germplasm only one germplasm (Maloti) had purple green and 3 had light green basal leaf sheath color. With respect to leaf characters, among 42 germplasm, 36 had shown erect leaf angle, 5 had horizontal and one germplasm Lombaail had drooping type of leaf angle of main axis. In case of legule shape, most of the germplasm (95.25%) had 2-cleft legule shape. For collar color and auricle color most of the germplasm were pale green. Anthocyanin color in culm was absent in 37 germplasm and present in 6 germplasm. Most of the germplasm (64.29%) had erect culm angle, 9 had intermediate, 4 had open and 2 germplasm (Kalabirun and Chengermuri) had spreading culm angle.

Among 42 germplasm, 23 germplasm had strong lodging resistance while 6 had shown very weak performance to lodging resistance. But at dough stage, 100% plants of 10 germplasm had lodged and the plants of 22 germplasm had not lodged. Compact and enclosed panicle was

found in 8 germplasm (Kaijam, Kalobirun, Ojanabirun, Kalojira, Boroabji, Hashemiri, Gobinda and sadapaijam). With respect to panicle characters, 23.81% germplasm were straight and 76.19% germplasm were of drooping type of panicle curvature of main axis.

In case of awn distribution, 71.43% germplasm recorded the absence of awns and 12 germplasm (i.e. Chengermuri, Molaireti, Chanmoni, Kashiabinni, Kalobirun, Chaklosh, Kutimurarbirun, Lombaail, Sonajuri, putibirun, Chinigura-1, and Lalpaijam) recorded the presence of awns. Out of which, six germplasm found straw, four germplasm were brown and two germplasm had purple coloured awns. In stigma colour, 73.80% cultivars exhibited white stigma, 23.81% landraces were of light green stigma and 2.38% were of purple stigma.

With regard to colour of the lemma and palea, 47.48% of germplasm were straw colour, 33.33% germplasm recorded gold and gold furrows on straw background, 2.38% germplasm were of brown spots on straw, 2.38% germplasm were of brown furrows on straw, 4.76% germplasm were of brown, 4.76% germplasm were reddish to light purple, 2.38% germplasm were of brown (tawny), 4.76% germplasm were purple and 4.76% germplasm were of black. In case of density of pubescence of lemma, 32 germplasm exhibited short hairs, 2 germplasm with long hairs, 6 germplasm with hairs on lemma keel and 22 germplasm had no pubescence. All most all the landraces were of straw coloured sterile lemma, except for 7 germplasm, which have gold and purple colour sterile lemma. For the character seed coat (bran) colour of 11 germplasm were of white in colour, 13 germplasm were of light brown, 14 germplasm were of Speckled brown, 3 germplasm were of brown and 14 germplasm exhibited Variable purple type seed coat color. Non-glutinous (no waxy) endosperm was found in 11 germplasm, 22 germplasm had shown glutinous endosperm and 9 germplasm had shown Intermediate type endosperm. Aroma of decorticated grain was recorded in six germplasm, among them Parbotjira was lightly scented and 5 germplasm (Hasakalo, Chinigura-1, Kalojira, Chinishail and Chinishail-3) were of highly scented.

Table 117. Characterization of rice germplasm based on qualitative characters, T. Aman, 2019

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (Table 116)	Frequency (%)
1	Blade Pubescence	Glabrous	29	1,2,3,4,5,6,7,8,9,10,11,12,14,22,23,24,26, 27, 28,30,31,32,33,34,35,37,38,39,42	69.05
		Intermediate	12	15,16,17,18,19,20,21,25,29,36, 40,41	28.57
		Pubiscent	1	13	2.38
2	Blade color	Pale green (1)	9	4,7,8,15,24,26,34,39,42	21.43
		Green (2)	25	3,5,6, 10,14,16,17,18,19,20,21,22,23, 25, 27,28,29,30,32,33,35,36,38,40,41	59.53
		Dark green (3)	6	1,9,11,13,31, 37	14.29
		Purple tips (4)	1	2	2.38
		Purple (7)	1	12	2.38
3	Leaf sheath: Anthocyanin color	Absent (1)	38	1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,20,22,24,25, 26,27,28,29,30,31,32,33,34,35,36, 37,38,40, 41, 42	90.48
		Present (9)	4	13, 21, 23, 39	9.52
4	Basal leaf sheath color	Green (1)	38	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,22,23, 24,25,26, 28,29, 30,31,32,33,34,35,36, 38,39,40, 42	90.48
		Purple green (2)	1	27	2.38
		Light green(3)	3	21, 37, 41	7.14
5	Leaf angle	Erect (1)	36	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,18,19,20,21, 22,23, 24,25,26,27, 28, 30,32,34,36, 37,38,39, 40, 41, 42	85.72

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (Table 116)	Frequency (%)
		Horizontal (5)	5	15,17,31,33, 35	11.91
		Drooping (9)	1	29	2.38
6	Flag leaf angle	Erect (1)	38	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,17,18,19,20, 21, 22,23,24,25,26, 28, 30,32,33,34,36, 37, 38,39,40, 41, 42	90.48
		Semi-erect (3)	1	29	2.38
		Horizontal (5)	3	15,31, 35,	7.14
7	Ligule color Stem elongation to booting	White (1)	27	1,2,3,4,5,6,8,10,11,12,13,14,19,20,21,22,23,24,25,28,33,35,37,39,40,41,42	64.29
		Purple lines (2)	13	7,9,15,16,17,18,27, 30,31,32, 34,36,38	30.95
		Purple (3)	2	26,29	4.76
8	Ligule shape	Acute to acuminate (1)	2	7,16,	4.76
		2-cleft (2)	40	1,2,3,4,5,6,8,9,10,11,12,13,14,15,17,18,19,20,21,22,23,24, 25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42	95.24
9	Collar color	Pale green (1)	39	2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,24,25, 26,27,28,29,30,31,32, 33,34,35,36,37,38,39,40,41,42	92.86
		Purple (3)	3	1,7,23,	7.14
10	Auricle color	Pale green (1)	37	1,2,3,5,6,7,8,9,10,11,12,13,15,16,17,18,19,20,21,24,25,26, 27,28,29,30,31,32,33,34,35,36,37, 38,39,40,41,42	88.10
		Purple (2)	5	4, 14,18,22,23	11.91
11	Culm anthocyanin color	Absent (1)	36	1,2,4,5,7,9,10,11,13,14,15,16,17,18,19,21,22,23,24,25,26, 27,28,29,30,31,32,33,34,35, 37, 38,39,40,41,42	85.72
		Present (9)	6	3,6,8,12,20, 36	14.29
12	Culm angle	Erect (1)	27	2,4,7,10,12,13,14,15,17,18,19,20,21,22,23,24,25,26,28,29, 34,35, 37, 38,39,40,41,42	64.29
		Intermediate ((3)	9	5,6,8,11,27, 30,32, 33,36	21.43
		Open (5)	4	1,16, 20,31	9.52
		Spreading (7)	2	3,9,	4.76
13	Inter node color	Green (1)	32	4,5,7,9,10,11,13,14,15,16,17,18,19,21,22,23,24,25,26,27, 28,29,31,32,34,35, 37, 38,39,40,41,42	76.19
		Light gold (2)	4	1,2,30,33	9.52
		Purple lines (3)	4	3,6,8,20,	9.52
		Purple (4)	2	36,12	4.76
14	Culm strength (lodging resistance)	Strong (1)	23	4,7,13,14,17,18,22,23,24,25,28,29, 31,32,34,35, 37, 38,39,40,41,42	54.76
		Moderately strong (3)	4	2,5,10,26	9.52
		Intermediate (5)	4	1,12,30, 33	9.52
		Weak (7)	5	6,11,15,19,27	11.91
		Very weak (9)	6	3,8, 9,16,20,21,	14.29
15	Lodging incidence (%) (% of plants that lodged)	Lodging (0%)	22	2,4,7,13,14,17,18,22,23,24,25,28,29,31,32,34,35,36,37,38, 39,40	52.38
		Lodging ≥ (30-50%)	6	6,10,26,33, 41,42	14.29
		Lodging ≥ (60-90%)	4	5,12,15,21,	9.52
		Lodging (100%)	10	1,3,8,9,11,16,19,20,27,30,	23.81
16	Panicle type	Compact (1)	23	1,2,4,5,6,7,8, 9,10,11,13,14, 15,16,17, 28,31,32,36, 38,39,40	54.76
		Intermediate (5)	14	3,18,19,20,21,22,23,24,25,26,27,29,30,41	33.33
		Open (9)	5	28,34,35,37,42	11.91
17	Panicle exertion	Enclosed (1)	11	2,4,17,24,25,31,32,33,36,39,40	26.19
		Partly exerted (3)	18	1,3,5,6,7,8,10,11,12,13,14,15,27,29,30,34,35,37	42.86
		Just exerted (5)	1	9	2.38
		Moderately well exerted (7)	4	21,22,28,41	9.52
		Well exerted (9)	8	16,18,19,20,23,26,38,42	19.05

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (Table 116)	Frequency (%)
18	Axis	Straight (1)	10	1,7,9,11,13,14,15,17,18,24,	23.81
		Droopy (2)	32	2,3,4,5,6,8,10,12,16,19,20,21,22,23,25,26,27,28,29,30,31,32,33,34,35,36,37, 38,39,40,41,42	76.19
19	Shattering	Very low (1)	9	3,5,6,11,13,17,18,22,25	21.43
		Low (3)	29	1,2,4,7,12,14,15,16,19,20,21,23,24,26,28,32,34,35,36,39,41,42	69.05
		Moderate (5)	3	8,9,10	7.14
		High (7)	1	31	2.38
20	Threshability	Moderately Difficult (3)	3	6,11,15	7.14
		Intermediate (5)	14	3,8,13,16,17,18,19,20,,22,23,25,27, 29,30	33.33
		Loose (7)	12	5,14,21,26,28,32,34,35,36,37,39,42	28.57
		Easy(9)	13	1,2,4,7,9,10,12,24,31,33,38,40,41	30.95
21	Awn: distribution	None (0)	30	1,2,4,5,6,7,8,10,11,12,13,14,15,16,17,18,21,24,26,27,28,30,31,32,34,35, 36,38,39,40,42	71.43
		Tip only (1)	4	9,25,41,37,	9.52
		Upper quarter only (2)	4	3,19,20,29,	9.52
		Upper half only (3)	2	13,23,	4.76
		Upper three-quarters only (5)	2	33,21	4.76
22	Awn color at maturity	Straw (1)	6	9,19,20,25,29,37	14.29
		Brown (tawny) (3)	4	3, 23,33,41,	9.52
		Purple (5)	2	13,22,	4.76
23	Length of the longest awn	Very short (1)	3	3,20, 37	
		Short (3)	6	9,23, 25,29,33, 41	
		Intermediate (5)	3	13, 19,22,	
24	Apiculus color	White (1)	13	1,3,6,7,10,18,24,26,27,30,33,36,40	30.95
		Straw (2)	4	2,4,9,41	9.52
		Brown (3)	21	5,11,14,15,16,17,19,20,21,22,23,25,28,29,32,34,35,37,39,42	50.00
		Red apex (6)	1	8	2.38
		Purple (7)	3	13,31,38	7.14
		Black(9)	1	12	2.38
25	Stigma color	White(1)	31	1,3,6,7,8,12,13,14,17,18,42,19,20,22,23,24,28,29,30,31,32,33,34,35,36,37,38,39, ,41	73.80
		Light green (2)	10	2,4,5,10,11,15,17,22,25,26,27	23.81
		Yellow (3)	1	40	2.38
26	Lemma and palea color	Straw (0)	17	1,6,9,10,11, 14,15,17, 19,21,26,29,30, 34,35,36,40	40.48
		Gold & gold furrows on straw background (1)	14	2, 7,13, 20, 25,27,28,32,33,37,38,39,41,42	33.33
		Brown spots on straw (2)	1	24,	2.38
		Brown furrows on straw (3)	1	12,	2.38
		Brown (4)	2	4,18,	4.76
		Reddish to light purple (5)	2	5, 8,	4.76
		6	1	23	2.38
		Purple (8)	2	3,8,16	4.76
		Black (9)	2	22, 31	4.76
27	Lemma and palea pubescence	Glabrous (1)	2	38,24	4.76
		Hairs on lemma keel (2)	6	16,21, 25,33,34,40	14.29

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (Table 116)	Frequency (%)
		Short hairs (4)	32	1,2,3,4,5,6,7,9,10,11,12,14,15,17,18,19,20,22,23,24,26,27,28,29,30,31,32,35,36,37,38,39, 41,42	76.19
		Long hairs (5)	2	8,13	4.76
28	Sterile lemma color	Straw (1)	35	1,4,6,8,9,10,11,12,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30,32,33,34,35,36,37,39,40,41	83.34
		Gold (2)	4	2, 7,38,42	9.52
		Purple (4)	3	3,5,31,	7.14
29	Seed coat (bran) color	White (1)	11	1,4,6,15,24, 26, 27, 28,32,36, 40	26.19
		Light brown (2)	13	7,9,10,11,14,19,21,29, 30,33,34,35,38	30.95
		Speckled brown (3)	14	3,8,12,13,16,18,20,22,23, 25,31,37, 41, 42,	33.33
		Brown (4)	3	2,17,39	7.14
		Variable purple (6)	1	5	2.38
30	Endosperm type	Non-glutinous (no waxy) (1)	11	3,8,14, 21, 23, 27, 30,32, 33, 39, 42	26.19
		Glutinous (waxy) (2)	22	1,2,4,5, 6,7,9,10, 11,13,17,19,24,25,26,28, 35,36,37,38	52.38
		Intermediate (3)	9	12,15, 16, 18,20, 22, 26, 29,41	21.43
31	Decorticated grain: Scent (aroma)	Non-scented (0)	36	1,2,3,4,5,6,7,8,9,11,13,14,15,16,17,18,19,20,22,23,24,25, 26, 27, 28, 29,30,32, 33,34,36,37,.38,39,40,41,42	85.71
		Lightly scented (1)	1	10	2.38
		Scented (2)	5	21, 34, 12,31,35	11.90

Characterization based on quantitative characters by DUS test

Observed variables of quantitative characters of included seven traits and five plants from each replication of each germplasm were randomly selected for recording data on plant height (cm), Days to 50% flowering, Days to 80% of maturity, Number of effective tillers, Panicle length (cm), 100 seed weight (g), Grain yield m⁻².

Range, mean, standard deviation (SD) and coefficient of variation (CV) of different quantitative characters of rice germplasm have been given in Table 118. The range of plant height 82cm -130.67cm, tallest plant was recorded in Hasakalo (130.67 cm) whereas the shortest plant was recorded in Mukta (82.00cm). Sumanth *et al.* (2017) and Sarkar (2014) also observed significant variation in rice for plant height.

Sumanth *et al.* (2017) reported that the significant variation was observed among the genotypes for plant height. Haque and Biswas (2014) found significant variation for plant height in their experiment.

Days to fifty % flowering ranged from 87.67 to 113.67 days with an average 104 days. Among the studied germplasm, Nagra took longest time (113 days) while Bashiraj (87.67 days) took the shortest time. Saha (2018) reported in her MS thesis Days to 50% flowering ranged from 80.67 to 120.33. The maturity (80%) of the studied germplasm ranged 120.33-146.33 days with an average of 137.31 days and CV% was lowest (3.47%) among the characters. Shonajuri and Hashemiri took the maximum time (146.33 days) to mature, while Bashiraj took only 120.33 days to mature. Number of effective tillers per hill ranged 4.33 to 14.33 with an average 9.6, CV% was 21.84 and SD was 2.10. Sadapajam had produced maximum number of effective tillars (14.33), Maloti had lowest number of effective tillers. Parbotjira had the longest panicle length (29.67 cm) and Kashiabinni (15.33cm) had the shortest panicle. Average panicle length was 23.24 with 12.10 % CV and SD was found 2.81.

The highest grain yield m^{-2} found 640.00 g in Ojanabirun and lowest was 200.00 g in Birui and average yield was 370.76 g. The highest CV% (28.48%) was found in grain yield among the studied quantitative characters and SD was 105.59. In this study, 100-grain weight ranged from 0.84 g to 3.03g with an average value of 1.83 g. The variation observed for this trait was highly significant. Hundred grain weights have been used for characterizing rice varieties which was reported by several workers (Bose and Pradhan, 2005 and Joshi *et al.*, 2007). Hundred-grain weight was marked the highest in Lalpaijam (3.03 g) whereas 100-grain weight was marked the lowest in Kalojira (0.84g).

Table 118. Variability in test rice germplasm in quantitative characters, T. Aman, 2019

Characters	Range	Mean	SD	CV (%)
Plant height (cm)	82.00-130.67	109.86	9.20	8.37
Days to 50% flowering	87.67-113.67	104.89	5.69	5.42
Days to 80% maturity	120.33- 146.33	137.31	4.76	3.47
Number of effective tillers hill ⁻¹	4.33-14.33	9.6	2.10	21.84
Panicle length (cm)	15.33-29.67	23.24	2.81	12.10
Grain yield plant ⁻¹ (g)	200.00 – 640.00	370.76	105.59	28.48
1000-grain weight (g)	0.84-3.03	1.83	0.50	27.31

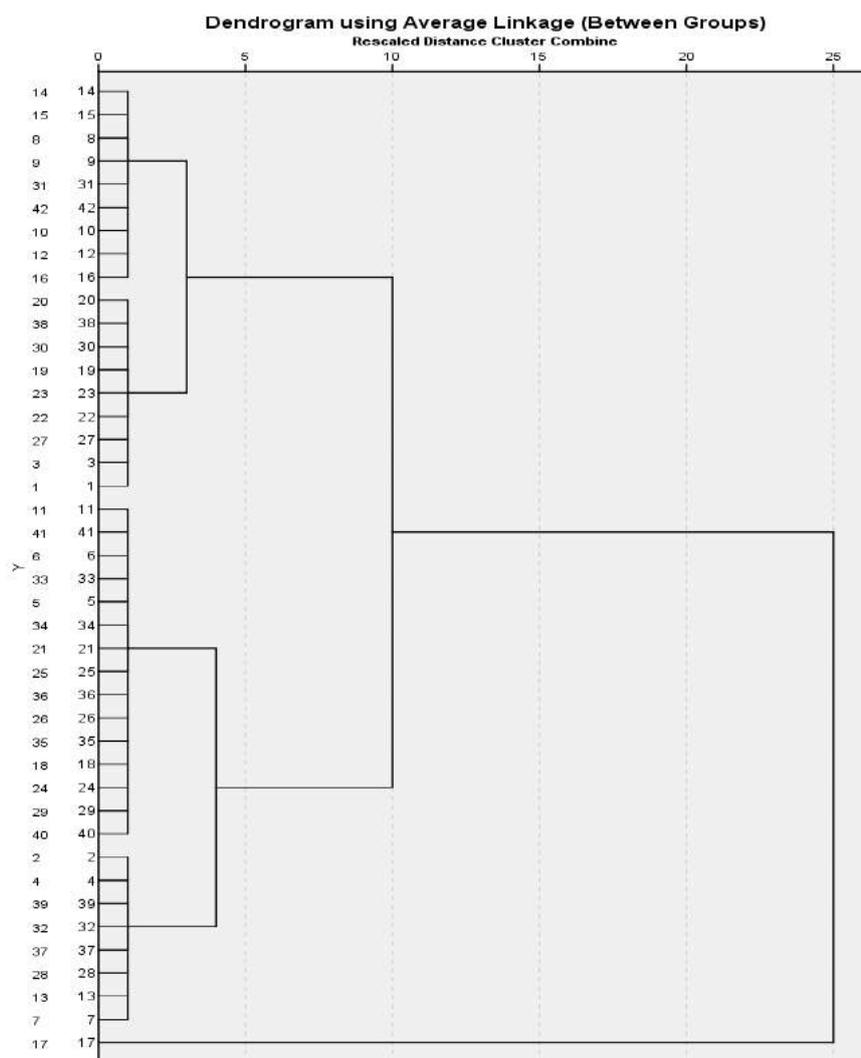


Fig. 89. Hierarchical cluster analysis using UPGMA among test rice germplasm

Table 119. Distribution of germplasm in different non-hierarchical clusters of rice germplasm

Name of cluster	No. of germplasm	Name of germplasm
Cluster-I	9	Bedhabirum, Chengermuri, Parbotjira, Hasakalo, Noliguarchara, Hasasada, Biruidhan, Kalojira, Lalkumri
Cluster-II	9	Ailagota, Kalobirun, Chaklosh, Kutimurabirun, Guar chara, Putibirun, Maloti, Bashiraj, Birui
Cluster-III	15	Moinashail, Deshi-32, Lalcheng, Soragotobirun, Chinigura-1, Guabari, Molaireti, Guamouri, Lomba ail, Lalpajam, Chinishail, Chinishail-3, Hashemirri, Sadapajam, Kashiabinni
Cluster-IV	8	Kaijam, Mukta, Pajam, Shonajuri, Nagra, Boroabji, Chanmoni, Gobinda
Cluster-V	1	Ojanabirun
Total	42	

Hierarchical cluster analysis using UPGMA among 42 germplasm of rice are shown in figure 63. The 42 germplasm were grouped into five non-hierarchical clusters (Table 119). Number of germplasm in each cluster ranged from 1 (cluster-V) to 15 (cluster III). Ojanabirun classified into Cluster-V (Fig. 90).

On the basis of cluster analysis, different qualitative and quantitative characters Ojanabirun, Pajam, Boroabji, Birui, Nagra, Bashiraj, Deshi-32, Kalojira, Hasa sada, Hasakalo, Parbotjira would be selected for breeder for further varietal development. For short duration Bashiraj and Deshi-32, based on higher yield Ojanabirun, Pajam, Boroabji, Birui and Nagra, based on fine and scented grain Kalojira, Parbotjira, Hasasada, Hasakalo, chinisail would be selected. In this study, among the germplasm, Ojanabirun and Pajam had performed best. Ojanabirun and Pajam produced higher yield with shorter plant height, 0% lodging tendency, flag leaf and leaf angle erect, compact and enclosed panicle. Among five scented rice germplasm, Chinishail performed best. These identified germplasm will be used for developing improved varieties through breeding program that would be high yield potential with superior quality.

Conclusion

Wide variations were found among the 31 qualitative characters like blade color, legule color, culm angle, Internode color, Culmstrength, Lodging incidence, panicle type, panicle exertion, lemma palea color, seed coat color etc. Significant variations were found among the seven quantitative characters such as plant height, days to 50 % flowering, days to 80 % maturity, panicle length. 100 Seed weight, grain yield per m² had shown significant difference among the germplasm. The maximum coefficient of variations was in grain yield per m². The 42 germplasm were classified into five clusters. Some promising germplasm (Ojanabirun, Pajam, and Chinishail) were identified and these germplasm would be used for varietal development.

11.6.4. Morphological characterization of chilli germplasm

A total of 5 local chilli germplasm have been characterized at morphological level during winter 2018-19 season. Five local chilli germplasm exhibited a wide variation for several morphological characters studied. The frequency percentage of each parameter is presented in Table 120.

Table 120. Qualitative descriptors of chilli germplasm

Sl. No.	Character	Character state	No. of germplasm	Name of germplasm	% of germplasm
1	Hypocotyl colour	Purple	4	Balijhuri (Kagmari), Chata morich, Balijhuri (shayampur) , Super hot master	80
		White	1	Ulta morich	20
2	Hypocotyl pubescence	Intermediate	5	-	100
3	Cotyledonous leaf color	light green	3	Ulta morich, Balijhuri (shayampur), Balijhuri (Kagmari),	60
		Green	2	Super hot master, Chata morich	40
4	Cotyledonous leaf shape	Ovate-2	2	Super hot master, Ulta morich	40
		Lanceolate-3	3	Balijhuri (Kagmari), Chata morich, Balijhuri (shayampur)	60
5	Life cycle	Annual	4	Balijhuri (Kagmari), Chata morich, Balijhuri (shayampur)	80
		Biennial	1	Ulta morich	20
6	Stem colour	Green	5		100
7	Nodal anthocyanin	Green	5		100
8	Stem shape	Angular	5		100
9	Stem pubescence	Intermediate	2	Super hot master, Ulta morich	20
		Dense	2	Balijhuri (Kagmari), Balijhuri (shayampur)	20
10	Plant growth habit	Erect	2	Super hot master, Ulta morich	40
		Intermediate	3	Chata morich, Balijhuri (Kagmari), Balijhuri (shayampur)	60
11	Branching habit	Intermediate	4	Balijhuri (Kagmari), Balijhuri (shayampur) ,Super hot master, Ulta morich	80
		Sparse	1	Chata morich,	20
12	Tillering	Intermediate	3	Balijhuri (Kagmari), Balijhuri (shayampur) ,Super hot master,	60
		Sparse	1	Chata morich,	20
		Dense	1	Ulta morich	20
13.	Leaf density	Dense	3	Super hot master, Ulta morich, Chata morich	60
		Intermediate	2	Balijhuri (Kagmari), Balijhuri (shayampur)	40
14	Leaf colour	Green	4	Super hot master , Chata morich, Balijhuri (shayampur), Balijhuri(Kagmari)	80
		Light green	1	Ultamorich	20
15	Leaf shape	Deltoid	2	Super hot master, Ulta morich	40
		Lanceolate	2	Balijhuri (shayampur), Balijhuri(Kagmari)	40
		Ovate	1	Chata morich	20
16	Leaf margin	Entire	3	Super hot master, Ulta morich, Chata morich	60
		Undulate	2	Balijhuri (shayampur), Balijhuri(Kagmari)	40
17	Leaf pubescence	Sparse	5		100
18	Number of flowers per axil	2	1	Super hot master	20
		3 or more	4	Balijhuri (shayampur), Balijhuri(Kagmari), Chata morich, Ultamorich	80

Cont'd. Table 120.

Sl. No.	Character	Characters	No. of germplasm	Name of germplasm	% of germplasm
19	Flower position	Pendant	4	Super hot master , Baliyhuri (shayampur), Baliyhuri (Kagmari), Chata morich	80
		Erect	1	Ultamorich	20
20	Corolla color	Yellow-	1	Super hot master	20
		Light yellow	3	Baliyhuri (shayampur), Baliyhuri (Kagmari), Chata morich	60
		White	1	Ultamorich	20
21	Corolla spot color	Purple	1	Super hot master	20
		Green	2	Baliyhuri (shayampur), Baliyhuri (Kagmari)	40
		White	2	Ultamorich, Chata morich	40
22	Corolla shape	Rotate	5		100
23	Anther colour	Blue	1	Super hot master	20
		Pale blue	4	Baliyhuri (shayampur), Baliyhuri (Kagmari), Ultamorich, Chata morich	80
24	Filament colour	Purple	1	Super hot master	20
		Light purple	4	Baliyhuri (shayampur), Baliyhuri (Kagmari), Ultamorich, Chata morich	80
25	Stigma exertion	Same level	2	Super hot master , Chata morich	40
		Exerted	3	Baliyhuri (shayampur), Baliyhuri (Kagmari), Ultamorich	60
26	Male sterility	Absent	4	Super hot master , Chata morich, Baliyhuri (shayampur), Baliyhuri (Kagmari),	80
		Present	1	Ulta morich	20
27	Calyx pigmentation	Absent	5		100
28	Calyx margin	Intermediate	3	Super hot master , Chata morich, Ulta morich	60
		Entire	2	Baliyhuri (shayampur), Baliyhuri (Kagmari),	40
29	Calyx annular constriction	Absent	3	Super hot master , Chata morich, Ulta morich	60
		Present	2	Baliyhuri (shayampur), Baliyhuri(Kagmari),	40
30	Anthocyanin spots or stripes	Absent	5		100
31	Fruit color at intermediate stage	Green	3	Super hot master , Chata morich, Baliyhuri (shayampur)	60
			2	Baliyhuri (Kagmari), Ulta morich	40
32	Fruit set	Intermediate	5		100
33	Fruit color at mature stage	Red	5		100
34	Fruit shape	Elongate	5		100
35	Fruit shape at pedicel attachment	Obtuse	5		100
36	Neck at base of fruit	Absent	2	Chata morich, Ulta morich	40
		Present	3	Super hot master , Baliyhuri (Shayampur), Baliyhuri (Kagmari),	60

Cont'd. Table 120.

Sl. No.	Character	Characters	No. of germplasm	Name of germplasm	% of germplasm
37	Fruit shape at blossom end	Pointed	4	Super hot master , Chata morich, Balijhuri (shayampur), Balijhuri (Kagmari)	80
		Blunt	1	Ulta morich	20
38	Fruit blossom end appendage	Absent	5		100
39	Fruit cross-sectional corrugation	Intermediate	4	Super hot master , Chata morich, Balijhuri (Shayampur), Balijhuri (Kagmari)	80
		Slightly corrugated	1	Ulta morich	20
40	Fruit surface	Semi wrinkle	5		100
41	Seed colour	Brown	1	Super hot master	20
		Deep yellow	4	Chata morich, Balijhuri (shayampur), Balijhuri (Kagmari), Ulta morich	80
42	Seed surface	Wrinkle	3	Super hot master, Balijhuri (shayampur), Balijhuri (Kagmari)	60
		Smooth	2	Chata morich, Ulta morich	40
43	Seed size	Intermediate	5		100

All germplasm performed same for the characters of hypocotyl pubescence, stem colour, nodal anthocyanin, stem shape, leaf pubescence, corolla shape, calyx pigmentation, anthocyanin spots or stripes, fruit set, fruit color at mature stage, fruit shape, fruit shape at pedical attachment, fruit blossom end appendage, fruit surface and seed size. Hypocotyl colour observed purple and white. Cotyledon leaf colour ranged from light green to green with ovate to lanceolate shape. Stem pubescence had shown dense and intermediate with sparse character. Two modes of plant growth were observed. Leaf shape varied between deltoid, ovate and lanceolate. Yellow-green corolla was common among the germplasm with filament colour mostly white. Anther colour varied from pale blue to blue. Fruit colour at intermediate stage ranged from green to pale green.

Table 121 shows the mean performance for all the quantitative traits measured. Cotyledon leaf length ranged from 11mm in Balijhuri (Shayampur) to 20 mm in Super hot master with an average of 15.4 mm. Cotyledon leaf widths is ranging from 5-10 mm. The heights of the chilli germplasm ranged from 45.00-108 cm with the average of 66.2 cm. Days to flowering ranged from 89-150 after sowing was done. Fruit length and width ranged from 3.5-9 cm and 0.75-1.4 cm, respectively. The mean fruit length was 6.26 cm with Ulta morich and Super hot master having the shortest and longest fruit lengths. Fruit weight which is the most economic trait ranged from 0.86 -1.75g with Ulta morich and Super hot master. Seed diameter ranged from 3mm -5mm in Super hot master to Ulta morich with an average of 3.8 mm.

Table 121. Quantitative descriptors of chilli germplasm

SL. No.	Character	Measurable indicator					Mean
		Super hot master	Balijhuri (shayampur)	Chata morich	Balijhuri (Kagmari)	Ulta morich	
1	Cotyledonous leaf length (mm)	20	11	17	10	19	15.4
2	Cotyledonous leaf width (mm)	10	5	7	6	9	7.4
3	Plant height(cm)	72	49	57	45	108	66.2
4	Plant canopy width (cm)	50	57	70	36	57	54
5	Stem length(cm)	20	17	18	18	29	20.4
6	Stem diameter (cm)	2.0	1.5	1.75	1.25	2.5	1.8
7	Mature leaf length (cm)	6.0	4.0	5.2	5.0	12.0	6.44
8	Mature leaf width	2.2	1.4	1.8	1.8	5.4	2.52
9	Days to flowering	101	85	83	79	150	99.6
10	Corolla length (cm)	1.5	0.75	1.2	0.80	1.1	1.07
11	Anther length (mm)	0.75	0.5	0.65	0.6	0.45	0.59
12	Filament length (mm)	5	5	4	6	6	5.2
13	Days to fruiting	105	99	87	86	110	97.4
14	Fruit bearing period (d)	150	160	150	140	322	-
15	Fruit length (cm)	9	7	5	6.8	3.5	6.26
16	Fruit width (cm)	1.4	0.95	1.5	0.90	0.75	1.1
17	Fruit weight (g)	1.75	1.0	1.6	1.2	0.86	1.28
18	Seed diameter(mm)	3	3.5	4	3.5	5	3.8
19	1000 seed weight (g)	4.8	4.0	4.8	4.5	4.8	4.58
20	Number of seeds per fruit	70	59	93	77	12	62.2

Conclusion: Superhot master and Chata morich was the promising germplasm for higher yield, fruit shape and color. The germplasm ultra morich was good for getting year round chilli yield.

11.6.5. Characterization of sesame germplasm

The aim of the present study is to characterize 30 germplasm of sesame (*Sesamum indicum* L.) based on the DUS descriptors. The list of the experimental materials along with their collector's number is shown in Table 122. The experiment was conducted at the Experimental field of Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh during kharif 2020. On the basis of DUS descriptors, sesame varieties were characterized for 18 morphological traits. A significant amount of variation was observed for most of the traits studied. The results revealed that maximum variation was recorded in seed coat colour, capsule shape, leaf lobe, leaf size, leaf serration, capsule hairiness, capsule arrangement, stem hairiness, petal colour, seed size, days to 50% flowering, branching pattern and petal hairiness. On the basis of frequency distribution, a majority of sesame germplasm were found to possess early duration of 50% flowering with light purple petal colour, sparse petal hairiness, basal branching pattern, medium plant height, medium plant branching, sparse stem hairiness, medium leaf size, slightly lobed leaf, strong leaf serration, sparse capsule hairiness, broad oblong capsule shape, alternate capsule arrangement, medium capsule length, early maturity and white seed coat colour.

Above study revealed the distinct characteristics of sesame germplasm and indicated that morphological variations exist in these germplasm due to variation in genetic makeup and could be better utilized by breeders in the selection based on their specific requirement for breeding program. This is highly useful study for varietal identification and conservation.

Table 122. List of sesame germplasm used in this study

Sl. No.	Name	Collectors No.	Sl. No.	Name	Collectors No.
1	BD-6987	FI-01	16	BD-6979	FI-15
2	BD-6988	FI-02	17	BD-6972	FI-16
3	BD-6989	FI-03	18	BD-6978	FI-17
4	BD-6995	FI-04	19	Binatil-3	FI-18
5	BD-6983	FI-05	20	BD-6993	FI-19
6	BD-6986	FI-06	21	BD-6994	FI-20
7	Kalotil *	F-03	22	BD-6991	FI-21
8	BD-6984	FI-07	23	BD-6992	FI-22
9	BD-6971	FI-08	24	BD-6990	FI-23
10	BD-6970	FI-09	25	BD-6980	FI-24
11	BD-6968	FI-10	26	BD-6966	FI-25
12	BD-6962	FI-11	27	BD-6964	FI-26
13	BD-6982	FI-12	28	BD-6985	FI-27
14	Binatil-2	FI-13	29	Binatil-4	FI-28
15	BD-6981	FI-14	30	Sadatil *	F-04

*Indicate collected germplasm

The qualitative characters for germplasm are presented in table 123. Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated (Table 126). The collected data on 16 quantitative characters were analyzed for ANOVA. Hierarchical and non-hierarchical cluster analysis was done using SPSS 16 software (Fig. 82 and Table 127).

Qualitative descriptor

Results revealed that a significant amount of variation was recorded on almost all the characters recorded. Qualitative variations of different characters in sesame are shown in Table 123. Most of germplasm were indeterminate type (93.33 %) and only two germplasm were determinate (6.67%) Erect (53.33%), semi-erect (26.67%) and prostrate (6.67%) were found on plant growth habit. Among the 30 germplasm, only one germplasm showed glabrous (3.33%) stem hairiness, 15 germplasm had weak (50%), 11 had medium (36.67%) and 3 germplasm had strong (10%) stem hairiness. In this study, basal (50%) and top (50%) patterns were observed.

Leaf characters varied significantly among the germplasm. In case of leaf color, 70% germplasm were found green, 23.33 % were green with yellowish cast and 6.67 % germplasm were green with purple cast. Among the 30 germplasm, 2 germplasm had not hairiness in leaf and one had strong hairiness. 63.33 % germplasm were weak and 26.67% germplasm were medium hairiness in leaf. Most of the germplasm (90%) had shown lanceolate leaf shape. There were no leaf lobes in all germplasm except one. In case of leaf angle, 17 had acute, 10 had horizontal and 3 had drooping. All the germplasm were exhibited entire basal leaf margin. Among 30 germplasm, 14 had green, 13 had greenish purple and 3 had purple petiole color. Most of the germplasm (66.67%) had produced one flower per axil and 33.33 % had produced more. Sixteen germplasm had small, 5 had rudimentary, 5 had medium and 4 had large extra floral development in inflorescence.

On the basis of capsule number per leaf axil, 21 had four locules, 5 had eight locules and 4 had five locules per capsule. Among the 30 genotypes, 23 had narrow oblong and 7 had broad oblong shaped capsules. On the basis of capsule arrangement, 26 germplasm had monocapsular and only 4 germplasm had monocapsular type in capsule arrangement. Among the 30 germplasm, 19 were short capsule, 8 were medium and 3 were long and bent in shape of capsule hairiness. 50% germplasm had shown straw color, 46.67% had brown or tan color in dry capsule. Six distinct seed coat colours such as cream (3.33 %), medium brown (6.67%), tan (13.33%), grey (26.67%), dull black (36.67%) and bright black, (13.33) were observed among the germplasm at maturity stage after sun drying.

Table 123. Qualitative descriptors for individual sesame germplasm

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (List in Table 124)	Frequency (%)
1	Plant growth type	Indeterminate (1)	28	1,2,3,5,6,7,8,9,10,11,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30	93.33
		Determinate (2)	2	4,16	6.67
2	Plant growth habit	Prostrate (1)	6	15,16,17,27,28,30	20.00
		Semi-erect (2)	8	4,7,8,12,14,18,19,26	26.67
		Erect (3)	16	1,2,3,5,6,9,10,11,13,20,21,22,23,24,25,29	53.33
3	Stem hairiness	Glabrous (0)	1	10	3.33
		Weak or sparse (3)	15	2,3,4,6,11,12,13,16,17,18,19,23,25,27, 29,	50.00
		Medium (5)	11	1,5,7,8,9,15,21,22,24,28,30	36.67
		Strong (7)	3	14,20,26	10.00
4	Branching pattern	Basal branching (1)	15	7,8,9,10, 11,15,16,18,20,21, 22,23,24,28,30	50.00
		Top branching (2)	15	1,2,3,4,5,6, 12,13,14,17,19,25,26,27,29	50.00
5	Leaf color	Green (1)	21	1,6,7,8,9,10,11,12,15,16,19,21,22,23,24,25,26,27,28,29,30	70.00
		Green with yellowish cast (2)	7	2,3,4,5,13,14,17	23.33
		Green with purple cast (4)	2	18,20	6.67
6	Leaf hairiness	Glabrous (0)	2	4,23	6.67
		Weak or sparse (3)	19	1,3,5,6,8,9,12,13,15,16,17,18,19,20,22,25,27, 29,30,	63.33
		Medium (5)	8	2,7,10,14,21,24,26,28	26.67
		Strong (7)	1	11,	3.33
7	Leaf shape	Linear (1)	2	20,23	6.67
		Lanceolate (2)	27	1,2,3,4,6,7,8,9,10,11,12,13,14,15,16,19,21,22,24,25,26,27,28,29,30	90.00
		Eliptic (3)	1	5,	3.33
8	Basal leaf margin	Entire (1)	30	All	100
		Serrate (2)			0.00
9	Lobe incision of basal leaf	Absent (0)	29	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,19,20, 21,22,23,24,25,26,27,28,29,30	96.67
		Weak (3)	1	18	3.33
10	Leaf angle to main stem	Acute (1)	17	1,2,3,4, 6, 7,8,9,10,11,12,17, 23,24,25,30	56.67
		Horizontal (2)	10	5,13,14, 16,18, 20, 21,22,28,30	33.33
		Drooping (3)	3	15,19,29	10.00
11	Petiole Color	Green (1)	14	1,2,3,4, 5,6,7,8,9,18,27,28,29,30	46.67
		Greenish purple (2)	13	13,14,15,16,17,19,,20,21,22,23,24,25,26	43.33
		Purple (3)	3	10,11,12,	10.00
12	Petiole hairiness	Weak or sparse (3)	17	2,3,6,8,9,10,12,13,14,15,17,18, 19,20,21,28, 29 30	56.67
		Medium (5)	12	1,4,5,7,11,16,22,23,24,25,26,27,	40.00
		Strong or profuse (7)	1	19,	3.33

Cont'd. Table 123.

Sl. no.	Character	State of characters	No. of germplasm	Germplasm (List in Table 124)	Frequency (%)
13	No. of flowers/ axil	One (1)	20	1,2,3,6,7,8,9,10,12,13,14,15,17,18,19,20,21,28, 29, 30,	66.67
		More than one (2)	10	4,5,11,16,22,23,24,25,26,27,	33.33
14	Extra floral nectar development	Rudimentary (1)	5	2,9,11,16,17,	16.67
		Small (2)	16	3,5,12,18, 19,21,22,23,24,25,26,27,28,29,30	53.33
		Medium (3)	5	1,4,10,13,14, 20,	16.67
		Large (4)	4	6,7,8,15,	13.33
15	Number of locules per capsule	Four (1)	21	1,2,4,6,7,8,10,11,14,15,16,17,18,20,21,22,27,28,29,30	70.00
		Eight (3)	5	5,9,23,24,25,	16.67
		Mix (4)	4	3,12,19,26,	13.33
16	Bicarpellate capsule shape	Narrow oblong (2)	23	1,2,3,4,5,6,7,8,10,11,12,13,14,15,16,18,19,20,22,23,24,28,30	76.67
		Broad oblong (3)	7	9,17,21,25,26,27,29	23.33
17	Capsule arrangement	Monocapsular (1)	26	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,17,16,18,20,21, 22,23,24,28,29,30	86.67
		Multi capsular (2)	4	19,25,26,27	13.33
18	Capsule hairiness	Weak or sparse (3)	21	1,4,5,6,7,8,9,10,13,14,15,16,17,19,21,22,23,27,28,29	70.00
		Medium (5)	6	2,3,11,12, 20,25,30	20.00
		Strong (7)	3	18, 24,26	10.00
19	Shape of capsule hair	Short and strait (1)	19	1,2,4,5,6,7,8,9,10,13,14,16,21,22,23,24,26,28,30	63.33
		Medium & strait (2)	8	3,11,12,15,17,20,25,27	26.67
		Long and bent (3)	3	18,19,20, 29	10.00
20	Color of dry capsule	Green (1)	1	7	3.33
		Straw or Yellow (2)	15	2,5,6,8,9,10,11,16,17,16,17,20,21,22,23,24,25,	50.00
		Brown /tan (3)	14	1,3,4,12,13,14,15,18,19,26,27,28,29,30	46.67
21	Type of capsule beak	Short (1)	1	1,2,5,6,7,10,22,23,24,28	3.33
		Long (2)	4	8,11,21,28	13.33
		Curved (3)	16	3,4,9,12,13,14,15,16,17,18,19,20,25,26,27,29,30	53.33
22	Seed coat color	Cream (2)	1	30	3.33
		Medium brown (5)	2	5,12	6.67
		Tan (8)	4	2,16,17,28	13.33
		Grey (10)	8	1,4,6,8,19,24,26,29	26.67
		Dull black (11)	11	7,10,13,14,15,18,20,21,23,25,27,	36.67
		Bright black (12)	4	3,9,11,22	13.33

Quantitative descriptor

Quantitative variations of 16 descriptors in sesame are shown in table 124. The highest plant height was exhibited in BD-6990 (153.33 cm) while the lowest 108.00 cm was observed in BD-6995. Internodes length ranges 8.33 cm (BD-6971) to 18 cm (BD-6987) with an average of 13.50 cm. Number of primary branches ranges from 2 (BD-6995) to 7 (Kalotil). Length of basal leaf and width of basal leaf ranged from 4.50 to 15.33cm and 1.17 to 7.50 cm, respectively. Length of top leaf and width of top leaf ranged from 3.33 to 7.67 cm and 0.23 to 1.00 cm, respectively. The highest petiole length of basal leaf (7.67 cm) was found in BD-6968 while BD-6988 had produced the shortest petiole length (3.17cm) with an average of 4.30 cm. The germplasm produced fifty% flower on 40.33 days (BD-6964) to 49.33 days (Sadatil). Maximum number of capsule (137) per plant was found in the landrace Kalotil while minimum number of capsule (19) was found in BD-6962.

The variation in capsule per plant might be due to differences in number of inflorescence per plant and shattering tendency of plant. The mean capsule length ranged from 20.67 to 29.33 mm in BD-6966 and BD-6979, respectively. On the contrary, mean capsule width ranged from 5.33 to 11.33 mm in BD-6995 and BD-6983, respectively. The germplasm produced 23 to 85.67 seeds per capsule from Binatil-2 and Kalotil, respectively. An average of 46 seeds per capsule was found. The germplasm exhibited 0.13 to 0.90 g 100 seed weight from BD-6978 and BD-6970, respectively with an average of 0.14 g.

Finally the yield per plant ranged from 2.97 to 57.71 g. The germplasm BD-6979 produced highest yield per plant while BD-6995 yielded lowest. Such the lowest yield might be inherent characteristics of the germplasm and also due to the inherent potential of germplasm. The maximum co-efficient of variation was found in petiole length of top leaf (19.15%) followed by width of top leaf (18.76%), seeds per capsule (16.72%), number of primary branch and length of basal leaf (14.63%), mean capsule width (13.93%), petiole length of basal leaf (13.58%), width of basal leaf (13.11%), length of top leaf (7.34%), number of capsule per plant (7.15%), 100-seed weight (6.82%), mean capsule length (6.59%), internode length (6.34%), plant height (3.80%) and seed yield per plant (1.44%). The quantitative descriptors for individual characters are presented in table 126.

Table 124. Quantitative variation in different descriptors of sesame germplasm

Sl.#	Name of descriptor	Range	Mean	SD	CV (%)
1	Plant height (cm)	108.00-153.33	126.83	12.14	3.80
2	Internodes length (cm)	8.33-18.00	13.50	2.12	6.40
3	No. of primary branch	2.00-7.00	4.00	1.35	14.63
4	Length of basal leaf (cm)	4.50-15.33	8.25	2.14	14.63
5	Width of basal leaf (cm)	1.17-7.50	1.88	1.38	13.11
6	Length of top leaf (cm)	3.33-7.67	4.30	1.01	7.34
7	Width of top leaf (cm)	0.23-1.00	0.48	0.20	18.76
8	Petiole length of basal leaf (cm)	3.17-7.67	4.30	0.99	13.58
9	Petiole length of top leaf (cm)	0.13-1.13	0.37	0.24	19.15
10	Days to fifty % flowering	40.33-49.33	45.67	1.86	1.96
11	Number of capsules per plant	19-137	48.83	28.06	7.15
12	Mean capsule length (mm)	20.67-29.33	25.67	2.39	6.59
13	Mean capsule width (mm)	5.33-11.33	6.67	1.46	13.93
14	Seeds per capsule	23.00-85.67	46.00	17.31	16.72
15	100 seed weight (g)	0.13-0.90	0.20	0.138325	6.82
16	Seed yield per plant (g)	2.97-57.71	13.09	12.38027	1.44

Table 125. Distribution of germplasm in different non-hierarchical clusters of sesame

Name of cluster	No. of germplasm	Germplasm with their code number
Cluster-I	08	BD-6962, BD-6982, BD-6983, BD-6992, BD-6984, BD-6980, Binatil-2, BD-6995
Cluster-II	08	Binatil-3, Binatil-4, Sadatil, BD-6978, BD-6966, BD-6964, BD-6989, BD-6972
Cluster-III	09	BD-6986, BD-6994, BD-6991, BD-6988, BD-6985, BD-6993, BD-6970, BD-6990, BD-6971
Cluster-IV	02	BD-6987, BD-6968
Cluster-V	03	BD-6981, BD-6979, Kalotil
Total	30	

Hierarchical cluster analysis using UPGMA among 30 germplasm of sesame are shown in Fig. 90. The 30 germplasm were grouped into 5 non-hierarchical clusters (Table 125). Number of germplasm in each cluster ranged from 2 (cluster-IV) to 9 (cluster-III). Kalotil classified into Cluster-V.

Breeding objectives in sesame have focused many characters such as seed size, shape, coat color and oil content. Especially for physiological needs, color is an important argument because color production is an integral part of the development of various plant parts; type of color may adapt the plant part for a specific function (Padi, 2003). Therefore, these characters are most important attributes of foods, being considered as a quality indicator and determining frequently their acceptance (Azerado, 2009).

On the basis of cluster analysis, different qualitative and quantitative characters Kalotil, BD-6979, BD-6981, BD-6987, BD-6972, BD-6978, BD-6970, BD-6985, BD-6988, BD-6984 may be selected. Based on elongated capsule, BD-6987, BD-6988, Kalotil and BD-6984 would be selected. Based on maximum number of seeds per plant Kalotil, BD-6979, BD-6981, BD-6987 would be selected. BD-6970, BD-6972, BD-6979, BD-6981, BD-6985 as bold seed; for higher yield Kalotil, BD-6979, BD-6981, BD-6972 and BD-6978 would be selected. Considering all characters Kalotil, BD-6979, BD-6981 selected for varietal development and seeking further research to sesame breeder.

Conclusion

Wide variations were found among the 22 qualitative characters like plant growth habit, stem hairiness, leaf color, leaf hairiness, capsule shape, capsule color, seed size, seed color etc. Significant variations were found among the 16 quantitative characters such as days to 50 % flowering, length, width of basal leaf, top leaf and petiole length. 100 Seed weight, seed yield capsule per plant, seeds per capsule had shown significant difference among the germplasm. The maximum coefficient of variations was found in petiole length of top leaf and minimum in seed yield per plant. The 30 germplasm were classified into four clusters. Some promising germplasm (Kalotil, BD-6979 and BD-6981) were identified and these germplasm can be used for varietal development of sesame.

**Dendrogram using Average Linkage (Between Groups)
Rescaled Distance Cluster Combine**

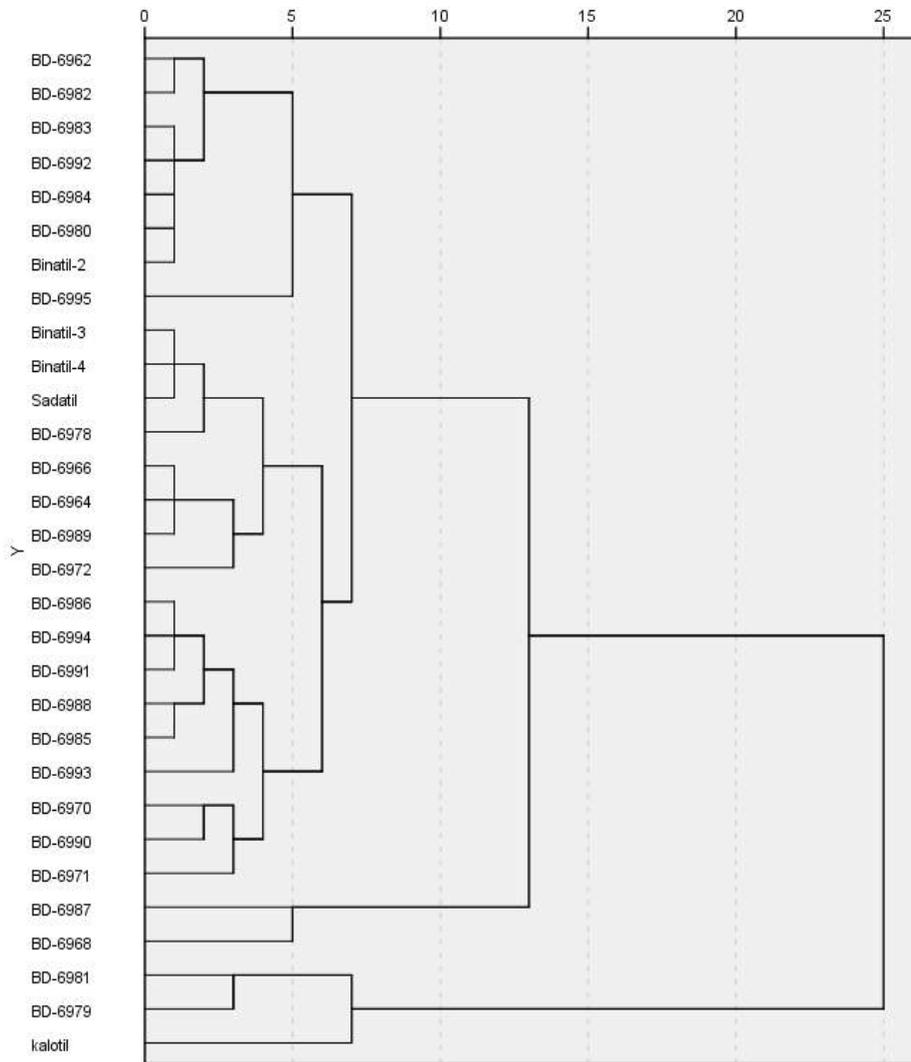


Fig. 90. Hierarchical cluster analysis using UPGMA among test sesame germplasm

Table 126. Quantitative characters of sesame germplasm

Genotype	Plant height (cm)	Internode length (cm)	Number of primary branch	Length of basal leaf (cm)	Width of basal leaf (cm)	Length of top leaf (cm)	Width of top leaf (cm)	Petiole length of basal leaf (mm)	Petiole length of top leaf (mm)	Number of capsules per plant
1	2	3	4	5	6	7	8	9	10	11
BD-6987	124.67	18.00	3.33	4.50	1.17	3.83	0.47	3.83	0.43	103.33
BD-6988	137.67	13.67	5.00	7.73	1.77	3.33	0.50	3.17	0.13	54.67
BD-6989	133.00	13.67	3.00	7.00	1.40	3.77	0.23	3.77	0.13	35.33
BD-6995	108.00	11.67	2.00	6.83	1.47	3.67	0.43	3.67	0.13	20.00
BD-6983	125.67	13.67	3.67	6.17	1.83	4.33	0.67	4.00	0.67	38.00
BD-6986	142.00	16.67	5.67	6.00	1.60	4.07	0.43	4.07	0.33	66.33
Kalotil	119.67	10.33	7.00	11.27	4.47	6.00	0.80	5.20	0.67	137.00
BD-6984	112.33	11.33	4.67	7.10	1.33	4.67	0.53	4.63	0.33	41.33
BD-6971	134.67	8.33	6.00	7.33	1.33	5.00	0.50	4.87	0.47	76.00
BD-6970	133.67	16.67	4.00	8.67	1.67	6.57	0.70	6.67	0.80	51.33
BD-6968	152.00	17.33	6.67	10.33	3.57	7.67	1.00	7.67	0.90	87.33
BD-6962	118.00	11.00	4.00	7.67	1.30	4.57	0.30	4.73	0.33	19.00
BD-6982	116.67	14.00	4.00	8.07	1.43	3.67	0.33	3.67	0.23	20.00
Binatil-2	114.00	14.33	3.00	7.83	1.57	3.80	0.33	3.80	0.50	36.00
BD-6981	134.00	12.33	7.00	12.33	2.23	6.73	0.83	6.73	1.13	110.33
BD-6979	126.00	12.33	5.00	15.33	5.67	4.83	0.50	4.93	0.33	97.67
BD-6972	133.33	12.00	3.67	10.17	2.40	5.03	0.67	5.03	0.37	36.67
BD-6978	124.67	14.67	3.67	9.83	2.90	5.20	0.67	5.20	0.73	46.33
Binatil-3	122.33	14.67	3.33	7.67	2.40	3.80	0.70	5.03	0.73	43.33
BD-6993	143.00	14.00	4.33	7.50	7.50	3.83	1.00	3.80	0.60	72.00
BD-6994	136.00	12.67	6.33	7.50	1.50	4.07	0.37	4.07	0.33	68.33
BD-6991	140.00	12.67	6.33	11.00	2.83	4.83	0.33	4.83	0.27	75.33
BD-6992	125.33	12.33	4.67	11.00	2.83	3.87	0.33	4.07	0.27	39.33
BD-6990	153.33	11.67	6.00	8.97	1.87	4.63	0.43	4.63	0.33	53.67
BD-6980	110.67	11.33	3.00	10.07	2.90	4.87	0.47	4.87	0.40	43.33
BD-6966	134.67	11.33	4.00	8.33	2.43	4.27	0.43	4.27	0.50	44.33
BD-6964	142.00	14.33	4.00	8.27	2.33	4.17	0.60	4.17	0.33	39.00
BD-6985	127.67	14.00	3.33	8.23	1.90	4.00	0.47	4.00	0.37	55.67
Binatil-4	110.33	13.33	3.00	8.50	1.77	3.80	0.67	4.33	0.30	40.33
Sadatil	117.67	14.33	4.00	9.50	1.93	4.47	0.47	4.17	0.37	55.67
Max	153.33	18.00	7.00	15.33	7.50	7.67	1.00	7.67	1.13	137.00
Min	108.00	8.33	2.00	4.50	1.17	3.33	0.23	3.17	0.13	19.00
Mean	126.83	13.50	4.00	8.25	1.88	4.30	0.48	4.30	0.37	48.83
SD	12.1353	2.123998	1.3547	2.141	1.384	1.01	0.1965	0.985	0.237	28.06

Table 126. Quantitative characters of sesame germplasm (Cont'd)

Genotype	Yield/ m ² (g)	100 Seed weight (g)	Mean capsule length (mm)	Mean capsule width (mm)	Seeds/ capsule	Days to flowering (50 %)
1	12	13	14	15	16	17
BD-6987	12.92	0.16	29.33	9.00	38.33	46
BD-6988	15.77	0.14	29.33	9.67	46.00	48
BD-6989	15.65	0.15	23.33	6.00	50.33	46
BD-6995	2.97	0.16	26.33	5.33	57.67	45
BD-6983	8.83	0.23	24.33	11.33	33.33	43
BD-6986	15.75	0.24	27.00	6.00	46.00	48
Kalotil	32.95	0.16	29.00	6.33	85.67	45.67
BD-6984	9.52	0.16	29.00	6.00	30.67	47
BD-6971	8.24	0.18	26.00	6.67	25.00	45
BD-6970	7.76	0.9	28.67	7.67	23.00	47
BD-6968	24.84	0.16	26.67	5.67	24.33	47
BD-6962	10.01	0.24	24.67	5.67	26.67	44
BD-6982	12.73	0.22	26.00	5.67	28.33	44
Binatil-2	8.25	0.23	24.67	7.33	23.33	43
BD-6981	45.19	0.3	25.67	7.67	74.00	47
BD-6979	57.71	0.28	29.33	6.00	58.67	45
BD-6972	38.24	0.25	26.67	6.33	52.33	46
BD-6978	30.98	0.13	25.00	7.00	67.00	43
Binatil-3	17.17	0.16	25.67	7.67	67.67	45
BD-6993	16.01	0.24	22.00	7.67	66.67	43
BD-6994	14.26	0.2	22.00	6.67	48.33	45
BD-6991	16.60	0.21	24.67	8.33	47.67	46
BD-6992	6.20	0.17	26.33	7.67	29.33	45.67
BD-6990	10.11	0.14	22.00	10.00	31.00	47
BD-6980	10.82	0.17	25.00	5.33	31.00	44
BD-6966	13.25	0.19	20.67	7.00	46.67	44
BD-6964	9.02	0.23	22.33	6.00	46.00	40.33
BD-6985	8.78	0.31	24.33	7.00	42.00	45.67
Binatil-4	11.91	0.35	24.67	6.67	69.33	45.67
Sadatil	15.77	0.18	25.67	5.67	61.67	49.33
Max	57.71	0.90	29.33	11.33	85.67	49.33
Min	2.97	0.13	20.67	5.33	23.00	40.33
Mean	13.09	0.20	25.67	6.67	46.00	45.67
SD	12.38	0.138	2.3949	1.46	17.31	1.864

11.6.6. Characterization of Peanut Germplasm

Exploring the genetic variation is the base of peanut (*Arachis hypogaea* L.) breeding program since peanut is an important food legumes and oilseed crop of the world. The aim of the present study is to characterize 33 germplasm of peanut based on the DUS descriptors. The experiment was conducted at the experimental field of Department of Agronomy, Bangladesh Agricultural University, Mymensingh during kharif 2020. On the basis of DUS descriptors, peanut varieties were characterized for twenty five morphological traits. A significant amount of variation was observed for most of the traits studied. The results revealed that maximum variation was recorded in growth habit, branching pattern, leaflet shape, leaflet surface, pod beak, pod constriction, pod reticulation, pod width, leaflet length and pod yield per plant. On the basis of frequency distribution, a majority of peanut germplasm was found in erect type, with alternate branching pattern; moderately stem surface, light green leaf color, oblong leaflet shape, hairy leaflet margin, acute leaflet tip, moderate pod beak and rose color seed. There were no variation in peg pigmentation and seed color.

Above study revealed the distinct characteristics of peanut germplasm and indicated that morphological variations exist in these germplasm due to variation in genetic makeup and could be better utilized by breeders in the selection based on their specific requirement for breeding programme. The list of the experimental materials along with their collector's number is shown in table 127.

Table 127. List of test peanut germplasm

Sl. No.	Name	Collector's Number	Sl. No.	Name	Collector's Number
1	7112-4-4-1	FI-29	18	ICGV-1901	FI-45
2	7112-2-1-2	FI-30	19	ICGV-5261	FI-46
3	ICGV-94322	FI-31	20	PK-1	FI-47
4	9112-2-1-1	FI-32	21	Beijing-2	FI-48
5	ICGV-1352	FI-33	22	ISD-4414	FI-49
6	Khenkhon	F-02	23	Vietnam	FI-50
7	ICGV-93389	FI-34	24	Mahosha	FI-51
8	7112-4-3-1	FI-35	25	ICGV-347	FI-52
9	9112-2-1-2	FI-36	26	ICGV-87055	FI-53
10	ICGV-94062	FI-37	27	ICGV-5268	FI-54
11	Binachinabadam-4	FI-38	28	ICGV-93199	FI-55
12	SM-6	FI-39	29	BARIBadam-9	FI-56
13	7112-4-1-2	FI-40	30	ISD-1314	FI-57
14	ICGV-4514	FI-41	31	ICGV-94366	FI-58
15	ICGV-211	FI-42	32	ICGV-88388	FI-59
16	9112-5-2-2	FI-43	33	Boro Elachibadam	H-03
17	China-1	FI-44			

The qualitative characters for germplasm are presented in table 128. Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated (Table 129).

Qualitative descriptor

Qualitative variations of different characters in peanut are shown in Table 128. Most of germplasm were erect type (57.58 %), 30.30% germplasm were Decumbent-3 type, two germplasm were found in Procumbent-2, one in Decumbent-1 and one in Decumbent-2 type plant growth habit. only two germplasm were determinate (6.67%), erect (53.33%), semi-erect (26.67%) and prostrate (6.67%) were found on plant growth habit. Among the 33 germplasm, only two germplasm showed irregular with flower on main stem, five germplasm showed irregular without flower on main stem and most of the germplasm (26) had alternate branching pattern. Stem pigmentation was absent in all germplasm except two germplasm (7112-4-4-1 and ICGV-94322). But peg pigmentation was absent in all germplasm.

Leaf characters varied significantly among the germplasm. In case of leaf color, 39.39% germplasm were found light green, 24.24 % were yellow and 36.36 % germplasm were orange yellow. Among the 33 germplasm, 3 germplasm had elliptic type in leaflet shape, 15 had oblong- elliptic, one had narrow-elliptic and 11 had wide elliptic, one had narrow- elliptic and only two had ovate leaflet shape. In case of leaflet margin, 63.64% germplasm had hairy leaflet margin and 15.15% germplasm had entire. There were three types leaflet tip, among the germplasm 18 germplasm were acute, 8 were mucronate and 5 were entire. All the germplasm were 2-1 seeded pod. On the basis of pod beak, 22 had moderate, 8 had slight, one prominent and 3 had not pod beak. Among the 33 germplasm, 12 had not any pod constriction, 10 had moderate, 7 had slight and one had deep pod constriction. All germplasm are in one color. In case of primary seed color, most of the germplasm were rose in color.

Table 128. Qualitative descriptors for test peanut germplasm

Sl. no.	Character	State of characters	No. of germplasm	Germplasm's serial No. (List in Table 129)	Frequency (%)
1	Growth habit	Procumbent-2	2	28, 31	6.06
		Decumbent-1	1	32	3.03
		Decumbent-2	1	3	3.03
		Decumbent-3	10	1,2, 4, 7, 8, 20, 22, 23, 27, 30	30.30
		Erect	19	5,6,9,10,11,12,13,14,15,16,17,18,19,21,24,25,26,29, 33	57.58
2	Branching Pattern	Alternate	26	1, 2, 4, 5, 6, 7, 8, 9, 11, 14, 16, 17, 18, 19, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33	78.79
		Irregular with flower on main stem	2	3, 10	6.06
		Irregular without flower on main stem	5	12, 13, 15, 22, 21	15.15
3	Stem pigmentation	0 Absent	20	2,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22	60.61
		+ Present	2	1, 3	6.06
4	Stem surface	Sub glabrous	1	2	3.03
		Moderately hairy	26	1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32	78.79
		Very hairy	5	6, 7, 20, 21, 33	15.15
		Woolly	1	15	3.03
5	Peg pigmentation	Absent (0)	33	All the germplasm	100
		Present(+)	0	-	0
6	Leaf color	Light green	13	1, 3, 11, 12, 14, 15, 17, 20, 28, 29, 30, 31, 33	39.39
		Yellow	8	2, 6, 7, 10, 13, 18, 21, 24	24.24
		Orange yellow	12	4, 5, 8, 9, 16, 19, 22, 23, 25, 26, 27, 32	36.36
7	Leaflet shape	Elliptic	3	20, 29, 31	9.09
		Oblong- elliptic	15	2, 3, 4, 5, 6, 9, 13, 14, 16, 18, 21, 24, 26, 28, 30, 32	45.45
		Narrow-elliptic	1	25	3.03
		Wide- elliptic	11	7, 10, 11, 12, 15, 17, 19, 22, 23, 27, 33	33.33
		Ovate	2	1, 8	6.06
8	Leaflet surface	Almost glabrous on both surface	1	24	3.03
		Almost glabrous bellow, hair above	4	1, 4, 29, 33	12.12
		Hairs on both surface, without bristol	21	2, 3, 5, 6, 7, 9, 12, 14, 18, 19, 20, 21, 22, 23, 25, 26, 27, 28, 30, 31, 32	63.64
		Hairs on both surface, with bristol	3	11, 15, 17	9.09
		Woolly without bristol	3	8, 10, 13	9.09
		Woolly with bristol	1	16	3.03
9	Leaflet margin	Entire	5	1, 2, 3, 4, 12	15.15
		Hairy	21	5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26	63.64
10	Leaflet tip	Obtuse	4	1, 2, 21, 28	12.12
		Acute	18	3, 8, 11, 13, 14, 15, 16, 18, 19, 20, 22, 23, 24, 25, 27, 30, 31, 33	54.55
		Mucronate	8	4, 9, 10, 12, 17, 26, 29, 32	24.24
11	No. of seeds/pod	2-1 seed	33	All the germplasm	100
12	Pod beak	Absent	3	7, 11, 28	9.09
		Slight	8	1, 4, 5, 6, 9, 22, 25, 27	24.24
		Moderate	22	2, 3, 8, 10, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 26, 29, 30, 31, 32, 33	66.67
		Prominent	1	16	3.03

Cont'd. Table 128.

Sl.#	Character	State of characters	No. of germplasm	Germplasm's serial No. (List in Table 129)	Frequency (%)
13	Pod constriction	None	12	3, 7, 11, 12, 15, 18, 19, 22, 23, 24, 25, 29	36.36
		Slight	7	8, 9, 10, 13, 16, 17, 28	21.21
		Moderate	10	1, 2, 4, 5, 6, 9, 14, 20, 21, 27	30.30
		Deep	1	26	3.03
14	Pod reticulation	None	2	31, 32	6.06
		Slight	11	7, 10, 11, 12, 18, 23, 24, 25, 26, 27, 29	33.33
		Moderate	12	1, 2, 3, 5, 6, 8, 9, 15, 20, 28, 30, 33	36.36
		Prominent	6	4, 13, 14, 16, 19, 21	18.18
		Very prominent	2	17, 22	6.06
15	Seed color	One color	33	All the germplasm	100
16	Primary seed color	White	1	22	3.03
		Off-white	2	2, 12	6.06
		Rose	28	4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33	84.85
		Light red	2	1, 2	6.06

B. Quantitative descriptor

Quantitative variations of 9 descriptors in peanut are shown in Table 129. The height of main stem ranged 7.33 to 35 cm. The highest plant was found in 9112-2-1-1 (35.00 cm) while the lowest 7.33 cm was observed in 7112-2-1-2 with a mean of 24.63 cm. The CV% and SD was found in plant height were 25.78% and 6.35, respectively. Plant width ranged from 3.67 cm to 19.33cm with a mean of 7.02. The highest plant width was found in 7112-4-4-1 while the lowest was observed in ICGV-4514. The highest CV (49.97%) was found in plant width. Leaflet length and width ranged from 10.67 to 28.33 mm and 1.47 to 5.40 cm with average of 4.65 and 1.12 respectively. Longest leaflet was found in ICGV-93389 while ICGV-5261 had produced the shortest (10.67) with an average of 19.90mm. Longest leaflet width was found in ISD-1314 while PK-1 had produced the shortest with an average of 3.63. Pod length and width of ranged from 10.67 (ICGV-1901) to 20.67 (ICGV-211) with the mean of 14.25mm and 4.00 (ICGV-1901) to 8.67 (Vietnam) with the mean of 5.71 respectively. Seed length ranged from 6.33 to 14.33 mm and seed width ranged from 1.90 to 3.13 mm. Long seed was found in ISD-4414 while ICGV-1901 had produced the shortest (6.33) with an average of 10.79 mm. Maximum seed width was found in ICGV-87055 while Mahosha had produced the shortest with an average of 2.52. The germplasm produced 3.19 g to 16.29 g yield per plant from ISD-4414 and 7112-4-3-1, respectively with an average of 10.44 g yield per plant was found.

Table 129. Quantitative variation in different descriptors of peanut germplasm

Sl. no.	Name of descriptor	Range	Mean	SD	CV (%)
1	Height of main stem (cm)	7.33-35.00	24.63	6.35	25.78
2	Plant width or spread (cm)	3.67-19.33	7.02	3.51	49.97
3	Leaflet length (mm)	10.67-28.33	19.90	4.65	23.35
4	Leaflet width (mm)	1.47-5.40	3.63	1.12	30.96
5	Pod length (mm)	10.67-20.67	14.25	2.49	17.47
6	Pod width (mm)	4.00-8.67	5.71	1.55	27.19
7	Seed length (mm)	6.33-14.33	10.79	2.33	21.59
8	Seed width (mm)	1.90-3.13	2.52	0.35	13.70
9	Yield/plant (g)	3.19-16.29	10.44	3.42	32.76

Conclusion

Wide variations were found among the 13 qualitative characters like plant growth habit, branching pattern, stem surface, leaflet shape, leaflet surface, pod beak, pod constriction, pod reticulation, Significant variations were found among the 9 quantitative characters such as plant width, leaflet length, yield per plant had shown significant difference among the germplasm. The maximum coefficient of variations was in plant width and minimum in pod length. Some promising germplasm (7112-4-4-1, 9112-2-1-1, 7112-4-3-1 and ICGV-347) were identified and these germplasm can be used for varietal development of peanut.

11.6.7. Genetic Diversity Analysis in Rice Landraces using SSR Markers

Plant materials

This study was conducted at pot yard and Molecular Laboratory of Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Eighty-three rice landraces of different location of Bangladesh were studied (Table 130) using SSR marker. Each of the entry was sown in plastic pots for growth and subsequent DNA extraction.

Table 130. List of test rice germplasm used for molecular characterization

SL. No.	Local name	SL. No.	Local name
1.	Kuttimora Birun	43.	Kashia Binni
2.	Dudh Binni	44.	Chinishail-3
3.	Goa Mouri	45.	Goabari
4.	Chaklashi	46.	Marrygold
5.	Goar chara	47.	Lalkumri
6.	Hashem Iri	48.	Porbot Jira
7.	Lal Pajam	49.	Sentu-18
8.	Birui	50.	Sentu-19
9.	Shoragot Birun	51.	Lalmatia
10.	Aila gota	52.	Faijam
11.	Bedha Birun	53.	Leda Binni
12.	Ojana Birun	54.	Hasa Shada
13.	Lal goarchara	55.	Lal Chini shail
14.	Kaijam	56.	Peyarjat
15.	Kotkoti	57.	Shonajuri
16.	Lalcheng	58.	Mukta-10
17.	Puti birun	59.	Choto Sharnalota
18.	Noli Goarchara	60.	Motamorang
19.	Chanmoni	61.	Chapal
20.	Sentu-6	62.	Ful lota
21.	Chapal-2	63.	Sentu-5
22.	Lomba Ail	64.	Hashakalo
23.	Shada Pajam	65.	Champa Mushuri
24.	Birushail	66.	Madhobi lota
25.	Chini shail	67.	Sentu-16
26.	Chenger muri	68.	Nagra
27.	Sentushail	69.	Gobinda

SL. No.	Local name	SL. No.	Local name
28.	Chinigura	70.	Sentu-9
29.	Shong Binni	71.	Sentu-11
30.	Champa mushuri	72.	Tulshimala
31.	Bashiraj	73.	Sentu-17
32.	Gandhishail	74.	Hashashada
33.	Boro Abji	75.	Laldinga
34.	Malai reti	76.	Goatibinni
35.	Deshi-32	77.	Sentu-18
36.	Moynashail	78.	Porabinni
37.	Maloti	79.	Ranishail
38.	Chollish	80.	Shonajuri
39.	Pajam	81.	Bishali Binni
40.	Sentu gold	82.	Kalo Birun
41.	Markabinni	83.	Fulkainja
42.	Moyna shail		

Genotyping

Nine SSR markers (Table 131) were used for diversity analysis. Total genomic DNA was extracted from young leaves of three-week-old plants following CTAB method (Doyle and Doyle 1987). PCR analysis was performed in 10µl reaction sample containing 50 ng of DNA template of 2 µl, 5 µl of master mix, 2 µl nuclear free water, 1µl each of 10 µM forward and reverse primers using Biometra T₃ thermal cycler with single 96-well. After initial denaturation for five minutes at 94°C, each cycle comprised one min denaturation at 94°C, one min annealing at 55°C, and two min extension at 72°C with a final extension for 7 min at 72°C at the end of 35 cycles. The PCR products were analyzed by electrophoresis on 8% polyacrylamide gel using mini vertical polyacrylamide gels for high throughput manual genotyping (CBS Scientific Co. Inc., CA, and USA). 2µl of amplification products were resolved by running gel in 1x TBE buffer for 2-2.5 hrs depending upon the allele size at around 80 volts and 400 mA current. The gels were stained in 0.5 mg/ml ethidium bromide and were documented using Whatman Biometra gel Documentation System (prod nr: 1603209).

Table 131. List of simple sequence repeat (SSR markers)

Locus name	Amplicon size range(bp)	Repeat motif	Sequence	Annealing Temperature (°C)
RM493	211	(CTT) ⁹	Forward:TAGCTCCAACAGGATCGACC Reverse:GTACGTAAACGCGGAAGGTG	55
RM248	102	(CT) ²⁵	Forward :TCCTTGTGAAATCTGGTCCC Reverse: GTAGCCTAGCATGGTGCATG	55
RM262	154	(CT) ¹⁶	Forward :CATTCCGTCTCGGCTCAACT Reverse:CAGAGCAAGGTGGCTTGC	55
RM7075	155	(ACAT) ¹³	Forward:TATGGACTGGAGCAAACCTC Reverse:GGCACAGCACCAATGTCTC	50
RM224	157	(AAG) ⁸ (AG) ¹³	Forward:ATCGATCGATCTTCACGAGG Reverse:TGCTATAAAAGGCATTCGGG	55
RM551	192	(AG) ¹⁸	Forward:AGCCCAGACTAGCATGATTG Reverse:GAAGGCGAGAAGGATCACAG	55

Locus name	Amplicon size range(bp)	Repeat motif	Sequence	Annealing Temperature (°C)
RM585	233	(TC) ⁴⁵	Forward:CAGTCTTGCTCCGTTTGTG	55
			Reverse:CTGTGACTGACTTGGTCATAGG	
RM3412b	211	(TA) ³⁴	Forward:TCATGATGGATCTCTGAGGTG	55
			Reverse:GGGAGGATGCACTAATCTTTC	
RM336	154	(CTT) ¹⁸	Forward:CTTACAGAGAAACGGCATCG	55
			Reverse:GCTGGTTTGTTCAGGTTTCG	

Data analysis

Molecular weight for each amplified allele was measured in base pair using Alpha-Ease 5.0 software. The summary statistics including the number of alleles per locus, major allele frequency, gene diversity, polymorphism information content (PIC) values were analysed using Power Marker - 3.25 (Liu and Muse, 2005). For the unrooted phylogenetic tree, genetic distance was calculated using the “C.S. Chord 1967” distance measure (Cavalli-Sfoza and Edwards, 1967) followed by phylogeny reconstruction using neighbourjoining as implemented in Power Marker using Treeview (Page, 1996).

Ninety-six rice landraces were successfully amplified with the nine micro-satellite markers where primer pairs referred to as loci and DNA bands as alleles. A total of 262 alleles were detected using nine micro-satellite markers across 83 rice landraces. The highest average band size was found for RM585 (233) followed by RM493 (211), and RM3412b (205). Among the nine SSR markers, the highest number of alleles (34) was found for RM336 followed by RM248 (33) and RM585 (32). The polymorphism information content (PIC) values ranged from 0.951 (RM336) to 0.766 (RM262), with an average of 0.90. The PIC values for other markers were 0.910 (RM493), 0.844 (RM7075), 0.913 (RM224) and 0.926 (RM551), respectively (Table 132). PIC value revealed RM336 as the best marker. Figure 91 shows the polymorphism survey of some SSR marker of two landraces. The allele frequency ranged from 37.35% (RM262) to 10.84% (RM585, RM336) with an average of 18.47%. Gene diversity varied from 0.95 to 0.78 and their average value was 0.91, which also indicated the presence of adequate genetic diversity (Table 132). Figure 92 and 93 shows the DNA profiles of 83 landraces with SSR marker RM493 and RM262, respectively (Figs. 91-93).

Table 132. Allele number, frequency, genetic diversity and PIC of 83 rice landraces screened with nine micro-satellite markers

Locus name	No. of Allele	Allele Frequency (%)	Gene Diversity	PIC
RM493	27	0.2169	0.9154	0.9106
RM248	33	0.1084	0.9531	0.9512
RM262	13	0.3735	0.7891	0.7660
RM7075	16	0.2530	0.8585	0.8443
RM224	25	0.2048	0.9186	0.9139
RM551	26	0.1205	0.9310	0.9269
RM585	32	0.1084	0.9496	0.9474
RM3412b	28	0.1687	0.9369	0.9338
RM336	34	0.1084	0.9537	0.9518
Mean	26	0.1847	0.9118	0.9051

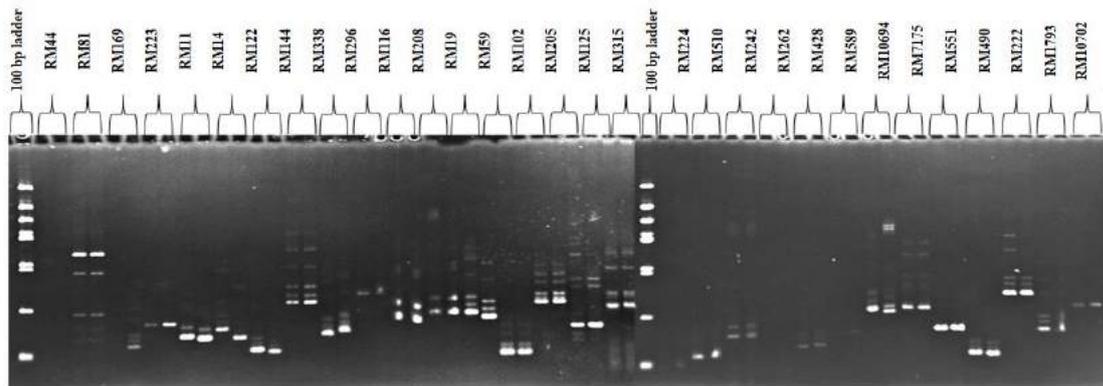


Fig. 91. Primer survey of two rice landraces

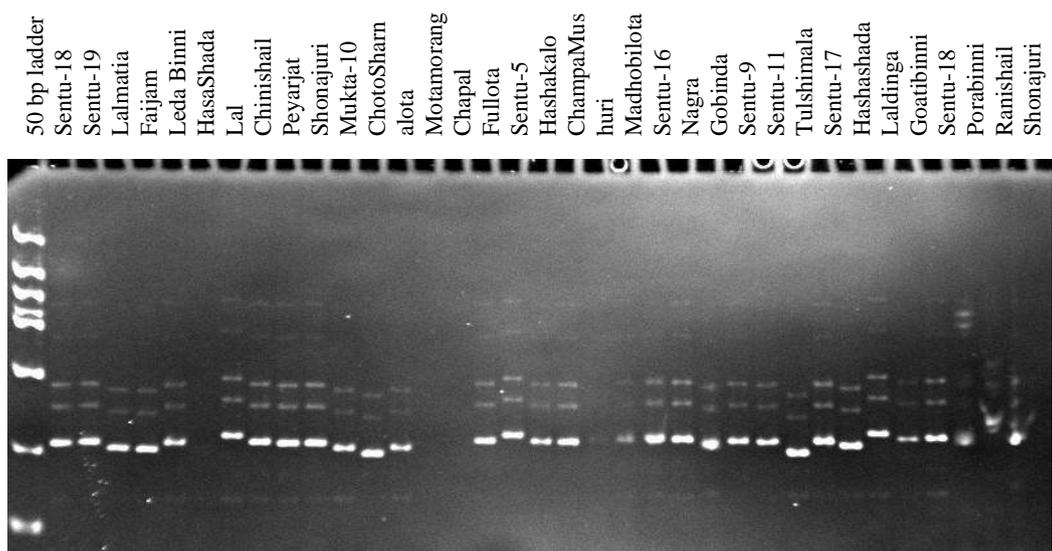
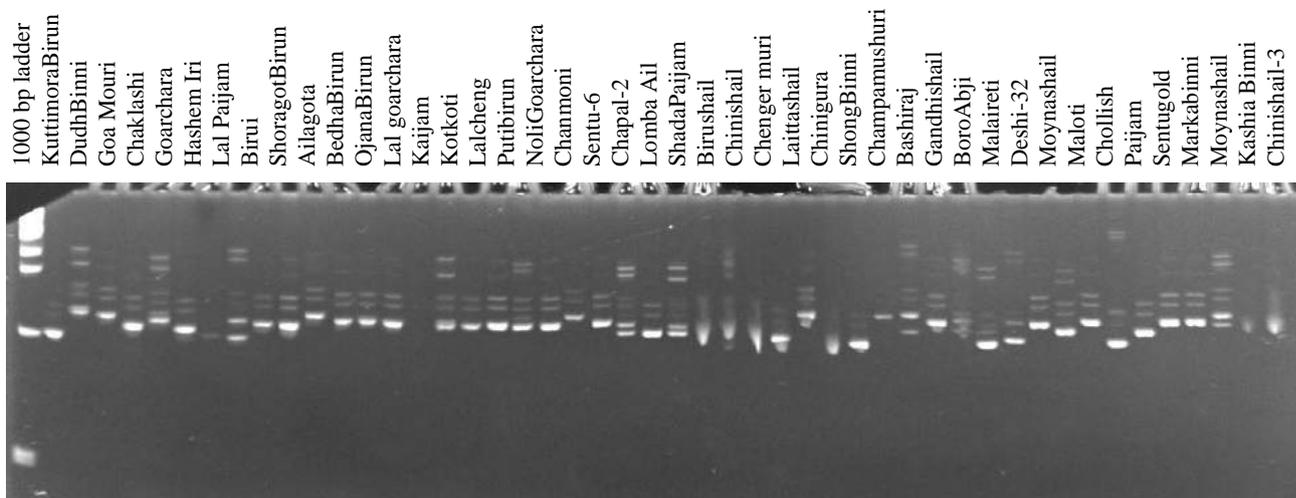


Fig. 92. DNA profile of 83 rice landraces with marker, RM493

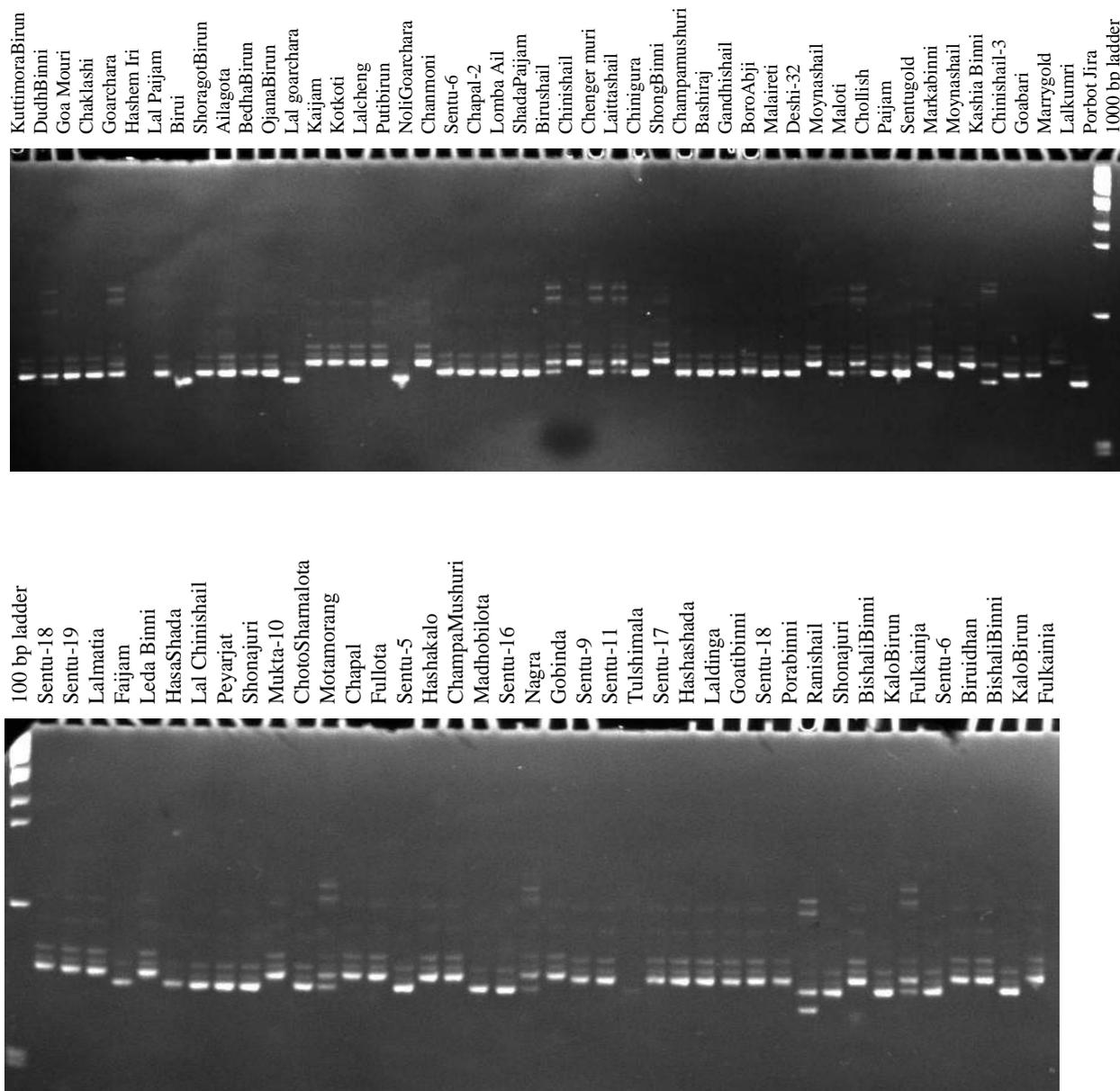


Fig. 93. DNA profile of 83 rice landraces with marker, RM262

Genetic distance-based analysis

Cluster analysis was done to group the genotypes into a dendrogram. From this dendrogram, the 83 rice landraces were grouped into five major clusters by 9 markers. All the 83 rice genotypes could be easily distinguished. The UPGMA cluster analysis led to the grouping of 83 rice genotypes in five major clusters at a coefficient of 0.6 and the similarity coefficient value ranged from 0.08 to 1.0. Cluster 2 consisted of 31 landraces and is the biggest group among five clusters, followed by cluster 4, which contained 30 landraces; cluster 3 comprised 11 landraces; cluster 1 comprised 6 landraces; cluster 5 was composed of 5 landraces (Fig. 94).

Conclusion

The traditional rice landraces can propose a valuable gene pool. There was a high level of genetic diversity among landraces of rice. In this study, it is suggested that SSR markers were effective in the detection of polymorphism in this ecosystem. To broaden the genetic base and for the improvement of rice, landraces having the lowest genetic similarities could be selected as parents. Therefore, hybridization may be made between two distant populations. Considering all these criteria and results from genetic diversity analysis, landraces that are far apart based on their genetic distance (like Kuttimura Biruin and Puti Biruin; Bedha Birun and Lalgoarchara; Ranishail and Gandhishail; Ojana Birun and Laldinga; Dudh Binni and Lalcheng; Chinigura and Noli Goarchara etc.) could be selected as parents for further breeding programs.

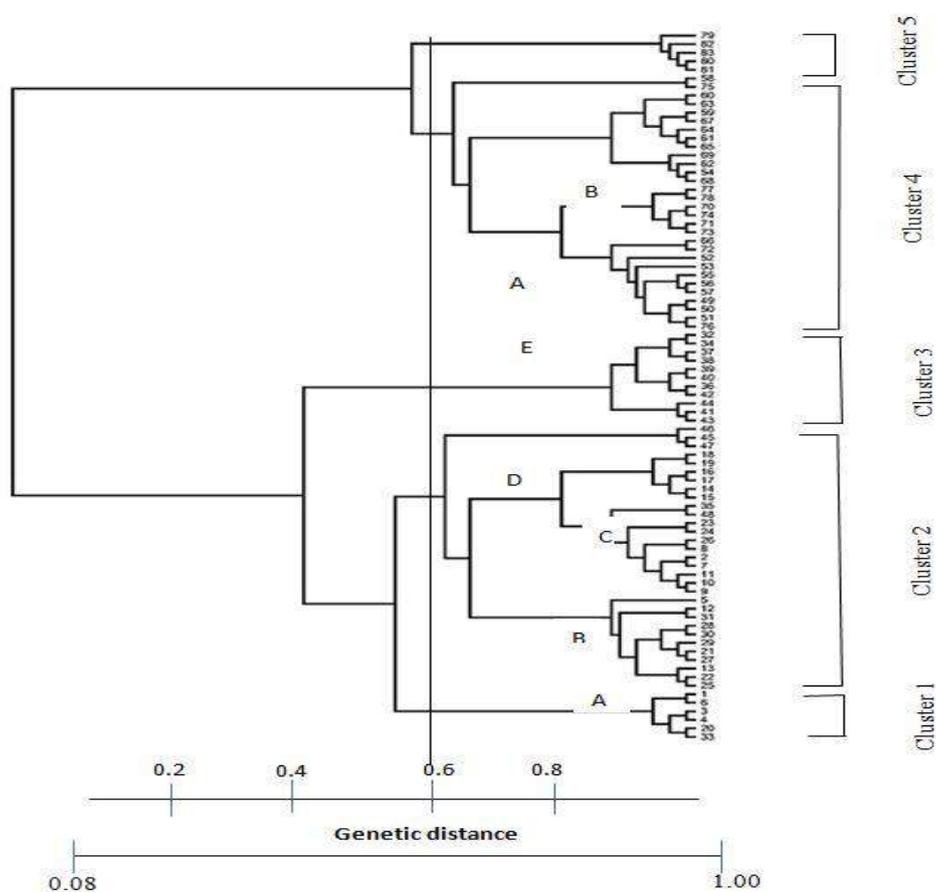


Fig. 94. An UPGMA dendrogram showing genetic relationships among 83 rice landraces based on alleles detected by nine micro-satellite markers

Legend: 1-Kuttimora Birun, 2-Dudh Binni, 3-Goa Mouri, 4-Chaklashi, 5-Goar chara, 6-Hashem Iri, 7-Lal Paijam, 8-Birui, 9-Shoragot Birun, 10-Aila gota, 11-Bedha Birun, 12-Ojana Birun, 13-Lal goarchara, 14-Kaijam, 15-Kotkoti, 16-Lalcheng, 17-Puti birun, 18-Noli Goarchara, 19-Chanmoni, 20-Sentu-6, 21-Chapal-2, 22-Lomba Ail, 23-Shada Paijam, 24-Birushail, 25-Chini shail, 26-Chenger muri, 27-Laittashail, 28-Chinigura, 29-Shong Binni, 30-Champa mushuri, 31-Bashiraj, 32-Gandhishail, 33-Boro Abji, 34-Malai reti, 35-Deshi-32, 36-Moynashail, 37-Maloti, 38-Chollish, 39-Paijam, 40-Sentu gold, 41-Markabinni, 42-Moyna shail, 43-Kashia Binni, 44-Chinishail-3, 45-Goabari, 46-Marry gold, 47-Lalkumri, 48-Porbot Jira, 49-Sentu-18, 50-Sentu-19, 51-Lalmatia, 52-Faijam, 53-Leda Binni, 54-Hasa Shada, 55-Lal Chinishail, 56-Peyarjat, 57-Shonajuri, 58-Mukta-10, 59-Choto Sharnalota, 60-Motamorang, 61-Chapal, 62-Ful lota, 63-Sentu-5, 64-Hashakalo, 65-Champa Mushuri, 66-Madhobi lota, 67-Sentu-16, 68-Nagra, 69-Gobinda, 70-Sentu-9, 71-Sentu-11, 72-Tulshimala, 73-Sentu-17, 74-Hashashada, 75-Laldinga, 76-Goatibinni, 77-Sentu-18, 78-Porabinni, 79-Ranishail, 80-Shonajuri, 81-Bishali Binni, 82-Kalo Birun, 83-Fulkainja

11.6.8. Conservation of Collected Germplasm

BINA collected 198 rice, oilseeds, pulses, spices and vegetables germplasm from Mymensingh, Tangail and Sylhet regions. Collected germplasm were multiplied in respective season and conserved in mid and short term storage room assigning accession number during March 2019 to September 2020. After confirmation 99-100% germination rate of multiplied or regenerated seeds were preserved with appropriate moisture % and quantity.

Table 133. Conservation status of germplasm collected under PBRG-PGR sub-project

Sl. No.	Cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
Rice							
1.	Gaindha	MM-30	200g	12	100	March 2019	BINA-1780
2.	Purabinni	MM-1	200g	12	100	March 2019	BINA-1781
3.	Fulkainja	MM-26	200g	12	100	March 2019	BINA-1782
4.	Rupashail	MM-23	200g	12	100	March 2019	BINA-1783
5.	Leda binni	MM-19	200g	12	100	March 2019	BINA-1784
6.	Biroi-2	MM-17	200g	12	100	March 2019	BINA-1785
7.	Chapal-1	MM-16	200g	12	100	March 2019	BINA-1786
8.	Sentu-15	MM-29	200g	12	100	March 2019	BINA-1786
9.	Sentu-19	MM-22	200g	12	100	March 2019	BINA-1787
10.	Lalchinishail	MM-07	200g	12	100	March 2019	BINA-1788
11.	Dudhbinni	MM-27	200g	12	100	March 2019	BINA-1789
12.	Champamashuri	MM-24	200g	12	100	March 2019	BINA-1790
13.	Chotosornolota	MM-28	200g	12	100	March 2019	BINA-1791
14.	Motamorang	MM-08	200g	12	100	March 2019	BINA-1792
15.	Pairjaat	MM-12	200g	12	100	March 2019	BINA-1793
16.	Sentu gold	MM-15	200g	12	100	March 2019	BINA-1794
17.	Markabini	MM-05	200g	12	100	March 2019	BINA-1795
18.	Bishalibini	MM-06	200g	12	100	March 2019	BINA-1796
19.	Goatibinni-1	MM-04	200g	12	100	March 2019	BINA-1797
20.	Shongbini	MM-18	200g	12	100	March 2019	BINA-1798
21.	Sentu-18	MM-21	200g	12	100	March 2019	BINA-1799
22.	Fullota	MM-20	200g	12	100	March 2019	BINA-1800
23.	Mery gold	MM-10	200g	12	100	March 2019	BINA-1801
24.	Lalmatia	MM-32	200g	12	100	March 2019	BINA-1802
25.	Chapal-2	MM-14	200g	12	100	March 2019	BINA-1803
26.	Sentu-6	MM-31	200g	12	100	March 2019	BINA-1804
27.	Sentushail	MM-13	200g	12	100	March 2019	BINA-1779
28.	Sentu-17	MM-25	200g	12	100	March 2019	BINA-1778
29.	Sentu-16	MM-09	200g	12	100	March 2019	BINA-1777
30.	Ranishail	MM-11	200g	12	100	March 2019	BINA-1776
31.	Sentu-5/Malonchi	MM-02	200g	12	100	March 2019	BINA-1775
32.	Kalahapa	H-01	200g	12	100	January 2020	BINA-1772
33.	Binnatoa	FA-01	200g	12	100	January 2020	BINA-1770
34.	Gourohati	FA-02	200g	12	100	January 2020	BINA-1769
35.	Begunbichi	FA-03	200g	12	100	January 2020	BINA-1768
36.	Rati Boro (local Aromatic rice)	FHS-01	200g	12	100	January 2020	BINA-1767
37.	Lafaya	FHS-02	200g	12	100	January 2020	BINA-1766
38.	Chengri	FM-01	200g	12	100	January 2020	BINA-1765

Cont'd. Table 133.

Sl. No.	Cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
39.	Arai	FM-02	200g	12	100	January 2020	BINA-1764
40.	Laldinga	FMM-01	200g	12	100	January 2020	BINA-1763
41.	Local (Boro)	FMM-02	200g	12	100	January 2020	BINA-1762
42.	Lalkumri	FS-01	200g	12	100	January 2020	BINA-1761
43.	Bishalibinni	FS-02	200g	12	100	January 2020	BINA-1760
44.	Paijam	FS-03	200g	12	100	January 2020	BINA-1759
45.	Gobinda	FS-04	200g	12	100	January 2020	BINA-1758
46.	Tulsimala	FS-05	200g	12	100	January 2020	BINA-1757
47.	Biroi	FS-06	200g	12	100	January 2020	BINA-1756
48.	Chanmoni	FS-07	200g	12	100	January 2020	BINA-1755
49.	Hashemirri	FS-08	200g	12	100	January 2020	BINA-1754
50.	Lal paijam	FS-09	200g	12	100	January 2020	BINA-1753
51.	Boroabji	FS-10	200g	12	100	January 2020	BINA-1752
52.	Chinisail	FS-11	200g	12	100	January 2020	BINA-1751
53.	Kalojira	FS-12	200g	12	100	January 2020	BINA-1750
54.	Bashiraj	FS-13	200g	12	100	January 2020	BINA-1749
55.	Lombaail	FS-14	200g	12	100	January 2020	BINA-1748
56.	Nagra	FS-15	200g	12	100	January 2020	BINA-1747
57.	Maloti	FS-16	200g	12	100	January 2020	BINA-1746
58.	Guamouri	FS-17	200g	12	100	January 2020	BINA-1745
59.	Chinisail-3	FS-18	200g	12	100	January 2020	BINA-1744
60.	Molaireti	FS-19	200g	12	100	January 2020	BINA-1743
61.	Putibirun	FS-20	200g	12	100	January 2020	BINA-1742
62.	Kutimurar birun	FS-21	200g	12	100	January 2020	BINA-1741
63.	Guarchara	FS-22	200g	12	100	January 2020	BINA- 1740
64.	Chinigura	FS-23	200g	12	100	January 2020	BINA-1739
65.	Soragotobirun	FS-24	200g	12	100	January 2020	BINA-1738
66.	Atonishail	FM-37	200g	12	100	February 2020	BINA-1781
67.	Gandhishail	FM-38	200g	12	100	February 2020	BINA-1782
68.	Chinishail-3	FS-18	200g	12	100	February 2020	BINA-1783
69.	Moinashail-1	FS-40	200g	12	100	February 2020	BINA-1784
70.	Birushail	FM-35	200g	12	100	February 2020	BINA-1785
71.	Laittashail	FM-36	200g	12	100	February 2020	BINA-1786
72.	Moinashail-2	FM-39	200g	12	100	February 2020	BINA-1787
73.	Biroi-1	MM-17	200g	12	100	February 2020	BINA-1788
74.	Biroi dhan-1	FS-27	200g	12	100	February 2020	BINA-1789
75.	Biroi-3	FM-06	200g	12	100	February 2020	BINA-1790
76.	Birun-1	FM-13	200g	12	100	February 2020	BINA-1791
77.	Birun-2	FM-14	200g	12	100	February 2020	BINA-1792
78.	Soragoto birun	FS-24	200g	12	100	February 2020	BINA-1793
79.	Ojana birun	FS-26	200g	12	100	February 2020	BINA-1794
80.	Kalobirun	FS-39	200g	12	100	February 2020	BINA-1795
81.	Bedabirun	FS-42	200g	12	100	February 2020	BINA-1796
82.	Asamyo birun	FM-08	200g	12	100	February 2020	BINA-1797
83.	Lal birun	FM-10	200g	12	100	February 2020	BINA-1798
84.	Paijam	FS-36	200g	12	100	February 2020	BINA-1799
85.	Faijam	FS-41	200g	12	100	February 2020	BINA-1800
86.	Desi paijam	FM-22	200g	12	100	February 2020	BINA-1801
87.	Sada paijam	FM-25	200g	12	100	February 2020	BINA-1802
88.	Painjab	FM-26	200g	12	100	February 2020	BINA-1803
89.	Biroi dhan-2	FS-27	200g	12	100	February 2020	BINA-1804
90.	Biroi-4	FM-	200g	12	100	February 2020	BINA-1632
91.	Kalijira	MSF-01	200g	12	100	February 2020	BINA--1633

Cont'd. Table 133.

Sl. No.	Cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
92.	Desi kalojira	FM-19	200g	12	100	February 2020	BINA-1634
93.	Guarchara	FS-22	200g	12	100	February 2020	BINA-1635
94.	Chinigura-1	FS-23	200g	12	100	February 2020	BINA-1636
95.	Chinigura -2	FM-18	200g	12	100	February 2020	BINA-1637
96.	Chiniguri	MFS-21	200g	12	100	February 2020	BINA-1638
97.	Guabari	M-23	200g	12	100	February 2020	BINA-1639
98.	Chakloshi	FS-25	200g	12	100	February 2020	BINA-1640
99.	Caplash	FM-15	200g	12	100	February 2020	BINA-1641
100.	Mukta	FS-28	200g	12	100	February 2020	BINA-1642
101.	Deshi-32	FS-29	200g	12	100	February 2020	BINA-1643
102.	Hashakalo	FS-30	200g	12	100	February 2020	BINA-1644
103.	Shonajuri	FS-31	200g	12	100	February 2020	BINA-1645
104.	Hasa sada	FS-32	200g	12	100	February 2020	BINA-1646
105.	Chenger muri-2	FM-17	200g	12	100	February 2020	BINA-1647
106.	Parbotjira	FS-34	200g	12	100	February 2020	BINA-1648
107.	Noliguar Chara	FS-35	200g	12	100	February 2020	BINA-1649
108.	Laal cheng	FS-37	200g	12	100	February 2020	BINA-1650
109.	Ailaguta	FS-38	200g	12	100	February 2020	BINA-1651
110.	Chollish (40)	FM-3	200g	12	100	February 2020	BINA-1652
111.	Chechollish (46)	FM-4	200g	12	100	February 2020	BINA-1653
112.	Bolok	FM-5	200g	12	100	February 2020	BINA-1654
113.	Abdul Halim dhan	FM-07	200g	12	100	February 2020	BINA-1655
114.	Deshi-32	FM-20	200g	12	100	February 2020	BINA-1656
115.	Desi paijam	FM-22	200g	12	100	February 2020	BINA-1657
116.	Laal paijam	FM-23	200g	12	100	February 2020	BINA-1658
117.	Sada paijam	FM-25	200g	12	100	February 2020	BINA-1659
118.	Painjab	FM-26	200g	12	100	February 2020	BINA-1660
119.	Goarchara-3	FM-27	200g	12	100	February 2020	BINA-1661
120.	Goarchara-2	FM-28	200g	12	100	February 2020	BINA-1662
121.	Guarchara-1	FS-22	200g	12	100	February 2020	BINA-1663
122.	Khudbadal/ Chinigura	FM-29	200g	12	100	February 2020	BINA-1664
123.	Kotkoti	FM-30	200g	12	100	February 2020	BINA-1665
124.	Maloti	FM-31	200g	12	100	February 2020	BINA-1666
125.	Maloti-2	FM-32	200g	12	100	February 2020	BINA-1667
126.	Murabadam	FM-34	200g	12	100	February 2020	BINA-1668
127.	Jiradhan	MSF-02	200g	12	100	February 2020	BINA-1669
128.	Jirabuti	MSF-03	200g	12	100	February 2020	BINA-1670
129.	Rajbuti	MSF-04	200g	12	100	February 2020	BINA-1671
130.	Chiniatob	MSF-05	200g	12	100	February 2020	BINA-1672
131.	Chini sakkhor	MSF-06	200g	12	100	February 2020	BINA-1673
132.	Shakkhor khora	MSF-07	200g	12	100	February 2020	BINA-1674
133.	Kaonkhir	MSF-08	200g	12	100	February 2020	BINA-1675
134.	Khirshabuti	MSF-09	200g	12	100	February 2020	BINA-1676
135.	Khirsapat	MKF-01	200g	12	100	February 2020	BINA-1677
136.	Sadagura	MSF-10	200g	12	100	February 2020	BINA-1678
137.	Doiorgura	MSF-11	200g	12	100	February 2020	BINA-1679
138.	Chanmoni	MSF-13	200g	12	100	February 2020	BINA-1680
139.	Ranjit	MSF-14	200g	12	100	February 2020	BINA-1681
140.	Sylhet balam	MSF-15	200g	12	100	February 2020	BINA-1682
141.	Lalbalam	MSF-16	200g	12	100	February 2020	BINA-1683
142.	Shatta	MSF-18	200g	12	100	February 2020	BINA-1684

Cont'd. Table 133.

Sl. No.	Cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
143.	Hutra	MSF-19	200g	12	100	February 2020	BINA-1685
144.	Ajanta	MSF-20	200g	12	100	February 2020	BINA-1686
145.	Kasalath	MSF-17	200g	12	100	February 2020	BINA-1687
146.	Halui	MKF-02	200g	12	100	February 2020	BINA-1688
147.	Ponkhiraj	FFH-01	200g	12	100	February 2020	BINA-1689
148.	Thoa	FFH-02	200g	12	100	February 2020	BINA-1690
149.	Bayful	FFH-05	200g	12	100	February 2020	BINA-1691
150.	Muraikka	FFH-08	200g	12	100	February 2020	BINA-1692
151.	Rataboro	FFH-09	200g	12	100	February 2020	BINA-1693
152.	Baiyakaichi	FFH-06	200g	12	100	February 2020	BINA-1694
Chilli							
153.	Superhot master	S-01	20g	10	100	Nov. 2019	BINA-2007
154.	Balijhuri morich (Shampur)	S-02	20g	10	100	Nov. 2019	BINA-2006
155.	Balijhuri (Kagmari)	S-03	20g	10	100	Nov. 2019	BINA-2005
156.	Chatamorich	S-04	20g	10	100	Nov. 2019	BINA-2004
157.	Ulto morich	S-05	20g	10	100	Nov. 2019	BINA-2003
Bitter gourd							
158.	Matikorla	M-01	75g	9	98	Nov. 2019	BINA-2023
159.	Bolder usta	M-02	75g	9	98	Nov. 2019	BINA-2022
160.	Goj korla	F-01	75g	9	98	July 2020	BINA-2021
161.	Soto elachibadam	H-02	300g	7.5	98	Sep. 2019	BINA-955
162.	Boro elachibadam	H-03	300g	7.5	98	Sep. 2019	BINA-954
163.	Tridanabadam	H-04	300g	7.5	98	Sep. 2019	BINA-953
164.	Khenkhen	F-02	300g	7.5	98	July 2020	BINA-956
165.	Deshi sorisha (Sunamganj)	FMM-13	200g	12	100	July 2020	BINA-351
166.	Sadatil	F-03	200g	12	100	July 2020	BINA-651
167.	Kalotil	F-04	200g	12	100	July 2020	BINA-652
Sweet gourd							
168.	Matilau	FM-06	300g	6-8	98	Jan. 2020	BINA-2058
169.	Oron khola Local Modhupur	FM-07	300g	6-8	98	Jan. 2020	BINA-2057
170.	Zolchotro lau/khet lau	FM-08	300g	6-8	98	Jan. 2020	BINA-2056
White gourd							
171.	Sunamganj local	FMM-14	300g	6-8	98	Jan. 2020	BINA-2068
172.	Vabokhali Local	FM-03	300g	6-8	98	Jan. 2020	BINA-2067
173.	Modhupur Local (Sinha)	FM-04	300g	6-8	98	Jan. 2020	BINA-2066
Sponge gourd							
174.	Sogorika	FM-10	250g	6-8	98	Jan. 2020	BINA-3004
Turmeric							
175.	Kishoreganj local	H-06	500g	65	98	Jan. 2020	BINA-1911
176.	Modhupur local	FM-13	500g	65	98	Jan. 2020	BINA-1910
Ginger							
177.	local Haluaghat	FM-11	500g	65	98	Jan. 2020	BINA-1981
178.	Modhupur local	FM-12	500g	65	98	Jan. 2020	BINA-1980

Cont'd. Table 133.

Sl. No.	Cultivar name	Collector's No.	Quantity of seeds conserved (g)	Moisture content (%)	Germination rate (%)	Date of conservation	Acc. No.
Brinjal							
179.	Taal Begun	M-03	100g	12	98	Jan. 2020	BINA-2068
180.	Mymensingh Local	M-4	100g	12	98	Jan. 2020	BINA-2067
181.	Local Begun	M-5	100g	12	98	Jan. 2020	BINA-2071
182.	Singnath	FMM-11	100g	12	98	Jan. 2020	BINA-2070
183.	Mohisasing	FMM-12	100g	12	98	Jan. 2020	BINA-2069
184.	Islampuri begun	FMI-01	100g	12	98	Jan. 2020	BINA-2072
185.	Gaforgaon Begun	FMI-02	100g	12	98	Jan. 2020	BINA-2073
186.	Jhumki begun	FMI-03	100g	12	98	Jan. 2020	BINA-2074
187.	Golbegun	FMI-04	100g	12	98	Jan. 2020	BINA-2075
188.	Blackgram (Maskalai local)	H-05	100g	12	98	Jan. 2020	BINA-2076
Okra							
189.	Baromasi	FM-35	100g	12	98	Sep. 2020	BINA-2035
190.	Sunamganj local	FM-36	100g	12	98	Sep. 2020	BINA-2036
191.	Modhupur local	FM-37	100g	12	98	Sep. 2020	BINA-2037
Bean							
192.	Khoilla sim	FMM-04	100g	12	98	February 2020	BINA-3004
193.	Sada nag	FMM-05	100g	12	98	February 2020	BINA-3005
194.	Ankhi sim	FMM-06	100g	12	98	February 2020	BINA-3006
195.	Hatir kani/ Goal gadda	FMM-07	100g	12	98	February 2020	BINA-3007
196.	Kaikka sim	FMM-08	100g	12	98	February 2020	BINA-3008
197.	Chitagaia sim	FMM-09	100g	12	98	February 2020	BINA-3009
198.	Bampata sim	FMM-10	100g	12	98	February 2020	BINA-3010

12. Research Highlights

12.3. Bangladesh Agricultural Research Institute

12.3.1. Title: Exploration and Collection of Plant Genetic Resources during January 2018- December 2020

Background: Plant genetic resources provide biological basis for world food security and support the livelihoods of mankind. Many plant species are in danger of extinction, threatened by habitat transformation, over-exploitation of natural resources, alien invasive species, pollution and climate change. It is essential to collect and conserve landraces, which possess some important characters regarding quality, tolerance to biotic and abiotic stresses etc. Future progress in crop improvement, food and nutrition security largely depends on conservation of vulnerable crop genetic resources and their sustainable use. The genetic resources are in danger not only in Bangladesh but all over the world and are being lost with the development of modern agriculture. Natural calamities occur almost every year, which is also one of the causes of genetic erosion. Systematic collection, conservation and utilization of genetic resources are very important for future generations to be able to breed crop varieties and face new challenges for food and nutritional security.

Objectives: i. to enrich genetic stock of PGRC, BARI genebank
ii. to rescue endangered PGR from erosion and
iii. to collect special genetic resources

Methodology: Fourteen (14) collecting missions were made for collection of different crops' germplasm from different regions of Bangladesh. Eleven teams such as NSR, SU, NRI, MRI, NSR, NQR, SN, SNQR, SAA, SSR and NQ were formed comprising 1-3 scientists in each team. Number of samples of a crop were depleted on the extent and availability of varieties observed during collection. The teams were equipped with plastic carton, GPS, compass, digital camera, hand lens, envelop, knife, scissors, drying sheet, pencil, stapler etc. Germplasm of target crops were collected from farmers' field/house/threshing floor and market especially from floating seed traders (Arora, 1991). Local extension services and scientists of BARI assisted the team in exploring the crops. Collector's number and date were recorded during collection. Name of crop species along with English, Bangla, local and cultivar name were recorded. Name of donor with ethnic group, village, union, upazila/thana, district, latitude and longitude were noted. Type of soil, topography, sample status, sample source, habitat, frequency, type of materials, cultural practices, season, sole or mixed with, sample type, sampling method, insect and disease, agronomic score and plant characteristics were documented. Passport Data Form was developed to record passport information. The samples were registered in Germplasm Collection Register after collection and conserved in medium term conservation unit (active collection) following appropriate procedure.

Key Findings: A total of 600 germplasm of 66 crops were collected from 69 upazilas of 30 districts. Among them, 14 germplasm from cereals (Barley, Foxtail millet and Wheat), 39 pulses (Black gram, Black pea, Cowpea, Field pea, Grass pea, Lentil, Mung bean, Pigeon pea and White pea), 26 oilseeds (Linseed, Mustard, Safflower and Sesame), 36 spices (Black cumin, Chilli, Coriander, Fennel, Fenugreek, Garlic, Onion and Turmeric), 455 vegetables (Amabashashak, Amaranth, Ash gourd, Babar shak, Bitter gourd, Bottle gourd, Brinjal, Chinese mellow, Country bean, Cucumber, French bean, Indian spinach etc.), 14 fruits (Banana, Custard apple, Musk melon and Papaya), 12 medicinal plants and 04 other germplasm (Indigo and Sesbania) have been collected and conserved.

Key Words: Exploration, Collection, Conservation, Germplasm

12.3.2. Title: Characterization of Pumpkin Germplasm

Background: Pumpkin (*Cucurbita moschata*) is a common and popular vegetable in Bangladesh. It is locally known as “Mistikumra”. The pumpkin is a diploid, self-compatible monoecious annual plant and cultivated all over the country. It belongs to the family Cucurbitaceae. There are three common types of pumpkin worldwide, namely *Curcubita pepo*, *Curcubita maxima* and *C. moschata* (Lee *et al.*, 2003). It grows extensively throughout the tropical and subtropical countries. The area of winter pumpkin is 177, 899 ha and production is 177, 899 metric tons and the area of summer pumpkin is 9,653 ha and production is 78,057 metric tons (BBS, 2017). Pumpkin is a good source of carotene, pectin, mineral salts, vitamins and other substances that are beneficial to health (Jun *et al.*, 2014). Pumpkin can be found in many shapes, sizes and colors. Pumpkin has a long storage capacity compared to other vegetables. Generally, the growers of Bangladesh store full ripe pumpkin fruits in house for 3 to 4 months under ordinary conditions. Four hundred and seventy-eight (478) accessions of pumpkin are conserved at PGRC genebank. Of them three hundred twenty-three germplasm have so far been characterized. Sixty-four germplasm of pumpkin were used in this study.

Objectives: i. to study the genetic variability and diversity in pumpkin germplasm,
ii. to identify salient features that distinguish germplasm from one another
iii. to identify germplasm having useful traits.

Methodology: The experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during winter 2017-18. Sixty-four (64) accessions of pumpkin were sown in the plastic pot on 16 November, 2017. Plant spacing was 2x2 m and unit plot size was 3 x 4 m. The seedlings were transplanted on 10 December 2017. The recommended doses of manure and fertilizers such as 5 ton/ha cow dung, 100 kg N, 48 kg P, 80 kg K, 28 kg S, 3 kg Zn and 2.1 kg/ha B in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc-sulphate and boric acid were applied in the experimental field (FRG, 2012). The full doses of cow dung, TSP, MP, gypsum, zinc-sulphate and boric acid were applied during pit preparation before one week of transplanting. The urea was applied in four installments as top dressing at 15, 35, 55 and 75 days after transplanting. Normal cultivation techniques and intercultural operations were followed to have a good crop. Pheromone trap was used for insect control. Thirty-three observations on qualitative (21) and quantitative (12) characters were recorded as per Minimal Descriptors of Agri-Horticultural Crops. Part II (Srivastava, 2001). Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated

Key Findings: Wide variations were observed among the germplasm in respect of qualitative and quantitative characters studied. Based on sweetness of fruit on brix % like AHI-63 (10% TSS), RAI-87 (10% TSS), RAI-254 (10% TSS), RAI-279 (8% TSS) and AC-512(8% TSS) were selected.

Key Words: Characterization, Diversity, Germplasm, Pumpkin

12.3.3. Title: Characterization of Cucumber Germplasm

Background: Cucumber (*Cucumis sativus* L.) is one of the oldest vegetable crops grown widely throughout the country, tropical and sub-tropical parts of the world (Singh and Prasad, 1992). Cucumber, which is one of the monoecious annual crops of the cool climates, belongs to the Cucurbitaceae family. Cucumber is generally rich in nutritional composition such as, carbohydrate, protein, total fat, dietary fiber, vitamins, minerals, and a number of phytonutrients. The crop is grown worldwide and according to Tatlioglu (1993) it ranks fourth in the list of economic vegetables in Asia after tomato, cabbage and onion. The cucumber is grown in Bangladesh in the kitchen garden and in commercial farm for substantial economic return. The production of cucumber in the country was about 55000 m. tons in 2013- 2014 (BBS, 2014). Although the crop is widely cultivated all over the country, the most extensively cultivated areas seem to be Narsingdi, Rangpur, Dinajpur, Rajshahi, Pabna and Chattogram districts. The yield of cucumber is very low compared to that of other developing countries. The potential yield of cucumber in the country is 15t/ha (Rashid, 1999). Generally, cucumber produces male and female flowers separately on the same individual plant (monoecious), though some may produce bisexual flowers (Lower *et al.*, 1986). Very few research works relating to variability of cucumber have been conducted in Bangladesh. So, Intensive research efforts are needed in several areas, particularly, selection of superior genotypes. There are a lot of variabilities among the existing cucumber germplasm of Bangladesh. An understanding of the nature and magnitude of the variability among the genetic stocks of cucumber is of prime importance for the breeder.

Objectives: to assess the characteristics in cucumber accessions.

Methodology: The experiment was conducted at the Plant Genetic Resources Centre Farm, BARI, Gazipur during the period from March to June, 2019. Twenty-six accessions of cucumber were included in this study. Among them eighteen accessions seed were finally harvested. Some plants died due to excessive rain just after transplanting of seedling. The materials were collected from different parts of Bangladesh. The experiment was laid out in non-replicated design. One accession represented one treatment, with two plants. The unit plot size was 2 m x 2 m maintaining 0.5 m between the plots. Treatments were randomly assigned to different plots of each block separately. After final land preparation, the bed was raised about 30 cm from the ground level. The cucumber seeds of different accessions were dibbled in the pot on 12 March 2019. The seedlings were transferred to the field on 10 April, 2019. Necessary intercultural operations were done throughout the cropping season for proper growth and development of the plant. Trellis were made with bamboo and plastic wire for proper growth and development of the cucumber plants. Harvesting of mature fruits continued up to end of June, 2019. Data was collected on qualitative and quantitative characters following descriptor and data were analyzed to find out the variable characters among associations of cucumber.

Key Findings: Variability was observed in different fruit characters at edible stage and at mature stage. In quantitative characters, days to edible fruit stage ranged from 73 to 85 respectively. Average fruit length and fruit width was 20.33 and 6.47 cm, number of fruits per plant ranged from 3.5 to 7.5. Maximum number fruit per plant was obtained from RAI-209 and minimum number of fruits per plant was recorded from IAH- 331. The highest coefficient of variation was found in fruit length (19.85 %) followed by number of fruits per plant (18.71%) and lowest in hundred seed weight (4.71%)

Key Words: Germplasm, Plant growth, Diversity, Cucumber

12.3.4. Title: Characterization of Brinjal germplasm

Background: Brinjal (*Solanum melongena* L.) is a member of large species-rich genus *Solanum* L. in the nightshade family Solanaceae. Approximately 1300 species comprise in the genus *Solanum* L. Not only because of its large size, *Solanum* L. is also important for containing species of great economic important crops, such as potato, tomato and eggplant, plus a host of minor fruit and leaf crops cultivated locally worldwide (Särkinen *et al.*, 2018). The combination of high species richness, considerable phenotypic plasticity of the species and their presence in a wide range of climatic and ecological conditions (Aubriot and Daunay, 2019).

Brinjal is the third most important vegetable in terms of production in Bangladesh. It was grown on 50,956 hectares during both rabi and kharif seasons 2018–2019 (BBS, 2019). Brinjal is grown all over the country but the yield is comparatively low due to the lack of improved variety and infestation of insect pests. To develop a variety through a hybridization program, characterization is definitely significant for finding out genetic information. Characterization is a fundamental work to provide necessary information for plant breeding programs (Lin, 1991).

Characterization is necessary to recognize the variability and to improve the local germplasm. It is also equally important for easy and rapid evaluation of collected germplasm. Different genotypes of brinjal are available in Bangladesh. Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI) collected and conserved different types of brinjal germplasm from different areas of Bangladesh. In crop breeding programs, investigations to identify the available level of diversity is an essential step in crop improvement, and this can be achieved by collection and classification of germplasm. Therefore, the present investigation was carried out to characterize indigenous brinjal germplasm through qualitative and quantitative characters to identify the promising germplasm and provide genetic diversity for crop improvement program.

Objectives: i. to characterize indigenous brinjal germplasm through qualitative and quantitative characters,
ii. to identify the promising germplasm and
iii. to provide genetic diversity for crop improvement program

Methodology: The experiment was conducted in the experimental field of Plant Genetic Resources Centre (PGRC) of Bangladesh Agricultural Research Institute (BARI), Gazipur during winter 2018-19. A total of 240 accession and four check varieties were used in this experiment. Direct seeding was done in the well-prepared seed beds on 14th November, 2018. Thirty-eight days aged seedlings were transplanted in the prepared pits of main experimental field on 28th December 2018. The plot size was 3x2.1 m². Each germplasm was planted in a plot of three rows. Row to row and plant to plant distance was 70×60 cm. The experimental design used in the study was Augmented Randomized Complete Block Design (Augmented RCBD) with four check varieties and 12 blocks. All check varieties received 12 replications, giving a total of 284 experimental plots.

Fertilizer doses were 10 ton/ha Cowdung, 210 kg/ha Urea, 33 kg/ha TSP, 200 kg/ha MP and 5 kg/ha Borax (Mondal *et al.*, 2011). The full doses of Cow-dung, TSP and Borax were applied during land preparation before one week of transplanting. Urea and MP were applied in the three equal splits at 15, 35 and 50 days after transplanting. Weeding and mulching were done four times at 25 days' interval starting from mid-December. Individual net was used per

plot to avoid the cross pollination. Sevin 75 WP @ 0.1 g/pit, Sumithion 60 EC @ 2.5 ml/L and Vertimac 18 EC @ 1.2 ml/L were sprayed for controlling insect and mite, respectively. The data was recorded as per the descriptor developed by IBPGR, 1990.

Key Findings: A wide variation was observed in the collected brinjal germplasm. Most of the qualitative characters showed distinct variation among the germplasm. Qualitatively the maximum variation was observed in leaf prickles, fruit calyx prickles, fruit color at ripening and fruit flesh density. Quantitatively highest variation was observed in fruit length which was followed by 100 seed weight and yield per plant. The overall performance of the genotypes indicated that the genotypes AC-285, K-12, K-19, K-28, K-20, K-47 and NSR-26 had higher yield potentiality. Therefore, selection of these genotypes might play a significant role for future breeding program.

Key Words: Characterization, Variability, Germplasm, Brinjal (set I)

12.3.5. Characterization of Landraces of Bitter gourd germplasm

Background: Bitter gourd (*Momordica charantia* L.), is one of the most important and a popular cucurbit vegetable grown in Bangladesh. The area of bitter gourd is 26,250 acres and production is 57,386 metric tons (BBS, 2017). Among the cucurbits, it is considered a prized vegetable because of its high nutritive values especially ascorbic acid and iron (Behera, 2004). It is rich in vitamin C (88 mg/100g) (Akter *et al.*, 2009). A compound known as charatin present in the bitter gourd is used in the treatment of diabetes to lower blood sugar levels (Shetty *et al.*, 2005). Bitter gourd is widely cultivated in this country during kharif season. Forty-six (46) germplasm along with two (02) check varieties of bitter gourd was collected in 2017-18. Hence, characterization of the collected germplasm is essential. The objectives of this study were to study the genetic diversity in bitter gourd germplasm, to identify the salient features that distinguish germplasm from one another and to identify germplasm having useful traits.

Objectives: i. to study the genetic diversity in bitter gourd germplasm
ii. to identify the salient features that distinguish germplasm from one another
iii. to identify germplasm having useful traits.

Methodology: The experiment was conducted at the Plant Genetic Resources Centre of BARI, Gazipur during summer 2019. Forty-six germplasm along with two check varieties of bitter gourd were used in this study. Passport data of germplasm used in this experiment. Two seeds were sown in each plastic pot (6 cm in diameter approximately) on 14 March 2019. Pits of 40x 40 x40 cm were prepared 10 days before transplanting the seedlings in the main field. Plant spacing was 2x2 m and unit plot size was 3 x 4 m with two replications. The seedlings were transplanted on 31 March 2019. The plants were given support of 4 m height bamboo stick. Two plants were used for each germplasm. The recommended doses of manure and fertilizers such as 5 ton/ha decomposed cow dung, 100 kg N, 40 kg P, 60 kg K, 20 kg S and 1.5 kg/ha B in the form of urea, triple super phosphate, murate of potash, gypsum and boric acid were applied in the experimental field (FRG, 2012). The full doses of cow dung, TSP, MP, gypsum and boric acid were applied during pit preparation before one week of transplanting. Normal cultivation techniques and intercultural operations were followed to have a good crop. Pheromone traps were used for controlling insects. Data were recorded as per NBPGR (2001) descriptors for bitter gourd. Nevertheless, selection was done based on total fruiting period and yield for future use.

Key Findings: Among forty-six newly collected germplasm all were identified as landraces. However, fruit of forty-six bitter gourd germplasm showed variation in shape, skin color, skin luster, surface texture, nature of tubercles, blossom-end shape, bitterness and also in seediness. Likewise, distinction was observed in early plant vigor, plant growth habit, twining tendency, tendril branching, leaf size, leaf pubescence, and in flower color. Similarly, notable variation was observed among 16 quantitative characters of forty-six germplasm. The maximum coefficient of variations was fruit weight and minimum in days to last fruit harvest. Also, among all few germplasms were selected based on total fruiting period and yield, where AHI-85 was certainly a good one.

Key Words: Characterization, Variability, Germplasm, Bitter gourd.

12.3.6. Title: Characterization of Brinjal germplasm (Set-II)

Background: Brinjal (*Solanum melongena* L.) is the second most important vegetable in Bangladesh. It is grown on approximate 52,227 hectares of land across the country both in winter and summer season, yielding an average of 10.13 ton per hectare for a total yield of about 528,923 ton (BBS, 2020). BARI released 14 varieties including 4 transgenic varieties of brinjal. The crop is extremely diverse in Bangladesh. PGRC of BARI conserved 282 accessions in the gene bank. About 175 accessions have already been characterized and 40 accessions have not characterized. Before these resources can be exploited, they should be systematically evaluated to assess genetic diversity, until a collection has been properly evaluated and its attributes become known to breeders, it has little practical use (Thomas and Mathur, 1991). Such a situation is just like a library where none of the books are catalogued. The experiment was undertaken to study the genetic diversity, identify salient features that distinguish accessions from one another, and identify the accessions having useful traits. The present investigation was conducted with the specific objective of identifying from suitable local brinjal accessions.

Objectives: i. to study the genetic diversity,
ii. to identify salient features that distinguishes accessions from one another and
iii. to identify the accessions having useful traits

Methodology: The experiment was conducted at Regional Plant Genetic Resources Center, RARS, Ishwardi, Pabna during 2019-2020. The experiment involved thirty-six brinjal accessions. Main field was prepared 10 days before transplanting the seedlings. The recommended doses of manure and fertilizers such as 5-ton ha⁻¹ cow dung, 120 kg N, 36 kg P, 90 Kg K, 15 kg S and 2.0. kgha⁻¹ Zn in the form of urea, triple super phosphate, murate of potash, gypsum and zinc sulphate (monohydrate), respectively were applied in the experimental field (FRG, 2018). The full doses of cowdung, TSP, gypsum and zincsulphate were applied during land preparation before one week of transplanting. Urea and MP were applied in the three equal splits at 21,35 and 50 days after transplanting as ring method around the plant followed by irrigation (105) days interval during dry season. The experiment was conducted in a non-replicated design. The unit plot size was 3 m X 2 m and 9 plants were accommodated in a plot with a plant spacing of 75 cm apart and row to row distance of 100 cm (excluding 50 cm drain). The seedlings were transplanted on 19 October, 2019. The plants were given support of 1 m height bamboo sticks. Admire (0.5 ml per liter) was applied for controlling aphids. Twenty-five observations on qualitative (12) and quantitative (13) characteristics were classified into descriptor state as per Descriptors for Eggplant (IBPGR, 1990). Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated.

Key Findings: Variations among 36 brinjal accessions were observed in different qualitative characteristics. Upright, intermediate to prostrate plant growth were observed. Leaf blade lobing was found weak, intermediate to strong and very acute, acute to intermediate in leaf blade tip angle were observed. Variations were found in number of prickles and leaf hair. Among the accessions, different corolla color was observed like pale violet, light violet and bluish violet. The accessions SM Ish-010 (4.98), SM Ish-015 (5.38) and SM Ish-025 (5.05) germplasm gave high edible fruit weight per fruit and per plant (4.77 to 5.38 kg/plant) and it may be considered as better accessions. These accessions may be used in brinjal improvement program.

Key Words: Brinjal, Qualitative character, Quantitative character, Characterization

12.3.7. Title: Characterization of Mung bean germplasm

Background: Mung bean (*Vigna radiata* (L.) also known as green gram or mung is one of the most important edible food legumes in Asia, particularly in the Indian subcontinent. It is one of the important pulse crops of Bangladesh, since it is a short duration legume, it fits well into many cropping systems, on an average in Bangladesh diet only 8 to 10% of the protein intake originates from animal sources, the rest can be met from plant sources by increasing the consumption of pulses. Hence from the point of nutritional value, mung bean is perhaps the best of all other pulses. However, the average yield of mung bean in the country is about 663 kg/ha, which is much lower than that of India and some other countries of the world. This poor yield may be attributed due to climatic condition, adaptation of varieties, disease and insect problems, poor crop management practices and judicious application of fertilizer especially nitrogenous fertilizers/biofertilizers as nitrogen is the most important element for crop. In the present investigation, the mung bean germplasm was collected from different districts in Bangladesh. A set of mung bean germplasm studied for genetic variability, varietal identification and genetic diversity based on qualitative and quantitative traits.

Objectives: i. to study genetic variability among collected mung bean germplasm,
ii. to confirm varietal identification and
iii. to verify genetic diversity based on qualitative and quantitative traits

Methodology: The experiment was carried out with 91 germplasm of mung bean with 6 check varieties at Plant Genetic Resources Centre, BARI, Gazipur during kharif 2020. The seeds were directly sown in prepared land dated on 08 March, 2020. The distance between line to line and accessions to accession was 30 cm and 50 cm in augmented design with 6 check varieties. Measurement was performed on five individual plants of each accession. Optimum cultural practices were followed mung bean production system. Data was recorded in qualitative and quantitative traits as per pulse descriptor on International Board for Plant Genetic Resources (IBPGR).

Key Findings: Wide variation was found among the accessions in both qualitative and quantitative characters. The frequency distribution observed higher on number of seed per pod and medium on days to 1st flowering and yield per plant. Unique selection and trait information is available within the population studied which may offer crop improvement opportunity. In addition of the evaluation for agronomic traits, DNA markers will be used to study the genetic diversity of present collection of mung bean germplasm.

Key Words: Mung bean, Germplasm, Characterization, Variation.

12.3.8. Title: Characterization of Bottle gourd germplasm

Background: Bottle gourd (*Lagenaria siceraria*) is a popular cucurbitaceous vegetable in Bangladesh. The climatic condition of winter in Bangladesh favors better growth and yield of bottle gourd. Bottle gourd is widely cultivated throughout the country. Its cultivation and uses are wide in winter season. It is found to cultivate in commercial way in the field as well as homestead in rural Bangladesh. The national average yield of bottle gourd is only 9.38 tons/hectare (Islam *et. al.*, 2015). Presence of variability in a base population is very important for any improvement program. Collection, conservation and maintenance of germplasm are important to develop new varieties. A large number of germplasm were collected from different district. Two hundred eighteen (218) germplasm were collected from different districts of Bangladesh. The present work has been undertaken to study characterization and genetic variability in bottle gourd for desirable yield contributing characters.

Objectives: to study characterization and genetic variability in bottle gourd for desirable yield contributing characters.

Methodology: The experiment was conducted at the Plant Genetic Resources Center, BARI, Joydebpur, Gazipur during 2019-2020. Two hundred eighteen (218) accessions of bottle gourd collected from different districts and five (5) check varieties were taken in this study. The seeds were sown in poly bags on 13 November, 2019. After 15 days, the seedlings were transplanted in prepared pits in the field. Lay out: Pit to pit and line to line distance was 4m X 4m. The experiment was conducted in augmented design with 5 check varieties. Fertilizer: When land was prepared the following fertilizers and manure were mixed in each pit, Cow dung-10kg, Urea- 50g, TSP-200g and MP-150g, Gypsum-75g. In vegetative stage, 20g Urea with water was sprayed per pit. Normal cultivation techniques, intercultural operations and irrigations were followed to grow the crop. Observations were recorded on eighteen (18) qualitative and fifteen (15) quantitative traits as per IBPGR descriptor.

Key Findings: All germplasm showed variation in qualitative and quantitative traits. Significant differences were observed among the quantitative traits. In qualitative traits, variability was found in fruit shape, matured fruit skin color, early plant vigor, leaf margin. The seeds are preserved as active and base collections for future utilization.

Key Words: Bottle gourd, Germplasm, Variability, Characterization

12.3.9. Title: Characterization of Amaranth germplasm

Background: Germplasm collection, conservation and evaluation are being regularly practiced in this crop for identification of new potential genotypes. So far, Plant Genetic Resources Centre (PGRC) is maintaining 773 accessions of amaranth. Knowledge of genetic diversity and trait variations in populations is useful in plant breeding and for developing ex-situ conservation strategies of plant genetic resources (Engles *et al.*, 2002). The availability of genetic variation among and within the different accessions for agronomic traits provides great scope for crop improvement through selection and other breeding methods to develop desired genotypes. Thus, insight into the genetic variation within and among the available amaranth genotypes in relation to the morphological traits is necessary. Such empirical knowledge will enhance effective genetic resources exploration, conservation, management, and utilization of amaranths species in future breeding programs.

Objectives: i. to study the genetic variation in 80 amaranths accessions and
ii. to identify salient features that distinguish germplasm from one another

Methodology: The experiment was conducted in augmented block design at the Plant Genetic Resources Centre of BARI, Gazipur during winter 2019-20. Eighty accessions of amaranth were considered in this study. Line sowing was done on 2 rows in 3m long plot maintaining 15 cm plant spacing. Row to row distance was 50 cm and plot to plot distance was 100 cm. Chemical fertilizers were applied (FRG, 2018). Sevin 20 was applied periodically in early stage to control ants. Normal cultivation techniques and intercultural operations were followed to have a good crop. Data were recorded as per NBPGR (2001) descriptors for Amaranth. However, under the epidemic status quo of the world due to COVID-19 some of the parameters stated in the descriptor were not possible to execute.

Key Findings: All the accessions of amaranth studied in this experiment showed color dissimilarity in leaf, stem, inflorescence and seed. However, based on the phenotypic appearance and performance in the field condition few accessions can be recommended as top-notch genotypes for future study. For instance, leaf amaranth: BD-2961, BD-9790, BD-9795 and BD-9825; stem amaranth: BD-9822, BD-9941 and BD-9942

Key Words: Amaranth, Accessions, Variability, Characterization

12.3.10. Title: Characterization of Guava germplasm

Background: There are probably more than 400 guava cultivars around the world, but only a few are under common cultivation (Pommer and Murakami, 2009). The cultivated cultivars are widely diverse regarding tree size, bearing habit, and yield, as well as fruit size, shape, ripening season and quality in terms of nutrient composition (Pommer and Murakami, 2009; Sharma *et al.*, 2010). Irrespective of the morphological and chemical diversities observed in these cultivars, several reports indicate that selection of the accessions was based on a few traits considered important (Mehmood *et al.*, 2013; Galli *et al.*, 2015; Mehmood *et al.*, 2015; Valera-Montero *et al.*, 2016), and, therefore, much of the variation is left untapped. This is likely to lead to genetic vulnerability of the crop (Nogueira *et al.*, 2014), especially with respect to climate change.

Objectives: i. to assess the morphological variations through phenotypic study,
ii. to investigate the genetic variability and
iii. to select parents for better and more production

Methodology: The study was conducted in the fruit orchard of Agricultural Research Station (ARS), Pahartali, Chattogram and Regional Agricultural Research Station (RARS), Hathazari, Chattogram during 2019-20. About 22 diversified guava germplasm were included in the experiment. The data was recorded as per the descriptor.

Key Findings: A wide variation was observed in the guava germplasm in this study. The maximum variation was observed in pulp color and seediness in guava fruits. The morphological dendrogram generated from agglomeration hierarchical clustering grouped the 22 genotypes into 5 major clusters. The biplot explaining the overall performance of the genotypes indicated that the genotypes PG Hat 017, PG Hat 012, PG Pah 07, BARI Peyara 2 and BARI Peyara 4 had higher yield potentiality. Therefore, selection of these genotypes might play a significant role for future guava improvement program.

Key Words: Guava, Production, Variety

12.3.11. Title: Molecular Characterization of Rapeseed-Mustard Germplasm using SSR Marker

Background: Among the different marker microsatellite or simple sequence repeat (SSR) is another PCR-based marker which is preferred by many geneticists and plant breeders because of higher repeatability, co-dominant nature, specificity and having multiple alleles (Plieske and Struss, 2001; Halton *et al.*, 2002). SSR markers have been developed and characterized for the efficient use of genetic studies of *Brassica* species (Sadia *et al.*, 2010). Information of molecular characterization of rapeseed-mustard germplasm will make benefit for future breeding program.

Objectives: to know the genetic diversity among the studied mustard germplasm

Methodology: Total genomic DNA was isolated from young actively growing fresh leaf tissues following SDS extraction, phenol: chloroform: isoamyl alcohol purification and ethanol precipitation method. DNA quality was checked by electrophoresis in a mini-gel and quantified using a spectrophotometer (Spectronic®Genesis™, New York, USA). All of the DNA samples were found to be in good quality in this study.

Key findings: All the primers selected for this study has been responded to SSR marker selection study. Among them tested 06 (six) microsatellite markers were found to be polymorphic conferring to previous study. Genetic diversity was found among the germplasm.

Key words: SSR, Polymorphism, Diversity, Mustard

12.4. Bangladesh Jute Research Institute

12.4.1. Title: Collection of Jute and Allied fibre (JAF) crop germplasm

Background: Jute is a tropical bast fibre crop next to cotton in use with its high socio-economic importance in Bangladesh. It is now in great threatening of erosion and replacement by modern agricultural system. Emphasis has been given since 1970 with an approach to collect and conserve the genetic resources of jute (*Corchorus* spp.), Kenaf (*Hibiscus cannabinus*) and mesta (*H. sabdariffa*) germplasm including their wild relatives for utilization in genetic improvement program (Roy & Ghoshdastidar, 2006). The numbers of land races collected at that time were very few and collection processes were not extensive. From 1951 to 1971 the collection of landraces was 892 of *C. capsularis*, 644 of *C. olitorius*, 15 of kenaf and 35 of mesta. After a long gap, an expedition was made in the 1978 and 1979 to collect landraces in and around Chattogram Hill Tracts, St. Martin Island and Sylhet. During that period 169 *C. capsularis*, 128 *C. olitorius* and 16 *H. sabdariffa* were collected. At present BJRI Gene Bank conserves 6012 accessions comprising 4180 accessions of *Corchorus* (15 species), 1461 accessions of *Hibiscus* (22 species), 252 accessions of allied genera (15 species) and 119 accessions of interspecific hybrids derivatives through different formal and informal collection missions. The necessity of a comprehensive collection mission for preventing the extinction of bio-diversity from their native is always keep deep attention to the breeders. It provides the wider scope of crop improvement by supplying desirable gene pool to them. Unfortunately, the collection approach for jute and allied fibre has not kept pace with the time being due to lack of required manpower, fund and other facilities.

Objectives: i. to rescue endangered PGR of JAF,
ii. to enrich gene pool of BJRI genebank and
iii. to collect germplasm from unexplored areas of Bangladesh

Methodology: Germplasm were collected from Rangpur, Kurigram, Nilphamary, Panchagarh, Dinajpur, Bogura, Cumilla, Patuakhali, Barguna and Barishal districts during February 2018 to January 2020. Random population samples of fruits and seeds at wide intervals (5-10 km) were collected from farmers' field, road side, stores and market place followed by intensive sampling demands in specific area depending on the records of past evaluation of materials collected previously from the area. Special sampling of disjunction populations, peripheral population and those occupying geographically remote and often peculiar or distinct ecological niches were given special importance for collection with the help of local Agricultural Officers, forest officers and community leaders. Samples were collected as seed and fruits from individual plant or population along with sufficient passport information. For each sample, there was a single collection number with its set of recordings of locality and habitat data as per descriptor. Cultivated species was determined from farmers' field and wild species was determined in relation to the variation observed in the population. At least 60, 40, 400 and 400 g of seeds were collected for deshi, tossa, kenaf and mesta samples respectively. In case of fruits sample collection, at least 555, 120, 1000 and 1000 number of fruits were collected for deshi, tossa, kenaf and mesta respectively. Sample collection site was varied from as small as 5m x 5m to as large as 50m x 50m according to the colony size and the density of individuals. The collected samples were cleaned, dried, registered and conserved in active collection for further activities.

Key findings: A total of 35 germplasm were collected from Rangpur, Barishal, Chattogram and Khulna division. Out of 35 germplasm 23 was deshi jute (*C. capsularis*), 9 was tossa jute (*C. olitorius*) and 3 was mesta (*Hibiscus sabdariffa*).

Key words: JAF crops, Germplasm, Collection.

12.4.2. Title: Characterization of Jute (*C. capsularis* and *C. olitorius*) germplasm in 2018 to 2020

Background: Jute is a tropical bast fibre crop next to cotton in use with its high socio economic importance in Bangladesh. Genetic Resources of JAF crops play a vital role for its improvement among the jute growing countries of the world, Bangladesh ranks second in respect of production. Jute is produced in about 0.75 million hectares of land in Bangladesh (BBS 2018-19). The crop is a versatile and environmental friendly bio-degradable natural fibre. It is mainly grows for fibre. Jute leaves also used as vegetable (Furumuto *et al.*, 2002). Genetic variability is the pre-requisite for any plant breeding program. The gene Bank of Bangladesh Jute Research Institute (BJRI) has conserved about 6012 germplasm. The number of germplasm is declining in jute growing areas (Choudhary *et al.*, 2013 and Heywood *et al.*, 2007). Before exploration of these germplasm, they should be systematically evaluated to assess the genetic diversity. Therefore, the experiment was undertaken to study the genetic diversity salient feature that distinguish germplasm from one another.

Objectives:

- i. to study the genetic diversity in jute germplasm,
- ii. to realize JAF species potential value for genetic improvement,
- iii. to identify salient features, which distinguish germplasm from one another,
- iv. to identify germplasm having desirable traits

Methodology: The experiments were conducted at the Jute Agriculture Experimental Station, Manikganj of Bangladesh Jute Research Institute from 2018 to 2020 growing season. The altitude of the experimental field was 4 m in the Active Brahmaputra-Jamuna Floodplain (AEZ 7) with a silt loam soil, pH 6.7. Single row of 4 m length for each germplasm was maintained. Row to row distance was 30 cm and about 5-6 cm between plants. The soil was plowed in two directions and smoothed. The soil received urea, triple superphosphate, muriate of potash, gypsum and zink @ 200, 25, 30, 45 and 12 kg/ha. Half of the urea and all other materials were applied during final land preparation. The remaining urea was top dressed at 20 days after sowing. All cultural operations were according to Chowdhury and Hasan (2013). Three times manual weeding were done at 10-15, 25-30 and 40-50 days after sowing. Morphological data such as plant stem color, leaf color, vein color, petiole color, stipule color, were recorded at 60 days of plant. Leaf shape and branching habit were recorded at pre bud stage of plant. Quantitative characters such as plant technical height, node number, plant base diameter, mid-diameter, top diameter, basal core diameter, dry fibre weight and dry stick weight recorded at harvesting time. The plant was harvested at 120 days. Ten plants were selected randomly from each line and data were recorded. Twenty one observations on qualitative and quantitative characters were recorded as per descriptors.

Key findings:

- i. Merha red (Collector's no. RS-4) and Birol red (Collector's no. RS-8) of two wild germplasm collected from Kurigram and Bogura were primarily identified as vegetable type jute. Acc. no. 742 collected from Rangpur was important for fibre and stick yield.
- ii. Wide variations were observed among the studied genotypes of deshi jute in respect of qualitative and quantitative characters. Considering yield contributing characters the accession no. 2143, 2061, 2122, 2090 and 2193 can be selected for crop improvement program.
- iii. Considering the yield contributing characters the accession no. 5038, 4792, 5163, 4851, 5145, 4794 and 5121 of tossa jute were selected for crop improvement program.

Key words: Jute, Characterization, Morphological diversity.

12.4.3. Title: Molecular characterization of jute germplasm through DNA fingerprinting in 2018, 2019 and 2020 growing season

Background: Closely related cultivars with low genetic variability can't readily be distinguished by morphological traits like pigmentation pattern, leaf shape, stipule shape, seed coat color and so on that are very difficult to identify in jute and allied fibregermplasm characterization. DNA fingerprinting for cultivar or varietal identification has become an important tool for genetic identification in germplasm management and plant breeding. When planning of DNA fingerprinting, one of the most important decision is the marker system and molecular technique to be used. Various system and their related techniques are currently available, and those are based on polymerase chain reaction (PCR). PCR based techniques or molecular markers such as Randomly Amplified Polymorphic DNA (RAPDs), Simple Sequence Repeats (SSRs) or, microsatellites and Amplified Fragment Length Polymorphisms (AFLPs), have an apparent advantage as cultivar descriptors. SSRs have become a powerful and popular tool for determining unique genetic identity or fingerprint, and establishing genetic relatedness as well as diversity among various crop cultivars. The present piece of work is undertaken to develop genetic fingerprints and to estimate genetic relatedness of 22 jute germplasm using some SSR markers.

Objectives: to develop genetic fingerprints and to estimate genetic relatedness of 22 jute germplasm using some SSR markers.

Methodology: The jute genotypes studied in this experiment was collected from the Gene Bank of Bangladesh Jute Research Institute (BJRI). Molecular characterization was done following standard protocol.

Key findings:

- i. Molecular characterization of 22 jute germplasm including 9 varieties were done during 2018. In this experiments 33 SSR primer were used, where 14 polymorphic primer were found respectively. Based on Nei's Genetic distance of the *C. olitorius* germplasm were subdivided into two sub-clusters in the UPGMA dendrogram.
- ii. Molecular characterization of 22 jute germplasm including 2 varieties was done during 2019. In the experiment 32 SSR primer were used, where 18 polymorphic primer were found respectively. Based on Nei's Genetic distance of the *C. capsularis* and *C. olitorius* germplasm is subdivided into two sub-clusters in the UPGMA dendrogram.
- iii. Molecular characterization of 22 jute germplasm including 4 varieties was done during 2020. In the experiments 31 SSR primer were used, where 16 polymorphic primer were found respectively. Based on Nei's Genetic distances, two different species were divided in two mainclusters. The tossa jute germplasm cluster was further subdivided into two sub-clusters in the UPGMA dendrogram.

Key words: SSR primer, Genetic diversity, Jute.

12.5. Bangladesh Sugarcrop Research Institute

12.5.1. Title: Morphological diversity of PBRG-PGR collected sugarcane germplasm

Background: Modern sugarcane varieties that are cultivated for sugar production are complex interspecific hybrids (*Saccharum* spp.) that have arisen through intensive selective breeding of species within the *Saccharum* genus primarily involving crosses between the species *Saccharum officinarum* L. and *S. spontaneum* L. (Cox *et al.*, 2000).

An essential first step in varietal development program is to come up with sugarcane germplasm which has sufficient genetic variability. Accurate assessment of genetic diversity is very important in crop breeding as it helps in the selection of desirable genotypes, identifying diverse parental combination for further improvement through selection in the segregating populations, and introgressing desirable genes from diverse germplasm into the available genetic base (Mohammadi *et al.*, 2003). Therefore, genetically diverse germplasm is needed in breeding programs to enhance the productivity and diversity of cultivars. Utilization of introduced germplasm and the knowledge of genetic remoteness among them are vital for their manipulation in crop improvement program (Malik *et al.*, 2010).

In order to obtain the wide spectrum of variation among the segregants the genotypes belonging to the distant clusters could be incorporated in hybridization program. Therefore keeping in view the importance of sugarcane in the country and use of genetic diversity in crop improvement, 51 genotypes were investigated for determining genetic diversity based on quantitative traits for planning future germplasm management and utilization.

Objectives:

- i. to investigate genetic diversity in landraces of sugarcane based on qualitative and quantitative traits for planning future germplasm management and utilization and
- ii. to exploit genetic diversity of sugarcane germplasm in crop improvement program

Methodology: Collected sugarcane germplasm under PBRG-PGR sub-project were grown at replicated plot for diversity study. Ten representative plants from each replication (30 plants from each variety) were randomly selected for recording data on Number of millable cane, Length of leaf blade (cm), Width of leaf blade (cm), Length of bud (mm), Width of bud (mm) Plant height (cm), Stalk length (cm), Number of internode, Internode length (cm), Internode diameter (cm), Single cane weight (kg) and Brix %. The analysis of variance, clustering and principal component were statistically analyzed as randomized complete block design using the R-software. Characters with count data were log transformed before analysis. All the genotypes were clustered on the basis of agglomerative cluster analysis, where specifications were made based on Euclidean distance.

Key Findings:

One promising clone has been released as early maturing chewing sugarcane variety named BSRI Akh 47. Three flowering germplasm can be utilized in hybridization program of BSRI. Five promising clones and two new traits (attractive pink and variegated color) can be utilized in future.

Key words: Genetic diversity, landraces, Sugarcane



BSRI Akh-47

12.6. Bangladesh Institute of Nuclear Agriculture

12.6.1. Title: Collection, Conservation and Characterization of Important Plant Genetic Resources from Mymensingh and Sylhet Region Including Tangail

Background: Genetic resources provide basic material for selection and improvement through breeding to ensure food security needs of the world's rapidly rising population. Conservation and utilization of plant genetic resources are important components of ex-situ collections. To conserve valuable genetic resources, collection of germplasm had been started since 2008 at BINA. Systematic and mission oriented collection programme have not yet been started at BINA. So that in BINA the existing collections are poor and there is continuing need to collection germplasm of different crops. We need to collect local germplasm of different crops from several areas such as hilly area, coastal, Barind tract, Haor areas, Northern and southern parts of Bangladesh. Characterization for agronomic and morphological traits is necessary to facilitate utilization of germplasm by breeders. To achieve this, germplasm accessions of all crops are characterized for morphological and agronomic traits. Information on the genetic diversity within and among closely related crop varieties is essential for a rational use of genetic resources. The analysis of genetic variation both within and among the landraces is of fundamental interest to plant breeders.

Objectives:

- i. to collect local germplasm of rice, oilseeds, pulses, spices and vegetables,
- ii. to characterize genetic resources including GI crops and released varieties at morphological and molecular level,
- iii. to identify germplasm with desired agronomic traits and select entries for more precise evaluation,
- iv. to document genetic resources and to protect them from piracy as well as for facilitating establishment of property rights and
- v. to estimate the extent of variation in the collection

Methodology: Local germplasm of different crops were collected from Sylhet and Mymensingh regions including Tangail district. BINA team was to collect germplasm from these areas involving farmers, different GO, NGO and private sector personnel. Both fields as well as store/harvested collection approaches were followed. During germplasm collection, passport data forms were used for documentation. After collection all germplasm, collected germplasm were multiplied in respective season and preserved in mid and short term storage room at BINA. After multiplication seeds of collected germplasm we carefully cleaned of each germplasm and grow for seed multiplication. After seed multiplication sufficient number of good qualities for a given accession has been sealed for subsequent storage. Selected germplasm were characterized using the standard descriptors. For rice 'Rice Germplasm Descriptors and Evaluation Form' and Descriptors for different crops, published by International Plant Genetic Resources Institute (IPGRI). Recommended doses of fertilizers were applied and appropriate control measures were taken for insect pests, diseases and weeds as and when necessary.

Total genomic DNA was extracted from young leaves of three-week-old plants following the simple and modified protocol of Zheng *et al.*, 1995. PCR analysis was performed in 12.5 µl reaction sample containing 5-25 ng of DNA template, 1.25 µl of MgCl₂ free 10X PCR buffer (100 mM Tris-HCl pH 9.0 at 25°C, 500 mM KCl, 0.1% Triton® X-100 and H₂O), 1.5 µl of 25 mM MgCl₂, 0.25 µl of 10mM dNTP, 0.25 µl of 5 U/µl Taq polymerase enzyme, 0.625 µl each of 10 µM forward and reverse primers using a MJ Research single 96-well thermal cycler. The mixture was overlaid with one drop of mineral oil to prevent evaporation. After initial denaturation for five minutes at 94°C, each cycle comprised one min denaturation at 94°C, one min annealing at 55°C, and two min extension at 72°C with a final extension for seven min at 72°C at the end of 35 cycles. The PCR products were mixed with bromophenol blue gel loading dye and were analyzed by electrophoresis on 8% polyacrylamide gel using mini vertical polyacrylamide gels for high throughput manual genotyping (CBS Scientific Co. Inc., CA, USA). 2.5 µl of amplification products were resolved by running gel in 1×TBE buffer for 2-2.5 hrs depending upon the allele size at around 75 volts and 180 mA current. The gels were stained in 0.5 mg/ml ethidium bromide and were documented using UVPRO (Uvipro Platinum, EU) gel documentation unit. Microsatellite or simple sequence repeat (SSR) markers were used for DNA analysis (Temnykh *et al.*, 2001; McCouch *et al.*, 2002).

Key findings:

- i. A total of 143 germplasm (73 rice, 30 sesame, 33 groundnuts, 5 chillis and 2 bitter gourd germplasm) have been characterized on the basis of morpho-agronomical characters according to standard descriptors. Ranishail, Sentu-16, Ojana birun, Paijam rice germplasm were the highest yielder (9.8-13.33g/plant) with excellent phenotypical acceptability. Sentu-17, Bashiraj, Deshi-32 rice germplasm were found having short duration (90-135 days). Among the 73 rice germplasm, Parbot jira, Kalo jira, Chinishail, Hasa sada, Hasa kalo were identified as fine and very light scented.
- ii. Among the 30 sesame germplasm, Kalo til, BD-6981 were found having higher yield (32-58g/plant) and the germplasm BD-6979 had stem, leaf hairiness. Among the 33 peanut germplasm, 7112-4-4-1, 9112-2-1-1, 7112-4-3-1 and ICGV-347 were found having higher yield (16-20 g/plant /plant). Among the 5 chilli germplasm was found having higher yield (16-20 g/plant /plant)
- iii. A total of 83 local rice germplasm from BINA genebank have been characterized on the molecular level by using SSR markers. A total of 262 alleles were detected by nine (9) polymorphic markers. The highest number alleles 34 were identified by RM336 while the lowest was 13 by RM262. The PIC value ranged from 0.951 to 0.766

Key words: Germplasm, Collection, Conservation, Characterization, Genetic Diversity



Sub-Project ID - 128

Volume III

Program Based Research Grant (PBRG)

Sub-Project Completion Report on

Collection, Conservation and Characterization of Important Plant Genetic Resources

Sub-Project Duration

February 2018 to February 2022

Coordinating Organization

Crops Division

Bangladesh Agricultural Research Council



Project Implementation Unit

National Agricultural Technology Program-Phase II Project

BANGLADESH AGRICULTURAL RESEARCH COUNCIL

New Airport Road, Farmgate, Dhaka-1215, Bangladesh

www.barc.gov.bd

Program Based Research Grant (PBRG)

Sub-project Completion Report

on

Collection, Conservation and Characterization of Important Plant Genetic Resources

Implementing Organization

1. Plant Genetic Resources Centre, Bangladesh Agricultural Research Institute
2. Genetic Resources and Seed Division, Bangladesh Rice Research Institute
3. Genetic Resources and Seed Division, Bangladesh Jute Research Institute
4. Breeding Division, Bangladesh Sugarcrop Research Institute
5. Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture
6. Cotton Development Board
7. Bangladesh Sericulture Research and Training Institute
8. Department of Horticulture, Bangladesh Agricultural University



Project Implementation Unit

National Agricultural Technology Program-Phase II Project

Bangladesh Agricultural Research Council

Farmgate, Dhaka-1215

December 2021

Citation:

Chowdhury, M.A.Z., M.N. Islam, M.A. Rahim, M. Khalequzzaman, M.A. Salam, M.M. Islam, M. Shamsunnahar, M.R. Islam, M.M. Hussain, S.N. Begum, M.A. Rahman, S. M.M. Hossain, M.M.A. Ali, F. Ahmed, M.A. Alim, M.H. Rahman, M.M. Hossain, M.H. Rashid, M.A. Hossain, M.S. Uddin, R.A. Chanda, E.S.M.H. Rashid, M.Z. Islam, A.K.M.S. Hossain, M.M. Ahmed, K.M.R. Karim, F. Yasmine, M.K. Islam, M.A.B. Siddique, M.S. Hossain, S. Rahman, Q.M. Ahmed and A.C. Manidas. 2021. Collection, Conservation and Characterization of Important Plant Genetic Resources: Sub-Project Completion Report: Vol. III: 769-1177.

Compiled and Edited by:

Md. Aziz Zilani Chowdhury, *PhD*
Md. Amjad Hossain, *PhD*
Md. Shamsheer Ali, *PhD*
Amal Chandra Manidas, *MS*

Reviewed by:

Project Implementation Unit
National Agricultural Technology Program-Phase II Project (NATP-2)
Bangladesh Agricultural Research Council (BARC)
New Airport Road, Farmgate, Dhaka - 1215
Bangladesh

Acknowledgement

The execution of PBRG sub-project has successfully been completed by BARC, BARI, BRRI, BJRI, BSRI, BINA, CDB, BSRTI and BAU using the research fund of WB, IFAD and GoB through Ministry of Agriculture. We would like to acknowledge to the World Bank for arranging the research fund and supervising the PBRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP-2 in respect of field implementation of the sub-project in multiple sites. Preparing the sub-project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who have made it possible, deserve appreciation. Our thanks are due to the Director, PIU-BARC, NATP-2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

Published: December 2021

ISBN Number: 978-984-35-1485-1

Cover Design: Mohammad Nazmul Islam

Graphics Designer, Agriculture Information Centre, BARC

Printed by: College Gate Binding & Printing,
1/7, College Gate, Mohammadpur, Dhaka-1207

Contributors

Institute with Activities	Contributor	Position in the Sub-project
BARC (Coordination)	Dr. Md. Aziz Zilani Chowdhury	Coordinator
	Dr. Md. Abdus Salam	Principal Investigator (February 2018 to May 2020)
	Dr. Shah Md. Monir Hossain	Principal Investigator
	Dr. Md. Harunur Rashid	Co- Principal Investigator (February 2018 to May 2020)
BARI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Nazirul Islam	Principal Investigator (February 2018 to January 2020)
	Dr. Mosammat Shamsunnahar	Principal Investigator (February 2020 to October 2021)
	Dr. Md. Shalim Uddin	Co-Principal Investigator
	Dr. Rozina Afroz Chanda	Co-Principal Investigator
	Dr. Sajia Rahman	Co-Principal Investigator
	Quazi Maruf Ahmed	Co-Principal Investigator
BRRI (Collection, Conservation, Documentation and Characterization)	Dr. Mohammad Khalequzzaman	Principal Investigator
	Dr. Ebna Syod Md. Harunur Rashid	Co-Principal Investigator
	Dr. Mohammad Zahidul Islam	Co-Principal Investigator
	Md. Abu Bakar Siddique	Co-Principal Investigator
BJRI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Mahboob Hussain	Principal Investigator (February 2018 to July 2018)
	Md. Rafiqul Islam	Principal Investigator (August 2018 to October 2021)
	Dr. A.K.M. Shahadat Hossain	Co-Principal Investigator
BSRI (Collection, Conservation, Documentation and Characterization)	Dr. Md. Anisur Rahman	Principal Investigator
	Md. Mostake Ahmed	Co-Principal Investigator
	K.M. Rezaul Karim	Co-Principal Investigator
BINA (Collection, Conservation, Documentation and Characterization)	Dr. Mirza Mofazzal Islam	Principal Investigator (February 2018 to March 2020)
	Dr. Shamsun Nahar Begum	Principal Investigator (April 2020 to October 2021)
	Dr. Fahmina Yasmine	Co-Principal Investigator
CDB (Characterization)	M M Abed Ali	Principal Investigator
	Dr. Md. Kamrul Islam	Co-Principal Investigator
BSRTI (Characterization)	Faruque Ahmed	Principal Investigator (February 2018 to July 2018)
	Md. Abdul Alim	Principal Investigator (August 2018 to October 2021)
	Md. Shakhawat Hossain	Co- Principal Investigator
BAU (Collection, Conservation, Documentation and Characterization)	Prof. Dr. M. A. Rahim	Principal Investigator
	Prof. Dr. Md. Habibur Rahman	Co-Principal Investigator
	Prof. Dr. Md. Mokter Hossain	Co-Principal Investigator

Abbreviation and Acronyms

ANOVA	: Analysis of Variance
BARC	: Bangladesh Agricultural Research Council
BARI	: Bangladesh Agricultural Research Institute
BAU	: Bangladesh Agricultural University
BCR	: Benefit Cost Ratio
BFRI	: Bangladesh Forest Research Institute
BI	: Bioversity International
BINA	: Bangladesh Institute of Nuclear Agriculture
BJRI	: Bangladesh Jute Research Institute
BRRRI	: Bangladesh Rice Research Institute
BSRI	: Bangladesh Sugarcrop Research Institute
BSRTI	: Bangladesh Sericulture Research and Training Institute
BTRI	: Bangladesh Tea Research Institute
CBD	: Convention on Biological Diversity
CDB	: Cotton Development Board
CGIAR	: Consultative Group on International Agricultural Research
CIP	: International Potato Centre
Co-PI	: Co-Principal Investigator
CRG	: Competitive Research Grant
CSRTI	: Central Sericultural Research & Training Institute
CV	: Coefficient of Variation
DAE	: Department of Agricultural Extension
DNA	: Deoxyribonucleic Acid
EC	: Executive Chairman
EDTA	: Ethylenediamine tetraacetic acid
FRG	: Fertilizer Recommendation Guide
GI	: Geographical Indication
GIS	: Geographic Information System
GO	: Government Organization
GoB	: Government of Bangladesh
GOT	: Ginning Out Turn
GPC	: Germplasm Centre
GPS	: Geographical Positioning System
GRM	: Grievance Redress Mechanism
GRSD	: Genetic Resources and Seed Division
HRC	: Horticulture Research Centre
HYV	: High Yielding Variety
IBPGR	: International Board for Plant Genetic Resources
IFAD	: International Fund for Agricultural Development
IITA	: International Institute of Tropical Agriculture

INIBAP	: International Network for the Improvement of Banana and plantain
IPGRI	: International Plant Genetic Resources Institute
IPR	: Intellectual Property Rights
KGF	: Krishi Goveshona Foundation
LoA	: Letter of Agreement
MEGA	: Molecular Evolutionary Genetic Analysis
MoA	: Ministry of Agriculture
NARS	: National Agricultural Research System
NATP	National Agricultural Technology Program
NBPGR	: National Bureau of Plant Genetic Resources
NGO	: Non-Government Organization
NIB	: National Institute of Biotechnology
NSB	: National Seed Board
PBD	: Plant Breeding Division
PBRG	: Program Based Research Grant
PCR	: Sub-project Completion Report
PCR	: Polymerase Chain Reaction
PGR	: Plant Genetic Resources
PGRC	: Plant Genetic Resources Centre
PGRFA	: Plant Genetic Resources for Food and Agriculture
PI	: Principal Investigator
PIC	: Polymorphism information Content
PIU	: Project Implementation Unit
PMU	: Project Management Unit
PRA	: Participatory Resource Appraisal
RAPD	: Random Amplified Polymorphic DNA
RCBD	: Randomized Complete Block Design
RFQ	: Request for Quotation
SAAO	: Sub-Assistant Agriculture Officer
SAARC	: South Asian Association for Regional Cooperation
SAU	: Sher-e-Bangla Agricultural University
SD	: Standard Deviation
SDG	: Sustainable Development Goal
SSR	: Single Sequence Repeat
UHML	: Upper half mean length
UI	: Uniformity Index
UPGMA	: Unweighted Pair Group Method with Arithmetic Mean
UPS	: Uninterrupted Power Supply
USA	: United States of America
WB	: World Bank

Table of Contents

Sl. No.	Subject	Page No.
1.	Title page	i
2.	Citation, Acknowledgement	ii
3.	Contributors	iii
4.	Abbreviation and Acronyms	iv
5.	Table of Contents	vi
6.	List of tables	ix
7.	List of figures	xiii
8.	Executive Summary	xviii
9.	Methodology in brief	769
	Cotton Development Board	769
	Bangladesh Sericulture Research and Training Institute	770
	Bangladesh Agricultural University	772
10.	Results and Discussion	800
	Cotton Development Board	800
	Bangladesh Sericulture Research and Training Institute	889
	Bangladesh Agricultural University	906
11.	Research Highlights	1048
	Cotton Development Board	1048
	Bangladesh Sericulture Research and Training Institute	1049
	Bangladesh Agricultural University	1050
12.	Implementation Status	1055
	Procurement:	1055
	Bangladesh Agricultural Research Council	1055
	Bangladesh Agricultural Research Institute	1055
	Bangladesh Rice Research Institute	1055
	Bangladesh Jute Research Institute	1056
	Bangladesh Sugarcrop Research Institute	1056
	Bangladesh Institute of Nuclear Agriculture	1057
	Cotton Development Board	1057
	Bangladesh Sericulture Research and Training Institute	1057
	Bangladesh Agricultural University	1057
13.	Establishment/renovation Facilities	1057
14.	Training/study tour/seminar/workshop/conference organized	1058
15.	Financial and Physical progress	1058
	Financial and Physical progress (Combined)	1058
	Bangladesh Agricultural Research Council	1058
	Bangladesh Agricultural Research Institute	1059
	Bangladesh Rice Research Institute	1059
	Bangladesh Jute Research Institute	1059

Sl. No.	Subject	Page No.
	Bangladesh Sugarcrop Research Institute	1060
	Bangladesh Institute of Nuclear Agriculture	1060
	Cotton Development Board	1060
	Bangladesh Sericulture Research and Training Institute	1061
	Bangladesh Agricultural University	1061
16.	Achievement of Sub-project by objectives (Tangible form): Technology generated/developed	1062
	Bangladesh Agricultural Research Council	1062
	Bangladesh Agricultural Research Institute	1062
	Bangladesh Rice Research Institute	1063
	Bangladesh Jute Research Institute	1066
	Bangladesh Sugarcrop Research Institute	1066
	Bangladesh Institute of Nuclear Agriculture	1069
	Cotton Development Board	1069
	Bangladesh Sericulture Research and Training Institute	1069
	Bangladesh Agricultural University	1069
17.	Information/knowledge generated/policy generated	1070
	Bangladesh Agricultural Research Institute	1070
	Bangladesh Rice Research Institute	1070
	Bangladesh Jute Research Institute	1071
	Bangladesh Sugarcrop Research Institute	1071
	Bangladesh Institute of Nuclear Agriculture	1071
	Cotton Development Board	1072
	Bangladesh Sericulture Research and Training Institute	1072
	Bangladesh Agricultural University	1072
18.	Materials Development/Publication made under the Sub-project	1073
	Bangladesh Agricultural Research Institute	1073
	Bangladesh Rice Research Institute	1073
	Bangladesh Jute Research Institute	1073
	Bangladesh Sugarcrop Research Institute	1073
	Bangladesh Institute of Nuclear Agriculture	1074
	Bangladesh Agricultural University	1074
19.	Description of Generated Technology/Knowledge/Policy	1075
	Technology Fact Sheets (title, introduction, description, suitable location/ecosystem, benefits, name and contact address of author)	1075
	Bangladesh Sugarcrop Research Institute	1075
	Bangladesh Agricultural University	1076
20.	Technology/Knowledge generation/Policy Support (as applied)	1090
	Bangladesh Agricultural Research Institute	1090
	Bangladesh Rice Research Institute	1090

Sl. No.	Subject	Page No.
	Bangladesh Jute Research Institute	1090
	Bangladesh Sugarcrop Research Institute	1091
	Bangladesh Institute of Nuclear Agriculture	1091
	Bangladesh Sericulture Research and Training Institute	1091
	Bangladesh Agricultural University	1091
	Overall sub-project achievements at a glance	1092
21.	Information regarding Desk and Field Monitoring	1095
	Bangladesh Agricultural Research Institute	1095
	Bangladesh Rice Research Institute	1096
	Bangladesh Jute Research Institute	1098
	Bangladesh Sugarcrop Research Institute	1098
	Bangladesh Institute of Nuclear Agriculture	1099
	Cotton Development Board	1099
	Bangladesh Sericulture Research and Training Institute	1100
	Bangladesh Agricultural University	1100
22.	Weather Data, flood/salinity/drought level (if applicable) and Natural calamities:	1101
	BARI Component	1101
	BRRI Component	1103
	BJRI Component	1105
	BSRI Component	1106
	BINA Component	1107
	CDB Component	1108
	BSRTI Component	1109
	BAU Component	1110
23.	Sub-project Auditing	1111
	Bangladesh Agricultural Research Council	1111
	Bangladesh Agricultural Research Institute	1112
	Bangladesh Rice Research Institute	1112
	Bangladesh Jute Research Institute	1112
	Bangladesh Sugarcrop Research Institute	1112
	Bangladesh Institute of Nuclear Agriculture	1112
	Cotton Development Board	1113
	Bangladesh Sericulture Research and Training Institute	1113
24.	Lessons Learned	1113
25.	Challenges	1114
26.	Suggestions for Future Planning	1115
27.	References	1115
28.	Annexure 1. Reports on field monitoring and evaluation of field and laboratory experimentations of implementing components as per reporting format of NATP-2	1123

List of tables

Table	Title	Page
134	Absorbance reading at 260 nm (ng/μl) of DNA samples and preparation of working sample	785
135	Absorbance reading and concentration of DNA samples	793
136	List of cotton genotypes for morphological characterization, Cotton Research Centre, Jagadishpur, Jashore	800
137	Qualitative variations in different descriptors of cotton genotypes, Cotton Research Centre, Jagadishpur, Jashore (2018-2021)	801
138	Qualitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2018-2019	802
139	Qualitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	812
140	Qualitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	822
141	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore 2018-2019	833
142	Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2018-2019	833
143	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	837
144	Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	837
145	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	841
146	Quantitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	841
147	List of cotton genotypes used in morphological characterization, Cotton Research Center, Sreepur, Gazipur	844
148	Qualitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur	845
149	Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	846
150	Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	856
151	Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	866
152	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	876
153	Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	877
154	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	881

Table	Title	Page
155	Quantitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	881
156	Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	885
157	Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	886
158	List of mulberry germplasm characterized, 2018-2020	889
159	Morphological variability of 60 mulberry germplasm based on 19 qualitative characters, 2018- 2020	891
160	Qualitative descriptors of 60 mulberry germplasm	894
161	Quantitative variation in different characters of mulberry germplasm	899
162	Quantitative characters of test mulberry germplasm	900
163	Collection of banana, aroids and yam germplasm from different districts of Bangladesh	907
164	List of banana germplasm collected from different locations	909
165	List of aroids germplasm collected from different locations	910
166	List of yam (<i>Dioscorea spp.</i>) germplasm collected from different locations with passport information	911
167	Qualitative variation in different characters in banana and plantains	918
168	Quantitative variation in different characters of banana germplasm	924
169	Qualitative characters of banana germplasm	925
170	Quantitative descriptors of banana germplasm	927
171	RAPD primers with corresponding bands and size range together with polymorphic bands observed in 30 banana germplasm	957
172	Number of amplified fragments scored against 30 banana germplasm using three RAPD markers	958
173	Frequencies of polymorphic RAPD markers in 30 banana germplasm	959
174	Summary of genetic diversity and Shanon Information Index statistics	959
175	Nei's Analysis of gene diversity in subdivided populations	960
176	Distribution of 30 banana germplasm under different clusters	963
177	Details of the test SSR markers	963
178	Frequency of polymorphic loci of amplified DNA profile of 40 collected banana germplasm with mMaCIR13 primer	964
179	Genetic diversity and frequency of polymorphic loci for mMaCIR13 primer in 40 banana germplasm	964
180	Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR13 primer	964

Table	Title	Page
181	Frequency of polymorphic loci of amplified DNA profile of 40 banana germplasm with mMaCIR307 primer	965
182	Genetic diversity and frequency of polymorphic loci for mMaCIR307 primer in 40 banana germplasm	965
183	Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR307 primer	966
184	Distribution of 40 banana germplasm in different clusters	968
185	Distribution of banana germplasm revealed by cluster analysis of morphological traits, RAPD and SSR markers	970
186	Qualitative descriptors of various aroid groups	972
187	Quantitative variations in different characters of aroids	973
188	Quantitative descriptors of nine mukhi kachu cultivars	975
189	Growth Performance of five panchamukhi kachu cultivars	978
190	Growth Performance of five pani kachu cultivars	980
191	Growth performance of five poidnyl kachu cultivars	983
192	Growth performance of five <i>Alocasia</i> cultivars	984
193	Growth Performance of five <i>Amorphophallus</i> cultivars	986
194	Growth performance of eleven <i>Xanthosoma</i> cultivars	989
195	RAPD primers with corresponding bands score and their size range together with polymorphic bands observed in test aroids germplasm	991
196	Frequencies of polymorphic RAPD markers in test aroids germplasm	996
197	Summary of genetic diversity and Shanon Information Index	997
198	Summary of Nei's genetic identity (above diagonal) and distance (below diagonal) among aroids germplasm	998
199	Qualitative variation of different characters in yam	1001
200	Quantitative variation of different descriptors in yam	1006
201	Qualitative characters of young and matured stem of yam	1007
202	Quantitative characters of young and matured stem of yam	1009
203	Qualitative characters of young and matured leaf of yam	1012
204	Quantitative characters of young and matured leaf of yam	1014
205	Qualitative characteristics of aerial and underground tubers of yam	1017
206	Quantitative characteristics of aerial and underground tubers of yam	1028
207	Quality characteristics of yam tubers	1029
208	Distribution of yam germplasm in seven clusters	1036

Table	Title	Page
209	Average Intra and Inter cluster (data in parenthesis) distances among test yam germplasm in seven clusters	1036
210	Cluster mean values of 15 characters of yam germplasm	1037
211	Eigen values and percentage of variation in corresponding 15 characters of yam germplasm	1038
212	Ten lower and higher inter-accessions distance between pairs of test yam germplasm	1039
213	RAPD primers with corresponding bands and size range together with polymorphic bands observed in six <i>Dioscorea spp.</i>	1041
214	Frequencies of polymorphic RAPD markers in six <i>Dioscorea spp.</i>	1041
215	Summary of genetic diversity and Shanon Information Index statistics	1042
216	Summary of genetic variation across loci	1043
217	Summary of Nei's genetic identity (above diagonal) and genetic distance (below diagonal) values	1045

List of figures

Figure	Title	Page
95	Data collection and intercultural operation of mulberry plant	771
96	Collection of yam germplasm from Tangail	773
97	Harvesting of underground tuber of yam	783
98	Research activities in Molecular Biology Lab, BAU	799
99	Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2018-2019	804
100	Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2018-2019	806
101	Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2018-2019	808
102	Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2018-2019	810
103	Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	814
104	Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	816
105	Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	818
106	Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020	820
107	Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	824
108	Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	826
109	Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	828
110	Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021	830
111	Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	848
112	Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	850
113	Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	852
114	Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019	854

Figure	Title	Page
115	Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	858
116	Petal color cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	860
117	Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	862
118	Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020	864
119	Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	868
120	Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	870
121	Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	872
122	Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021	874
123	Variation in leaf color of mulberry plant	895
124	Leaf wrinkles of mulberry plant	896
125	Leaf shape of mulberry plant	896
126	Leaf apex of mulberry plant	896
127	Leaf base of mulberry plant	896
128	Leaf lobation type of mulberry plant	897
129	Bud shape of mulberry plant	897
130	Leaf lobation of mulberry plant	897
131	Seed color of mulberry	897
132	Young shoot color of mulberry plant	897
133	Collection sites of banana, aroids and yam germplasm	908
134	Monitoring visit to BAU-GPC	916
135	Plant characters of indigenous banana germplasm	921
136	Leaf character of indigenous banana germplasm	931
137	Male bud characters of indigenous banana germplasm	936
138	Style shape of indigenous banana germplasm	939
139	Bunch characters of indigenous banana germplasm	942
140	Hand characters of indigenous banana germplasm	944
141	Finger characteristics indigenous banana germplasm	947
142	Pulp and peel characteristics and seediness of indigenous banana germplasm	950

Figure	Title	Page
143	Transverse section of fruits of indigenous banana	952
144	Shape, size and style of tips and pedicel of indigenous banana	954
145	RAPD profile of 30 banana accession using primer OPA-03	961
146	RAPD profile of 30 banana accession using primer OPA-14	961
147	RAPD profile of 30 banana accession using primer OPA-19	961
148	Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance	962
149	Microsatellite profiles of 30 banana germplasm with mMaCIR13 primer	966
150	Microsatellite profiles of 30 banana germplasm with primer mMaCIR307	966
151	Microsatellite profiles of 10 banana germplasm with primer mMaCIR307 (Left side) and mMaCIR13 (Right side)	967
152	Microsatellite profiles of 40 banana germplasm with primer mMaCIR13 r	967
153	Microsatellite profiles of 40 banana accession with primer mMaCIR307	967
154	Combined dendrogram constructed by unweighted pair group method of arithmetic mean (UPGMA) using mMaCIR13 and mMaCIR307 markers	969
155	Leaf, flower and root of different mukhi kachu	977
156	Variation in plant parts of <i>C. esculenta</i> L.	980
157	Morphological variation of different plant parts of Pani Kachu	982
158	Variation of different plant parts of <i>Alocasia</i>	985
159	Variation in plant, leaf, flower and corm characters of Ol Kachu	987
160	Variation of different plant parts of <i>Xanthosoma</i>	990
161	RAPD profile of 22 aroid germplasm using primer OPG 10	992
162	RAPD profile of 22 aroid germplasm using primer OPW 04	993
163	RAPD profile of 22 aroid germplasm (A+B) using primer OPW 09	994
164	RAPD profile of 22 aroid germplasm (A+B) using primer OPW 10	995
165	RAPD profile of 10 aroid germplasm using primer OPW 16	996
166	Unweighted pair group method of Arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance	999
167	Young stem of <i>Dioscorea spp.</i>	1008
168	Twining direction of matured stem of yam	1010
169	Spine of matured yam stem	1010
170	Wing color of matured stem yam	1011
171	Young leaf of <i>Dioscorea spp.</i>	1013

Figure	Title	Page
172	Matured leaf (Upper and lower surface) of <i>Dioscorea spp.</i>	1015
173	Position of leaf of <i>Dioscorea spp</i>	1017
174	Aerial tuber and transverse section of aerial yam tubers	1018
175	Underground tuber of yam	1021
176	Blister, crack, wrinkle and prickly appearance of underground tuber of yam	1024
177	Transverse section of underground yam tuber	1025
178	Boiled tuber and water discoloration	1030
179	Dendrogram based on Ward's method using Euclidean Distance	1040
180	RAPD profile of six yam germplasm using primer OPA-02	1045
181	RAPD profile of 6 yam germplasm using primer OPG13	1046
182	RAPD profile of 6 yam germplasm using primer OPW08	1046
183	RAPD profile of 6 yam germplasm using primer OPW16	1046
184	Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance	1047
185	Indigenous banana varieties released by BAU	1051
186	Aroid varieties released by BAU	1052
187	Yam varieties released by BAU	1054
188	Field picture and morphological characteristics of BSRI Akh47	1067
189	Research progress workshop and monitoring of research activities of PGRC, BARI by different monitoring teams	1096
190	Monitoring of research work of BRRI by monitoring teams	1097
191	Field monitoring of BJRI for sub-project evaluation	1098
192	Field monitoring by NATP team, BARC and MoA	1099
193	Field monitoring by PBRG team, BARC	1099
194	Field Visit to BINA, Mymensingh, 08 April 2019	1127
195	Field Visit to BARI, Gazipur, 25 June 2019	1133
196	Field and Lab Visit to GRSD, BRRI, Gazipur, 25 June 2019	1136
197	Field Visit to PGRC, BARI, Gazipur, 04 November 2019	1139
198	Field Visit to GRSD, BRRI, Gazipur, 04 November 2019	1142
199	Field Visit to BINA, Mymensingh, 08 November 2019	1045
200	Field visit to Germplasm Centre, BAU, Mymensingh; 08 November, 2019	1148
201	Filed visit to Research farm of CDB, Sreepur, Gazipur; 08 November, 2019	1151
202	Field visit to Research farm of CDB, Jagadishpur, Jashore; 17 January, 2020	1155

Figure	Title	Page
203	Field Visit to PGRC, BARI, Gazipur, 12 March 2020	1158
204	Field Visit to GRSD, BRRI, Gazipur, 12 March 2020	1162
205	Field Visit to BSRTI, Rajshahi, 20 March 2020	1165
206	Field Visit to BJRI, Jagir, Manikgonj, 17 October 2020	1168
207	Field Visit to BSRI, Ishwardi, 7-8 November 2020	1172
208	Field Visit to BINA, Mymensingh, 28 November 2020	1174

Executive Summary

Plant genetic resources are the most valuable and essential basic raw materials for crop improvement providing biological basis for world food security supporting livelihoods. Cultivated varieties, obsolete varieties, primitive cultivars (landraces), wild and weedy species, near relatives of cultivated species etc. are considered as component plant genetic resources. Bangladesh is characterized by a mixture of tropical and sub-tropical environments offering congenial growing condition for numerous agri-horticultural crops. It is bestowed with immense agro-biodiversity and rich diversity of landraces, traditional/farmers' varieties in several agri-horticultural crops with a good number of timber and medicinal plants which are indigenous to the country. The diverse 30 agro-ecological regions of the country have sustained rich genetic resources of crop plants. Collection and conservation of the plant genetic diversity is essential for present and future human well-being. Adoption of modern agriculture, destruction of habitat, aggression of local and overseas private seed companies and other reasons have caused high genetic erosion in the country. With a view to collect, characterize (morphological and molecular), conserve and documentation of important plant genetic resources including Geographical Indication (GI) crops, landraces and released varieties for establishing 'Intellectual Property Rights (IPR)' a coordinated sub-project titled "Collection, Conservation and Characterization of Important Plant Genetic Resources" (ID: 128) has been implemented by seven NARS institutes viz. BARI, BRRI, BJRI, BSRI, BINA, CDB, BSRTI and one University viz. BAU. As coordinating organization, BARC arranged meeting, inception, training and review workshops. It also monitored and evaluated technical activities at field and laboratory levels as well as edited and compiled reports (half yearly, annual and sub-project completion reports) submitted by implementing organizations. Participating organizations collected germplasm from target areas following appropriate procedures and the germplasm were conserved preliminary in active/short term storage and were characterized following standard descriptors for respective crops.

In total 1184 germplasm of different crops were collected by implementing institutes where BARI collected 600 (Cereals -14, Pulses-39, Oilseeds-26, Vegetables-455, Spices-36, Fruits-14, Medicinal plants-12 and Other crops - 4), BRRI collected 247 rice, BJRI collected 35 (*Corchorus capsularis*-23, *Corchorus olitorius*-9 and *Hibiscus sabdariffa*-3), BSRI collected 68 sugarcane, BINA collected 199 (Rice-151, Chilli-5, Turmeric-2, Ginger-2, Bitter gourd-3, Brinjal-9, White gourd-3, Sweet gourd-3, Bottle gourd-1, Sponge gourd-1, Okra -3, Bean -8, Groundnut-4, Mustard-1, Sesame-2 and Black gram -1) and BAU collected 35 Yam germplasm during sub-project tenure.

In total 1936 germplasm were characterized morphologically under the sub-project among which BARI has characterized 844 (Pumkin-64, Cucumber-26, Brinjal-284, Bitter gourd-48, Mungbean-97, Bottle gourd-223, Amaranthus-80 and Guava -22), BRRI characterized 264 rice (T. aman-120, Boro-96, Aus -48), BJRI characterized 97 jute (Deshi jute-62 and Tossa jute-35), BSRI characterized 51 sugarcane, BINA characterized 141 (Rice-73, Sesame-30, Groundnut-33 and Chilli-5), CDB characterized 343 cotton, BSRTI characterized 60 mulberry and BAU characterized 136 (Banana-60, Aroids-45 and 31 Yam) germplasm during the project period.

Molecular characterization of 526 germplasm of different crops has been completed by the implementing organizations. Twenty five mustard germplasm were characterized by BARI, whereas 216 rice (T. Aman-120; Boro-48 and Aus-48) and 66 jute germplasm were characterized by BRRI and BJRI, respectively. Likewise, BINA and BAU characterized 83 rice and 136 (Banana-60, Aroids-45 and Yam-31) germplasm, respectively.

All the germplasm comprised of orthodox seeds collected by BARI, BRRI, BINA and BJRI have been conserved in short term storage/active collection in the respective institutes. After completion of necessary procedures the seeds will be conserved in the base collection/long term preservation units. Recalcitrant seed germplasm collected by BARI, BSRI and BAU have been conserved in field gene bank of corresponding organizations.

An outstanding achievement of the sub-project came out with the release of 15 varieties (Banana-5, Aroids-4 and Yam-5 and chewing type sugarcane variety-1) by BAU and BSRI, respectively. All the released varieties are supposed to bring a positive impact in nutrition improvement of the farming community as the varieties are known as potent source of various health promoting stuffs. However previously collected germplasm were also been evaluated under the sub-project. Five research articles (BAU-4; BARI-1) are published and six are under process (BRRI-2, BJRI-1, BINA-2 and BSRI-1) from the results of this research.

10. Methodology in brief:

10.7. Cotton Development Board

10.7.1 Morphological Characterization of Cotton Genotypes

The experimental material for the present study consisted of 335 *G. hirsutum* accessions raised in Augmented Block Design at the Cotton Research Center, Jagadishpur, Jashore (172) and Cotton Research Center, Sreepur, Gazipur (163) during 2018-2019, 2019-2020 and 2020-2021 growing season. Seeds were sown on 21-07-2018, 27-07-2019 and 21-07-2020 at Jagadishpur and on 21-07-2018, 23-07-2019 and 09-07-2020 at Sreepur providing spacing of 45 cm within the row and 90 cm apart from the other row. Recommended agronomic and plant protection measures were followed from sowing till harvest of the crop.

The characterization was done following the Cotton Descriptors (Revised) published by the International Board for Plant Genetic Resources (IBPGR, 1985). The data on 11 qualitative traits viz. growth habit, color of plant, hairiness, leaf shape, petal color, petal spot, pollen color, boll shape, seed fuzz, fuzz color and lint color; 21 quantitative traits including 11 yield components viz. node number of first fruiting branches, number of vegetative branches per plant, number of primary fruiting branches per plant, number of secondary fruiting branches per plant, days to 50% flowering, days to 50% boll split, number of boll per plant, single boll weight, plant population at harvest (ha), plant height at harvest and seed cotton yield; 4 ginning characteristics viz. GOT (%), seed index, lint index and fuzz grade; and 6 lint characteristics viz. upper half mean length, fiber strength, uniformity index, elongation percent, moisture percent and micronaire value were recorded.

Mean values of quantitative traits of individual accession were computed for determining the frequency distribution and cluster analysis based on Euclidean distances and clustering using hierarchical clustering. Dissimilarity matrix based on Euclidean distance was calculated using these traits by the statistical software Past4.03. Most dissimilar and least dissimilar accessions were identified based on dissimilarity matrix. The hierarchical cluster analysis of pooled data was performed using scores of dissimilarity matrix (Ward, 1963).

A. Qualitative descriptors and descriptor states

1. Growth habit: 3 Prostrate, 5 Compact & 7 Erect
2. Color of plant: 1 Green, 2 Greenish purple (sun red) & 3 Red
3. Hairiness: 0 Glabrous, 3 Short hair & 7 Long hair
4. Leaf shape: 1 Entire, 2 Lobed
5. Petal color: 1 White, 2 Cream, 3 Light yellow, 4 Yellow & 5 Lavender
6. Petal spot: 0 Absent & 1 Present
7. Pollen color: 1 Cream & 2 Yellow
8. Boll shape: 1 Round, 2 Oval & 3 Conical
9. Seed fuzz: 0 Naked, 3 Sparse, 7 Fuzzy
10. Fuzz color: 1 White, 2 Green, 3 Grey & 4 Brown
11. Lint color: 1 White, 2 Cream, 3 Light brown & 4 Brown

B. Quantitative descriptors

1. Node number of 1st fruiting branch
2. Number of vegetative branches per plant
3. Number of primary fruiting branches per plant
4. Number of secondary fruiting branches per plant
5. Days to 50% flowering
6. Days to 50% boll split
7. Number of bolls per plant
8. Single boll weight
9. Plant population at harvest (ha)
10. Plant height at harvest
11. Seed cotton yield
12. GOT (%)
13. Seed Index (g)
14. Lint Index (g)
15. Fuzz Grade
16. Upper Half Mean Length (UHML) (mm)
17. Strength (g/tex)
18. Uniformity Index (UI)
19. Elongation (%)
20. Moisture (%)
21. Micronare Value ($\mu\text{g}/\text{inch}$)

10.8. Bangladesh Sericulture Research and Training Institute

10.8.1. Morphological Characterization of Mulberry Germplasm

This experiment was conducted at Mulberry Germplasm Bank of BSRTI, Rajshahi, during January, 2018 to December, 2020. Total 60 mulberry genotypes were included in this study. The experiment was laid out in randomized complete block design (RCBD) with three replications and each replication consisted of 20 plants. The unit plot size is 4 m \times 5 m. The recommended doses of manure and fertilizers such as 15 MT/ha cowdung, 300 kg N, 150 kg P and 100 kg K/ha per year with two split doses in the form of urea, triple super phosphate (TSP) and muriate of potash (MoP) were applied in the experimental field (BSRTI, Annual Research Report, 2002). The other cultural practices like- Digging cum weeding, irrigation, pruning and disease-pest control were done as per needed. Total sixty (60) observations on qualitative (19) and quantitative (41) characters were recorded following the descriptor and acceptable to International Compendium Program and International Board of Plant Genetic Resources (IBPGR) of Hackett (1979) and CSRTI (1986) (Fig. 95). During this period the range, mean, SD and mean coefficient of variation (CV%) of quantitative characters were calculated using the Microsoft Excel and Statistic 10 software.



Leaf Harvest for Data Collection



Growth data collection



Field view of the experimental germplasm Bank



Data collection on leaf yield



Inter-cultural operation of germplasm bank

Fig. 95. Data collection and intercultural operation of mulberry plant

A. Qualitative descriptors

1. Young shoot colour: Green = 1, Greenish purple = 2, Purple = 3 and light green = 4.
2. Growth nature: Erect = 1, Spreading = 2 and Drooping = 3.
3. Branching nature: Straight = 3.1, Slightly curved = 3.2 and Curved = 3.3.
4. Bud shape: Round = 1, Acute triangle = 2, Long triangle = 3 and Spindle shaped = 4.
5. Sex expression: Dioecious (Female) = 1, Monocious (Female) = 2, Dioecious (Male) = 3 and Monocious male = 4.
6. Leaf apex: Here, Acute = 1, Acuminate = 2.
7. Leaf margin: Here, Crenate = 1, Serrate = 2, Dentate = 3 and Repand = 4.
8. Leaf base: Cordate = 1, Inequilateral = 2 and Truncate = 3.
9. Leaf surface: Smooth = 1, slightly rough = 2 and Rough = 3.
10. Shape of the leaf scar: Elliptical = 1 Circular = 2 and Triangular = 3.
11. Leaf lobation type: Plane = 1, Shallow lobed = 2, Medium lobed = 3 and deeply lobed = 4.
12. Leaf lobation number: 0-lobed = 1, Multilobed = 2, 3-4 lobed = 3 and 1-2 lobed = 4.
13. Leaf colour: Green = 1, Light green = 2, Deep green = 3, Yellowish green = 4, Blackish green = 5 and Bean green = 6.
14. Leaf glossiness: Slightly glossy = 1, Non glossy = 2 and Strongly glossy = 3.
15. Leaf wrinkleness: Slightly wrinkle = 1, Smooth = 2 and Wrinkled = 3.
16. Leaf shape: Cordate = 1. Deltoid = 2, Palmate = 3, Ovate = 4, Wide ovate = 5, Aristate = 6, Narrow ovate = 7 and Pedate = 8.
17. Fruit colour: Radish-black = 1, Black-berry = 2, Cream = 3, Black = 4, White-cream = 5, Pink = 6, Pinkish = 7, Orange = 8 and Radish = 9.
18. Fruit taste: Sour-sweet = 1, Sweet = 2 Light sweet = 3, Light-sour sweet = 4 and deep sweet = 5.
19. Seed colour: Here, Light yellow = 1, Light brown = 2, Yellowish brown = 3, Dark brown = 4 and Blackish brown = 5.

B. Quantitative descriptors

SI. no.	Descriptor	SI. no.	Descriptor
1.	Number of branches:	22.	Male inflorescence breath (cm)
2.	Total shoot length/plant (m)	23.	Female inflorescence breath (cm)
3.	Length of the longest shoot/plant (m)	24.	Bisexual inflorescence breath (cm)
4.	Internodal distance (cm)	25.	Male inflorescence weight (g)
5.	Bud length (cm)	26.	Female inflorescence weight (g)
6.	Bud breath (cm)	27.	Bisexual inflorescence weight (g)
7.	Leaf apex length (cm)	28.	Floret number/male inflorescence
8.	Petiole length (cm)	29.	Floret number/female inflorescence
9.	Petiole breath (cm)	30.	Style length (mm)
10.	Petiole weight (g)	31.	Ovary length (mm)
11.	Leaf area (sq.cm)	32.	Ovary breath (mm)
12.	Weight of the hundred leaves (g)	33.	Fruit length (cm)
13.	Leaf yield/plant (g)	34.	Fruit breath (cm)
14.	100 seed weights (g)	35.	Fruit weight (g)
15.	No. of inflorescence /meter length of branch	36.	Seed setting (%)
16.	No. of male inflorescence /meter shoot	37.	Dry shoot weight (g)
17.	No. of female inflorescence /meter shoot	38.	Dry root weight (g)
18.	No. of bisexual inflorescence /meter shoot	39.	Sprouting (%)
19.	Male inflorescence length (cm)	40.	Rooting (%)
20.	Female inflorescence length (cm)	41.	Moisture (%)
21.	Bisexual inflorescence length (cm)		

10.9. Bangladesh Agricultural University

10.9.1. Collection of indigenous banana, aroids and yam germplasm

Collection of indigenous banana, aroids and yam germplasm was accomplished based on the information of Sub Assistant Agriculture Officer (SAAO) of Department of Agricultural Extension (DAE) working at upazila level and local dwellers of each location. Most of the germplasm were collected from the remote area of the country.

Six expeditions were made for collection of yam germplasm from different region of Bangladesh. Two teams RMHF (Rahim, Mokter, Habibur, Fatema) and RHMF (Rahim, Habibur, Mokter, Fatema) were formed comprising 4 members in each team. Each expedition was conducted for 1-4 days. The team members visited eight (8) upazilas of five (5) districts namely Rangamati, Bandarban, Tangail, Shatkhira, Laxmipur (Fig. 96) during the period from July 2017 to December 2018. The teams were equipped with plastic carton, GPS, compass, digital camera, hand lens, envelop, knife, scissors, pencil, stapler, marker etc. On the basis of preliminary information gathered from secondary sources like acquainted agriculturist scientists who work in sub-projects and after discussing with particular farmer who grow and sell yam to the market, field tours were planned to the different locations to collect the samples from those areas. Prior to final selection of a sample, after initial observation of the plant, informal interviews were arranged with the local farmer that included history of the cultivar, qualitative and quantitative information about quality of vegetable, amounts of yield; and any special feature, like, sustainability against water, wind and nature of growth etc. The gathered information was recorded in field notes. After negotiating the price with the farmer, small tubers (seed yams), cuttings off the tubers, setts (pre-sprouted tubers or pieces of tuber), or bulbils have been collected from the farmers. The Sub Assistant Agriculture Officers (SAAOs) of the Department of Agricultural Extension (DAE) were very supportive in all these activities of cultivar collections. Passport information of each germplasm was recorded as per recommended format of BARC.



Fig. 96. Collection of Yam germplasm from Tangail

10.9.2. Conservation of collected germplasm

The collected germplasm of indigenous banana, aroids and yams were registered in accession book of BAU-GPC immediately after collection (January 2012 to May 2018). Then the planting materials of each germplasm were planted in the field genebank of Bangladesh Agricultural University Germplasm Center (BAU-GPC). Banana germplasm were planted in replicates following experimental design, while aroid germplasm was conserved in separate sets of species considering their edaphic and environmental requirement. Yams were planted separately with woody and semi woody perennial plants (e.g. Neem, Mahogany etc.) during March to April 2017. Weeding, irrigation, drainage, fertilization and cultural operations were being done regularly. Cares were also taken to keep them healthy and disease free.

10.9.3. Morphological Characterization of Indigenous Banana Cultivars

Morphological characterization of banana germplasm was done at Bangladesh Agricultural University Germplasm Centre (BAU-GPC), Mymensingh during February 2014 to June 2017. The location of the site is 24.000 N latitude and 90.260 E longitudes at an altitude of 8.40 m above the sea level. Sixty indigenous banana germplasm collected from different locations of Bangladesh were included in this study. Pits of 50 x 50 x50 cm were prepared 10 days before planting of suckers. Manures and fertilizers were applied as per recommendation. The basal doses of manures and fertilizers were mixed well with the soil of the pits and the pits were prepared in such a way that the pit tips remained at least 10 cm above the ground level to facilitate drainage. The experiment was conducted in randomized complete block design with three replications. The suckers were planted on 22 February 2014 in the pits. Irrigation, weeding, staking, pest and disease control and other cultural operations were done as and when necessary. Fifty-four qualitative (24) and quantitative (30) characters were recorded following IPGRI-INIBAP-CIRAD Descriptors for Banana (*Musa spp.*). Observations were made ideally under standardized conditions. Vegetative characters were observed after plantation and fruit characters have been recorded when the first ripe fruit develop on the bunch unless otherwise specified. Characterization descriptors for the study included: (i) Plant descriptors, (ii) Leaf descriptors, (iii) Inflorescence/Male bud descriptors and (iv) Fruit descriptors. The data were recorded for three times from three different plants growing near to each other. Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated. The collected data on 30 quantitative characters were analyzed for ANOVA.

Passport information

Accession number: This number serves as a unique identifier for accessions and is assigned by the curators/gene bank scientist when an accession is entered into his collection. Once assigned this number should never be assigned to another accession in the collection. Even if an accession is lost, its assigned number is still not available for re-use.

Collector's number: Original number assigned by collector of the sample normally composed of the name or initials of the collector(s) followed by a number. This item is essential for identifying duplicates in different collections.

Descriptors and descriptor states of characterization

A. Qualitative characters/descriptors:

1. **Pseudostem colour:** 1 Green-yellow, 2 Medium green, 3 Green, 4 Dark green, 5 Green-red, 6 Red, 7 Red-purple, 8 Blue, 9 Chimerical, 10 Other
2. **Growth habit of plant:** 1 Slow growth, 2 Normal growth
3. **Appearance of leaf upper surface:** 1 Dull, 2 Shiny
4. **Appearance of leaf lower surface:** 1 Dull, 2 Shiny
5. **Leaf blade color:** 1 Green-yellow, 2 Medium green, 3 Green, 4 Dark green, 5 Dark green with red-purple (presence of large blotches of red-purple), 6 Blue, 7 Other
6. **Color of midrib:** 1 Yellow, 2 Light green, 3 Green, 4 Pink-purple, 5 Red-purple, 6 Purple to blue, 7 Other.
7. **Apex of leaf:** 1 Truncate, 2 Mucronate, 3 Obtuse, 4 Emarginate, 5 Acute
8. **Shape of Leaf base:** 1 Both sides rounded, 2 One side rounded, One pointed, 3 Both sides pointed.
9. **Leaf habit:** 1 Erect, 2 Intermediate, 3 Drooping, 4 Other (e.g. very drooping).
10. **Rachis type:** 1 Truncated, no bract scar below the last hand of fruit, 2 Present and male bud may be degenerated or persistent
11. **Rachis position:** 1 Falling vertically, 2 At an angle, 3 With a curve, 4 Horizontal, 5 Erect.
12. **Male bud shape:** (Note the general shape of the male bud at harvest): 1 Like a top, 2 Lance late, 3 Intermediate, 4 Ovoid, 5 Rounded.
13. **Bract apex shape:** Flatten the apex of the bract to observe its shape: 1 Pointed, 2 Slightly pointed, 3 Intermediate, 4 Obtuse, 5 Obtuse and split
14. **Bract behaviour before falling:** 1 Revolute (rolling), 2 Not revolute (not rolling).
15. **Colour of the bract external face:** 1 Yellow, 6 Purple, 2 Green, 7 Blue, 3 Red, 8 Pink-purple, 4 Red-purple, 9 Orange-red, 5 Purple-brown, 10 Other
16. **Colour of the bract internal face:** 1 Whitish, 5 Purple, 2 Yellow or green, 6 Purple brown, 3 Orange red, 7 Pink-purple, 4 Red, 8 Other
17. **Style shape:** Straight, 2 Arched
18. **Fruit shape (longitudinal curvature):** 1 Straight (or slightly curved), 2 Straight in distal part, 3 Curved (sharp curve), 4 Curved in 'S' shape (double curvature), 5 Other

19. **Fruit apex (Observed at the distal end of the fruit):** 1 Pointed, 2 Lengthily pointed, 3 Blunt-tipped 4 Bottle-necked 5 Rounded
20. **Colour of ripe fruits [Recorded at fruit maturity (ripe, but not over-ripe; full yellow stage)]:** 1 Yellow, 2 Bright yellow, 3 Orange, 4 Grey spots, 5 Brown/rusty-brown, 6 Orange red, red or pink/pink purple, 7 Red-purple, 8 Black, 9 Other.
21. **Pulp colour at maturity (Ripe, but not over-ripe; full yellow stage):** 1 White, 2 Cream, 3 Ivory, 4 Yellow, 5 Orange, 6 Beige-pink, 7
22. **Transverse section of fruit [Observed on mature fruit ('ready to eat' - ripe but not over-ripe, full yellow stage)]:** 1 Pronounced ridges, 2 Slightly ridged, 3 Rounded.
23. **Remains of flower relicts at fruit apex (Observed at the distal end of the fruit):** 1 Without any floral relicts, 2 Persistent style, 3 Base of the style prominent.
24. **Seed status:** 0 Absent, 1 Present.

B. Quantitative Characters

1. **Plant/Pseudostem height (m):** The height of plants was measured by a measuring tape at the time of flower emergence from the base of the plant to the stalk of the inflorescence.
2. **Basal girth (cm):** Three measurements were taken from three different distances, one at the ground level; second one at 150 cm above the ground level and the last 300 cm above the ground level. The average of these three values was recorded as basal girth.
3. **Total length of the leaf (Blade + petiole) (m):** The total length of leaf blade was measured by a measuring scale from the base of pedicel to the apex of the leaf and was expressed in metre (m).
4. **Leaf petiole length (m):** The length of petiole was measured by a measuring scale from the base of the leaf to end of the pedicel and was expressed in metre (m).
5. **Length of leaf blade (m):** The length of leaf blade was measured by a measuring scale from the base to the apex of the leaf and was expressed in metre (m).
6. **Breadth of leaf blade (m):** The breadth of leaf blade was measured by a measuring scale at the top, widest and lowest portions of the lamina and was expressed in metre (m). These three values were averaged and analyzed.
7. **No. of leaves/plant (at harvesting time):** The number of green leaves per plant was recorded at the time of harvesting.
8. **Length of the flag leaf (at harvesting time):**
9. **Breadth of the flag leaf (at harvesting time)**
10. **Leaf area (m²):** Leaf area was determined by using the formula $L \times B \times 0.767$ where L is length of lamina, B is breadth of lamina and k value = 0.767 is the correction factor (Saidha and Rao, 1985).
11. **Length of male bud (cm):** Taken by longitudinal section
12. **Diameter of male bud (cm):** Diameter of male bud was measured by a digital slide calipers at the middle of the male bud where maximum breadth occurred. Average diameter of three selected male bud was calculated.
13. **Weight of male bud (g)**

14. **Days to emergence of inflorescence:** was recorded from the date of planting.
15. **Days to maturity (from flowering to harvesting):** was recorded for three selected plants.
16. **Total bunch weight (kg):** was recorded for each cultivar.
17. **Number of fingers per hand:** No. of fingers per hand was recorded by counting
18. **Weight of each hand:** was taken with the help of a digital balance where fraction of a gram could be read accurately.
19. **Weight of each fruit (Peel +Pulp) (g):** average weight of each fruit for each hand was calculated from three previously randomly selected fruits.
20. **Weight of Pulp (g):** Weight of pulp (g) = Weight of fruit (g) – weight peel (g).
21. **Weight of Peel:** after taking the total fruit weight of randomly selected three fruits from each hand, the peels of fruits were taken off and weight were taken with the help of a digital balance and the average weight was calculated and mean values was expressed in gram (g).
22. **Total fruit length (pedicel + edible portion + tip):** Length of fruit was measured as the distance between the base of fruit and apex of fruits by a digital slide calipers. Length of three previously randomly selected fruits for each hand were taken. Average length was calculated and values were expressed in centimeters (cm).
23. **Length of Pedicel (cm):** Length of pedicel was measured as the distance between the base and edible portion of the fruit by a digital slide calipers. Average length of three previously randomly selected fruits for each hand was calculated.
24. **Length of Tip (cm):** Length of tip was measured as distance between end of the edible portion and apex of the fruit by a digital slide calipers. Average length of three previously randomly selected fruits for each hand was calculated.
25. **Length of Edible portion (cm):** Length was measured as the distance between the pedicel and tip of the fruit by a digital slide calipers. Average length of three previously randomly selected fruits for each hand was calculated.
26. **Dry weight of peel:** was taken after drying in an oven.
27. **Dry weight of pulp:** was taken after drying in an oven.
28. **TSS content (%):** Total soluble solids (TSS) content of banana pulp was estimated using Abbe refractometer. A drop of banana juice squeezed from the fruit pulp was placed on the prism of the refractometer. Percent TSS was obtained from the direct reading of the instrument.
29. **Per cent pulp/percent edible portion (The per cent pulp was calculated as follows):**

$$\% \text{ fruit pulp} = \frac{\text{Weight of pulp}}{\text{Weight of fruit}} \times 100$$

30. **Per cent peel (The per cent peel was calculated as follows):**

$$\% \text{ fruit peel} = \frac{\text{Weight of peel}}{\text{Weight of fruit}} \times 100$$

10.9.4. Morphological Characterization of Aroids Germplasm

Edible aroids under seven groups (Mukhikachu, Panchamukhikachu, Poidnylkachu, Panikachu, Olkachu, Maankachu and Maulavikachu) were characterized at morphological level in the experimental field of BAU-GPC, Mymensingh during February 2018–January 2021. A total of 45 aroids germplasm (*Colocasia*-24, *Amorphophallus*-5, *Alocasia*-5, *Xanthosoma*-11) collected during first phase of NATP were included in this study. The experiment was laid out in randomized complete block design with three replications. The crops were fertilized with recommended doses of manures and fertilizers. Weeding, irrigation, pest and disease control and other cultural operations were done as required. Thirty-two qualitative (13) and quantitative (19) characters were recorded as per IPGRI Descriptors for Taro. Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated. The collected data on 19 quantitative characters were analyzed for ANOVA.

Descriptors and descriptor states of characterization

A. Qualitative characters/descriptors:

1. **Growth habit:** 1 Erect, 2 Semierect
2. **Stolon formation:** 0 Absent, 1 Partly absent (1-5), 3 With stolon only
3. **Plant height:** 1 Dwarf (<50 cm), Medium (50-100 cm), Tall (>100 cm), Very tall
4. **Color of petiole:** 1 Whitish, 2 Yellow, 3 Orange, 4 Light green, 5 Green, 6 Red, 7 Brown, 8 Purple, 99 Other (e.g. 'bronze', black specify on descriptor 7.8 Notes)
5. **Leaf colour (Observed on fully expanded and mature leaves):** 1 Whitish, 2 Yellow or yellow green, 3 Green, 4 Dark green, 5 Pink, 6 Red, 7 Purple, 8 Blackish (violet-blue), 99 Other
6. **Shape of leaf:** Leaves were selected randomly from each of the three plant of every germplasm. The shape of leaves was recorded by visual observation.
7. **Vein junction colour (Observed on the upper side):** 0 Absent, 1 Yellow, 2 Green, 3 Red, 4 Purple, 99 Other (specify in descriptor 7.8 Notes)
8. **Eating quality:** 1 Poor quality, 2 Acceptable, 3 Good
9. **Flesh color:** 1 White, 2 Slightly yellow, 3 Yellow, 4 Slightly pink, 5 Slightly Purple
10. **Corm shape:** 1 Conical, 2 Round, 3 Cylindrical, 4 Elliptical, 5 Dumb-bell, 6 Elongated, 7 Flat and multifaced, 8 Clustered, 9 Hammer-shaped (not illustrated), 99 Other
11. **Maturity period:**
12. **Spathe shape:** 1 Hooded, 2 Keeled, 3 Flat, 4 Fully open and drooping, 5 Rolled backward, 6 Twisted, 7 Rolled and twisted, 8 Unopened and twisted (not illustrated)
13. **Spathe colour:** 1 Light yellow, 2 Yellow-orange, 3 Yellow with green or green-purple blotches, 4 Yellow with red or purple-red blotches, 5 Orange-red, 6 Red, 7 Purple or purple-blue, 99 Other
14. **Stolon color:** Stolon color of different germplasm was done by naked eye.

B. Quantitative characters

1. **Plant height (cm):** The height of the tallest petiole with the upper surface of leaf blade of the main plant over the ground level was considered as the plant height.

2. **Petiole length (cm):** The length of petiole was measured by a measuring scale from base of leaf to end of petiole and was expressed in centimeter (cm).
3. **Leaf number:** Number of leaf per plant was counted manually.
4. **Leaf length (cm):** The length of leaves was measured by a measuring scale from base to tip.
5. **Leaf breadth (cm):** The breadth of leaves was measured by a measuring scale from widest point.
6. **Inflorescence length (cm):** It was measured as the total length of 10 randomly selected inflorescence from peduncle base to the tip of the inflorescence.
7. **Inflorescence number:** It was counted from 10 randomly selected inflorescence.
8. **Peduncle length (cm):** The stem holding the whole inflorescence is called peduncle and measured as the length between peduncle base and starting portion of spathe.
9. **Peduncle breadth (cm)**
10. **Spathe length (cm):** Spathe length of was measured vertically from base to the tip.
11. **Spathe breadth (cm):** Spathe breadth is measured horizontally, which covered the total spadix.
12. **Sucker number/pseudostem:** Total number of suckers/pseudostem grown per plant.
13. **Stolon number**
14. **Corm length (cm):** The length of corm was measured by scale vertically.
15. **Corm breadth (cm):** Breadth of the corm was measured horizontally through its middle position.
16. **Corm weight (g):** After harvesting the corm was weighed by digital balance.
17. **Rhizome length (cm):**
18. **Rhizome breadth (cm):**
19. **Rhizome weight (g)**
20. **Cormel number:** The number of cormels present or attached adjacent to the corm after harvesting.
21. **Cormel length (cm):** The length of cormel was measured by scale vertically.
22. **Cormel weight (g or kg):** After harvesting the cormel was weighed.
23. **Yield per plant (g or kg):**
24. **Number of Eye:**

10.9.5. Morphological characterization of yams

Morphological characterization of 31 Yam germplasm collected from various parts of Bangladesh were done at BAU-GPC following IPGRI/CIP descriptors during March 2017 to January 2020 (Fig. 97). Characterization of descriptors for the study included: (i) Plant descriptors and (ii) Evaluation. The location of the experimental site is 24.000 N latitude and 90.260 E longitudes at an altitude of 8.40 m above the sea level. Thirty one germplasm of *Dioscorea* species were used in this study. During land preparation, clods were broken, and weeds and stubbles were collected and removed from the field. Final land was prepared 15 days before pit preparation. 45 cm x 45 cm x 45 cm size pits were prepared, and 3 m x 3 m distance was maintained between pits. Tuberos root, bulbil or stem cutting was used as planting material. The basal doses

of fertilizers including cowdung and ash were mixed well with the soil of the pits. The collected cultivars were laid out in Randomized Complete Block Design (RCBD) with three replicates in each and the spacing was used 3m each to another. Yams were planted separately with a woody and semi woody perennial plants (e.g. Neem, Mahogany etc.). Weeding was done whenever necessary. The plants were irrigated by plastic pipe whenever required. The recommended doses of manure and fertilizers were applied in the experimental field (FRG, 2012). The full doses of cowdung, TSP, gypsum, and half dose of MP were applied during pit preparation before one week of planting. The remaining MP and urea were applied in the three equal installments as top dressing. One hundred and nineteen observations on qualitative (99) and quantitative (20) characters were recorded as per Descriptor List for *Dioscorea* spp. (IPGRI / IITA, 1997). Range, mean, standard deviation and coefficient of variation of quantitative characters were calculated. The collected data on 20 quantitative characters were further statistically analyzed applying standard (MSTAT) tools.

Descriptors and descriptor states of characterization

A.1. Qualitative characteristics of Young stem

1. **Stem colour (Assessed at 20 days after emergence):** 1 Green, 2 Purplish green, 3 Brownish green, 4 Dark brown, 5 Purple, 99 Other
2. **Waxiness:** 0 Absent, 1 Present
3. **Wings:** 0 Absent, 1 Present
4. **Wing colour (Assessed at 20 days after emergence):** 1 Green, 2 Green with purple edges, 3 Purple, 99 Other
5. **Hairs:** 0 Absent, 1 Present
6. **Spines:** 0 Absent, 1 Present
7. **Spine base (Assessed at 30 days after emergence):** 0 Absent, 1 Present
8. **Barky patches (Assessed at 30 days after emergence):** 0 Absent, 1 Present

A.2. Qualitative characteristics of Matured stem

1. **Plant type:** 1 Dwarf, 2 Shrub-like, 3 Climbing
2. **Twining direction:** 1 Clockwise, 2 Anticlockwise
3. **Stem color:** 1 Green, 2 Purplish green, 3 Brownish green, 4 Dark brown, 5 Purple, 99 Other
4. **Absence/presence of waxiness:** 0 Absent, 1 Present
5. **Wing colour:** 1 Green, 2 Green with purple edge, 3 Purple, 99 Other
6. **Absence/presence of ridges:** 0 Absent, 1 Present
7. **Hairiness:** 3 Sparse, 7 Dense
8. **Spines on stem base:** 3 Few, 7 Many
9. **Spines on stem above base:** 3 Few, 7 Many
10. **Spine position:** 1 Wings, 2 Ridges, 3 Stem
11. **Spine shape:** 1 Straight, 2 Curved upwards, 3 Curved downwards
12. **Absence/presence of coalescent spines:** 0 Absent, 1 Present

13. **Colour of spot at spine base:** 1 Red, 2 Purple, 3 Maroon, 99 Green

A.3. Qualitative characteristics of Young leaves

1. **First leaf emergence:** 1 Early, 2 Late
2. **Leaf colour:** 1 Yellowish, 2 Pale green, 3 Purplish green, 4 Purple, 5 Dark green, 99 Other
3. **Vein colour:** 1 Yellowish, 2 Green, 3 Pale purple, 4 Purple, 99 Other
4. **Petiole colour:** 1 All green with purple base, 2 All green with purple leaf junction, 3 All green with purple at both ends, 4 All purplish green with purple base, 5 All purplish green with purple leaf junction, 6 All purplish green with purple at both ends, 7 Green, 8 Purple, 9 Brownish green, 10 Brown, 11 Dark brown, 99 Other
5. **Petiole wing colour:** 1 Green, 2 Green with purple edges, 3 Purple, 99 Other

A.4. Qualitative characteristics of Matured leaves

6. **Position of leaves:** 1 Alternate, 2 Opposite, 3 Alternate at base/opposite above, 99 Other
7. **Leaf density:** 3 Low, 5 Intermediate, 7 High
8. **Leaf type :** 1 Simple, 2 Compound
9. **Leaf margin:** 1 Entire, 2 Serrate
10. **Leaf lobation:** 1 Shallowly lobed, 2 Deeply lobed
11. **No. of leaflets in compound leaf:** 1 Mainly 3 (trifoliate), 2 Mainly 5 (quinate), 3 More than 5
12. **Leatheriness:** 0 No, 1 Yes
13. **Leaf colour:** 1 Yellowish, 2 Pale green, 3 Dark green, 4 Purplish green, 5 Purple, 99 Other
14. **Leaf vein colour (upper surface):** 1 Yellowish, 2 Green, 3 Pale purple, 4 Purple, 99 Other
15. **Leaf vein colour (lower surface):** 1 Yellowish, 2 Green, 3 Pale purple, 4 Purple, 99 Other
16. **Leaf margin colour:** 1 Green, 2 Purple, 99 Other (Yellowish)
17. **Hairiness of upper surface:** 0 Glabrous, 3 Sparse, 7 Dense
18. **Hairiness of lower surface:** 0 Glabrous, 3 Sparse, 7 Dense
19. **Waxiness of upper/lower surface:** 0 Absent, 1 Waxy upper surface, 2 Waxy lower surface, 3 Both
20. **Leaf shape:** 1 Ovate, 2 Cordate, 3 Cordate long, 4 Cordate broad, 5 Sagittate long, 6 Sagittate broad, 7 Hastate, 8 Reniform, 99 Other (Palmtisect)
21. **Leaf apex shape:** 1 Obtuse, 2 Acute, 3 Emarginate, 99 Other
22. **Undulation of leaf:** 3 Few, 7 Many
23. **Distance between lobes:** 1 No measurable distance, 5 Intermediate, 9 Very distant
24. **Upward folding of leaf along main vein:** 3 Weak, 7 Strong

25. **Downward arching of leaf along main vein:** 0 No, 1 Yes
26. **Upward folding of leaf lobes to form a cup:** 0 No, 1 Yes
27. **Position of the widest part of the leaf:** 1 Third upper, 2 Middle, 3 Third lower
28. **Tip colour :** 1 Light green, 2 Dark green, 3 Purple/green, 4 Red, 99 Other
29. **Petiole length in correlation to leaf blade:** 3 Short (<2 cm), 5 Medium (=2 cm), 7 Long (>2 cm)
30. **Hairiness of petiole:** 0 Glabrous, 3 Sparse, 7 Dense
31. **Petiole colour:** 1 All green with purple base, 2 All green with purple leaf junction, 3 All green with purple at both ends, 4 All purplish green with purple base, 5 All purplish green with purple leaf junction, 6 All purplish green with purple at both ends, 7 Green, 8 Purple, 9 Brownish green, 10 Brown, 11 Dark brown, 99 Other
32. **Petiole wing colour:** 1 Green, 2 Green with purple edges, 3 Purple, 99 Other

A.5. Qualitative characteristics of Aerial tubers

1. **Absence/presence of aerial tuber:** 0 Absent, 1 Present
2. **Aerial tuber shape:** 1 Round, 2 Oval, 3 Irregular (not uniform), 4 Elongate
3. **Skin colour:** 1 Greyish, 2 Light brown, 3 Dark brown, 99 Other
4. **Surface texture:** 1 Smooth, 2 Wrinkled, 3 Rough
5. **Absence/presence of bumps:** 0 Absent, 1 Present
6. **Skin thickness:** 3 Thin, 7 Thick
7. **Flesh colour:** 1 White, 2 Yellowish white or off-white, 3 Yellow 4 Orange, 5 Light purple, 6 Purple, 7 Purple with white, 8 White with purple, 9 Outer purple/inner yellowish, 99 Other

A.6.1. Underground tubers at harvest time

1. **Relationship of tubers:** 1 Completely separate and distant, 2 Completely separate but close together, 3 Fused at neck
2. **Absence/presence of corms:** 0 Absent, 1 Present
3. **Absence/presence of rhizome:** 0 Absent, 1 Present
4. **Spininess of roots:** 0 Absent, 3 Sparse, 7 Dense
5. **Absence/presence of anchor roots:** 0 Absent, 1 Present

A.6.2. Underground tubers a few days after harvest

1. **Tuber shape:** 1 Round, 2 Oval, 3 Oval-oblong, 4 Cylindrical, 5 Flattened, 6 Irregular, 7 Falcate, 8 Fusiform, 99 Clavate
2. **Tendency of tuber to branch:** 0 Absent, 3 Slightly branched, 5 Branched, 7 Highly branched
3. **Place where tuber branches:** 1 Upper third, 2 Middle, 3 Lower third
4. **Roots on the tuber surface:** 3 Few, 7 Many
5. **Place of roots on the tuber:** 1 Lower, 2 Middle, 3 Upper, 4 Entire tuber
6. **Prickly appearance of the tuber:** 0 No, 1 Yes
7. **Wrinkles on tuber surface:** 3 Few, 7 Many

8. **Absence/presence of blisters on tuber surface:** Non-prickly blisters on the tuber surface (i.e. blisters appear different from those with a prickly appearance) 0 Absent, 1 Present
9. **Absence/presence of cracks on the tuber surface:** 0 Absent, 1 Present
10. **Tuber skin colour (beneath the bark):** 1 Light maroon, 2 Dark maroon, 3 Greyish, 99 Other

A.6.3. Underground tubers at planting time

1. **Hardness of tuber (When cut with a knife):** 1 Hard, 2 Easy
2. **Skin colour at head of the tuber:** 1 White, 2 Yellowish white or off-white, 3 Yellow, 4 Orange, 5 Light purple, 6 Purple, 7 Purple with white, 8 White with purple, 9 Outer purple/inner yellowish, 99 Brown/dark brown
3. **Flesh colour at central transverse cross-section:** 1 White, 2 Yellowish white or offwhite, 3 Yellow, 4 Orange, 5 Light purple, 6 Purple, 7 Purple with white, 8 White with purple, 9 Outer purple/inner yellowish, 99 Other
4. **Flesh colour of lower part of tuber:** 1 White, 2 Yellowish white or off-white, 3 Yellow, 4 Orange, 5 Light purple, 6 Purple, 7 Purple with white, 8 White with purple, 9 Outer purple/inner yellowish, 10 Grey, 99 Brown/Dark brown
5. **Uniformity of flesh colour in cross-section (From cortex to centre):** 0 No, 1 Yes
6. **Texture of flesh:** 1 Smooth, 2 Grainy, 3 Very grainy
7. **Flesh oxidation colour:** 1 Grey, 2 Purple, 3 Orange, 99 White
8. **Amount of gum released by cut tuber:** 3 Low, 5 Intermediate, 7 High
9. **Ability of cut tuber to irritate human skin (When tuber is rubbed on the arm):** 0 No, 3 Low, 7 High

Quality characteristics of tubers (Aerial and underground)

1. **Ease of peeling:** 1 Difficult, 2 Easy, 3 Usually eaten unpeeled
2. **Preferred cooking method:** 1 Baked, 2 Boiled, 3 Roasted, 99 Other
3. **Poundability of boiled tuber:** 1 Poor, 2 Good
4. **Discolouration of cooking water:** 1 Very low, 5 Intermediate, 9 Very high
5. **Appearance of tuber after cooking:** 3 Poor, 5 Fair, 7 Good
6. **Color of tuber after cooking:** 1 White, not colored, 5 Intermediate, 9 Highly colored
7. **Attractiveness of cooked tuber (With respect to colour alone):** 3 Low 5 Intermediate, 7 High
8. **Erosion of tuber upon cooking:** 0 No 1 Yes
9. **Texture of cooked tuber:** 1 Smooth, 2 Grainy, 3 Fibrous
10. **Stickiness of cooked tuber:** 0 Not sticky, 1 Sticky 2 Very sticky
11. **Flavour of cooked tuber:** 0 Not acceptable 1 Acceptable 2 Very acceptable
12. **Absence/presence of moisture on cooked tuber:** 0 Absent 1 Present
13. **Bitterness of cooked tuber:** 0 Not bitter, 1 Bitter 2 Very bitter
14. **Sweetness of cooked tuber:** 0 Not sweet, 1 Sweet, 2 Very sweet
15. **Overall assessment of cooked tuber:** 3 Low 5 Intermediate 7 High

B. Quantitative Characters

1. **Days to emergence (day):** Number of days between planting and emergence
2. **Stem length (cm):** Assessed at 20 days after emergence. Mean of 10 plants
3. **Internode number:** Assessed at 20 days after emergence
4. **Stem height:** 1 <2 m, 2 2-10 m, 3 >10 m
5. **Stem diameter [cm]:** At 15 cm from the base of the plant
6. **Internode length [cm]:** Recorded at 1 m height. Average of five plants
7. **Wing size (Recorded at 1 m height):** 1 <1 mm, 2 1-2 mm, 3 >2 mm
8. **Spine length (Mean of 20 spines located approximately between the first 0.5 to 1.5 m stem length):** 3 Short, 5 Intermediate, 7 Long
9. **Number of internodes to first branching**
9. **Number of leaves Recorded at 30 days after emergence**
10. **Tip length:** 1 <2 mm, 2 2-5 mm, 3 >5 mm
11. **Petiole length:** 1 \leq 5 cm, 2 6-9 cm, 3 \geq 10 cm
12. **Leaf area (cm²):**
13. **Leaf measurement (cm):** Observed on 20 adult leaves.
14. **Aerial tuber diameter (cm):** 1 \leq 1 cm, 2 2-5 cm, 3 6-10 cm, 4 >10 cm
15. **Yield of aerial tuber per plant (kg)**
16. **Number of tubers per hill:** 1 One, 2 Few (2-5), 3 Several (>5)
17. **Tuber length:** 1 \leq 20 cm, 2 21 - 40 cm, 3 \geq 41 cm
18. **Tuber width [cm]:** Recorded at the widest part
19. **Tuber skin thickness:** 1 <1 mm, 2 \geq 1 mm
20. **Time for flesh oxidation after cutting:** 1 <1 min, 2 1-2 min, 3 >2 min



Fig. 97. Harvesting of underground tuber of yam

10.9.6. Molecular Characterization of Banana Cultivars using RAPD and SSR Markers

Plant material collection

For molecular characterization extraction of genomic DNA, 40 banana cultivars were used in this study. Young, vigorously growing fresh leaf sample were collected from each treatment randomly in the morning hour (8.00-9.00 a.m.) that were used as the source of genomic DNA. After collection, each Sample was kept in polythene bag with tag separately and immediately placed in an ice-box. Finally, the ice-box was brought to the laboratory.

Isolation of genomic DNA

Total genomic DNA was isolated from each cultivar, by using Wizard® Genomic DNA Purification Kit solution: pH 8.0 (Promega, Madison, WI, USA). However, the following reagents viz. nucleilysis solution, RNase A solution, protein precipitation solution, isopropanol, 70% ethonal and DNA rehydration solution were used.

Genomic DNA of banana was extracted by using aforesaid Kit following manufacturer's instructions. The procedure was considered as a typical DNA extraction techniques comparison reagents and Kits. The detail procedure of DNA extraction was described below.

1. Process leaf tissue by freezing with liquid nitrogen and grinding into a fine powder using a micro centrifuge tube pestle or a mortar and pestle. 40mg of this leaf powder was taken to a 15ml micro centrifuge tube.
2. 600µl of Nuclei Lysis Solution was added, and vortex 1-3 seconds to wet the tissue.
3. Then incubated at 65⁰C for 15 minutes.
4. 3µl Rnase Solution was added to the cell lysate, and the sample was mixed by inverting the tube 2-5 times. The mixture was incubated at 37⁰C for 15 minutes. Then the sample was allowed to cool to room temperature for 5 minutes before proceeding.
5. 200µl of Protein Precipitation Solution was added and vortex vigorously at high speed for 20 seconds.
6. Then centrifuged for 3 minutes at 13,000-16,000 rpm. The precipitated proteins would form a tight pellet.
7. The supernatant containing the DNA (leaving the protein pellet behind) was carefully removed and transferred to a clean 1.5ml micro centrifuge tube containing 600µl of room temperature isopropanol.

Note: Some supernatant may remain in the original tube containing the protein pellet. This residual liquid was left in the tube to avoid contaminating the DNA solution with the precipitated protein.
8. Solution was then gently mixed by inversion unit thread-like strands of DNA form a visible mass.
9. Then the solution was centrifuged at 13,000-16,000 rpm for 1 minute.
10. The supernatant was carefully decanted. 600 µl of room temperature 70% ethanol was added and the tube several was gently inverted several times to wash the DNA. After that centrifuged at 13,000-16,000 rpm for 1 minute at room temperature.

11. The ethanol using either a drawn Pasteur pipette or a sequencing pipette tip was carefully aspirated. The DNA pellet was very loose at this point and care was taken to avoid aspirating the pellet into the pipette.
12. The tube was then inverted onto clean absorbent paper and the pellet was air-dried for 15 minutes.
13. The DNA pellet was rehydrated by adding 25 μ l of DNA Rehydration Solution and kept it over-night at 4⁰C.
14. Finally, the all isolated genomic DNA samples were preserved at -20⁰C in deep freeze for further use.

Determination of DNA concentration

For quantification of DNA concentration, the spectrophotometer wave length was set at 260 m after the spectrophotometer UV lamp was warmed up. A square cuvette (the zero or blank cuvette) was filled with 2 ml double distilled water and placed in the cuvette chamber then the absorbance reading was adjusted to zero for standardization. The test samples were prepared by taking 2 μ l of each DNA sample in the cuvette containing 2 ml sterile distilled water then mixed comprehensively by pipetting placed in spectrophotometer and the absorbance reading was taken at 260 nm (Table 134). Then the cuvette was rinsed out with sterile water, stamped out on a paper wipe, and absorbance reading for each sample was recorded in the same way. Using the above absorbance readings, the original concentrations were determined according to the following formula.

$$\text{DNA concentration (ng/}\mu\text{l)} = \text{Absorbance} \times \text{Error} \times \text{CF (0.05)} \times 1000.$$

Table 134. Absorbance reading at 260 nm (ng/ μ l) of DNA samples and preparation of working sample

Sample ID	Absorbance at 260 nm	DNA concentration (ng/ μ l)	Working solution (100ng/ μ l)	
			Stock DNA (μ l)	Distilled water (μ l)
1	0.007	350	14	36
2	0.013	650	8	42
3	0.009	450	11	39
4	0.005	250	20	30
5	0.002	100	50	00
6	0.004	200	25	25
7	0.003	150	33	17
8	0.012	600	8	42
9	0.017	850	6	44
10	0.017	850	6	44
11	0.017	850	6	44
12	0.006	300	17	33
13	0.006	300	17	33
14	0.004	200	25	25
15	0.001	50	50	00
16	0.005	250	20	30
17	0.022	1100	5	45
18	0.005	250	20	30

Sample ID	Absorbance at 260 nm	DNA concentration (ng/μl)	Working solution (100ng/μl)	
			Stock DNA (μl)	Distilled water (μl)
19	0.004	200	25	25
20	0.006	300	17	33
21	0.004	200	25	25
22	0.004	200	25	25
23	0.019	950	5	45
24	0.005	250	20	30
25	0.008	400	12	37
26	0.005	250	20	30
27	0.004	200	25	25
28	0.008	400	12	37
29	0.003	150	33	17
30	0.006	300	17	33
31	0.002	100	50	00
32	0.008	400	12	37
33	0.002	100	50	00
34	0.007	350	14	36
35	0.008	400	12	37
36	0.001	50	50	00
37	0.005	250	20	30
38	0.007	350	14	36
39	0.005	250	20	30
40	0.004	200	25	25

Preparation of working solution of DNA samples

Before PCR, it is necessary to make uniform concentration of DNA for each banana cultivar. Dilution was done simply by adding de-ionized water with the concentrated DNA samples. A concentration of about 100 ng/μl was maintained for working DNA samples. Working solution (100 ng/μl) from different DNA samples was prepared using the following formula:

$$S_1V_1 = S_2V_2$$

Where,

S_1 = Initial strength (ng/μl)

V_1 = Initial volume of DNA solution (μl)

S_2 = Final strength (ng/μl)

V_2 = Final volume of DNA solution (μl)

Polymerase Chain Reaction (PCR)

- a. For Polymerase Chain Reaction (PCR) reaction PCR- mixture was prepared by following the following composition (for SSR markers)-

Total Vol.^m/Sample: 20 μl

For preparation of 20 µl per sample (PCR- mixture)	Amount (µl)
Master Mix	10.00
Forward Primer	0.80
Reverse Primer	0.80
Nuclease free H ₂ O	7.4
DNA template	1.00

Composition of PCR reaction mixture

For preparation of 20µl for 42 sample (PCR- mixture)	Amount (µl)
Master Mix	10×42 = 420
Forward Primer	0.80×42 = 33.60
Reverse Primer	0.80×42 = 33.60
Nuclease free H ₂ O	310.80
DNA template	1×42 = 42

- b. For Polymerase Chain Reaction (PCR) reaction PCR- mixture was prepared by following the following composition (for RAPD markers)-

For preparation of 20µl per sample (PCR- mixture)	Amount (µl)
Master Mix	10.00
Primer	1.50
Nuclease free H ₂ O	7.50
DNA template	1.00

Reagents preparation

i) 0.5 MEDTA pH 8.0 (100 ml)

18.612 g EDTA was added to ddH₂O
pH was adjusted to 8.0 with NaOH
Sterilized ddH₂O was added to make the volume 100 ml
The solution was autoclaved

ii) 70% Ethanol (500 ml)

150 ml ddH₂O was added in 350 ml absolute ethanol

iii) 5X TBE Buffer, PH 8.3 (For 1000 ml)

54 g Tris base was taken in 800 ml ddH₂O
Then the mixture was stirred for 30 minutes.
After stirring, 27.5 g boric acid was added.
Then again stirring was done for several hours.
After that, 20 ml 0.5 M EDTA (pH 8.0) was added.
Finally, water (ddH₂O) was added to make the volume up to 1000 ml.

iv) 1X TBE (1000 ml)

200 ml 5X TBE was added in 900 ml DDH₂O

Confirmation of DNA: DNA isolated through above protocol often contains a large amount of RNA and pigments which can usually cause spuriously high estimation of DNA concentration on a spectrophotometer. For this ground, 1% agarose gel was used for assessing both the quantity and the quality of isolated DNA either it was high molecular weight or was there substantial shearing or degradation of DNA and the amount of RNA present. The procedure of DNA confirmation is presented below.

Preparation of agarose gel: To prepare 1% gel, 1 g agarose powder was taken into a 250 ml Erlenmeyer flask containing 100 ml of 1× TBE buffer. The top of the flask was covered with aluminum foil paper to prevent excessive evaporation. Then the flask was heated in a microwave oven for 3 minutes with occasional swirling for generating uniform suspension until no agarose particle was seen. After the agarose solution cooled enough then 2µl ethidium bromide (1.0% DNA stain) was added to make the DNA visible under ultraviolet light and was shaken gently to mix well. The solution was then poured on to the gel bed that was placed on a level bench. The combs were placed gently and the air bubbles were removed. The gel became completely cooled and solidified within 30 minutes and then combs were removed carefully.

Preparation of DNA samples for electrophoresis: For each sample, 6 µl of 1×TBE buffer was placed on a piece of aluminum foil paper and 2 µl loading dye was added to it by 0.5-10 µl adjustable micropipette. Loading buffer was used to monitor the progress of the electrophoresis. Finally, 2 µl extracted DNA was added to it and mixed well using same micropipette. The samples were then loaded into each comb cell slowly and carefully to allow them to sink to the bottom of the wells.

Electrophoresis: For the confirmation of DNA, the loaded gel was placed in the gel chamber, containing 1 × TBE buffer. The final level of buffer was 5mm above the gel. Electrophoresis was started by connecting the power supply unit and was carried out for 1 hour at 100 volt. After the bromophenol blue dye had reached three fourths of the gel length, then the electrophoresis was stopped and the power supply was disconnected.

Documentation of the DNA: The gel was taken from the gel chamber and placed on ultraviolet light box to examine and photograph of band was taken by gel documentation system.

Principle of the PCR: A principle of PCR based markers to characterize the cultivars is briefly described below. The purpose of a PCR is to make a huge number of copies of a gene. This is necessary to have enough starting template for sequencing (Vieistraete, 1999). The major steps of PCR are denaturation, annealing, extension and final step which are repeated for 30 to 40 cycles. This is done on an automated cycler, which can heat and cool the tubes with the reaction mixture in a very short time.

Thermal profiles for RAPD markers

Step	Temperature °C	Time	No. of cycle
Initial denaturation	94	5 minutes	1
Denaturation	94	1 minutes	35 cycles
Annealing	36	1 minutes	
Primer extension	72	1 minutes	
Final extension	72	7 minutes	

Thermal profiles for SSR markers

Step	Temperature °C	Time	No. of cycle
Initial denaturation	94	5 minutes	1
Denaturation	94	45 seconds	35 cycles
Annealing	54	1 minutes	
Primer extension	72	1 minutes	
Final extension	72	5 minutes	

Electrophoresis of the amplified products

The PCR products were analyzed by gel electrophoresis using a 1.5% agarose in IX TBE buffer (Tris base, boric acid and 0.5 M EDT A [pH 8.0]) containing ethidium bromide (0.5µg/ml). Detail procedure was described as follows-

- The gel casting tray was assembled with gel comb of appropriate teeth size and number.
- 1.5% agarose solution was prepared in 80 ml IX TBE buffer by melting the agarose powder with a microwave oven for proper melting.
- Two micro-liter ethidium bromide was added in melted agarose to have a final concentration of 0.5µg/ml.
- Melted agarose solution was poured onto the gel casting tray carefully to avoid bumping and allowed to solidify on the bench.
- The comb was removed from the gel after 30 minutes when gel was hardened enough.
- A total of 20 µl PCR product was loaded to appropriate well of the gel carefully.
- A total of 7 µl (5 µl ladder and 2 µl 6X bromophenol blue loading dye) of 1 kb DNA ladder was loaded at the end side of the gel.
- The gel casting tray was then placed to the electrophoresis tank containing sufficient IX TBE buffer to submerge the gel.
- The lid of the electrophoresis apparatus was connected to power supply and electrophoresis was done at 80 V for 45 minutes.
- When DNA migration was sufficient, as just from the migration of bromophenol blue of loading buffer, the power supply of the apparatus switched off.
- The gel was gently removed from the tank and was taken to documentation.

Gel documentation: After electrophoresis, the gel was placed under UV transilluminator using the Alphaimager HP System (Protein Simple, San Jose, CA, USA) for visualization of DNA bands. The UV light of the apparatus switched on, the image of the desired bands on the gel was viewed on the monitor and saved on the computer disc (CD-R) for taking photograph.

Data analysis of RAPD and construction of dendrogram: The RAPD bands were scored visually on the basis of their presence (1) or absence (0), separately for each cultivars of banana and each primer. Two independent persons performed band scoring for more accuracy. Bands not identified by the two readers were considered as non-scorable. The scores obtained using all primers in the RAPD analysis were then pooled for constructing a single data matrix. This was used for estimating polymorphic loci, Nei's (1973) gene diversity, population differentiation (GST), gene flow (Nm,) genetic distance (D) and constructing a UPGMA (Unweighted Pair Group Method of Arithmetic Means) dendrogram (Fig. 140) among populations based on Nei's (1972) genetic distance, summarizing data on differentiation in 30 banana accessions according to RAPD analysis using POPGENE (version 1.31) (Yeh *et al.*, 1999) and G-stat, version 3.1 (Siegismund, 1995) computer programme. The same programme was also used to perform test of homogeneity in different locus between population pairs.

Gene frequencies of RAPD loci were estimated based on the assumption of a two alleles system. From the two alleles, only one is capable of amplification of a RAPD band by primer

annealing at an unknown genomic position (locus). The other is the "null" allele which is incapable of amplification, mainly because of loss of the primer-annealing site by mutation. The two alleles assumption is in most cases acceptable, because co-dominant loci showing band shifts are few (Elo *et al.*, 1997; Welsh and McClelland, 1990). These cases only a null homozygote is detectable as negative for the RAPD band of interest. Under the assumption of Hardy-Weinberg equilibrium, the null allele frequency (q) may be $(N/n)^{1/2}$, where N and n are the number of band negative individuals observed and the sample size, respectively. The frequency of the other allele (P) is 1-q. The assumption of the two alleles system enables us to calculate the Nei's genetic distance (Nei, 1972) from the RAPD pattern.

Data analysis of SSR and construction of dendrogram: Since these markers are dominant, we assumed that each band represented the phenotype at a single allelic locus (Williams *et al.*, 1990). 1 kb DNA ladder was used to estimate the size of the amplification products by comparing the distance travelled by each fragment with that of the known sized fragments of molecular weight marker. All distinct bands or fragments were thereby given identical numbers according to the position on gel and scored visually on the basis of their presence (1) or absence (0), separately for each isolate and primer. For more accuracy, two independent persons performed band scoring. Bands not identified by the readers were considered as non-scorable. The scores obtained using all primers in the analysis were then pooled to create a single data matrix. This was used to estimate polymorphic loci, Nei's gene diversity (Nei, 1973), population differentiation (G_{st}), gene flow (Nm), gene distance (D) and a construct a UPGMA (Unweighted Pair Group Method of Arithmetic Means) dendrogram among populations using a computer program, NT SYS PC 2.02i (Yeh *et al.*, 1999). The same program was also used to perform test of homogeneity in different loci between population pairs.

Gene frequency: Gene frequency estimation for polymorphic loci was based on the assumption of a two-allele system. Only one of the two alleles is capable to amplify by primer annealing, at an unknown genomic position (locus). The other is the "null" allele incapable of amplification, mainly because of loss of primer annealing site by mutation.

The two-allele assumption is in most cases acceptable because, co-dominant loci showing band shift are few (Elo *et al.*, 1997; Welsh and McClelland, 1990). In this system only a null homozygote is detectable as negative for the polymorphic band of interest.

Under the assumption of Hardy-Weinberg equilibrium, the null allele frequency (q) may be $(N/n)^{1/2}$, when N and n are the number of band negative individuals observed and the sample size, respectably. The frequency of the other allele (P) is 1-q. the assumption of the two-allele system enable us to calculate the Nei's, genetic distance (Nei, 1972) from the polymorphic banding pattern.

Gene flow

Gene flow, (Nm) was estimated according to the following formula:

$$\text{Gene flow, Nm} = \frac{0.5 (1 - G_{st})}{G_{st}}$$

Where, G_{st} is the proportion of total genetic diversity attributable to subpopulation. It is also known as coefficient of gene differentiation.

The G_{st} values were calculated by using the following formula:

$$G_{st} = \frac{1-H_s}{H_t}$$

Where, H_s is the Hardy-Weinberg average heterozygosity expected in isolates and H_t is the Hardy-Weinberg average heterozygosity obtained in isolates.

Nei's genetic distance and identity values: Nei's genetic distance and identity values were computed from frequencies of polymorphic markers to estimate genetic relationship between the studied Isolates using the Unweighted Pair Group Method of Arithmetic means (UPGMA) (Sneath and Sokal, 1973). The dendrogram (Fig. 148) was constructed using the NT SYS PC 2.02i (Yeh *et al.*, 1999) computer program.

10.9.7. Molecular characterization of aroids

Molecular characterization was conducted using RAPD markers

- Collection of leaf sample for genomic DNA extraction
- Genomic DNA extraction using cetyltrimethyl ammonium bromide (CTAB) method
- Confirmation and quantification of DNA
- Preparation of working solution of DNA samples
- Polymerase chain reaction (PCR)
- Electrophoresis: Agarose gel electrophoresis
- Visualization of DNA samples
- Scoring of bands
- Data analysis

Sample collection

Extraction of genomic DNA: For isolation of genomic DNA, actively growing unfurled young fresh leaves were collected from each 22 germplasms. Total genomic DNA was isolated from leaves following CTAB (Cetyl Trimethyl Ammonium Bromide) method.

Procedure for plant genomic DNA isolation: At first leaf materials were washed very well with sterile distilled water to remove wastes and any source of foreign DNA. The leaf tissue was cut into small pieces and taken into centrifuge tubes (1.5 ml). After adding 400 µl extraction buffers, the samples were grounded with tissue homogenizer stick followed by further addition of 400 µl extraction buffer making the total volume 800 µl. Then the grounded samples were vortex (IUCHI Automatic Labo mixture, Japan) for 20 seconds and incubated at 60°C for 5 minutes in a hot water bath. After adding 150 µl 20% SDS was in the samples and vortex well. The extract was then centrifuges for 15 minutes at 14,000 rpm to precipitate the cell debris and the upper aqueous phase of about 600 µl was recovered to another micro-centrifuge tube.

For purification, equal volume (600 µl) of Phenol: Chloroform: Isoamyle alcohol (25:24:1, v/v/v) was added to the tube and vortex for seconds. Then the solution was centrifuged for 15 minutes at 14,000 rpm. After that 400 µl upper aqueous phase was recovered carefully without upsetting the lower portion and placed in a new micro-centrifuge tube and added Iso-propanol (2/3 vol. of supernatant) + 20 µl Sodium Acetate to it. It was then centrifuged for 10 minutes at 12000 rpm. The supernatant was then discarded.

DNA was precipitated first and visualized as white strands with 800 µl of absolute (100%) ethanol and pelleted by centrifugation for 10 minutes at 14000 rpm. After discarding the

liquid completely, re-precipitation of DNA solution was done with 400 μ l of 70% ethanol and centrifuged for 10 minutes at 14000 rpm. After removing the liquid completely the pellets were then air dried and dissolved in an appropriate volume of (20 μ l- 50 μ l) TE buffer. Finally, the DNA samples were stored at -20°C.

Precautions: All glassware, micropipette tips, centrifuge tube, glass pipettes, distilled water and buffer solutions were properly autoclaved to keep away from DNAs contamination. Scissors, forceps and tissue homogenizer sticks etc. were sterilized with absolute ethanol.

Confirmation of DNA preparation: Sometimes isolated genomic DNA contains a large amount of RNA and pigments which usually cause over estimation of DNA concentration on a spectrophotometer. Thus the DNA samples were evaluated both quantitatively and qualitatively (was it higher molecular weight or was there substantial shearing or degradation) using 1% agarose gel.

Preparation of 1% agarose gel: At first, 0.4g agarose powder (Nacalaitesque, Inc, Kyoto, Japan) was taken in a 250 ml Erlenmeyer flask containing 40 ml electrophoretic buffer (1 X TBE buffer) and 20 ml distilled water. The liquid was cooked for about 3 minutes into a microwave oven with occasional swirling until disappearance of agarose particles to generate homogeneous clear suspension. Then the agarose solution was cooled to about 50°C and 2 μ l (10 mg/ml) ethidium bromide (DNA stain) was added and mixed well by gentle shaking to make the DNA visible under ultraviolet light. The molten gel was poured immediately on to a gel bed (15 X 15 X 2 cm³ in size), that was placed on a level bench and appropriate comb was inserted parallel to the plate's edge, with the bottom of the teeth about 2 mm above the plate. After one hour, gel became completely cooled at room temperature and solidified and the comb was removed gently.

Preparation of DNA sample for electrophoresis: The samples were all in the same concentration of buffer. For each sample, 6 μ l 1X TBE buffer was placed on a piece of aluminum foil paper and 2 μ l loading dye (0.25% xylene cyanol, 0.25% bromo phenol blue, 30% glycerol and 1 m MEDTA) was added to it using adjustable micropipette (0.5-10 μ l). Then 2 μ l DNA sample was added to it and mixed well. The prepared samples were then loaded slowly to the bottom wells.

The gel was transferred carefully to the electrophoresis chamber (Blue Marine Serva) keeping the gel horizontal and in a submerged condition in 1X TBE buffer and final level of the buffer was about 5 mm above the gel. Electrophoresis was carried out at 120 V for 45 min and the electrophoresis power supply was provided by EPS- 301 (Amersham Pharmacia Biotech). When the bromophenol blue dye had reached three – fourths of the gel length, then the electrophoresis was stopped.

Documentation of the DNA sample: After electrophoresis, the gel was taken out from the electrophoresis chamber and placed on ultraviolet light (UV trans illuminator) to examine and photograph of DNA band was taken by gel documentation system.

Quantification of DNA concentration: Different DNA extraction methods provide DNA of widely different purity. Thus, it is necessary to optimize the amount of DNA used in the RAPD analysis to achieve reproducibility and also strong signal. Below a certain critical concentration of genomic DNA, RAPD amplification is no longer reproducible (Williams *et al.*, 1990). Thus it is essential to optimize the purity of DNA concentration.

For quantification of DNA concentration, the spectrophotometer's (0) wave length was set at 260 nm after the spectrophotometer UV lamp was warmed up. A square cuvette ("blank" cuvette) was filled with 2ml sterile distilled water and placed on cuvette chamber and the

absorbance reading was adjusted to zero. The samples were prepared by taking 2 µl of DNA samples in the cuvette containing 2 ml sterile distilled water and mixed well. After recording the absorbance reading, the cuvette was cleaned carefully with sterile water and wiped with fresh tissue paper. The absorbance reading of extracted DNA sample of different population are listed in Table 135.

Table 135. Absorbance reading and concentration of DNA samples

Sl. No.	Accession ID	Nucleic Acid Conc. ηg/µl	A 260	A 280	260/280	260/230
	Blank	1.5	0.03	0.016	1.92	0.29
1	CE-1	246.8	4.936	2.845	1.73	2.16
2	CE-2	322.4	6.448	3.851	1.67	0.71
3	CE-3	396.6	7.932	5.055	1.57	0.67
4	CE-4	135.2	2.705	1.849	1.46	0.86
5	CE-15	255.5	5.111	2.918	1.75	1.87
6	CE-16	156.2	3.123	2.354	1.33	0.54
7	CE-17	227.4	4.548	3.104	1.47	0.5
8	CE-18	292.8	5.856	3.722	1.57	0.8
9	CE-19	184	3.681	2.284	1.61	0.92
10	AC-1	143.3	2.865	1.914	1.5	0.71
11	AC-2	85.2	1.705	1.019	1.67	1.57
12	AC-4	185.6	3.713	2.777	1.34	0.63
13	AC-5	694.5	13.89	7.604	1.83	2.1
14	AI-1	384.2	7.685	4.271	1.8	1.86
15	AI-3	191.3	3.826	2.264	1.69	1.35
16	AI-4	162.6	3.253	1.934	1.68	1.46
17	AI-5	201.7	4.034	3.201	1.26	0.47
18	XA-1	1231.8	24.635	16.493	1.49	1.4
19	XA-2	534.7	10.693	5.875	1.82	1.52
20	XA-6	791.6	15.831	11.74	1.35	0.97
21	XA-7	957.9	19.157	11.198	1.71	1.39
22	XA-8	377.5	7.551	4.273	1.77	1.19
23	XA-9	504	4.401	3.105	1.22	0.45

Using the above absorbance reading, the original sample concentrations were determined according the following formula:

$$\text{DNA concentration } (\eta\text{g}/\mu\text{l}) = \text{Absorbance} \times \text{Conversion factor } (0.05) \times 1000$$

Preparation of working solution (25 ηg/ µl) of DNA samples

Original stock solution concentration of each DNA sample was adjusted to a unique concentration (25 ηg/µl) using the formula:

$$S_1 V_1 = S_2 V_2$$

Where,

- S₁ = Initial DNA concentration (ηg/µl)
- V₁ = Initial volume of DNA solution (µl)
- S₂ = Final DNA concentration (ηg/µl)
- V₂ = Final volume of DNA solution (µl)

Precautions

1. All glassware, micropipette tips, eppendorf tube, glass pipettes, de-ionized water and buffer solutions were properly autoclaved to keep away from DNAase contamination. Scissors, forceps were sterilized with absolute ethanol.

2. As Ethidium Bromide (EtBr) is powerful mutagen and carcinogenic. So, hand gloves were used when handling anything that has been exposed to EtBr.
3. Always power pack was kept turn off and leads was unplugged before opening the electrophoresis unit to avoid electric hazard.
4. A trans-illuminator produces UV radiation 254 nm ranges. The wave length can cause eye damage (short term = burns, long term cataracts and cancers). Thus eye protector used while working with it.

Amplification of RAPD marker by polymerase chain reaction (PCR)

Principle of the amplification of RAPD marker: The RAPD technique is based on the polymerase chain reaction (PCR), A target DNA sequence is exponentially amplified with help of arbitrary primers, a thermo stable DNA polymerase, deoxy nucleotide tri-phosphates, magnesium chloride and reaction buffer. The reaction involves repeated cycles, each consisting of a denaturation, a primer annealing and an elongation step. In the first step the DNA is made single stranded by raising the temperature to 94°C (denaturation) five minutes. In the Second step, lowering of the temperature to about an optimal annealing temperature 50°C, the primer binds to their target sequences on the template DNA (annealing step). In the third cycle, temperature is chosen as where the activity of the thermo stable *Taq* DNA polymerase is optimal, i.e., usually 72°C. The polymerase then extends the 3' end of the DNA primer hybrids towards the other primer binding site. Since this happens at both primer-annealing sites on both the DNA strands, the target fragment is completely replicated. Repeating these three step cycles 40 to 50 times results in the exponential amplification of the target between the 5' ends of the two primer binding sites. Amplification products are separated by agarose gel electrophoresis and visualized by ethidium bromide staining.

Precautions: The usual precautions were maintained when performing PCR reactions. All the disposable such as PCR tubes, tips, eppendorf tubes and reagents used during preparation of PCR reactions were autoclaved. Freezing condition was maintained when necessary especially for *Taq* polymerase. Hand-gloves were worn during handling of PCR components. Contamination of PCR components was avoided.

Primer Selection

Primer Code and sequences used for the detection of polymorphism of aroids

SI No.	Primer Codes	Sequence (5' to 3')	(G+C)%
1	OPG-10	5'AGGGCCGTCT-3'	70%
2	OPW-04	5'CAGAAGCGGA-3'	60%
3	OPW-09	5'GGCGGATAAG-3'	60%
4	OPW-10	5'TCGCATCCCT-3'	60%
5	OPW-16	5'CAGCCTACCA-3'	60%

RAPD Data analysis

RAPD markers were scored visually on the basis of their presence (1) or absence (0), separately for each germplasm and each primer. For more accuracy, two independent persons performed band scoring. Bands not identified by the two readers were considered as non-scorable. The scores obtained using all primers in the RAPD analysis were then pooled for constructing a single data matrix. This was used for estimating polymorphic loci, Nei's (1973) gene diversity, Nei's (1972) genetic distance (D) and constructing a UPGMA, (Unweighted Pair Group Method of Arithmetic Means) dendrogram using POPGENE;

(version 1.31) (Yeh *et al.*, 1999) computer program. Estimation of gene frequencies of RAPD loci was based on the assumption of a two-allele system. Of the two alleles, only one is capable of amplification of a RAPD band by primer annealing at an unknown genomic position (locus). The other is the 'null' allele incapable of amplification, mainly because of loss of the primer annealing site by mutation. The two-allele assumption was in most cases acceptable, because co-dominant loci showing band shifts are few (Elo *et al.*, 1997; Welsh and McClelland 1990). In this system only a null homozygote is detectable as negative for the RAPD band of interest. Under the assumption of Hardy-Weinberg equilibrium the null allele frequency (q) may be $(N/n)^{1/2}$ where N and n are the number of band negative individuals observed and the sample size, respectively. The frequency of the other allele (P) is $1-q$. The assumption of the two allele system enables us to calculate the Nei's genetic distance (Nei's, 1972) from the RAPD pattern.

10. 9.8. Molecular Characterization of Yam Germplasm

Plant material collection

For molecular characterization extraction of genomic DNA, 6 *Dioscorea spp.* were used in this study. Young, vigorously growing fresh young leaf sample were collected from each treatment randomly in the morning hour (8.00-9.00 a.m.) that were used as the source of genomic DNA. After collection, each sample was kept in polythene bag with tag separately and immediately placed in an ice-box. Finally, the icebox was brought to the laboratory.

Isolation of genomic DNA

Total genomic DNA was isolated from each species, by using the protocol is derived from Asemota (1995).

Disruption and Extraction Method

1. Disrupt the yam leaf tissue in liquid nitrogen
 - i) Weigh 150 mg of leaf tissue, place it in a chilled mortar, and cover with liquid nitrogen.
 - ii) When the liquid nitrogen is almost evaporated, begin grinding with the chilled pestle.
 - iii) Repeat grinding with additional liquid nitrogen until the tissue becomes a fine powder.
 - iv) Carefully transfer 80-130 mg of tissue into a microcentrifuge tube (weigh by difference).
 - v) Add 800 μ l of isolation buffer, mix well and vortex.
2. Add 100 μ l of 10% SDS and then 14 μ l of BME to the tissue samples.
3. Mix contents of the tubes vigorously and incubate for 15 min at 65°C.
4. Add 350 μ l of 5 M potassium acetate. Shake vigorously.
5. Cool on ice for 5 min.
6. Centrifuge at 12,000 rpm for 15 min at 20°C.

Precipitation

7. Transfer the supernatant to a clean microcentrifuge tube, and add 535 μ l of cold isopropanol. Mix gently to precipitate the DNA.
8. Incubate for 5-10 min on ice.
9. Centrifuge at 12,000 rpm for 10-20 min at 20°C.
10. Carefully decant the supernatant.

11. Rinse the DNA pellet with 500 μ l of cold 70% ethanol.
12. Drain the ethanol completely and dry the pellet for several hours (overnight is fine) in a fume hood or in an evaporator until all traces of ethanol are completely removed.

Resuspension

13. Add 120 μ l of dissolution buffer to the DNA pellet. Tap gently to dislodge the pellet, and incubate for 10 min at 55°C.
14. Mix the solution gently and cool on ice for 2 min.
15. Centrifuge at 12,000 rpm for 5 min at 20°C to remove any undissolved material.

Precipitation with Sodium Acetate

16. Transfer the supernatant to a clean microcentrifuge tube. Add 12 μ l of 3 M sodium acetate solution (pH 5.2) and 88 μ l of isopropanol.
17. Centrifuge at 12,000 rpm for 5 min at 20°C. The DNA pellet that forms is almost colorless.
18. Decant the supernatant and wash the pellet with 500 μ l of cold 70% ethanol.
19. Dry the DNA for several hours (or overnight) in a fume hood or evaporator until all traces of ethanol are completely removed.
20. Resuspend the DNA in 60 μ l of TE-RNase. Store at -80°C

Determination of DNA concentration

For quantification of DNA concentration, the spectrophotometer wave length was set at 260 m after the spectrophotometer UV lamp was warmed up. A square cuvette (the zero or blank cuvette) was filled with 2 ml double distilled water and placed in the cuvette chamber then the absorbance reading was adjusted to zero for standardization. The test samples were prepared by taking 2 μ l of each DNA sample in the cuvette containing 2 ml sterile distilled water then mixed comprehensively by pipetting placed in spectrophotometer and the absorbance reading was taken at 260 nm. Then the cuvette was rinsed out with sterile water, stamped out on a paper wipe, and absorbance reading for each sample was recorded in the same way. Using the above absorbance readings, the original concentrations were determined according to the following formula.

DNA concentration (ng/ μ l) = Absorbance = Error \times CF (0.05) \times 1000.

$$\frac{\text{Volume of distilled water } (\mu\text{l})}{\text{Amount of DNA sample } (\mu\text{l})}$$

Preparation of working solution of DNA samples

Before PCR, it is necessary to make uniform concentration of DNA for each yam cultivar. Dilution was done simply by adding de-ionized water with the concentrated DNA samples. A concentration of about 100 ng/ μ l was maintained for working DNA samples. Working solution (100 ng/ μ l) from different DNA samples was prepared using the following formula:

$S_1V_1 = S_2V_2$ (Where, S_1 = Initial strength (ng/ μ l), V_1 = Initial volume of DNA solution (μ l), S_2 = Final strength (ng/ μ l) and V_2 = Final volume of DNA solution (μ l))

Polymerase Chain Reaction (PCR)

For Polymerase Chain Reaction (PCR) reaction PCR- mixture was prepared by following the following composition (for RAPD markers)-

For preparation of 20 μ l per sample (PCR- mixture)

Total Volm. /Sample: 20 μ l

For preparation of 20 μ l per sample (PCR- mixture)	Amount (μ l)
Master Mix	10.00
Primer	1.00
Nuclease free H ₂ O	8.00
DNA template	1.00

Confirmation of DNA

DNA isolated through above protocol often contains a large amount of RNA and pigments which can usually cause spuriously high estimation of DNA concentration on a spectrophotometer. For this ground, 1% agarose gel was used for assessing both the quantity and the quality of isolated DNA either it was high molecular weight or was there substantial shearing or degradation of DNA and the amount of RNA present. The procedure of DNA confirmation is presented below.

Preparation of agarose gel

To prepare 1% gel, 1 g agarose powder was taken into a 250 ml Erlenmeyer flask containing 100 ml of 1 \times TBE buffer. The top of the flask was covered with aluminum foil paper to prevent excessive evaporation. Then the flask was heated in a microwave oven for 3 minutes with occasional swirling for generating uniform suspension until no agarose particle was seen. After the agarose solution cooled enough then 2 μ l ethidium bromide (1.0% DNA stain) was added to make the DNA visible under ultraviolet light and was shaken gently to mix well. The solution was then poured on to the gel bed that was placed on a level bench. The combs were placed gently and the air bubbles were removed. The gel became completely cooled and solidified within 30 minutes and then combs were removed carefully.

Preparation of DNA samples for electrophoresis

For each sample, 6 μ l of 1 \times TBE buffer was placed on a piece of aluminum foil paper and 2 μ l loading dye was added to it by 0.5-10 μ l adjustable micropipette. Loading buffer was used to monitor the progress of the electrophoresis. Finally, 2 μ l extracted DNA was added to it and mixed well using same micropipette. The samples were then loaded into each comb cell slowly and carefully to allow them to sink to the bottom of the wells.

Electrophoresis

For the confirmation of DNA, the loaded gel was placed in the gel chamber, containing 1 \times TBE buffer. The final level of buffer was 5mm above the gel. Electrophoresis was started by connecting the power supply unit and was carried out for 1 hour at 100 volt. After the bromophenol blue dye had reached three fourths of the gel length, then the electrophoresis was stopped and the power supply was disconnected.

Documentation of the DNA

The gel was taken from the gel chamber and placed on ultraviolet light box to examine and photograph of band was taken by gel documentation system.

Principal of the PCR

A principal of PCR based markers to characterize the cultivars is briefly described below. The purpose of a PCR is to make a huge number of copies of a gene. This is necessary to have enough starting template for sequencing (Vieistraete, 1999). The major steps of PCR are

denaturation, annealing, extension and final step which are repeated for 30 to 40 cycles. This is done on an automated cycler, which can heat and cool the tubes with the reaction mixture in a very short time.

Thermal profiles for RAPD markers

Step	Temperature °C	Time	No. of cycle
Initial denaturation	94	5 minutes	1
Denaturation	94	1 minutes	} 45 cycles
Annealing	36	1 minutes	
Primer extension	72	2 minutes	
Final extension	72	10 minutes	

Electrophoresis of the amplified products

The PCR products were analyzed by gel electrophoresis using a 1.5% agarose in 1 X TBE buffer (Tris base, boric acid and 0.5 M EDT A [pH 8.0]) containing ethidium bromide (0.5 µg/ml).

Gel documentation

After electrophoresis, the gel was placed under UV transilluminator using the Alpha imager HP System (Protein Simple, San Jose, CA, USA) for visualization of DNA bands. The UV light of the apparatus switched on, the image of the desired bands on the gel was viewed on the monitor and saved on the computer disc (CD-R) for taking photograph.

Data analysis of RAPD and construction of dendrogram

The RAPD bands were scored visually on the basis of their presence (1) or absence (0), separately for each cultivars of yam and each primer. Two independent persons performed band scoring for more accuracy. Bands not identified by the two readers were considered as non-scorable. The scores obtained using all primers in the RAPD analysis were then pooled for constructing a single data matrix. This was used for estimating polymorphic loci, Nei (1973) gene diversity, population differentiation (Gst), gene flow (Nm,) genetic distance (D) and constructing a UPGMA (Unweighted Pair Group Method of Arithmetic Means) dendrogram (Fig. 166) among populations based on Nei (1972) genetic distance, summarizing data on differentiation in 24 yam accessions according to RAPD analysis using POPGENE (version 1.31) (Yeh *et al.*, 1999) and G-stat, version 3.1 (Siegismund, 1995) computer program. The same program was also used to perform test of homogeneity in different locus between population pairs.

Gene frequencies of RAPD loci were estimated based on the assumption of a two alleles system. From the two alleles, only one is capable of amplification of a RAPD band by primer annealing at an unknown genomic position (locus). The other is the "null" allele which is incapable of amplification, mainly because of loss of the primer-annealing site by mutation. The two alleles assumption is in most cases acceptable, because co-dominant loci showing band shifts are few (Elo *et al.*, 1997; Welsh and McClelland, 1990). These cases only a null homozygote is detectable as negative for the RAPD band of interest. Under the assumption of Hardy-Weinberg equilibrium, the null allele frequency (q) may be $(N/n)^{1/2}$, where N and n are the number of band negative individuals observed and the sample size, respectively. The frequency of the other allele (P) is 1-q. The assumption of the two alleles system enables us to calculate the Nei's genetic distance (Nei 1972) from the RAPD pattern.

Gene frequency

Gene frequency estimation for polymorphic loci was based on the assumption of a two-allele system. Only one of the two alleles is capable to amplify by primer annealing, at an unknown genomic position (locus). The other is the "null" allele incapable of amplification, mainly because of loss of primer annealing site by mutation. The two-allele assumption is in most cases acceptable because, co-dominant loci showing band shift are few (Elo *et al.*, 1997; Welsh and McClelland, 1990). In this system only a null homozygote is detectable as negative for the polymorphic band of interest.

Under the assumption of Hardy-Weinberg equilibrium, the null allele frequency (q) may be $(N/n)1/2$, when N and n are the number of bandnegative individuals observed and the sample size, respectively. The frequency of the other allele (P) is $1-q$. the assumptions of the two-allele system enable us to calculate the Nei genetic distance (Nei, 1972) from the polymorphic banding pattern.

Gene flow

Gene flow, (Nm) was estimated according to the following formula:

$$0.5 (1 - G_{st})$$

Gene flow, $Nm = G_{st}$ Where, G_{st} is the proportion of total genetic diversity attributable to subpopulation. It is also known as coefficient of gene differentiation. The G_{st} values were calculated by using the following formula:

$$G_{st} = \frac{1 - H_s}{H_t}$$

Where, H_s is the Hardy-Weinberg average heterozygosity expected in isolates and H_t is the Hardy-Weinberg average heterozygosity obtained in isolates.

Nei's genetic distance and identity values

Nei genetic distance and identity values were computed from frequencies of polymorphic markers to estimate genetic relationship between the studied Isolates using the Unweighted Pair Group Method of Arithmetic means (UPGMA) (Sneath and Sokal, 1973). The dendrogram was constructed using the NT SYS PC 2.02i (Yeh *et al.*, 1999) computer program.



Fig. 98. Research activities, Molecular Biology Lab, BAU

11. Results and Discussion:

11.7. Cotton Development Board

11.7.1. Morphological Characterization of Cotton Genotypes at Cotton Research Center, Jagadishpur, Jashore during February 2018 - January 2021

A total of 172 cotton genotypes were characterized at Cotton Research Center, Jagadishpur, Jashore on the basis of morpho-agronomical (Table 136) (serial no. 1-60 in 2018-19; 61-119 in 2019-20 and 120-172 in 2020-21) during the period from August 2018 - January 2021.

Table 136. List of cotton genotypes for morphological characterization, Cotton Research Center, Jagadishpur, Jashore

Sl. No.	Acc. No.						
1	BC-0201	44	BC-0252	87	BC-0384	130	BC-0509
2	BC-0202	45	BC-0253	88	BC-0385	131	BC-0510
3	BC-0203	46	BC-0254	89	BC-0388	132	BC-0511
4	BC-0204	47	BC-0255	90	BC-0390	133	BC-0512
5	BC-0205	48	BC-0256	91	BC-0392	134	BC-0513
6	BC-0206	49	BC-0257	92	BC-0396	135	BC-0514
7	BC-0207	50	BC-0258	93	BC-0397	136	BC-0515
8	BC-0208	51	BC-0259	94	BC-0399	137	BC-0516
9	BC-0209	52	BC-0260	95	BC-0400	138	BC-0517
10	BC-0211	53	BC-0262	96	BC-0401	139	BC-0518
11	BC-0212	54	BC-0263	97	BC-0403	140	BC-0519
12	BC-0214	55	BC-0264	98	BC-0404	141	BC-0520
13	BC-0215	56	BC-0265	99	BC-0405	142	BC-0521
14	BC-0216	57	BC-0266	100	BC-0406	143	BC-0522
15	BC-0217	58	BC-0267	101	BC-0409	144	BC-0523
16	BC-0218	59	BC-0268	102	BC-0410	145	BC-0524
17	BC-0219	60	BC-0270	103	BC-0414	146	BC-0525
18	BC-0220	61	BC-0344	104	BC-0415	147	BC-0526
19	BC-0222	62	BC-0346	105	BC-0417	148	BC-0527
20	BC-0223	63	BC-0347	106	BC-0418	149	BC-0528
21	BC-0224	64	BC-0351	107	BC-0419	150	BC-0529
22	BC-0225	65	BC-0354	108	BC-0420	151	BC-0530
23	BC-0226	66	BC-0355	109	BC-0421	152	BC-0531
24	BC-0227	67	BC-0356	110	BC-0422	153	BC-0532
25	BC-0228	68	BC-0358	111	BC-0424	154	BC-0533
26	BC-0230	69	BC-0359	112	BC-0425	155	BC-0534
27	BC-0231	70	BC-0360	113	BC-0427	156	BC-0535
28	BC-0232	71	BC-0362	114	BC-0429	157	BC-0536
29	BC-0233	72	BC-0363	115	BC-0430	158	BC-0537
30	BC-0234	73	BC-0364	116	BC-0431	159	BC-0538
31	BC-0235	74	BC-0365	117	BC-0432	160	BC-0539
32	BC-0236	75	BC-0367	118	BC-0433	161	BC-0540
33	BC-0237	76	BC-0368	119	BC-0434	162	BC-0541
34	BC-0239	77	BC-0369	120	BC-0499	163	BC-0542
35	BC-0240	78	BC-0371	121	BC-0500	164	BC-0543
36	BC-0241	79	BC-0372	122	BC-0501	165	BC-0544
37	BC-0242	80	BC-0373	123	BC-0502	166	BC-0545
38	BC-0243	81	BC-0374	124	BC-0503	167	BC-0546
39	BC-0244	82	BC-0375	125	BC-0504	168	BC-0547
40	BC-0245	83	BC-0376	126	BC-0505	169	BC-0548
41	BC-0246	84	BC-0380	127	BC-0506	170	BC-0549
42	BC-0247	85	BC-0381	128	BC-0507	171	BC-0550
43	BC-0248	86	BC-0383	129	BC-0508	172	BC-0551

11.7.1.1. Morphological Characterization of cotton genotypes based on Qualitative Characteristics (February 2018 to January 2021)

A total of 172 cotton genotypes were characterized morphologically at the Cotton Research Center, Jagadishpur, Jashore during the period from August 2018 to January 2021. Data of qualitative characterization are shown in Table 137 and list of qualitative characters are shown in Tables 138, 139 and 140.

A total of 163 genotypes (94.77%) were erect in growth habit. Plant color of 144 genotypes (83.72%) was green and that of 28 genotypes (16.28%) was greenish purple. Ninety (90) (52.23%) genotypes had short hair, five (2.91%) had long hair and the remaining 77 genotypes (44.77%) were glabrous. Leaf shape of 156 genotypes (90.70%) was entire and that of 16 genotypes (9.30%) was lobed. In case of petal color, 151 cotton genotypes were creamy (87.79%). Pollen color of 158 genotypes was cream (91.86%). Boll shape of studied cotton genotypes was conical (48.84%), oval (47.67%) and round (1.16%). Seeds of all tested genotypes were fuzzy. A total of 169 cotton genotypes were grey in fuzz color and white in lint color and frequency was 98.26%.

Table 137. Qualitative variations in different descriptors of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore (2018-2021)

Variable	States	No. of genotypes	Frequency (%)
Growth Habit	Compact	07	4.07
	Erect	163	94.77
	Prostrate	02	1.16
Color of plant	Green	144	83.72
	Greenish Purple	28	16.28
Hairiness	Glabrous	77	44.77
	Short Hair	90	52.23
	Long Hair	05	2.91
Leaf shape	Entire	156	90.70
	Lobed	16	9.30
Petal color	White	03	1.74
	Cream	151	87.79
	Light yellow	10	5.81
	Yellow	08	4.65
Petal spot	Absent	165	95.93
	Present	07	4.07
Pollen color	Cream	158	91.86
	Yellow	14	8.14
Boll shape	Oval	82	47.67
	Round	02	1.16
	Conical	84	48.84
Seed fuzz	Fuzzy	172	100.00
Fuzz color	Grey	169	98.26
	Brown	03	1.74
Lint color	White	169	98.26
	Brown	03	1.74

Qualitative Characteristics of 60 Cotton Genotypes (2018-2019)

The qualitative characteristics of 60 cotton genotypes grown in Cotton Research Center Jagadishpur, Jashore in 2018-2019 growing season are given in Table 138. The growth habit of all the 60 genotypes was erect; plant color was green and the leaf shape was entire. The parameter 'Hairiness' showed different type characters. Among the 60 entries, 20 accessions showed short hair, 4 accessions showed hairy and rest of the 31 showed glabrous. In case of petal color and petal spot, all the genotypes were showed creamy type petal color and also were not found petal spot in all the genotypes. In case of pollen color and boll shape, 59 genotypes were showed creamy type pollen color except the accession number BC-0217 (Yellow type pollen color). On the other hand, 32 genotypes were produced conical shape boll and 28 produced oval shaped boll. In case of seed fuzz, fuzz color and lint color all the genotypes produced fuzzy seed, fuzz color was grey and lint color was white (Figs. 99, 100, 101 and 102).

Table 138. Qualitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2018-2019

Acc.No	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0201	7	1	3	1	1	0	2	3	7	3	1
BC-0202	7	1	0	1	1	0	2	3	7	3	1
BC-0203	7	1	3	1	1	0	2	2	7	3	1
BC-0204	7	1	3	1	1	0	2	3	7	3	1
BC-0205	7	1	0	1	1	0	2	2	7	3	1
BC-0206	7	1	0	1	1	0	2	2	7	3	1
BC-0207	7	1	3	1	1	0	2	3	7	3	1
BC-0208	7	1	3	1	1	0	2	2	7	3	1
BC-0209	7	1	3	1	1	0	2	3	7	3	1
BC-0211	7	1	3	1	1	0	2	2	7	3	1
BC-0212	7	1	0	1	1	0	2	2	7	3	1
BC-0214	7	1	0	1	1	0	2	3	7	3	1
BC-0215	7	1	0	1	1	0	2	2	7	3	1
BC-0216	7	1	3	1	1	0	2	2	7	3	1
BC-0217	7	1	7	1	1	0	4	3	7	3	1
BC-0218	7	1	7	1	1	0	2	2	7	3	1
BC-0219	7	1	7	1	1	0	2	2	7	3	1
BC-0220	7	1	7	1	1	0	2	3	7	3	1
BC-0222	7	1	3	1	1	0	2	3	7	3	1
BC-0223	7	1	3	1	1	0	2	3	7	3	1
BC-0224	7	1	0	1	1	0	2	2	7	3	1
BC-0225	7	1	0	1	1	0	2	2	7	3	1
BC-0226	7	1	0	1	1	0	2	2	7	3	1
BC-0227	7	1	3	1	1	0	2	3	7	3	1
BC-0228	7	1	0	1	1	0	2	3	7	3	1
BC-0230	7	1	0	1	1	0	2	3	7	3	1
BC-0231	7	1	3	1	1	0	2	3	7	3	1

Table 138 (Cont'd)

Acc. No	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0232	7	1	0	1	1	0	2	3	7	3	1
BC-0233	7	1	3	1	1	0	2	2	7	3	1
BC-0234	7	1	3	1	1	0	2	3	7	3	1
BC-0235	7	1	0	1	1	0	2	2	7	3	1
BC-0236	7	1	0	1	1	0	2	2	7	3	1
BC-0237	7	1	3	1	1	0	2	2	7	3	1
BC-0239	7	1	0	1	1	0	2	3	7	3	1
BC-0240	7	1	3	1	1	0	2	2	7	3	1
BC-0241	7	1	0	1	1	0	2	2	7	3	1
BC-0242	7	1	3	1	1	0	2	2	7	3	1
BC-0243	7	1	0	1	1	0	2	3	7	3	1
BC-0244	7	1	0	1	1	0	2	3	7	3	1
BC-0245	7	1	3	1	1	0	2	3	7	3	1
BC-0246	7	1	0	1	1	0	2	2	7	3	1
BC-0247	7	1	3	1	1	0	2	2	7	3	1
BC-0248	7	1	0	1	1	0	2	3	7	3	1
BC-0252	7	1	3	1	1	0	2	2	7	3	1
BC-0253	7	1	0	1	1	0	2	3	7	3	1
BC-0254	7	1	0	1	1	0	2	2	7	3	1
BC-0255	7	1	0	1	1	0	2	2	7	3	1
BC-0256	7	1	0	1	1	0	2	3	7	3	1
BC-0257	7	1	0	1	1	0	2	3	7	3	1
BC-0258	7	1	0	1	1	0	2	3	7	3	1
BC-0259	7	1	0	1	1	0	2	2	7	3	1
BC-0260	7	1	0	1	1	0	2	3	7	3	1
BC-0262	7	1	0	1	1	0	2	3	7	3	1
BC-0263	7	1	0	1	1	0	2	3	7	3	1
BC-0264	7	1	3	1	1	0	2	2	7	3	1
BC-0265	7	1	3	1	1	0	2	3	7	3	1
BC-0266	7	1	3	1	1	0	3	3	7	3	1
BC-0267	7	1	0	1	1	0	2	2	7	3	1
BC-0268	7	1	3	1	1	0	2	3	7	3	1
BC-0270	7	1	3	1	1	0	2	3	7	3	1

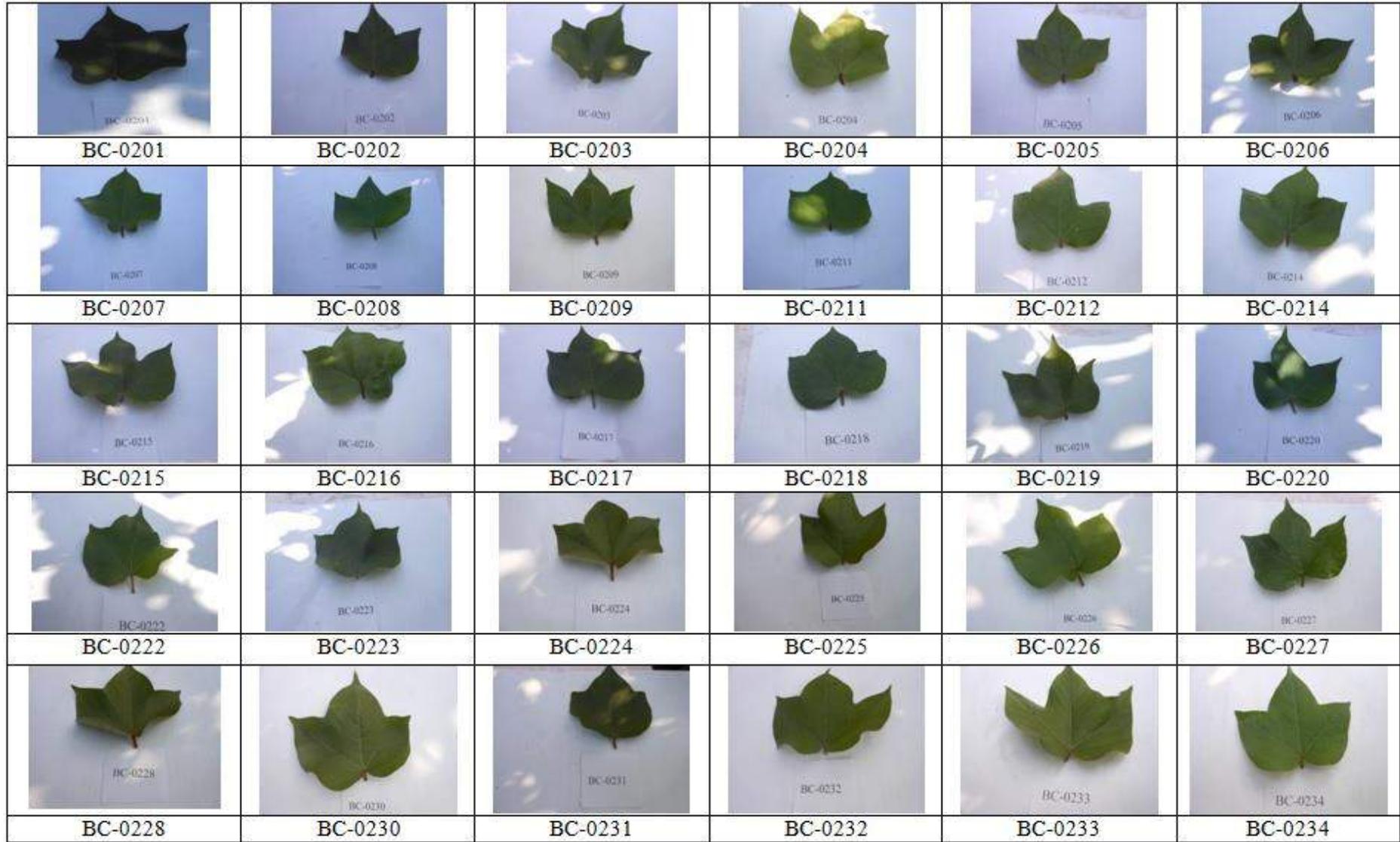


Fig. 99. Leaf shape of cotton genotypes, Cotton Research Center, Jagdishpur, Jashore, 2018-2019

					
BC-0235	BC-0236	BC-0237	BC-0239	BC-0240	BC-0241
					
BC-0242	BC-0243	BC-0244	BC-0245	BC-0246	BC-0247
					
BC-0248	BC-0252	BC-0253	BC-0254	BC-0255	BC-0256
					
BC-0257	BC-0258	BC-0259	BC-0260	BC-0262	BC-0263
					
BC-0264	BC-0265	BC-0266	BC-0267	BC-0268	BC-0270

Cont'd. Fig. 99. Leaf shape of cotton genotypes grown, Cotton Research Center, Jagdishpur, Jashore in 2018-2019

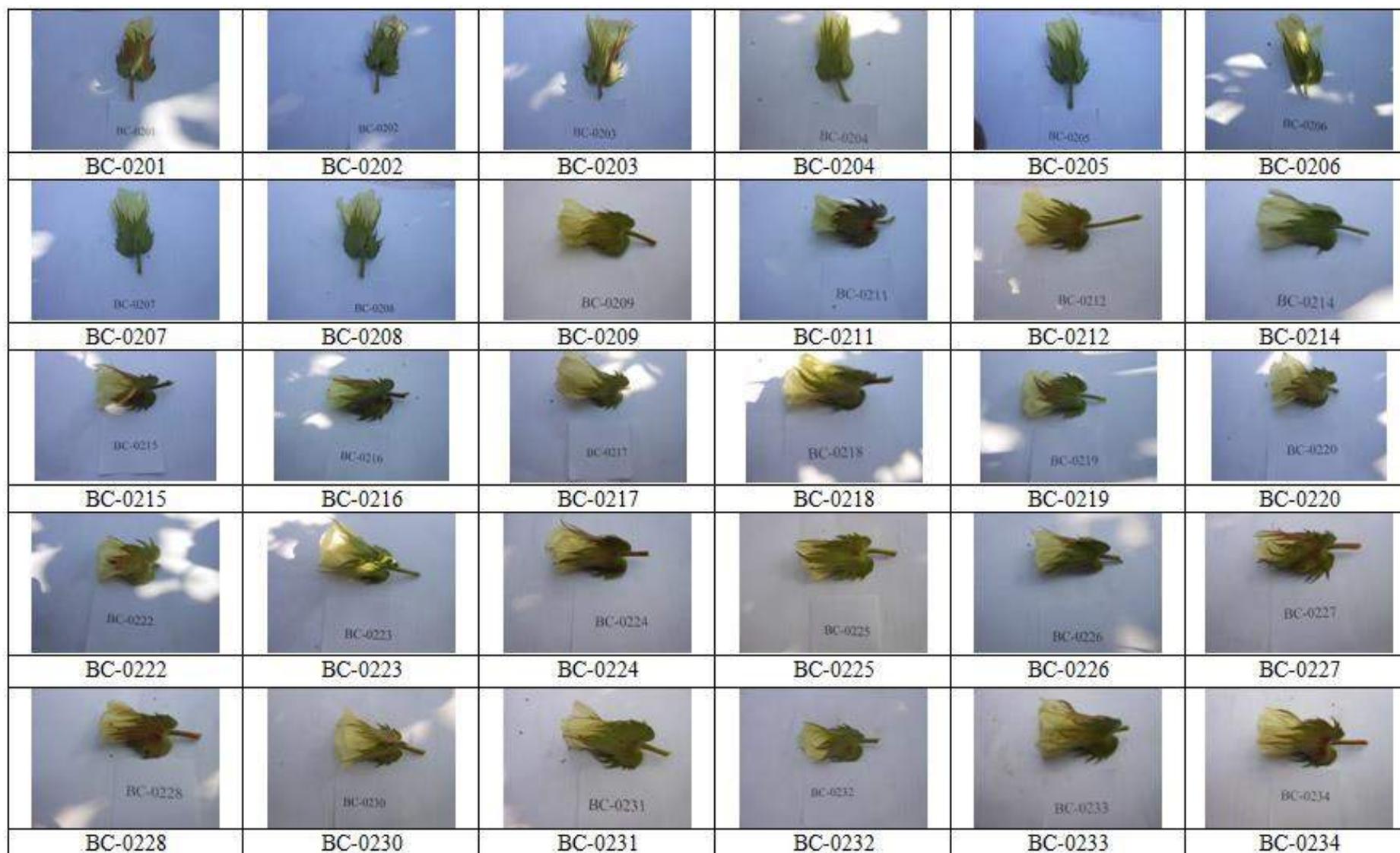


Fig. 100. Petal color of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

					
BC-0235	BC-0236	BC-0237	BC-0239	BC-0240	BC-0241
					
BC-0242	BC-0243	BC-0244	BC-0245	BC-0246	BC-0247
					
BC-0248	BC-0252	BC-0253	BC-0254	BC-0255	BC-0256
					
BC-0257	BC-0258	BC-0259	BC-0260	BC-0262	BC-0263
					
BC-0264	BC-0265	BC-0266	BC-0267	BC-0268	BC-0270

Cont'd. Fig. 100. Petal color of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

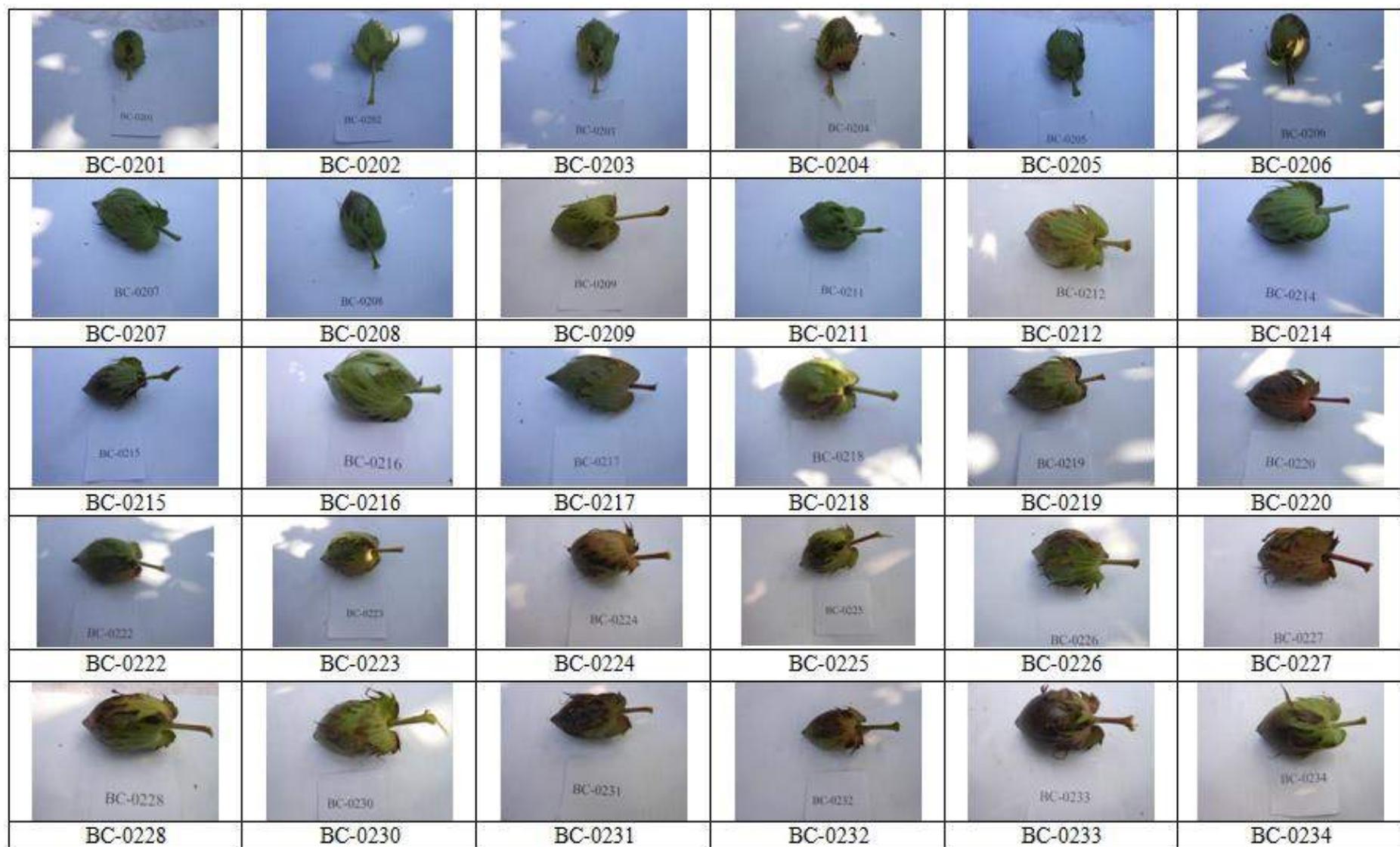
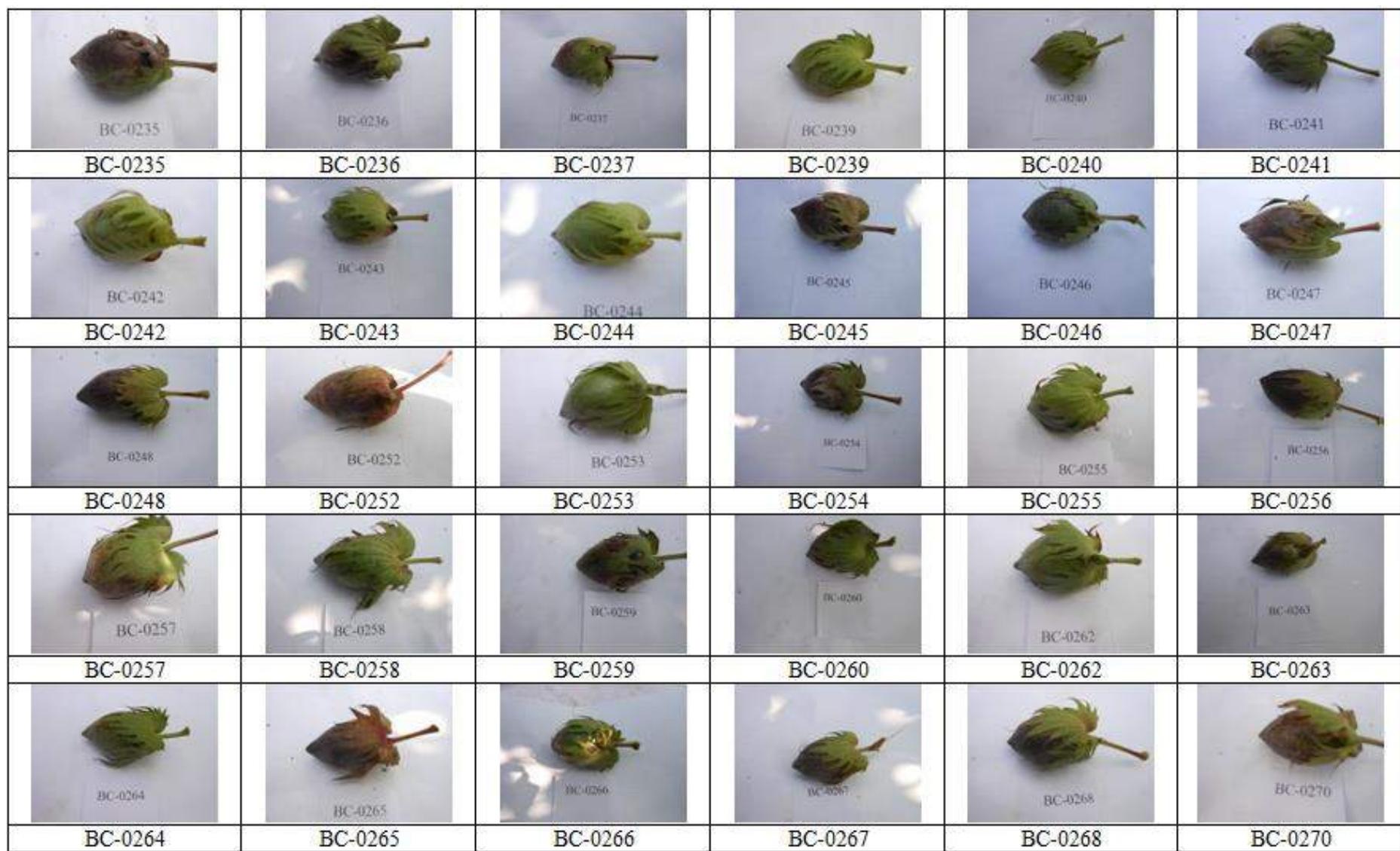


Fig. 101. Boll shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019



Cont'd. Fig. 101. Boll shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

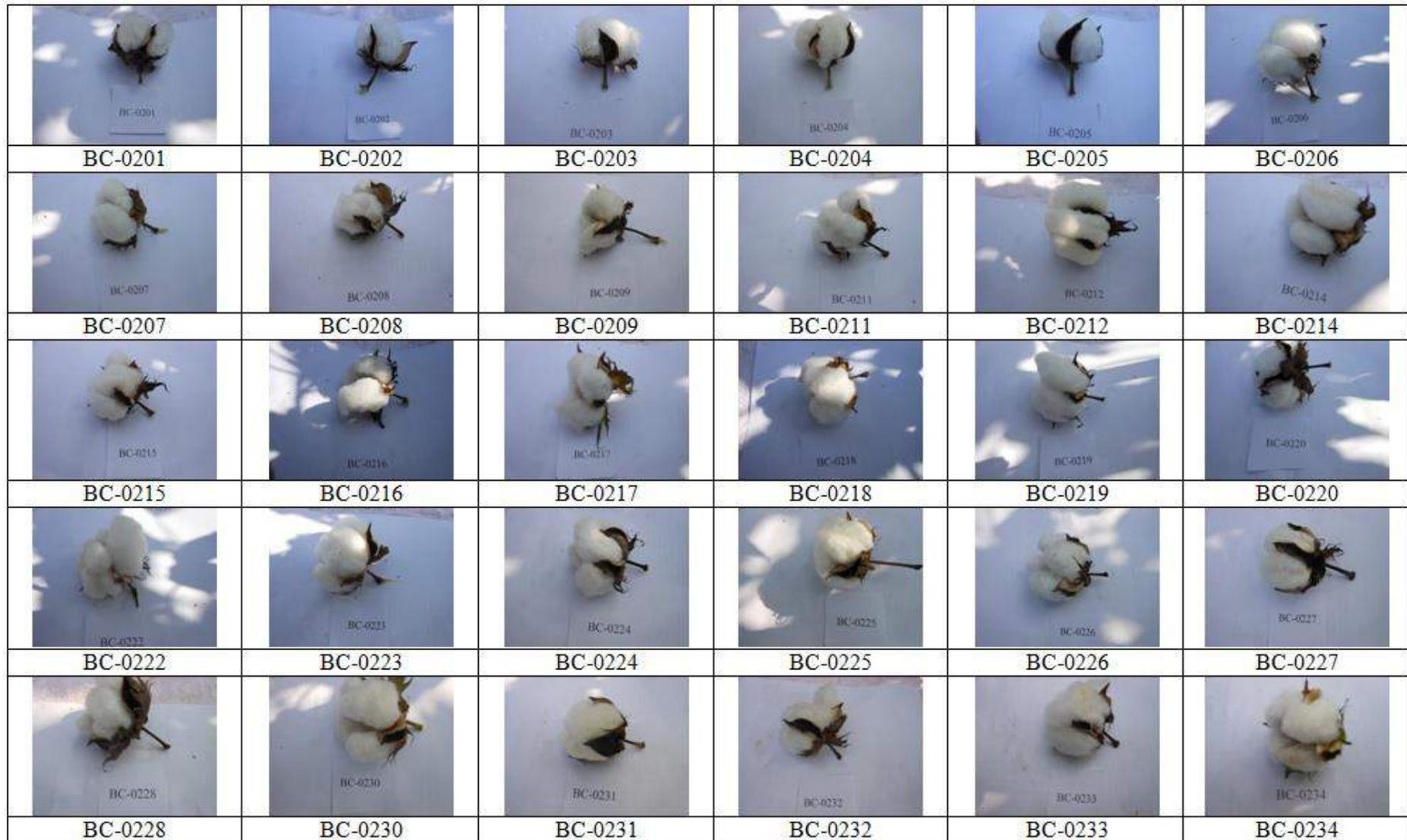


Fig. 102. Lint color of cotton genotypes grown, Cotton Research Center, Jagdishpur, Jashore in 2018-2019

					
BC-0235	BC-0236	BC-0237	BC-0239	BC-0240	BC-0241
					
BC-0242	BC-0243	BC-0244	BC-0245	BC-0246	BC-0247
					
BC-0248	BC-0252	BC-0253	BC-0254	BC-0255	BC-0256
					
BC-0257	BC-0258	BC-0259	BC-0260	BC-0262	BC-0263
					
BC-0264	BC-0265	BC-0266	BC-0267	BC-0268	BC-0270

Cont'd. Fig. 102. Lint color of cotton genotypes found, Cotton Research Center, Jagdishpur, Jashore in 2018-2019

Qualitative Characteristics of 59 Cotton Genotypes (2019-2020)

Qualitative characteristics of 59 cotton genotypes grown at the Cotton Research Center Jagdishpur, Jashore in 2019-2020 growing season are shown in Table 139. Growth habit of 50 genotypes was erect, 7 was compact and 2 genotypes showed prostrate type of growth habit. In case of plant color, 32 genotypes showed green color, 24 greenish purple, 1 purple, 1 deep purple and 1 purple green respectively. Hairiness showed different type of characters. 23 accessions showed short hair, 02 long hair, 10 hair, 02 velvet hair and the rest 22 genotypes was glabrous. In case of leaf shape, one genotype had okra lobed, four full okra lobed, three half okra lobed, four loaded and rest 47 were entire type. In case of petal color and petal spot, 38 genotypes were showed cream, 08 showed yellow, 10 showed light yellow, 02 showed white and 01 showed white purple petal color and also was not found petal spot in all the genotypes. In case of pollen color, 52 genotypes showed creamy type pollen color and rest 07 showed yellow type of pollen color. In case of boll shape, 31 genotypes produced oval shaped boll, 26 produced conical shaped boll and rest two produced round boll. All the genotypes had fuzzy seed, grey colored fuzz and white lint (Figs. 103, 104, 105 and 106).

Table 139. Qualitative characters of cotton genotypes, Cotton Research Center, Jagdishpur, Jashore, 2019-2020

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0344	7	1	0	1	2	0	1	2	7	3	1
BC-0346	7	1	0	1	2	0	1	2	7	3	1
BC-0347	7	1	3	1	2	0	1	2	7	3	1
BC-0351	7	1	3	1	2	0	1	1	7	3	1
BC-0354	7	1	3	2	2	0	1	3	7	3	1
BC-0355	7	1	3	2	2	0	1	2	7	3	1
BC-0356	7	1	0	1	2	0	1	2	7	3	1
BC-0358	7	1	3	1	2	0	1	3	7	3	1
BC-0359	7	1	3	1	2	0	1	3	7	3	1
BC-0360	7	1	3	1	2	0	1	3	7	3	1
BC-0362	7	1	3	1	2	0	1	2	7	3	1
BC-0363	7	2	0	2	1	0	1	3	7	3	1
BC-0364	7	1	3	1	2	0	2	3	7	3	1
BC-0365	7	1	3	2	2	0	1	3	7	3	1
BC-0367	7	2	3	1	2	0	1	3	7	3	1
BC-0368	7	2	3	1	2	0	1	3	7	3	1
BC-0369	7	1	3	1	2	0	1	3	7	3	1
BC-0371	7	1	3	2	2	0	1	1	7	3	1
BC-0372	7	1	3	1	2	0	1	3	7	3	1
BC-0373	7	1	3	2	2	0	1	2	7	3	1
BC-0374	7	1	0	1	2	0	1	3	7	3	1
BC-0375	7	1	3	2	2	0	1	2	7	3	1
BC-0376	7	1	3	1	2	0	1	3	7	3	1
BC-0380	7	1	3	1	2	0	1	3	7	3	1
BC-0381	7	1	0	1	2	0	1	2	7	3	1
BC-0383	7	1	3	1	2	0	1	2	7	3	1
BC-0384	7	1	3	2	2	0	1	2	7	3	1

Table 139 (Cont'd)

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0385	7		0	1	2	0	1	3	7	3	1
BC-0388	5	2	0	1	4	0	1	2	7	3	1
BC-0390	5	2	0	1	2	0	1	2	7	3	1
BC-0392	3	2	3	1	4	0	1	2	7	3	1
BC-0396	7	2	0	1	2	0	1	2	7	3	1
BC-0397	3	2	0	1	4	0	1	2	7	3	1
BC-0399	7	2	0	1	2	0	1	3	7	3	1
BC-0400	5	2	0	1	2	0	1	3	7	3	1
BC-0401	7	2	3	1	3	0	1	2	7	3	1
BC-0403	5	2	3	1	3	0	1	3	7	3	1
BC-0404	7	2	7	1	4	0	2	2	7	3	1
BC-0405	7	2	0	1	4	0	2	3	7	3	1
BC-0406	7	2	0	2	4	0	1	3	7	3	1
BC-0409	5	2	0	1	2	0	1	3	7	3	1
BC-0410	7	2	3	1	3	0	1	2	7	3	1
BC-0414	5	2	7	2	2	0	1	3	7	3	1
BC-0415	7	2	0	2	3	0	2	3	7	3	1
BC-0417	7	2	0	2	3	0	1	2	7	3	1
BC-0418	5	2	3	1	3	0	1	2	7	3	1
BC-0419	7	2	3	1	3	0	1	2	7	3	1
BC-0420	7	2	3	1	3	0	1	2	7	3	1
BC-0421	7	1	3	1	2	0	2	2	7	3	1
BC-0422	7	2	3	1	3	0	1	2	7	3	1
BC-0424	7	2	3	1	3	0	1	2	7	3	1
BC-0425	7	2	3	1	4	0	1	2	7	3	1
BC-0427	7	2	3	1	4	0	2	2	7	3	1
BC-0429	7	1	0	1	2	0	1	3	7	3	1
BC-0430	7	1	0	1	2	0	1	2	7	3	1
BC-0431	7	1	0	1	2	0	1	3	7	3	1
BC-0432	7	1	0	1	2	0	1	2	7	3	1
BC-0433	7	1	3	1	1	0	1	3	7	3	1
BC-0434	7	1	3	1	1	0	2	2	7	3	1

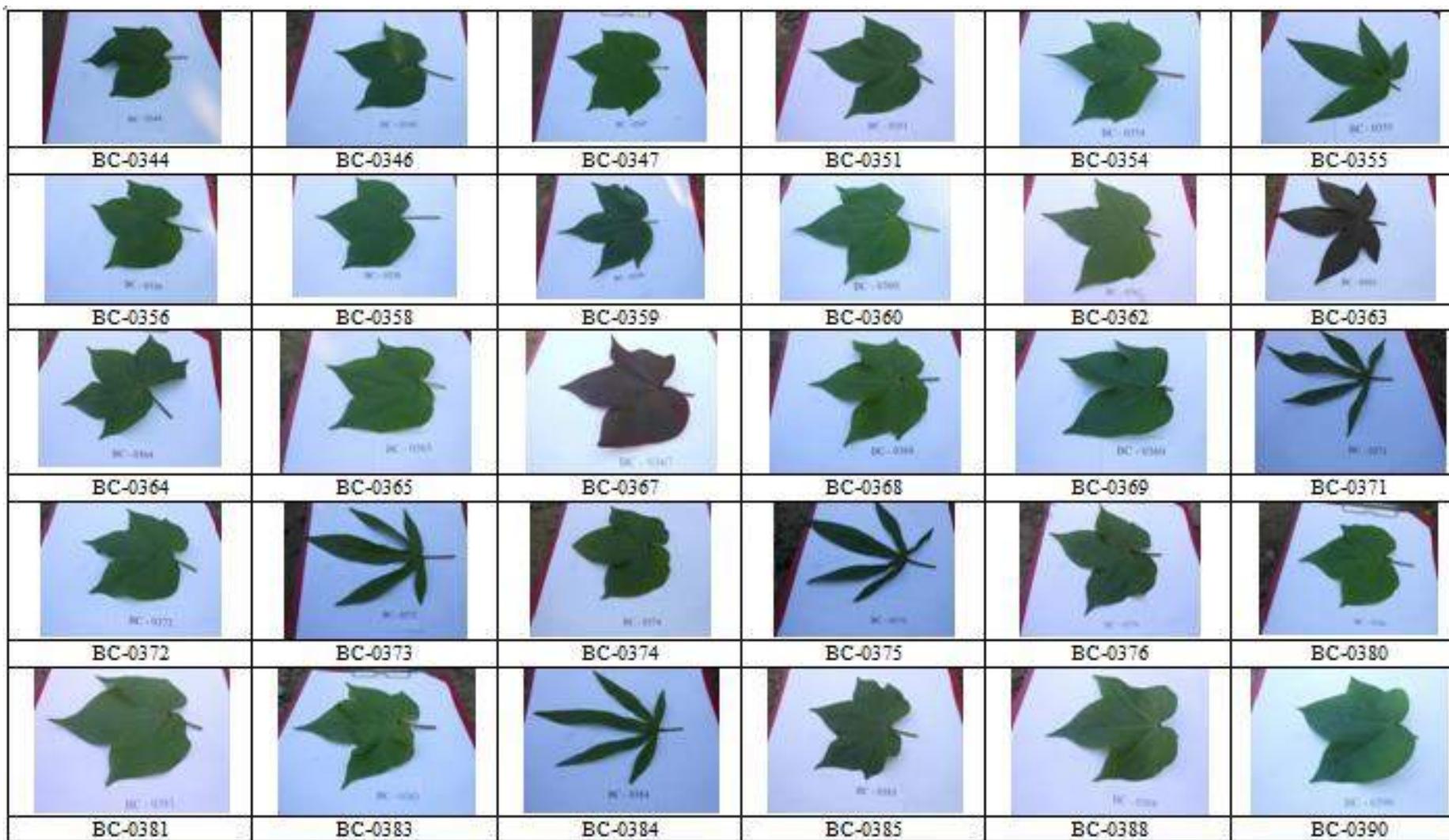
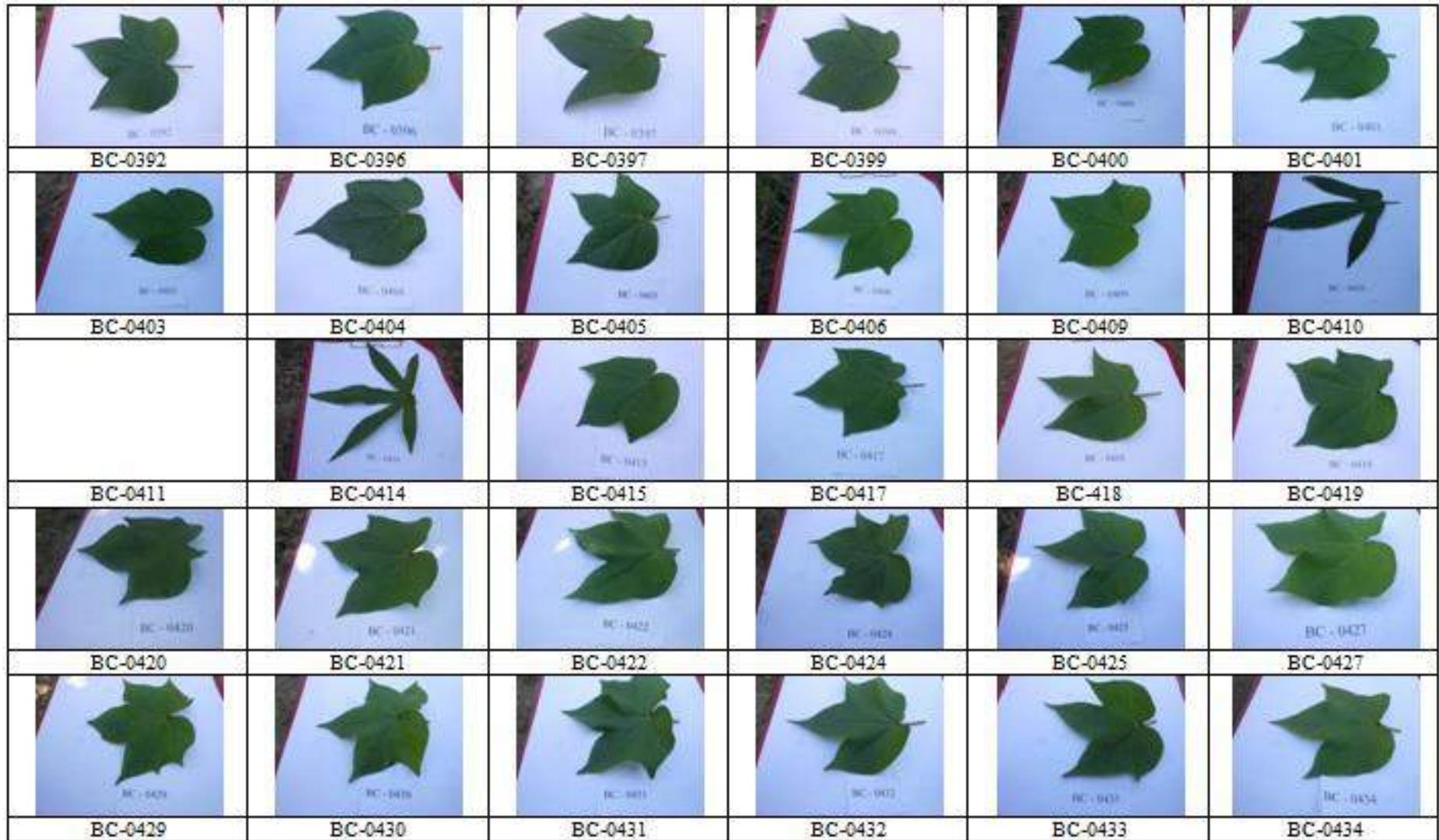


Fig. 103. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020



Cont'd. Fig. 103. Leaf shape of cotton genotypes, Cotton Research Center, Jagdishpur, Jashore, 2019-2020

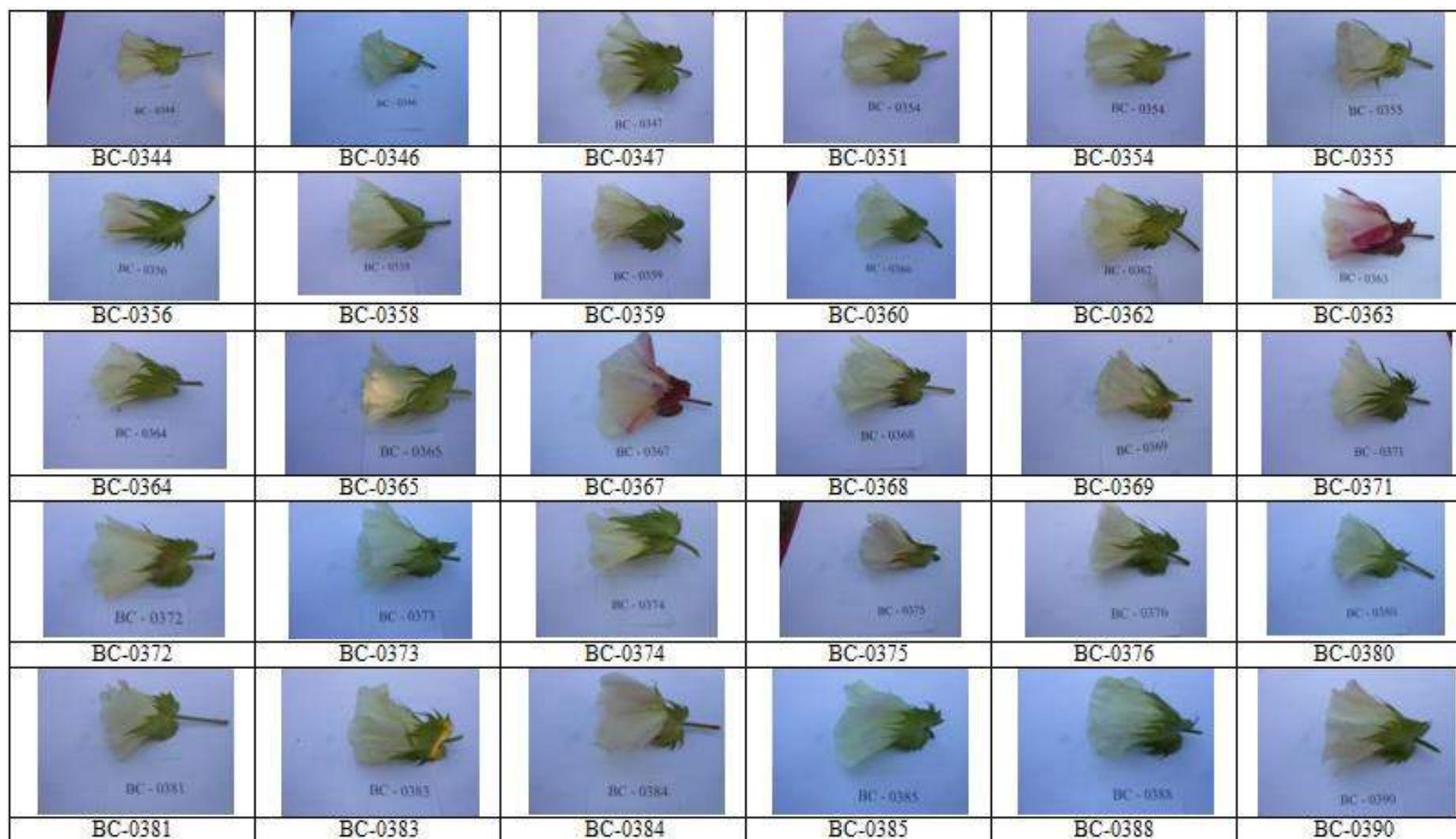
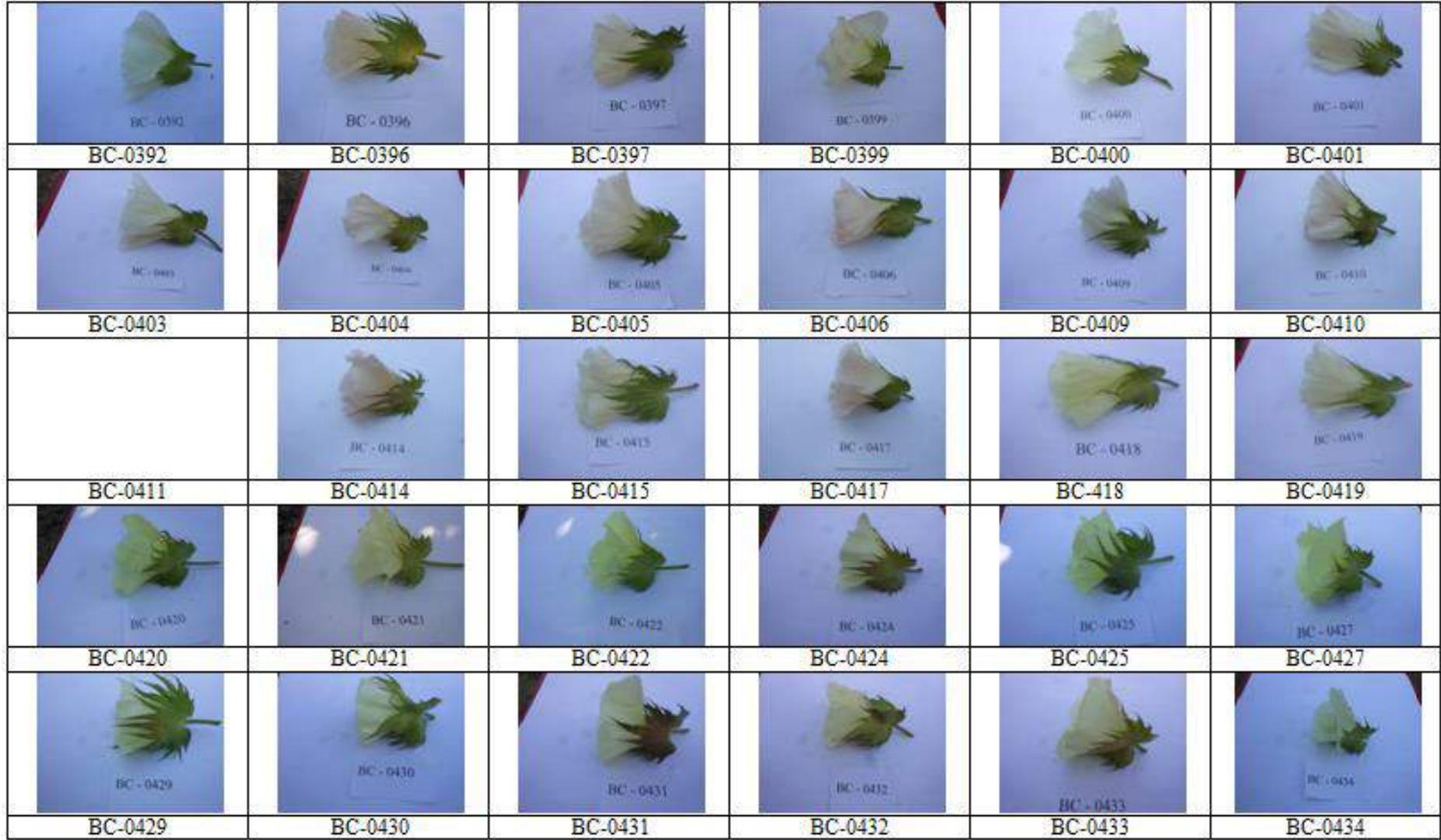


Fig. 104. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020



Cont'd. Fig. 104. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

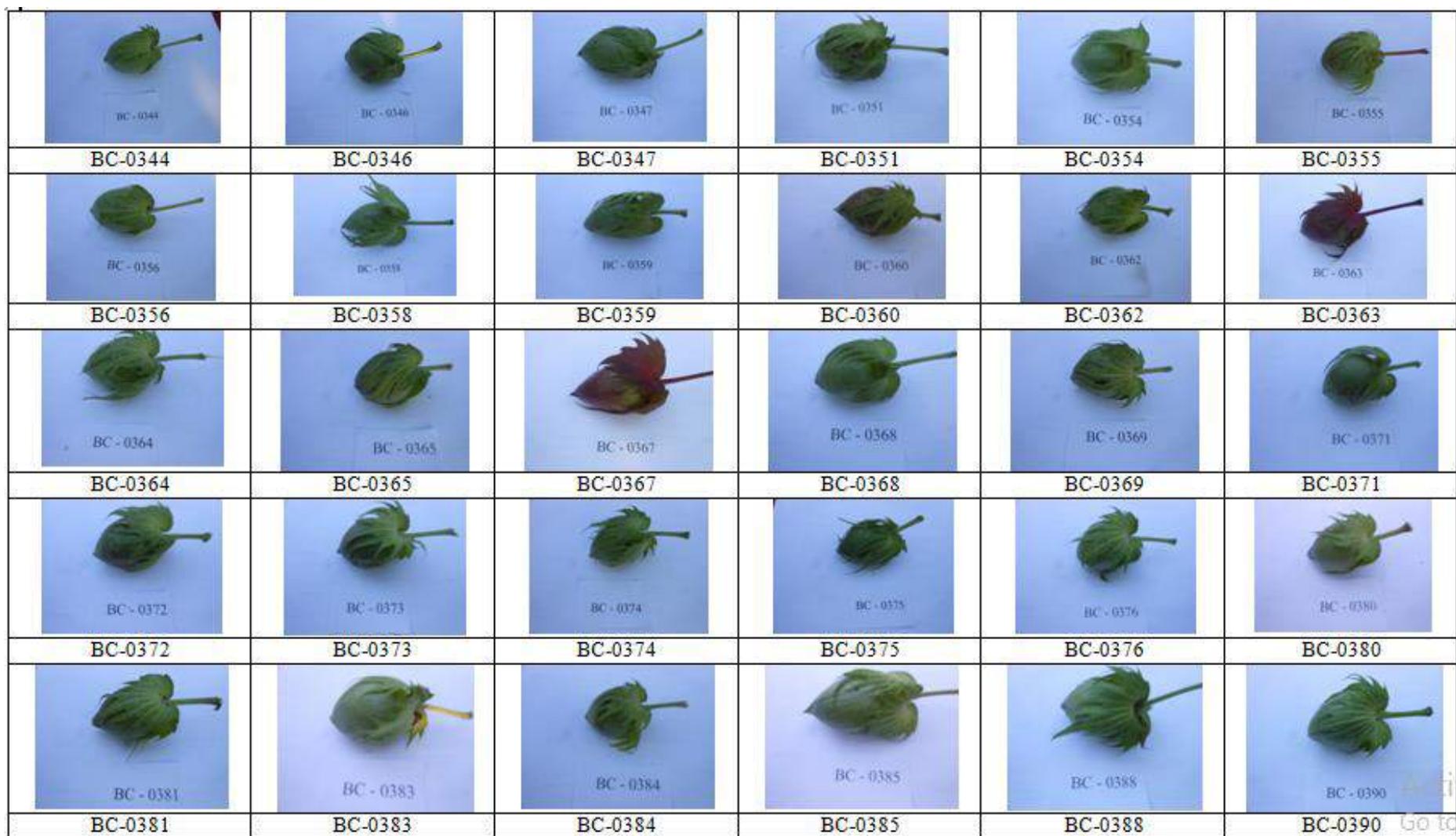
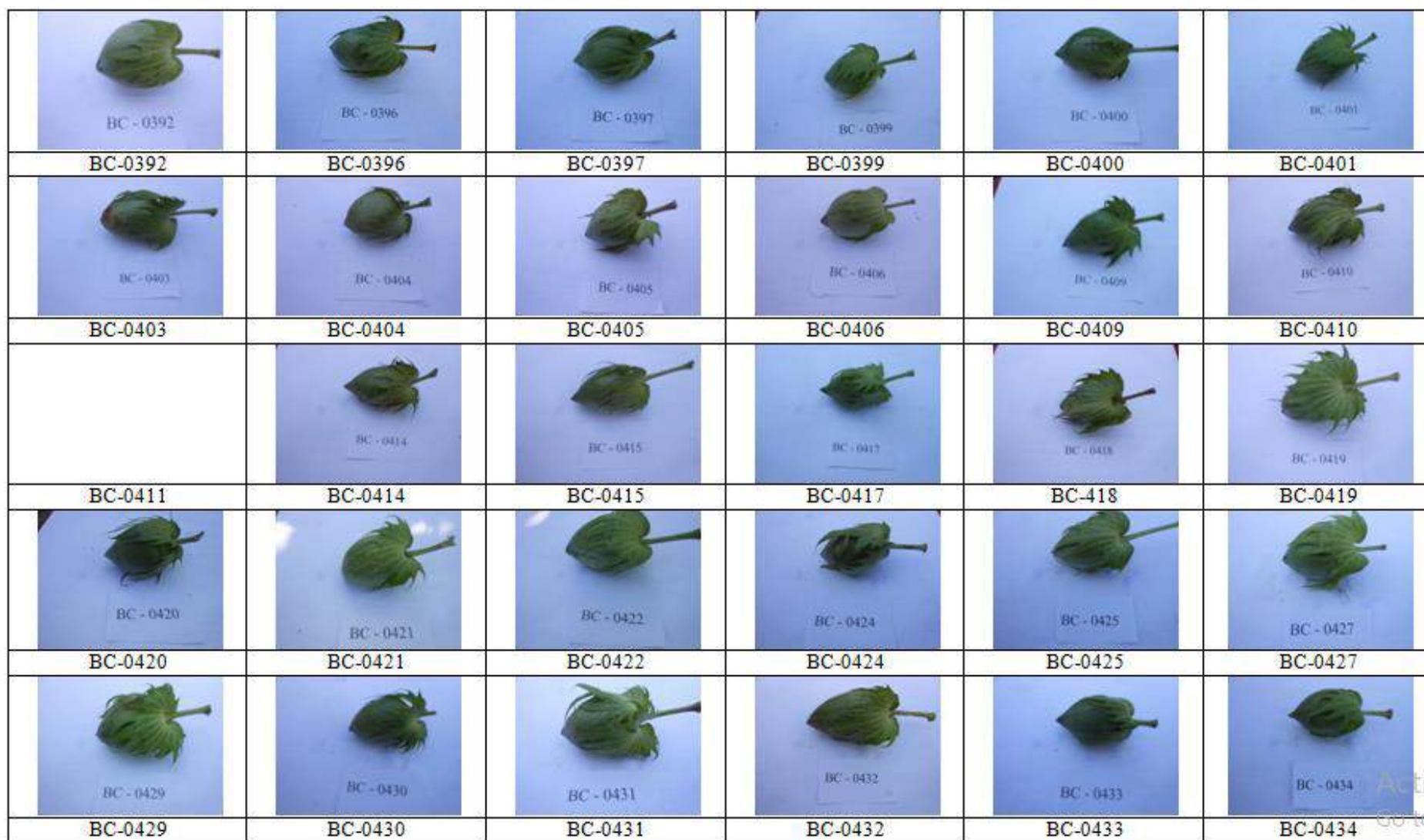


Fig. 105. Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020



Cont'd. Fig. 105. Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020



Fig. 106. Lint color of cotton genotypes grown, Cotton Research Center, Jagdishpur, Jashore, 2019-2020



Cont'd. Fig. 106. Lint color of cotton genotypes, Cotton Research Center, Jagdishpur, Jashore, 2019-2020

Qualitative Characteristics of 53 Cotton Genotypes (2020-2021)

Qualitative characteristics of 53 cotton genotypes grown at the Cotton Research Center, Jagadishpur, Jashore during 2020-2021 growing season are shown in Table 140. Growth habit of all the genotypes was erect. Plant and petal colors of all the 53 genotypes were green and cream, respectively. Among the 53 entries, 26 entries had short hair, 03 had long hair and rest 24 was glabrous. In case of leaf shape, 03 genotypes showed okra, 02 genotypes showed ½ okra lobbed and rest 48 showed entire type of leaf shape. Petal spot was present in 07 genotypes and absent in 46 genotypes. Pollen color of 47 genotypes was creamy and that of 06 genotypes was yellow. In case of boll shape, 28 genotypes produced conical shaped boll and 25 produced oval shaped boll. In case of seed fuzz, fuzz color and lint color, all the genotypes produced fuzzy seed, fuzz color was grey and lint color was white except the genotypes BC-0505, BC-0523 and BC-0539. These three genotypes produced fuzzy seed, fuzz and lint color was brown.

Table 140. Qualitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0499	7	1	0	1	2	0	1	3	7	3	1
BC-0500	7	1	0	1	2	0	1	3	7	3	1
BC-0501	7	1	0	1	2	0	1	3	7	3	1
BC-0502	7	1	0	1	2	0	1	3	7	3	1
BC-0503	7	1	3	2	2	1	2	3	7	3	1
BC-0504	7	1	0	1	2	0	1	3	7	3	1
BC-0505	7	1	0	2	2	0	2	3	7	4	4
BC-0506	7	1	3	1	2	0	2	2	7	3	1
BC-0507	7	1	0	1	2	0	1	2	7	3	1
BC-0508	7	1	0	1	2	0	1	2	7	3	1
BC-0509	7	1	0	1	2	0	1	2	7	3	1
BC-0510	7	1	0	1	2	0	1	3	7	3	1
BC-0511	7	1	3	1	2	0	1	2	7	3	1
BC-0512	7	1	0	1	2	0	1	2	7	3	1
BC-0513	7	1	0	1	2	0	1	3	7	3	1
BC-0514	7	1	3	1	2	0	1	3	7	3	1
BC-0515	7	1	3	1	2	0	1	3	7	3	1
BC-0516	7	1	3	1	2	0	1	2	7	3	1
BC-0517	7	1	0	1	2	0	1	3	7	3	1
BC-0518	7	1	0	2	2	1	2	3	7	3	1
BC-0519	7	1	0	1	2	1	1	3	7	3	1
BC-0520	7	1	0	1	2	1	1	3	7	3	1
BC-0521	7	1	3	1	2	1	1	2	7	3	1
BC-0522	7	1	0	2	2	1	2	3	7	3	1
BC-0523	7	1	0	2	2	1	2	3	7	4	4
BC-0524	7	1	3	1	2	0	1	2	7	3	1
BC-0525	7	1	3	1	2	0	1	2	7	3	1
BC-0526	7	1	0	1	2	0	1	2	7	3	1
BC-0527	7	1	3	1	2	0	1	2	7	3	1

Table 140 (Cont'd)

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0528	7	1	3	1	2	0	1	3	7	3	1
BC-0529	7	1	3	1	2	0	1	2	7	3	1
BC-0530	7	1	0	1	2	0	1	2	7	3	1
BC-0531	7	1	3	1	2	0	1	3	7	3	1
BC-0532	7	1	0	1	2	0	1	3	7	3	1
BC-0533	7	1	3	1	2	0	1	3	7	3	1
BC-0534	7	1	3	1	2	0	1	2	7	3	1
BC-0535	7	1	3	1	2	0	1	2	7	3	1
BC-0536	7	1	3	1	2	0	1	2	7	3	1
BC-0537	7	1	3	1	2	0	1	3	7	3	1
BC-0538	7	1	0	1	2	0	1	3	7	3	1
BC-0539	7	1	3	1	2	0	1	2	7	4	4
BC-0540	7	1	3	1	2	0	1	2	7	3	1
BC-0541	7	1	3	1	2	0	1	3	7	3	1
BC-0542	7	1	7	1	2	0	1	2	7	3	1
BC-0543	7	1	3	1	2	0	1	2	7	3	1
BC-0544	7	1	3	1	2	0	1	2	7	3	1
BC-0545	7	1	7	1	2	0	1	2	7	3	1
BC-0546	7	1	0	1	2	0	1	3	7	3	1
BC-0547	7	1	3	1	2	0	1	2	7	3	1
BC-0548	7	1	3	1	2	0	1	3	7	3	1
BC-0549	7	1	0	1	2	0	1	3	7	3	1
BC-0550	7	1	7	1	2	0	1	2	7	3	1
BC-0551	7	1	3	1	2	0	1	3	7	3	1

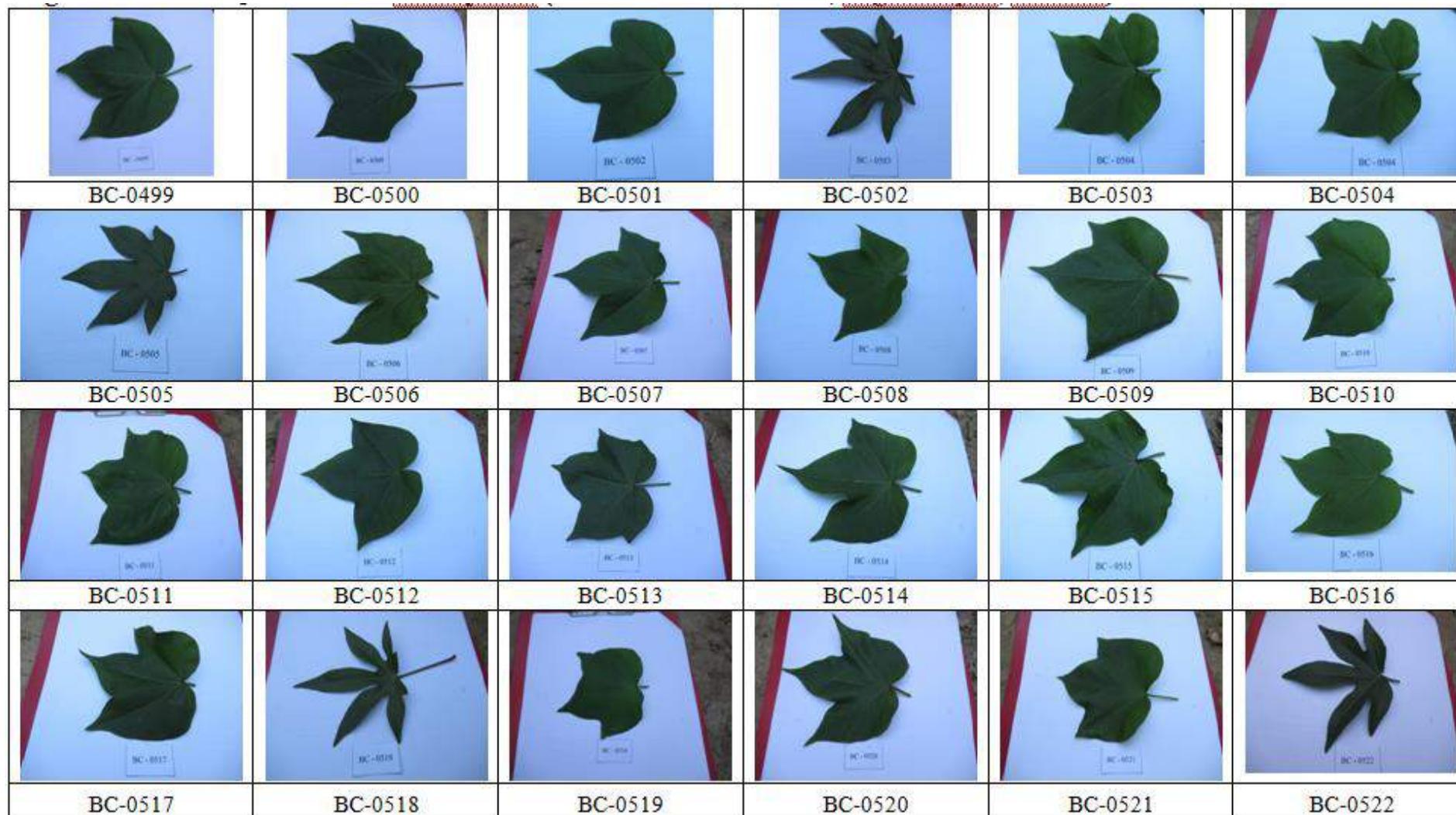
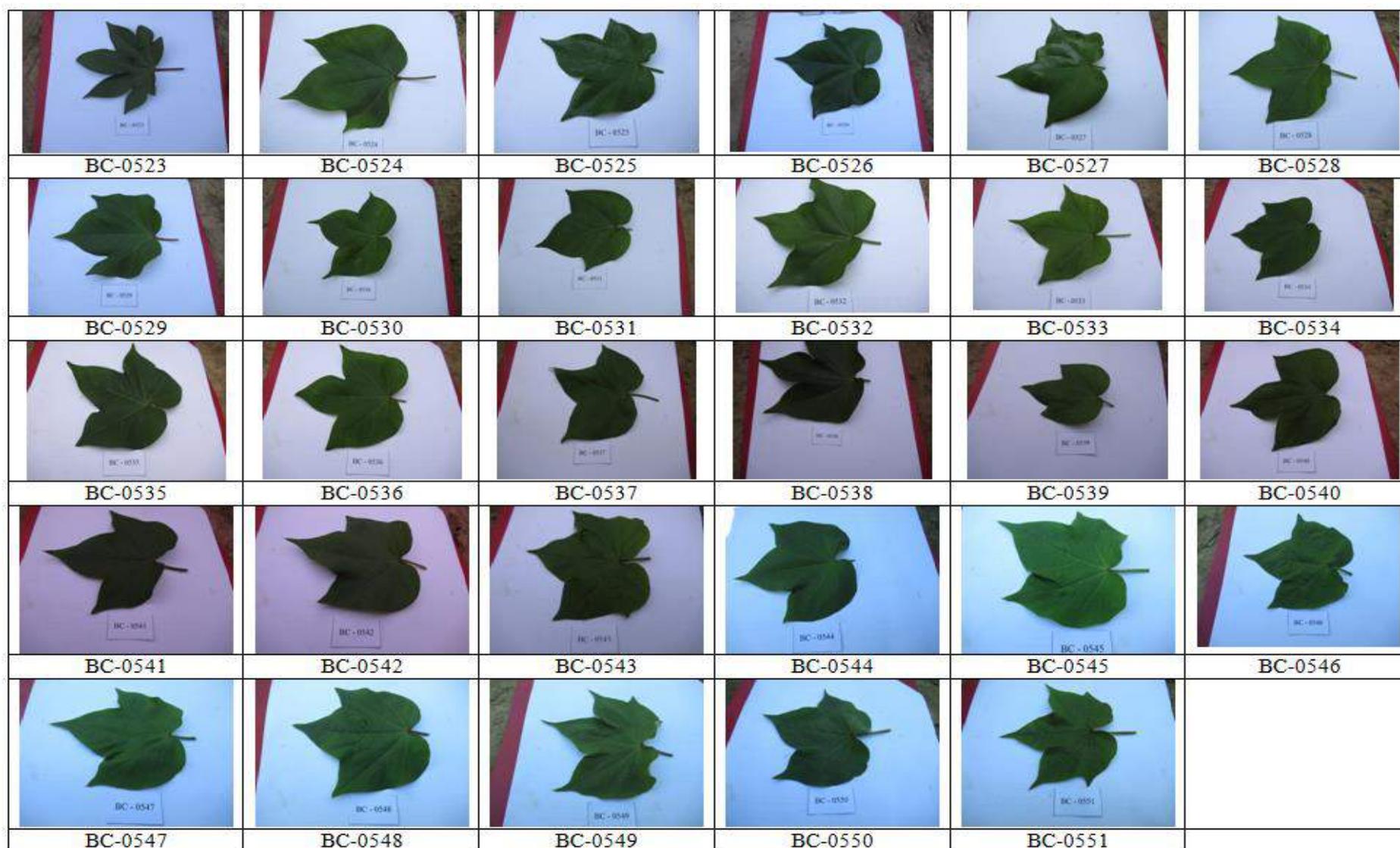


Fig. 107. Leaf shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore, 2020-2021



Cont'd. Fig. 107. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

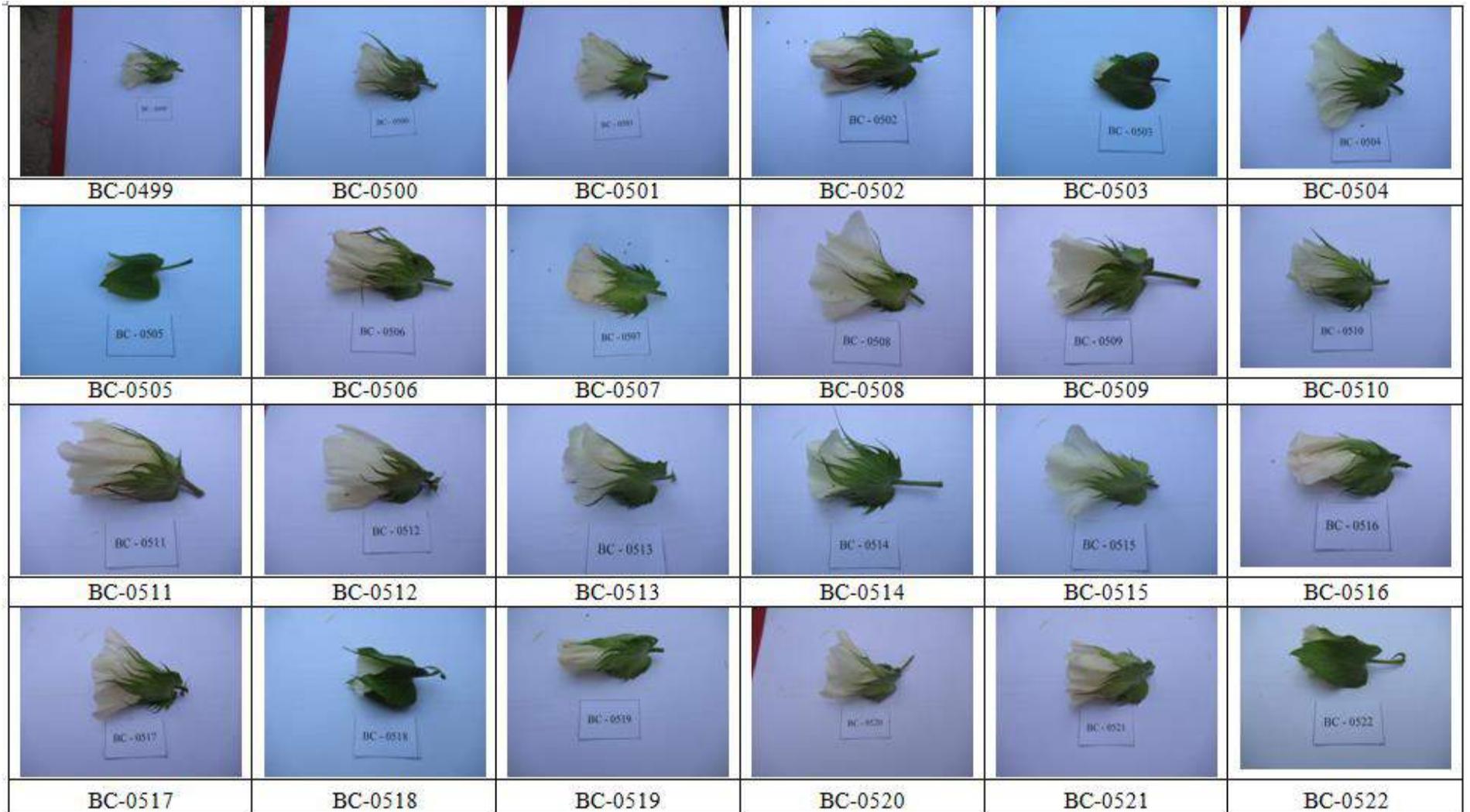
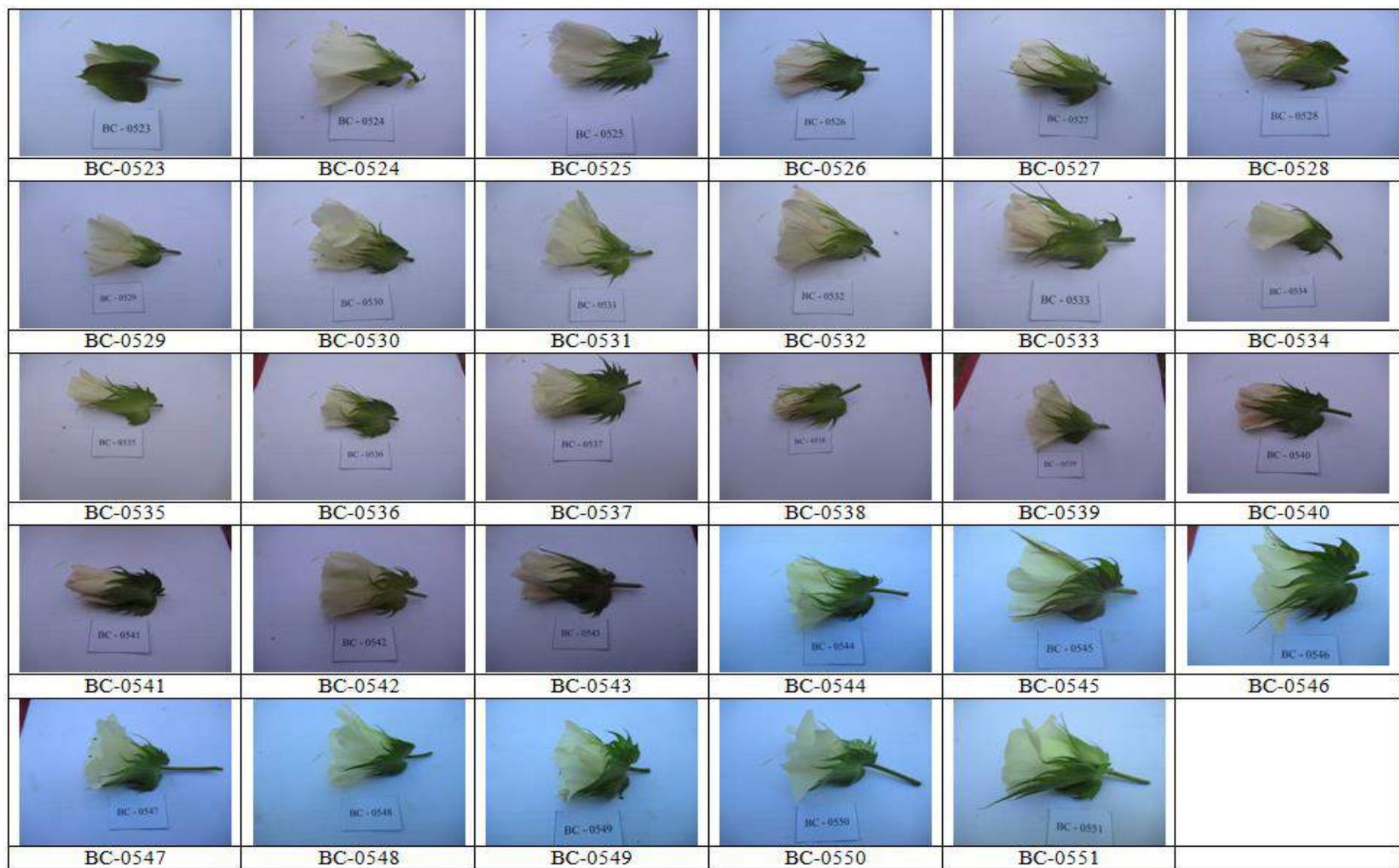


Fig. 108. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2020-2021



Cont'd. Fig. 108. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

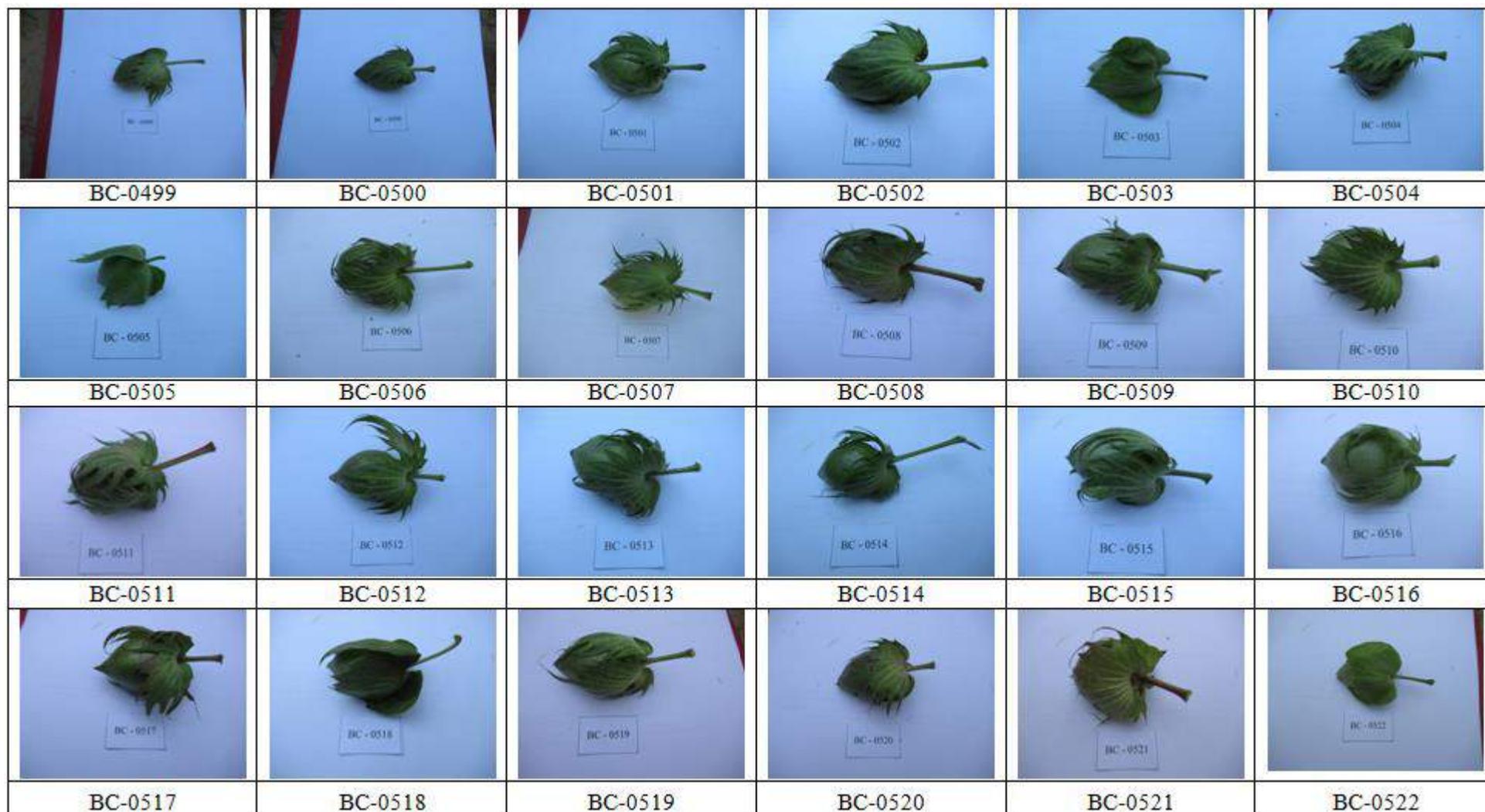
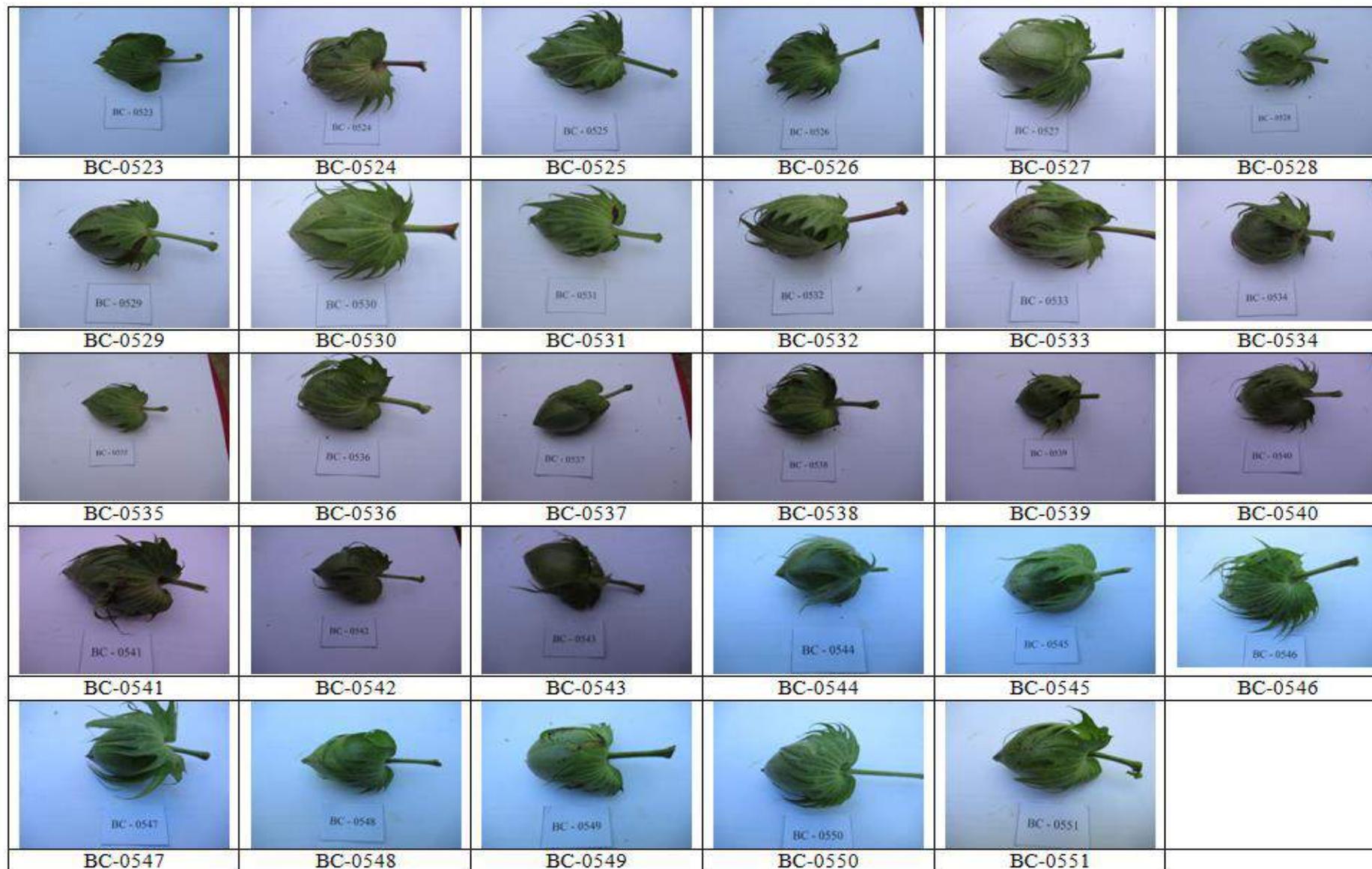


Fig. 109. Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021



Cont'd. Fig. 109. Boll shape of cotton genotypes, Cotton Research Center, Jagdishpur, Jashore, 2020-2021

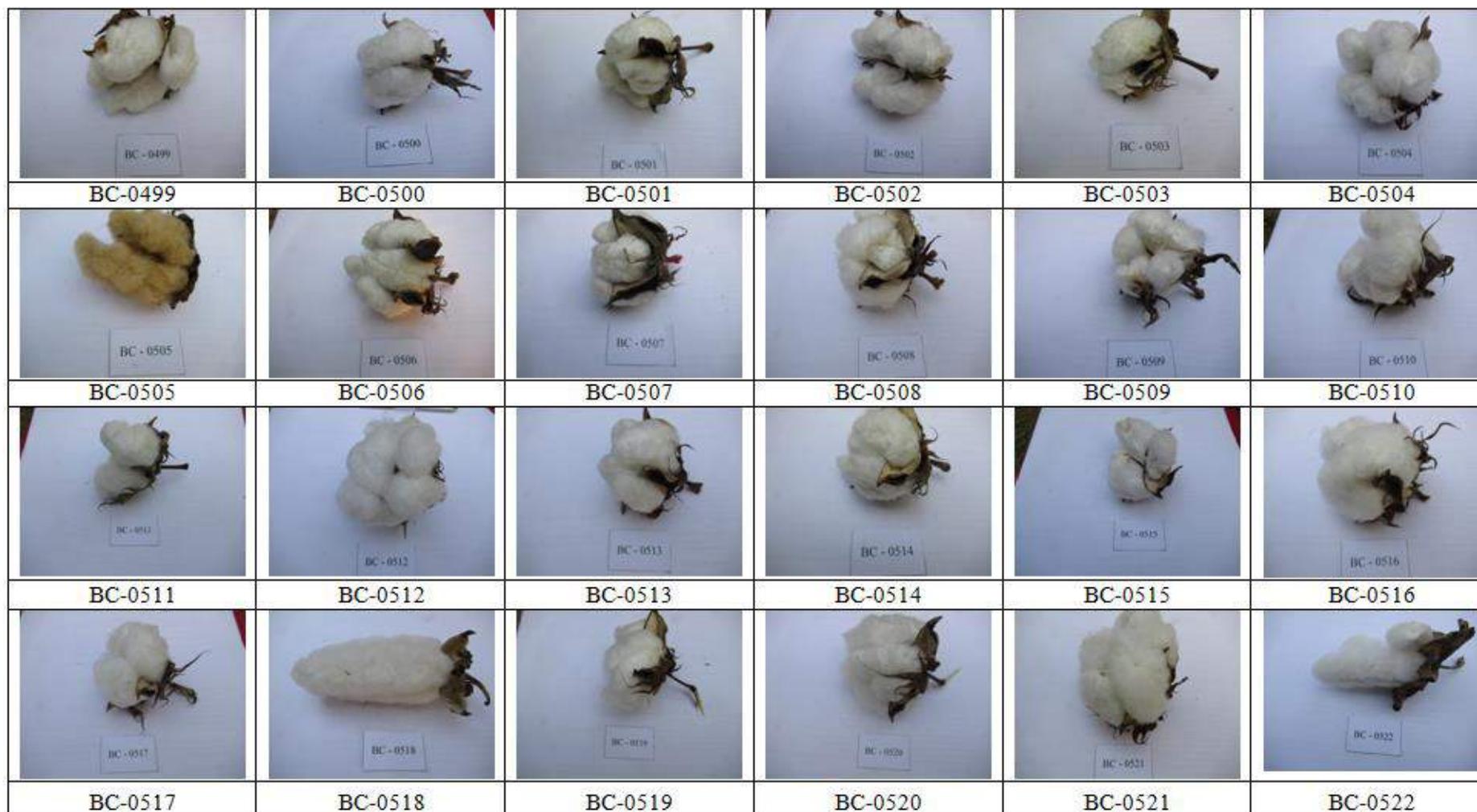
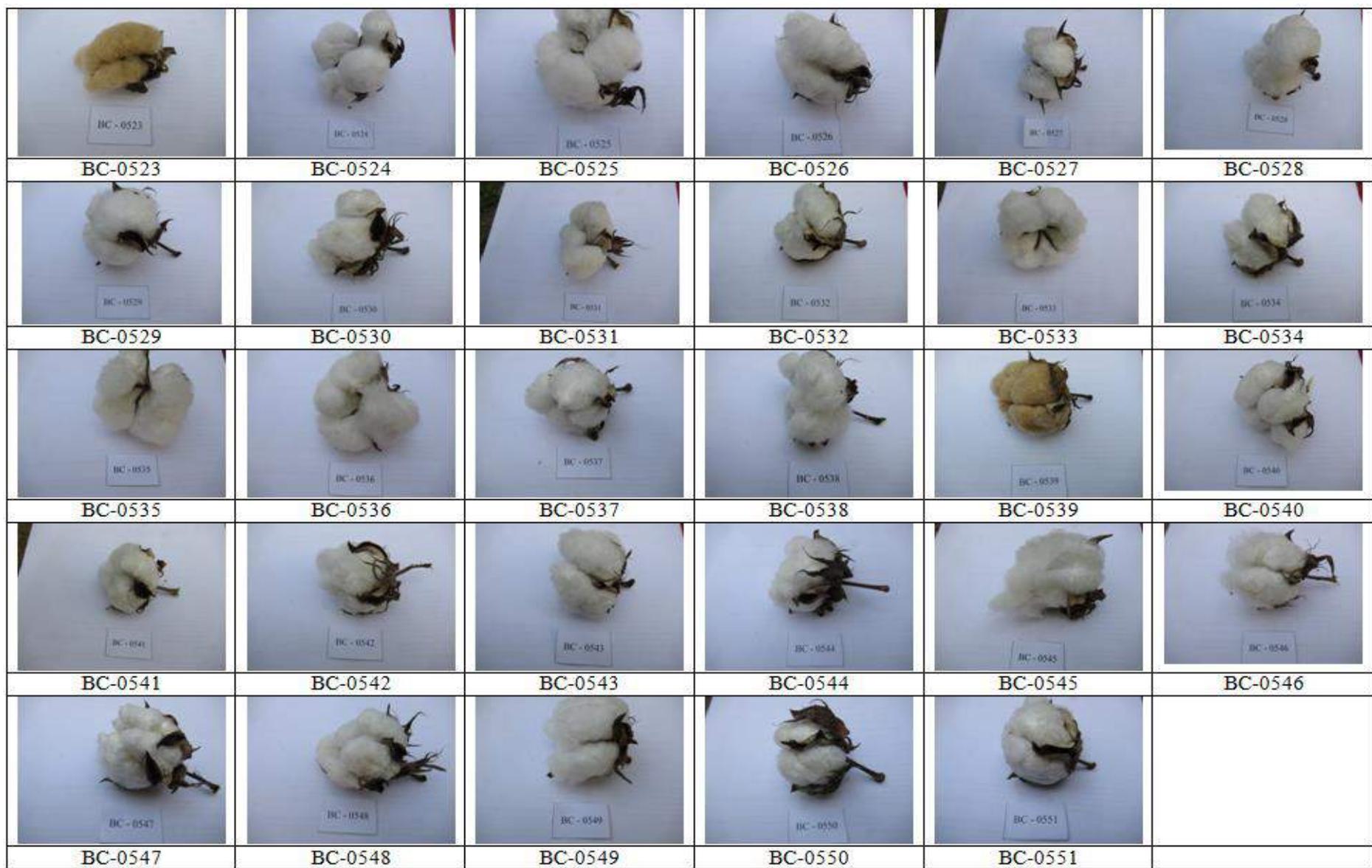


Fig. 110. Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021



Cont'd. Fig. 110. Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

11.7.1.2. Characterization of Cotton Genotypes on the Basis of Quantitative Characters (February 2018 to January 2021)

Quantitative Characters of 60 Cotton Genotypes (2018-19)

Range, mean, standard deviation (SD) and coefficient of variation (CV) of different quantitative characters of 60 cotton genotypes grown at the Cotton Research Center Jagadishpur, Jashore in 2019-2020 growing season are presented in Table 141. The list quantitative characteristics of 60 cotton genotypes are given in Table 142.

The range of number of primary and secondary fruiting branches/plant were 16.30 (BC-0223) to 29.80 (BC-0254) and 13.40 (BC-0240) to 35.30 (BC-0209), respectively with the mean values of 24.60 and 25.95 (Table 142 and 143). On an average, days to 50% flowering were 61.43 and range was 53 (BC-0214) to 68 (BC-0226, BC-0227 and BC-0231). In case of days to 50% boll split, the range was 121 (BC-0252) to 132 (BC-0226, BC-0227, BC-0231, BC-0266 and BC-0270) with an average of 128.37 days. The average number of bolls per plant was 36.91 and range was 22.50 (BC-0206) to 48.40 (BC-0222). Single boll weight ranged from 4.00-4.63 g. The range of plant height was 105.90 cm (BC-0223) to 236.50 cm (BC-0260). The average seed cotton yield was 2796.77 kg/ha and the range was 1728 (BC-0256) to 4691 kg/ha (BC-0220).

The highest variation was observed in seed cotton yield (CV- 23.03%) followed by number of secondary fruiting branches (21.49%), number of bolls (16.25%, number of vegetative branches/plant (14.86%) and plant height at harvest (14.69%). Comparatively, lowest variation was observed in the days to 50% boll split (2.11%) preceded single boll weight (4.29%), days to 50% flowering (6.44%), node number of 1st fruiting branch (7.19%) and number of primary fruiting branches/plant (8.96%).

There was not much variations among the tested cotton genotypes grown in Cotton Research Center Jagadishpur, Jashore in 2018-2019 growing season in respect of ginning characteristics; CV ranged from 1.58 (GOT%) to 8.19% (fuzz grade) (Table 141). The range of ginning out turn (GOT) and fuzz grade were 38.60% (BC-0260) to 41.00% (BC-0232) and 6 to 8, respectively. Seed index and lint index ranged 9.1 (BC-0204) to 12.0 g (BC-0227, BC-0233, BC-0240 & BC-0265) and 5.75g (BC-0204) to 8.08g (BC-0216), respectively.

Fiber characteristics also did not show much variation. Upper half mean length ranged from 29.93 mm (BC-0252) to 35.49 mm (BC-0206). The range of fiber strength and uniformity index BC-0260 (27.92 g/tex) to BC-0202 (36.70 g/tex) and 83.70% (BC-0252) to 86.05% (BC-0206), respectively. Average elongation and moisture were 6.0% and 6.84% respectively. The range of micronaire value was 3.06 µg/inch (BC-0256) to 4.87µg/inch (BC-0247) with an average of 3.78 µg/inch. Coefficient of variation (CV) ranged from 0.34 (UI) to 8.43% (micronaire value).

Table 141. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Centre, Jagadishpur, Jashore 2018-2019 season

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node no. of 1 st fruiting branch	5.80	8.50	7.24	0.52	7.19
No. of vegetative branches/plant	1.70	3.80	2.91	0.43	14.86
No. of primary fruiting branches/plant	16.30	29.80	24.60	2.20	8.96
No. of secondary fruiting branches/plant	13.40	35.30	25.95	5.57	21.49
Days to 50% flowering	53.00	68.00	61.43	3.95	6.44
Days to 50% boll split	121.00	132.00	128.37	2.71	2.11
Number of bolls/plant	22.50	48.40	36.91	6.00	16.25
Single boll weight (g)	4.00	4.63	4.32	0.19	4.29
Plant Population at Harvest (ha)	24691.00	27160.00	26830.90	637.35	2.38
Plant height at harvest (cm)	105.90	236.50	177.97	26.14	14.69
Seed cotton yield (kg/ha)	1728.00	4691.00	2796.77	643.99	23.03
Ginning traits					
GOT (%)	38.60	41.00	39.62	0.63	1.58
Seed Index (g)	9.10	12.00	10.77	0.64	5.92
Lint Index (g)	5.75	8.08	7.07	0.47	6.62
Fuzz Grade	6.00	8.00	7.17	0.59	8.19
Fiber traits					
Upper Half Mean Length (UHML) (mm)	29.93	35.49	32.72	0.84	2.56
Strength (g/tex)	27.92	36.70	32.67	1.83	5.61
Uniformity Index (UI)	83.70	86.05	85.40	0.29	0.34
Elongation (%)	5.48	7.01	6.00	0.29	4.88
Moisture (%)	6.35	7.25	6.84	0.17	2.51
Micronare Value (µg/inch)	3.06	4.87	3.78	0.32	8.43

Table 142. Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, in 2018-2019 season

Acc. No	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0201	7.70	2.80	23.50	19.20	66	129	25.60	4.22	27160	158.10	2667
BC-0202	7.90	3.20	23.00	22.50	65	130	38.70	4.30	27160	163.00	3235
BC-0203	7.80	3.10	23.20	21.60	60	129	32.60	4.00	25926	167.00	2469
BC-0204	7.60	3.30	21.90	25.60	62	129	41.70	4.10	27160	178.40	2963
BC-0205	8.00	3.30	25.80	28.90	64	130	40.40	4.60	27160	171.40	2864
BC-0206	7.00	2.40	21.10	13.80	64	129	22.50	4.30	25926	134.40	2346
BC-0207	7.50	2.90	25.30	24.20	60	127	35.60	4.08	27160	180.20	2370
BC-0208	7.60	2.80	25.20	27.10	60	128	34.40	4.40	27160	204.80	2864
BC-0209	8.50	3.60	26.10	34.90	56	126	28.90	4.00	27160	169.00	2222
BC-0211	7.50	3.50	25.70	33.20	65	131	33.60	4.02	27160	210.80	2222
BC-0212	7.70	2.90	26.10	25.60	54	125	33.40	4.18	27160	201.50	2988
BC-0214	7.80	2.90	26.10	23.20	53	127	34.40	4.40	27160	214.70	2963
BC-0215	7.80	3.10	26.10	30.90	58	128	37.50	4.51	27160	185.30	2716
BC-0216	7.50	3.10	25.30	24.90	57	125	41.90	4.16	27160	164.30	2716

Table 142 (Cont'd)

Acc. No	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0217	7.70	3.30	26.40	31.20	55	127	44.40	4.02	25926	186.40	3123
BC-0218	7.50	3.10	25.00	22.60	66	132	44.70	4.41	27160	185.20	3210
BC-0219	7.00	2.90	22.00	19.60	56	126	46.00	4.32	27160	134.70	3333
BC-0220	7.40	2.80	21.70	20.60	58	127	46.40	4.40	27160	152.10	4691
BC-0222	7.00	2.60	20.00	25.30	65	131	48.40	4.50	27160	156.50	3704
BC-0223	6.60	2.20	16.30	13.90	64	129	39.20	4.62	27160	105.90	4198
BC-0224	7.50	2.70	19.80	18.40	65	129	38.40	4.60	27160	114.00	3358
BC-0225	7.20	2.60	22.20	20.00	66	130	43.70	4.22	27160	138.10	2617
BC-0226	7.60	2.90	22.50	23.80	68	132	45.80	4.46	25926	142.70	2667
BC-0227	7.40	1.90	23.00	14.80	68	132	31.50	4.36	24691	167.40	2963
BC-0228	7.50	2.80	23.70	23.90	56	125	40.50	4.26	27160	166.70	2840
BC-0230	7.20	2.80	25.00	24.24	57	121	31.50	4.20	27160	189.60	2272
BC-0231	7.80	3.30	25.40	34.30	68	132	45.00	4.52	25926	181.10	2716
BC-0232	6.90	3.00	25.60	29.60	62	129	43.40	4.60	27160	175.90	2963
BC-0233	7.80	3.40	26.30	31.10	68	132	43.20	4.08	27160	187.70	3951
BC-0234	7.50	3.00	25.70	28.10	58	122	35.00	4.62	27160	205.90	4198
BC-0235	7.70	3.50	25.30	30.20	63	128	29.50	4.38	27160	196.80	2667
BC-0236	8.10	3.80	25.80	35.30	64	127	35.40	4.56	25926	210.60	3333
BC-0237	7.50	2.90	24.40	26.50	65	129	39.40	4.40	27160	179.30	3062
BC-0239	6.80	2.90	23.90	24.20	64	130	39.00	4.63	27160	169.20	2593
BC-0240	6.30	1.70	25.90	13.40	62	129	26.50	4.48	27160	182.80	2667
BC-0241	7.30	2.90	25.00	28.90	60	129	34.30	4.40	27160	190.00	2889
BC-0242	7.60	3.20	22.90	30.50	62	128	43.90	4.60	25926	177.50	3827
BC-0243	7.50	3.20	22.50	30.70	64	130	45.40	4.28	27160	152.00	3062
BC-0244	6.90	3.00	22.70	24.80	65	131	47.80	4.02	25926	144.30	3827
BC-0245	6.30	2.80	22.20	22.70	66	131	39.10	4.30	27160	147.50	2963
BC-0246	6.80	2.20	24.90	19.90	64	131	31.60	4.20	27160	161.90	3099
BC-0247	7.00	2.70	26.80	24.40	66	131	39.70	4.40	25926	176.00	2321
BC-0248	7.00	2.90	25.10	24.60	67	131	29.50	4.30	27160	174.70	2667
BC-0252	7.50	3.50	25.00	32.20	58	121	32.90	4.20	27160	175.80	2370
BC-0253	7.00	2.80	24.10	31.60	58	126	37.20	4.26	27160	171.50	2469
BC-0254	6.50	2.40	29.80	25.30	58	125	32.70	4.20	24691	214.90	2123
BC-0255	6.80	2.50	25.70	22.90	59	126	34.90	4.42	25926	176.10	1951
BC-0256	7.40	3.70	24.50	34.30	58	126	28.20	4.12	27160	169.60	1728
BC-0257	7.00	3.10	26.50	30.10	58	127	35.80	4.22	27160	185.20	2222
BC-0258	6.90	2.90	25.60	31.40	60	129	37.70	4.00	27160	177.40	1877
BC-0259	6.80	2.80	26.80	26.50	61	129	31.50	4.20	27160	218.40	1753
BC-0260	7.00	3.20	27.40	30.50	56	125	32.20	4.36	27160	236.50	2099
BC-0262	6.50	2.90	25.40	28.90	64	130	30.60	4.26	25926	185.20	2173
BC-0263	6.30	2.30	26.50	23.60	62	129	42.90	4.20	27160	216.50	2247
BC-0264	7.30	3.10	26.80	33.30	58	131	39.20	4.40	27160	210.40	2247
BC-0265	6.90	3.30	26.30	34.50	60	125	36.80	4.06	27160	208.70	1827
BC-0266	6.30	2.00	24.90	18.40	58	132	34.40	4.20	25926	185.50	1877
BC-0267	7.00	3.20	27.20	31.10	64	129	33.80	4.43	27160	215.30	2667
BC-0268	7.00	2.40	27.10	27.40	60	126	32.60	4.50	27160	206.00	3086
BC-0270	5.80	2.30	24.20	21.70	58	132	31.80	4.58	27160	169.70	3704

Table 142. Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2018-2019 season (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	(UHML) (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronaire Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0201	38.90	10.20	6.50	8	31.49	34.76	85.11	6.49	6.80	4.11
BC-0202	39.00	10.10	6.46	7	33.30	36.70	85.59	6.32	6.88	3.91
BC-0203	40.00	10.60	7.07	7	33.79	28.57	85.68	6.11	6.82	3.35
BC-0204	38.70	9.10	5.75	8	33.37	33.02	85.59	6.49	6.88	3.95
BC-0205	39.80	11.20	7.41	7	32.81	33.00	85.46	6.17	6.79	3.98
BC-0206	38.90	11.00	7.01	7	35.49	30.10	86.05	5.87	7.07	4.27
BC-0207	38.80	11.00	6.99	7	32.61	32.38	85.37	6.17	6.75	3.86
BC-0208	38.90	10.20	6.50	7	33.68	32.89	85.66	6.11	6.68	4.26
BC-0209	40.00	10.40	6.95	7	32.80	33.33	85.46	6.17	6.46	4.04
BC-0211	38.90	11.00	7.01	8	32.99	30.94	85.48	6.38	6.89	3.27
BC-0212	39.60	11.00	7.22	8	31.74	30.96	85.16	6.32	7.25	3.84
BC-0214	41.00	11.00	7.65	6	32.81	33.96	85.46	6.32	6.77	4.07
BC-0215	40.40	10.00	6.78	7	32.44	32.06	85.36	6.38	7.18	3.84
BC-0216	41.00	11.60	8.08	6	32.12	35.46	85.27	5.99	6.59	3.55
BC-0217	40.00	11.20	7.47	7	32.47	31.42	85.34	6.17	6.71	4.07
BC-0218	39.10	10.20	6.55	7	31.95	30.13	85.23	5.48	7.20	3.94
BC-0219	39.80	10.20	6.75	8	33.26	33.56	85.54	5.81	6.88	3.81
BC-0220	40.00	11.20	7.49	8	34.01	31.11	85.74	5.72	6.80	3.63
BC-0222	39.80	11.00	7.28	7	33.25	31.91	85.53	5.66	7.04	3.55
BC-0223	40.00	10.40	6.95	8	32.69	31.20	85.44	5.66	6.75	3.97
BC-0224	39.40	11.20	7.29	7	32.00	31.93	85.22	5.87	6.89	3.78
BC-0225	39.00	11.00	7.05	7	33.07	32.01	85.52	5.99	6.68	4.14
BC-0226	40.00	10.00	6.67	7	33.36	32.85	85.58	5.72	6.80	3.42
BC-0227	38.90	12.00	7.65	7	32.77	33.58	85.44	5.93	6.97	4.11
BC-0228	39.60	11.00	7.22	8	33.55	31.64	85.63	5.93	6.82	3.53
BC-0230	39.00	10.20	6.54	8	33.71	34.32	85.64	6.22	6.98	3.79
BC-0231	39.00	11.00	7.04	8	33.80	35.79	85.68	6.22	6.84	3.50
BC-0232	40.10	10.00	6.70	7	32.33	31.31	85.34	5.99	6.88	3.95
BC-0233	39.00	12.00	7.69	8	32.25	31.35	85.30	5.60	6.88	3.60
BC-0234	39.80	11.00	7.28	7	32.27	32.38	85.31	5.55	6.84	3.65
BC-0235	41.00	10.00	6.96	6	31.84	31.76	85.18	5.55	6.64	3.73
BC-0236	39.00	11.00	7.04	7	32.70	32.01	85.44	5.66	7.15	3.46
BC-0237	40.00	10.20	6.82	6	31.84	33.42	85.18	5.99	6.66	3.71
BC-0239	38.60	11.00	6.93	8	33.09	33.10	85.49	6.22	7.00	3.98
BC-0240	39.60	12.00	7.88	7	33.53	35.52	85.62	6.11	6.71	3.47
BC-0241	40.00	10.00	6.68	7	31.71	31.13	85.15	5.93	6.35	3.74
BC-0242	40.00	10.20	6.81	7	33.74	30.55	85.66	6.05	6.71	3.93
BC-0243	38.90	11.60	7.39	7	33.57	32.89	85.64	5.55	6.89	3.82
BC-0244	40.70	11.00	7.57	6	33.12	30.02	85.51	5.99	6.71	4.16
BC-0245	39.80	10.20	6.77	7	32.19	30.96	85.31.	5.55	7.05	3.57
BC-0246	39.00	10.20	6.53	8	32.99	32.29	85.48	5.99	6.66	3.98
BC-0247	39.00	10.40	6.66	8	32.55	30.80	85.38	5.81	6.82	4.87

Table 142 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	(UHML) (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronaire Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0248	40.60	10.00	6.84	7	32.71	33.83	85.42	5.81	6.55	3.62
BC-0252	39.60	9.80	6.43	8	29.93	34.52	83.70	6.32	6.80	4.02
BC-0253	40.00	10.80	6.22	7	32.55	32.58	85.38	6.17	6.77	3.74
BC-0254	40.20	11.60	7.82	7	32.13	33.16	85.28	5.81	7.02	3.41
BC-0255	40.20	11.00	7.40	7	33.53	30.19	85.62	5.81	6.91	3.17
BC-0256	40.10	11.20	7.51	7	31.27	32.38	85.19	5.60	7.00	3.06
BC-0257	40.00	11.80	7.88	7	31.86	32.32	85.19	5.99	6.79	3.63
BC-0258	39.40	10.60	6.91	7	31.82	33.98	85.20	5.93	6.70	3.58
BC-0259	39.10	10.80	6.94	7	32.44	34.10	85.36	5.93	6.80	3.63
BC-0260	38.60	11.00	6.92	7	33.20	27.92	85.54	5.60	6.75	3.31
BC-0262	39.60	11.30	7.43	7	32.28	34.21	85.32	6.22	6.66	3.32
BC-0263	40.00	10.00	6.68	6	33.15	36.16	85.52	6.32	7.02	4.06
BC-0264	39.00	11.00	7.05	7	32.46	34.00	85.34	6.05	6.91	3.89
BC-0265	40.00	12.00	8.02	8	32.73	35.92	85.43	6.22	7.06	3.70
BC-0266	39.00	11.00	7.05	7	32.19	34.94	85.31	6.11	6.82	3.50
BC-0267	40.00	10.10	6.74	7	31.86	33.20	85.19	5.99	6.89	4.38
BC-0268	40.10	11.20	7.51	7	33.54	34.70	85.63	6.17	6.89	3.74
BC-0270	39.80	11.40	7.54	7	32.48	32.75	85.34	7.01	6.77	3.78

Quantitative Characteristics of 59 Cotton Genotypes (2019-2020)

The quantitative variations of 59 cotton genotypes grown at the Cotton Research Center Jagadishpur, Jashore in 2019-2020 growing season are shown in Table 143. Quantitative characters are enlisted in Table 144.

The number of primary and secondary fruiting branches per plant ranged from 16.10 (BC-0434) to 25.40 (BC-0344) and 1.10 (BC-0380) to 22.70 (BC-0375), respectively. On an average, days to 50% flowering were 61 and range was 56 (BC-0421) to 67 (BC-0422). In case of days to 50% boll split, the range was 115 (BC-0384) to 131 (BC-0367 and BC-0400). The average number of bolls per plant was 34.43 and range was 20.50 (BC-0404) to 43.40 (BC-0425). The range of plant height was 105.50 cm (BC-0396) to 186.20 cm (BC-0381) with the mean of 138.62 cm. mean single boll weight was 3.93g. The average seed cotton yield was 2382.97 kg/ha and range was 1457 kg/ha (BC-0359) to 3407 kg/ha (BC-0409).

The highest variation was observed in the number of secondary fruiting branches (CV- 47.76%) followed by number of vegetative branches/plant (42.42%). The lowest variation was observed in the days to 50% boll split (3.47%) preceded by days to 50% flowering (5.13%), single boll weight (6.61%) and node number of 1st fruiting branch (8.36%).

The ginning characteristics of 59 cotton genotypes are given in Table 144. The range of ginning out turn (GOT) and fuzz grade were 38.00% (BC-0410) to 42.00% (BC-0365 and BC-0427) and 7 to 8, respectively. Seed index and lint index ranged from 8.0g (BC-0396) g to 13.0 g (BC-0410) and 5.55g (BC-0396) to 8.07g (BC-0355), respectively. The highest variation was observed in the seed index (9.00%) character of cotton genotype.

There was not much variation among the fiber characteristics. Micronaire value exhibited maximum variation (CV-12.56%). The range of was 3.38 µg/inch (BC-0376) to 6.05µg/inch (BC-0368).

Table 143. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Centre, Jagadishpur, Jashore, 2019-2020

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node number of 1 st fruiting branch	5.40	7.60	6.27	0.52	8.36
No. of vegetative branches/plant	0.20	3.30	1.58	0.67	42.42
No. of primary fruiting branches/plant	16.10	25.40	20.02	2.17	10.82
No. of secondary fruiting branches/plant	1.10	22.70	9.98	4.76	47.76
Days to 50% flowering	56.00	67.00	61.00	3.13	5.13
Days to 50% boll split	115.00	131.00	123.39	4.28	3.47
Number of bolls/plant	20.50	43.40	34.43	4.60	13.37
Single boll weight (g)	3.10	4.40	3.93	0.26	6.61
Plant Population at Harvest (ha)	20988.00	27160.00	26616.07	1240.16	4.66
Plant height at harvest (cm)	105.50	186.20	138.62	19.64	14.17
Seed cotton yield (kg/ha)	1457.00	3407.00	2382.97	442.99	18.59
Ginning traits					
GOT (%)	38.00	42.00	40.08	1.05	2.63
Seed Index (g)	8.00	13.00	10.74	0.97	9.00
Lint Index (g)	5.55	8.07	7.17	0.57	7.97
Fuzz Grade	7.00	8.00	7.76	0.43	5.53
Fiber traits					
Upper Half Mean Length (mm)	25.17	33.37	29.83	1.75	5.85
Strength (g/tex)	24.01	33.24	27.67	1.93	6.96
Uniformity Index (UI)	78.70	85.59	96.51	99.82	1.91
Elongation (%)	3.74	7.12	6.33	0.50	7.87
Moisture (%)	5.20	7.09	6.22	0.47	7.51
Micronaire Value (µg/inch)	3.38	6.05	4.66	0.59	12.56

Table 144. Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0344	6.10	1.90	25.40	12.60	58	120	36.00	4.20	27160	164.60	2988
BC-0346	6.50	1.30	21.40	11.60	65	129	41.60	3.80	27160	129.00	2913
BC-0347	7.20	2.00	23.70	11.40	64	128	24.20	3.10	27160	156.10	1716
BC-0351	6.20	1.80	21.10	15.00	56	118	33.40	3.80	27160	147.30	3012
BC-0354	6.10	1.30	19.30	9.90	58	121	37.20	3.90	27160	123.20	2642
BC-0355	6.10	1.00	16.70	5.90	56	117	24.00	4.10	27160	119.90	2494
BC-0356	6.30	1.30	22.30	9.70	56	120	38.70	3.60	27160	156.70	1914

Table 144 (Cont'd)

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0358	5.80	0.90	17.50	5.60	62	117	32.60	4.00	27160	115.00	2099
BC-0359	6.00	1.90	17.50	13.70	65	129	33.00	3.50	20988	110.00	1457
BC-0360	5.70	1.40	20.40	12.50	62	128	35.30	3.76	25926	119.20	1531
BC-0362	6.20	1.60	22.40	12.80	65	127	32.00	4.20	27160	142.30	2716
BC-0363	7.00	1.20	19.40	7.40	66	128	31.60	4.00	27160	127.60	2395
BC-0364	6.20	0.80	21.20	3.10	64	127	36.10	3.90	27160	139.20	2148
BC-0365	5.40	1.00	21.00	4.00	61	127	40.00	3.86	27160	138.20	2506
BC-0367	5.90	1.70	19.50	11.70	62	131	36.10	3.90	27160	135.10	2864
BC-0368	6.50	1.90	21.70	14.20	60	122	34.40	3.80	25926	138.60	1975
BC-0369	6.30	1.90	22.20	12.10	67	129	38.80	3.90	27160	152.40	2024
BC-0371	7.30	2.90	20.00	18.00	59	123	34.10	3.70	27160	118.70	2395
BC-0372	6.00	1.60	20.90	10.70	62	121	40.20	4.00	27160	113.70	2222
BC-0373	5.60	2.10	18.90	15.10	60	121	37.00	4.20	27160	133.40	1876
BC-0374	7.60	2.20	22.10	15.80	58	121	36.30	4.30	27160	159.60	2444
BC-0375	7.30	3.30	21.90	22.70	59	120	37.80	3.60	27160	150.40	2148
BC-0376	6.00	0.40	22.30	3.00	58	119	36.30	4.00	27160	152.20	2394
BC-0380	6.20	0.20	23.80	1.10	60	126	37.10	3.80	27160	166.30	2667
BC-0381	6.10	1.10	24.40	5.40	62	125	39.00	3.86	27160	186.20	2432
BC-0383	6.80	2.70	19.80	17.10	58	117	42.50	4.00	27160	149.20	2814
BC-0384	6.80	2.30	22.50	10.90	56	115	33.00	3.60	24691	135.70	1950
BC-0385	7.30	2.60	19.00	19.80	60	119	36.60	3.80	27160	126.20	2296
BC-0388	5.80	1.00	16.60	5.50	64	127	31.50	4.00	25926	110.30	1679
BC-0390	5.90	1.40	18.50	8.40	58	120	34.40	4.20	27160	106.00	2394
BC-0392	6.60	2.00	18.80	16.10	60	123	35.20	4.40	27160	133.30	2667
BC-0396	6.10	1.90	16.80	12.30	58	115	34.60	3.96	27160	105.50	2716
BC-0397	5.70	0.40	20.40	2.50	56	115	33.30	4.00	25926	113.50	2691
BC-0399	5.70	0.50	18.90	3.10	60	119	33.90	4.20	27160	120.60	2691
BC-0400	7.60	2.50	23.40	14.50	62	131	34.30	3.60	27160	171.10	1654
BC-0401	6.50	2.40	19.70	15.60	64	128	39.70	3.70	27160	134.20	2691
BC-0403	6.50	0.60	21.70	3.60	62	128	32.70	4.20	27160	168.90	2694
BC-0404	5.50	0.40	21.00	1.40	61	123	20.50	3.50	27160	157.30	1555
BC-0405	6.10	1.40	21.40	8.30	56	121	32.70	4.28	27160	181.10	1654
BC-0406	5.90	1.20	21.10	7.90	65	120	40.80	4.10	25926	140.10	2716
BC-0409	6.00	1.10	20.60	5.40	56	119	32.40	4.20	27160	155.90	3407
BC-0410	5.80	2.50	20.80	14.60	57	120	35.40	4.40	27160	152.60	2814
BC-0414	7.00	2.50	18.60	13.80	60	125	33.70	3.70	27160	142.50	2716
BC-0415	6.50	2.00	20.30	10.30	64	128	33.00	3.80	27160	151.90	3062
BC-0417	6.70	1.50	19.20	5.70	65	125	36.60	3.60	27160	143.80	2889
BC-0418	6.70	1.40	19.40	7.30	62	124	28.00	3.90	22222	179.60	2222
BC-0419	6.30	1.70	19.09	11.00	61	123	34.50	4.20	27160	144.10	2370
BC-0420	6.10	1.80	19.07	12.40	62	124	33.50	4.00	27160	159.20	2172
BC-0421	5.70	1.10	17.00	7.40	56	119	37.30	4.10	25926	137.70	2419
BC-0422	6.50	2.00	16.60	13.60	67	129	39.30	3.90	24691	127.90	2309

Table 144 (Cont'd)

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0424	5.80	1.40	16.30	8.80	62	125	38.50	4.00	23457	107.80	2394
BC-0425	6.50	2.20	20.40	12.60	62	124	43.40	4.40	24691	133.90	2963
BC-0427	5.90	1.50	19.00	9.60	62	125	27.70	3.90	27160	129.40	2716
BC-0429	6.40	1.70	17.60	8.50	65	128	28.90	3.80	27160	131.20	2222
BC-0430	6.20	2.00	16.90	10.10	62	123	28.70	3.50	27160	116.40	2469
BC-0431	5.80	1.20	20.40	7.00	64	128	33.00	3.80	27160	129.20	2074
BC-0432	5.80	1.00	17.60	5.60	64	127	35.30	4.00	25926	137.50	1877
BC-0433	6.10	0.90	19.40	5.30	63	126	24.50	4.00	27160	125.90	1827
BC-0434	5.70	1.50	16.10	7.60	60	123	29.10	4.30	25926	124.40	2839

Table 144. Quantitative characteristics of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	(UHML) (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0344	40.00	11.00	7.34	8	31.51	30.21	85.12	6.49	6.05	3.77
BC-0346	41.00	11.00	7.67	7	28.21	27.81	82.10	6.38	5.94	5.09
BC-0347	40.00	11.00	7.34	8	29.73	25.27	83.55	6.32	6.71	5.60
BC-0351	39.00	12.00	7.68	8	31.41	29.56	85.07	6.94	6.64	4.72
BC-0354	38.20	11.60	7.12	8	31.82	28.38	85.20	6.67	6.88	4.66
BC-0355	41.00	11.60	8.07	8	31.26	29.83	85.03	6.62	6.77	4.66
BC-0356	39.60	10.00	6.56	7	31.14	28.34	85.00	6.38	6.71	4.45
BC-0358	39.40	10.00	6.51	8	30.85	28.82	84.51	6.22	6.70	4.49
BC-0359	39.00	11.00	7.04	8	31.67	27.91	85.16	6.67	6.66	5.24
BC-0360	38.10	12.00	7.36	8	26.81	26.29	80.64	6.38	6.61	5.63
BC-0362	40.00	11.00	7.35	8	30.41	27.98	84.12	6.74	6.61	5.60
BC-0363	41.00	9.60	6.67	7	30.72	27.77	84.41	6.32	7.09	4.89
BC-0364	41.00	9.00	6.26	8	30.02	24.96	83.81	5.81	6.75	4.78
BC-0365	42.00	9.00	6.52	7	30.33	27.07	84.08	6.32	6.59	5.54
BC-0367	40.00	9.00	6.01	8	29.28	27.95	83.13	6.49	6.55	5.70
BC-0368	39.00	10.00	6.40	8	26.21	26.40	79.97	6.56	6.55	6.05
BC-0369	39.40	11.00	7.16	8	27.85	25.23	81.72	6.17	6.52	5.75
BC-0371	40.60	11.20	7.66	7	32.29	26.58	85.32	6.38	6.52	4.89
BC-0372	41.00	11.00	7.65	8	30.79	29.92	84.48	7.01	6.48	4.91
BC-0373	38.30	12.00	7.37	8	31.07	29.73	85.00	6.43	6.41	4.91
BC-0374	41.00	11.00	7.65	7	30.21	30.06	83.98	6.32	6.34	3.79
BC-0375	39.40	11.00	7.16	8	28.85	25.44	82.74	5.66	6.32	3.78
BC-0376	40.40	11.40	7.74	8	31.31	26.19	85.05	5.60	6.37	3.38

Table 144 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	(UHML) (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronaire Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0380	39.00	9.00	5.76	8	30.19	28.20	83.97	6.49	6.21	3.39
BC-0381	41.00	11.00	7.65	7	31.56	27.82	85.14	6.17	6.12	4.14
BC-0383	40.00	11.00	7.34	8	32.22	28.03	85.29	6.32	6.03	4.21
BC-0384	38.20	12.00	7.36	8	28.18	24.01	82.08	6.56	6.05	4.26
BC-0385	39.00	11.60	7.04	8	30.20	27.75	83.97	6.38	5.69	4.21
BC-0388	39.70	12.00	7.91	8	29.84	25.16	83.65	5.66	5.63	4.22
BC-0390	40.00	11.00	7.35	7	25.17	25.16	78.70	5.66	5.20	4.17
BC-0392	41.00	9.70	6.75	7	28.04	26.13	81.95	5.87	5.29	4.21
BC-0396	41.00	8.00	5.55	8	27.20	24.19	81.07	6.56	6.98	4.22
BC-0397	41.00	11.00	7.65	8	27.97	25.77	81.87	6.05	6.82	4.25
BC-0399	41.00	11.00	7.65	8	27.03	26.18	80.91	6.62	6.73	4.26
BC-0400	41.60	9.80	6.99	8	32.37	27.98	85.33	6.32	6.64	4.91
BC-0401	41.00	10.00	6.96	8	31.55	26.32	85.13	6.17	6.62	4.50
BC-0403	40.00	10.00	6.67	8	31.77	27.50	85.17	6.22	6.59	5.00
BC-0404	39.00	11.80	7.55	8	27.96	25.58	81.87	6.11	6.57	4.98
BC-0405	40.00	11.00	7.34	8	30.50	27.55	84.23	6.22	6.52	4.59
BC-0406	39.60	11.40	7.48	8	28.59	26.71	82.48	6.05	6.58	4.63
BC-0409	41.60	10.00	7.13	8	30.59	26.45	84.31	5.93	5.54	4.57
BC-0410	38.00	13.00	7.98	8	29.89	26.37	82.67	5.81	5.26	4.85
BC-0414	40.00	12.00	8.01	8	29.17	26.85	85.03	5.81	6.01	4.80
BC-0415	40.60	11.60	7.94	8	29.88	30.34	83.67	6.22	5.98	3.49
BC-0417	41.70	10.60	7.59	8	27.74	25.96	81.61	6.38	5.94	5.17
BC-0418	38.40	12.00	7.36	8	33.37	31.83	85.59	3.74	5.90	3.93
BC-0419	39.00	11.00	7.04	7	29.01	28.03	82.90	6.43	5.94	4.70
BC-0420	39.80	10.00	6.62	8	32.33	31.03	85.34	6.67	5.87	4.28
BC-0421	39.70	10.40	6.85	8	27.66	27.46	81.56	7.01	5.85	4.53
BC-0422	41.00	9.00	6.26	7	27.91	28.34	81.83	6.56	5.87	4.59
BC-0424	40.60	10.80	7.39	8	29.74	27.14	83.56	6.38	5.83	4.55
BC-0425	40.90	10.80	7.48	7	28.54	27.58	82.45	6.49	5.83	4.91
BC-0427	42.00	10.60	7.68	8	28.66	27.65	82.55	6.62	5.80	5.06
BC-0429	38.60	11.00	6.92	7	29.96	30.94	83.78	7.12	5.80	4.93
BC-0430	40.00	10.00	6.67	8	30.76	30.84	84.43	7.07	5.76	5.00
BC-0431	41.00	11.00	7.65	8	31.32	33.24	85.06	6.80	5.72	4.28
BC-0432	41.60	11.00	7.84	8	31.21	28.64	85.00	6.94	5.72	5.13
BC-0433	40.00	10.00	6.67	7	28.30	27.27	82.19	6.49	5.56	5.21
BC-0434	39.70	10.00	6.59	8	29.72	28.95	83.41	6.61	5.84	4.66

Quantitative Characteristics Cotton Genotypes (2020-2021)

The quantitative variations of 53 cotton genotypes grown at the Cotton Research Center Jagdishpur, Jashore in 2020-2021 growing season are shown in Table 145. Quantitative characteristics are enlisted Table 146. The range of number of primary and secondary fruiting branches per plant were 16.50 (BC-0516) to 25.50 (BC-0516) and 3.0 (BC-0548) to 25.50 (BC-0523), respectively. On an average, days to 50% flowering were 62 and range was 57 (BC-0512 and BC-0517) to 66 (BC-0548). In case of days to 50% boll split, the range was found 110 (BC-0521) to 123 (BC-0518 and BC-0522). The average number of bolls per plant was 32.84 and range was 17.70 (BC-538) to 44.90 (BC-0550). The range of plant height was

127.10 cm (BC-0518) to 200.30 cm (BC-0522) and average single boll weight was 4.65g. The average seed cotton yield was found 2518.47 kg/ha and range was 1091 kg/ha (BC-0505) to 3254 kg/ha (BC-0521). The highest variation was observed in the number of secondary fruiting branches/plant (CV-35.97%) followed by number of vegetative. The lowest variation was observed in the days to 50% boll split (2.24%). The range of ginning out turn (GOT) and fuzz grade were 36.00% (BC-0535) to 43.00% (BC-0522) and 7 to 8 respectively. Seed index and lint index ranged from 8.0g (BC-0505, BC-0518, BC-0522 and BC-0523) to 14.0 g (BC-0519, BC-0535, BC-0536 and BC-0542) and 5.56g (BC-0505 and BC-0518) to 9.12g (BC-0512), respectively. There was not much variation in fiber characteristics of tested cotton genotypes.

Table 145. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Centre, Jagadishpur, Jashore, 2020-2021

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node no. of 1 st fruiting branch	5.90	9.30	6.96	0.67	9.68
No. of vegetative branches/plant	0.60	3.40	2.03	0.64	31.51
No. of primary fruiting branches/plant	16.50	25.50	20.85	1.91	9.18
No. of secondary fruiting branches/plant	3.00	25.50	11.70	4.21	35.97
Days to 50% flowering	57.00	66.00	62.55	2.28	3.65
Days to 50% boll split	110.00	123.00	116.96	2.62	2.24
Number of bolls/plant	17.70	44.90	32.84	6.11	18.60
Single boll weight (g)	3.60	5.20	4.65	0.33	7.06
Plant Population at Harvest (ha)	12346.00	27160.00	25878.94	2283.53	8.82
Plant height at harvest (cm)	127.10	200.30	159.87	18.32	11.46
Seed cotton yield (kg/ha)	1091.00	3254.00	2518.47	474.14	18.83
Ginning traits					
GOT (%)	36.00	43.00	39.63	1.53	3.86
Seed Index (g)	8.00	14.00	12.07	1.43	11.86
Lint Index (g)	5.56	9.12	7.90	0.71	8.94
Fuzz Grade	6.00	8.00	7.70	0.54	7.02
Fiber traits					
Upper Half Mean Length (mm)	30.44	36.18	33.71	1.32	3.92
Strength (g/tex)	25.16	31.09	28.67	1.51	5.27
Uniformity Index (UI)	81.70	86.29	85.11	0.97	1.14
Elongation (%)	5.62	7.03	6.33	0.36	5.67
Moisture (%)	6.64	7.61	7.02	0.21	3.04
Micronare Value (µg/inch)	4.25	5.60	5.01	0.31	6.26

Table 146. Quantitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary fruiting Branches/Plant	No. of Secondary fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0499	6.50	2.00	23.30	9.70	63	117	32.00	4.80	25926	180.30	2849
BC-0500	6.50	2.50	19.90	13.20	64	118	19.20	4.60	27160	152.40	2768
BC-0501	6.40	1.50	18.90	9.90	63	116	21.30	4.80	24691	170.70	2574
BC-0502	6.30	1.60	19.30	10.30	63	117	21.20	4.60	24691	146.40	2768

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary fruiting Branches/Plant	No. of Secondary fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0503	6.20	1.80	20.70	10.30	65	119	21.90	4.70	25926	150.00	1715
BC-0504	6.40	1.80	17.00	11.90	63	118	23.60	4.90	24691	138.20	2719
BC-0505	6.90	2.70	25.50	19.20	65	119	27.70	4.00	12346	187.90	1091
BC-0506	6.60	1.70	18.00	9.00	64	117	28.90	4.80	27160	142.10	2719
BC-0507	7.00	2.20	20.60	13.10	63	119	30.80	5.00	27160	152.10	3011
BC-0508	6.40	1.50	21.90	9.00	65	119	31.40	4.80	24691	175.70	2557
BC-0509	6.10	1.60	20.00	9.20	64	118	30.10	4.70	24691	134.20	2525
BC-0510	6.40	1.30	18.10	5.90	65	117	29.70	4.50	27160	137.00	2606
BC-0511	6.00	0.80	22.20	4.30	61	116	32.00	4.80	27160	159.20	2557
BC-0512	6.40	1.40	20.50	7.20	57	113	29.00	4.60	27160	141.80	2849
BC-0513	6.90	1.70	21.00	8.60	58	113	30.40	4.20	27160	136.10	2201
BC-0514	7.20	2.20	22.10	12.60	63	117	30.60	4.40	27160	154.30	2395
BC-0515	7.80	2.10	20.90	11.90	61	116	28.50	4.50	24691	160.40	1958
BC-0516	7.40	2.10	16.50	10.80	61	117	31.90	4.70	24691	130.30	2353
BC-0517	6.90	1.70	21.50	11.30	57	111	30.40	4.80	27160	156.40	3197
BC-0518	7.70	2.60	24.00	20.90	59	123	31.40	3.80	24691	127.10	2353
BC-0519	7.60	3.10	21.70	14.50	58	112	31.00	4.70	27160	140.10	2913
BC-0520	7.20	2.10	21.40	12.10	59	111	31.80	4.80	24691	160.40	3108
BC-0521	6.80	1.70	18.70	10.60	61	110	39.30	5.00	27160	144.20	3254
BC-0522	8.30	3.40	25.10	20.80	64	123	38.00	4.20	27160	200.30	1877
BC-0523	9.30	3.40	22.60	25.50	64	121	37.40	3.60	22222	174.40	1354
BC-0524	6.60	1.90	20.70	11.50	63	117	31.90	5.00	27160	154.60	2889
BC-0525	5.90	1.10	20.00	7.00	64	118	32.20	5.20	24691	140.00	2768
BC-0526	6.30	1.50	20.10	8.30	59	115	33.40	4.60	24691	141.50	2808
BC-0527	6.40	1.20	20.50	8.50	65	117	37.20	4.80	27160	163.30	2541
BC-0528	6.70	1.10	19.80	7.20	63	118	42.30	4.50	27160	144.10	3011
BC-0529	6.20	1.80	19.90	11.60	61	117	40.10	4.00	27160	147.80	2865
BC-0530	7.00	2.20	23.50	14.50	65	118	37.00	5.10	24691	165.40	2735
BC-0531	6.70	1.70	20.20	10.90	61	116	38.80	5.00	27160	145.20	2768
BC-0532	6.90	1.70	18.60	8.50	64	117	39.50	4.60	24691	147.80	2128
BC-0533	7.40	2.00	20.80	9.30	65	118	39.40	4.50	24691	157.70	2444
BC-0534	7.70	2.90	22.10	13.50	65	119	37.70	4.60	27160	177.60	2379
BC-0535	6.50	1.50	19.40	7.50	61	115	37.10	4.90	27160	153.20	3076
BC-0536	7.30	2.20	21.70	12.00	63	117	38.20	4.90	24691	165.70	2509
BC-0537	7.80	2.90	21.30	15.90	61	115	36.10	4.70	27160	176.00	2817
BC-0538	7.90	2.90	19.90	15.50	65	114	17.70	4.40	24691	170.60	1164
BC-0539	7.60	1.70	22.80	12.50	61	113	32.10	4.40	24691	166.50	1731
BC-0540	7.10	2.20	21.00	12.10	65	117	33.60	4.90	27160	187.80	2800
BC-0541	6.60	1.60	21.70	8.40	64	118	41.50	4.80	24691	170.70	2428
BC-0542	7.60	2.90	22.10	14.20	61	117	33.90	4.90	27160	157.30	2420
BC-0543	7.50	2.70	20.50	14.00	62	117	40.70	4.70	27160	162.10	2201
BC-0544	7.60	2.70	21.00	15.70	65	119	26.80	4.90	25926	179.70	2493
BC-0545	7.30	2.70	18.40	13.30	63	118	39.30	5.20	27160	161.70	2136
BC-0546	5.90	2.60	19.60	14.00	62	119	31.30	4.60	27160	163.20	2622
BC-0547	6.90	2.20	17.40	12.10	65	118	27.30	4.20	27160	151.50	2322
BC-0548	6.20	0.60	21.90	3.00	66	119	38.80	4.60	27160	184.60	2849

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary fruiting Branches/Plant	No. of Secondary fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0549	7.20	2.70	21.60	16.60	61	118	35.90	4.70	27160	189.50	3011
BC-0550	7.20	1.50	24.00	5.40	63	119	44.90	5.00	27160	199.40	2606
BC-0551	7.70	2.60	23.10	15.30	62	119	36.20	4.50	27160	196.40	2687

Table 146. Quantitative characters of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0499	40.00	12.00	8.01	8	33.48	29.21	85.60	6.35	7.02	5.13
BC-0500	39.60	12.00	7.88	8	34.28	27.07	84.79	6.45	6.95	4.98
BC-0501	38.00	13.00	7.98	8	34.90	26.27	85.93	6.32	6.86	4.78
BC-0502	39.60	12.00	7.88	7	35.03	28.56	83.95	6.88	7.38	4.72
BC-0503	38.00	12.80	7.85	8	31.77	28.30	85.17	6.69	6.91	5.21
BC-0504	38.60	12.00	7.55	8	31.15	29.10	85.01	6.56	6.82	5.28
BC-0505	41.00	8.00	5.56	7	-	-	-	-	-	-
BC-0506	39.70	13.00	8.57	8	32.31	28.30	84.39	6.38	6.78	5.30
BC-0507	40.00	12.60	8.41	8	32.06	28.72	85.31	6.20	7.34	5.11
BC-0508	39.00	12.00	7.68	8	33.60	27.91	83.68	6.55	7.06	4.70
BC-0509	41.30	11.00	7.75	8	33.80	26.25	84.77	6.88	6.77	5.11
BC-0510	41.00	11.80	8.21	8	34.47	27.90	85.90	6.74	7.09	5.21
BC-0511	38.00	13.00	7.98	8	33.66	27.67	85.71	6.32	7.13	5.39
BC-0512	41.20	13.00	9.12	8	34.12	25.90	82.95	5.95	7.29	5.21
BC-0513	40.00	11.00	7.34	7	34.13	28.30	85.82	6.30	7.15	4.25
BC-0514	41.60	11.00	7.84	8	33.83	29.07	84.75	6.45	6.95	4.55
BC-0515	40.00	12.00	8.01	7	33.47	26.23	85.66	6.56	7.61	4.81
BC-0516	40.00	12.00	8.01	8	33.03	29.10	84.56	6.14	7.24	5.45
BC-0517	40.00	12.00	8.01	8	33.12	28.73	85.57	6.33	7.42	4.85
BC-0518	41.00	8.00	5.56	7	-	-	-	-	-	-
BC-0519	37.80	14.00	8.52	8	36.18	29.13	86.29	7.02	7.09	4.70
BC-0520	39.00	13.00	8.32	8	33.44	30.18	85.68	6.33	7.22	4.83
BC-0521	41.00	12.00	8.35	7	32.03	25.85	85.67	5.78	6.89	5.51
BC-0522	43.00	8.00	6.04	6	-	-	-	-	-	-
BC-0523	42.60	8.00	5.94	6	-	-	-	-	-	-
BC-0524	41.00	12.00	8.35	7	32.36	26.30	85.38	5.62	6.95	5.60
BC-0525	40.00	12.00	8.01	8	33.56	28.03	85.70	6.70	6.82	5.26
BC-0526	39.00	13.00	8.32	8	34.99	25.16	86.02	6.10	6.91	5.45
BC-0527	41.00	11.00	7.65	7	33.38	28.03	85.65	6.35	6.84	4.68
BC-0528	39.00	13.00	8.32	8	31.75	27.50	85.23	5.67	7.22	5.11
BC-0529	42.00	12.00	8.71	8	31.81	30.18	83.26	6.09	6.93	4.89
BC-0530	38.00	13.00	7.98	8	33.86	29.09	84.76	5.66	7.13	4.65

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0531	40.00	12.00	8.01	7	32.51	30.18	83.42	6.03	6.88	5.41
BC-0532	38.00	13.00	7.98	8	33.90	28.09	85.78	5.87	6.71	4.70
BC-0533	39.00	12.00	7.68	8	33.73	29.39	85.74	6.56	7.15	5.13
BC-0534	38.60	12.80	8.06	8	33.64	30.10	81.70	6.30	7.02	5.13
BC-0535	36.00	14.00	7.88	8	33.27	27.17	85.63	6.32	7.25	5.49
BC-0536	37.00	14.00	8.23	8	30.44	29.11	84.23	6.19	6.93	5.36
BC-0537	41.60	11.00	7.84	7	33.25	30.78	85.62	6.25	6.77	5.06
BC-0538	37.00	13.60	8.00	8	34.22	30.93	84.83	6.10	6.77	4.93
BC-0539	38.00	12.00	7.36	8	-	-	-	-	-	-
BC-0540	39.00	13.00	8.32	8	34.54	30.57	85.93	6.30	7.18	5.21
BC-0541	38.60	13.80	8.68	8	36.06	31.09	86.27	6.09	6.88	5.02
BC-0542	37.00	14.00	8.23	8	32.15	28.17	85.35	6.98	7.11	5.32
BC-0543	38.60	13.00	8.18	8	33.67	29.01	85.71	5.85	6.98	5.17
BC-0544	40.60	11.80	8.07	7	34.62	30.12	84.93	5.73	6.77	4.85
BC-0545	39.00	13.00	8.32	8	34.53	30.01	85.15	6.25	6.64	4.93
BC-0546	39.60	13.00	8.53	8	34.35	30.17	83.88	6.38	7.33	4.89
BC-0547	42.00	11.80	8.55	7	35.15	29.10	86.06	7.03	7.20	4.42
BC-0548	41.00	11.60	8.07	8	36.12	30.02	86.27	6.43	6.84	4.85
BC-0549	39.00	12.00	7.68	8	35.34	29.07	86.11	6.56	6.75	4.74
BC-0550	40.60	11.00	7.53	8	36.08	30.11	84.25	6.80	7.09	4.63
BC-0551	39.00	12.00	7.68	8	35.17	31.02	85.07	6.61	6.93	4.57

11.7.2. Morphological Characterization of Cotton genotypes at Cotton Research Center, Sreepur, Gazipur (February 2018- January 2021)

A total of 163 cotton genotypes were characterized at Cotton Research Center, Sreepur, Gazipur during the period from February 2018 to January 2021 (Table 147) (serial no. 1-57 in 2018-19; 58-113 in 2019-20 and 114-163 in 2020-21).

Table 147. List of cotton genotypes used for morphological characterization, Cotton Research Center, Sreepur, Gazipur

Sl. No.	Acc. No.						
1	BC-0273	42	BC-0323	83	BC-0463	124	BC-0562
2	BC-0276	43	BC-0324	84	BC-0464	125	BC-0563
3	BC-0277	44	BC-0325	85	BC-0465	126	BC-0564
4	BC-0278	45	BC-0327	86	BC-0466	127	BC-0565
5	BC-0279	46	BC-0328	87	BC-0467	128	BC-0566
6	BC-0280	47	BC-0329	88	BC-0468	129	BC-0567
7	BC-0283	48	BC-0330	89	BC-0469	130	BC-0568
8	BC-0284	49	BC-0331	90	BC-0470	131	BC-0569
9	BC-0285	50	BC-0332	91	BC-0472	132	BC-0570
10	BC-0286	51	BC-0333	92	BC-0473	133	BC-0571
11	BC-0287	52	BC-0335	93	BC-0474	134	BC-0572
12	BC-0288	53	BC-0336	94	BC-0475	135	BC-0573
13	BC-0289	54	BC-0338	95	BC-0476	136	BC-0574
14	BC-0290	55	BC-0339	96	BC-0477	137	BC-0575

Sl. No.	Acc. No.						
15	BC-0291	56	BC-0340	97	BC-0478	138	BC-0576
16	BC-0292	57	BC-0341	98	BC-0479	139	BC-0577
17	BC-0293	58	BC-0435	99	BC-0480	140	BC-0578
18	BC-0294	59	BC-0436	100	BC-0481	141	BC-0579
19	BC-0295	60	BC-0437	101	BC-0482	142	BC-0580
20	BC-0297	61	BC-0439	102	BC-0483	143	BC-0581
21	BC-0299	62	BC-0440	103	BC-0484	144	BC-0582
22	BC-0301	63	BC-0441	104	BC-0486	145	BC-0583
23	BC-0302	64	BC-0442	105	BC-0487	146	BC-0584
24	BC-0303	65	BC-0444	106	BC-0488	147	BC-0585
25	BC-0304	66	BC-0445	107	BC-0489	148	BC-0586
26	BC-0305	67	BC-0446	108	BC-0490	149	BC-0587
27	BC-0306	68	BC-0447	109	BC-0491	150	BC-0588
28	BC-0307	69	BC-0448	110	BC-0492	151	BC-0589
29	BC-0308	70	BC-0449	111	BC-0493	152	BC-0590
30	BC-0309	71	BC-0450	112	BC-0494	153	BC-0591
31	BC-0310	72	BC-0451	113	BC-0495	154	BC-0592
32	BC-0311	73	BC-0452	114	BC-0552	155	BC-0593
33	BC-0312	74	BC-0453	115	BC-0553	156	BC-0594
34	BC-0313	75	BC-0454	116	BC-0554	157	BC-0595
35	BC-0314	76	BC-0455	117	BC-0555	158	BC-0596
36	BC-0316	77	BC-0456	118	BC-0556	159	BC-0597
37	BC-0318	78	BC-0458	119	BC-0557	160	BC-0598
38	BC-0319	79	BC-0459	120	BC-0558	161	BC-0599
39	BC-0320	80	BC-0460	121	BC-0559	162	BC-0600
40	BC-0321	81	BC-0461	122	BC-0560	163	BC-0601
41	BC-0322	82	BC-0462	123	BC-0561		

11.7.2.1. Morphological Characterization on the Basis of Qualitative Characteristics (February 2018 to January 2021)

Data on qualitative variation are shown in (Table 148) and qualitative characters of tested cotton genotypes recorded as per IPGRI descriptors for cotton are enlisted in Table 149. All tested cotton genotypes showed as erect in growth habit, absent in petal spot and fuzzy in seed fuzz. Wide variations were recorded for hairiness (frequency was glabrous-51.53%, short hair-38.65% and long hair- 9.82%), petal color (frequency was cream- 85.89%, white-12.88% and yellow-1.23%) and boll shape (frequency was oval-68.71%, conical-26.99% and round-4.29%). A total of 157 genotypes were green in plant color and frequency was 96.32%. Among the tested cotton genotypes, 150 genotypes showed entire leaf shape and frequency was 92.02%. Pollen color of 153 genotypes was cream and that of the remaining 10 genotypes was yellow and frequency was 93.87% and 6.13%, respectively. A total of 162 cotton genotypes was grey in fuzz color and white in lint color and frequency was 99.39%.

Table 148. Qualitative variations in different descriptors of cotton genotypes, Cotton Research Center Sreepur, Gazipur

Variable	States	No. of genotypes	Frequency (%)
Growth Habit	Erect	163	100.00
Color of plant	Green	157	96.32
	Greenish Purple	06	3.68
Hairiness	Glabrous	84	51.53
	Short Hair	63	38.65
	Long Hair	16	9.82

Variable	States	No. of genotypes	Frequency (%)
Leaf shape	Entire	150	92.02
	Lobed	13	7.98
Petal color	White	21	12.88
	Cream	140	85.89
	Yellow	02	1.23
Petal spot	Absent	163	100.00
Pollen color	Cream	153	93.87
	Yellow	04	2.45
	Purple grey/grey	06	3.68
Boll shape	Oval	112	68.71
	Round	07	4.29
	Conical	44	26.99
Seed fuzz	Fuzzy	163	100.00
Fuzz color	Grey	162	99.39
	Brown	01	0.61
Lint color	Grey	162	99.39
	Brown	01	0.61

11.7.2.2. Qualitative Characteristics of 57 Cotton Genotypes (2018-2019)

The qualitative characteristics of 57 cotton genotypes grown in Cotton Research Center Sreepur, Gazipur in 2018-2019 growing season are given in Table 149. The growth habit of 57 cotton genotypes was erect, plant color was green, and the leaf shape was entire (Fig. 111). In case of 'Hairiness' 16 entries showed long hair and 41 showed short hair. The highest node number of 1st fruiting branches/plant was found in the accession number BC-0285 and BC-0310 (8.20) and the lowest value was found in the accession number BC-0320 (5.90). The highest vegetative branches/plant were produced by the accession number BC-0310 (3.70) and lowest was produced by BC-0313 (1.40). In case of petal color and petal spot, all the genotypes (57 genotypes) showed creamy type petal color except the accession number BC-0283 (light yellow) (Fig. 112). All the 57 genotypes showed creamy type pollen color. On the other hand, 15 genotypes produced conical shaped boll, 38 produced oval shaped boll and 4 produced round shaped boll (Fig. 113). All the genotypes (57 genotypes) had fuzzy seed, grey colored fuzz and white colored lint (Fig. 114).

Table 149. Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

Acc. No	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0273	7	1	3	1	2	0	1	2	7	3	1
BC-0276	7	1	3	1	2	0	1	2	7	3	1
BC-0277	7	1	3	1	2	0	1	2	7	3	1
BC-0278	7	1	3	1	2	0	1	2	7	3	1
BC-0279	7	1	3	1	2	0	1	2	7	3	1
BC-0280	7	1	3	1	2	0	1	2	7	3	1
BC-0283	7	1	3	1	3	0	1	2	7	3	1
BC-0284	7	1	3	1	2	0	1	2	7	3	1
BC-0285	7	1	3	1	2	0	1	2	7	3	1
BC-0286	7	1	3	1	2	0	1	2	7	3	1

Acc. No	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0287	7	1	7	1	2	0	1	2	7	3	1
BC-0288	7	1	7	1	2	0	1	2	7	3	1
BC-0289	7	1	7	1	2	0	1	2	7	3	1
BC-0290	7	1	7	1	2	0	1	3	7	3	1
BC-0291	7	1	7	1	2	0	1	3	7	3	1
BC-0292	7	1	7	1	2	0	1	3	7	3	1
BC-0293	7	1	3	1	2	0	1	3	7	3	1
BC-0294	7	1	3	1	2	0	1	2	7	3	1
BC-0295	7	1	3	1	2	0	1	2	7	3	1
BC-0297	7	1	3	1	2	0	1	3	7	3	1
BC-0299	7	1	3	1	2	0	1	2	7	3	1
BC-0301	7	1	3	1	2	0	1	2	7	3	1
BC-0302	7	1	3	1	2	0	1	3	7	3	1
BC-0303	7	1	3	1	2	0	1	3	7	3	1
BC-0304	7	1	3	1	2	0	1	2	7	3	1
BC-0305	7	1	3	1	2	0	1	2	7	3	1
BC-0306	7	1	7	1	2	0	1	2	7	3	1
BC-0307	7	1	3	1	2	0	1	3	7	3	1
BC-0308	7	1	7	1	2	0	1	2	7	3	1
BC-0309	7	1	3	1	2	0	1	2	7	3	1
BC-0310	7	1	7	1	2	0	1	3	7	3	1
BC-0311	7	1	3	1	2	0	1	3	7	3	1
BC-0312	7	1	7	1	2	0	1	2	7	3	1
BC-0313	7	1	7	1	2	0	1	3	7	3	1
BC-0314	7	1	3	1	2	0	1	2	7	3	1
BC-0316	7	1	3	1	2	0	1	2	7	3	1
BC-0318	7	1	3	1	2	0	1	2	7	3	1
BC-0319	7	1	3	1	2	0	1	2	7	3	1
BC-0320	7	1	7	1	2	0	1	3	7	3	1
BC-0321	7	1	3	1	2	0	1	2	7	3	1
BC-0322	7	1	7	1	2	0	1	2	7	3	1
BC-0323	7	1	3	1	2	0	1	3	7	3	1
BC-0324	7	1	3	1	2	0	1	2	7	3	1
BC-0325	7	1	7	1	2	0	1	1	7	3	1
BC-0327	7	1	3	1	2	0	1	2	7	3	1
BC-0328	7	1	7	1	2	0	1	2	7	3	1
BC-0329	7	1	3	1	2	0	1	2	7	3	1
BC-0330	7	1	3	1	2	0	1	2	7	3	1
BC-0331	7	1	3	1	2	0	1	1	7	3	1
BC-0332	7	1	3	1	2	0	1	1	7	3	1
BC-0333	7	1	3	1	2	0	1	3	7	3	1
BC-0335	7	1	3	1	2	0	1	2	7	3	1
BC-0336	7	1	3	1	2	0	1	2	7	3	1
BC-0338	7	1	3	1	2	0	1	2	7	3	1
BC-0339	7	1	3	1	2	0	1	1	7	3	1
BC-0340	7	1	3	1	2	0	1	2	7	3	1
BC-0341	7	1	7	1	2	0	1	3	7	3	1

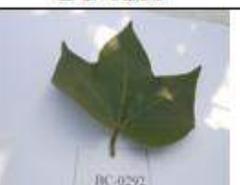
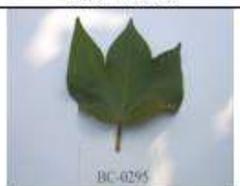
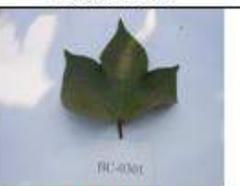
Not Germinated					
BC-0272	BC-0273	BC-0276	BC-0277	BC-0278	BC-0279
					
BC-0280	BC-0283	BC-0284	BC-0285	BC-0286	BC-0287
					
BC-0288	BC-0289	BC-0290	BC-0291	BC-0292	BC-0293
					
BC-0294	BC-0295	BC-0297	BC-0299	BC-0301	BC-0302
					
BC-0303	BC-0304	BC-0305	BC-0306	BC-0307	BC-0308

Fig. 111. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

					
BC-0309	BC-0310	BC-0311	BC-0312	BC-0313	BC-0314
					
BC-0316	BC-0318	BC-0319	BC-0320	BC-0321	BC-0322
					
BC-0323	BC-0324	BC-0325	BC-0327	BC-0328	BC-0329
					
BC-0330	BC-0331	BC-0332	BC-0333	BC-0335	BC-0336
Not Germinated					Not Germinated
BC-0337	BC-0338	BC-0339	BC-0340	BC-0341	BC-0342

Cont'd. Fig. 111. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

Not Germinated					
BC-0272	BC-0273	BC-0276	BC-0277	BC-0278	BC-0279
					
BC-0280	BC-0283	BC-0284	BC-0285	BC-0286	BC-0287
					
BC-0288	BC-0289	BC-0290	BC-0291	BC-0292	BC-0293
					
BC-0294	BC-0295	BC-0297	BC-0299	BC-0301	BC-0302
					
BC-0303	BC-0304	BC-0305	BC-0306	BC-0307	BC-0308

Fig. 112. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

					
BC-0309	BC-0310	BC-0311	BC-0312	BC-0313	BC-0314
					
BC-0316	BC-0318	BC-0319	BC-0320	BC-0321	BC-0322
					
BC-0323	BC-0324	BC-0325	BC-0327	BC-0328	BC-0329
					
BC-0330	BC-0331	BC-0332	BC-0333	BC-0335	BC-0336
Not Germinated					Not Germinated
BC-0337	BC-0338	BC-0339	BC-0340	BC-0341	BC-0342

Cont'd. Fig. 112. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

Not Germinated					
BC-0272	BC-0273	BC-0276	BC-0277	BC-0278	BC-0279
					
BC-0280	BC-0283	BC-0284	BC-0285	BC-0286	BC-0287
					
BC-0288	BC-0289	BC-0290	BC-0291	BC-0292	BC-0293
					
BC-0294	BC-0295	BC-0297	BC-0299	BC-0301	BC-0302
					
BC-0303	BC-0304	BC-0305	BC-0306	BC-0307	BC-0308

Fig. 113. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

					
BC-0309	BC-0310	BC-0311	BC-0312	BC-0313	BC-0314
					
BC-0316	BC-0318	BC-0319	BC-0320	BC-0321	BC-0322
					
BC-0323	BC-0324	BC-0325	BC-0327	BC-0328	BC-0329
					
BC-0330	BC-0331	BC-0332	BC-0333	BC-0335	BC-0336
Not Germinated					Not Germinated
BC-0337	BC-0338	BC-0339	BC-0340	BC-0341	BC-0342

Cont'd. Fig. 113. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

					
BC-0309	BC-0310	BC-0311	BC-0312	BC-0313	BC-0314
					
BC-0316	BC-0318	BC-0319	BC-0320	BC-0321	BC-0322
					
BC-0323	BC-0324	BC-0325	BC-0327	BC-0328	BC-0329
					
BC-0330	BC-0331	BC-0332	BC-0333	BC-0335	BC-0336
Not Germinated					Not Germinated
BC-0337	BC-0338	BC-0339	BC-0340	BC-0341	BC-0342

Fig. 114. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

Not Germinated					
BC-0272	BC-0273	BC-0276	BC-0277	BC-0278	BC-0279
					
BC-0280	BC-0283	BC-0284	BC-0285	BC-0286	BC-0287
					
BC-0288	BC-0289	BC-0290	BC-0291	BC-0292	BC-0293
					
BC-0294	BC-0295	BC-0297	BC-0299	BC-0301	BC-0302
					
BC-0303	BC-0304	BC-0305	BC-0306	BC-0307	BC-0308

Cont'd. Fig. 114. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019 (Cont'd)

Qualitative Characteristics of 56 Cotton Genotypes (2019-2020)

The qualitative characteristics of 56 cotton genotypes grown in Cotton Research Center Sreepur, Gazipur in 2019-2020 growing season is given in Table 150. In case of growth habit, 56 genotypes were erect. Plant color 50 genotypes was green color and that of 06 genotypes was greenish purple. Hair of 07 genotypes was short and the remaining 49 entries were glabrous. In case of leaf shape, one (1) genotype showed okra lobed, twelve (12) showed lobed and rest 43 showed entire type of leaf shape. Petal color of 29 genotypes was cream, 20 white, 04 purple cream and 01 purple yellow. Petal spot was not observed in any genotype. In case of pollen color, 49 genotypes showed creamy type pollen color, 05 were purple grey, 01 was grey and another 01 was yellow type pollen color. Boll shape of 37 genotypes was oval and that of the rest 19 genotypes was conical. In case of seed fuzz, fuzz color and lint color, all the genotypes produced fuzzy seed, grey colored fuzz and white colored lint (Figs. 115-118).

Table 150. Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

Acc. No.	Growth Habit	Color of Plant	Hairness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0435	7	1	0	1	2	0	2	2	7	3	1
BC-0436	7	1	3	2	1	0	1	3	7	3	1
BC-0437	7	1	0	1	1	0	1	2	7	3	1
BC-0439	7	1	3	2	1	0	1	2	7	3	1
BC-0440	7	1	0	1	1	0	1	2	7	3	1
BC-0441	7	1	0	1	1	0	1	2	7	3	1
BC-0442	7	1	3	1	2	0	1	3	7	3	1
BC-0444	7	2	0	1	2	0	1	2	7	3	1
BC-0445	7	2	0	1	2	0	1	2	7	3	1
BC-0446	7	2	0	2	2	0	1	2	7	3	1
BC-0447	7	2	0	1	2	0	1	2	7	3	1
BC-0448	7	2	0	1	3	0	1	2	7	3	1
BC-0449	7	2	0	1	1	0	1	2	7	3	1
BC-0450	7	1	0	1	4	0	1	3	7	3	1
BC-0451	7	1	3	1	2	0	1	2	7	3	1
BC-0452	7	1	0	1	2	0	1	2	7	3	1
BC-0453	7	1	3	1	1	0	1	2	7	3	1
BC-0454	7	1	0	2	1	0	1	2	7	3	1
BC-0455	7	1	0	2	1	0	1	3	7	3	1
BC-0456	7	1	0	1	2	0	1	2	7	3	1
BC-0458	7	1	0	1	2	0	1	2	7	3	1
BC-0459	7	1	0	2	1	0	1	2	7	3	1
BC-0460	7	1	0	1	1	0	1	2	7	3	1
BC-0461	7	1	0	1	2	0	1	2	7	3	1

Table 150 (Cont'd)

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0462	7	1	0	1	1	0	1	2	7	3	1
BC-0463	7	1	0	1	1	0	1	3	7	3	1
BC-0464	7	1	0	1	1	0	1	2	7	3	1
BC-0465	7	1	0	1	1	0	1	2	7	3	1
BC-0466	7	1	0	1	2	0	1	2	7	3	1
BC-0467	7	1	0	1	1	0	1	3	7	3	1
BC-0468	7	1	0	1	1	0	1	2	7	3	1
BC-0469	7	1	0	1	1	0	1	2	7	3	1
BC-0470	7	1	0	2	1	0	1	2	7	3	1
BC-0472	7	1	0	1	2	0	1	2	7	3	1
BC-0473	7	1	0	1	2	0	1	3	7	3	1
BC-0474	7	1	0	2	2	0	1	3	7	3	1
BC-0475	7	1	0	1	2	0	1	2	7	3	1
BC-0476	7	1	0	2	2	0	1	3	7	3	1
BC-0477	7	1	0	1	2	0	1	3	7	3	1
BC-0478	7	1	0	2	2	0	1	3	7	3	1
BC-0479	7	1	0	1	1	0	1	2	7	3	1
BC-0480	7	1	0	2	2	0	1	3	7	3	1
BC-0481	7	1	0	1	2	0	1	3	7	3	1
BC-0482	7	1	0	2	2	0	1	3	7	3	1
BC-0483	7	1	0	1	2	0	1	2	7	3	1
BC-0484	7	1	0	1	2	0	1	2	7	3	1
BC-0486	7	1	0	2	2	0	1	2	7	3	1
BC-0487	7	1	0	1	2	0	1	3	7	3	1
BC-0488	7	1	0	1	2	0	1	3	7	3	1
BC-0489	7	1	0	1	2	0	1	3	7	3	1
BC-0490	7	1	3	1	2	0	1	3	7	3	1
BC-0491	7	1	3	1	1	0	1	2	7	3	1
BC-0492	7	1	0	1	2	0	1	2	7	3	1
BC-0493	7	1	0	1	2	0	1	3	7	3	1
BC-0494	7	1	0	1	2	0	1	2	7	3	1
BC-0495	7	1	0	1	2	0	1	2	7	3	1

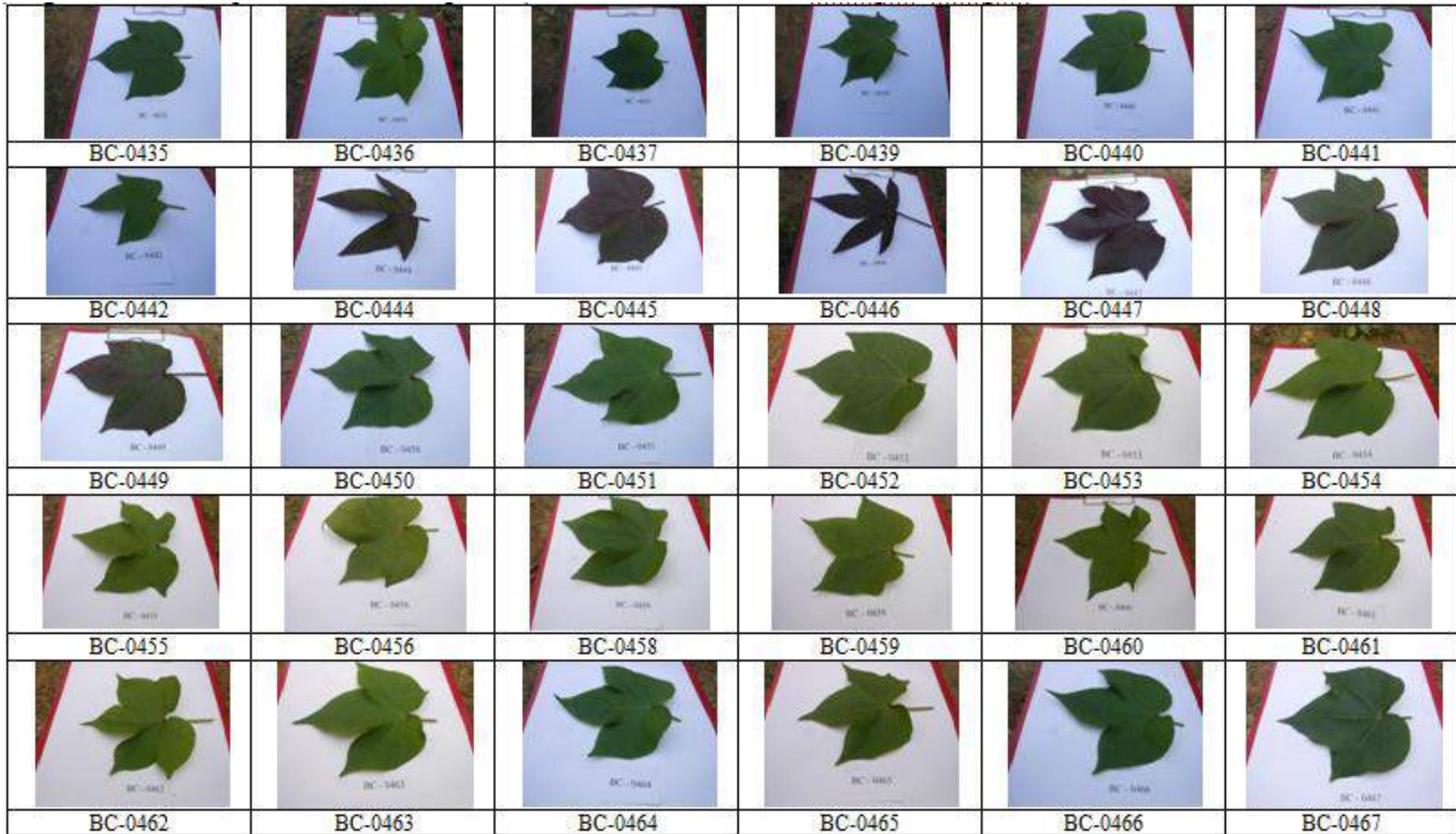
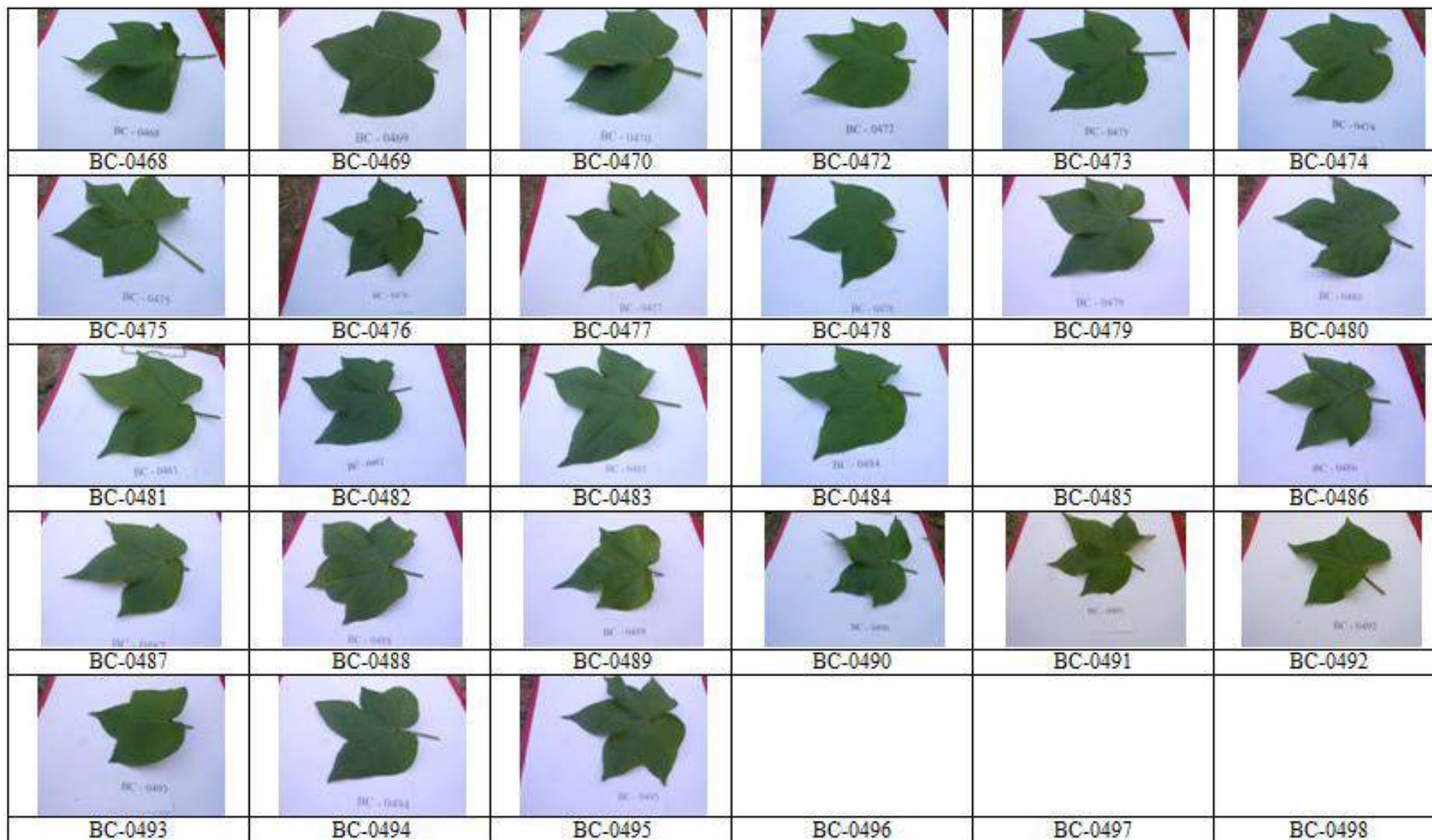


Fig. 115. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020



Cont'd. Fig. 115. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

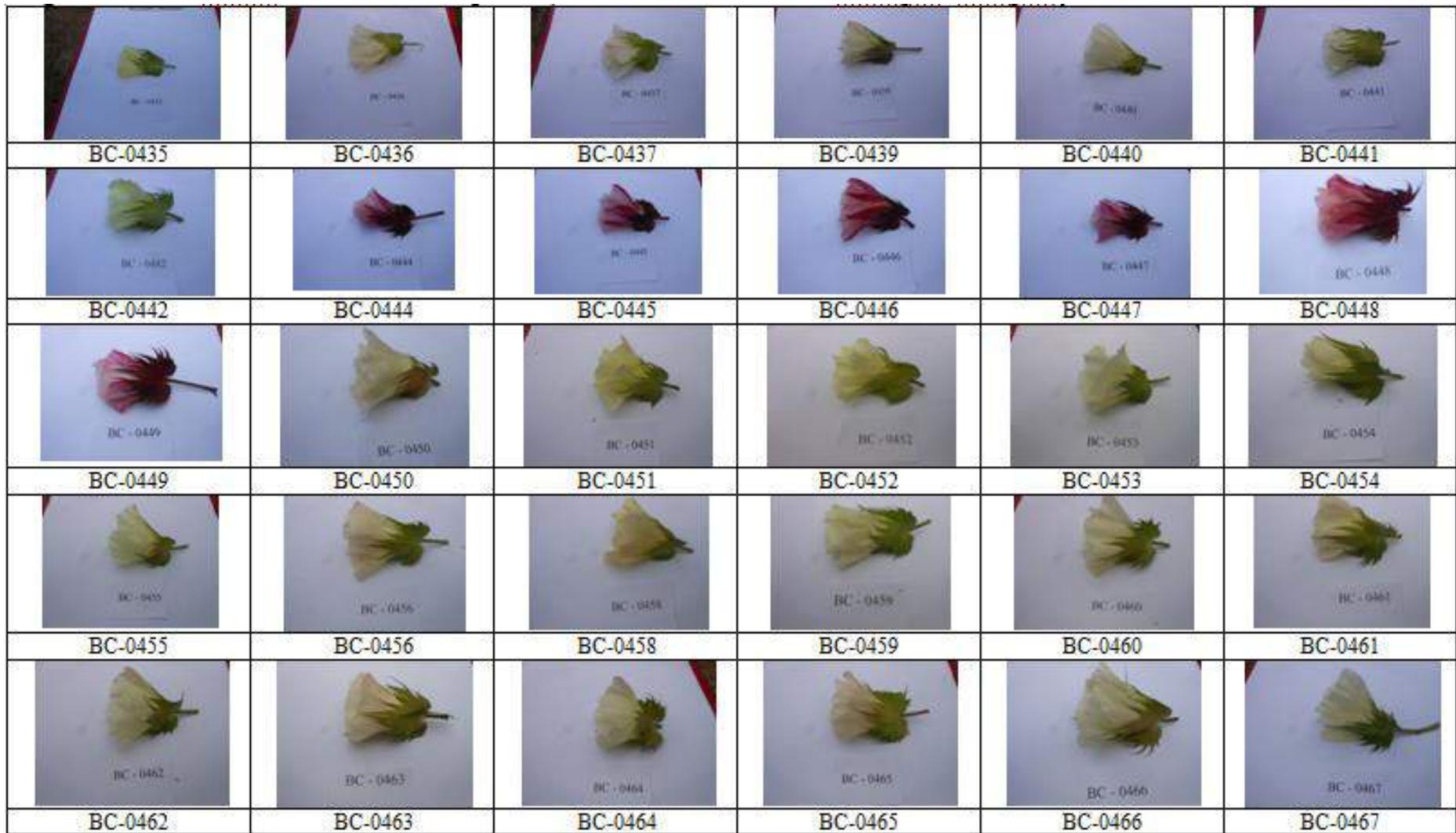


Fig. 116. Petal color cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

 BC - 0468	 BC - 0469	 BC - 0470	 BC - 0472	 BC - 0473	 BC - 0474
BC-0468	BC-0469	BC-0470	BC-0472	BC-0473	BC-0474
 BC - 0475	 BC - 0476	 BC - 0477	 BC - 0478	 BC - 0479	 BC - 0480
BC-0475	BC-0476	BC-0477	BC-0478	BC-0479	BC-0480
 BC - 0481	 BC - 0482	 BC - 0483	 BC - 0484		 BC - 0486
BC-0481	BC-0482	BC-0483	BC-0484	BC-0485	BC-0486
 BC - 0487	 BC - 0488	 BC - 0489	 BC - 0490	 BC - 0491	 BC - 0492
BC-0487	BC-0488	BC-0489	BC-0490	BC-0491	BC-0492
 BC - 0493	 BC - 0494	 BC - 0495			
BC-0493	BC-0494	BC-0495	BC-0496	BC-0497	BC-0498

Cont'd. Fig. 116. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

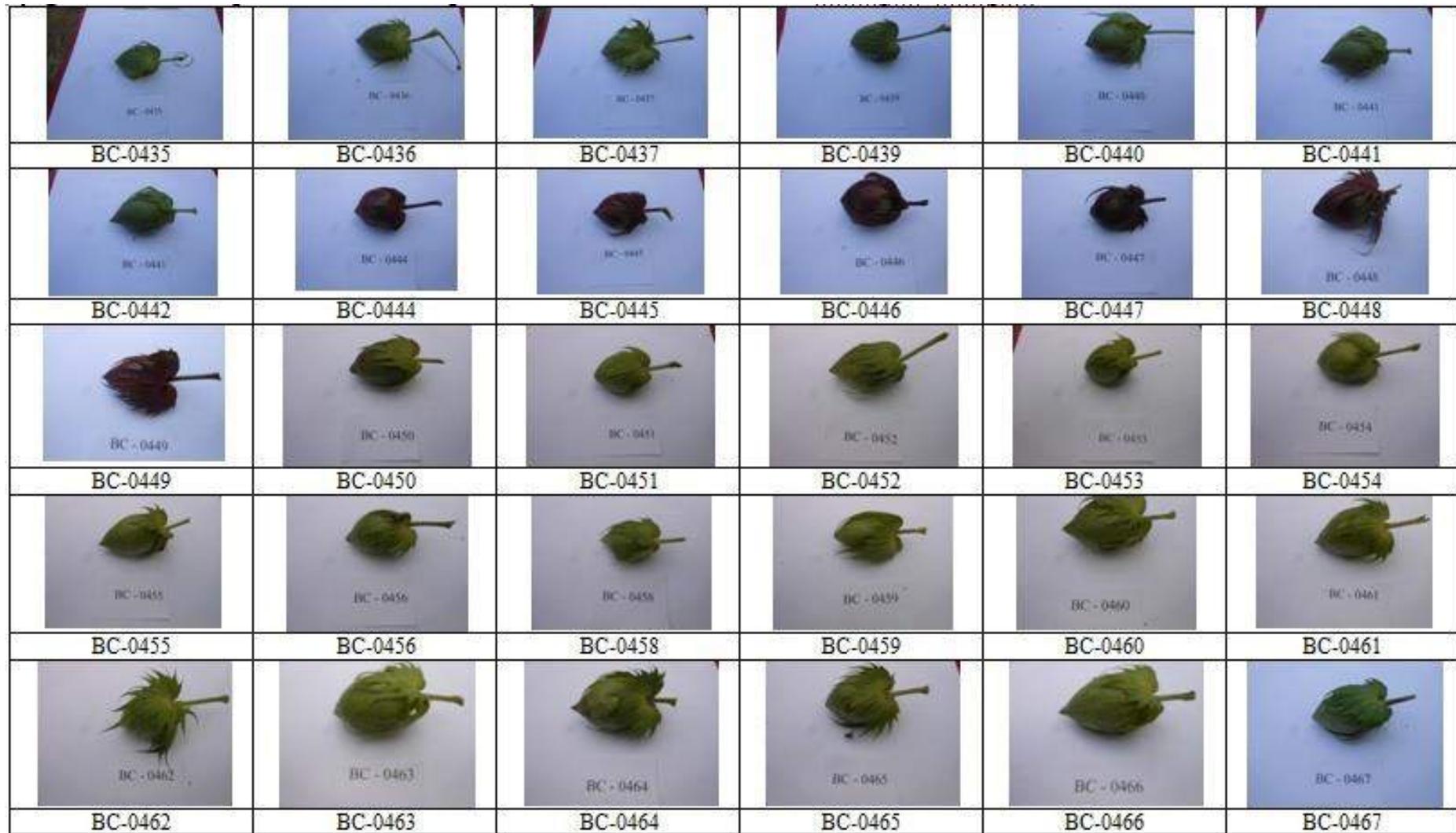


Fig. 117. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020



Cont'd. Fig. 117. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020



Fig. 118. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

					
BC-0468	BC-0469	BC-0470	BC-0472	BC-0473	BC-0474
					
BC-0475	BC-0476	BC-0477	BC-0478	BC-0479	BC-0480
					
BC-0481	BC-0482	BC-0483	BC-0484	BC-0485	BC-0486
					
BC-0487	BC-0488	BC-0489	BC-0490	BC-0491	BC-0492
					
BC-0493	BC-0494	BC-0495	BC-0496	BC-0497	BC-0498

Cont'd. Fig. 118. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

Qualitative Characteristics 50 of Cotton Genotypes (2020-2021)

The qualitative characteristics of 50 cotton genotypes grown at the Cotton Research Center, Sreepur, Gazipur in 2020-2021 growing season is given in Table 151. All the 50 tested genotypes showed erect type of growth habit, green plant color, entire leaf shape, cream petal color and zero petal spot. Among the 50 entries, 35 entries showed glabrous and the rest 15 showed short hair. In case of pollen color, 47 genotypes showed creamy type of pollen color and 03 genotypes showed yellow type of pollen color. In case of boll shape, 37 genotypes produced oval shaped boll, 10 produced conical shaped boll and 3 produced round shaped boll. In case of seed fuzz, fuzz color and lint color, all the genotypes produced fuzzy seed, grey fuzz color and white lint except the genotype BC-0559, which produced fuzzy seed, and brown fuzz and lint (Figs. 119 to 122)

Table 151. Qualitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0552	7	1	3	1	2	0	2	2	7	3	1
BC-0553	7	1	3	1	2	0	2	2	7	3	1
BC-0554	7	1	3	1	2	0	1	1	7	3	1
BC-0555	7	1	0	1	2	0	1	3	7	3	1
BC-0556	7	1	0	1	2	0	1	2	7	3	1
BC-0557	7	1	0	1	2	0	2	3	7	3	1
BC-0558	7	1	0	1	2	0	1	2	7	3	1
BC-0559	7	1	3	1	2	0	1	2	7	4	4
BC-0560	7	1	0	1	2	0	1	3	7	3	1
BC-0561	7	1	3	1	2	0	1	2	7	3	1
BC-0562	7	1	0	1	2	0	1	2	7	3	1
BC-0563	7	1	3	1	2	0	1	3	7	3	1
BC-0564	7	1	0	1	2	0	1	2	7	3	1
BC-0565	7	1	3	1	2	0	1	2	7	3	1
BC-0566	7	1	3	1	2	0	1	2	7	3	1
BC-0567	7	1	3	1	2	0	1	1	7	3	1
BC-0568	7	1	0	1	2	0	1	2	7	3	1
BC-0569	7	1	3	1	2	0	1	2	7	3	1
BC-0570	7	1	3	1	2	0	1	1	7	3	1
BC-0571	7	1	3	1	2	0	1	2	7	3	1
BC-0572	7	1	3	1	2	0	1	3	7	3	1
BC-0573	7	1	3	1	2	0	1	2	7	3	1
BC-0574	7	1	0	1	2	0	1	2	7	3	1
BC-0575	7	1	0	1	2	0	1	2	7	3	1
BC-0576	7	1	0	1	2	0	1	3	7	3	1

Table 151 (Cont'd)

Acc. No.	Growth Habit	Color of Plant	Hairiness	Leaf Shape	Petal Color	Petal Spot	Pollen Color	Boll Shape	Seed Fuzz	Fuzz Color	Lint Color
1	2	3	4	5	6	7	8	9	10	11	12
BC-0577	7	1	0	1	2	0	1	2	7	3	1
BC-0578	7	1	0	1	2	0	1	2	7	3	1
BC-0579	7	1	3	1	2	0	1	3	7	3	1
BC-0580	7	1	0	1	2	0	1	2	7	3	1
BC-0581	7	1	0	1	2	0	1	2	7	3	1
BC-0582	7	1	0	1	2	0	1	2	7	3	1
BC-0583	7	1	0	1	2	0	1	2	7	3	1
BC-0584	7	1	0	1	2	0	1	2	7	3	1
BC-0585	7	1	0	1	2	0	1	2	7	3	1
BC-0586	7	1	0	1	2	0	1	2	7	3	1
BC-0587	7	1	0	1	2	0	1	2	7	3	1
BC-0588	7	1	0	1	2	0	1	2	7	3	1
BC-0589	7	1	0	1	2	0	1	2	7	3	1
BC-0590	7	1	0	1	2	0	1	2	7	3	1
BC-0591	7	1	0	1	2	0	1	2	7	3	1
BC-0592	7	1	0	1	2	0	1	2	7	3	1
BC-0593	7	1	0	1	2	0	1	2	7	3	1
BC-0594	7	1	0	1	2	0	1	2	7	3	1
BC-0595	7	1	0	1	2	0	1	2	7	3	1
BC-0596	7	1	0	1	2	0	1	2	7	3	1
BC-0597	7	1	0	1	2	0	1	3	7	3	1
BC-0598	7	1	0	1	2	0	1	3	7	3	1
BC-0599	7	1	0	1	2	0	1	3	7	3	1
BC-0600	7	1	0	1	2	0	1	2	7	3	1
BC-0601	7	1	0	1	2	0	1	2	7	3	1

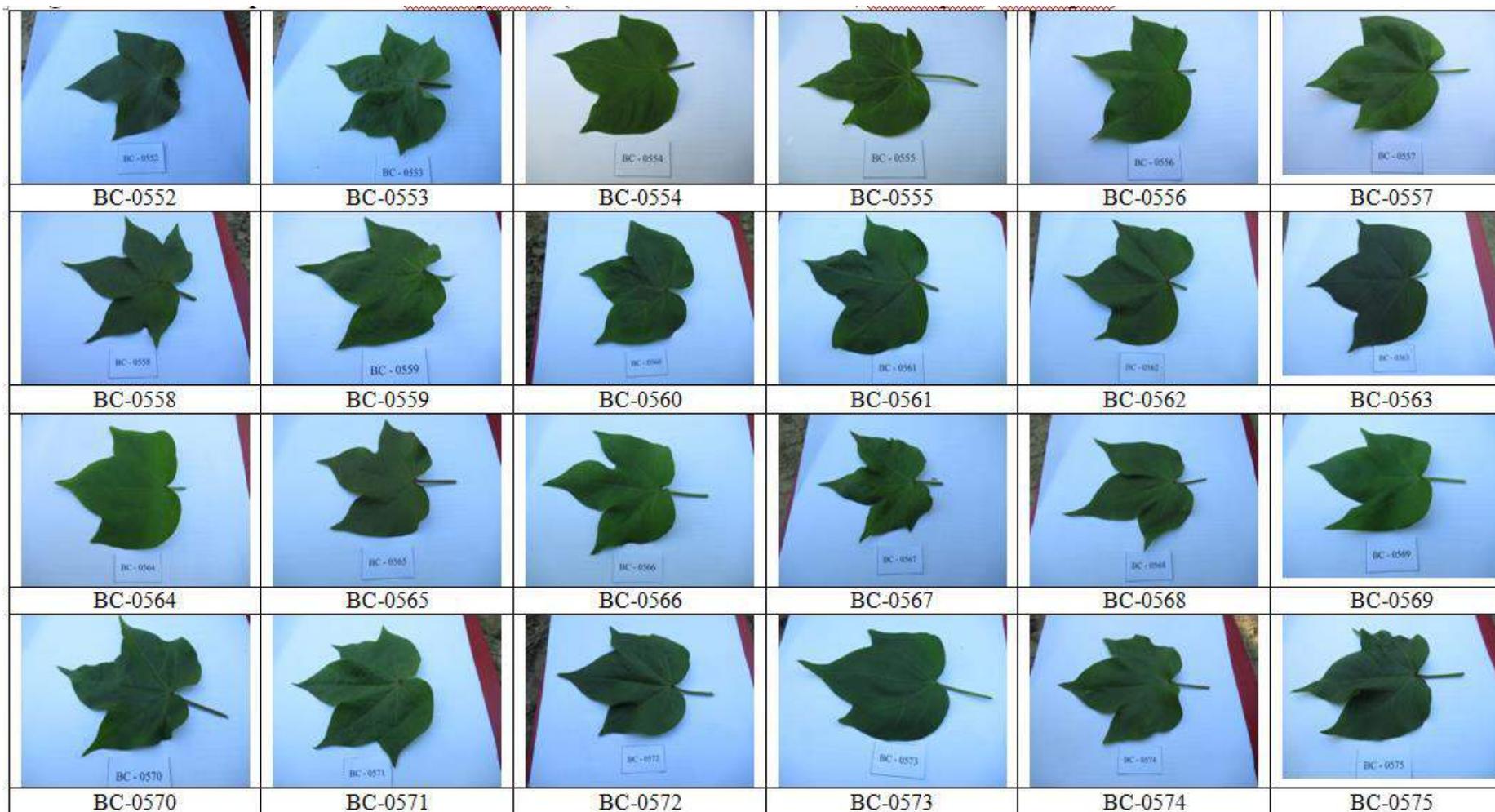
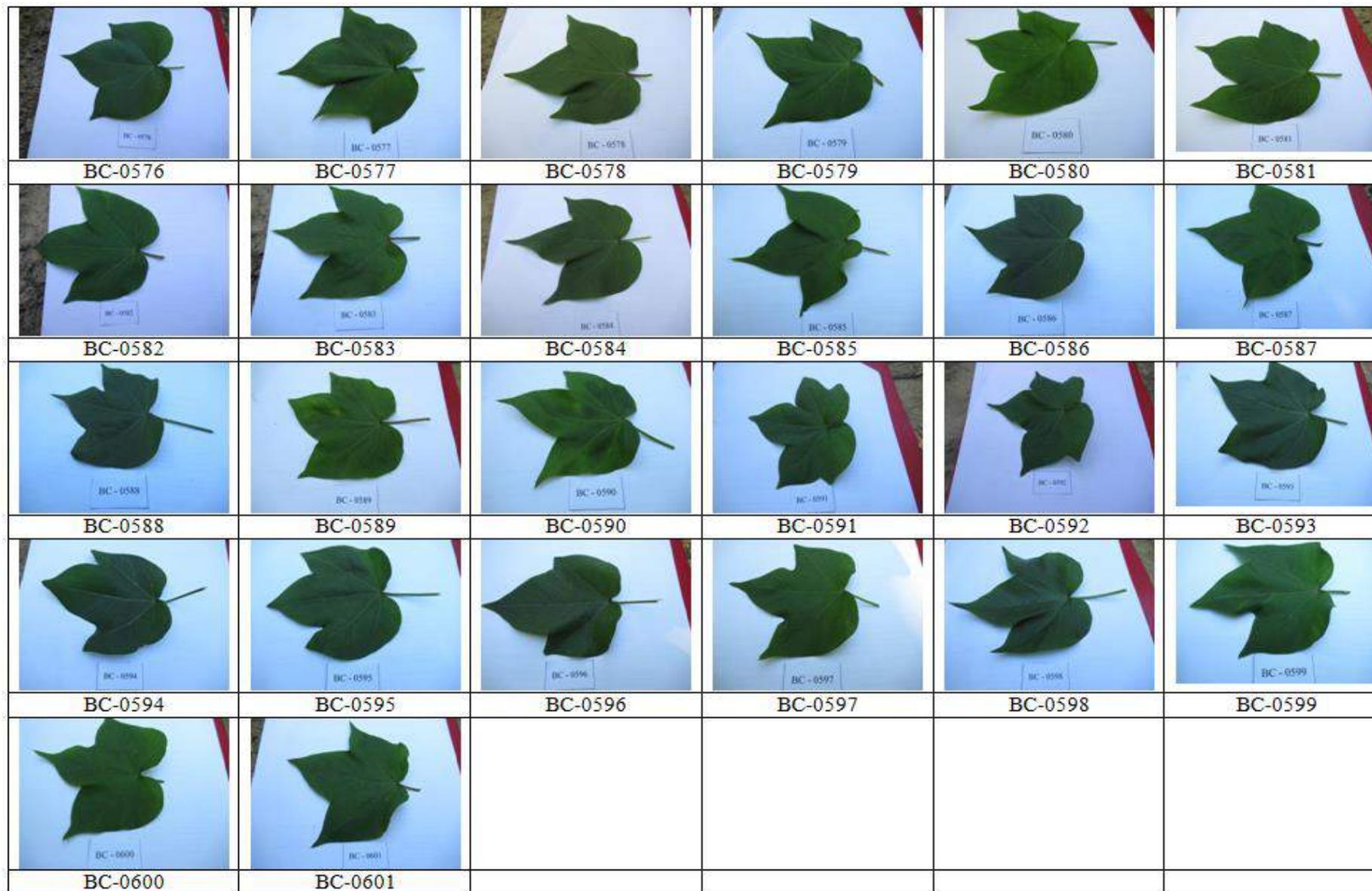


Fig. 119. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021



Cont'd. Fig. 119. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2020-2021

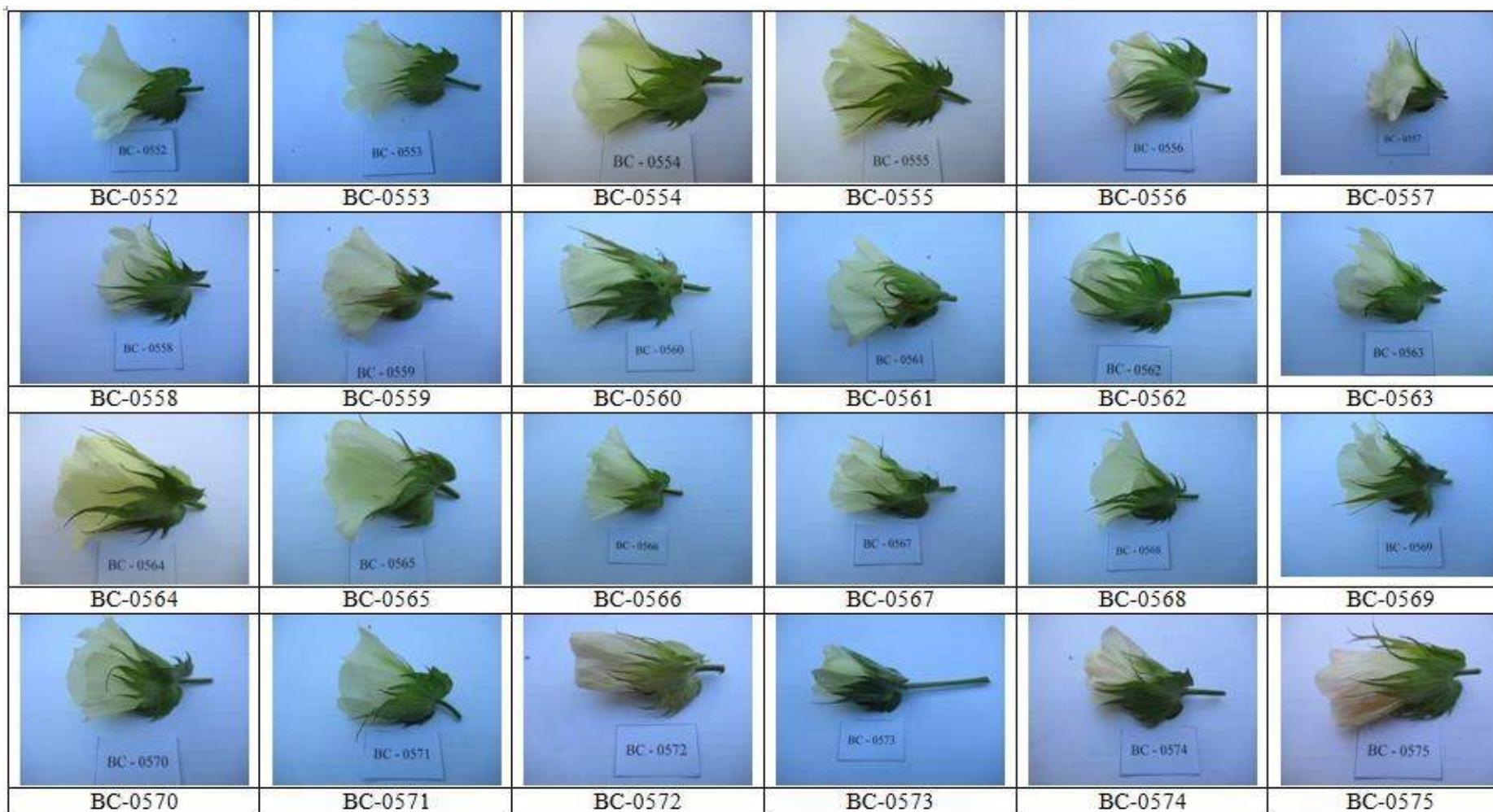


Fig. 120. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021



Cont'd. Fig. 120. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

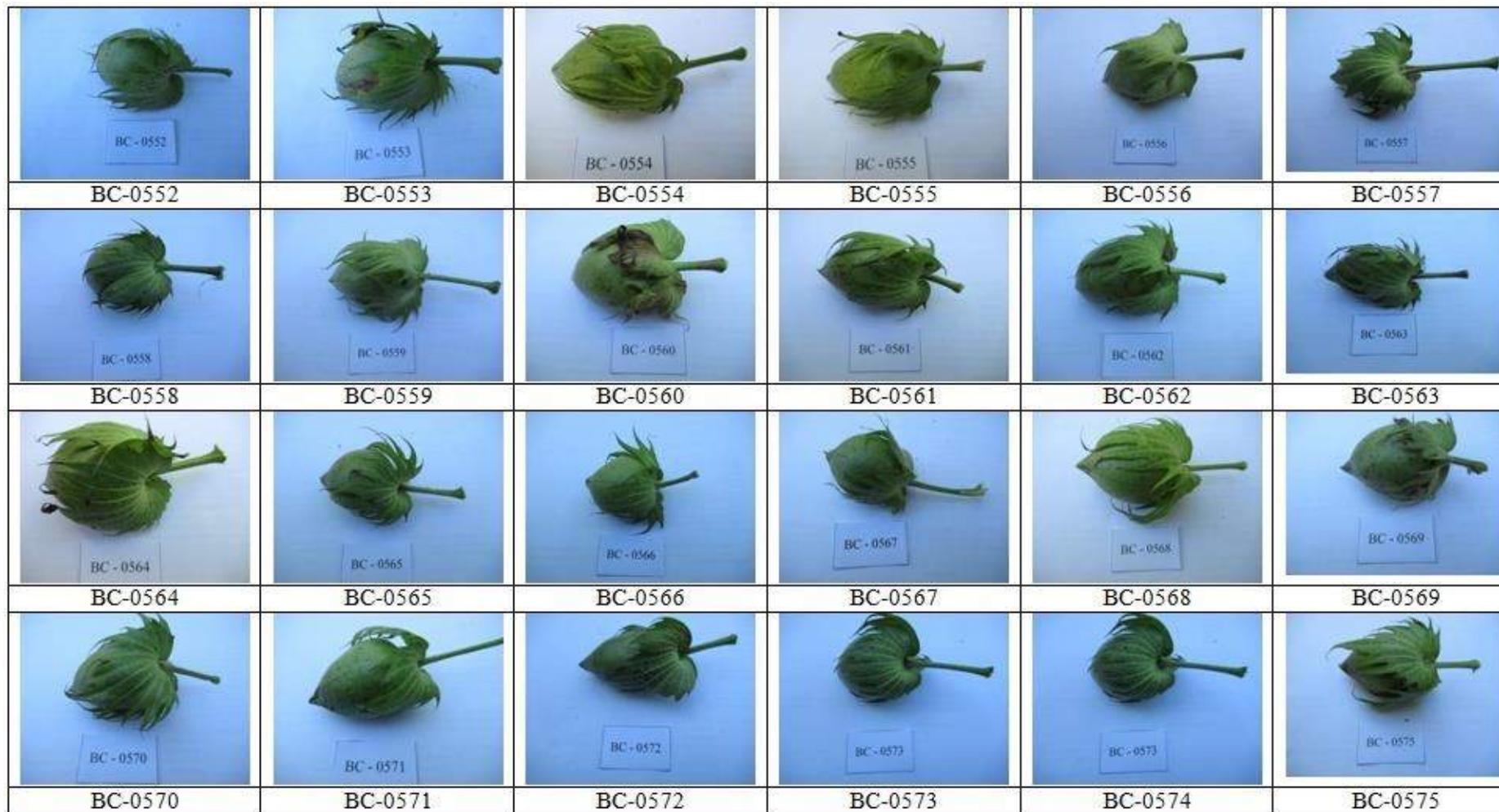
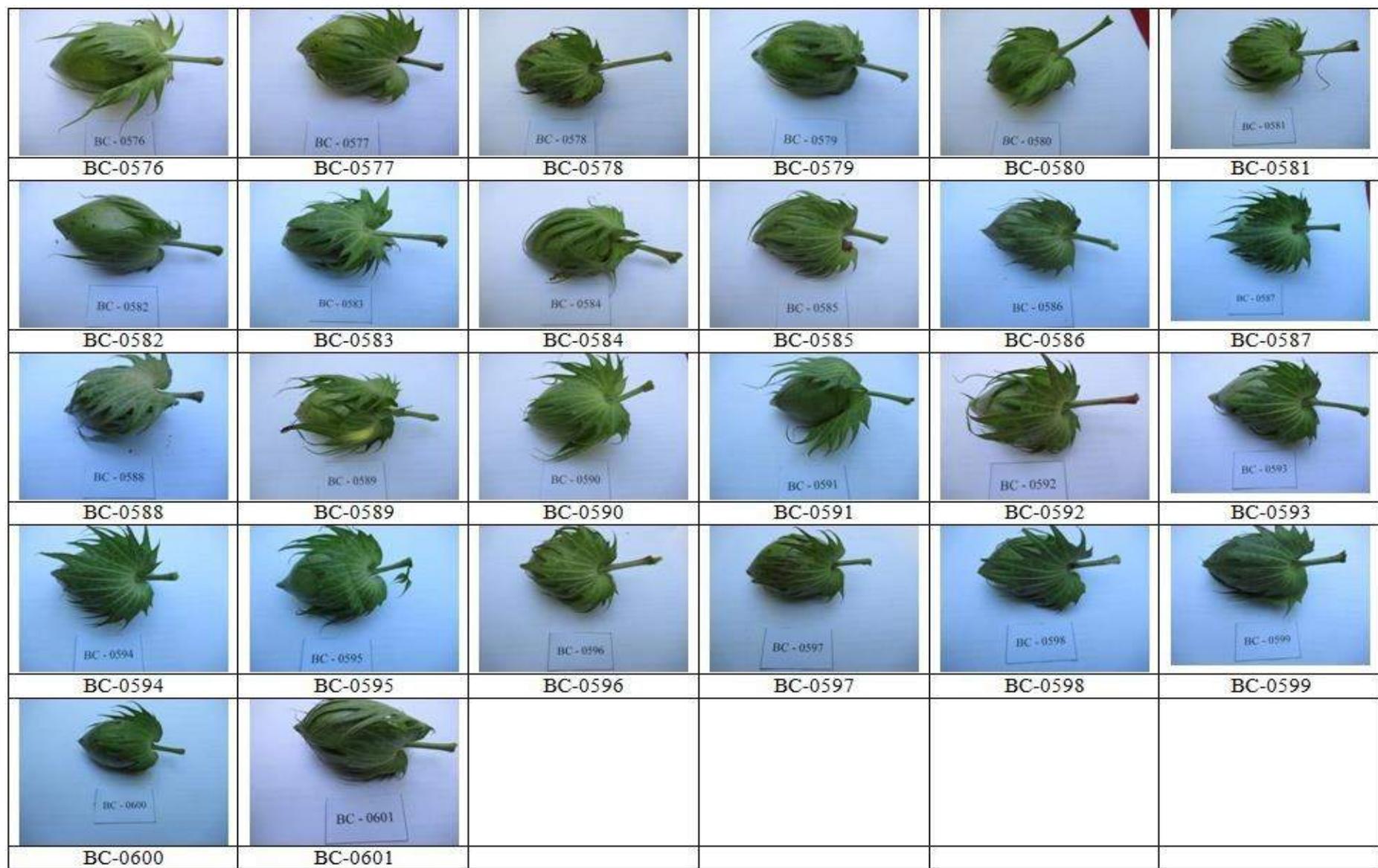


Fig. 121. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021



Cont'd. Fig. 121. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

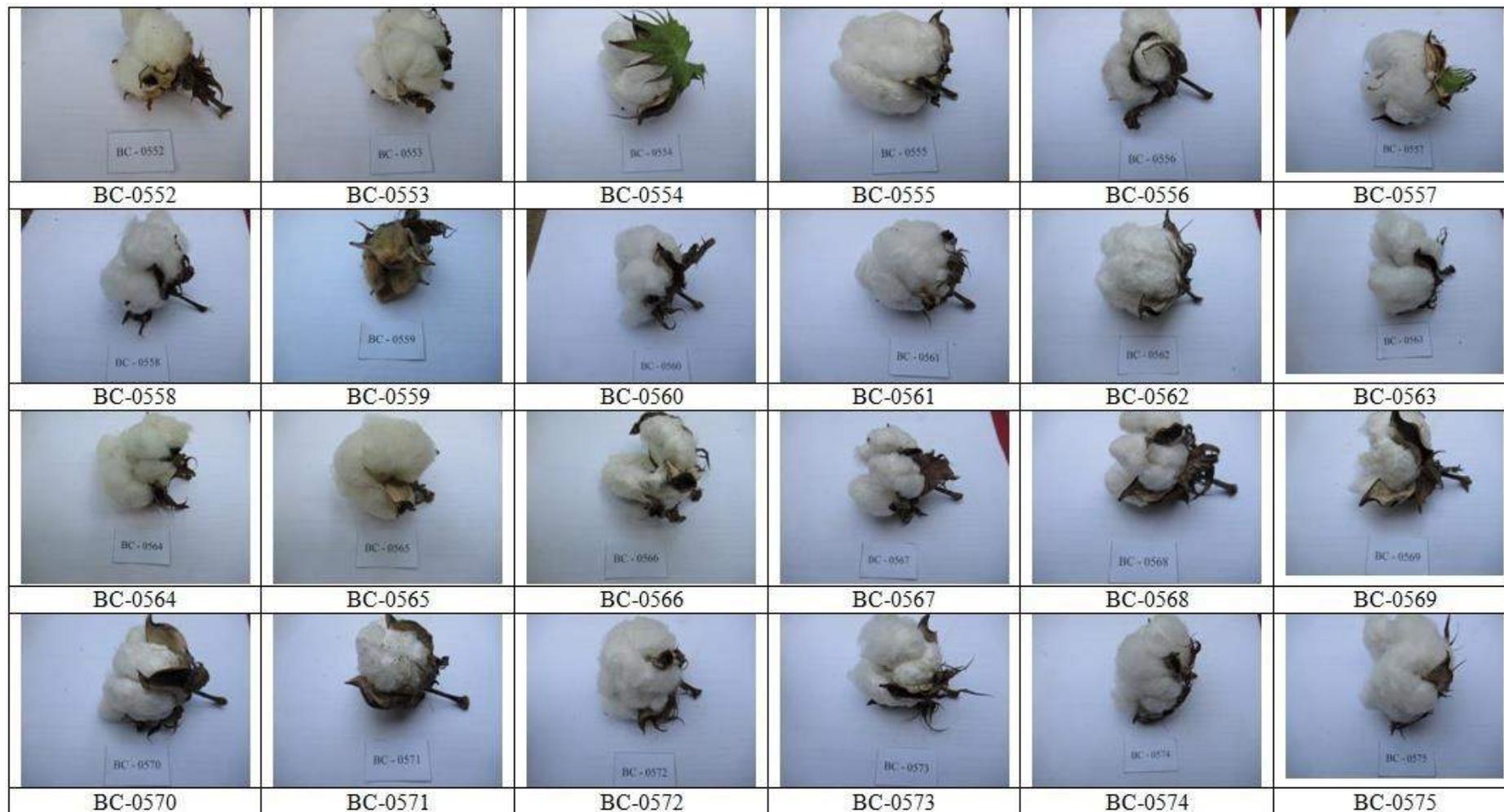


Fig. 122. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

					
BC-0576	BC-0577	BC-0578	BC-0579	BC-0580	BC-0581
					
BC-0582	BC-0583	BC-0584	BC-0585	BC-0586	BC-0587
					
BC-0588	BC-0589	BC-0590	BC-0591	BC-0592	BC-0593
					
BC-0594	BC-0595	BC-0596	BC-0597	BC-0598	BC-0599
					
BC-0600	BC-0601				

Cont'd. Fig. 122. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2020-2021

11.7.2.2. Characterization of Cotton Genotypes on the Basis of Quantitative Characters (February 2018 to January 2021)

Quantitative Characters of 57 Cotton Genotypes (2018-19)

Range, mean, standard deviation (SD) and coefficient of variation (CV) of quantitative characters of 57 cotton genotypes (2018-2019 season) are presented in Table 152. Quantitative characteristics of 57 cotton genotypes grown at the Cotton Research Center Sreepur, Gazipur in 2018-2019 growing season are enlisted in Table 153.

The range of number of primary and secondary fruiting branches per plant were 18.30 (BC-0295) to 30.10 (BC-0327) and 12.0 (BC-0279) to 33.30 (BC-0310), respectively. On an average, days to 50% flowering were 61 and range was 53 (BC-0287) to 69 (BC-0301). In case of days to 50% boll split, the range was 118 (BC-0290, BC-0308 and BC-0324) to 131 (BC-0307). The average number of bolls per plant was 35.31 and range was 23.30 (BC-0279) to 45.80 (BC-0292). The range of plant height at harvest was 125.30 cm (BC-0295) to 203.30 cm (BC-0336) and average single boll weight was 4.37 g. The average seed cotton yield was 2905.42 kg/ha and range was 1993 kg/ha (BC-0331) to 4013 kg/ha (BC-0295).

The highest variation was observed in the number of secondary fruiting branches (CV- 21.63%) followed by seed cotton yield (20.10%), number of vegetative branches per plant (15.94%), number of bolls/plant (15.79%) and plant height at harvest (11.75%). Comparatively, lowest variation was observed for days to 50% boll split (2.74%).

The range of ginning out turn (GOT) and fuzz grade were 38.25% (BC-0312) to 41.10% (BC-0309) and 6 to 8, respectively (Table 152). Seed index and lint index ranged from 9.20g (BC-0277) to 12.10 g (BC-330) and 5.85 g (BC-0277) to 8.12 g (BC-0338), respectively.

Fiber characteristics, Upper half mean length ranged from 25.74 mm (BC-0335) to 32.10 mm (BC-0292). The range of fiber strength and uniformity index 26.62 g/tex (BC-0276) to 34.37 g/tex (BC-0288) and 79.41% (BC-0335) to 85.26% (BC-0292), respectively. Average elongation and moisture were 5.84% and 6.74%, respectively. The range of micronaire value was 3.03 µg/inch (BC-0305) to 4.89 µg/inch (BC-0324). The highest variation was observed in the character of micronaire value (10.58%).

Table 152. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2018-2019

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node number of 1 st fruiting branch	5.90	8.20	7.11	0.51	7.19
Number of vegetative branches/plant	1.40	3.70	2.73	0.44	15.94
Number of primary fruiting branches/plant	18.30	30.10	24.71	2.23	9.01
Number of secondary fruiting branches/plant	12.10	33.30	24.95	5.40	21.63
Days to 50% flowering	53.00	69.00	60.89	4.15	6.82
Days to 50% boll split	118.00	131.00	123.79	3.39	2.74
Number of bolls/plant	23.30	45.80	35.31	5.57	15.79
Single boll weight (g)	4.02	4.90	4.37	0.18	4.07
Plant population at harvest (ha)	18519.00	27160.00	24341.85	2031.03	8.34

Character	Range		Mean	SD	CV (%)
	Min	Max			
Plant height at harvest (cm)	125.30	203.60	170.52	20.03	11.75
Seed cotton yield (kg/ha)	1993.00	4319.00	2905.42	584.07	20.10
Ginning traits					
GOT (%)	38.25	41.10	39.64	0.64	1.62
Seed Index (g)	9.20	12.10	10.71	0.65	6.11
Lint Index (g)	5.85	8.12	7.10	0.47	6.67
Fuzz Grade	6.00	8.00	7.19	0.58	8.07
Fiber traits					
Upper Half Mean Length (UHML) (mm)	25.74	32.10	30.09	1.46	4.87
Strength (g/tex)	26.62	34.37	30.81	1.64	5.31
Uniformity Index (UI)	79.41	85.26	83.81	1.36	1.63
Elongation (%)	5.27	6.67	5.84	0.31	5.27
Moisture (%)	5.40	7.38	6.74	0.44	6.48
Micronare Value ($\mu\text{g}/\text{inch}$)	3.03	4.89	3.97	0.42	10.58

Table 153. Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2018-2019

Acc. No.	Node no. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of primary fruiting branches/plant	No. of secondary fruiting branches/plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0273	7.60	2.90	22.90	21.40	66	126	36.20	4.15	24691	165.20	3290
BC-0276	7.20	3.10	23.10	20.20	61	123	33.70	4.20	20988	170.60	2593
BC-0277	6.80	3.10	21.20	22.30	60	128	42.10	4.11	25926	175.30	3169
BC-0278	7.90	2.90	24.80	26.80	66	126	39.20	4.19	27160	172.40	2755
BC-0279	7.00	2.40	21.50	12.10	62	119	23.30	4.25	27160	131.30	2219
BC-0280	7.20	2.70	25.10	23.20	61	122	36.60	4.20	27160	181.30	2455
BC-0283	6.80	2.90	25.60	25.10	58	120	33.30	4.33	22222	190.20	2970
BC-0284	7.80	3.20	27.10	30.90	55	123	29.30	4.11	25926	165.30	2384
BC-0285	8.20	3.40	25.40	31.20	67	127	32.60	4.31	20988	199.20	2270
BC-0286	7.20	2.70	26.50	25.60	58	120	33.60	4.33	24691	180.30	3077
BC-0287	8.00	2.80	26.20	22.20	53	124	32.20	4.39	20988	190.30	3155
BC-0288	7.20	3.10	26.50	29.90	60	126	36.50	4.45	23457	169.20	2613
BC-0289	6.90	3.10	25.30	23.90	58	121	40.90	4.18	22222	158.30	2772
BC-0290	7.20	3.40	27.10	30.20	56	118	43.30	4.03	22222	178.40	3236
BC-0291	7.10	2.90	26.00	22.20	68	120	42.20	4.90	19753	175.20	3197
BC-0292	7.00	2.20	21.50	18.60	57	130	45.80	4.30	20988	131.70	3405
BC-0293	8.00	2.70	22.70	19.40	60	128	44.30	4.38	23457	148.30	3992
BC-0294	7.20	2.40	20.50	24.10	66	130	42.80	4.50	23457	151.50	3812
BC-0295	6.40	2.10	18.30	13.90	63	122	43.20	4.62	18519	125.30	4013
BC-0297	7.30	2.60	20.80	17.40	67	126	36.30	4.60	24691	125.30	3307
BC-0299	6.50	2.40	21.20	19.80	68	127	40.20	4.22	25926	141.20	2416
BC-0301	8.00	2.80	22.00	22.80	69	124	43.80	4.46	27160	135.30	2970

Table 153 (Cont'd)

Acc. No.	Node no. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of primary fruiting branches/plant	No. of secondary fruiting branches/plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0302	7.10	1.80	22.90	13.90	68	129	33.50	4.36	27160	156.20	3265
BC-0303	6.90	2.60	23.10	22.80	55	124	39.60	4.26	23457	170.70	2924
BC-0304	7.60	2.70	26.00	22.40	58	119	35.20	4.20	27160	180.90	2179
BC-0305	7.40	3.10	25.30	30.70	68	128	37.80	4.52	25926	177.10	2819
BC-0306	6.20	2.90	25.60	28.40	60	127	35.30	4.60	24691	169.50	3152
BC-0307	7.50	3.20	24.80	30.10	65	131	33.20	4.08	25926	182.70	4170
BC-0308	7.60	2.70	25.10	27.10	55	118	40.30	4.62	25926	195.50	4319
BC-0309	7.70	3.40	25.20	29.20	61	124	33.20	4.38	22222	183.60	2752
BC-0310	8.20	3.70	24.90	33.30	62	126	32.60	4.56	24691	189.00	3449
BC-0311	7.10	2.80	23.80	25.50	67	121	40.20	4.40	24691	175.90	3137
BC-0312	7.20	2.70	24.10	23.20	59	123	36.20	4.63	25926	157.60	2490
BC-0313	6.50	1.40	25.00	12.40	60	124	28.30	4.48	25926	183.80	2772
BC-0314	7.20	2.50	26.10	26.90	58	123	36.30	4.40	25926	176.90	3080
BC-0316	7.20	3.10	21.80	28.50	58	123	39.90	4.65	22222	171.70	3561
BC-0318	7.60	3.20	22.20	29.70	60	126	43.20	4.33	25926	148.20	2960
BC-0319	6.80	3.00	23.00	24.70	64	129	45.30	4.18	23457	143.40	3799
BC-0320	5.90	2.70	21.90	21.60	62	119	33.20	4.35	23457	145.40	3269
BC-0321	6.70	2.10	24.20	18.80	59	123	33.30	4.28	24691	159.60	3195
BC-0322	7.10	2.60	26.10	22.40	65	128	31.20	4.49	24691	172.20	2559
BC-0323	6.90	2.60	23.90	23.60	62	124	35.20	4.28	23457	165.40	2495
BC-0324	7.20	3.10	24.80	31.80	56	118	28.20	4.39	25926	173.50	2530
BC-0325	7.10	2.70	25.20	30.60	60	122	25.20	4.30	24691	177.10	2462
BC-0327	6.20	2.20	30.10	24.30	63	120	29.20	4.21	27160	185.40	2219
BC-0328	7.20	2.40	26.40	22.90	58	123	32.30	4.48	27160	168.10	2017
BC-0329	7.60	3.20	23.90	32.30	56	122	30.20	4.28	23457	175.60	2129
BC-0330	6.90	3.00	26.50	29.60	61	125	31.10	4.31	24691	180.50	2072
BC-0331	6.70	2.80	24.90	30.80	65	121	35.20	4.08	24691	185.70	1993
BC-0332	6.90	2.60	26.20	25.60	58	125	30.20	4.29	23457	195.40	2855
BC-0333	7.10	3.10	27.80	29.50	54	123	27.20	4.32	25926	197.60	2481
BC-0335	6.60	2.80	26.40	28.80	62	126	25.60	4.40	24691	182.50	2775
BC-0336	6.20	2.20	25.90	22.60	60	124	38.30	4.51	25926	203.60	2449
BC-0338	6.80	2.90	26.30	32.50	59	120	40.30	4.02	24691	165.00	2019
BC-0339	6.50	2.10	25.10	17.60	57	128	31.40	4.30	24691	172.50	2676
BC-0340	7.10	3.00	28.30	29.20	65	123	30.20	4.60	22222	190.50	3139
BC-0341	7.20	2.20	27.40	26.40	61	125	33.60	4.58	22222	201.60	3562

Table 153. Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2018-2019 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronaire Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0273	39.20	10.20	6.33	8	30.24	30.05	83.99	6.17	6.57	4.59
BC-0276	40.30	10.70	7.12	7	30.33	26.62	84.08	5.36	7.18	4.68
BC-0277	38.65	9.20	5.85	7	30.92	29.87	84.57	5.87	7.30	4.17
BC-0278	39.62	11.50	7.45	8	29.78	29.04	83.58	5.48	7.15	4.35
BC-0279	38.75	11.00	7.00	7	31.24	32.07	85.02	6.38	7.07	4.08
BC-0280	38.80	11.39	6.88	7	30.90	34.18	84.53	5.72	7.13	4.00
BC-0283	38.77	10.65	6.42	7	31.15	30.82	85.01	6.05	7.13	4.06
BC-0284	40.10	10.85	6.90	8	29.77	31.81	83.53	5.81	7.06	4.21
BC-0285	39.25	11.10	7.05	7	31.30	31.22	85.05	5.60	6.91	3.40
BC-0286	39.61	11.00	7.18	8	31.13	32.88	85.00	6.11	7.38	3.88
BC-0287	40.77	10.90	7.75	6	30.85	31.63	84.51	5.81	7.16	3.91
BC-0288	40.16	9.98	6.85	7	30.66	34.37	84.34	5.93	7.20	4.07
BC-0289	41.00	10.89	7.79	8	31.35	33.36	85.04	5.99	7.24	3.65
BC-0290	39.90	11.20	7.42	6	31.61	32.40	85.13	5.66	6.23	3.67
BC-0291	39.15	9.90	7.10	7	30.95	30.32	84.59	5.30	7.31	3.56
BC-0292	39.72	10.35	7.23	8	32.10	32.92	85.26	6.43	7.22	4.12
BC-0293	40.10	11.00	7.48	7	29.83	30.87	83.64	5.66	6.19	4.25
BC-0294	39.70	11.20	7.10	7	29.81	29.54	83.60	5.66	7.22	4.04
BC-0295	40.12	9.85	6.98	8	29.56	30.07	83.39	6.22	7.04	4.45
BC-0297	39.29	11.00	7.80	7	29.26	32.03	83.12	6.67	7.18	4.36
BC-0299	38.79	10.89	7.15	7	30.28	29.80	84.02	5.72	6.66	3.73
BC-0301	39.85	10.11	6.77	7	30.70	30.63	84.40	6.38	7.09	4.08
BC-0302	38.80	12.00	7.55	6	31.31	31.96	85.05	5.72	7.06	3.71
BC-0303	39.60	10.98	6.88	8	30.94	30.48	84.58	5.87	6.97	3.76
BC-0304	39.10	9.80	6.63	7	30.64	31.70	84.33	5.93	6.50	3.82
BC-0305	40.00	11.25	6.12	7	31.96	29.48	85.20	5.55	5.98	3.03
BC-0306	39.90	10.11	6.79	7	30.39	32.12	84.11	5.55	6.59	3.17
BC-0307	39.24	12.05	7.98	8	29.68	32.64	83.49	6.22	7.11	4.11
BC-0308	39.85	10.50	7.21	8	28.17	29.27	82.07	5.81	6.73	4.80
BC-0309	41.10	10.18	6.87	7	31.00	29.73	84.65	6.05	7.13	4.22
BC-0310	39.17	11.05	7.13	7	29.53	30.53	83.37	5.66	7.15	4.35
BC-0311	40.11	10.03	6.93	7	30.53	31.55	84.25	5.99	7.15	4.33
BC-0312	38.25	11.00	6.37	6	31.41	30.28	85.07	5.48	6.44	4.25
BC-0313	39.77	11.90	7.94	8	31.60	32.57	85.13	5.27	6.21	3.74
BC-0314	40.20	10.11	6.77	7	28.89	31.97	82.76	5.99	6.44	4.09
BC-0316	40.12	10.20	6.77	8	30.92	33.83	84.57	6.17	5.74	3.39
BC-0318	38.54	11.40	7.43	7	26.09	30.10	79.84	6.05	6.64	3.45
BC-0319	40.17	10.89	7.58	7	30.95	30.97	84.59	5.87	6.66	4.23
BC-0320	39.77	10.35	6.62	7	31.74	31.85	85.16	5.55	6.57	3.68
BC-0321	39.10	10.18	6.53	6	27.28	29.59	81.16	5.87	6.68	3.95
BC-0322	39.00	9.90	6.72	7	29.95	30.08	83.77	5.48	5.40	3.61
BC-0323	39.69	10.00	6.89	7	30.89	29.64	84.53	5.60	6.41	3.78
BC-0324	38.85	9.65	7.12	7	29.07	31.44	82.94	6.32	6.64	4.89
BC-0325	39.90	10.72	7.40	8	29.18	29.49	83.04	5.87	6.05	3.92
BC-0327	40.25	11.25	7.95	7	30.46	31.22	84.21	5.72	6.79	3.57

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI)(%)	Elongation (%)	Moisture (%)	Micronaire Value ($\mu\text{g}/\text{inch}$)
1	13	14	15	16	17	18	19	20	21	22
BC-0328	40.80	11.10	7.22	7	29.33	29.32	83.19	5.42	6.64	3.46
BC-0329	39.95	10.85	7.45	8	31.65	30.84	85.15	5.72	6.68	3.09
BC-0330	40.00	12.10	7.73	7	28.11	29.74	82.00	5.99	6.71	4.09
BC-0331	39.82	10.46	7.03	7	28.14	30.43	82.05	5.93	6.57	4.32
BC-0332	38.95	10.77	6.82	7	26.17	27.37	79.90	6.17	6.64	4.30
BC-0333	38.77	11.00	7.00	7	32.00	32.90	85.22	5.81	6.80	3.70
BC-0335	39.33	10.89	7.51	8	25.74	26.90	79.41	5.42	6.68	3.36
BC-0336	40.12	10.10	6.98	7	29.46	28.14	83.33	5.48	6.17	3.91
BC-0338	40.04	11.98	8.12	7	30.55	29.83	84.29	6.22	6.75	4.33
BC-0339	39.28	10.77	6.89	7	29.00	30.69	82.90	5.66	6.62	3.99
BC-0340	40.10	10.00	6.77	7	28.58	30.36	82.47	6.05	5.81	4.87
BC-0341	40.35	9.97	7.47	8	30.00	30.92	83.80	5.72	6.62	3.83

Quantitative Characteristics of 56 Cotton genotypes (2019-2020)

Quantitative variations of 56 cotton genotypes grown at the Cotton Research Center Sreepur, Gazipur in respect of different characters (2019-20) are presented in Table 154. The quantitative characteristics of 56 cotton genotypes are shown in Table 155.

The range of number of primary and secondary fruiting branches per plant was 16.20 (BC-0446 and BC-0448) to 20.70 (BC-0468) and 1.50 (BC-0435) to 18.70 (BC-0492), respectively. On an average, days to 50% flowering were 62 and range was 53 (BC-0436) to 67 (BC-046, BC-0468 and BC-0489). In case of days to 50% boll split, the range was 116 (BC-0441) to 131 (BC-0468 and BC-0489). The average number of bolls per plant was 49.33 and range was 29.90 (BC-0442) to 64.50 (BC-0462). The range of plant height at harvest was 98.40 cm (BC-0435) to 163.10 cm (BC-0468) and average single boll weight was 5.62g. The average seed cotton yield was 3570.21 kg/ha and range was 1228 kg/ha (BC-0454) to 5400 kg/ha (BC-0446). The highest variation was observed in the number of secondary fruiting branches (CV-46.81%) followed by number of vegetative branches/plant (43.73%) and seed cotton yield (29.38%). The lowest variation was observed in the days to 50% boll split (2.71%).

The ginning characteristics of 56 cotton genotypes grown in Cotton Research Center Sreepur, Gazipur in 2019-2020 growing season is given in Table 154. The range of ginning out turn (GOT) and fuzz grade were 24.98% (BC-0494) to 44.19% (BC-0453) and 6 to 8 respectively. Seed index and lint index ranges were 8.60 g (BC-0470) to 12.20 g (BC-0472) and 4.60 g (BC-0456) to 9.60 g (BC-0441), respectively. The highest variation was observed in lint index (29.38%) and lowest variation was in fuzz grade (5.78%). Fiber characteristics, upper half mean length was ranged from 28.18mm (BC-0472) to 33.49mm (BC-0442). The range of fiber strength and uniformity index 24.23 g/tex (BC-0455) to 31.57 g/tex (BC-0475) and 82.08% (BC-0472) to 85.61% (BC-0442), respectively. Average elongation and moisture were 6.46% and 6.18%, respectively. The range of micronaire value was 4.65 $\mu\text{g}/\text{inch}$ (BC-0489) to 6.16 $\mu\text{g}/\text{inch}$ (BC-0473). The highest and lowest variation in moisture (%) was (10.68%) and uniformity index (1.13%), respectively.

Table 154. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Centre, Sreepur, Gazipur, 2019-2020

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node number of 1 st fruiting branch	4.80	7.40	5.66	0.56	9.90
Number of vegetative branches/plant	0.10	3.70	1.33	0.58	43.73
Number of primary fruiting branches/plant	16.20	20.70	17.92	1.21	6.74
Number of secondary fruiting branches/plant	1.50	18.70	7.27	3.40	46.81
Days to 50% flowering	53.00	67.00	62.16	2.68	4.32
Days to 50% boll split	116.00	131.00	126.23	3.41	2.71
Number of bolls/plant	29.90	64.50	49.33	6.53	13.24
Single boll weight (g)	4.30	6.90	5.62	0.62	11.01
Plant Population at Harvest (ha)	12346.00	23457.00	17988.84	3085.90	17.15
Plant height at harvest (cm)	98.40	163.10	135.39	11.71	8.65
Seed cotton yield (kg/ha)	1228.00	5400.00	3570.21	1049.10	29.38
Ginning traits					
GOT (%)	24.98	44.19	39.03	4.09	10.48
Seed Index (g)	8.60	12.20	10.57	0.82	7.74
Lint Index (g)	4.60	9.60	6.97	1.16	16.59
Fuzz Grade	7.00	8.00	7.73	0.45	5.78
Fiber traits					
Upper Half Mean Length (UHML) (mm)	28.18	33.49	30.92	1.27	4.12
Strength (g/tex)	24.23	31.57	27.85	1.37	4.91
Uniformity Index (UI)	82.08	85.61	84.44	0.95	1.13
Elongation (%)	6.05	7.07	6.46	0.23	3.58
Moisture (%)	4.99	7.07	6.18	0.66	10.68
Micronare Value (µg/inch)	4.65	6.16	5.35	0.37	6.84

Table 155. Quantitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0435	6.10	0.20	17.50	1.50	55	125	43.80	5.00	22222	98.40	3947
BC-0436	7.40	2.20	17.30	9.90	53	126	36.10	5.80	23457	115.70	4067
BC-0437	7.40	1.30	16.80	7.50	54	126	44.10	6.00	19753	132.30	4091
BC-0439	7.40	1.80	17.50	8.90	63	121	44.90	6.20	18519	128.00	4227
BC-0440	6.10	1.30	17.20	5.00	61	122	59.20	6.30	19753	135.40	4113
BC-0441	6.00	0.60	16.40	2.50	55	116	49.40	5.60	17284	129.80	3533
BC-0442	6.90	2.00	20.10	11.70	56	125	29.90	5.70	18519	142.40	2697

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0444	6.00	0.80	16.80	2.50	59	125	47.40	5.70	19753	134.40	3763
BC-0445	6.00	1.00	16.60	4.70	61	126	55.50	6.70	14815	132.20	3430
BC-0446	6.30	1.70	16.20	5.90	63	126	54.20	5.50	22222	135.90	5400
BC-0447	6.40	1.30	17.20	4.90	64	125	57.80	5.80	17284	143.10	3233
BC-0448	6.40	1.30	16.20	5.90	63	127	55.60	5.10	18519	122.70	2956
BC-0449	5.80	1.30	18.00	6.40	61	123	50.00	4.70	12346	131.70	2320
BC-0450	6.30	1.40	16.70	3.70	63	128	55.30	6.30	17284	134.40	4238
BC-0451	6.10	1.80	16.50	5.80	64	128	48.50	5.70	16049	124.10	3018
BC-0452	5.70	1.00	17.20	2.80	63	129	54.00	5.60	13540	141.40	2533
BC-0453	6.60	0.10	17.40	1.60	64	130	48.10	5.50	17284	139.00	3062
BC-0454	4.90	0.80	17.20	2.40	61	123	43.60	5.40	12346	135.80	1228
BC-0455	5.20	1.90	16.70	6.80	63	130	52.30	4.40	13580	130.00	2301
BC-0456	6.20	2.10	17.00	7.70	62	126	43.40	4.60	12346	136.00	1691
BC-0458	5.50	3.70	16.40	18.70	66	127	45.70	5.50	18519	116.90	3894
BC-0459	5.20	0.60	17.40	2.60	63	129	47.40	5.00	22222	104.90	3941
BC-0460	5.50	1.70	18.00	9.60	66	130	48.60	6.90	19753	126.10	4593
BC-0461	5.10	1.20	18.10	8.30	61	121	53.30	6.10	20988	133.20	4581
BC-0462	5.60	1.60	20.60	11.00	63	127	64.50	6.00	22222	146.10	5159
BC-0463	5.30	1.40	18.70	9.90	61	122	55.80	6.50	18519	132.60	5162
BC-0464	5.10	1.80	16.80	10.30	63	127	49.90	6.30	18519	126.20	3663
BC-0465	4.80	0.80	17.50	5.30	62	129	47.20	5.60	20988	125.00	4102
BC-0466	5.90	1.00	18.10	5.40	66	130	47.90	6.10	19753	152.00	4446
BC-0467	6.10	1.00	19.90	5.30	67	130	54.70	5.10	19753	157.10	4320
BC-0468	5.70	1.30	20.70	7.50	67	131	58.20	5.30	19753	163.10	3472
BC-0469	5.50	1.50	19.10	7.00	64	129	48.60	6.10	18519	149.80	4620
BC-0470	5.00	1.50	19.80	11.20	65	128	59.90	5.80	17284	156.00	5014
BC-0472	5.00	1.20	18.90	9.10	66	130	59.20	5.70	17284	150.50	4216
BC-0473	5.20	2.10	17.90	11.90	64	127	52.10	6.10	18519	141.90	4630
BC-0474	5.20	1.00	18.20	4.50	65	125	51.50	5.40	14815	137.50	3356
BC-0475	5.10	1.10	18.50	6.80	57	123	47.50	5.80	20988	146.10	4644
BC-0476	5.00	1.30	16.80	9.30	58	125	41.10	6.90	12346	128.10	3000
BC-0477	5.40	1.50	16.70	9.50	61	126	43.40	6.40	22222	123.50	4041
BC-0478	5.50	1.50	17.00	7.70	66	130	39.20	6.10	19753	119.60	3992
BC-0479	5.50	1.50	19.10	11.10	64	127	62.50	5.90	16049	126.20	4355
BC-0480	5.10	1.00	19.10	8.10	61	122	50.30	4.90	20988	153.40	4204
BC-0481	5.40	0.90	17.30	6.50	62	127	37.30	5.00	12346	127.20	1569
BC-0482	5.60	0.30	19.00	2.00	61	120	56.70	5.60	17284	150.80	3537
BC-0483	5.70	0.50	20.30	4.30	59	125	50.80	5.00	17284	154.10	3867
BC-0484	5.60	1.40	18.00	9.60	60	125	45.40	5.10	20988	128.10	3744
BC-0486	5.30	0.90	17.40	5.70	64	128	43.50	5.60	12346	130.50	1438
BC-0487	5.60	1.00	19.60	6.50	61	117	49.80	4.30	12346	133.90	1601
BC-0488	5.10	1.00	17.40	6.00	63	128	43.90	6.20	12346	129.30	1561
BC-0489	5.60	0.90	17.90	5.10	67	131	44.90	5.40	17284	128.50	1978

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/Plant	No. of Secondary Fruiting Branches/Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0490	5.00	1.60	17.60	9.50	66	130	41.40	5.70	18519	129.30	2861
BC-0491	5.40	1.00	19.70	6.30	62	130	46.10	4.50	19753	148.00	2778
BC-0492	5.00	2.10	18.40	13.90	64	127	52.70	4.90	22222	153.70	3620
BC-0493	4.80	1.40	18.80	10.00	64	127	49.20	5.20	20988	140.60	3928
BC-0494	5.30	2.00	18.70	11.80	63	127	47.00	6.00	18519	144.70	4114
BC-0495	4.90	2.30	17.80	11.50	61	125	52.00	4.90	18519	144.40	4083

Table 155. Quantitative characteristics of cotton genotypes, Cotton Research Center, Sreepur, Gazipur in 2019-2020 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronare Value(µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0435	38.76	11.00	6.99	8	28.94	25.88	82.83	6.38	6.80	5.32
BC-0436	42.34	10.00	7.36	7	30.62	29.13	84.32	6.49	7.00	5.63
BC-0437	39.88	10.00	7.65	8	31.00	28.77	84.65	6.94	7.07	5.60
BC-0439	42.67	11.00	8.22	8	31.81	26.27	85.19	6.56	6.75	5.88
BC-0440	42.39	10.00	7.42	8	30.33	26.42	84.08	6.62	6.93	6.01
BC-0441	41.46	11.00	9.60	7	32.05	28.02	85.24	6.74	6.88	5.00
BC-0442	35.44	10.00	5.51	8	33.49	28.68	85.61	6.88	6.36	5.08
BC-0444	43.50	10.00	7.72	8	32.91	28.86	85.48	6.49	6.79	5.34
BC-0445	43.60	11.00	8.54	8	32.62	29.97	85.38	7.07	6.93	5.06
BC-0446	41.40	10.60	7.52	8	32.53	29.97	85.37	6.56	6.73	5.30
BC-0447	39.17	10.00	6.44	7	30.93	27.32	84.58	6.67	6.68	5.26
BC-0448	37.00	9.00	6.11	7	31.79	28.95	85.18	6.62	6.88	5.11
BC-0449	39.36	9.00	5.88	7	31.96	28.69	85.20	6.67	6.77	5.24
BC-0450	41.52	10.00	7.13	8	31.51	28.70	85.12	6.38	6.70	5.09
BC-0451	41.59	11.00	7.95	8	30.04	26.82	83.82	6.38	6.86	5.13
BC-0452	43.84	10.00	7.80	8	30.74	27.69	84.42	6.32	6.89	4.89
BC-0453	44.19	10.00	7.96	8	31.80	27.03	85.19	6.49	6.84	5.00
BC-0454	32.30	11.00	5.44	8	28.64	28.39	82.54	6.43	6.41	5.69
BC-0455	37.07	10.60	5.29	8	29.62	24.23	83.46	6.32	6.84	5.24
BC-0456	30.87	10.00	4.60	8	29.60	26.08	83.45	6.17	6.75	5.75
BC-0458	42.87	11.00	8.28	8	31.14	28.09	85.00	6.74	5.63	5.43
BC-0459	36.84	10.00	5.87	7	31.83	27.92	85.20	6.67	5.29	5.43
BC-0460	40.52	11.00	7.55	8	31.51	25.72	85.12	6.17	6.73	5.75
BC-0461	42.87	11.20	8.43	8	30.18	28.18	83.96	6.88	6.62	5.23
BC-0462	43.33	11.00	8.43	8	30.34	26.14	84.08	6.43	6.53	6.08
BC-0463	42.88	11.00	8.30	8	30.79	25.99	84.48	6.22	6.34	6.12

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0464	42.82	10.00	7.53	7	31.61	29.56	85.13	6.43	5.94	5.11
BC-0465	42.90	10.00	7.54	8	32.42	27.29	85.35	6.56	5.81	5.28
BC-0466	43.34	11.00	8.45	8	29.54	26.49	83.38	6.05	6.82	4.93
BC-0467	38.96	10.00	7.51	7	31.65	28.77	85.15	6.67	6.66	5.26
BC-0468	38.37	11.00	6.90	8	31.99	29.15	85.21	6.56	6.59	5.26
BC-0469	42.85	8.62	6.48	7	31.28	26.64	85.04	6.11	6.52	5.49
BC-0470	43.27	8.60	6.58	8	32.63	27.75	85.38	6.32	6.35	5.47
BC-0472	39.60	12.20	7.70	8	28.18	28.08	82.08	6.38	6.12	5.47
BC-0473	40.98	11.00	7.68	7	31.28	27.98	85.04	6.49	6.05	6.16
BC-0474	35.42	12.00	6.58	8	30.02	27.05	83.81	6.38	5.89	6.08
BC-0475	42.42	11.00	8.17	7	32.23	31.57	85.29	6.62	5.74	5.28
BC-0476	41.03	11.00	7.65	8	32.02	26.76	85.23	6.17	5.69	5.28
BC-0477	37.67	11.00	6.67	7	29.46	27.98	83.33	6.32	5.63	5.08
BC-0478	42.04	11.00	8.02	8	29.32	28.55	83.15	6.38	5.56	4.96
BC-0479	39.37	12.00	7.82	8	31.13	29.10	85.00	6.17	5.53	4.98
BC-0480	40.59	12.00	8.57	8	29.79	26.73	83.59	6.49	6.68	5.49
BC-0481	34.17	11.00	5.76	8	31.79	27.11	85.18	6.22	6.21	5.37
BC-0482	35.72	11.00	6.14	8	32.94	28.87	85.49	6.67	6.01	5.37
BC-0483	34.25	12.00	6.28	8	32.18	30.79	85.30	6.80	5.76	5.19
BC-0484	41.13	11.00	7.81	8	28.27	26.22	82.17	6.11	5.92	5.34
BC-0486	35.83	10.00	5.63	7	30.37	26.24	84.10	6.43	5.51	5.36
BC-0487	36.92	10.00	5.90	8	30.53	28.99	84.25	6.17	5.26	4.89
BC-0488	35.66	11.00	6.12	7	31.11	27.03	84.99	6.11	5.22	4.96
BC-0489	39.41	10.00	6.53	8	29.46	28.45	83.33	6.22	5.17	4.65
BC-0490	35.66	11.00	6.15	8	30.81	28.88	84.49	6.56	5.15	5.04
BC-0491	30.85	11.00	5.01	8	28.67	28.22	82.56	6.38	5.11	4.89
BC-0492	34.20	11.00	5.73	8	29.16	27.54	83.02	6.43	5.08	4.85
BC-0493	33.59	10.00	5.07	7	30.91	28.59	84.57	6.43	5.02	5.95
BC-0494	24.98	9.00	4.86	8	30.17	28.29	83.92	6.67	5.00	5.85
BC-0495	34.18	11.00	5.73	8	31.72	26.94	85.15	6.22	4.99	5.75

Quantitative Characteristics 50 Cotton genotypes (2020-2021)

Range, mean, standard deviation (SD) and coefficient of variation (CV) of different quantitative characters of 50 cotton genotypes grown in Cotton Research Center, Sreepur, Gazipur (2020-2021) are presented in Table 156. The quantitative characteristics of 50 cotton genotypes are enlisted in Table 157.

The range of number of primary and secondary fruiting branches per plant were 15.90 (BC-0586) to 29.10 (BC-0560) and 3.60 (BC-0580) to 14.50 (BC-0556), respectively (Table 156). On an average, days to 50% flowering were 63 and range was 56 (BC-0599) to 71 days (BC-0586). In case of days to 50% boll split, the range was 114 (BC-0562) to 124 (BC-0486). The average number of bolls per plant was 31.91 and range was 19.20 (BC-0555) to 46.00 (BC-0598). The range of plant height at harvest was 140.10 cm (BC-0554) to 197.20 cm (BC-

0569) and average single boll weight was 4.79 g. The average seed cotton yield was 2100.28 kg/ha and the range was 704 kg/ha (BC-0586) to 3205 kg/ha (BC-0586).

The highest variation was observed in the number of secondary fruiting branches per plant (34.88%) followed by the number of vegetative branches per plant (29.64%) and seed cotton yield (24.19%). The lowest variation was observed in the days to 50% boll split (1.87%). The ginning characteristics of 53 cotton genotypes grown in Cotton Research Center, Sreepur, Gazipur in 2020-2021 growing season is given in Table 157. The range of ginning out turn (GOT) and fuzz grade were 36.00% (BC-0554, BC-0558 and BC-570) to 42.00% (BC-0567, BC-0578 and BC-0580) and 7 to 8, respectively. Seed index and lint index ranges were 10.00 g (BC-0570) to 14.00 g (BC-0554, BC-0558, BC-0559, BC-0560 and BC-0583) and 5.63 g (BC-0570) to 9.04 g (BC-0569), respectively.

Fiber characteristics, Upper half mean length ranged from 30.19 mm (BC-0594) to 36.56mm (BC-0571). The ranges of fiber strength and uniformity index were 25.98 g/tex (BC-0554) to 31.01 g/tex (BC-0560) and 82.07% (BC-0594) to 86.38% (BC-0571), respectively. Average elongation and moisture were 6.48% and 6.65%, respectively. The range of micronaire value was 3.15 µg/inch (BC-0554) to 6.38µg/inch (BC-0575). The highest and lowest variation was observed in micronaire value (10.68%) and uniformity index (0.94%), respectively.

Table 156. Quantitative variations in different descriptors of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

Character	Range		Mean	SD	CV (%)
	Min	Max			
Yield components					
Node no. of 1 st fruiting branch	5.80	7.70	6.71	0.35	5.18
Number of vegetative branches/plant	0.70	2.50	1.46	0.43	29.64
Number of primary fruiting branches/plant	15.90	29.10	20.13	2.21	10.97
Number of secondary fruiting branches/plant	3.60	14.50	7.93	2.77	34.88
Days to 50% flowering	56.00	71.00	63.56	3.89	6.12
Days to 50% boll split	114.00	124.00	118.68	2.22	1.87
Number of bolls/plant	19.20	46.00	31.91	5.46	17.13
Single boll weight (g)	4.00	7.70	4.79	0.55	11.41
Plant population at harvest (ha)	12346.00	27160.00	25629.26	3009.05	11.74
Plant height at harvest (cm)	140.10	197.20	169.84	15.49	9.12
Seed cotton yield (kg/ha)	704.00	3205.00	2100.28	508.05	24.19
Ginning traits					
GOT (%)	36.00	42.00	39.60	1.74	4.40
Seed Index (g)	10.00	14.00	12.48	0.93	7.45
Lint Index (g)	5.63	9.04	8.18	0.50	6.15
Fuzz Grade	7.00	8.00	7.78	0.42	5.38
Fiber traits					
Upper Half Mean Length (mm)	30.19	36.56	32.48	1.34	4.14
Strength (g/tex)	25.98	31.01	28.37	1.27	4.46
Uniformity Index (UI)	82.07	86.38	85.10	0.80	0.94
Elongation (%)	6.03	7.18	6.48	0.26	4.06
Moisture (%)	6.01	6.98	6.65	0.20	2.94
Micronaire Value (µg/inch)	3.15	6.38	5.34	0.61	11.43

Table 157. Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/ Plant	No. of Secondary Fruiting Branches/ Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0552	7.00	2.40	18.10	13.80	66	119	23.20	5.00	25926	146.50	1415
BC-0553	7.20	2.30	19.80	14.20	58	115	22.50	7.70	27160	143.30	1690
BC-0554	6.50	1.70	16.70	9.50	59	115	19.30	4.00	24691	140.10	1180
BC-0555	7.10	2.00	21.80	11.20	61	117	19.20	4.40	24691	163.80	1537
BC-0556	7.20	2.50	21.70	14.50	59	118	19.30	4.60	25926	171.20	1699
BC-0557	6.70	1.80	21.10	8.80	59	115	29.00	4.50	24691	166.40	1893
BC-0558	6.40	1.30	20.10	7.80	67	119	32.30	4.60	12346	169.80	1618
BC-0559	6.70	1.40	21.50	7.50	66	120	32.70	4.00	27160	174.80	1780
BC-0560	6.70	1.50	29.10	9.30	57	117	30.50	5.00	27160	168.20	1618
BC-0561	6.70	1.50	22.30	9.10	65	120	33.50	4.80	24691	187.20	1772
BC-0562	7.20	2.30	21.50	12.10	61	114	32.10	4.30	24691	185.90	1788
BC-0563	7.10	1.60	20.70	6.90	65	117	33.40	4.40	27160	192.90	1715
BC-0564	6.50	1.20	18.80	6.50	63	118	33.40	4.20	27160	175.00	1861
BC-0565	6.50	1.00	19.70	5.80	68	121	32.90	4.00	27160	174.90	1634
BC-0566	6.60	1.60	22.00	8.70	69	122	31.10	4.00	27160	186.50	2039
BC-0567	6.90	1.20	20.90	5.80	67	119	31.70	4.60	27160	189.20	2314
BC-0568	6.40	1.90	20.30	8.10	63	118	35.00	5.20	24691	183.00	2241
BC-0569	7.30	1.60	21.40	8.30	58	117	33.40	4.60	24691	197.20	1909
BC-0570	6.70	1.30	18.80	5.00	65	119	28.00	4.00	27160	172.00	2152
BC-0571	6.60	1.60	20.00	8.80	67	120	37.30	4.80	24691	184.20	2201
BC-0572	6.30	1.80	21.20	12.40	65	119	34.80	4.80	27160	190.00	2088
BC-0573	6.60	1.10	17.20	6.00	67	121	30.60	4.90	24691	155.00	1634
BC-0574	7.00	1.40	16.70	9.50	64	118	32.40	4.80	27160	151.40	2250
BC-0575	6.60	0.90	16.70	6.20	58	117	34.30	4.80	27160	160.50	2282
BC-0576	6.60	0.80	19.90	4.10	69	121	28.80	4.60	22222	168.40	2217
BC-0577	6.50	1.30	22.10	6.90	64	119	31.60	4.80	27160	168.90	2079
BC-0578	6.50	1.00	23.00	5.40	65	118	36.90	5.00	24691	175.70	2339
BC-0579	7.00	1.00	19.70	4.70	67	121	28.30	4.80	24691	162.30	1942
BC-0580	7.00	1.10	17.70	3.60	67	121	28.40	4.70	27160	160.00	2250
BC-0581	6.60	1.00	22.10	5.30	57	116	31.00	5.20	27160	186.30	2412
BC-0582	6.50	1.30	20.60	5.30	64	119	29.80	4.90	27160	169.30	2169
BC-0583	6.20	1.00	21.70	5.10	59	117	31.60	4.80	27160	179.90	1990
BC-0584	7.00	1.20	21.20	6.40	60	118	34.60	4.90	27160	193.10	2266
BC-0585	6.80	1.20	19.50	5.00	58	117	30.40	5.40	27160	167.00	2233
BC-0586	6.70	1.00	15.90	4.70	71	124	25.10	4.60	12346	144.00	704
BC-0587	7.10	1.60	21.40	9.40	61	117	35.90	5.40	24691	181.80	2233
BC-0588	6.60	2.00	18.30	10.80	59	115	35.70	5.20	24691	156.30	2071
BC-0589	5.80	1.00	19.20	6.40	65	119	30.20	4.90	27160	150.00	909

Acc. No.	Node No. of 1 st Fruiting Branches	No. of Vegetative Branches/Plant	No. of Primary Fruiting Branches/ Plant	No. of Secondary Fruiting Branches/ Plant	Days to 50% Flowering	Days to 50% Boll Split	No. of Bolls/ Plant	Single Boll Weight (g)	Plant Population at Harvest (ha)	Plant Height at Harvest (cm)	Seed Cotton Yield (kg/ha)
1	2	3	4	5	6	7	8	9	10	11	12
BC-0590	6.50	1.60	20.50	9.00	66	121	37.00	4.90	27160	173.20	2541
BC-0591	6.60	1.20	19.80	6.80	69	122	29.80	4.80	27160	160.00	2557
BC-0592	6.40	0.90	18.40	4.70	61	119	33.50	5.10	27160	158.40	2703
BC-0593	6.50	1.50	18.60	9.30	69	120	37.00	4.80	24691	167.10	2995
BC-0594	6.30	0.70	18.10	3.60	66	121	37.70	5.00	27160	148.70	2687
BC-0595	6.70	1.20	21.60	5.40	65	119	28.40	5.10	24691	194.80	2509
BC-0596	6.70	1.50	21.70	10.60	64	120	32.60	4.90	25926	179.30	2752
BC-0597	6.00	1.40	19.80	8.40	61	119	35.40	4.70	27160	154.40	2557
BC-0598	6.90	1.90	21.20	10.10	65	123	46.00	5.00	25926	165.30	2865
BC-0599	7.20	2.00	16.30	10.20	56	115	31.70	4.70	27160	142.30	3205
BC-0600	7.70	1.80	21.60	9.30	66	118	45.30	4.50	27160	194.00	2719
BC-0601	6.70	1.70	18.60	10.30	67	120	40.70	4.80	27160	162.70	2800

Table 157. Quantitative characters of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021 (Cont'd)

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0552	39.10	13.00	8.36	8	31.95	29.88	85.29	6.35	6.64	5.08
BC-0553	41.00	11.00	7.65	7	31.68	28.66	85.23	6.39	6.61	5.08
BC-0554	36.00	14.00	7.88	8	33.09	30.15	84.95	6.74	6.64	3.15
BC-0555	40.00	13.00	8.68	7	33.79	29.16	85.77	6.46	6.91	5.49
BC-0556	39.30	12.00	7.78	8	32.99	28.17	85.54	6.52	6.62	5.11
BC-0557	38.00	13.00	7.98	8	32.85	27.88	84.51	6.84	6.30	5.13
BC-0558	36.00	14.00	7.88	8	34.02	30.90	83.90	6.98	6.73	5.45
BC-0559	36.00	14.00	7.88	8	31.95	26.10	85.29	6.29	6.84	3.53
BC-0560	37.00	14.00	8.23	8	34.66	31.01	85.95	7.18	6.82	5.00
BC-0561	39.00	13.00	8.32	8	32.77	28.01	84.90	6.46	6.73	5.34
BC-0562	39.00	12.80	8.19	8	33.27	27.09	85.63	6.78	6.84	5.43
BC-0563	38.00	13.00	7.98	8	32.13	26.10	85.34	6.52	6.73	6.12
BC-0564	40.60	13.00	8.90	8	31.90	25.98	85.27	6.57	6.66	4.18
BC-0565	39.00	13.00	8.32	8	34.04	30.60	85.81	6.48	6.55	5.36
BC-0566	41.00	11.00	7.65	7	32.90	28.02	85.83	6.28	6.80	5.17

Acc. no.	GOT (%)	Seed Index (g)	Lint Index (g)	Fuzz Grade	UHML (mm)	Strength (g/tex)	Uniformity Index (UI) (%)	Elongation (%)	Moisture (%)	Micronare Value (µg/inch)
1	13	14	15	16	17	18	19	20	21	22
BC-0567	42.00	11.00	7.97	7	33.63	29.10	84.70	6.22	6.79	5.26
BC-0568	39.00	13.00	8.32	8	32.68	27.95	85.50	6.40	6.73	5.17
BC-0569	41.00	13.00	9.04	8	35.31	30.27	86.12	6.53	6.82	4.49
BC-0570	36.00	10.00	5.63	8	31.61	27.10	85.19	6.62	6.79	4.97
BC-0571	39.00	13.00	8.32	8	36.56	30.68	86.38	6.19	6.77	4.89
BC-0572	38.00	13.00	7.98	8	35.61	29.10	86.16	6.70	6.68	4.81
BC-0573	40.00	12.00	8.01	7	34.00	29.78	85.79	6.88	6.77	4.63
BC-0574	38.60	13.00	8.18	8	32.85	28.17	85.51	6.09	6.70	5.04
BC-0575	39.00	13.00	8.32	8	30.99	29.09	84.67	6.98	6.93	6.38
BC-0576	39.20	13.00	8.39	8	32.17	27.50	85.36	6.53	6.80	5.72
BC-0577	41.30	12.00	8.45	8	30.67	26.40	84.41	6.22	6.98	5.98
BC-0578	42.00	11.00	7.97	7	32.48	27.18	85.41	6.33	6.84	5.49
BC-0579	41.30	12.00	8.45	8	33.16	28.30	85.59	6.56	6.82	5.41
BC-0580	42.00	11.00	7.97	8	33.03	29.07	85.56	6.03	6.70	5.39
BC-0581	41.70	11.00	7.88	7	33.35	29.19	85.64	6.88	6.57	4.72
BC-0582	38.00	13.00	7.98	8	31.65	27.10	85.62	6.65	6.84	5.41
BC-0583	36.40	14.00	8.02	8	33.20	28.17	83.03	6.13	6.48	5.63
BC-0584	41.60	12.00	8.56	8	32.63	28.55	85.44	6.28	6.70	5.69
BC-0585	41.00	12.00	8.35	8	32.20	28.33	85.37	6.48	6.66	5.43
BC-0586	40.00	11.00	7.34	7	31.80	27.67	85.03	6.59	6.55	5.43
BC-0587	40.00	13.00	8.68	8	32.03	27.85	84.30	6.30	6.62	5.51
BC-0588	41.00	12.00	8.35	8	31.82	26.19	83.26	6.82	6.35	5.66
BC-0589	37.60	13.00	7.84	8	31.86	27.48	85.25	6.19	6.01	5.41
BC-0590	40.00	13.00	8.68	8	31.22	28.18	85.07	6.30	6.71	5.34
BC-0591	41.31	12.00	8.45	8	32.33	29.33	85.40	6.35	6.66	5.63
BC-0592	39.00	13.00	8.32	8	32.12	28.78	85.34	6.17	6.55	6.00
BC-0593	40.00	12.00	8.01	8	31.60	27.40	85.19	6.49	6.50	6.12
BC-0594	41.80	12.00	8.63	8	30.19	28.47	82.07	6.80	6.61	6.23
BC-0595	41.60	12.00	8.56	8	31.08	28.91	85.18	6.43	6.53	5.91
BC-0596	39.70	13.00	8.57	8	31.08	27.68	85.07	6.11	6.75	5.66
BC-0597	41.60	12.00	8.56	7	30.96	27.88	84.66	6.38	6.62	5.98
BC-0598	40.00	13.00	8.68	8	30.26	28.10	84.07	6.43	6.61	5.85
BC-0599	40.00	12.00	8.01	7	30.31	27.18	84.13	6.17	6.41	5.57
BC-0600	41.00	12.00	8.35	7	31.30	29.10	85.11	6.67	6.19	5.85
BC-0601	39.20	13.00	8.39	8	32.47	29.47	85.40	6.30	6.17	5.60

11.8. Bangladesh Sericulture Research and Training Institute

11.8.1. Morphological Characterization Mulberry Germplasm

In total 60 mulberry germplasm conserved in BSRTI field gene bank were characterized during 2018 to 2020. On the basis of morpho-agronomical characters data on 19 qualitative and 41 quantitative characters were recorded. List of mulberry germplasm included in this study are shown in table 158.

Table 158. List of mulberry germplasm characterized, 2018-2020

Sl. No.	Germplasm name	Accession number	Remarks
1.	White mulberry	BSRM-1	Bangladesh local
2.	Black mulberry	BSRM-2	Bangladesh local
3.	Bombay	BSRM-3	Bangladesh local
4.	Bangla local	BSRM-4	Bangladesh local
5.	BM-1	BSRM-5	Bangladesh develop
6.	Bangla local	BSRM-6	Bangladesh local
7.	Bangla local	BSRM-7	Bangladesh local
8.	Tellia	BSRM-8	Bangladesh local
9.	Ghagra	BSRM-9	Bangladesh local
10.	Bangla local	BSRM-10	Bangladesh local
11.	Bangla local	BSRM-11	Bangladesh local
12.	Dudiya	BSRM-12	Bangladesh local
13.	Sadabombay	BSRM-13	Bangladesh local
14.	Lalbombay	BSRM-14	Bangladesh local
15.	Kanva-2	BSRM-15	Indian developed
16.	BM-4	BSRM-16	Bangladesh develop
17.	C-776	BSRM-17	Indian develop
18.	BM-2	BSRM-18	Bangladesh develop
19.	BM-3	BSRM-19	Bangladesh develop
20.	S-54	BSRM-20	Indian develop
21.	Jink	BSRM-21	China develop
22.	Lup-40	BSRM-22	China develop
23.	Indian local	BSRM-23	Indian local
24.	BM-5	BSRM-24	Bangladesh develop
25.	Bangla develop	BSRM-25	Bangladesh develop
26.	Bangla develop	BSRM-26	Bangladesh develop
27.	Bangla develop	BSRM-27	Bangladesh develop
28.	<i>Moruslaevigata</i>	BSRM-28	Indigenous wilt
29.	Bangla develop	BSRM-29	Bangladesh develop
30.	Bangla develop	BSRM-30	Bangladesh develop
31.	Bangla develop	BSRM-31	Bangladesh develop
32.	Bangla develop	BSRM-32	Bangladesh develop
33.	Bangla develop	BSRM-33	Bangladesh develop
34.	BM-7	BSRM-34	Bangladesh develop
35.	Bangla develop	BSRM-35	Bangladesh develop
36.	Bangla develop	BSRM-36	Bangladesh develop
37.	Bangla develop	BSRM-37	Bangladesh develop
38.	Bangla develop	BSRM-38	Bangladesh develop
39.	S-13	BSRM-39	Indian develop
40.	S-30	BSRM-40	Indian develop
41.	S-34	BSRM-41	Indian develop
42.	S-36	BSRM-42	Indian develop

Cont'd. Table 158

Sl. No.	Germplasm name	Accession number	Remarks
43.	S-42	BSRM-43	Indian develop
44.	S-61	BSRM-44	Indian develop
45.	BM-6	BSRM-45	Bangladesh develop
46.	MR-2	BSRM-46	Indian develop
47.	R-135	BSRM-47	Indian develop
48.	Kosen	BSRM-48	Japan develop
49.	Mijusawa	BSRM-49	Japan develop
50.	Multicaules	BSRM-50	Japan develop
51.	Bird-foot	BSRM-51	Indian develop
52.	Bangla wilt	BSRM-53	Bangladesh local
53.	China diploid	BSRM-54	China develop
54.	China triploid	BSRM-55	China develop
55.	BM-8	BSRM-56	Bangladesh develop
56.	OP-34	BSRM-57	Bangladesh develop
57.	BM-9	BSRM-58	Bangladesh develop
58.	OP-146	BSRM-69	Bangladesh develop
59.	V-5	BSRM-60	Indian develop
60.	China	BSRM-61	China develop

Characterization based on Qualitative characters

Qualitative variations of several different characters in mulberry are presented in Table 159. Four categories of young shoot such as green (30%), greenish purple (20%), purple (28.33%) and light green (21.67%) color were observed among the 60 germplasm of mulberry (Fig. 132). However, the green color young shoot was maximum among the mulberry germplasm. The round (23.33%), acute triangle (45%) and long triangle (31.67%) bud shape was observed among the 60 mulberry germplasm and the acute triangle bud was maximum (Fig. 129). Three types of growth nature viz: erect (20%), spreading (73.33%) and drooping (6.67%) was exhibited among the germplasm. Three types of branching nature were found in the germplasm. These were straight (30%), slightly curved (50%) and curved (20%) respectively. Sex expression exhibited as dioecious female, monoecious female, dioecious male and monoecious male category, where dioecious female were found in the maximum germplasm (45%). Leaf apex was found two categories such as acute (70%) and acuminate (30%) respectively (Fig. 126). Serrate (31.67%) crenate (25%), sinuate (18.33%), lobate (13.33%), dentate (6.67%), bi-serrate (1.67%), bi-crenate (1.67%) and serrulate (1.67%) type leaf margin was found among the germplasm. Similarly, leaf base was exhibited as cordate (50%), inequilateral (36.67%) and truncate (13.33%) (Fig.127). Three categories of leaf surface such as smooth (55%), slightly rough (40%) and rough (5%) was observed among the germplasm. Out 60 germplasm 36.67% leaf scar was elliptical, 33.33% circular and 30% triangular. The leaf lobation type of maximum germplasm was plane (60%), shallow lobed (25%), medium lobed (8.33%) and deeply lobed (6.67%) respectively (Fig. 128). Out of 60 germplasm 0-lobed leaf was 65%, multilobed (20%), 3-4 lobed (8.33%) and 1-2 lobed (5%) respectively. Likewise, the previous findings of Vijayan *et al.* (2011) were similar with this morphological finding. They found the wide variations in leaf morphology among different species and accessions within species. They observed the leaves of white mulberry are simple, alternate, stipulate, petiolate, entire, or lobed. The number of lobes varies from one to five. Leaves of the red mulberry are often lobed and upper surfaces rough, pubescent and under neat.

The shape of the leaf vary viz. leaves of wild mulberry species such as *M. laevigata*, *M. serrata*, and *M. tiliae folia* are considered too rough and leathery. Six color of leaf such as green (41.67%), light green (28.33%), deep green (13.33%), yellowish green (13.33%), blackish green (1.67%) and bean green (1.67%) was found among the germplasm. Among the

60 germplasm 36.67% leaf was slightly glossy, 33.33% non glossy and 30% leaf was strongly glossy. The various types of leaf wrinkleless such as slightly wrinkle (75%), smooth (20%) and wrinkled (5%) was observed among the germplasm. Eight categories of leaf shape was observed among the germplasm, where, 23.33% was cordate, 23.33% deltoid, 13.33% palmate, 11.67% ovate, 10% wide ovate, 8.33% aristate, 8.33% narrow ovate and 1.67% pedate. Similarly, genetic diversity of 44 mulberry genotypes was observed by Chanotra *et al.*, (2019) on different phenotypic characters viz, leaf shape, apex, base, margins, leaf length, leaf area, fresh leaf weight and internodal distance among the genotypes.

Correspondingly, phenotypic variability of mulberry germplasm has been detected (Thangavelu *et al.*, 2000; Tikader & Rao, 2002). This kind of performance was reported by Ogunbodede and Ajibade (2001) to be a function of environmental adaptation as well as genetic component. The leaf apex, margin and surface texture could be used for identification purpose. Young shoot and newly sprouted leaf colors are also forms of identification of different mulberry accessions (Adolkar *et al.*, 2007).

Table 159. Morphological variability of 60 mulberry germplasm based on 19 qualitative characters, 2018- 2020

Sl. no.	Descriptor	Descriptor state	No. of germplasm	% of germplasm	Germplasm (Serial number in table 158)
1.	Young shoot color	Green	18	30.00	2,9,13,15,18,20,25,27,29,33,36,38,41,43,44,55,57,58
		Greenish purple	12	20.00	1, 4,6, 14, 17, 22, 24, 26, 28, 40, 45, 53
		Purple	17	28.33	10,21,30,31,35, 39, 42, 48, 49, 51, 59, 60, 61
		Light green	13	21.67	3,5,7,8,11,12,16,19,23,32,34,37,46,47,50,54,56
2.	Growth nature	Drooping	4	6.67	56, 58, 59, 60
		Erect	12	20.00	3, 5, 14, 31, 46, 47, 48, 49, 51, 53, 57, 61
		Spreading	44	73.33	1,2,4,6,7,8,9,10,11,12,13,15,16,17,18,19,20,21,22,23, 24,25,26,27,28,29,30,32,33,34,35,36,37,38,39,40,41, 42,43,44,45,50,54,55
3.	Branching nature	Straight	18	30.00	6, 8, 19, 20, 26, 29, 33, 45, 50, 53, 59, 60
		Slightly curved	30	50.00	1,4,9,10,12,13,14,15,17,23,24,30,32,34,35,37, 38,39, 40, 41,42,43,44,48,49, 51, 55, 56, 57, 58
		Curved	12	20.00	2,3,5,7,11,16,21,22,25,27,28,31,36,46, 47, 54, 61, 18
4.	Bud shape	Round	14	23.33	12,17,20,30,34,35,37,38,40,41,43,44,46,49
		Acute triangle	27	45.00	2, 3, 4, 5, 6, 7, 8, 11, 14, 15, 16, 21, 22, 23, 25, 26, 28, 31, 32, 33, 45, 48, 56, 57, 58, 59, 60
		Long triangle	19	31.67	1,9,10,13,18,19,24,27,29,36,39,42,47,50,51,53,54,55,61
5.	Sex expression	Dioecious female	27	45	1, 4,5,6,7, 1,12, 13, 14, 15, 16, 20, 22, 26, 27, 28, 29, 33, 34, 35, 36, 38, 40, 42, 45, 55, 58,
		Monoecious female	15	25	8, 10, 21, 30, 37, 46, 49, 50, 51, 53, 54, 56, 59, 60, 61,
		Dioecious male	9	15	9, 17, 24, 31, 32, 39, 41, 43, 44
		Monoecious male	9	15	2, 3, 18, 19, 23, 25, 47, 48, 57
6.	Leaf apex	Acute	42	70	1,3,4,5,6,7,9,11,13,16,18,21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 34, 35, 36, 38, 39, 41, 43, 44, 45, 4, 48, 49, 50, 53, 55, 56, 57, 58, 59, 61
		Acuminate	18	30	2,8,10,12,14,15,17,19,20,25,33,37,40,42,46,51,54,60

Table 159 (Cont'd)

Sl. no.	Descriptor	Descriptor state	No. of germplasm	% of germplasm	Germplasm (Serial number in table 158)
7.	Leaf margin	Serrate	19	31.67	7,8,13,14,15,17,19,20,21,27,30,34,36,40,42,43,44,45,55
		Crenate	15	25.00	2,3,4,6,16,18,22,23, 4, 32, 35, 39, 46, 47, 58
		Sinuate	11	18.33	1, 28, 37, 38, 41, 48, 50, 54, 56, 57, 59
		Lobate	8	13.33	5, 9, 10, 11, 12, 51, 53, 61
		Dentate	4	6.67	25, 26, 31, 49
		Bi-serrate	1	1.67	33
		Bi-crenate	1	1.67	60
		Serrulate	1	1.67	29
8.	Leaf base	Cordate	30	50.00	1,3,4,6,7,10,13,15,16,18,19,20,22,24,25,29,36, 37,39, 40, 1, 42, 44, 47, 48, 50, 53, 54, 55, 61,
		Inequilateral	22	36.67	5,8,9,11,14,21,23,24,27,28,30,31,32,33,34,35,38,45
		Truncate	8	13.33	2, 12, 17, 43, 46, 51, 56, 57
9.	Leaf surface	Smooth	33	55.00	2,4,5,11,12,14,15,16,19,0,21,22,23,24,25,27,31, 32,33, 35,38,39,40,42,44,45,46,47,55,56,57,58,60
		Slightly rough	24	40.00	1, 6, 7, 8, 9, 10, 13, 17, 18, 26, 28, 30, 34, 36, 37, 41, 43, 48, 49, 50, 53, 54, 59,
		Rough	3	5.00	3, 29, 51
10.	Shape of the leaf scar	Elliptical	22	36.67	5, 7, 11, 20, 21, 22, 25, 30, 31, 33, 34, 39, 40, 42, 43, 44, 47, 48, 51, 54, 56, 58
		Circular	20	33.33	2,3,6,8,9,10,12,24,26,27,29,32,35,36,41,50,53,57,60, 61
		Triangular	18	30.00	1,4,13,14,15,16,17,18,19,23,28,37,38,45,46,49,55,59
11.	Leaf lobation type	Plane	36	60.00	1,2,4,16,17,18,19,20,21,22,23,24,27,29,31,32,35,36, 37,38,39,40,41,42,43,44,45,46,47,48,49,54,55,57,58,59
		Shallow lobed	15	25.00	3,6,12,14,15,25,26, 28, 33, 34, 50, 53, 56, 60, 61
		Medium lobed	5	8.33	5, 7, 8, 9, 13
		Deeply lobed	4	6.67	10, 11, 30, 51
12.	Leaf lobation number	0 lobed	39	65.00	1,2,16,17,18,19,20,21,22,23,24,27,29,30,31,32,35,36,37 ,38,39,40,41,42,43,44,45,46,47,48,49,50,54,55,56,57,58, 59
		Multi-lobed	12	20.00	6, 7, 8, 9, 10, 11, 13, 14, 25, 51, 53, 61
		3-4 lobed	6	10.00	3, 12, 15, 26, 28, 33
		1-2 lobed	3	5.00	5, 34, 60
13.	Leaf color	Green	25	41.67	1, 4, 5, 7, 8, 9, 10, 11, 12, 17, 23, 33, 36, 39, 43, 46, 48, 49, 51, 53, 55, 57, 59, 60, 61
		Light green	17	28.33	3,6,13,15,22,26,28,30,31,34,35,37,45,47,54,56,58
		Dark green	8	13.33	2, 16, 19, 24, 25, 27, 38, 50
		Yellowish green	8	13.33	18, 20, 21, 32, 40, 41, 42, 44
		Blackish green	1	1.67	14
		Bean green	1	1.67	29
14.	Leaf glossiness	Slightly glossy	22	36.67	8, 10, 11, 12, 14, 15, 27, 37, 39, 40, 42, 46, 47, 48, 49, 51, 54, 55, 56, 57, 58, 60
		Non glossy	20	33.33	1,3,5,6,9,13,17,18,26,29,30,31,34,35,36,41,43,44,45, 53
		Strongly glossy	18	30.00	2,4,7,16,19,20,21,22,23,24,25,28,32,33,38,50,59,61
15.	Leaf wrinkleless	Slightly wrinkle	45	75.00	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,22,23,24, 25,26,27,28,29,31,33,35,37,38,39,40,41,42,43,44,45,46, 50, 53
		Smooth	12	20.00	30, 32, 34, 36, 47, 48, 49, 56, 57, 59, 60, 61
		Wrinkled	3	5.00	21, 51, 54

Table 159 (Cont'd)

Sl. no.	Descriptor	Descriptor state	No. of germplasm	% of germplasm	Germplasm (Serial number in table 158)
16.	Leaf shape	Cordate	14	23.33	2, 3, 7, 16, 18, 28, 29, 32, 36, 41, 43, 48, 50, 56
		Deltoid	14	23.33	25, 26, 30, 31, 34, 39, 40, 42, 44, 45, 55, 58, 59, 60
		Palmate	8	13.33	5, 8, 9, 10, 11, 12, 51, 61
		Ovate	8	13.33	4, 6, 14, 15, 20, 24, 33, 35,
		Wide ovate	6	10.00	21, 22, 46, 47, 49, 57
		Aristate	5	8.33	1, 19, 27, 37, 53
		Narrow ovate	4	6.67	13, 17, 23, 38
		Pedate	1	1.67	54
17.	Fruit color	Radish black	12	20.00	13, 21, 22, 26, 38, 40, 42, 45, 48, 53, 55, 61
		Black-berry	11	18.33	36, 2, 4, 6, 10, 11, 12, 15, 16, 20, 56
		Cream	6	10.00	1, 5, 25, 30,33,51
		Black	5	8.33	3, 18, 23, 27,58
		White-cream	4	6.67	7, 34, 46,59
		Pink	4	6.67	19, 35, 3, 49
		Pinkish	2	3.33	14, 28
		Orange	2	3.33	50, 29
18.	Fruit test	Radish	1	1.67	60
		Sour-sweet	17	28.33	13,16,53,55,58,61,4,8,15,20,22,26,36,40,42,45,50
		Sweet	13	21.67	1, 10,12,18,23,27, 33,34,35,46,49, 1,56, 59, 60
		Light- sweet	3	5.00	2,5, 14, 25, 28, 30
		Light-sour sweet	3	5.00	11, 3, 6
19.	Seed color	Deep sweet	3	5.00	19, 37, 54
		Light yellow	19	38.77	1,4,8,13,14,22,23,26,27,30,36,37,38,45,47,48,54,55, 58
		Light brown	12	22.45	3, 6, 7, 12, 15, 16, 33, 34, 49, 53, 5, 60
		Yellowish brown	09	18.37	2, 18, 20, 25, 28, 29, 40, 42, 56
		Dark brown	02	4.08	10, 61,
	Blackish brown	08	16.33	11, 21, 19, 46, 51, 59, 50, 35	

Nine distinct fruit colors such as reddish-black (23.33%), black-berry (18.33%), cream (10%), black (8.33%), white-cream (6.67%), pink (6.67%), pinkish (3.33%), orange (3.33%) and reddish (1.6%) were observed among the germplasm at maturity stage after 90 days of pruning. The reddish black color fruits were markedly and black-berry was medium. Out of 60 mulberry germplasm 3.39% fruits were sour sweet, 21.67% fruits sweet, 5% light sweet, 5% light sour sweet and 5% deep sweet respectively in taste. However, sour-sweet fruit was markedly sweet fruit moderately observed in the germplasm. This finding was similar with the previous finding of Vijayan *et al.* (2011). They obtained that the color of the fruit varies greatly from white to black with different color shades upon ripening viz. white mulberries, can produce white, lavender, or even black fruits depending, to certain extent, on the timing of harvest. If the harvesting of fruits is delayed, the over ripened fruits of white mulberry turn into somewhat black. Correspondingly, Ercisli and Orhan (2007) reported that the coloring compounds tend to concentrate in the outer drupelets cells in *Morusalba*, whereas in the fruits of *Morusnigra* and *Morusrubra*, these substances concentrate in all the cells of drupelets. White mulberry fruits are generally very sweet. Red mulberry fruits are sweet and usually deep red or almost black. Black mulberry fruits are attractive, large and juicy, with a good balance of sweetness and tartness that makes them the best-flavored fruits in mulberry. Total five categories of seed color observed such as light yellow (38.77%), light brown (22.45%),

yellowish brown (18.37%), dark brown (4.08) and blackish brown (16.33%), respectively (Table 159 and Fig. 131). The qualitative descriptors for individual germplasm are presented in Table 160.

Table 160. Qualitative descriptors of 60 mulberry germplasm

Acc. No.	Young shoot color	Growth nature	Branching nature	Bud shape	Sex expression	Leaf apex	Leaf margin	Leaf base	Leaf surface	Shape of the leaf scar	Leaf lobation type	Leaf lobation no.	Leaf color	Leaf glossiness	Leaf wrinkleness	Leaf shape	Fruit color	Fruit taste	Seed color
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BSRM-1	2	2	2	3	1	1	3	1	2	3	1	1	1	2	1	6	3	2	1
BSRM-2	1	2	1	2	4	2	2	3	1	2	1	1	3	3	1	1	2	3	3
BSRM-3	3	1	1	2	4	1	2	1	3	2	2	3	2	2	1	1	4	4	2
BSRM-4	2	2	2	2	1	1	2	1	1	3	1	1	1	3	1	4	2	1	1
BSRM-5	3	1	1	2	1	1	4	2	1	1	3	4	1	2	1	3	3	3	2
BSRM-6	2	2	3	2	1	1	2	1	2	2	2	2	2	2	1	4	2	4	2
BSRM-7	3	2	1	2	1	1	1	1	2	1	3	2	1	3	1	1	5	3	2
BSRM-8	3	2	3	2	2	2	1	2	2	2	3	2	1	1	1	3	1	1	1
BSRM-9	1	2	2	3	3	1	4	2	2	2	3	2	1	2	1	3			
BSRM-10	4	2	2	3	2	2	4	1	2	2	4	2	1	1	1	3	2	2	4
BSRM-11	3	2	1	2	1	1	4	2	1	1	4	2	1	1	1	3	2	4	5
BSRM-12	3	2	2	1	1	2	4	3	1	2	2	3	1	1	1	3	2	2	2
BSRM-13	1	2	2	3	1	1	1	1	2	3	3	2	2	2	1	7	1	1	1
BSRM-14	2	1	2	2	1	2	1	2	1	3	2	2	5	1	1		7	3	1
BSRM-15	1	2	2	2	1	2	1	1	1	3	2	3	2	1	1	4	2	1	2
BSRM-16	3	2	1	2	1	1	2	1	1	3	1	1	3	1	1	1	2	1	2
BSRM-17	2	2	2	1	3	2	1	3	2	3	1	1	1	2	1	7			
BSRM-18	1	2	1	3	4	1	2	1	2	3	1	1	4	2	1	1	4	2	3
BSRM-19	3	2	3	3	4	2	1	1	1	3	1	1	3	3	1	6	6	5	5
BSRM-20	1	2	3	1	1	2	1	1	1	1	1	1	4	3	1	4	2	1	3
BSRM-21	4	2	1	2	2	1	1	2	1	1	1	1	4	3	3	5	1	1	5
BSRM-22	2	2	1	2	1	1	2	1	1	1	1	1	2	3	1	5	1	1	1
BSRM-23	3	2	2	2	4	1	2	2	1	3	1	1	1	3	1	7	4	2	1
BSRM-24	2	2	2	3	3	1	2	1	1	2	1	1	3	3	1	4			
BSRM-25	1	2	1	2	4	2	5	1	1	1	2	2	3	3	1	2	3	3	3
BSRM-26	2	2	3	2	1	1	5	2	2	2	2	3	2	2	1	2	1	1	1
BSRM-27	1	2	1	3	1	1	1	2	1	2	1	1	3	1	1	6	4	2	1
BSRM-28	2	2	1	2	1	1	3	2	2	3	2	3	2	3	1	1	7	3	3
BSRM-29	1	2	3	3	1	1	8	1	3	2	1	1	6	2	1	1	8	3	3
BSRM-30	4	2	2	1	2	1	1	2	2	1	4	1	2	2	2	2	3	3	1
BSRM-31	4	1	2	2	3	1	5	2	1	1	1	1	2	2	1	2			
BSRM-32	3	2	2	2	3	1	2	2	1	2	1	1	4	3	2	1			
BSRM-33	1	2	3	2	1	2	6	2	1	1	2	3	1	3	1	4	3	2	2
BSRM-34	3	2	2	1	1	1	1	2	2	1	2	4	2	2	2	2	5	2	2
BSRM-35	4	2	2	1	1	1	2	2	1	2	1	1	2	2	1	4	6	2	5
BSRM-36	1	2	1	3	1	1	1	1	2	2	1	1	1	2	2	1	2	1	1
BSRM-37	3	2	2	1	2	2	3	1	2	3	1	1	2	1	1	6	6	5	1
BSRM-38	1	2	2	1	1	1	3	2	1	3	1	1	3	3	1	7	1	1	1
BSRM-39	4	2	2	3	3	1	2	1	1	1	1	1	1	1	1	2			
BSRM-40	2	2	2	1	1	2	1	1	1	1	1	1	4	1	1	2	1	1	3
BSRM-41	1	2	2	1	3	1	3	1	2	2	1	1	4	2	1	1			

Acc. No.	Young shoot color	Growth nature	Branching nature	Bud shape	Sex expression	Leaf apex	Leaf margin	Leaf base	Leaf surface	Shape of the leaf scar	Leaf lobation type	Leaf lobation no.	Leaf color	Leaf glossiness	Leaf wrinkleness	Leaf shape	Fruit color	Fruit taste	Seed color
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
BSRM-42	4	2	2	3	1	2	1	1	1	1	1	1	4	1	1	2	1	1	3
BSRM-43	1	2	2	1	3	1	1	3	2	1	1	1	1	2	1	1			
BSRM-44	1	2	2	1	3	1	1	1	1	1	1	1	4	2	1	2			
BSRM-45	2	2	3	2	1	1	1	2	1	3	1	1	2	2	1	2	1	1	1
BSRM-46	3	1	1	1	2	2	2	3	1	3	1	1	1	1	1	5	5	2	5
BSRM-47	3	1	1	3	4	1	2	1	1	1	1	1	2	1	2	5			1
BSRM-48	4	1	2	2	4	1	3	1	2	1	1	1	1	1	2	1	1	1	1
BSRM-49	2	1	2	1	2	1	5	2	2	3	1	1	1	1	2	5	6	2	2
BSRM-50	3	2	3	3	2	1	3	1	2	2	2	1	3	3	1	1	8	1	5
BSRM-51	2	1	2	3	2	2	4	3	3	1	4	2	1	1	3	3	3	2	5
BSRM-53	2	1	3	3	2	1	4	1	2	2	2	2	1	2	1	6	1	1	2
BSRM-54	3	2	1	3	2	2	3	1	2	1	1	1	2	1	3	8	1	5	1
BSRM-55	1	2	2	3	1	1	1	1	1	3	1	1	1	1	1	2	1	1	1
BSRM-56	3	3	2	2	2	1	3	3	1	1	2	1	2	1	2	1	2	2	3
BSRM-57	1	1	2	2	4	1	3	3	1	2	1	1	1	1	2	5			
BSRM-58	1	3	2	2	1	1	2	2	1	1	1	1	2	1	1	2	4	1	1
BSRM-59	4	3	3	2	2	1	3	2	2	3	1	1	1	3	2	2	5	2	5
BSRM-60	1	3	3	2	2	2	7	2	1	2	2	4	1	1	2	2	9	2	2
BSRM-61	1	1	1	3	2	1	4	1	2	2	2	2	1	3	2	3	1	1	4

Photograph of qualitative descriptor states of mulberry



Green



Light green



Deep green



Yellowish green



Blackish green



Bean green

Fig. 123. Variation in leaf color of Mulberry plant

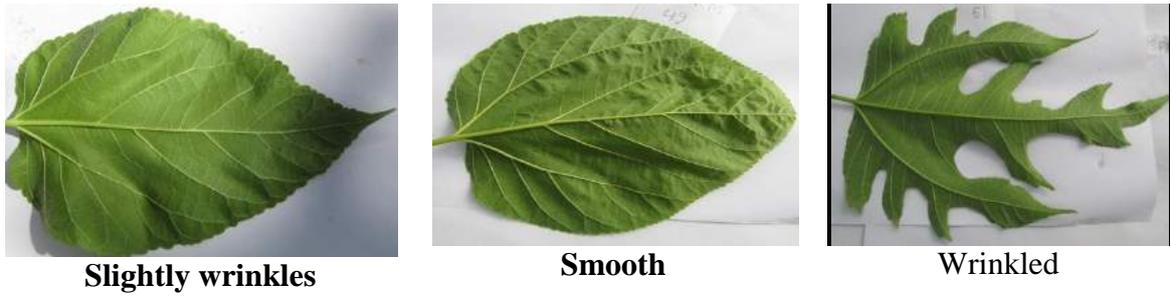


Fig. 124. Leaf wrinkles of Mulberry plant

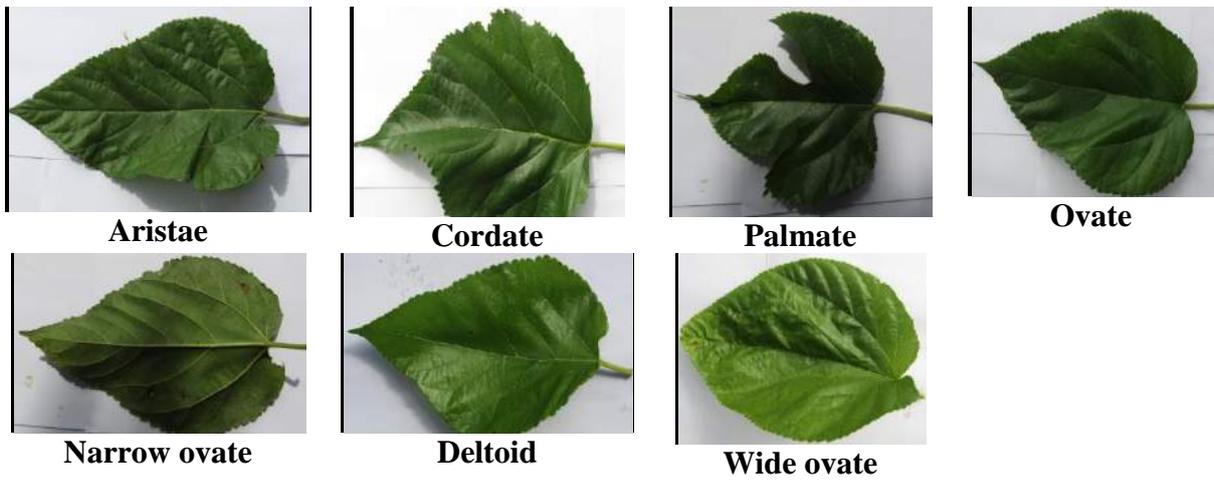


Fig.125. Leaf shape of Mulberry plant

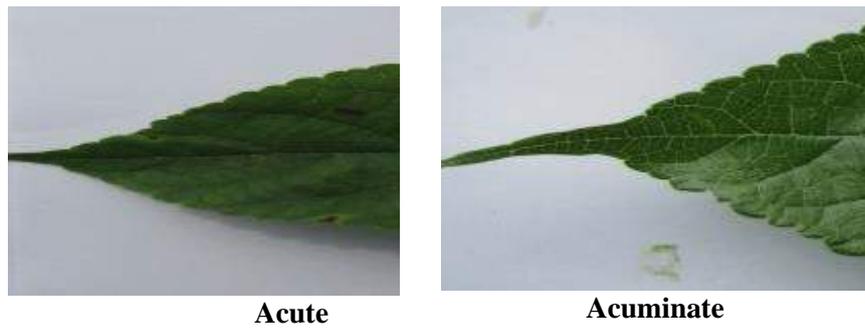


Fig. 126. Leaf apex of Mulberry plant



Fig. 127. Leaf base of Mulberry plant

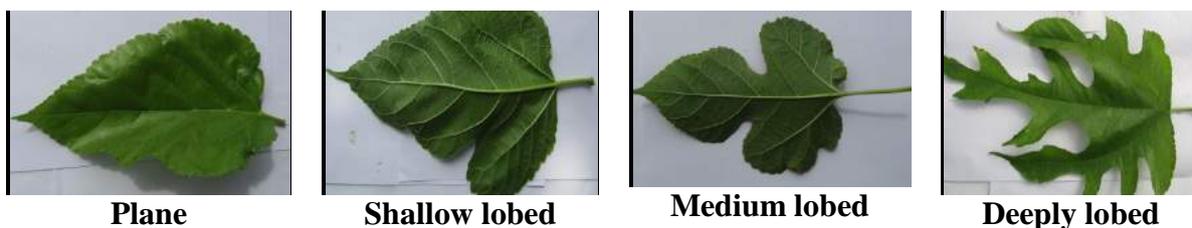


Fig. 128. Leaf lobation type of Mulberry plant



Fig. 129. Bud shape of Mulberry plant



Fig. 130. Leaf lobation of Mulberry plant



Fig. 131. Seed color of Mulberry



Fig. 132. Young shoot color of Mulberry plant

Quantitative characters

Range, mean, standard deviation and CV% of the quantitative data of 41 descriptors among the 60 mulberry germplasm is presented in Table 161. The highest quantitative variation was observed in male inflorescence weight per plant (CV- 389.47%) which was followed by no. of male inflorescence per meter shoot (CV- 56.69%), no. of female inflorescence per meter shoot (CV- 55.08%), male inflorescence length per plant (CV- 53.01%), no. of bisexual inflorescence per meter shoot (CV- 42.52%), dry root weight per plant (CV- 42.21%), petiole weight per plant (CV- 41.94%), seed setting percentage (CV- 39.42%), weight of 100 leaves per plant (CV- 39.24%), leaf area per plant (CV- 38.46%) and leaf yield per plant (CV- 36.37%) respectively. The average maximum number of total branches/plant was found in BSRM-7 (51.22) while the minimum 6.50 was observed in BSRM-51. Total shoot length ranges varies from 33.16 m (BSRM-7) to 4.99 m (BSRM-31) with an average of 19.08 m. The maximum length of longest shoot was 2.53 m for BSRM-60 and the minimum length of longest shoot was 0.50 m in BSRM-21 and BSRM-22 respectively whereas the average length of longest shoot was 1.52 m. The intermodal distance ranged from 8.2 cm to 3.07 cm in BSRM-50 and BSRM-7 respectively. The bud length and bud breath of mulberry germplasm were varies from 0.93 cm to 0.32 cm and 0.73 cm to 0.25 cm respectively. However, the maximum bud length was 0.93 in BSRM-49 and minimum 0.32 cm in BSRM-41 germplasm. Similarly, the maximum bud breath was 0.73 cm in BSRM-49 and minimum breath 0.25 cm in BSRM-41 respectively. The maximum apex length was 10.67 cm in BSRM-53 and the minimum length was 0.70 cm in BSRM-9 whereas the average length was 5.69 cm. The petiole length, petiole breath and petiole weight ranged from 4.60 cm to 1.2 cm, 0.67 cm to 0.33 cm and 0.57 g to 0.04 g respectively. However, the maximum petiole length, petiole breath and petiole weight was 4.60 cm (BSRM-50), 0.67 cm (BSRM-29) and 0.57 g (BSRM-53) respectively. Contrary, the minimum petiole length, petiole breath and petiole weight was 1.92 cm (BSRM-9), 0.33 cm (BSRM-19 and BSRM-26) and 0.04 g (BSRM-9) respectively. Similarly, Peris *et al.* (2014) found the genetic divergence of five mulberry accessions including Embu, Thika, Thailand (*Morus alba*), Kanva-2 and S-41 (*Morusindica*) grown in Kenya among the twelve phenotypic traits. They observed the significantly different across the mulberry accessions included petiole length and petiole width. The maximum leaf area was 0.0098 m² in BSRM-53 and the minimum leaf area was 0.0006 m² in BSRM-9 respectively. 1000 seeds weight was found maximum in BSRM-61 (0.35 g), BSRM-57 (30 g), BSRM-47 (0.27 g) and BSRM-55 (25 g) and the minimum in BSRM-29 (0.02 g), BSRM-10 (0.07 g), BSRM-35 (0.09 g) respectively. The weight of 100 leaves were varies from 600 to 30 g whereas the average weight was 315 g. However, the average maximum weight of 100 leaves were found in the germplasm of BSRM-53 (600 g), BSRM-61 (600 g), BSRM-45 (500 g), BSRM-51 (460 g) and BSRM-49 (400 g) respectively. Conversely, the average minimum weight of 100 leaves was BSRM-9 (30 g), BSRM-8 (50 g), BSRM-10 (60 g), BSRM-35 (70 g) and BSRM-7 (80 g) respectively. Leaf yield per plant ranged from 2410 g to 162.20 g. The average leaf yield was found 1286.10 g per plant. The highest leaf yield per plant was found in germplasm BSRM-56 (2410 g), BSRM-55 (1909 g), BSRM-47 (1839.5 g), BSRM-2 (1754.6 g), BSRM-54 (1677 g) and BSRM-57 (1590 g) which was followed by BSRM-1 (448.3 g), BSRM-6 (408 g), BSRM-10 (237.7 g) and BSRM-3 (253.8 g) respectively. The lowest leaf yield per plant was found in BSRM-8 (162.2 g) and BSRM-9 (185.2 g) respectively. Correspondingly, Peris *et al.* (2014) also observed the significantly different among the growth height, internodes distance and number of branches across the above mentioned five mulberry accessions. The above findings also lined with the previous finding of Chanotra *et al.* (2019), who found the significant variability among the different phenotypic characters *viz.* leaf shape, apex, base, margins, leaf length, leaf width, leaf area, fresh leaf weight, intermodal distance and number of leaves per meter twig with the 44 mulberry genotypes.

Table 161. Quantitative variation in different characters of mulberry germplasm

Sl. no.	Character	Range		Mean	SD	CV (%)
		Min.	Max.			
1.	Number of branches/plant	6.50	51.22	28.86	8.63	29.90
2.	Total shoot length/plant (m)	4.99	33.16	19.08	6.61	29.90
3.	Length of longest shoot/plant (m)	0.50	2.53	1.52	0.48	31.58
4.	Intermodal distance (cm)	3.07	8.20	5.64	1.22	21.63
5.	Bud length (cm)	0.32	0.93	0.63	0.15	23.81
6.	Bud breath (cm)	0.25	0.73	0.49	0.11	22.45
7.	Apex length (cm)	0.70	10.67	5.69	1.76	30.93
8.	Petiole length (cm)	1.2	4.60	2.9	0.52	17.93
9.	Petiole breath (cm)	0.33	0.67	0.50	0.08	16.00
10.	Petiole weight (g)	0.04	0.57	0.31	0.13	41.94
11.	Leaf area (cm ²)	0.0006	0.0098	0.0052	0.002	38.46
12.	Weight of 100 leaves (g)	30	600	315	123.62	39.24
13.	Leaf yield/plant (g)	162.20	2410	1286.10	467.78	36.37
14.	100 seed weight (g)	0.02	0.35	0.19	0.06	31.58
15.	No. of inflorescence/meter length of branch	1.33	225.98	113.66	40.38	35.53
16.	No. of male inflorescence /m shoot	0.17	212.53	106.35	60.29	56.69
17.	No. of female inflorescence/m shoot	1.25	212.53	106.89	58.87	55.08
18.	No. of bisexual inflorescence/meter shoot	7.00	63.17	35.09	14.92	42.52
19.	Male inflorescence length (cm)	0.34	2.97	1.66	0.88	53.01
20.	Female inflorescence length (cm)	0.53	4.47	2.5	0.54	21.60
21.	Bisexual inflorescence length (cm)	0.72	1.71	1.22	0.33	27.05
22.	Male inflorescence breath (cm)	0.14	0.76	0.45	0.19	42.22
23.	Female inflorescence breath (cm)	0.36	0.93	0.65	0.09	13.85
24.	Bisexual inflorescence breath (cm)	0.37	0.71	0.54	0.09	16.67
25.	Male inflorescence weight (g)	0.04	0.34	0.19	0.74	389.47
26.	Female inflorescence weight (g)	0.02	0.25	0.14	0.05	35.71
27.	Bisexual inflorescence weight (g)	0.03	0.27	0.15	0.06	40.00
28.	Floret no./male inflorescence	3.95	79.86	41.91	16.51	39.39
29.	Floret no./female inflorescence	0.05	133.46	66.76	18.63	27.91
30.	Style length (mm)	0.356	1.372	0.864	0.19	21.99
31.	Ovary length (mm)	0.779	1.992	1.386	0.26	18.76
32.	Ovary breath (mm)	0.524	1.702	1.113	0.24	21.56
33.	Fruit length (cm)	0.73	5.58	3.155	0.78	24.72
34.	Fruit breath (cm)	0.52	1.9	1.21	0.34	28.10
35.	Fruit weight (g)	0.07	4.11	2.09	0.82	39.23
36.	Seed setting (%)	8.13	94.24	51.19	20.18	39.42
37.	Dry shoot weight (g)	0.41	13.24	6.83	2.68	39.24
38.	Dry root weight (g)	0.05	3.03	1.54	0.65	42.21
39.	Sprouting (%)	36.67	96.67	66.67	14.85	22.27
40.	Rooting (%)	13.89	98.33	56.11	17.33	30.89
41.	Moisture (%)	69.91	77.92	73.92	1.90	2.57

Number of inflorescence per meter length of branch ranged from 1.33 to 225.98 with an average of 113.66. Number of bisexual inflorescence/meter shoot was 7.00 to 63.17 with an average of 35.09. The maximum number of female inflorescence/meter shoot was 212.53 in BSRM-56 and minimum number of female inflorescence/meter shoot was 1.25 in BSRM-25. The higher number of floret/male inflorescence was 79.89 (BSRM-29) and lower number of floret/male inflorescence was 0.05 (BSRM-56). The range of ovary length was 0.779 to 1.992 cm with an average of 1.386 cm.

The maximum fruit length was 5.58 cm in BSRM-29 and minimum fruit length was 0.73 cm in BSRM-8. The fruit weight varied from 0.07 to 4.11 g with an average of 2.09 g, where, the maximum fruit weight was 4.11 g in BSRM-59 and minimum 0.07 g in BSRM-8 genotype. Dry shoot weight ranged from 0.41 g to 13.24 g with an average of 6.83 g. Dry root weight ranged from 0.05 g to 3.03 g with an average of 1.54 g. The highest seed setting (%) was 94.24 in BSRM-16 and lowest (%) was 8.13 in BSRM-29 genotypes. The range of sprouting was varied 36.67 to 96.67 with an average of 66.67%. The BSRM-38 showed the maximum sprouting 96.67% and BSRM-22 minimum 36.67% respectively. The higher moisture% was 77.92 in BSRM-24 and lower% 69.91 in BSRM-14 genotypes with an average was 73.92%. However, the quantitative descriptors for individual germplasm are presented in Table 162.

Table 162. Quantitative characters of test mulberry germplasm

Germplasm	No. of branches/plant	Total shoot length (m)	Length of the longest shoot (m)	Intermodal distance (cm)	Bud length (cm)	Bud breath (cm)	Apex length (cm)	Petiole length (cm)	Petiole breath (cm)	Petiole weight (g)	Leaf area (m ²)
1	2	3	4	5	6	7	8	9	10	11	12
BSRM-1	17.21	9.71	0.9	5.17	0.4	0.32	1.05	3.15	0.50	0.16	0.0025
BSRM-2	38.1	28.01	1.04	3.9	0.42	0.34	1.34	3.3	0.37	0.16	0.0031
BSRM-3	10.43	5.18	0.64	5.9	0.36	0.28	0.97	3.5	0.43	0.14	0.0028
BSRM-4	28.18	17.47	1.01	6.17	0.39	0.32	0.87	2.91	0.50	0.13	0.0024
BSRM-5	23.36	22.71	1.42	5.33	0.44	0.34	1.41	3.04	0.43	0.15	0.0032
BSRM-6	17.25	12.78	0.98	5.53	0.39	0.31	1.18	2.83	0.37	0.09	0.0019
BSRM-7	51.22	33.16	1.01	3.07	0.37	0.27	1.17	2.79	0.37	0.09	0.0017
BSRM-8	13.43	5.16	0.58	4.33	0.39	0.27	1.09	2.58	0.37	0.05	0.001
BSRM-9	20.7	8.82	0.56	3.8	0.33	0.27	0.7	1.92	0.33	0.04	0.0006
BSRM-10	15.22	8.94	0.67	3.4	0.4	0.29	1.19	2.56	0.40	0.06	0.001
BSRM-11	43.27	32.96	1.07	5.97	0.37	0.28	1.49	3.09	0.37	0.09	0.0017
BSRM-12	24.04	14.61	0.75	3.23	0.37	0.28	1.13	2.86	0.40	0.08	0.0014
BSRM-13	21.35	15.95	1.03	5.87	0.41	0.32	1.29	2.74	0.43	0.09	0.0017
BSRM-14	25.7	25.62	1.3	6.97	0.42	0.33	1.38	2.86	0.53	0.15	0.0028
BSRM-15	23.5	14.51	0.88	5.33	0.37	0.28	1.31	2.93	0.40	0.1	0.0018
BSRM-16	21.47	10.67	0.75	5.17	0.38	0.29	1.13	2.69	0.50	0.18	0.0035
BSRM-17	20.9	18.5	1.24	6.17	0.4	0.31	1.14	3.63	0.37	0.17	0.003
BSRM-18	25.85	20.84	1.06	4.8	0.41	0.3	1.26	3.12	0.57	0.18	0.0031
BSRM-19	28.53	23.34	1.22	4.43	0.43	0.34	1.28	2.81	0.33	0.13	0.0023
BSRM-20	35.29	21.67	0.95	6.8	0.36	0.28	1.09	2.91	0.40	0.17	0.0032
BSRM-21	18.82	7.32	0.5	5.73	0.41	0.33	1.44	3.74	0.50	0.19	0.0032
BSRM-22	16.23	6.7	0.5	5.57	0.51	0.4	1.11	3.85	0.60	0.25	0.0037
BSRM-23	15.86	14.27	1.13	4.13	0.42	0.33	1.35	3.05	0.47	0.26	0.0047
BSRM-24	15.97	8.85	0.81	4.37	0.35	0.27	1.06	3.31	0.57	0.22	0.0039
BSRM-25	26.1	20.01	1.25	6.23	0.4	0.31	1.66	3.05	0.43	0.15	0.0027
BSRM-26	16.96	12.74	1.09	4.93	0.4	0.31	1.24	2.49	0.33	0.11	0.002
BSRM-27	15.07	12.55	1.08	3.6	0.4	0.3	1.27	2.35	0.50	0.14	0.0027
BSRM-28	23.68	20.94	1.19	4.77	0.42	0.32	1	2.69	0.43	0.14	0.0019
BSRM-29	14.41	7.29	0.75	7.57	0.62	0.4	1.81	3.03	0.67	0.17	0.0039
BSRM-30	24.6	23.64	1.35	5.87	0.41	0.3	1.38	3.84	0.37	0.19	0.0026
BSRM-31	12.05	4.99	0.83	4.7	0.38	0.28	0.96	3.22	0.47	0.17	0.0026
BSRM-32	19.22	13.65	0.96	3.9	0.4	0.31	1.05	3.15	0.47	0.18	0.0033
BSRM-33	17.04	12.92	1.1	5.47	0.43	0.31	1.66	3.06	0.40	0.18	0.003
BSRM-34	19.9	16.93	1.06	4.9	0.46	0.33	1.24	3.39	0.43	0.17	0.0033
BSRM-35	12.15	7.11	0.8	5.93	0.41	0.31	1.2	2.83	0.43	0.09	0.001

Germplasm	No. of branches/plant	Total shoot length (m)	Length of the longest shoot (m)	Intermodal distance (cm)	Bud length (cm)	Bud breadth (cm)	Apex length (cm)	Petiole length (cm)	Petiole breadth (cm)	Petiole weight (g)	Leaf area (m ²)
1	2	3	4	5	6	7	8	9	10	11	12
BSRM-36	20.76	16.6	1.05	6.57	0.5	0.39	1.34	2.95	0.53	0.16	0.0029
BSRM-37	22.86	14.98	0.89	7.73	0.38	0.29	0.95	2.8	0.43	0.13	0.0022
BSRM-38	17.61	12.92	1.2	6.6	0.46	0.34	1.06	2.98	0.43	0.12	0.0023
BSRM-39	16.69	10.76	0.82	6.47	0.33	0.27	1.12	2.55	0.33	0.11	0.0021
BSRM-40	20.37	11.9	0.86	6.33	0.33	0.26	1.1	2.78	0.50	0.14	0.0022
BSRM-41	17.83	11.47	0.89	5.1	0.32	0.25	1.02	3.03	0.60	0.15	0.0022
BSRM-42	24.25	12.2	0.78	3.83	0.34	0.26	1.01	3.49	0.40	0.17	0.0027
BSRM-43	19.79	14.47	1	6	0.45	0.35	1.44	3.83	0.50	0.2	0.0033
BSRM-44	17.81	12.25	0.84	4.53	0.38	0.31	1.08	3.81	0.40	0.18	0.0024
BSRM-45	11.85	9.66	0.97	4.83	0.42	0.32	1.25	3.86	0.50	0.19	0.0028
BSRM-46	17.33	22.53	1.44	4.77	0.67	0.43	2.43	3.3	0.50	0.23	0.0039
BSRM-47	16	22.1	1.55	3.6	0.6	0.43	1.77	3.6	0.43	0.22	0.0046
BSRM-48	10.8	16.1	1.74	4.53	0.7	0.47	1.33	3.5	0.57	0.38	0.0055
BSRM-49	9	15.81	2.13	6.77	0.93	0.73	1.27	3.4	0.50	0.42	0.0065
BSRM-50	7.33	13.78	1.94	8.2	0.8	0.7	1.37	4.6	0.47	0.48	0.0055
BSRM-51	6.5	10.42	1.82	6.87	0.77	0.63	4.27	4.5	0.50	0.48	0.0075
BSRM-53	10.83	11.48	1.28	3.33	0.6	0.4	10.67	3.5	0.33	0.57	0.0098
BSRM-54	7.66	12.04	1.86	5.13	0.77	0.6	1.1	3.4	0.43	0.45	0.0062
BSRM-55	7.83	13.85	2.02	4.33	0.83	0.57	1.1	4.3	0.60	0.23	0.0052
BSRM-56	10.16	17.92	2	3.87	0.77	0.53	0.9	4.3	0.43	0.47	0.0049
BSRM-57	12.83	28.15	2.52	6.03	0.6	0.5	1.37	3.5	0.43	0.43	0.0039
BSRM-58	10	17.74	1.95	5.8	0.67	0.5	1.3	3.3	0.37	0.19	0.0029
BSRM-59	8.33	15.62	2.08	6.4	0.73	0.57	1.47	3.6	0.43	0.52	0.0059
BSRM-60	11.16	25.17	2.53	6.2	0.57	0.47	1.27	3.2	0.37	0.18	0.0036
BSRM-61	7.5	10.42	1.35	3.33	0.8	0.4	10.67	3.5	0.33	0.57	0.0098

Table 162. Quantitative characters of test mulberry germplasm (Cont'd)

Germplasm	Weight of 100 leaves (g)	Leaf yield/plant (g)	100 seed weight (g)	No. of inflorescence/m length of branch	No. of male inflorescence/meter shoot	No. of female inflorescence/m shoot	No. of bisexual inflorescence/mshoot	Male inflorescence length (cm)	Female inflorescence length (cm)	Bisexual inflorescence length (cm)
1	13	14	15	16	17	18	19	20	21	22
BSRM-1	150	448.3	0.14	169.63		169.63	-	-	1.19	-
BSRM-2	170	1754.6	0.16	116.22	69.56	21.5	25	1.88	1.11	0.85
BSRM-3	150	253.8	0.13	34.17	21	6.3	7	1.55	0.88	1.09-
BSRM-4	130	1052.7	0.12	127.38		127.38	-	-	0.96	-
BSRM-5	160	1036.3	0.13	117.84		117.84	-	-	0.93	-
BSRM-6	100	408	0.11	114.67		114.67	-	-	1.28	-
BSRM-7	80	1467.3	0.13	31.24		33.24	-	-	0.83	-
BSRM-8	50	162.2	0.14	60.67	2.17	34.5	23.92	0.34	0.53	0.72
BSRM-9	30	185.2	-	147.98	147.98	-	-	1.7	-	-
BSRM-10	60	237.7	0.07	87.08	0.17	23.75	63.17	0.4	0.63	0.82
BSRM-11	100	1218.6	0.13	133.92		133.92	-	-	1.12	-
BSRM-12	80	524.5	0.17	143.18		143.18	-	-	0.94	-
BSRM-13	90	515	0.11	133.81		133.81	-	-	1.23	-

Germplasm	Weight of 100 leaves (g)	Leaf yield/plant (g)	100 seed weight (g)	No. of inflorence/m length of branch	No. of male inflorence/meter shoot	No. of female inflorence/m shoot	No. of bisexual inflorence/mshoot	Male inflorence length (cm)	Female inflorence length (cm)	Bisexual inflorence length (cm)
1	13	14	15	16	17	18	19	20	21	22
BSRM-14	140	1255.9	0.14	112.63		112.63	-	-	1.28	-
BSRM-15	100	733.9	0.17	129.26		129.26	-	-	1.13	-
BSRM-16	190	947.9	0.14	113.01		133.01	-	-	1.52	-
BSRM-17	150	1081.7	-	80.65	80.65	-	-	1.84	-	-
BSRM-18	150	1079.3	0.11	187.61	125.5	34.89	27.22	2.35	1.56	1.18
BSRM-19	120	1062.4	0.13	135.52	107	17.14	11.39	2.35	0.99	0.91
BSRM-20	170	1526.3	0.14	139.01	-	139.01	-	-	1.19	-
BSRM-21	180	435.4	0.15	118.67	20.67	85.11	12.39	2.52	2.05	1.68
BSRM-22	220	525.4	0.13	130.69	-	130.69	-	-	1.59	-
BSRM-23	250	798.2	0.11	225.98	172.22	25.65	28.11	2.2	1.35	1.25
BSRM-24	210	831.2	-	192.97	192.97	-	-	2.56	-	-
BSRM-25	150	1135.5	0.13	112.3	100.44	1.25	10.61	2.24	1.44	1.25-
BSRM-26	120	653	0.11	143.33	-	143.33	-	-	1.45	1.51
BSRM-27	150	704.1	0.15	123.45	58.42	36.58	28.42	2.36	1.35	-
BSRM-28	120	986.5	0.11	131.98	-	131.98	-	-	1.08	-
BSRM-29	240	528.8	0.02	69.98	-	69.98	-	-	4.47	-
BSRM-30	140	1216.4	0.15	121.3	6.33	107.42	9.5	1.62	1.37	1.71
BSRM-31	140	313.6	-	112.41	112.41	-	-	1.92	-	-
BSRM-32	190	1004.5	-	140.51	140.51	-	-	2.85	-	-
BSRM-33	170	835.1	0.14	123.52	-	123.52	-	-	1.17	-
BSRM-34	170	1041.7	0.13	168.43	-	168.43	-	-	1.44	-
BSRM-35	70	240.6	0.09	107.92	46.05	49.5	12.37	2.13	0.86	0.87
BSRM-36	150	968.1	0.11	141.06	-	141.06	-	-	1.28	-
BSRM-37	120	809	0.14	139.5	115.75	9.5	14.25	2.29	0.88	1.2
BSRM-38	140	809.9	0.15	151.95	-	151.95	-	-	0.93	-
BSRM-39	120	923	-	163.95	163.95	-	-	2.65	-	-
BSRM-40	140	689.3	0.12	167.49	-	167.49	-	-	1.25	-
BSRM-41	130	767.3	-	129.32	129.32	-	-	2.97	-	-
BSRM-42	160	1006.4	0.15	168.24	-	168.24	-	-	1.1	-
BSRM-43	180	1139.7	-	147.95	147.95	-	-	2.35	-	-
BSRM-44	140	808.6	-	160.56	160.56	-	-	2.57	-	-
BSRM-45	500	460.5	0.13	155.08	-	155.08	-	-	1.52	-
BSRM-46	240	1555	0.27	115.2		115.2			1.13	
BSRM-47	280	1839.5	-	136.63	136.63			0.57		
BSRM-48	340	1468	-	133.23	133.23			0.61		
BSRM-49	400	1367	-	155.67		155.67			1.11	
BSRM-50	340	1366	0.15	165.53		165.53			1.18	
BSRM-51	460	954.6	-	1.33		1.33			1.21	
BSRM-53	600	1135	-	145.31		145.31			1.22	
BSRM-54	380	1677	0.1	162.13		162.13			1.33	
BSRM-55	320	1909	0.25	157.61	47.71	19.9			1.17	0.93
BSRM-56	300	2410	0.2	212.53	212.53	212.53			1.15	
BSRM-57	240	1590	0.3	122.31	122.31			0.54		
BSRM-58	180	1084	-	165.77	43.37	122.4			1.29	0.97
BSRM-59	360	1147.66	0.18	67.77		67.77			1.35	
BSRM-60	220	620.33	0.15	172.31		172.31			1.13	
BSRM-61	600	1135	0.35	155.13		155.13			1.31	

Table 162. Quantitative characters of test mulberry germplasm (Cont'd)

Germplasm	Male inflorence breadth (cm)	Female inflorence breadth (cm)	Bisexual inflorence breadth (cm)	Male inflorence weight (g)	Female inflorence weight (g)	Bisexual inflorence weight (g)	Floret no/male inflorence	Floret no/female inflorence	Style length (mm)	Ovary length (mm)
1	23	24	25	26	27	28	29	30	31	32
BSRM-1	-	0.6	-	-	0.18	-	-	40.94	0.686	1.501
BSRM-2	0.57	0.56	0.46	0.09	0.05	0.05	33.16	29.55	0.501	1.627
BSRM-3	0.49	0.52	0.52	0.08	0.06	0.05	27.14	23.21	0.384	1.251
BSRM-4	-	0.53	-	-	0.07	-	-	35.87	0.546	0.957
BSRM-5	-	0.53	-	-	0.07	-	-	34.64	0.647	1.632
BSRM-6	-	0.56	-	-	0.09	-	-	44.46	0.641	1.077
BSRM-7	-	0.74	-	-	0.07	-	-	30.12	0.356	0.779
BSRM-8	0.15	0.36	0.37	0.04	0.02	0.03	3.95	17.91	0.443	0.907
BSRM-9	0.52	-	-	0.12	-	-	31.82	-	-	-
BSRM-10	0.14	0.37	0.41	0.1	0.05	0.03	5.45	19.2	0.608	0.984
BSRM-11	-	0.47	-	-	0.06	-	-	30.56	0.85	1.531
BSRM-12	-	0.5	-	-	0.07	-	-	34.55	0.606	1.013
BSRM-13	-	0.55	-	-	0.07	-	-	37.53	0.536	1.328
BSRM-14	-	0.58	-	-	0.08	-	-	38.95	0.746	1.573
BSRM-15	-	0.57	-	-	0.09	-	-	39.68	1.02	1.416
BSRM-16	-	0.67	-	-	0.08	-	-	52.77	0.411	1.285
BSRM-17	0.53	-	-	0.19	-	-	41.18	-	-	-
BSRM-18	0.56	0.65	0.6	0.11	0.09	0.08	42.66	36.41	0.914	1.73
BSRM-19	0.57	0.58	0.58	0.16	0.06	0.06	37.3	29.29	0.644	1.603
BSRM-20	-	0.61	-	-	0.09	-	-	37.48	0.451	0.994
BSRM-21	0.69	0.93	0.71	0.34	0.25	0.27	79.86	49.27	0.558	1.205
BSRM-22	-	0.65	-	-	0.25	-	-	76.57	0.773	1.261
BSRM-23	0.56	0.5	0.62	0.11	0.06	0.08	39.04	32.64	0.476	1.304
BSRM-24	0.72	-	-	0.22	-	-	42.3	-	-	-
BSRM-25	0.57	0.63	0.47	0.16	0.06	0.06	34.28	29.2	0.521	1.165
BSRM-26	-	0.55	-	-	0.07	-	-	41.94	0.49	1.16
BSRM-27	0.65	0.58	0.66	0.13	0.13	0.14	39.35	40.04	0.474	1.195
BSRM-28	-	0.58	-	-	0.07	-	-	39.63	0.692	1.448
BSRM-29	-	0.46	-	-	0.21	-	-	133.46	0.477	1.112
BSRM-30	0.51	0.69	0.59	0.11	0.08	0.09	37.69	41.98	0.491	1.2
BSRM-31	0.51	-	-	0.21	-	-	34.19	-	-	-
BSRM-32	0.76	-	-	0.29	-	-	79.64	-	-	-
BSRM-33	-	0.54	-	-	0.07	-	-	30.54	0.578	1.547
BSRM-34	-	0.67	-	-	0.07	-	-	43.46	1.012	1.531
BSRM-35	0.58	0.5	0.49	0.09	0.06	0.05	33.69	25.62	0.503	1.085
BSRM-36	-	0.67	-	-	0.11	-	-	47.28	0.628	1.677
BSRM-37	0.59	0.56	0.59	0.05	0.08	0.07	40.59	27.05	0.374	1.144
BSRM-38	-	0.56	-	-	0.05	-	-	33.57	0.678	1.992
BSRM-39	0.64	-	-	0.16	-	-	47.42	-	-	-
BSRM-40	-	0.56	-	-	0.07	-	-	43.72	0.648	1.219
BSRM-41	0.61	-	-	0.18	-	-	48.25	-	-	-
BSRM-42	-	0.62	-	-	0.13	-	-	48.28	0.683	1.296
BSRM-43	0.68	-	-	0.21	-	-	41.15	-	-	-
BSRM-44	0.56	-	-	0.13	-	-	41.09	-	-	-
BSRM-45	-	0.63	-	-	0.11	-	-	44.09	0.629	1.048
BSRM-46	-	0.57	-	-	0.06	-	-	-	0.509	1.147
BSRM-47	0.19	-	-	0.04	-	-	31.19	-	-	-

Germplasm	Male inflorence breadth (cm)	Female inflorence breadth (cm)	Bisexual inflorence breadth (cm)	Male inflorence weight (g)	Female inflorence weight (g)	Bisexual inflorence weight (g)	Floret no/male inflorence	Floret no/female inflorence	Style length (mm)	Ovary length (mm)
1	23	24	25	26	27	28	29	30	31	32
BSRM-48	0.21			0.13			32.87			
BSRM-49		0.54			0.05			5.47	0.689	1.205
BSRM-50		0.63			0.07			40.17	0.862	1.537
BSRM-51		0.64			0.08			42.63		
BSRM-53		0.65			0.08					
BSRM-54		0.58			0.12			41.77	0.773	0.873
BSRM-55		0.59	0.53		0.1	0.06		43.13	0.687	1.327
BSRM-56		0.56			0.07			40.1	0.459	1.266
BSRM-57	0.14			0.05				0.05	1.372	1.832
BSRM-58		0.61	0.56		0.11	0.09				
BSRM-59		0.55			0.08			38.3	0.669	1.211
BSRM-60		0.54			0.07			39.97	0.842	1.213
BSRM-61		0.55			0.13			41.1	0.683	1.432

Table 162. Quantitative characters of test mulberry germplasm (Cont'd)

Germplasm	Ovary breadth (mm)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Seed setting (%)	Dry shoot weight (g)	Dry root weight (g)	Sprouting (%)	Rooting (%)	Moisture (%)
1	33	34	35	36	37	38	39	40	41	42
BSRM-1	1.516	2.13	1.09	1.06	85.66	5.78	1.04	75	57.45	72.82
BSRM-2	0.911	1.33	0.87	0.42	81.63	3.03	0.65	71.67	69.7	75.57
BSRM-3	1.102	1.25	0.88	0.39	89.4	5.94	1.51	95	79.04	74.72
BSRM-4	0.924	1.64	1.13	0.71	86.54	3.43	0.68	48.33	43.65	76.9
BSRM-5	1.431	1.34	0.82	0.47	67.63	6.85	1.3	76.67	90.48	75.73
BSRM-6	0.929	1.82	1.06	0.88	89.05	6.2	1.23	64.5	88.89	73.39
BSRM-7	0.72	1.34	1.04	0.62	74.29	1.93	0.39	68.33	71.43	71.92
BSRM-8	0.796	0.73	0.52	0.07	22.82	3.53	0.64	85	94.21	73.85
BSRM-9						2.79	0.47	76.67	59.27	70.98
BSRM-10	0.986	1.06	0.68	0.24	28.86	4.46	0.96	93.33	98.33	73.02
BSRM-11	1.266	1.82	0.93	0.77	71.4	8.05	1.95	95	79.18	73.52
BSRM-12	1.004	1.41	0.67	0.53	70.5	5.17	1.23	75	75.4	70.86
BSRM-13	1.226	1.8	0.99	0.72	82.1	8.6	1.94	75	75.74	72.99
BSRM-14	1.644	1.6	0.9	0.69	87.15	6.35	1.39	90	88.89	69.91
BSRM-15	1.409	2	1.11	1.29	81.56	12.3	2.72	85	93.29	73.86
BSRM-16	1.24	2.3	1.72	1.54	94.24	7.31	2.29	43	59.58	76.97
BSRM-17						11.05	3.03	90	86.3	72.89
BSRM-18	1.529	1.84	1.05	0.73	57.91	7.02	1.81	58.33	71.95	76.52
BSRM-19	1.44	1.4	0.86	0.56	83.56	5.21	1	81.67	89.31	76.94
BSRM-20	1.035	1.8	0.97	0.96	91.29	6.38	0.75	61.67	67.5	75.38
BSRM-21	1.187	2.83	1.4	2.45	54.91	4.22	1.03	56.67	54.42	74.33
BSRM-22	1.102	3.08	1.28	1.97	16.65	0.47	0.05	36.67	13.89	75.46
BSRM-23	1.191	1.77	0.84	0.79	75.58	9.7	1.15	91.67	87.38	77.35
BSRM-24						6.4	1.48	56.67	47.62	77.92
BSRM-25	1.342	1.71	0.87	0.98	78.07	6.45	0.88	73.33	81.01	76.76

Germplasm	Ovary breadth (mm)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Seed setting (%)	Dry shoot weight (g)	Dry root weight (g)	Sprouting (%)	Rooting (%)	Moisture (%)
1	33	34	35	36	37	38	39	40	41	42
BSRM-26	1.222	1.84	1.03	1.13	86.36	9.03	1.87	90	92.26	73.93
BSRM-27	1.182	1.77	0.79	0.88	64.09	7.1	1.19	90	79.2	74.74
BSRM-28	1.222	1.65	0.86	0.69	86.25	3.29	0.39	86.67	93.98	75.62
BSRM-29	1.098	5.58	0.8	1.46	8.13	2.01	0.1	55	33.06	74.31
BSRM-30	1.235	2.24	1.07	1.24	80.38	8.51	2.19	61.67	85.63	75.11
BSRM-31						4.28	0.69	81.67	92.6	74.59
BSRM-32						0.41	0.08	50	26.67	75.87
BSRM-33	1.391	1.7	0.87	0.72	89.12	5.01	0.92	81.67	82.59	76.09
BSRM-34	1.524	2.24	1.09	1.21	80.48	8.46	1.58	75	87.67	75.06
BSRM-35	1.084	1.36	0.71	0.32	78.02	4.52	0.83	86.67	72.71	74.9
BSRM-36	1.702	1.93	0.92	0.91	58.14	5.38	1.16	56.67	65.28	75.62
BSRM-37	1.066	1.36	0.93	0.35	73.41	13.24	1.67	79.67	55.79	76.26
BSRM-38	1.088	1.79	0.99	0.83	70.92	11.33	2.04	96.67	57.96	74.81
BSRM-39						6.82	0.79	78.33	75.55	77.47
BSRM-40	1.311	1.93	1.14	1.05	85.98	7.06	1.6	70	63.89	76.72
BSRM-41						3.6	0.57	81.67	63.33	76.43
BSRM-42	1.213	2.13	1.14	1.12	93.22	4.23	0.43	50	64.37	76.21
BSRM-43						5.12	1.85	86.67	75.08	76.95
BSRM-44						2.77	0.29	53.33	49.47	74.23
BSRM-45	1.106	2.39	1.07	1.3	90.12	5.76	1.37	90	89.25	74.51
BSRM-46	0.997	2.3	1.4	1.97	83.77	5.71	1.33	86.61	77.34	71.57
BSRM-47		2	0.8	0.357	86.77	4.13	0.76	84.67	81.3	70.67
BSRM-48		1.7	0.8	0.349	79.98	3.93	0.64	88.77	77.81	72.3
BSRM-49	1.002	1.9	1.5	1.765	83.23	3.13	0.51	89.97	81.3	76.5
BSRM-50	0.524	2.6	1.7	2.28	89.79	2.87	0.33	91.67	67.77	77.51
BSRM-51						3.03	0.73	89.97	63.67	74.3
BSRM-53										75.41
BSRM-54	0.811	2	1.2	1.29	91.23	3.57	0.61	79.97	73.37	73.21
BSRM-55	1.225	3.7	1.9	3.43	92.39	3.67	0.63	88.7	69.73	76.5
BSRM-56	1.239	2.8	1.8	2.49	91.23	4.89	0.83	77.87	87.61	71.31
BSRM-57	0.987	2.7	1.8	2.39	89.89	6.31	1.26	75.63	59.8	73.41
BSRM-58						4.75	0.49	73.79	56.73	75.31
BSRM-59	1.188	1.9	1.5	1.463	92.23	3.76	0.55	86.67	79.79	75.61
BSRM-60	1.239	3.4	1.9	4.111	91.37	5.37	1.23	88.71	83.31	74.43
BSRM-61	1.262	1.9	1.3	1.316	93.57	2.85	0.31	91.1	83.67	74.63

11.9. Bangladesh Agricultural University

11.9.1. Collection of indigenous banana, aroids and yam germplasm

One hundred and forty germplasm out of which banana (60), aroids (45) and yams (35) were collected from 46 upazilas of 28 districts during January 2012 to May 2018 (Table 163, 164 & 165). During germplasm collection, passport data form was used for recording preliminary data of the collected germplasm. Areas explored for collection are shown in map (Fig. 133 and Table 163). Germplasm samples were received directly from farmers. Prior to final selection of a sample, after initial observation of the plant, informal interviews were arranged with the local farmer that included history of the cultivar, qualitative and quantitative information about quality of vegetable, amounts of yield; and any special feature, like, sustainability against water, wind and nature of growth etc. The gathered information was recorded in field notes. Passport information of collected germplasm of banana, aroids and yams are shown in Tables 164, 165 and 166, respectively.

Maximum number of indigenous banana germplasm was collected from Mymensingh (15) followed by Lalmonirhat (8) and Satkhira (6) (Table 163). Among the collected indigenous banana, 43 cultivars were seedless and less seeded, 12 were seeded and five were plantains. Twelve of the banana germplasm were collected from south-eastern hill districts (Bandarban and Khagrachari) and north-eastern hilly areas (Sykhet), twenty from southern coastal districts (Bhola, Satkhira, Bagerhat, Khulna, Pirojpur, Barishal), twelve from northern districts (Lalmonirhat, Naogaon, Gaibandha and Pabna) and sixteen from central regions (Mymensingh and Narsingdi).

Maximum aroids germplasm were collected from Gazipur (8) followed by Tangail (6), Bandarban and Mymensingh (5) (Table 163). Edible aroids cultivars under seven groups viz. Mukhikachu, Panchamukhikachu, Poidnylkachu, Panikachu (stoloniferous and corm producing), Olkachu, Maankachu and Mawlavikachu were collected from hill, plains and saline areas. Out of 45 germplasm of aroids, maximum number of germplasm (20) were collected from central districts (Mymensingh, Gazipur, Tangail and Kishoreganj), seven from hilly areas (Bandarban, Chattogram and Moulvibazar), eleven from south and south-western districts (Bhola, Satkhira, Khulna, Meherpur, Jhinaidah and Jashore) and eight from northern districts (Lalmonirhat, Pabna, Rangpur and Joypurhat).

Maximum yam germplasm was collected from Bandarban and Tangail (8) followed by Rangamati (5) and Mymensingh (4) (Table 163). Of the 35 yam cultivars 17 were collected from the hill districts Bandarban and Rangamati, 15 from central region viz. Mymensingh, Tangail and Kishoreganj and 3 from southern coastal regions Satkhira and Laxmipur (Table 165).

As per visual observation it was found that collected germplasm of each crop varied from each other by name and appearance. There may remain some duplication, which will be sorted out during characterization during at morphological and molecular level. Commercial cultivation of some the cultivars are concentrated in some particular areas, and bear several characteristics behavior, which they attained from the environmental condition of those areas.

Table 163. Collection of banana, aroids and yam germplasm from different districts of Bangladesh

District	No. of upazilas explored	No. of germplasm collected			Total
		Banana	Aroids	Yams	
1. Bandarban	3	5	5	11	21
2. Khagrachari	1	5	0	0	5
3. Bhola	1	2	3	0	5
4. Lalmonirhat	1	8	1	0	9
5. Mymensingh	6	15	5	4	24
6. Satkhira	5	6	2	2	10
8. Narsingdi	1	1	0	0	1
9. Bagerhat	2	5	0	0	5
10. Khulna	3	4	3	0	7
11. Pirojpur	1	1	0	0	1
12. Naogaon	1	1	0	0	1
13. Gaibandha	1	1	0	0	1
14. Barishal	1	2	0	0	2
15. Sylhet	1	2	0	0	2
16. Pabna	2	2	4	0	6
17. Chattogram	1	0	1	0	1
18. Meherpur	1	0	1	0	1
19. Gazipur	2	0	8	0	8
20. Tangail	3	0	6	8	14
21. Rangpur	1	0	1	0	1
22. Kishorgonj	2	0	1	3	4
23. Jhinaidah	1	0	1	0	1
24. Joypurhat	1	0	1	0	1
25. Jashore	1	0	1	0	1
26. Moulvibazar	1	0	1	0	1
27. Rangamati	1	0	0	6	6
28. Lakshipur	1	0	0	1	1
Total	46	60	45	35	140

Location Map:

Legends:

- Indigenous banana: ●
- Aroids: ▲
- Yams: ■



Fig. 133. Collection sites of banana, aroids and yam germplasm

Table 164. List of banana germplasm collected from different locations

Acc.#	Local name	Place of collection
Seedless and less seeded banana germplasm (<i>Musa sapientum</i>)		
MS001	Agnissar Kala	Khagrachari
MS002	Bangla Kala	Bandarban
MS003	Bangla Kala	Bhola
MS004	Bangla Kala	Khagrachari
MS005	Basonti Sagar Kala	Velabari, Lalmonirhat
MS006	Bou Sundari/Bodhu Sundari kala	Velabari, Lalmonirhat
MS007	Chapa Kala	Khagrachari
MS008	Chinichampa Kala	Velabari, Lalmonirhat
MS009	Chinichampa Kala	Gafargao, Mymensingh
MS010	Deshi Sabri kala	Guddirdanga, Satkhira
MS011	Deshi Sabri kala	Barisal
MS012	Deshi Sabri Kala	Muktagacha, Mymensingh
MS013	Deshi Sabri Kala	Munshipara, Satkhira
MS014	Gara Sundari Kala	BAU, Campus
MS015	GaraSundari Kala	Gafargao, Mymensingh
MS016	Gara Kala	Narsingdi
MS017	Hati Dudh Kala	Bandarban
MS018	Jat Kala	BAU,Campus, Mymensingh
MS019	Jeen Kala	KaraparaBazar, Bagerhat
MS020	Joltaranga	Akra, Dumuria, Khulna
MS021	Kabri Kala	Bhola
MS022	Kabri Kala	Fulbaria, Mymensingh
MS023	Kabri Kala	Gafargao, Mymensingh
MS024	Kanthali Kala	Pirojpur
MS025	Kul Pat Kala	Karapara Bazar, Bagerhat
MS026	Madhubash Kala	Velabari, Lalmonirhat
MS027	Manik kala	Naogaon
MS028	Manua Kala	Velabari, Lalmonirhat
MS029	Malbhog kala	Velabari, Lalmonirhat
MS030	Malbhog kala	Polashbari, Gaibandha
MS031	Mortaman Kala	Satkhira
MS032	Mortaman Kala	Barishal
MS033	Mostakbihin	Velabari, Lalmonirhat
MS034	Pahari Bangla Kala	Lama, Bandarban
MS035	Pahari Bangla Kala	Khagrachari
MS036	Pahari Champa Kala	Lama, Bandarban
MS037	Pahari Chini Champa Kala	Bandarban
MS038	PahariChini Champa Kala	Khagrachari
MS039	Rumni/Rumki Kala	Satkhira
MS040	Shail Kala	Sylhet Sadar
MS041	Shathi Madna	Lakkhikunda, Iswardi
MS042	Sonamukhi Sagor	Velabari, Lalmonirhat
MS043	Thaitta Kala	Akra, Dumuria, Khulna
Seeded banana germplasm (<i>Musa sapientum</i>)		
MS044	Aitta Kala	BAU Campus, Mymensingh
MS045	Aitta Kala	Gafargao, Mymensingh
MS046	Aitta Ajja Kala	Lakkhanpur, Gafargao,Mymensingh
MS047	AittaMadna Kala	Lakkhanda, Iswardi

Acc.#	Local name	Place of collection
MS048	Bichi/Bhuitta Kala	Gafargao, Mymensingh
MS049	Bichi Kala	BAU Campus, Mymensingh
MS050	Bhuitta Kala (Nala Aitta)	BAU Campus, Mymensingh
MS051	Bartaman Kala	Akra, Dumuria, Khulna
MS052	Doya Kala	Debhata, Satkhira
MS053	Doya Kala	Karapara Bazar, Bagerhat
MS054	Mortaman Kala	Rupsha Feri-Ghat, Bagerhat
MS055	Tulshi Doya Kala	Karapara Bazar, Bagerhat
Plantains (<i>Musa paradisiaca</i>)		
MS056	Anaji kala	BAU campus, Mymensingh
MS057	Anaji Kala	Gafargao, Mymensingh
MS058	Anaji Kala	Syhet Sadar, Sylhet
MS059	Kanthali Kanch Kala	Dumuria, Khulna
MS060	Barabaghi kala	Noyarchak, Parulia, Satkhira

Table 165. List of aroids germplasm collected from different locations

Sl. no.	Acc. no.	Local name	Place of collection	Growing condition	Palatability
Mukhikachu (<i>Colocasia antiquiram</i>)					
1.	Ce-1	Poitta	Chattogram	Upland	Acceptable
2.	Ce-2	Boya	Bandarban	Upland	Acceptable
3.	Ce-3	Veradosa	Satkhira	Upland	Acceptable
4.	Ce-4	Chara	Bhola	Upland+Saline soil	Acceptable
5.	Ce-5	Meherchandi	Meherpur	Upland	Acceptable
6.	Ce-6	Iswardi muk	Iswardi	Upland	Acceptable
7.	Ce-7	Ban mukhi	Gazipur	Slightly wetland	Acceptable
8.	Ce-8	Got/Thama	Gazipur	Upland	Acceptable
9.	Ce-9	Salad Kachu	Bandarban	Upland	Acceptable
Panchamukhikachu (<i>Colocasia esculenta</i>)					
10.	Ce-10	Panchamukhi Black	Madhupur	Upland	Acceptable
11.	Ce-11	Panchamukhi Black	Gazipur	Upland	Acceptable
12.	Ce-12	Panchamukhi Green	Bandarban	Upland	Acceptable
13.	Ce-13	Panchamukhi Black	Dumuria	Upland	Acceptable
14.	Ce-14	Panchamukhi Green	Tangail	Upland	Acceptable
Panikachu (<i>Colocasia esculenta</i>)					
15.	Ce-15	Pani-green/Naricali/Kat	Trishal	Wet land	Acceptable
16.	Ce-16	Pani-brown strip/Shola	Rangpur	Wet land	Acceptable
17.	Ce-17	Pani-purple	Kishorgonj	Wet land	Acceptable
18.	Ce-18	Pani-Brown strip	Jhinaidah	Wet land	Acceptable
19.	Ce-19	Pani-brown strip/shola/kali	Trishal	Wet land	Acceptable
Poidnylkachu (<i>Colocasia esculenta</i>)					
20.	Ce-20	Poidnyl- green)/Bansh/Garo	Gazipur	High land	Acceptable
21.	Ce-21	Poidnyl- black	Gazipur	High land	Acceptable
22.	Ce-22	Poidnyl- black	Madhupur	High land	Acceptable
23.	Ce-23	Poidnyl- black	Tangail	High land	Acceptable
24.	Ce-24	Poidnyl- green	Tangail	High land	Acceptable
Olkachu (<i>Amorphopholus</i> spp.)					
25.	Ac-1	(Madrasi) Ol Kachu	Madhupur	High land	Poor
26.	Ac-2	(Deshi) Ol Kachu	Bandarban	High land	Poor
27.	Ac-3	(Talas) Ol Kachu	Panchbibi	High land	Poor
28.	Ac-4	(Deshi) Ol Kachu	Gazipur	High land	Poor

Sl. no.	Acc. no.	Local name	Place of collection	Growing condition	Palatability
29.	Ac-5	(Madrasi) Ol Kachu	Khulna	High land	Poor
Maankachu (<i>Alocasia</i> spp.)					
30.	Ai-1	Mugur/Maan	Khulna	Upland	Acceptable
31.	Ai-2	Mugur	Satkhira	Upland	Acceptable
32.	Ai-3	Mugur	Jashore	Upland	Acceptable
33.	Ai-4	Mugur	Bhola	Upland	Acceptable
34.	Ai-5	Maan/Fan	Trishal	Upland	Acceptable
Mawlavikachu (<i>Xanthosoma</i> spp.)					
35.	Xan-1	Mowlavi	Ishwardi	Upland	Acceptable
36.	Xan-2	Mowlavi	Moulvibazar	Upland	Acceptable
37.	Xan-3	Mowlavi	Mymensingh	Upland	Acceptable
	Xan-4	Bombay/Mowlavi	Ishwardi	Upland	Acceptable
38.	Xan-5	Bombay/Mowlavi	Gazipur	Upland	Acceptable
39.	Xan-6	Bombay/Mowlavi	Bandarban	Upland	Acceptable
40.	Xan-7	Shaheby/Babu/Tele/Mowlavi	Bhola	Upland	Acceptable
41.	Xan-8	Dud Man/Fan/Mowlavi	Mymensingh	Upland	Acceptable
42.	Xan-9	Surma/Dastar/Krishna/Kalo/Mowlavi	Gazipur	Upland	Acceptable
43.	Xan-10	Surma/Kalo/Mowlavi	Lalmonirhat	Upland	Acceptable
44.	Xan-11	Surma/Mowlavi	Pabna	Upland	Acceptable

Table 166. List of yam (*Dioscorea* spp.) germplasm collected from different locations with passport information

Sl. no.	Collector's No.	Cultivar/local name/cultural practice	Donors name and address	Geographical location and date	Photograph
1	RMHF001	Pahari Dhusor alu	Name: Nalnumlom Village: bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21 ⁰⁵ ' E-92 ⁰⁶ '	
2	RHMF002	Mou Alu	Name: Mrs. Hafiza Village: Hatirled Union: Ghatail Upazila: Ghatail District: Tangail	07.07.2017 N-24 ⁰²⁸ ' E-89 ⁰⁵⁸ '	
3	RHMF003	Shore Alu	Name: Mrs. Hafiza Village: Hatirled Union: Ghatail Upazila: Ghatail District: Tangail	07.07.2017 N-24 ⁰²⁸ ' E-89 ⁰⁵⁸ '	

Table 166 (Cont'd)

Sl. no.	Collector's No.	Cultivar/ local name/ cultural practice	Donors name and address	Geographical location and date	Photograph
4	RMHF004	Dud Alu	ATM Fozlul Hauque Village: Idilpur Union: Idilpur Upazila: Modhupur District: Tangail	11.5.2018 N-24 ⁰ 37' E-90 ⁰ 1.5'	
5	RMHF005	Mete/Gas Alu	ATM Fozlul Hauque Village: Idilpur Union: Idilpur Upazila: Modhupur District: Tangail	11.5.2018 N-24 ⁰ 37' E-90 ⁰ 1.5'	
6	RMHF006	Pan Alu	ATM Fozlul Hauque Village: Idilpur Union: Idilpur Upazila: Modhupur District: Tangail	11.5.2018 N-24 ⁰ 37' E-90 ⁰ 1.5'	
7	RMHF007	Dhan Mocha	ATM Fozlul Hauque Village: Idilpur Union: Idilpur Upazila: Modhupur District: Tangail	11.5.2018 N-24 ⁰ 37' E-90 ⁰ 1.5'	
8	RMHF008	Bish Alu	Mrs. Hafiza Village: Hatirled Union: Ghatail Upazila: Ghatail District: Tangail	07.07.2017 N-24 ⁰ 28' E-89 ⁰ 58'	
9	RMHF009	Murailla	Trina Chakma Village: Apalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	15.1.2018 N-21 ⁰ 5' E-92 ⁰ 6'	
10	RMHF010	Sagol Dud Alu	Sufia Begum Village: Hossanpur Union: Hossanpur sadar Upazila: Hossanpur District: Kishoregonj	12.12.2017 N-24 ⁰ 25' E-90 ⁰ 47'	
11	RMHF011	Jum Pesta Alu	Sufia Begum Village: Hossanpur Union: Hossanpur sadar Upazila: Hossanpur District: Kishoregonj	12.12.2017 N-24 ⁰ 25' E-90 ⁰ 47' 11.6448"	

Table 166 (Cont'd)

Sl. no.	Collector's No.	Cultivar/local name/cultural practice	Donors name and address	Geographical location and date	Photograph
12	RMHF012	Hoeng Alu	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21°5' E-92°6'	
13	RMHF013	Koeng Alu	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21°5' E-92°6'	
14	RMHF014	Gudey Alu	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21°5' E-92°6'	
15	RMHF015	Gati Alu	Sufia Begum Union: Hossanpursadar Upazila: Hossanpur Dist: Kishoregonj	14.12.2017 N-24° 25' 59.2428" E-90° 47' 11.6448" (Check)	
16	RHMF016	Pesta Alu (Nandail)	Tara Mia Village: Nandail Union: Nandail Upazila: Nandail Dist: Mymensingh	14.12.2017 N-24° 44' 36.4128" E-90° 47' 54.1824' E'	
17	RHMF 017	Bel Alu (Nandail)	Tara Mia Village: Nandail Union: Nandail Upazila: Nandail Dist: Mymensingh	14.12.17 24° 44' N- 36.4128' 90° 23' E-54.1824'	
18	RHMF 018	Mou Alu (Nandail)	Tara Mia Village: Nandail Union: Nandail Upazila: Nandail Dist: Mymensingh	14.12.173 E 24° 44' N-6.4128' 90° 23' E-54.1824'	
19	RHMF 019	Mete Alu (Nandail)	Tara Mia Village: Nandail Union: Nandail Upazila: Nandail Dist: Mymensingh	14.12.17 E24° 44' N-36.4128' 90° 23' E-54.1824'	

Table 166 (Cont'd)

Sl. no.	Collector's No.	Cultivar/ local name/ cultural practice	Donors name and address	Geographical location and date	Photograph
20	RMHF020	Chupri Alu	Sumon Malakar Village: Shayamnagar Union: Shayamnagar Upazila: Shayamnagar District: Satkhira	28.01.2018 22° 20' 14.2764' N	
21	RMHF021	Gas Alu	Sumon Malakar Village: Shayamnagar Union: Shayamnagar Upazila: Shayamnagar District: Satkhira	28.01.201 22° 20' E 14.2764' 89° 6' N-31.1400'	
22	RMHF022	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21°5' E-92°6'	
23	RMHF023	Gati Alu (Ghatail)	Mrs. Hafiza Village: Garo bazar Union: Ghatail Upazila: Ghatail District: Tangail	09.07.2017 N-21°5' E-92°6'	
24	RMHF024	Unidentified	lalnunlom Village: bompara Union: Rumasadar Upazila: Ruma District: Bandarban	15.1.2018 N-21°5' E-92°6'	
25	RMHF025	Unidentified	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21°5' E-92°6'	
26	RMHF026	Unidentified	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21°5' E-92°6'	
27	RMHF027	Unidentified	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21°5' E-92°6'	

Table 166 (Cont'd)

Sl. no.	Collector's No.	Cultivar/local name/cultural practice	Donors name and address	Geographical location and date	Photograph
28	RMHF028	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21°5' E-92°6'	
29	RMHF029	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21°5' E-92°6'	
30	RMHF030	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21°5' E-92°6'	
31	RMHF031	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21°5' E-92°6'	
32	RMHF032	Munshi Alu	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21°5' E-92°6'	
33	RMHF033	Edo Teng Alu	Mr. A. Khalek Village: Kathaligram Union: Chnadranganj Upazila: Chnadranganj District: Lakshmipur	20.08.17 N-22° 56' 39.48" E-90° 49' 48.18"	
34	RMHF034	Unidentified	Mostafizur Rahman Village: Bompara Union: Ruma Sadar Upazila: Ruma District: Bandarban	15.1.18 N-21°5' E-92°6'	
35	RMHF035	Unidentified	Lalnunlom Village: Bompara Union: Ruma Sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21°5' E-92°6'	

Collected germplasm have been conserved in field genebank of BAU-GPC, which can be exploited in crop improvement programs and other research activities of the respective crop.

11.9.2. Conservation of collected germplasm of Banana, Aroids and Yams

Banana, aroids and yams are comprised of recalcitrant seed. Therefore the collected germplasm of these crops have been conserved in the field genebank of BAU-GPC. A total of 136 germplasm: banana (60), aroids (45) and yams (31) are being conserved (Table 164, 165 and 166). Four yam germplasm were lost due to germination failure. Banana germplasm were planted in replicates following experimental design, while aroids germplasm were conserved in separate sets of species considering their edaphic and environmental requirement. Yams were planted separately with woody and semi woody perennial trees (e.g. Neem, Mahogany etc.). Each plant/plot has been labeled with durable sticker. Field layout of the genebank is being maintained properly. Proper care like weeding, irrigation, fertilization, crop protection and recycling are being taken regularly to keep healthy and well growing condition. A team of expert and sub-project management personnel monitor ongoing activities (Fig. 134).



Fig. 134. Monitoring visit to BAU-GPC

11.9.3. Morphological Characterization of Indigenous Banana Germplasm

To determine the plant character, a number of parameters were identified and accordingly the data are presented in tables. Quantitative and qualitative characters of 60 accessions of banana and plantain were determined following Descriptors for Banana (*Musa* spp.) during February 2014 to June 2017. To determine the plant descriptors, a number of parameters were identified and accordingly the data were recorded in tables. All the germplasm collected were indigenous cultivated banana (Geographical Indication) genotypes (Fig. 135). Among 60 genotypes, 55 accessions refer to desert banana and 5 accessions refer to plantain.

A. Qualitative descriptors

Qualitative variations in 25 characters of banana and plantain are shown in Table 167. Characterization descriptors for the study included: (i) Plant descriptors, (ii) Leaf descriptors, (iii) Inflorescence/Male bud descriptors and (iv) Fruit descriptors. Frequency of Yellowish green pseudostem color was maximum (21.67%) followed by Blackish green (16.67%), Dark green (15%), Green (10.00%) and Greenish yellow (10.00%). Frequency of other pseudostem colors was 1.67 to 6.67%. Growth habit was normal in 98.33% genotypes and slow in 1.67% genotypes.

Leaf habit of studied genotypes was intermediate (66.67%), drooping (30.00%) and erect (3.33%) (Fig. 136). Apex of leaf was mucronate in maximum genotypes (30%) closely followed by truncate (28.33%) and obtuse (25%). Acute leaf apex shape was found in 5% genotypes. Both side rounded leaf base shape was exhibited by most of the genotypes (63.33%). One side rounded and one side pointed leaf base was in 31.67% genotypes. All the genotypes showed shiny appearance of leaf upper surface. Appearance of leaf lower surface was shiny (waxy) in 33.33%, shiny (less waxy) in 26.67%, less shiny (waxy) in 16.67%, shiny in 11.67% and less shiny (less waxy) in 3.33% genotypes. Almost all the genotypes had dark green color in upper surface of leaf blade (98.33%). Lower surface of leaf blade was dark green (68.33%), green (30%) and Medium green (1.67%). Wide variation was observed in color of midrib ventral surface. Eight colors were found in this descriptor, and frequency of color ranged from 1.67% for pink purple, red purple, purple green, and reddish green to 50% for dark green. Various colors (8 different colors) were also observed in dorsal surface of midrib, where maximum genotypes (63.33%) had green colored dorsal surface of midrib. Male bud shape was Ovoid (58.33%), intermediate (28.33%), lanceolate (10%) and rounded (3.33%). Intermediate bract apex shape was found in 63.33% genotypes, slightly pointed in 21.67%, obtuse in 8.33% and pointed in 6.67% genotypes. Bract behaviour before falling was revolute (66.67%) and not revolute (33.33%). Twenty different color and presence/absence of wax was found in bract external face with maximum frequency for red (waxy) (23.33%). Bract internal face also had 11 color variations, where maroon and red color was appeared in 25% genotypes each. Style shape was straight in maximum genotypes (61.67%) and slightly curved under stigma in minimum genotypes (5.00) (Fig. 138). Frequency of fruit shape ranged from 1.67% for curved to 55.00% for straight (or slightly curved). Fruit apex was bottle-necked (68.33%), blunt tipped (23.33%), lengthily pointed (5.00%) and pointed (3.33%). Skin color of ripe fruit varied widely among the genotypes characterized. Maximum genotypes exhibited yellow skin color at ripen stage (36.67%). Wide variation was also recorded for pulp color of ripe fruit, which varied from light cream to dark orange yellow. Rounded (68.33%), slightly ridged (18.33%) and pronounced ridged (13.33%) transverse section of fruits were recorded among the genotypes. Seed was present in 41.67% genotypes and absent in the rest (58.67%). Indigenous banana genotypes included in this study also showed variation in respect of rachis position. Bunch characters of test indigenous banana cultivars are shown in fig. 139. Hand finger characteristics of indigenous banana shown in figs. 140 & 141.

Table 167. Qualitative variation in different characters in banana and plantain

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
Pseudostem color	Light yellow	3	5.00
	Reddish green	2	3.33
	Green	6	10.00
	Dark green	9	15.00
	Greenish yellow	6	10.00
	Red	1	1.67
	Pinkish red	2	3.33
	Light green	4	6.67
	Blackish green	10	16.67
	Yellowish green	13	21.67
	Yellow	1	1.67
	Brownish green	2	3.33
	Dark red	1	1.67
Growth habit	Normal growth	59	98.33
	Slow growth	1	1.67
Leaf habit	Intermediate	40	66.67
	Drooping	18	30.00
	Erect	2	3.33
Apex of the leaf	Truncate	17	28.33
	Mucronate	18	30.00
	Obtuse	15	25.00
	Emarginate	7	11.67
	Acute	3	5.00
Shape of leaf base	Both sides pointed	3	5.00
	One side rounded and one side pointed	19	31.67
	Both sides rounded	38	63.33
Appearance of leaf upper surface	Shiny	60	100.00
Appearance of leaf lower surface	Less shiny	5	8.33
	Less shiny (Less waxy)	2	3.33
	Less shiny (waxy)	10	16.67
	Shiny	7	11.67
	Shiny (Less waxy)	16	26.67
	Shiny (waxy)	20	33.33
Leaf blade color (Upper surface)	Green	1	1.67
	Dark green	59	98.33
Leaf blade color (lower surface)	Green	18	30.00
	Dark green	41	68.33
	Medium green	1	1.67
Color of midrib ventral (upper) surface	Dark green	30	50.00
	Green	19	31.67
	Light Green	3	5.00
	Pink Purple	1	1.67
	Red Purple	1	1.67
	Purple Green	1	1.67
	Reddish Green	1	1.67
	Yellowish green	4	6.67
Color of midrib dorsal (lower) surface	Dark green	1	1.67
	Green	38	63.33
	Light Green	14	23.33

Table 167 (Cont'd)

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
	Pink Purple	1	1.67
	Purple Green	2	3.33
	Red	1	1.67
	Red Purple	2	3.33
	Yellowish green	1	1.67
Male bud shape	Intermediate	17	28.33
	Lanceolate	6	10.00
	Ovoid	35	58.33
	Rounded	2	3.33
Bract apex shape	Intermediate	38	63.33
	Obtuse	5	8.33
	Pointed	4	6.67
	Slightly pointed	13	21.67
Bract behaviour before falling	Not Revolute (Not rolling)	20	33.33
	Revolute (rolling)	40	66.67
Color of bract external face	Dark pink	1	1.67
	Dark pink red	5	8.33
	Dark pink red (waxy)	4	6.67
	Dark pink violet	1	1.67
	Dark red	1	1.67
	Dark red (waxy)	9	15.00
	Dark violet	1	1.67
	Maroon	3	5.00
	Maroon (dark pink red)	1	1.67
	Maroon (dark red)	1	1.67
	Maroon (waxy)	3	5.00
	Pink purple	1	1.67
	Pink purple (waxy)	2	3.33
	Pink violet	1	1.67
	Purple	1	1.67
	Purple red	5	8.33
	Purple red (waxy)	1	1.67
	Red	2	3.33
	Red (waxy)	14	23.33
	Red pink	2	3.33
Red pink (waxy)	1	1.67	
Color of the bract internal face	Dark pink red	6	10.00
	Dark pink violet	2	3.33
	Dark red	10	16.67
	Light maroon	2	3.33
	Maroon	15	25.00
	Maroon (Dark red)	3	5.00
	Maroon (red)	4	6.67
	Pink purple	1	1.67
	Pink violet	1	1.67
	Purple red	1	1.67
	Red	15	25.00
Style shape	Curved at the base	10	16.67
	Curved under stigma	10	16.67
	Slightly curved under stigma	3	5.00
	Straight	37	61.67

Table 167 (Cont'd)

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
Fruit shape	Curved	1	1.67
	Slightly curved	4	6.67
	Straight	20	33.33
	Straight (or slightly curved)	33	55.00
	Straight in the distal part	2	3.33
Fruit apex	Blunt-tipped	14	23.33
	Bottle-necked	41	68.33
	Lengthily pointed	3	5.00
	Pointed	2	3.33
Remains flower relicts at fruit apex	Base of the style prominent	34	56.67
	Persistent style	10	16.67
	Without any floral relicts	16	26.67
Color of the fruit	Dark golden yellow	1	1.67
	Dark orange yellow	1	1.67
	Dark purple red	2	3.33
	Dark red	1	1.67
	Golden yellow	6	10.00
	Greenish yellow	5	8.33
	Light yellow green	1	1.67
	Orange yellow	9	15.00
	Red	1	1.67
	Reddish yellow	3	5.00
	Yellow	22	36.67
	Yellow with black spot	1	1.67
	Green	5	8.33
	Yellow green	2	3.33
Pulp color	Dark cream	2	3.33
	Dark orange yellow	1	1.67
	Light cream	7	11.67
	Cream	5	8.33
	Light orange yellow	2	3.33
	Light yellow	1	1.67
	Orange	1	1.67
	Orange cream	8	13.33
	Orange yellow	2	3.33
	Yellowish cream	4	6.67
Transverse section of fruit	Pronounced ridges	8	13.33
	Rounded	41	68.33
	Slightly ridged	11	18.33
Status of seed (present/absent)	Present	25	41.67
	Absent	35	58.33
Rachis position	At an angle	6	10.00
	Horizontal	2	3.33
	With a curve	20	33.33
	With two curves	3	5.00
	Falling vertically	29	48.33

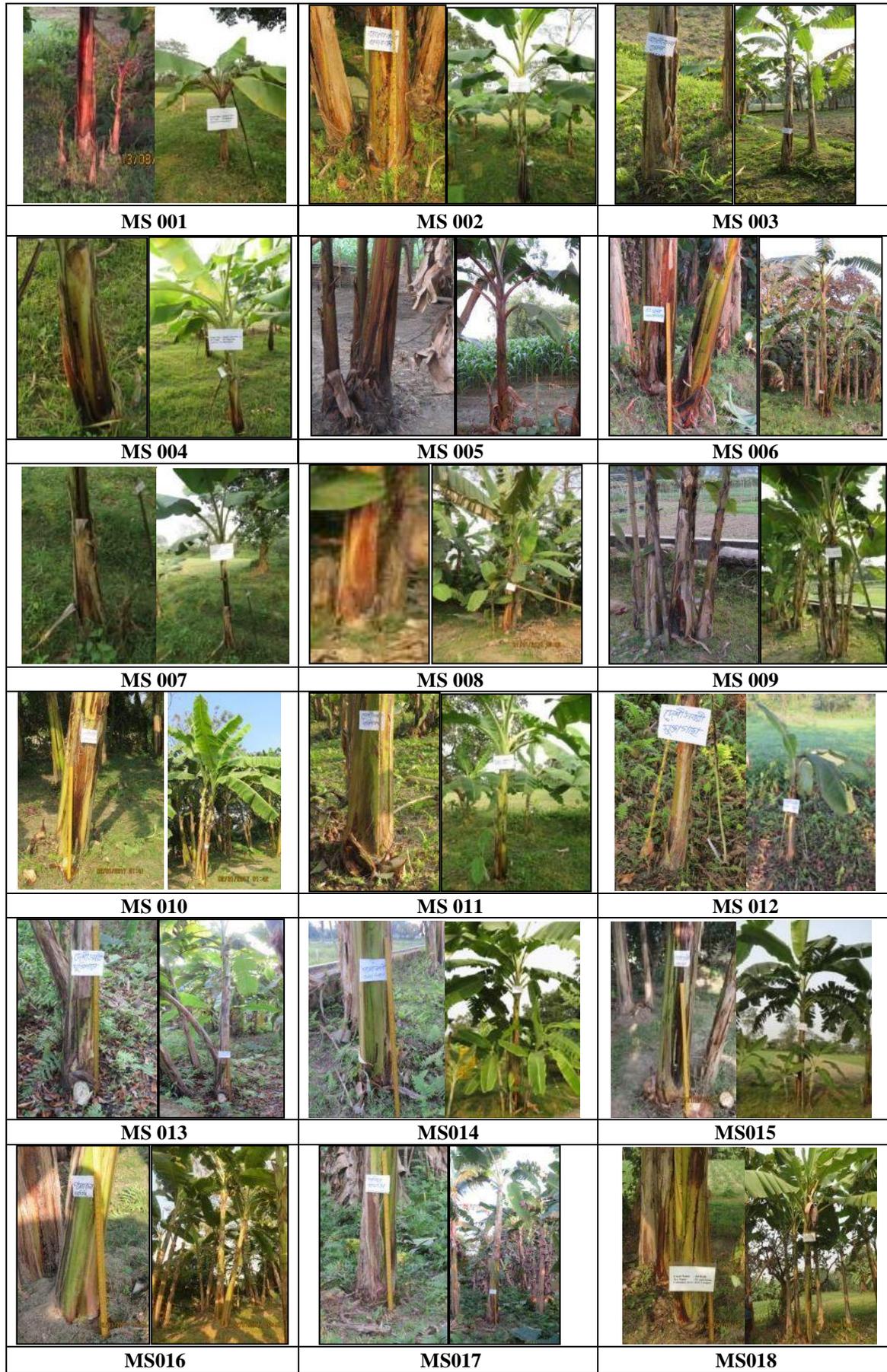
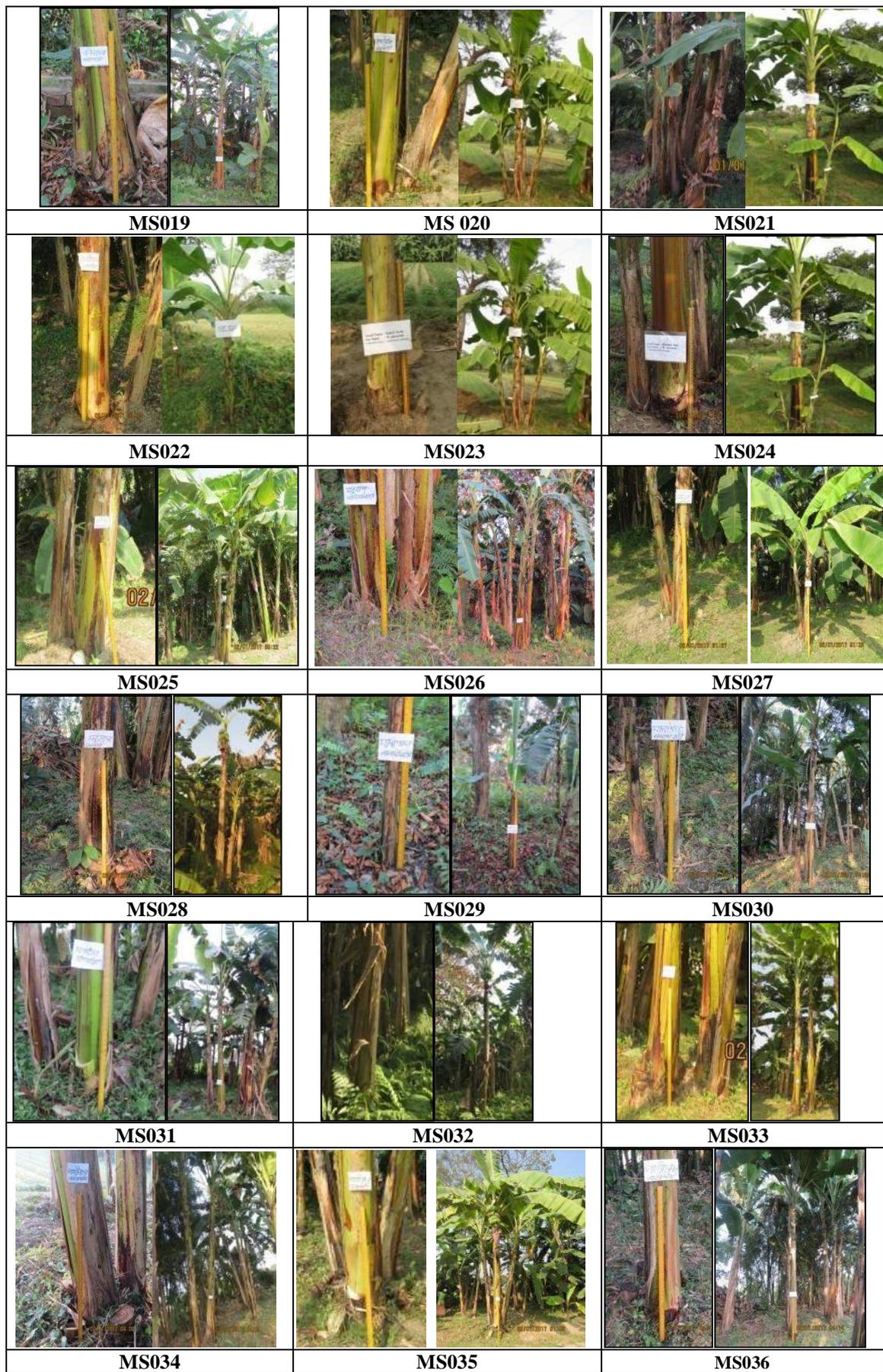


Fig.135. Plant characters of indigenous banana germplasm



Cont'd. Fig.135. Plant characters of indigenous banana germplasm



Cont'd. Fig.135. Plant characters of indigenous banana germplasm

B. Quantitative descriptors of Banana and Plantains

The highest quantitative variation observed in male bud weight (59.91%) followed by total yield per plant (51.35%), length of fruit tip (41.07%) and male bud diameter (38.91%) (Table 168). The highest yield per plant was found in MS044 (32.68 kg) followed by MS048 (32.27 kg), MS050 (29.34 kg) and MS049 (24.56 kg) (Table 170). The lowest yield per plant was found in MS040 (2.08 kg). Number of finger per hand ranged from 7.00 in MS032 to 18.00 in MS005 with an average of 13.90 (Table 168 & 170). Individual finger weight was maximum (383.33 g) in MS020 closely followed by MS053 (337.33 g) and MS048 (314.67 g). Individual finger weight ranged from 14.00 g to 383.33 g with an average of 157.82 g (Table. 168). Pulp and peel characteristics and seediness of test indigenous banana genotypes is shown in Fig. 136. Transverse section of indigenous banana fruits is shown in Fig. 137. Shape, size and style of tips and pedicel in indigenous banana genotypes is shown in Fig. 138. UPGMA Dendrogram based on Ward's method using Euclidean Distance summarizing the date on differentiation among 55 banana genotypes according to 14 morphological descriptors is shown in Fig. 139.

Pulp content was highest (87.07%) in MS022 closely followed by MS007 (86.47%) and MS002 (86.40%). The lowest pulp content (43.98%) was recorded in MS053. The average pulp content was 68.88%. Total soluble solids content in fruit juice ranged from 15.89% in MS020 to 31.44% in MS033 with an average of 23.03% (Table 168). Data on individual accession of test characters is shown in table 169 and 170. Estimation of some genetic parameters of 55 banana accessions is shown in Table 171. Estimation of some genetic parameters of 55 banana accessions and genotypic (upper) and phenotypic (lower) correlation coefficient for important 14 characters of 55 banana accessions is shown in Table 172 and 173, respectively.

Table 168. Quantitative variation in different characters of banana germplasm

Character	Range		Mean	SD	CV%
	Minimum	Maximum			
Pseudostem height (m)	2.03	5.85	3.93	0.90	22.91
Base Girth (m)	0.45	1.60	0.77	0.22	28.53
No. of leaves per plant	5.33	13.67	7.56	1.98	26.15
Flag leaf length (m)	0.52	1.61	0.87	0.22	24.71
Breadth (m)	0.16	0.45	0.31	0.06	18.42
Length of leaf (Petiole + Blade) (m)	1.30	3.46	2.65	0.44	16.58
Petiole (m)	0.30	0.68	0.51	0.09	18.37
Length of Leaf Blade (m)	1.00	2.95	2.14	0.38	17.80
Breadth of leaf Blade (m)	0.33	0.80	0.52	0.07	13.71
Leaf area (cm ²)	0.25	1.61	0.88	0.24	27.87
Male bud Length (cm)	11.48	32.21	19.93	4.24	21.29
Male bud Diameter (cm)	4.15	22.00	9.12	3.55	38.91
Male bud weight (g)	80.00	1070.33	262.62	157.34	59.91
Days to Inflorescence Initiation	260.00	892.67	529.57	156.46	29.54
Days to Maturity	75.00	283.00	144.80	46.83	32.34
Total yield/plant (kg)	2.08	32.68	12.93	6.64	51.35
Length of tip of fruit (cm)	0.73	4.56	2.07	0.85	41.07
Hand weight (g)	162.00	3445.00	1486.15	729.70	49.10
Normal Weight (Pulp)	20.00	30.00	29.83	1.29	4.33
Normal Weight (Peel)	20.00	30.00	29.83	1.29	4.33
No. of finger per hand	7.00	18.00	13.53	2.35	17.39

Table 168 (Cont'd)

Character	Range		Mean	SD	CV%
	Minimum	Maximum			
Length of edible portion (cm)	3.87	15.16	9.56	2.44	25.49
Dia. of edible portion (cm)	1.93	5.62	3.77	0.79	20.96
Finger wt. (g)	14.00	383.33	157.39	76.76	48.77
Weight of pulp (g)	10.67	304.33	117.44	60.15	51.22
Dry weight (Pulp)	4.04	9.42	7.13	1.32	18.48
Dry weight (Peel)	1.88	6.21	3.83	0.74	19.38
% pulp	43.98	87.07	68.40	14.81	21.65
% peel	12.93	55.02	23.23	9.63	41.45
Total soluble solids (TSS)	15.89	31.44	23.03	2.08	9.04

Table 169. Qualitative characters of banana germplasm

Acc./coll. no.	Pseudostem color	Growth habit	Apex of leaf	Shape of leaf base	Appearance of leaf upper surface	Appearance of leaf lower surface	Leaf habit	Leaf Blade Color (upper surface)	Leaf Blade Color (lower surface)	Color of midrib ventral	Color of midrib dorsal	Male bud shapes
1	2	3	4	5	6	7	8	9	10	11	12	13
MS001	11	1	5	2	2	1	2	4	3	4	5	2
MS002	1	2	1	1	2	1	2	4	2	7	7	2
MS003	4	2	5	1	2	2	2	4	3	2	2	3
MS004	4	2	1	2	2	2	2	4	3	3	2	4
MS005	6	2	2	1	2	2	3	4	3	5	8	4
MS006	4	2	1	2	2	2	2	4	3	3	3	4
MS007	4	2	2	1	2	2	2	4	4	2	5	4
MS008	7	2	5	1	2	2	2	4	3	3	2	4
MS009	7	2	5	1	2	2	2	4	3	8	5	4
MS010	1	2	1	1	2	2	2	4	3	3	3	2
MS011	2	2	1	1	2	2	2	4	3	7	2	2
MS012	2	2	5	1	2	2	2	4	4	3	2	3
MS013	2	2	1	1	2	2	2	4	4	3	3	3
MS014	3	2	1	1	2	2	3	4	3	3	2	4
MS015	8	2	5	2	2	2	2	4	4	3	3	4
MS016	3	2	1	1	2	2	2	4	3	9	3	3
MS017	3	2	3	1	2	2	3	4	3	9	3	4
MS018	12	2	1	2	2	2	1	4	4	3	3	3
MS019	3	2	1	2	2	2	1	4	3	3	3	3
MS020	12	2	1	1	2	2	3	4	4	9	3	4
MS021	4	2	2	1	2	2	2	4	3	7	2	3
MS022	12	2	1	2	2	2	3	4	3	7	2	4
MS023	8	2	5	1	2	1	3	4	4	9	3	4
MS024	5	2	2	2	2	1	3	3	3	3	3	4
MS025	12	2	2	2	2	2	3	4	4	9	3	3
MS026	5	2	5	1	2	1	3	4	4	9	3	4
MS027	12	2	3	2	2	1	2	4	4	9	3	3
MS028	8	2	3	2	2	1	2	4	4	9	3	4
MS029	1	2	3	2	2	1	2	4	4	9	3	3
MS030	12	2	5	2	2	2	2	4	4	9	3	3
MS031	3	2	2	3	2	1	2	4	4	9	3	3
MS032	12	2	5	2	2	2	2	4	4	3	3	4
MS033	12	2	2	1	2	2	2	4	4	9	3	2
MS034	3	2	2	1	2	2	2	4	3	9	3	4
MS035	12	2	1	2	2	2	3	4	4	9	9	4
MS036	9	2	1	1	2	2	2	4	4	9	3	4
MS037	8	2	2	1	2	2	2	4	4	10	10	4
MS038	12	2	3	1	2	2	3	4	4	9	3	4
MS039	8	2	3	1	2	2	2	4	4	9	10	4
MS040	12	2	1	1	2	2	2	4	3	3	2	4
MS041	2	2	3	2	2	2	2	4	4	3	2	4
MS042	8	2	2	2	2	2	2	4	4	9	3	2
MS043	10	2	3	3	2	2	2	4	4	9	3	4
MS044	8	2	1	2	2	2	2	4	4	9	3	3

Acc./coll. no.	Pseudostem color	Growth habit	Apex of leaf	Shape of leaf base	Appearance of leaf upper surface	Appearance of leaf lower surface	Leaf habit	Leaf Blade Color (upper surface)	Leaf Blade Color (lower surface)	Color of midrib ventral	Color of midrib dorsal	Male bud shapes
1	2	3	4	5	6	7	8	9	10	11	12	13
MS045	8	2	2	1	2	2	3	4	4	3	2	4
MS046	8	2	2	1	2	2	3	4	4	9	3	4
MS047	9	2	2	1	2	1	3	4	4	9	3	5
MS048	9	2	2	1	2	1	3	4	4	9	3	4
MS049	9	2	3	1	2	2	3	4	4	9	3	3
MS050	8	2	3	1	2	2	3	4	4	9	3	4
MS051	9	2	2	1	2	1	3	4	4	3	2	4
MS052	9	2	3	1	2	2	2	4	4	9	3	5
MS053	9	2	3	1	2	1	2	4	4	9	3	4
MS054	9	2	3	1	2	1	2	4	4	9	3	4
MS055	9	2	3	1	2	1	2	4	4	3	3	4
MS056	13	2	2	2	2	2	2	4	4	9	3	3
MS057	12	2	2	1	2	1	2	4	4	3	2	3
MS058	13	2	1	1	2	1	2	4	4	2	2	3
MS059	8	2	3	1	2	2	2	4	4	9	3	4
MS060	12	2	2	1	2	2	2	4	4	3	3	4

Table 169. Qualitative characters of banana germplasm (Cont'd)

Acc./coll. no.	Bract apex shape	Bract behavior before falling	Color of the bract external face	Color of the bract internal face	Style shape	Fruit shapes	Transverse section of fruit	Fruit apex	Remains of flower rellicts at fruit apex	Color of the fruit	Pulp color	Seed status
1	14	15	16	17	18	19	20	21	22	23	24	25
MS001	1	1	10	13	1	1	3	3	1	10	5	0
MS002	2	1	4	10	1	1	3	4	3	11	5	0
MS003	3	1	11	10	1	1	3	4	3	1	2	1
MS004	1	2	4	11	1	1	3	4	3	1	2	1
MS005	2	2	6	8	1	3	3	3	2	6	5	0
MS006	3	2	7	11	1	1	3	4	3	12	7	1
MS007	3	1	4	12	2	1	3	4	3	13	2	0
MS008	2	1	10	13	1	1	3	4	3	13	2	1
MS009	3	1	4	10	1	1	3	4	3	13	8	0
MS010	2	1	13	4	1	1	3	4	3	1	2	0
MS011	2	1	3	10	1	1	3	4	3	13	7	1
MS012	2	1	10	10	1	1	3	4	1	13	2	0
MS013	2	1	11	11	1	1	3	4	3	1	2	0
MS014	3	1	11	4	2	1	2	4	3	1	7	1
MS015	3	1	11	10	2	1	2	4	3	1	7	1
MS016	2	1	4	4	2	1	2	4	3	9	7	1
MS017	2	2	11	10	2	1	2	4	3	9	7	1
MS018	3	1	11	10	1	1	3	4	3	1	9	0
MS019	3	1	4	12	2	1	3	4	3	1	5	1
MS020	3	1	10	10	1	1	1	2	1	7	2	0
MS021	3	1	11	10	1	1	3	4	3	1	5	0
MS022	3	1	7	11	1	1	3	4	3	13	2	1
MS023	3	1	10	10	1	1	3	4	3	1	2	0
MS024	4	1	3	4	1	1	3	4	3	6	8	0
MS025	3	1	3	10	1	1	3	4	2	1	8	0
MS026	3	1	3	12	2	1	3	4	3	12	2	0
MS027	3	2	13	13	2	1	3	4	3	1	5	0
MS028	3	1	3	4	2	1	3	4	3	1	8	0
MS029	3	1	3	4	1	1	3	4	2	1	2	0
MS030	3	1	13	13	1	1	3	3	3	1	2	0
MS031	2	1	11	4	2	1	3	1	2	1	2	0
MS032	3	1	3	4	2	1	1	3	1	7	5	0
MS033	1	2	7	13	2	1	1	2	3	1	5	0
MS034	3	1	11	10	2	1	3	4	3	14	5	0
MS035	3	1	3	4	2	1	3	4	3	1	2	0
MS036	3	1	10	10	2	1	3	3	1	1	2	0
MS037	3	1	10	10	2	1	3	3	1	1	2	0

Acc./coll. no.	Bract apex shape	Bract behavior before falling	Color of the bract external face	Color of the bract internal face	Style shape	Fruit shapes	Transverse section of fruit	Fruit apex	Remains of flower rellicts at fruit apex	Color of the fruit	Pulp color	Seed status
1	14	15	16	17	18	19	20	21	22	23	24	25
MS038	2	1	11	4	1	1	3	4	1	1	2	0
MS039	2	2	10	10	1	1	3	4	3	14	5	0
MS040	3	1	3	12	1	1	3	4	3	14	5	1
MS041	3	1	10	10	2	1	3	3	3	1	5	0
MS042	1	2	11	13	1	2	2	3	2	13	5	0
MS043	3	1	12	10	2	1	3	4	3	14	10	0
MS044	2	2	12	10	2	1	3	4	1	9	7	1
MS045	3	2	4	11	2	1	3	4	1	14	5	1
MS046	4	2	3	4	2	1	3	4	1	12	2	1
MS047	4	1	11	11	2	1	3	3	1	14	2	1
MS048	3	2	12	10	1	1	2	4	1	12	2	1
MS049	3	2	12	12	1	1	2	4	1	11	2	1
MS050	3	2	3	12	1	1	2	4	1	14	2	1
MS051	3	2	3	12	1	1	2	3	1	1	2	1
MS052	4	2	3	12	1	1	2	3	3	14	10	1
MS053	4	2	12	12	1	1	3	3	1	14	5	1
MS054	3	2	12	12	1	1	3	3	3	12	2	1
MS055	3	2	3	4	1	2	2	3	2	11	2	1
MS056	3	1	3	4	1	1	1	4	2	9	2	0
MS057	3	1	12	10	1	1	1	4	3	9	2	0
MS058	3	1	12	10	1	1	1	4	2	9	2	0
MS059	3	2	12	4	1	1	1	2	2	9	2	0
MS060	3	1	3	4	2	1	1	4	2	9	2	0

Table 170. Quantitative descriptors of 60 banana germplasm

Acc. no.	Pseudostem height (m)	Girth (m)	No. of leaves per plant	Flag leaf length (m)	Breadth (m)	Length of leaf (Petiole + Blade) (m)	Petiole (m)	Length of leaf blade (m)	Breadth of leaf blade (m)	Leaf area (cm ²)
1	2	3	4	5	6	7	8	9	10	11
MS001	2.93	0.61	6.67	0.66	0.28	1.97	0.38	1.59	0.50	0.61
MS002	4.20	0.76	6.67	0.76	0.31	3.13	0.68	2.45	0.56	1.05
MS003	2.83	0.57	6.00	0.79	0.16	1.97	0.41	1.56	0.49	0.59
MS004	2.76	0.56	5.33	0.88	0.30	2.81	0.50	2.31	0.48	0.85
MS005	2.88	0.67	6.33	0.77	0.26	2.12	0.38	1.74	0.52	0.69
MS006	5.22	0.84	8.67	0.72	0.29	2.66	0.42	2.24	0.50	0.86
MS007	2.76	0.57	7.00	0.65	0.31	2.18	0.49	1.69	0.49	0.64
MS008	3.08	0.62	6.67	1.07	0.36	2.00	0.35	1.65	0.48	0.61
MS009	2.80	0.60	6.33	0.72	0.29	2.13	0.60	1.53	0.51	0.60
MS010	3.41	0.73	7.67	1.02	0.32	2.90	0.53	2.37	0.53	0.96
MS011	4.44	0.79	7.67	0.68	0.28	2.95	0.58	2.37	0.52	0.95
MS012	2.50	0.51	5.67	0.58	0.24	2.31	0.42	1.89	0.43	0.62
MS013	4.37	0.70	6.67	0.85	0.45	2.25	0.37	1.88	0.47	0.68
MS014	4.12	0.79	10.00	0.80	0.34	3.00	0.55	2.45	0.55	1.03
MS015	4.60	0.78	8.33	0.90	0.37	2.56	0.40	2.16	0.51	0.84
MS016	4.12	0.73	10.33	0.83	0.41	2.49	0.44	2.05	0.50	0.79
MS017	3.82	0.72	6.33	0.75	0.32	2.58	0.41	2.17	0.50	0.83
MS018	3.55	0.69	6.00	0.90	0.35	2.47	0.45	2.02	0.47	0.73
MS019	3.27	0.53	5.33	0.75	0.44	2.57	0.61	1.96	0.45	0.68
MS020	3.65	0.63	6.67	0.59	0.31	2.37	0.43	1.94	0.49	0.73
MS021	3.08	0.60	5.33	0.66	0.27	2.03	0.38	1.65	0.47	0.59
MS022	2.51	0.55	6.00	0.75	0.29	1.30	0.30	1.00	0.33	0.25
MS023	3.59	0.77	6.33	0.71	0.19	2.08	0.44	1.64	0.52	0.65
MS024	4.28	0.91	8.00	0.67	0.29	2.65	0.55	2.10	0.55	0.89
MS025	4.88	0.87	8.67	0.80	0.28	2.55	0.52	2.03	0.54	0.84
MS026	5.02	0.89	10.00	0.87	0.31	2.46	0.46	2.00	0.48	0.74
MS027	3.61	0.54	5.67	1.37	0.38	2.76	0.41	2.35	0.46	0.83
MS028	4.21	0.72	7.00	0.78	0.32	2.74	0.55	2.19	0.44	0.74
MS029	3.21	0.68	5.67	0.52	0.29	2.28	0.35	1.93	0.53	0.78
MS030	3.12	0.66	5.67	0.94	0.33	3.14	0.61	2.53	0.52	1.01

Table 170 (Cont'd)

Acc. no.	Pseudostem height (m)	Girth (m)	No. of leaves per plant	Flag leaf length (m)	Breadth (m)	Length of leaf (Petiole + Blade) (m)	Petiole (m)	Length of leaf blade (m)	Breadth of leaf blade (m)	Leaf area (cm ²)
1	2	3	4	5	6	7	8	9	10	11
MS031	3.13	0.62	6.33	0.99	0.33	2.55	0.55	2.00	0.47	0.72
MS032	3.90	0.67	6.67	0.54	0.38	2.95	0.59	2.36	0.46	0.83
MS033	4.39	0.75	7.67	1.28	0.43	3.20	0.53	2.67	0.58	1.19
MS034	4.26	0.82	6.00	0.96	0.33	3.25	0.55	2.70	0.55	1.14
MS035	3.88	0.81	6.67	0.89	0.36	3.26	0.67	2.59	0.55	1.09
MS036	3.73	0.70	6.33	0.52	0.22	3.15	0.57	2.58	0.66	1.31
MS037	4.17	0.78	7.00	0.54	0.25	2.97	0.60	2.37	0.52	0.95
MS038	2.93	0.54	6.33	0.75	0.28	2.99	0.41	2.58	0.62	1.23
MS039	4.35	0.79	7.00	0.86	0.28	2.52	0.47	2.05	0.52	0.82
MS040	2.86	0.58	6.33	0.84	0.29	1.79	0.44	1.35	0.40	0.41
MS041	4.36	0.72	7.67	0.88	0.26	2.88	0.54	2.34	0.57	1.02
MS042	2.03	0.45	6.67	0.78	0.26	2.34	0.46	1.88	0.51	0.74
MS043	4.52	0.83	6.33	1.13	0.33	2.95	0.54	2.41	0.60	1.11
MS044	5.85	1.03	12.00	1.61	0.36	3.34	0.59	2.75	0.63	1.33
MS045	4.98	1.27	13.67	0.91	0.31	3.02	0.62	2.40	0.58	1.07
MS046	4.39	0.87	7.33	0.93	0.28	2.73	0.55	2.18	0.49	0.82
MS047	4.40	0.79	9.00	0.84	0.26	2.62	0.47	2.15	0.54	0.89
MS048	5.40	1.19	9.00	1.20	0.32	3.03	0.61	2.42	0.64	1.19
MS049	5.82	1.04	12.00	0.92	0.24	3.25	0.63	2.62	0.80	1.61
MS050	5.48	1.15	7.33	1.12	0.34	2.49	0.49	2.00	0.45	0.69
MS051	4.42	0.98	8.33	1.02	0.36	2.93	0.50	2.43	0.56	1.04
MS052	5.23	0.94	9.00	0.62	0.20	3.07	0.59	2.48	0.53	1.01
MS053	4.98	1.60	12.67	1.08	0.41	2.29	0.40	1.89	0.61	0.88
MS054	5.25	1.12	11.33	0.91	0.36	2.84	0.55	2.29	0.62	1.09
MS055	4.94	0.92	10.00	1.16	0.32	2.93	0.56	2.37	0.62	1.13
MS056	3.68	0.64	6.33	1.17	0.33	3.46	0.51	2.95	0.52	1.18
MS057	3.74	0.64	5.33	1.08	0.30	2.38	0.66	1.72	0.42	0.55
MS058	3.38	0.60	6.67	1.04	0.34	2.52	0.61	1.91	0.50	0.73
MS059	3.14	0.63	7.00	0.98	0.34	3.23	0.60	2.63	0.59	1.19
MS060	3.67	1.36	10.67	1.00	0.35	2.80	0.66	2.14	0.56	0.92

Table 170. Quantitative descriptors of 60 banana germplasm (Cont'd)

Acc. No.	Male bud length (cm)	Male bud diameter (cm)	Male bud weight (g)	Days to inflorescence initiation	Days to maturity	Total yield/plant (kg)	Length of tip of fruit (cm)	Hand weight (g)	Normal weight (pulp)	Normal weight (peel)
1	12	13	14	15	16	17	18	19	20	21
MS001	30.33	17.00	1070.33	854.00	109.67	6.30	1.39	1221.00	30.00	30.00
MS002	17.43	6.76	151.33	601.67	110.00	7.67	2.17	990.00	30.00	30.00
MS003	25.25	11.20	774.67	747.67	99.33	9.68	1.68	1584.00	30.00	30.00
MS004	18.35	7.37	217.33	528.33	149.00	8.95	1.75	784.00	30.00	30.00
MS005	13.89	4.15	88.67	341.00	112.67	11.21	3.08	1533.00	30.00	30.00
MS006	21.00	10.15	506.67	458.33	169.67	21.61	3.09	3225.00	30.00	30.00
MS007	21.85	11.56	320.00	840.00	202.33	5.04	0.81	488.00	30.00	30.00
MS008	12.68	5.28	108.67	317.67	115.00	8.78	1.06	1005.00	30.00	30.00
MS009	19.50	7.32	113.33	373.00	170.67	17.24	0.91	1911.00	30.00	30.00
MS010	20.94	5.59	108.33	304.33	229.00	8.48	1.86	835.00	30.00	30.00
MS011	24.20	12.93	226.00	541.33	126.33	13.49	1.60	1613.00	30.00	30.00
MS012	24.49	12.30	315.67	774.33	113.33	5.23	1.86	875.00	30.00	30.00
MS013	18.84	7.03	212.00	383.00	283.00	7.84	1.44	832.00	30.00	30.00
MS014	18.34	6.06	219.00	759.33	134.67	12.93	2.40	2312.00	30.00	30.00
MS015	19.53	6.89	255.00	561.00	110.00	14.68	2.14	2000.00	30.00	30.00
MS016	21.17	7.39	343.33	583.00	125.67	13.40	2.65	1490.00	30.00	30.00
MS017	19.18	7.34	299.33	436.00	159.67	13.57	2.12	2009.00	30.00	30.00
MS018	20.00	6.39	267.33	387.33	147.00	18.52	2.41	1695.00	30.00	30.00
MS019	23.40	12.46	308.00	535.67	152.67	3.07	1.09	570.00	30.00	30.00
MS020	20.19	13.70	333.67	382.00	128.00	21.66	2.56	3328.00	30.00	30.00
MS021	18.33	5.63	189.67	572.67	121.00	5.55	1.70	618.00	30.00	30.00

Acc. No.	Male bud length (cm)	Male bud diameter (cm)	Male bud weight (g)	Days to inflorescence initiation	Days to maturity	Total yield/plant (kg)	Length of tip of fruit (cm)	Hand weight (g)	Normal weight (pulp)	Normal weight (peel)
1	12	13	14	15	16	17	18	19	20	21
MS022	22.79	10.72	364.67	797.00	99.67	8.00	1.26	1174.00	30.00	30.00
MS023	19.00	6.60	265.33	382.33	131.67	12.88	1.93	1057.00	30.00	30.00
MS024	20.67	7.22	232.33	549.33	141.33	19.60	2.51	1890.00	30.00	30.00
MS025	21.25	10.79	265.67	583.00	148.33	16.72	2.74	1602.00	30.00	30.00
MS026	15.21	6.48	162.33	438.33	173.33	17.67	2.40	1243.00	30.00	30.00
MS027	29.07	13.40	247.67	260.00	143.33	2.50	0.73	162.00	30.00	30.00
MS028	11.48	4.29	112.00	429.00	108.00	12.33	1.79	1175.00	30.00	30.00
MS029	15.98	6.92	93.67	492.00	152.00	10.41	1.36	1280.00	30.00	30.00
MS030	19.68	12.54	221.33	350.00	116.33	14.63	1.27	1726.00	30.00	30.00
MS031	20.53	11.92	224.00	375.33	92.33	8.06	1.60	1155.00	30.00	30.00
MS032	24.65	14.50	355.00	404.33	131.67	7.24	2.30	1536.00	30.00	30.00
MS033	32.21	10.11	175.00	637.33	162.33	7.99	4.22	2150.00	30.00	30.00
MS034	24.34	9.83	148.00	374.33	127.00	19.42	1.80	1403.00	30.00	30.00
MS035	19.25	7.25	191.00	414.67	124.33	11.78	1.83	1117.00	30.00	30.00
MS036	14.81	5.15	191.67	375.67	111.67	11.13	1.29	1120.00	30.00	30.00
MS037	18.13	6.27	136.67	390.67	110.00	10.60	1.25	1518.00	30.00	30.00
MS038	18.60	7.68	135.00	305.00	116.67	10.64	1.25	1518.00	30.00	30.00
MS039	18.67	7.94	284.67	585.67	139.67	6.60	1.46	680.00	30.00	30.00
MS040	12.46	4.30	80.00	671.33	165.67	2.08	1.40	208.00	30.00	30.00
MS041	19.27	6.77	258.33	892.67	255.33	13.82	1.52	1078.00	30.00	30.00
MS042	27.17	14.31	305.33	333.00	109.00	11.21	3.08	1533.00	30.00	30.00
MS043	21.32	10.61	320.00	408.33	128.33	9.46	2.09	1176.00	30.00	30.00
MS044	15.21	6.77	177.00	606.00	170.33	32.68	1.98	835.00	30.00	30.00
MS045	16.17	8.06	271.00	614.00	132.33	8.62	2.01	1047.00	30.00	30.00
MS046	17.65	8.37	275.67	622.67	126.67	8.29	1.79	459.00	30.00	30.00
MS047	13.62	6.68	191.00	507.00	221.00	10.45	1.07	1072.00	30.00	30.00
MS048	17.02	9.85	244.67	708.33	175.00	32.27	3.52	3445.00	30.00	30.00
MS049	14.41	7.39	281.67	702.00	151.33	24.56	3.17	3075.00	30.00	30.00
MS050	20.52	8.10	179.00	759.67	179.00	29.34	2.99	2457.00	30.00	30.00
MS051	20.07	14.73	173.67	576.67	152.33	19.42	1.74	1927.00	30.00	30.00
MS052	22.00	8.93	171.00	604.00	278.00	8.46	1.81	990.00	30.00	30.00
MS053	19.48	8.74	295.67	609.67	158.00	20.45	1.40	2133.00	30.00	30.00
MS054	24.17	17.52	499.00	660.67	221.67	21.66	1.82	1415.00	30.00	30.00
MS055	16.74	7.07	266.33	417.67	243.67	14.14	1.84	2410.00	30.00	30.00
MS056	17.31	6.953	296.00	586.00	75.33	15.01	3.01	1503.00	30.00	30.00
MS057	16.58	7.437	147.33	672.00	75.00	14.26	3.40	2385.00	30.00	30.00
MS058	20.00	9.473	288.00	524.67	81.67	10.79	3.77	2102.00	30.00	30.00
MS059	22.83	9.310	346.33	385.33	100.33	12.35	4.56	1184.00	30.00	30.00
MS060	26.33	22.000	455.66	486.67	89.67	13.28	3.48	2311.00	20.00	20.00

Table 170. Quantitative descriptors of 60 banana germplasm (Cont'd)

Acc. No.	No. of finger per hand	Length of edible portion (cm)	Dia. of edible portion (cm)	Finger wt. (g)	Weight of pulp (g)	Dry weight (Pulp)	Dry weight (Peel)	% pulp	% peel	TSS (%)
1	22	23	24	25	26	27	28	29	30	31
MS001	10.00	10.07	3.85	182.00	140.33	7.15	3.41	76.57	23.43	21.89
MS002	16.00	7.17	3.01	61.33	38.33	9.42	3.55	74.81	25.19	20.22
MS003	14.00	9.05	3.34	167.33	143.33	8.65	4.79	86.40	13.60	23.67
MS004	16.00	7.46	2.84	70.00	54.33	8.47	4.24	78.84	21.16	21.33
MS005	14.00	13.10	4.85	145.33	104.00	8.19	3.89	72.55	27.45	18.22
MS006	18.00	11.73	4.46	238.00	175.33	6.55	3.26	77.32	22.68	19.89
MS007	13.00	6.45	3.08	73.33	64.33	6.86	3.58	86.47	13.53	23.22
MS008	17.00	6.65	3.21	93.33	78.33	5.37	3.53	84.02	15.99	23.22
MS009	16.00	8.71	3.71	136.00	114.00	7.77	5.35	82.18	17.81	20.78
MS010	16.00	7.61	2.67	76.00	61.00	5.44	3.26	50.00	17.80	24.44
MS011	13.00	8.28	3.99	173.33	149.00	5.89	3.38	50.00	14.27	22.33
MS012	10.00	8.73	3.87	152.00	127.33	5.26	3.10	85.07	14.93	21.44
MS013	16.00	7.82	3.32	88.00	69.00	7.04	3.80	50.00	19.07	22.67

Acc. No.	No. of finger per hand	Length of edible portion (cm)	Dia. of edible portion (cm)	Finger wt. (g)	Weight of pulp (g)	Dry weight (Pulp)	Dry weight (Peel)	% pulp	% peel	TSS (%)
1	22	23	24	25	26	27	28	29	30	31
MS014	14.00	9.97	4.14	214.00	156.33	8.65	3.75	72.31	27.69	24.89
MS015	14.00	9.36	3.97	206.00	164.33	9.20	3.57	79.92	20.08	24.00
MS016	12.00	8.75	3.82	173.33	129.33	8.76	3.70	50.00	24.00	24.56
MS017	14.00	10.23	3.98	200.67	153.34	7.59	3.75	77.73	22.27	23.33
MS018	13.00	11.19	3.90	228.67	193.00	9.10	4.14	83.99	16.01	24.89
MS019	12.00	6.87	2.53	58.67	45.00	7.85	3.95	50.00	23.44	22.67
MS020	12.00	14.12	4.79	383.33	304.33	7.28	3.48	50.00	20.24	15.89
MS021	14.00	6.59	2.83	74.00	61.67	8.96	4.46	83.92	16.07	24.67
MS022	12.00	7.94	3.54	138.67	121.34	7.93	4.59	87.07	12.93	22.78
MS023	15.00	7.66	2.87	100.00	85.33	8.87	5.66	85.12	14.88	25.11
MS024	16.00	9.85	3.66	176.00	149.00	5.84	3.30	84.76	15.24	23.78
MS025	15.00	9.74	3.78	185.33	139.33	6.55	3.36	50.00	24.28	25.00
MS026	15.00	8.15	3.90	118.00	84.33	6.00	3.33	50.00	27.31	25.89
MS027	15.00	3.87	1.93	14.00	10.67	8.72	4.78	81.31	18.67	24.89
MS028	16.00	9.77	2.75	99.33	74.00	8.42	3.75	50.00	22.59	22.89
MS029	12.00	9.81	3.39	149.33	126.66	6.30	3.33	50.00	15.54	23.67
MS030	11.00	10.84	3.88	274.67	233.00	5.52	3.53	50.00	16.64	21.67
MS031	9.00	9.36	3.73	171.33	148.00	7.46	3.83	85.46	14.54	22.89
MS032	8.00	9.77	4.67	276.67	224.67	8.54	5.15	61.65	17.80	23.22
MS033	13.00	14.78	3.73	159.33	63.33	8.40	4.35	48.97	51.03	31.44
MS034	16.00	9.17	3.31	142.67	113.00	7.49	3.73	50.00	21.60	27.00
MS035	16.00	7.69	3.25	108.00	91.00	7.82	4.12	50.00	15.40	24.78
MS036	14.00	7.26	3.44	113.33	97.00	5.29	3.02	84.97	15.03	21.78
MS037	14.00	9.07	3.60	147.33	125.66	4.74	2.53	86.25	13.75	20.33
MS038	14.00	9.07	3.60	147.33	125.66	5.13	3.21	86.25	13.75	22.45
MS039	12.00	7.25	3.21	85.33	68.33	8.40	4.26	77.52	22.48	24.11
MS040	7.00	6.47	2.32	45.33	35.66	7.00	6.21	80.78	19.22	22.44
MS041	16.00	8.62	3.43	96.67	75.34	6.66	3.52	50.00	20.38	23.89
MS042	14.00	13.10	4.85	145.33	104.00	4.04	1.88	72.55	27.45	22.33
MS043	14.00	9.86	4.29	118.67	90.67	5.58	3.16	50.00	21.24	23.78
MS044	16.00	7.48	2.81	58.67	27.34	6.93	3.55	70.34	29.66	23.56
MS045	12.00	8.46	4.27	172.00	133.33	8.07	4.37	78.40	21.60	21.00
MS046	12.00	6.46	2.83	48.67	18.34	8.14	5.56	75.72	24.28	22.22
MS047	15.00	7.29	3.26	110.67	92.34	6.68	3.47	81.51	18.49	22.78
MS048	14.00	11.05	4.64	314.67	227.00	7.40	3.79	71.29	28.71	23.78
MS049	14.00	10.39	5.15	259.33	188.33	6.81	3.68	74.63	25.37	24.11
MS050	15.00	8.84	4.28	224.67	141.34	6.61	3.59	63.96	36.04	22.56
MS051	16.00	10.69	4.69	185.33	128.66	5.39	2.69	72.42	27.58	22.44
MS052	14.00	7.74	2.72	75.33	57.00	7.37	3.80	50.00	21.36	23.22
MS053	10.00	13.37	5.62	337.33	264.00	6.32	3.96	79.42	20.58	21.78
MS054	16.00	11.82	4.70	205.33	167.66	6.81	4.22	81.59	18.41	22.78
MS055	14.00	13.48	4.82	264.00	184.00	6.96	3.63	70.42	29.58	22.56
MS056	14.00	13.02	5.09	156.67	74.67	8.16	4.10	56.73	43.27	23.55
MS057	11.00	15.16	4.14	199.33	83.33	7.56	3.64	43.98	55.02	23.11
MS058	9.00	12.91	4.70	246.00	134.67	4.07	3.29	55.03	44.97	22.89
MS059	10.00	12.30	4.73	142.00	71.33	6.84	3.71	53.64	46.36	23.22
MS060	12.00	14.09	4.45	236.00	141.00	7.31	4.17	50.00	44.25	21.77

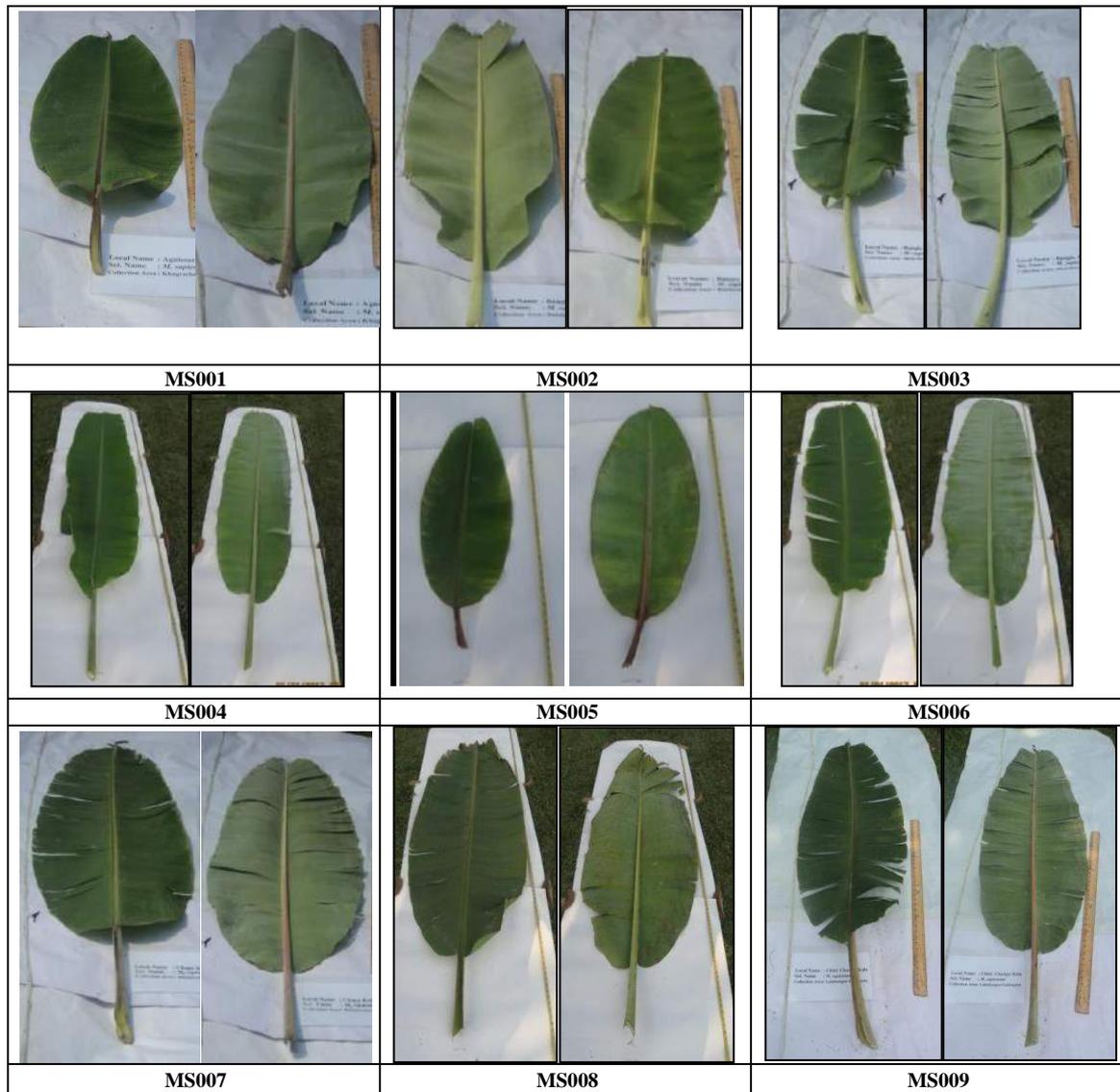
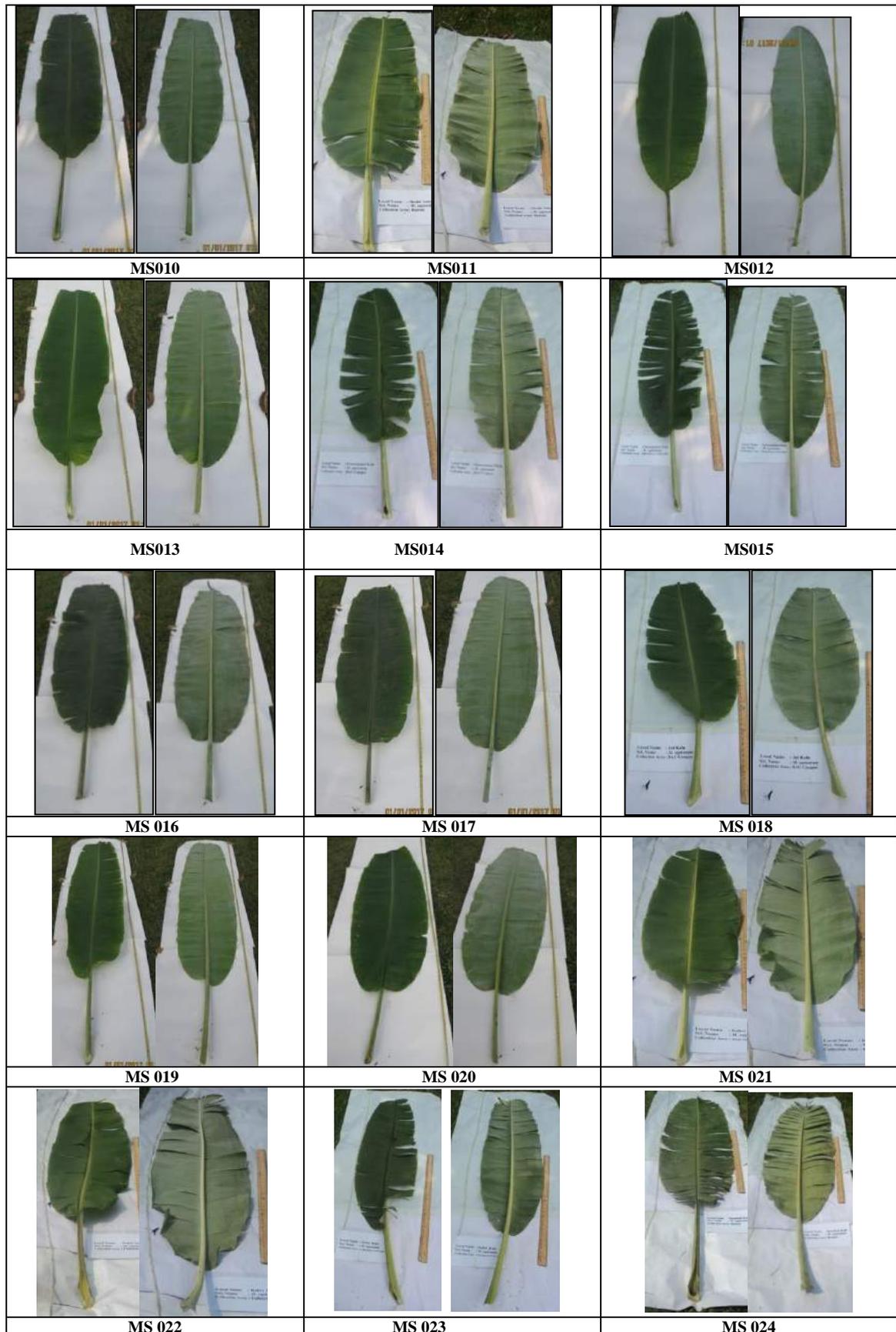
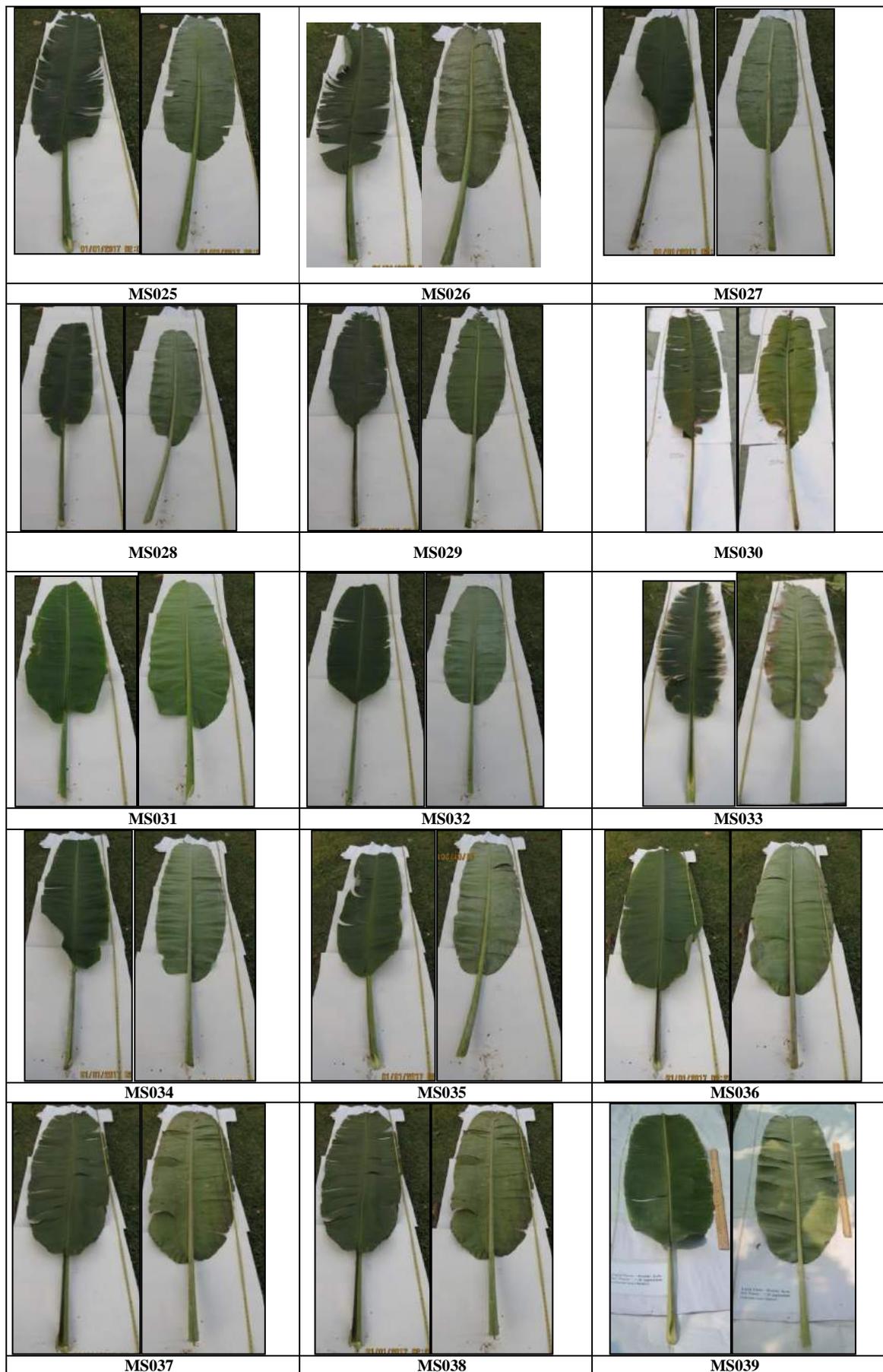


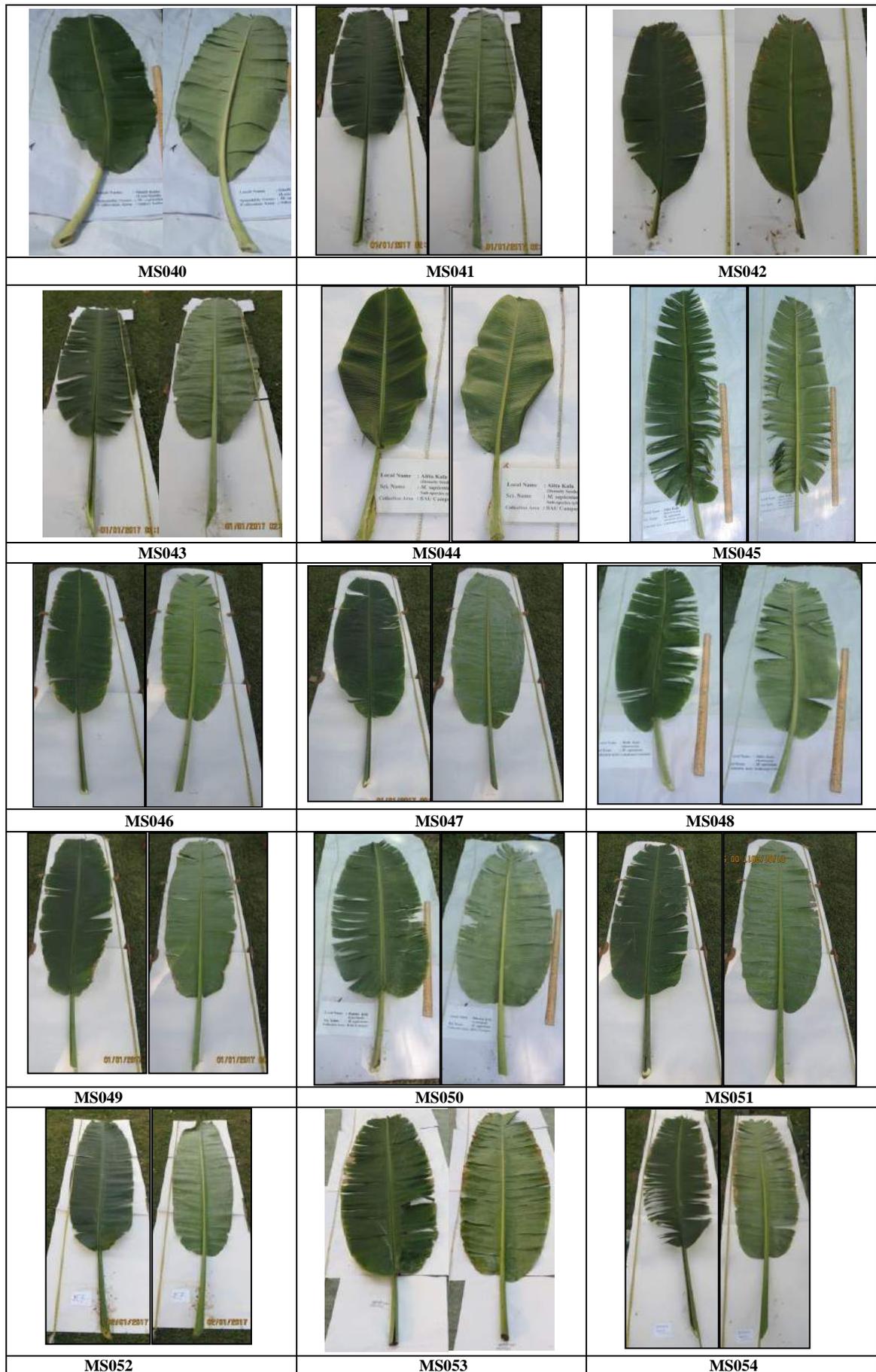
Fig. 136. Leaf character of indigenous banana germplasm



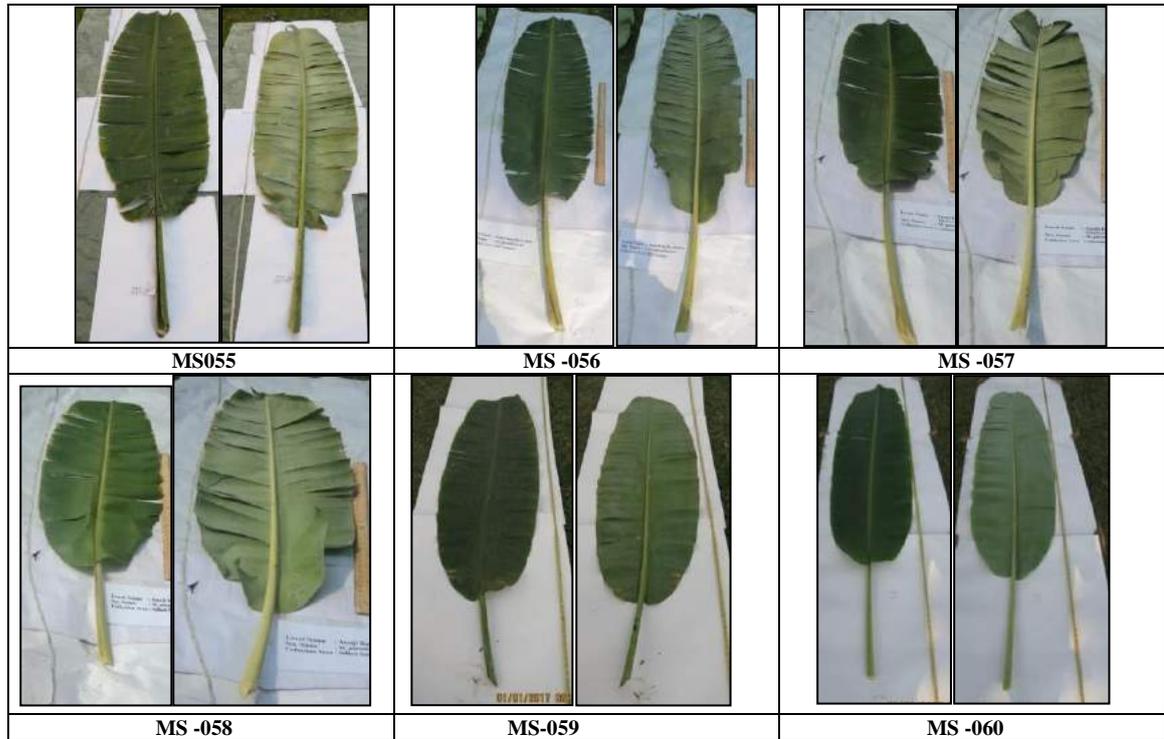
Cont'd. Fig. 136. Leaf character of indigenous banana germplasm



Cont'd. Fig. 136. Leaf character of indigenous banana germplasm



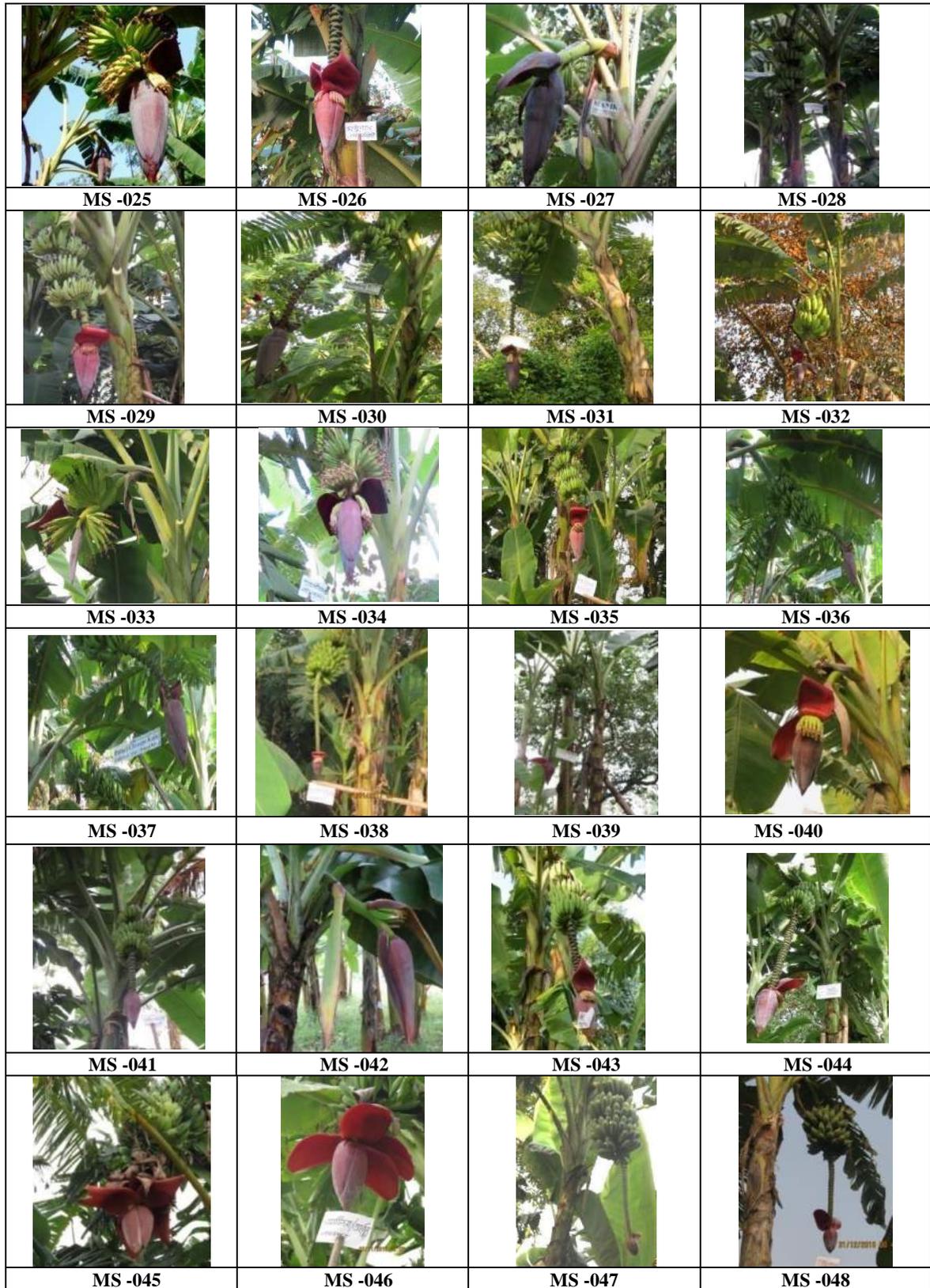
Cont'd. Fig. 136. Leaf character of indigenous banana germplasm



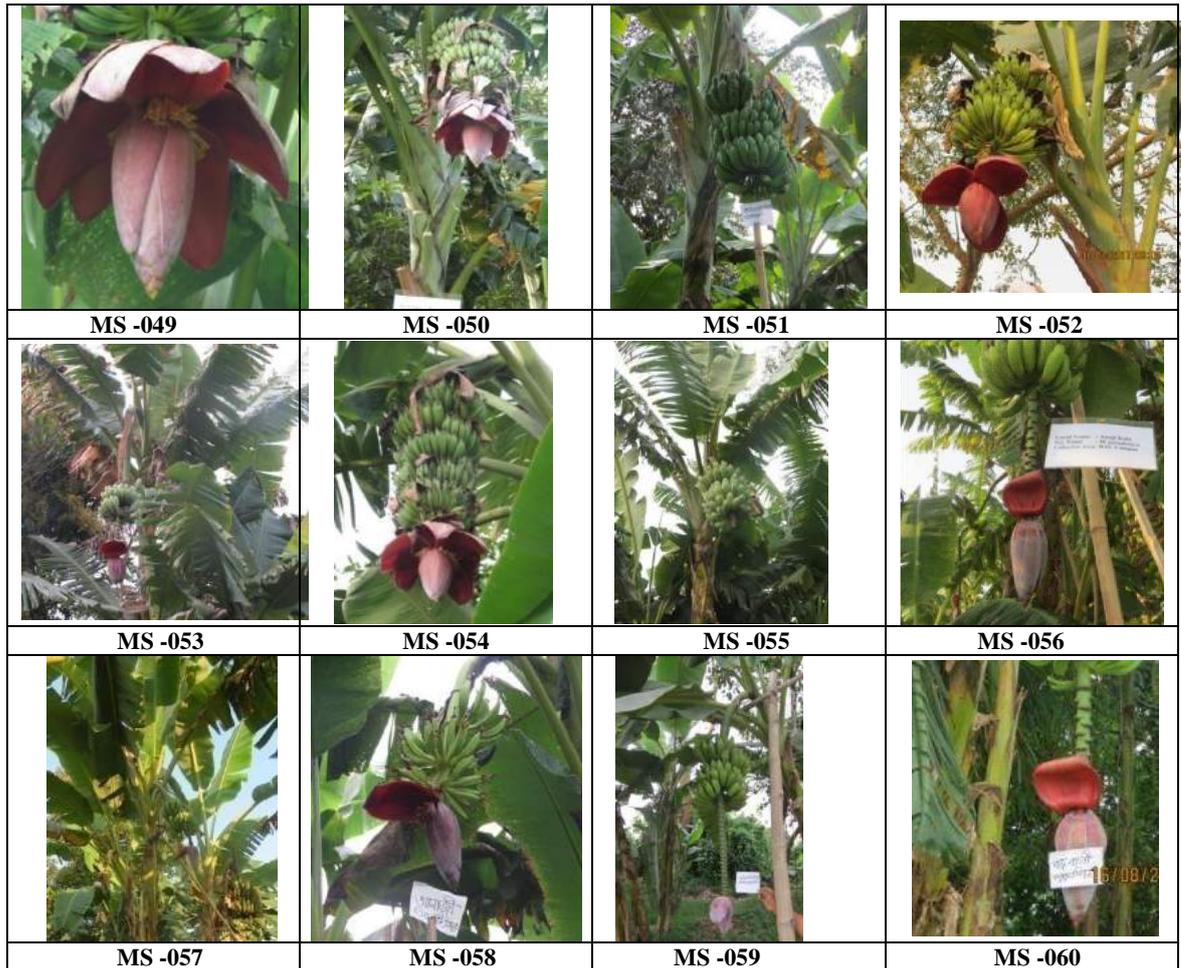
Cont'd. Fig. 136. Leaf character of indigenous banana germplasm



Fig. 137. Male bud characters of indigenous banana germplasm



Cont'd. Fig. 137. Male bud characters of indigenous banana germplasm



Cont'd. Fig. 137. Male bud characters of indigenous banana germplasm

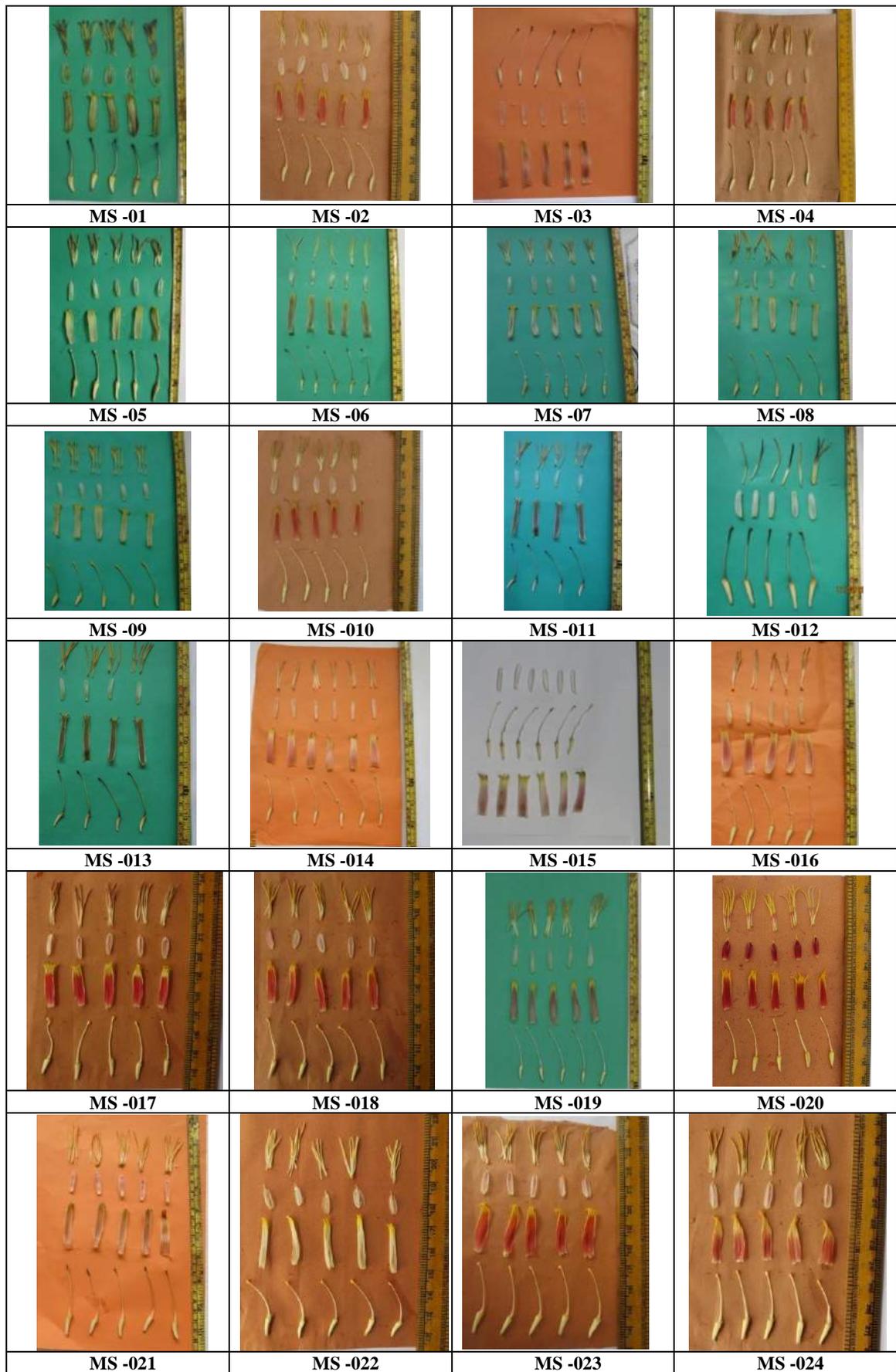
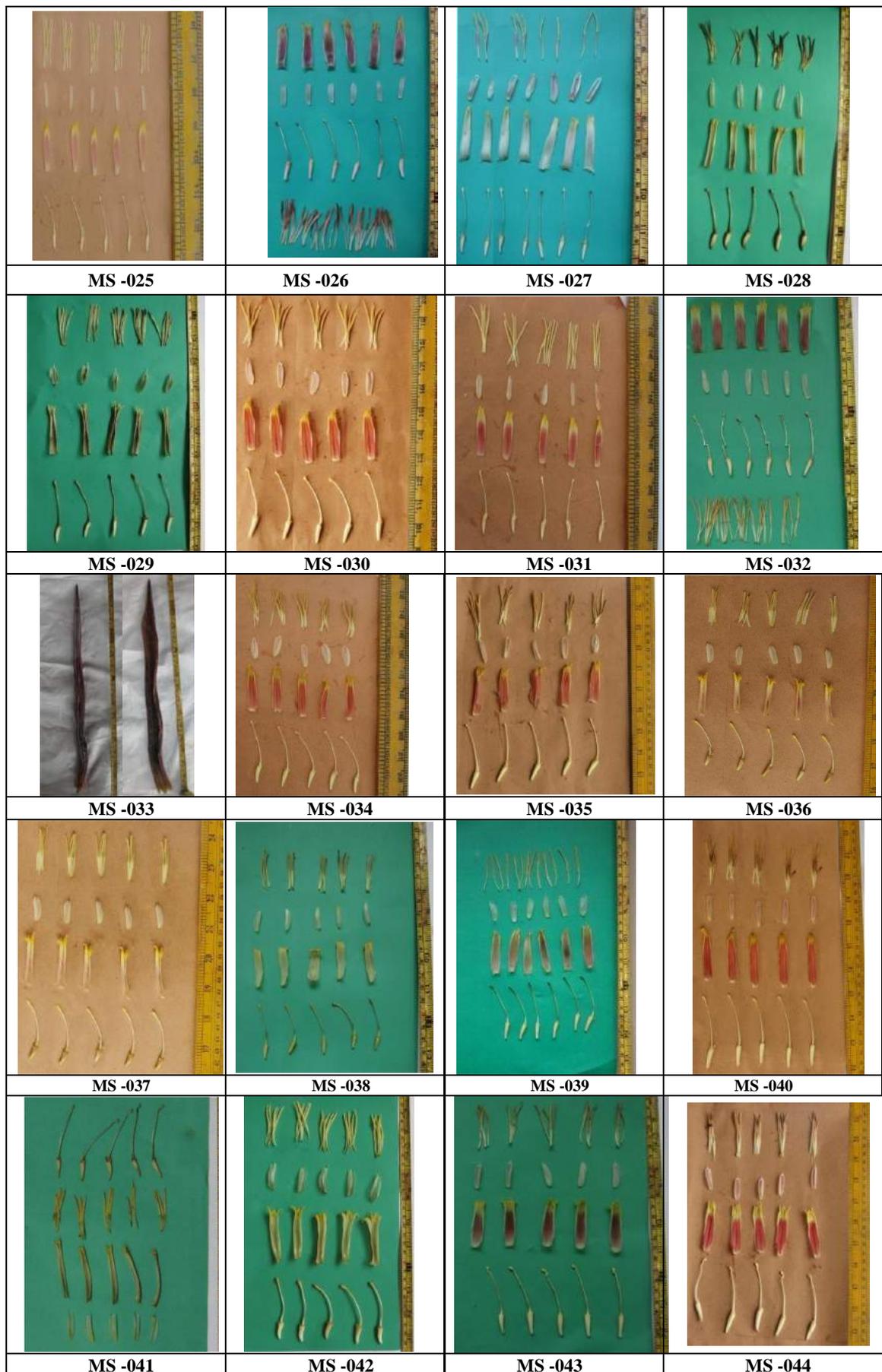
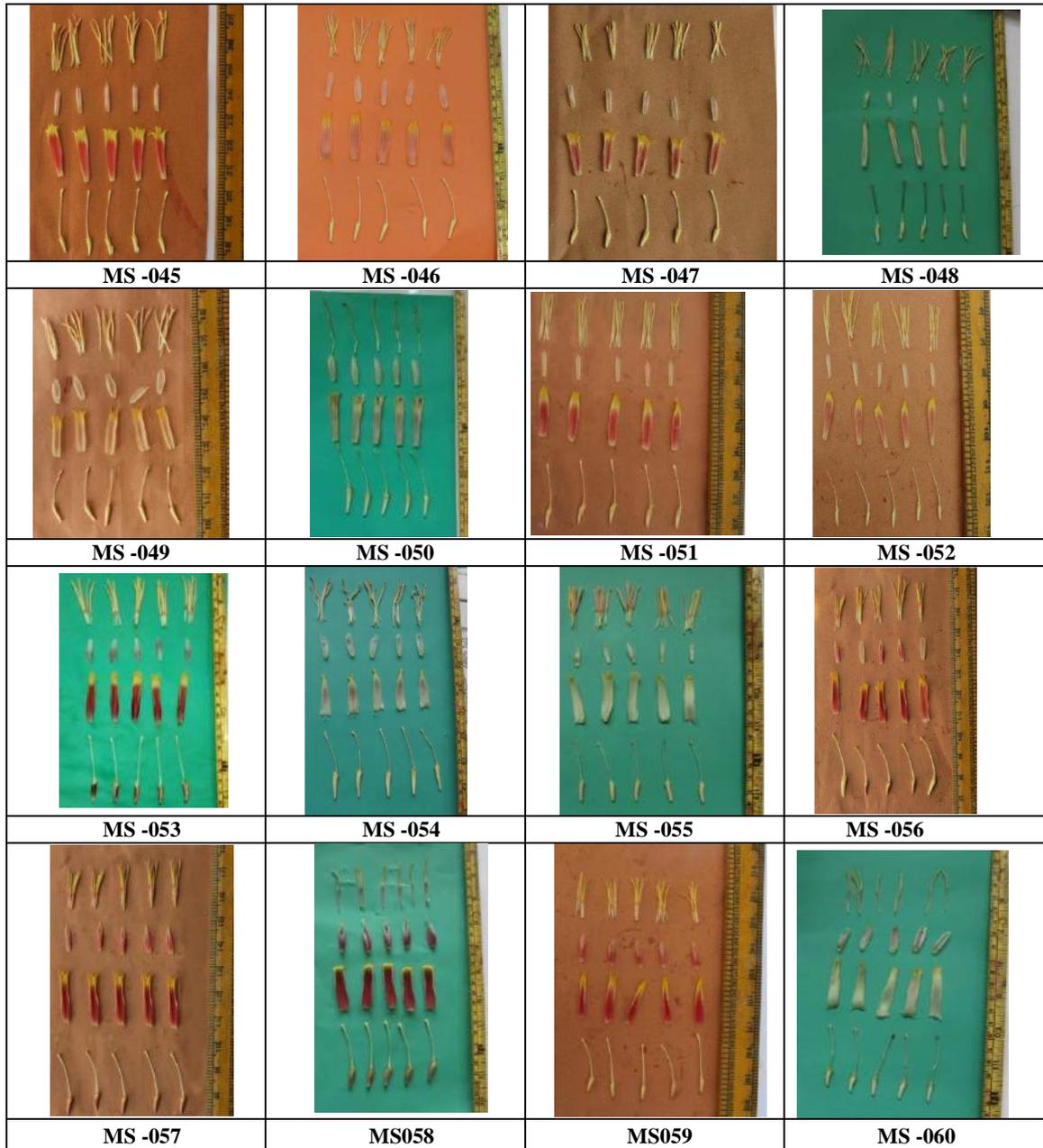


Fig. 138. Style shape of indigenous banana germplasm



Cont'd. Fig. 138. Style shape of indigenous banana germplasm



Cont'd. Fig. 138. Style shape of indigenous banana germplasm

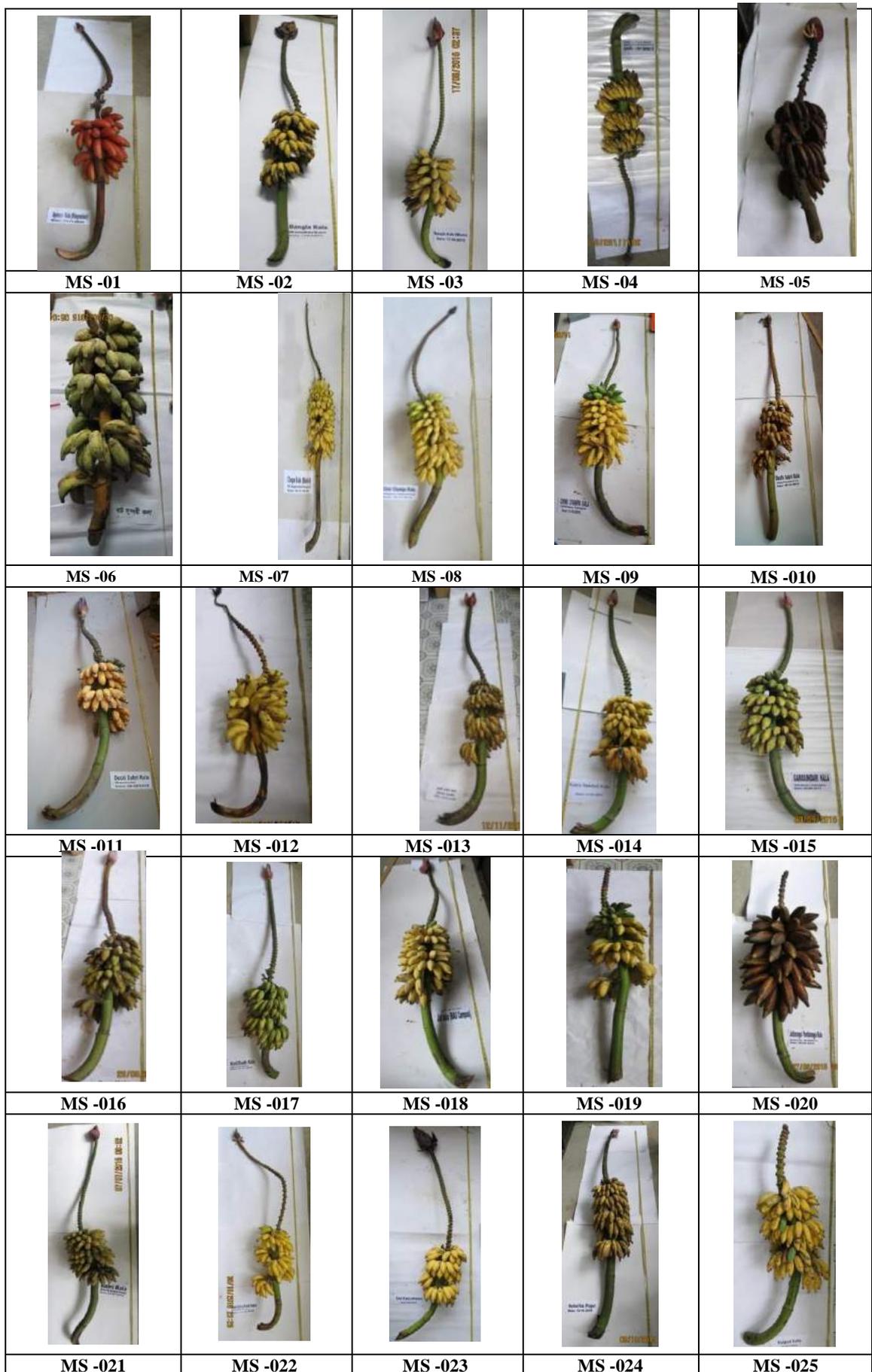
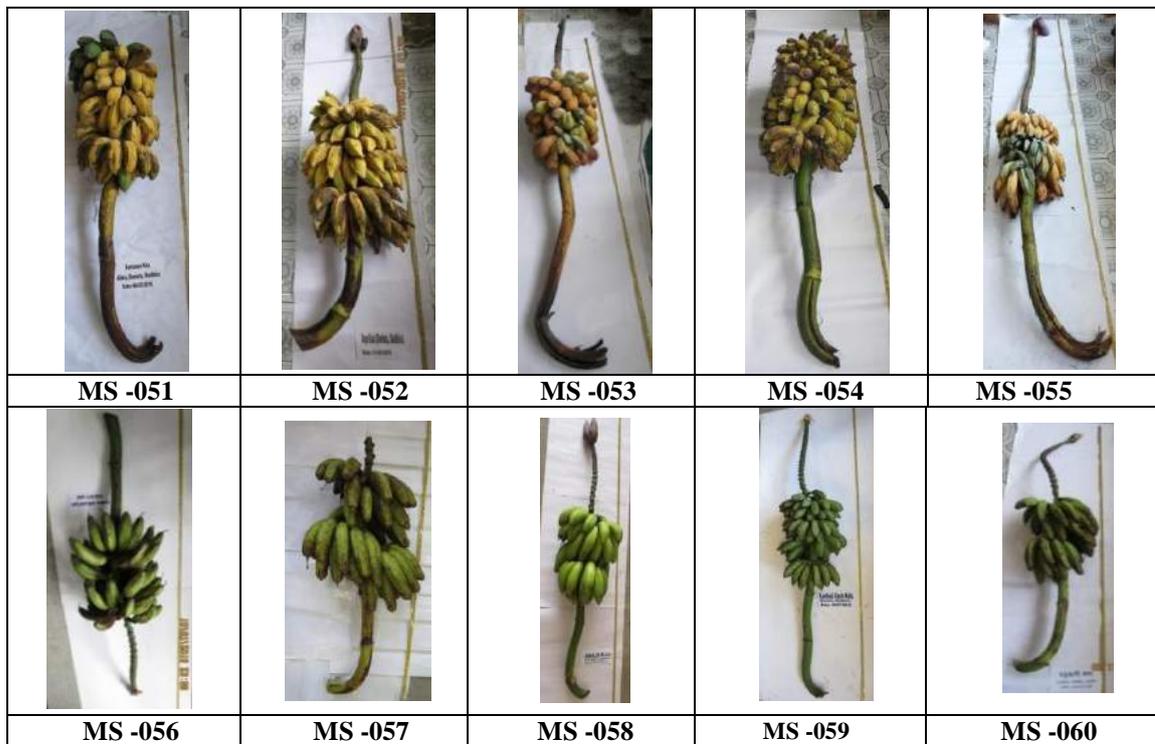


Fig. 139. Bunch characters of indigenous banana germplasm



Cont'd. Fig. 139. Bunch characters of indigenous banana germplasm



Cont'd.Fig. 139. Showing bunch characters of indigenous banana germplasm

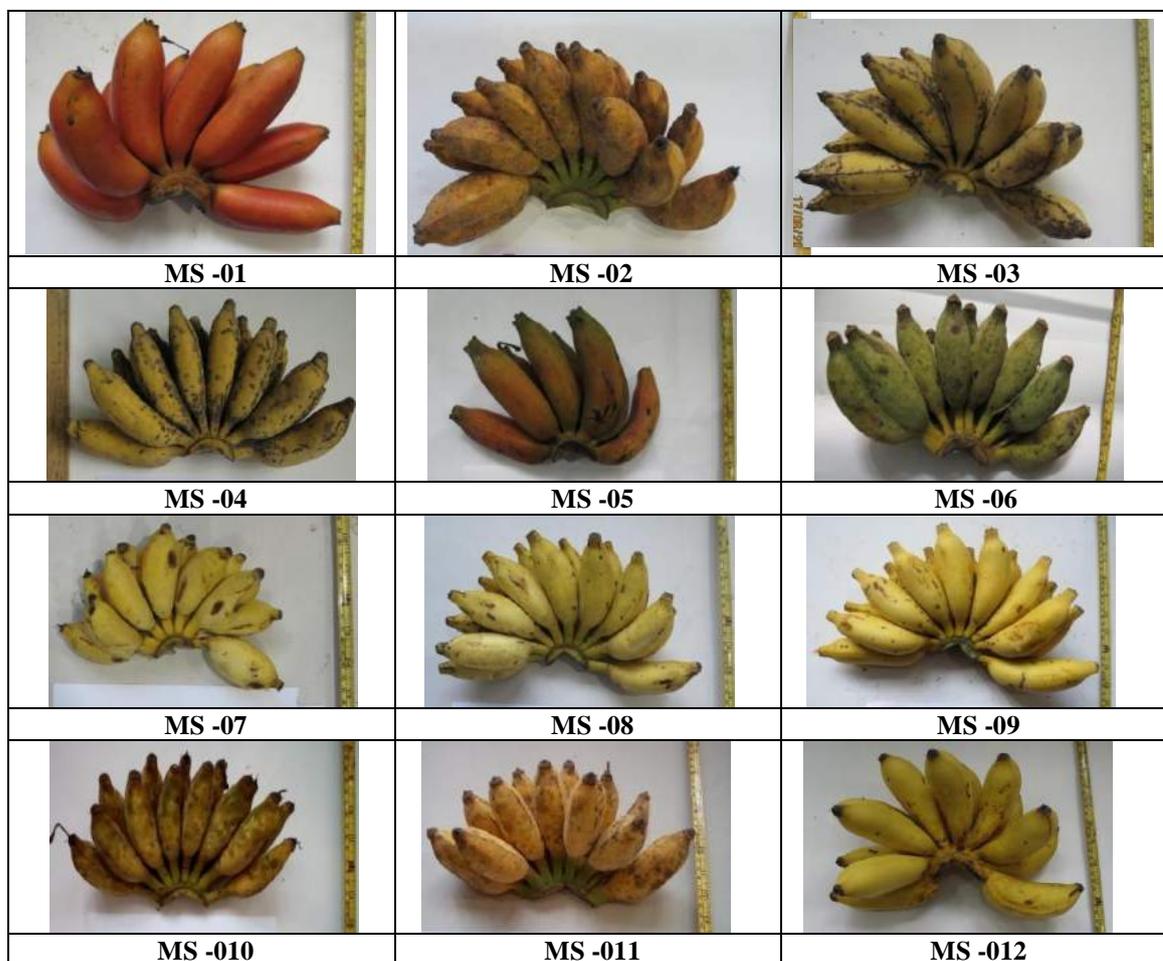
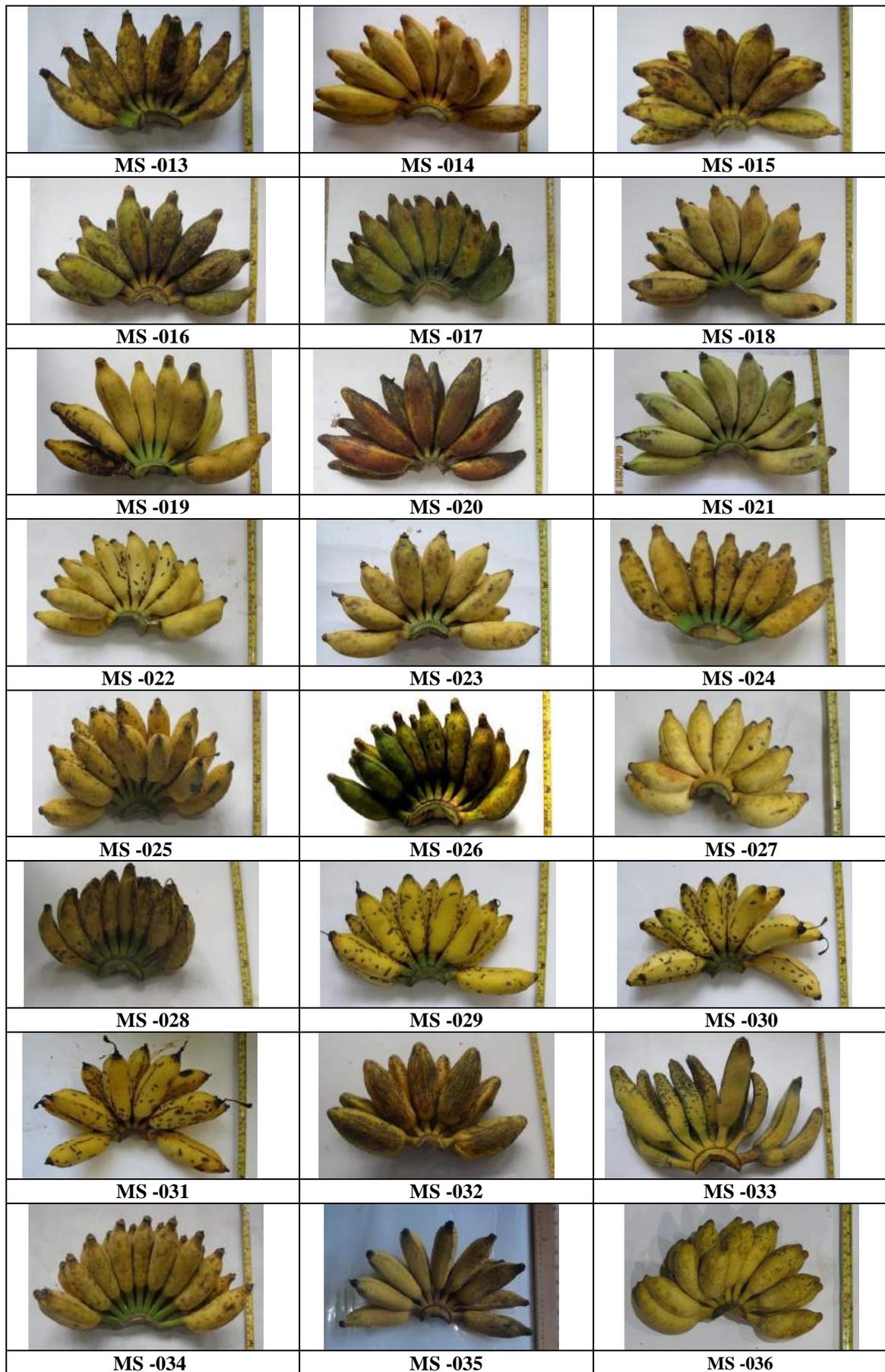
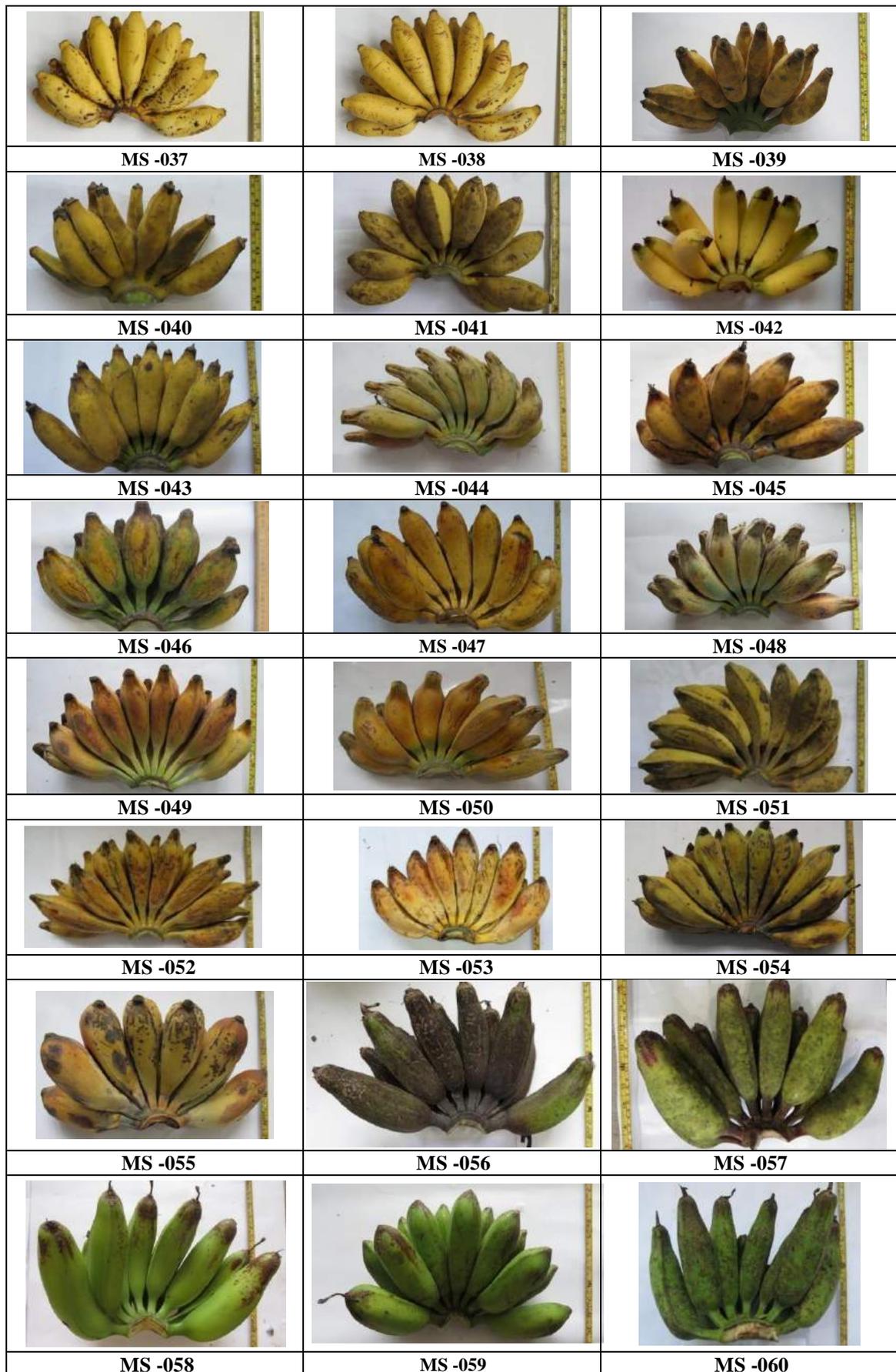


Fig. 140. Hand characters of indigenous banana germplasm



Cont'd. Fig. 140. Hand characters of indigenous banana germplasm



Cont'd. Fig. 140. Hand characters of indigenous banana germplasm

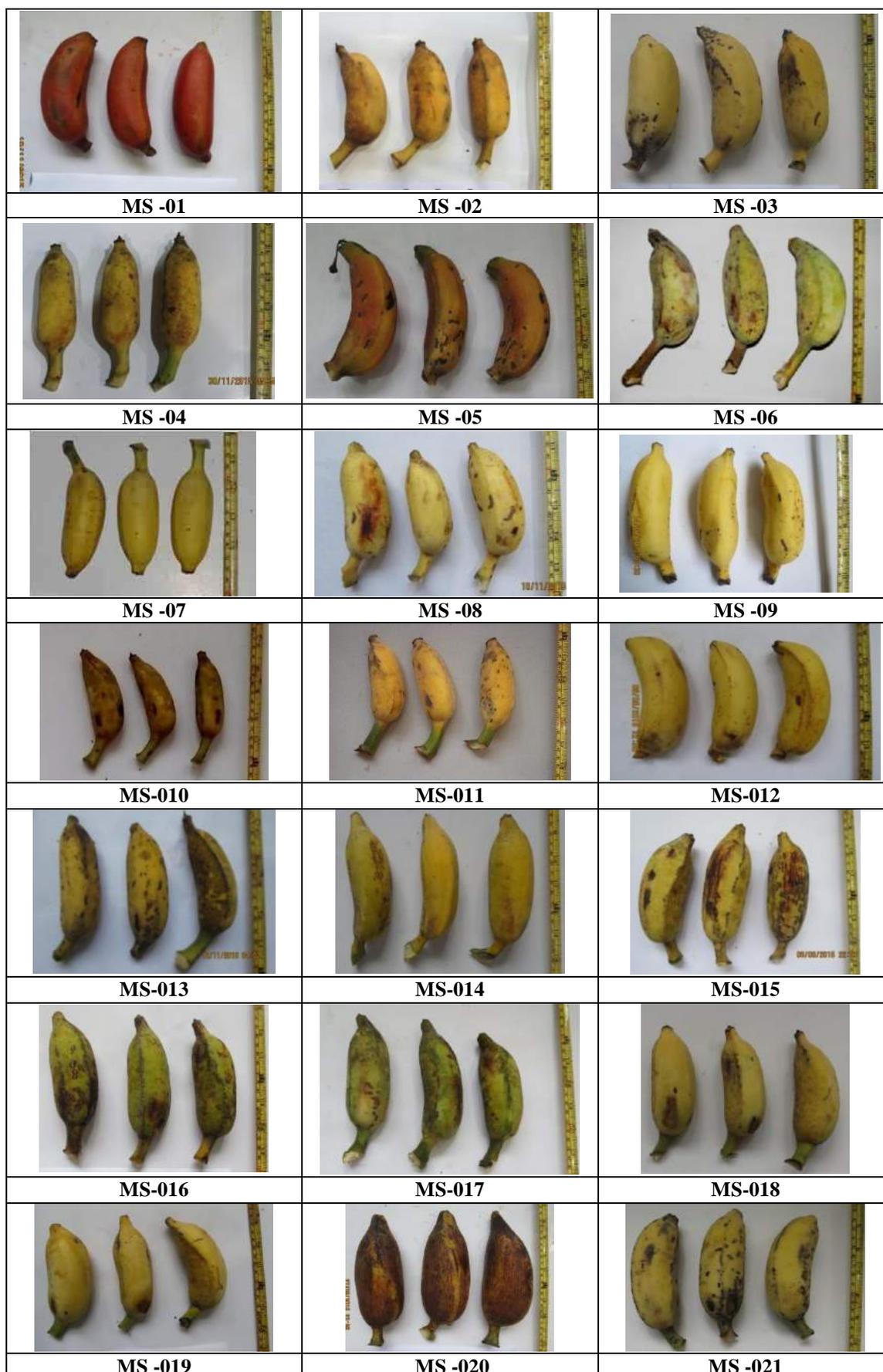
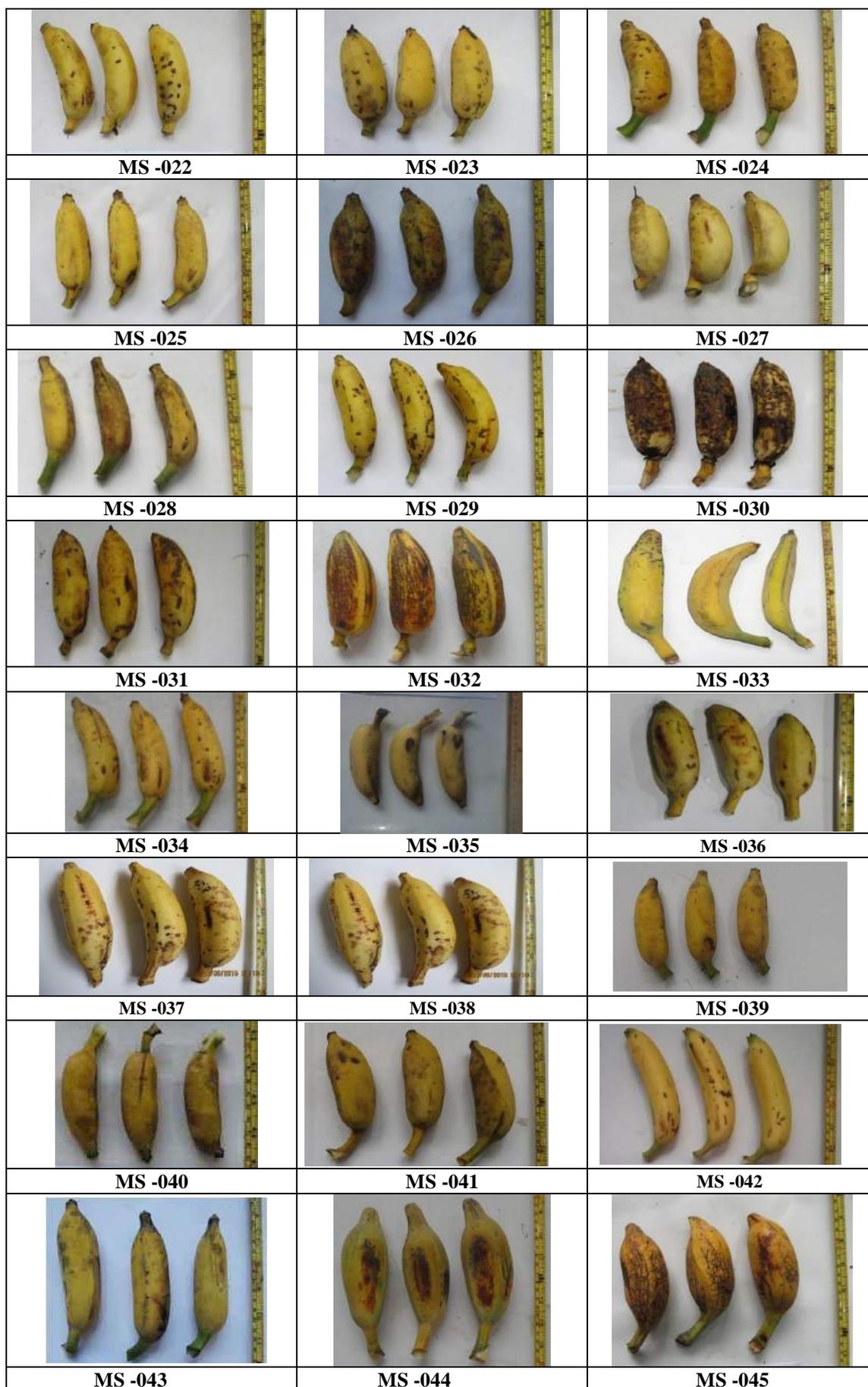
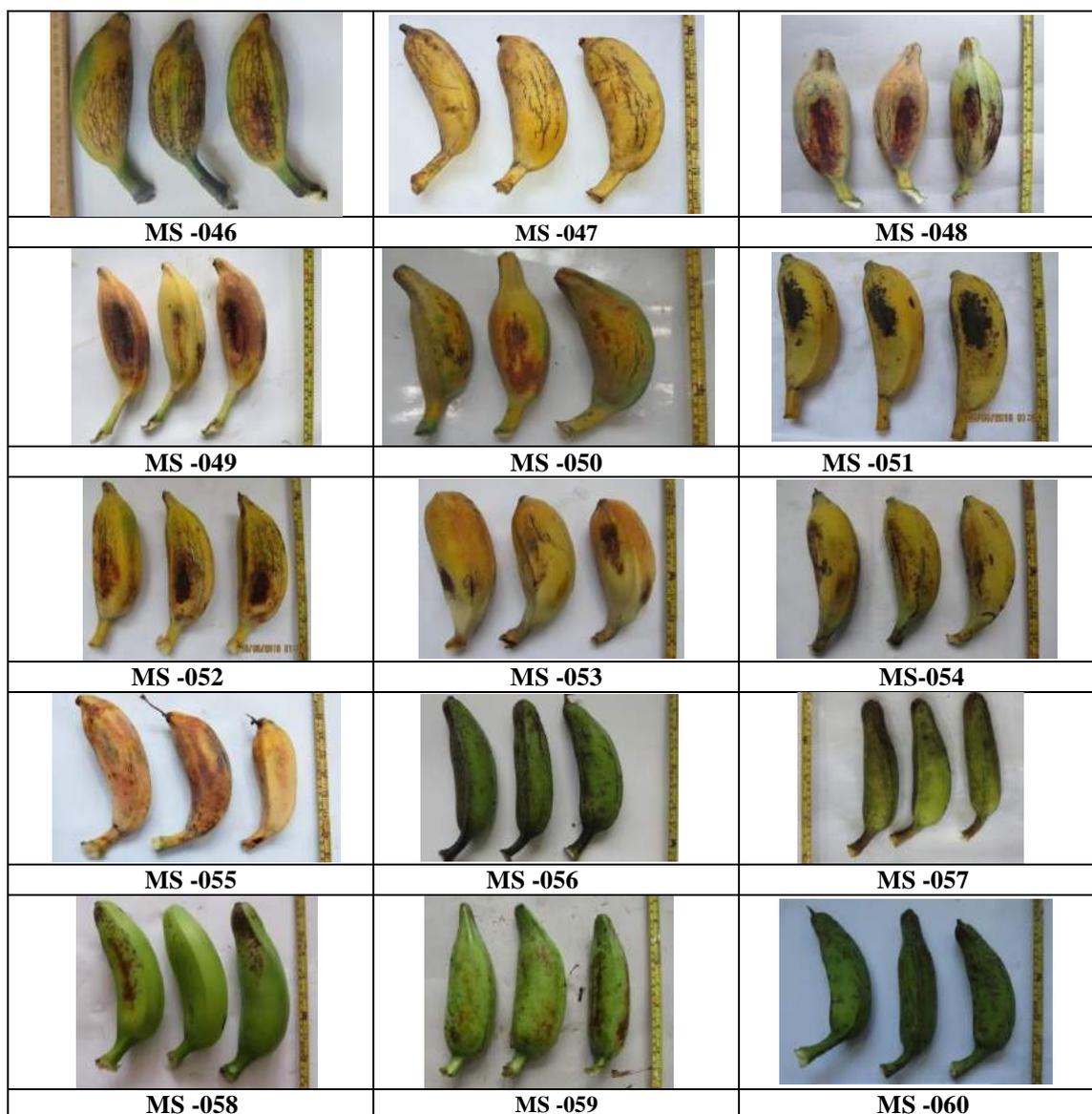


Fig. 141. Finger characteristics indigenous banana germplasm



Cont'd. Fig. 141. Finger characteristics indigenous banana germplasm



Cont'd. Fig. 141. Finger characteristics indigenous banana germplasm

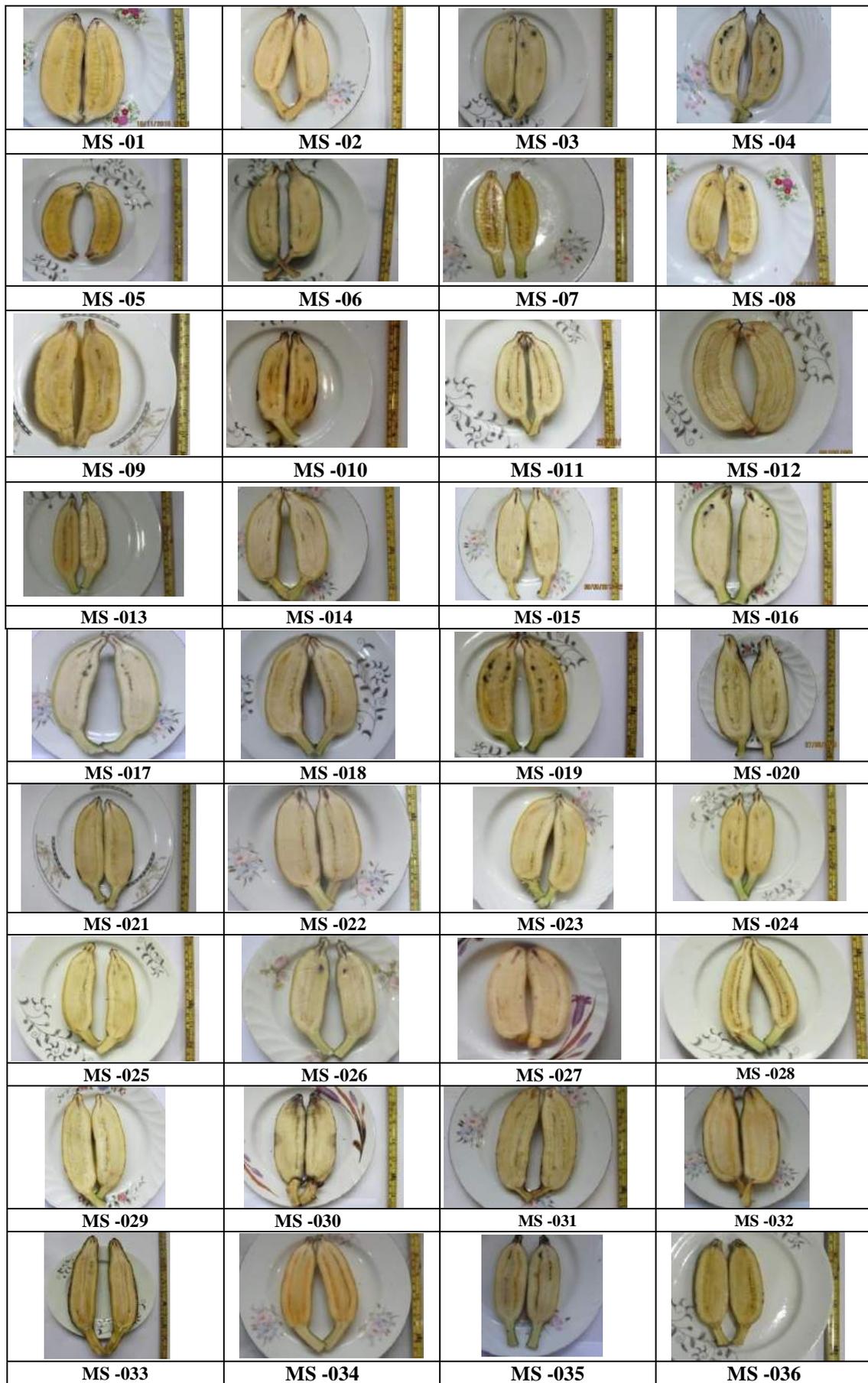
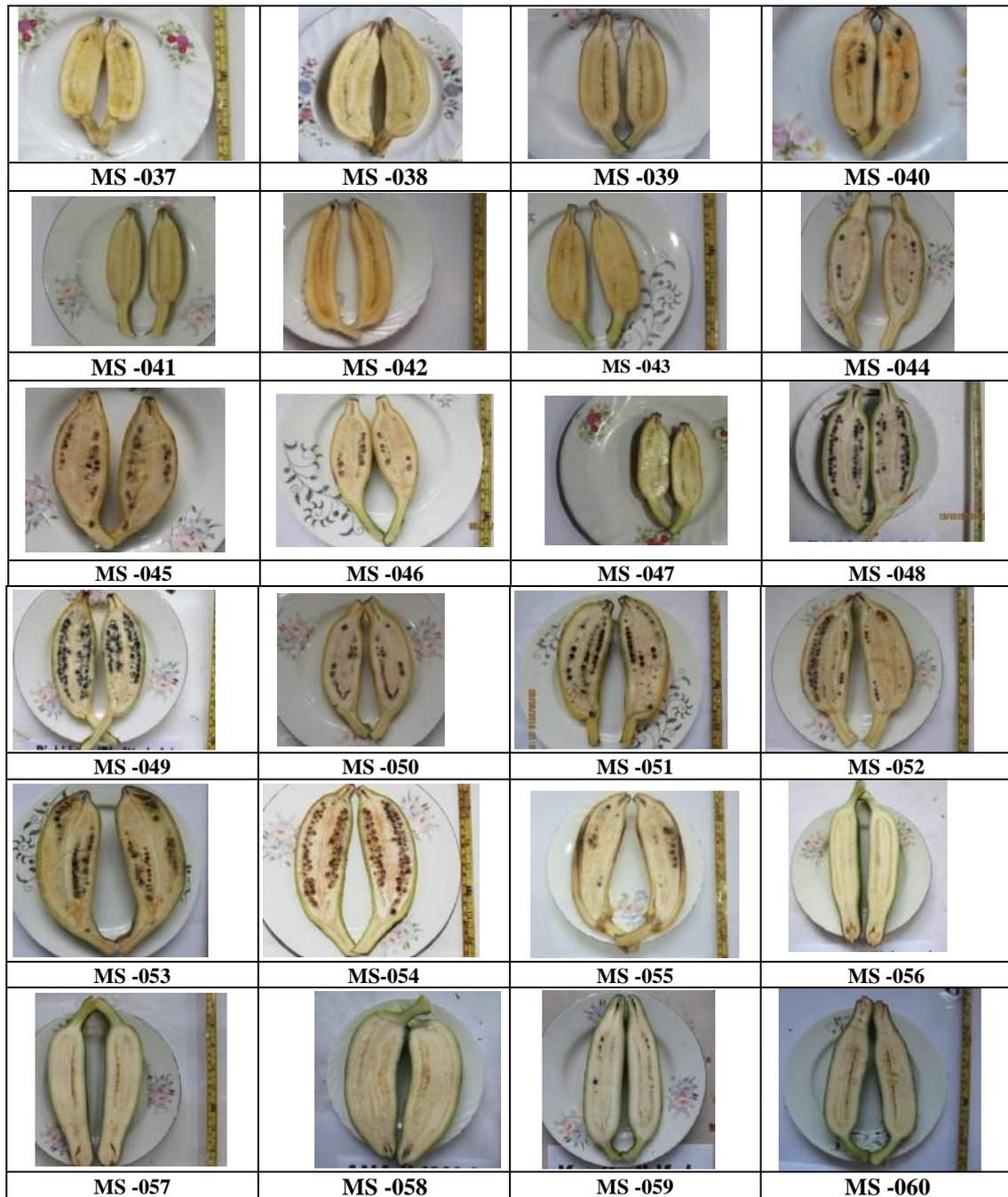


Fig. 142. Pulp and peel characteristics and seediness of indigenous banana germplasm



Cont'd. Fig. 142. Pulp and peel characteristics and seediness of indigenous banana germplasm

			
MS -01	MS -02	MS -03	MS -04
			
MS -05	MS -06	MS -07	MS -08
			
MS -09	MS -10	MS -11	MS -12
			
MS -13	MS -14	MS -15	MS -16
			
MS -17	MS -18	MS -019	MS -020
			
MS -021	MS -022	MS -023	MS -024
			
MS -025	MS -026	MS -027	MS -028
			
MS -029	MS -030	MS -031	MS -032

Fig. 143. Transverse section of fruits of indigenous banana

			
MS -033	MS -034	MS -035	MS -036
			
MS -037	MS -038	MS -039	MS -040
			
MS -041	MS -042	MS -043	MS -044
			
MS -045	MS -046	MS -047	MS -048
			
MS -049	MS -050	MS -051	MS -052
			
MS -053	MS -054	MS -055	MS -056
			
MS -057	MS -058	MS -059	MS -060

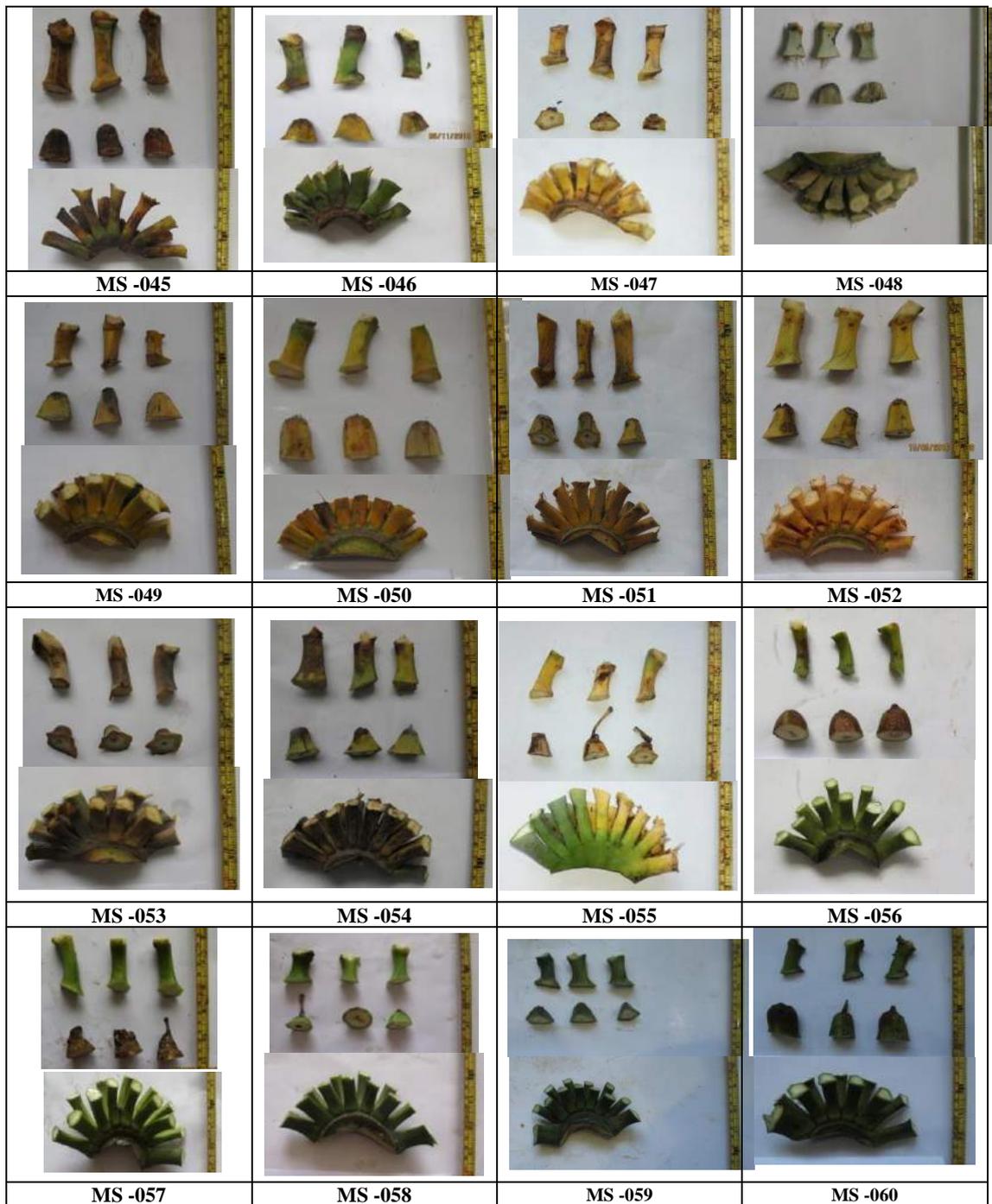
Cont'd. Fig. 143. Transverse section of fruits of indigenous banana



Fig. 144. Shape, size and style of tips and pedicel of indigenous banana



Cont'd. Fig. 144. Shape, size and style of tips and pedicel of indigenous banana



Cont'd. Fig. 144. Shape, size and style of tips and pedicel of indigenous banana

11.9.4. Molecular Characterization of Banana Cultivars using RAPD and SSR Markers

Crouch *et al.*, 1999 stated that the development and application of molecular markers provide powerful tools to reveal polymorphism, and are also robust to detect genetic variability and are not influenced by environment or developmental stages of the plant, thus making them an ideal tool for genetic diversity studies. However, the potential usefulness of molecular techniques in identifying genetic relationships among species varies greatly because of the uniqueness of each genome.

11.9.4.1. Molecular Characterization of Banana using RAPD Marker

This experiment was conducted at Plant Breeding Division of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh.

i) Selection of primer

Three primers were selected named OPA-3, OPA-14 and OPA-19 on the basis of band resolution intensity. Selected 3 primers generated 16 bands with an average of 5.33, which were 100% polymorphic. Selected 3 primers showed clear polymorphism which were used in for further analysis (Table 171).

Table 171. RAPD primers with corresponding bands and size range together with polymorphic bands observed in 30 banana germplasm

Primer code	Sequences (5'-3')	Total number of bands scored	Size ranges (bp)	Number of polymorphic bands	Proportion of polymorphic loci (%)
OPA03	AGTCAGCCAC	6	1100-10000	6	100
OPA14	TCTGTGCTGG	5	500-10000	5	100
OPA19	CAAACGTCGG	5	500-1000	5	100
Total		16		16	300
Average		5.33		5.33	100

ii) Band size

The size of amplification products were estimated by comparing the migration of each amplified fragment with that of a known size fragments of molecular weight marker (1 kb DNA ladder). The sizes of the amplified bands in the 30 banana accession ranged from 500 to 10000 bp (Table 171). (Figs.145,146 and 147).

iii) Number of bands

Three RAPD primers generated 223 bands and average 7.43 from the 30 banana germplasm using the Thermal Cycler (Genius, Techne) and 1.5% agarose gel electrophoresis with size ranging from 500 to 10000bp (Table 172). The electrophoregrams according to primers OPA-03, OPA-14 and OPA-19 were shown in figs 145, 146 and 147 respectively. In case of three primers, the total number of bands (223) varied from 54 to 100 (Table 4.1.85). The highest number of bands (100) was amplified by the primer OPA-03 and the primer OPA-14 produced the lowest number of bands (54). The highest number of bands (12) was produced from MS015, MS016 followed by MS018, MS025, MS033 (11) and the lowest number of bands (3) were recorded from the accession MS004.

Table 172. Number of amplified fragments scored against 30 germplasm using three RAPD markers

Accession	Primer			
	OPA03	OPA14	OPA19	Total
(1) MS056	2	0	4	6
(2) MS057	3	0	1	4
(3) MS058	1	0	3	4
(4) MS059	3	0	3	6
(5) MS001	2	0	2	4
(6) MS003	4	0	4	8
(7) MS004	2	0	1	3
(8) MS002	4	0	2	6
(9) MS006	3	0	3	6
(10) MS051	3	0	3	6
(11) MS009	5	0	1	6
(12) MS008	5	0	3	8
(13) MS010	4	0	2	6
(14) MS013	3	0	2	5
(15) MS012	4	0	3	7
(16) MS014	4	0	2	6
(17) MS016	4	5	3	12
(18) MS015	4	5	3	12
(19) MS017	3	4	2	9
(20) MS018	4	4	3	11
(21) MS019	3	4	2	9
(22) MS023	4	3	1	8
(23) MS021	2	3	4	9
(24) MS022	4	3	1	8
(25) MS024	3	4	1	8
(26) MS025	4	4	3	11
(27) MS028	3	3	1	7
(28) MS030	4	4	2	10
(29) MS029	2	3	2	7
(30) MS033	4	5	2	11
Total	100	54	69	223
Average	3.33	1.8	2.3	7.43

Frequency of polymorphic loci in 30 collected banana germplasm with OPA-03, OPA-14 and OPA-19 primer

On the basis of presence and absence of the bands of the PCR product with OPA-03, OPA-14 and OPA-19 primer, the polymorphisms of the collected samples were detected. Absence of bands may be caused by failure of primers to anneal a site in some individuals due to nucleotide sequence differences or by insertions or deletions in primer sites (Clark and Lanigan, 1993). Results showed that the highest gene frequency observed in OPA-03, OPA-14 and OPA-19 were 0.8000, 0.4667 and 0.9667 respectively. The lowest gene frequency observed in OPA-03, OPA-14 and OPA-19 were 0.2667, 0.2333 and 0.1667, respectively (Table 173).

Table 173. Frequencies of polymorphic RAPD markers in 30 banana germplasm

RAPD Markers	Gene frequency	RAPD Markers	Gene frequency
OPA03-1	0.2667	OPA14-3	0.3000
OPA03-2	0.8000	OPA14-4	0.3333
OPA03-3	0.8000	OPA14-5	0.2333
OPA03-4	0.7000	OPA19-1	0.3667
OPA03-5	0.3667	OPA19-2	0.3333
OPA03-6	0.4000	OPA19-3	0.9667
OPA14-1	0.4667	OPA19-4	0.1667
OPA14-2	0.4667	OPA19-5	0.4667

Genetic Diversity and Frequency of polymorphic loci in 30 collected banana germplasm with OPA-03, OPA-14 and OPA-19 primer.

Genetic diversity for the primer OPA-03, OPA-14 and OPA-19 is presented in (Table 174). The mean of Nei's (1973) gene diversity and Shannon's Information index (Lewontin) 1972, in 30 banana accession were 0.3976 and 0.5797 respectively. High level of gene diversity value was observed in OPA14-1- OPA14-2, OPA19-5 (0.4978 and 0.6909) respectively. Lowest value gene diversity and Shannon's Information index was observed in OPA19-3 (0.0644 and 0.1461), respectively.

Table 174. Summary of genetic diversity and Shanon Information Index statistics

Loci	Sample Size	Observed number of alleles (na)	Effective number of alleles (ne)	Gene diversity (h)	Shanon information index (i)
OPA03-1	30	2.0000	1.6423	0.3911	0.5799
OPA03-2	30	2.0000	1.4706	0.3200	0.5004
OPA03-3	30	2.0000	1.4706	0.3200	0.5004
OPA03-4	30	2.0000	1.7241	0.4200	0.6109
OPA03-5	30	2.0000	1.8672	0.4644	0.6572
OPA03-6	30	2.0000	1.9231	0.4800	0.6730
OPA14-1	30	2.0000	1.9912	0.4978	0.6909
OPA14-2	30	2.0000	1.9912	0.4978	0.6909
OPA14-3	30	2.0000	1.7241	0.4200	0.6109
OPA14-4	30	2.0000	1.8000	0.4444	0.6365
OPA14-5	30	2.0000	1.5571	0.3578	0.5433
OPA19-1	30	2.0000	1.8672	0.4644	0.6572
OPA19-2	30	2.0000	1.8000	0.4444	0.6365
OPA19-3	30	2.0000	1.0689	0.0644	0.1461
OPA19-4	30	2.0000	1.3846	0.2778	0.4506
OPA19-5	30	2.0000	1.9912	0.4978	0.6909
Mean	30	2.0000	1.7046	0.3976	0.5797
SD		0.0000	0.2592	0.1126	0.1378

* na = Observed number of alleles

* ne = Effective number of alleles

* h = Nei's (1973) gene diversity

* i = Shannon's Information index

Gene flow and Population differentiation in 30 banana germplasm for OPA-03, OPA-14 and OPA-19 primer

The average estimated gene flow (Nm) value was 0.0000 and co-efficient of gene differentiation (Gst) was 1.0000 across all loci (Table 175). Hardy-Weinberg expectation of average heterozygosity (Ht) in the accession was 0.3976 while obtained average heterozygosity (Hs) of Hardy-Weinberg for those accessions was 0.0000. The highest level of co-efficient of gene differentiation was 1.0000. RAPD marker revealed high level of differentiation (Gst = 1.0000) that supports the presence of sufficient polymorphisms banana accession.

Table 175. Nei's Analysis of gene diversity in subdivided populations

Loci	Sample Size	Ht	Hs	Gst	Nm*
OPA03-1	30	0.3911	0.0000	1.0000	0.0000
OPA03-2	30	0.3200	0.0000	1.0000	0.0000
OPA03-3	30	0.3200	0.0000	1.0000	0.0000
OPA03-4	30	0.4200	0.0000	1.0000	0.0000
OPA03-5	30	0.4644	0.0000	1.0000	0.0000
OPA03-6	30	0.4800	0.0000	1.0000	0.0000
OPA14-1	30	0.4978	0.0000	1.0000	0.0000
OPA14-2	30	0.4978	0.0000	1.0000	0.0000
OPA14-3	30	0.4200	0.0000	1.0000	0.0000
OPA14-4	30	0.4444	0.0000	1.0000	0.0000
OPA14-5	30	0.3578	0.0000	1.0000	0.0000
OPA19-1	30	0.4644	0.0000	1.0000	0.0000
OPA19-2	30	0.4444	0.0000	1.0000	0.0000
OPA19-3	30	0.0644	0.0000	1.0000	0.0000
OPA19-4	30	0.2778	0.0000	1.0000	0.0000
OPA19-5	30	0.4978	0.0000	1.0000	0.0000
Mean	30	0.3976	0.0000	1.0000	0.0000
SD		0.0127	0.0000		

* Nm = estimate of gene flow from Gst or Gcs. E.g., $Nm = 0.5(1 - Gst)/Gst$;
 See McDermott and McDonald, Ann. Rev. Phytopathol. 31:353-373 (1993).
 The number of polymorphic loci is: 16
 The percentage of polymorphic loci is: 100.00

Nei's (1972) genetic identity (above diagonal) and genetic distance (below diagonal) in 30 different banana germplasm for three primers

The values of pair-wise comparisons of Nei's genetic distance were calculated from combined data sets for 3 primers ranging from 0.065 to 2.079. The highest genetic distance (2.079) was found between MS016 and MS057. The lowest genetic distance (0.065) was revealed between MS012 and MS008. The differences between the lowest and highest genetic distance among 30 banana accession showed presence of wide genetic variability among the accession.

Genetic identity among the 30 banana accession was observed for 3 primers ranging from 0.125 to 0.938. Highest genetic identity (0.938) was recorded in MS006 and MS012; lowest genetic identity was found in MS016 and MS057.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 M

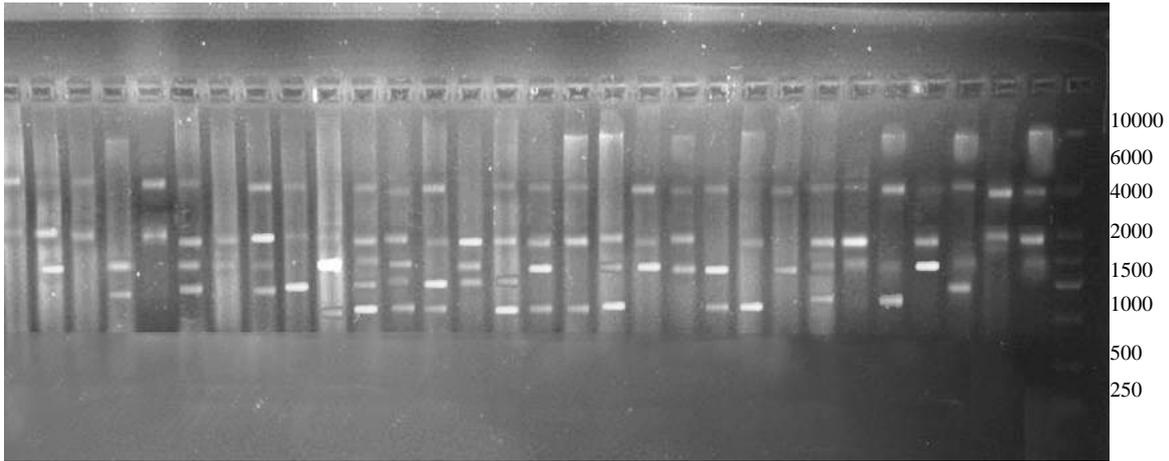


Fig. 145. RAPD profile of 30 banana germplasm using primer OPA-03

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

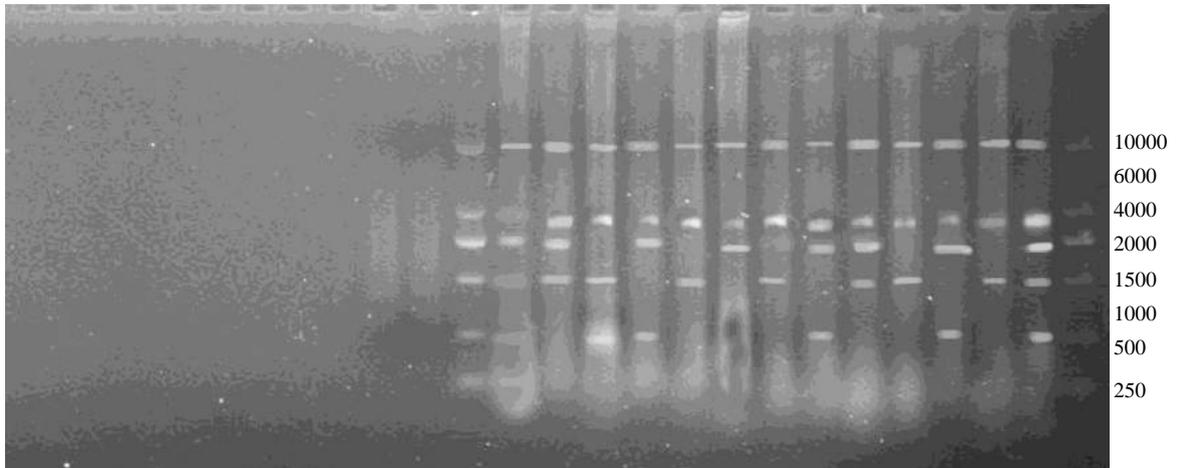


Fig. 146. RAPD profile of 30 banana germplasm using primer OPA-14

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 M

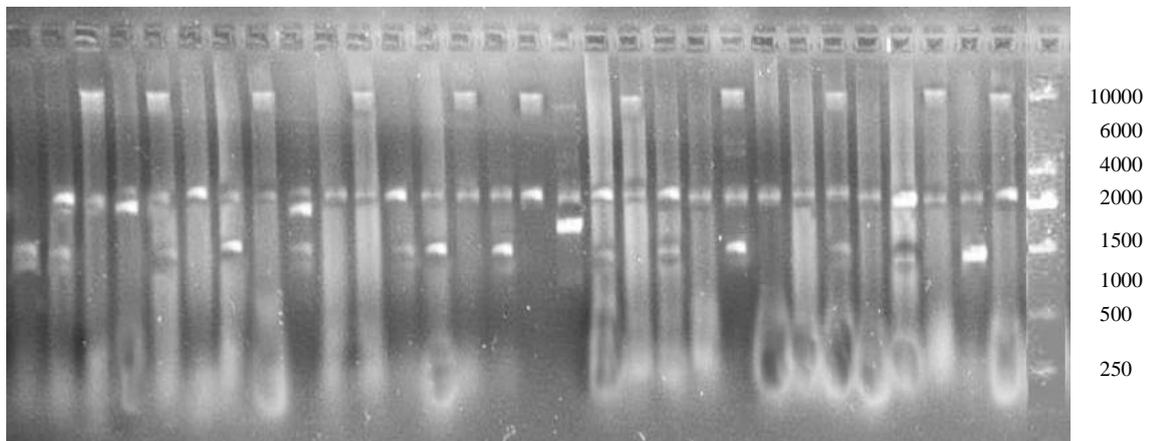


Fig. 147. RAPD profile of 30 banana germplasm using primer OPA-19

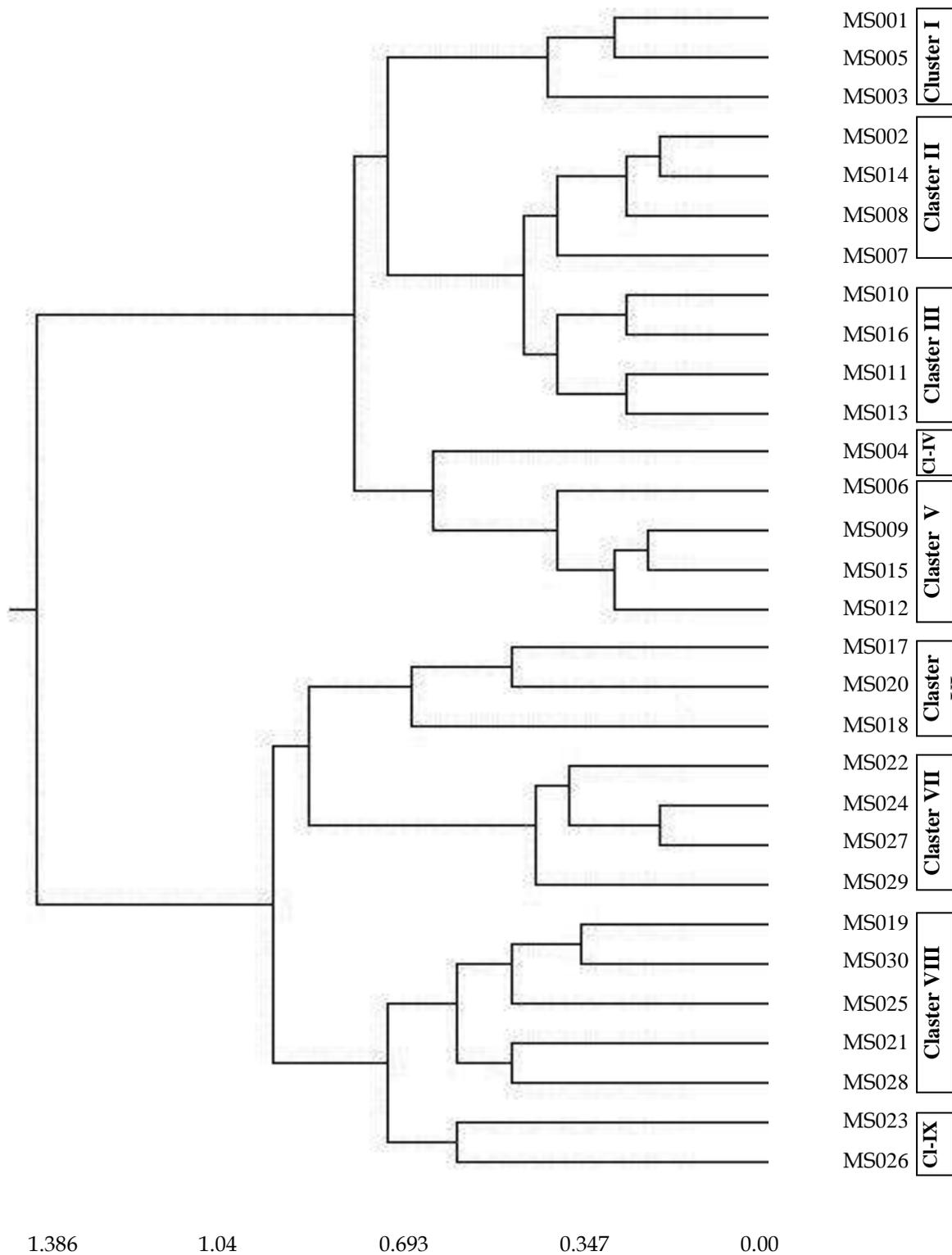


Fig. 148. Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

Legend, 1 = MS056, 2 = MS057, 3 = MS058, 4 = MS059, 5 = MS001, 6 = MS003, 7 = MS004, 8 = MS002, 9 = MS006, 10 = MS051, 11 = MS009, 12 = MS008, 13 = MS010, 14 = MS013, 15 = MS012, 16 = MS014, 17 = MS016, 18 = MS015, 19 = MS017, 20 = MS018, 21 = MS019, 22 = MS023, 23 = MS021, 24 = MS022, 25 = MS024, 26 = MS025, 27 = MS028, 28 = MS030, 29 = MS029, 30 = MS033.

Combined dendrogram of 30 banana accessions

A dendrogram (Fig 148) was constructed based on the genetic distance matrix by applying Unweighted Pair Group Method (UPGMA) with average means following Nei's (1972) distance matrix and presented in (Table 176).

The dendrogram showed 9 major groups designated as I, II, III, IV, V, VI, VII, VIII and IX. The distribution of the cluster members is shown in Table 176. Cluster VIII is a broad one which includes 5 accessions (MS019, MS030, MS025, MS021 and MS028). Cluster II (MS002, MS014, MS008 and MS007), III (MS010, MS016, MS011 and MS013), V (MS006, MS009, MS015 and MS012) and VII (MS022, MS024, MS027 and MS029), contained four accession each. Again cluster I (MS001, MS005 and MS003) and VI (MS017, MS020 and MS018), contained three accessions each. Two accessions were group IX (MS023 and MS026) and only single accession formed cluster IV (MS004).

Table 176. Distribution of 30 banana germplasm in different clusters

Number of cluster	Accession
I	MS001, MS005, MS003
II	MS002, MS014, MS008, MS007
III	MS010, MS016, MS011, MS013
IV	MS004
V	MS006, MS009, MS015, MS012
VI	MS017, MS020, MS018
VII	MS022, MS024, MS027, MS029
VIII	MS019, MS030, MS025, MS021, MS028
IX	MS023, MS026

11.9.4.2. Molecular characterization of banana using SSR marker

This experiment was conducted at Plant Pathology Laboratory, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh.

i) Selection of primer

Two primers were selected named mMaCIR13 and mMaCIR307 on the basis of band resolution intensity, presence of smearing, consistency within individuals and potential for population discrimination. Selected 2 primers showed clear polymorphism which were used in for further analysis.

Table 177. Details of the test SSR markers

Maker Name	Forward Sequence	Reverse Sequence	Annealing temperature (°C)
mMaCIR13	TCCCAACCCCTGCAA CCACT	ATGACCTGT CG AACATCCTTT	53
mMaCIR307	CACTCTCGCACCATTACGG	CACAAGAATTTGACCCACC	54

Frequency of polymorphic loci in 40 collected banana germplasm with mMaCIR13 primer

The polymorphisms of the collected samples were detected on the basis of presence and absence of the bands of the PCR product with mMaCIR13 primer. Absence of bands may be caused by failure of primers to anneal a site in some individuals due to nucleotide sequence differences or by insertions or deletions in primer sites (Clark and Lanigan, 1993). Results showed that the highest gene frequency was 0.9000 and the lowest gene frequency was 0.1000 (Table 178).

Table 178. Frequency of polymorphic loci of amplified DNA profile of 40 collected banana germplasm with mMaCIR13 primer

Allele/Locus	ACC-1	ACC-2	ACC-3
Allele 0	0.9000	0.2750	0.6500
Allele 1	0.1000	0.7250	0.3500

Genetic Diversity and Frequency of polymorphic loci in 40 collected banana accessions with mMaCIR13 primer

Genetic diversity for the primer mMaCIR13 (Fig. 149) is presented in (Table 179). The mean of Nei's (1973) gene diversity and Shannon's Information index (Lewontin) 1972, in 40 banana accessions were 0.3446 and 0.5202 respectively. Among the accessions highest level of gene diversity was 0.4550 while lowest the gene diversity was 0.1800.

Table 179. Genetic diversity and frequency of polymorphic loci for mMaCIR13 primer in 40 banana germplasm

Locus	Sample Size	na*	ne*	h*	I*
Acc-1	40	2.0000	1.2195	0.1800	0.3251
Acc-2	40	2.0000	1.6632	0.3987	0.5882
Acc-3	40	2.0000	1.8349	0.4550	0.6474
Mean	40	2.0000	1.5725	0.3446	0.5202
St. Dev		0.0000	0.3175	0.1453	0.1716

* na = Observed number of alleles

* ne = Effective number of alleles [Kimura and Crow (1964)]

* h = Nei's (1973) gene diversity

* I = Shannon's Information index [Lewontin (1972)]

Source: Nei's Analysis of Gene Diversity in Subdivided Populations, See Nei (1987) Molecular Evolutionary Genetics (p. 187-192).

Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR13 primer

Gene diversity Nei's analysis in the 40 banana accession estimated the gene flow (Nm) value (Table 180). Hardy-Weinberg expectation of average heterozygosity (Ht) in the accession was 0.3446 while obtained average heterozygosity (Hs) of Hardy-Weinberg for those accessions was 0.0000. The highest level of co-efficient of gene differentiation was 1.0000. High degree of differentiation of isolates supported the presence of sufficient polymorphisms in the isolates.

Table 180. Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR13 primer

Locus	Sample Size	Ht	Hs	Gst	Nm*
Acc-1	40	0.1800	0.0000	1.0000	0.0000
Acc-2	40	0.3987	0.0000	1.0000	0.0000
Acc-3	40	0.4550	0.0000	1.0000	0.0000
Mean	40	0.3446	0.0000	1.0000	0.0000
St. Dev		0.0211	0.0000		

Ht: Hardy-Weinberg average heterozygosity expected in isolates

Hs: Hardy-Weinberg average heterozygosity obtained in isolates

Gst: Co-efficient of gene differentiation

Nm = estimate of gene flow from Gst or Gcs. E.g., $Nm = 0.5(1 - Gst)/Gst$;

See McDermott and McDonald, Ann. Rev. Phytopathol. 31:353-373 (1993).

The number of polymorphic loci is: 3

The percentage of polymorphic loci is: 100.00

Source: Nei's Original Measures of Genetic Identity and Genetic distance, See Nei (1972) Am. Nat. 106:283-292).

Frequency of polymorphic loci in 40 collected banana germplasm with mMaCIR307 primer

On the basis of presence and absence of the bands of the PCR product with mMaCIR307 primer (Fig. 150), the polymorphisms of the collected samples were detected. Absence of bands may be caused by failure of primers to anneal a site in some individuals due to nucleotide sequence differences or by insertions or deletions in primer sites (Clark and Lanigan, 1993). Results showed that the highest gene frequency was 0.6750 and the lowest gene frequency was 0.3250 (Table 181).

Table 181. Frequency of polymorphic loci of amplified DNA profile of 40 banana germplasm with mMaCIR307 primer

Allele/Locus	ACC-1	ACC-2
Allele 0	0.3250	0.3250
Allele 1	0.6750	0.6750

Genetic Diversity and Frequency of polymorphic loci in 40 collected banana germplasm with mMaCIR307 primer.

Genetic diversity for the primer mMa CIR307 (Fig.151) is presented in (Table 182). The mean of Nei's (1973) gene diversity and Shannon's Information index (Lewontin) 1972, in 40 banana accessions were 0.4387 and 0.6306 respectively. Among the accession highest and lowest level of gene diversity was same (0.4387).

Table 182. Genetic diversity and frequency of polymorphic loci for mMaCIR307 primer in 40 banana germplasm

Locus	Sample Size	na*	ne*	h*	I*
Acc-1	40	2.0000	1.7817	0.4387	0.6306
Acc-2	40	2.0000	1.7817	0.4387	0.6306
Mean	40	2.0000	1.7817	0.4387	0.6306
St. Dev		0.0000	0.0000	0.0000	0.0000

* na = Observed number of alleles

* ne = Effective number of alleles [Kimura and Crow (1964)]

* h = Nei's (1973) gene diversity

* I = Shannon's Information index [Lewontin (1972)]

Source: Nei's Analysis of Gene Diversity in Subdivided Populations, See Nei (1987) Molecular Evolutionary Genetics (p. 187-192).

Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR307 primer

Gene diversity Nei's analysis in the 40 banana accession estimated the gene flow (Nm) value (Table 183). Hardy-Weinberg expectation of average heterozygosity (Ht) in the accession was 0.4387 while obtained average heterozygosity (Hs) of Hardy-Weinberg for those accessions was 0.0000. The highest level of co-efficient of gene differentiation was 1.0000. High degree of differentiation of isolates supported the presence of sufficient polymorphisms in the isolates.

Table 183. Gene flow and co-efficient gene differentiation in 40 banana germplasm for mMaCIR307 primer

Locus	Sample Size	Ht	Hs	Gst	Nm*
Acc-1	40	0.4387	0.0000	1.0000	0.0000
Acc-2	40	0.4387	0.0000	1.0000	0.0000
Mean	40	0.4387	0.0000	1.0000	0.0000
St. Dev		0.0000	0.0000		

Ht: Hardy-Weinberg average heterozygosity expected in isolates

Hs: Hardy-Weinberg average heterozygosity obtained in isolates

Gst: Co-efficient of gene differentiation

Nm = estimate of gene flow from Gst or Gcs. E.g., $Nm = 0.5(1 - Gst)/Gst$;

See McDermott and McDonald, Ann. Rev. Phytopathol. 31:353-373 (1993).

The number of polymorphic loci is: 3

The percentage of polymorphic loci is: 100.00

Source: Nei's Original Measures of Genetic Identity and Genetic distance, See Nei (1972) Am. Nat. 106:283-292).

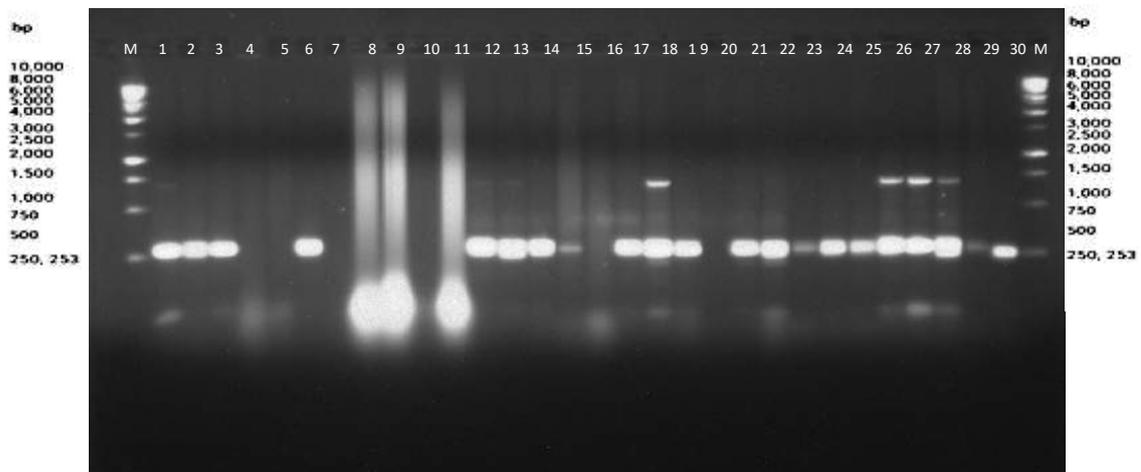


Fig.149. Microsatellite profiles of 30 banana accession with primer mMaCIR13

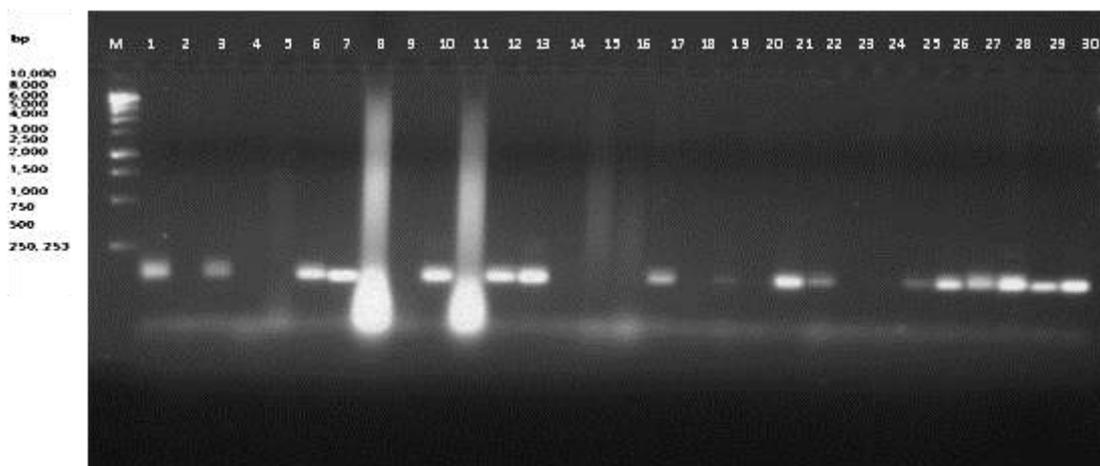


Fig.150. Microsatellite profiles of 30 banana germplasm with primer mMaCIR307

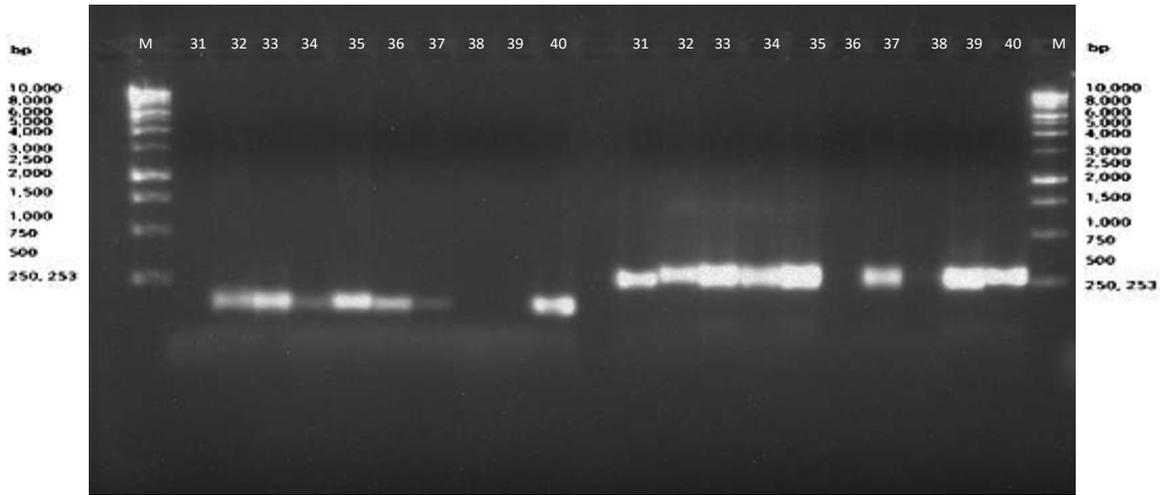


Fig.151. Microsatellite profiles of 10 banana germplasm with primer mMaCIR307 (Left side) and mMaCIR13 (Right side)

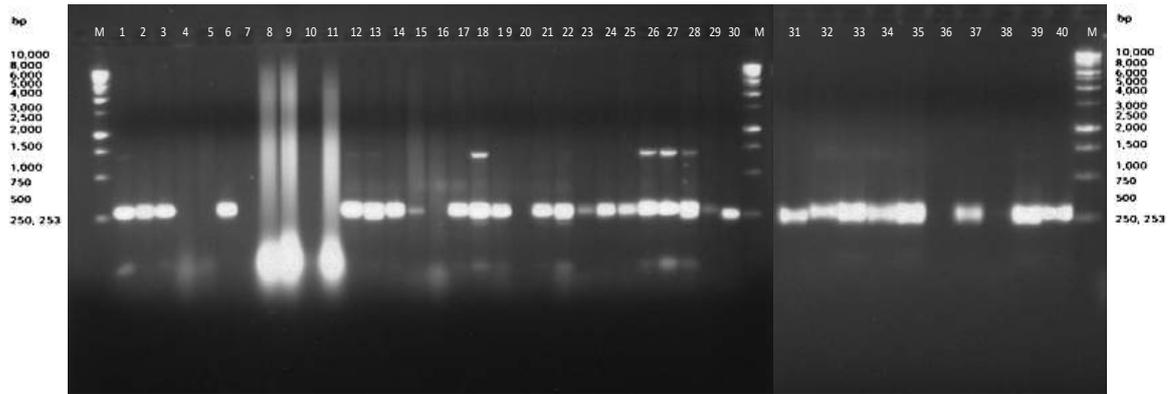


Fig.152. Microsatellite profiles of 40 banana germplasm with primer mMaCIR13

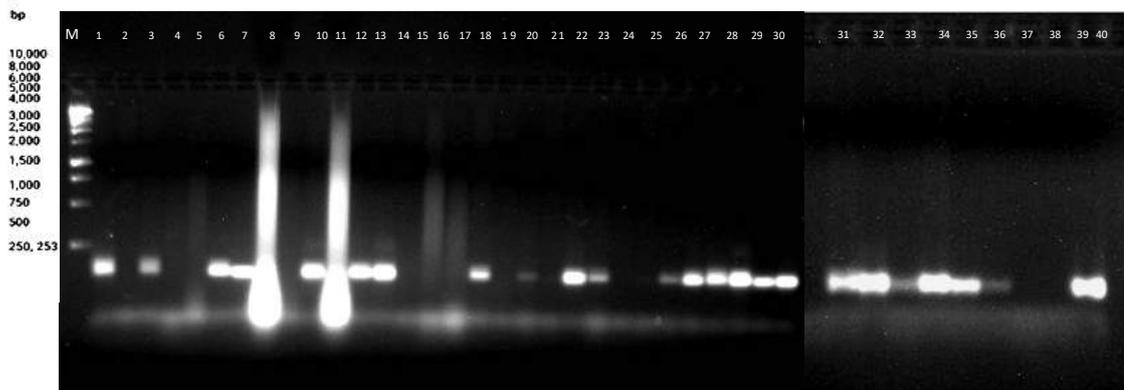


Fig.153. Microsatellite profiles of 40 banana germplasm with primer mMaCIR307

Here,

1 = MS001, 2 = MS004, 3 = MS005, 4 = MS006, 5 = MS009, 6 = MS012, 7 = MS015, 8 = MS017, 9 = MS018, 10 = MS019, 11 = MS020, 12 = MS023, 13 = MS024, 14 = MS025, 15 = MS026, 16 = MS027, 17 = MS028, 18 = MS030, 19 = MS031, 20 = MS032, 21 = MS033, 22 = MS034, 23 = MS036, 24 = MS039, 25 = MS040, 26 = MS041, 27 = MS042, 28 = MS043, 29 = MS046, 30 = MS047, 31 = MS051, 32 = MS058, 33 = MS059, 34 = MS053, 35 = MS054, 36 = MS050, 37 = MS055, 38 = MS007, 39 = MS060, 40 = MS048.

Combined dendrogram of 40 banana germplasm

Dendrogram (Fig. 154) constructed from the combined data matrix obtained from fingerprints of mMaCIR13 (Fig. 152) and mMaCIR307 (Fig. 153) primer was divided into four clusters at 64% similarity level. Among 40 accessions 16, 5, 8 and 11 were placed in cluster I, cluster II, cluster III and cluster IV respectively. It was observed from the dendrogram that samples collected from the same location were placed in different cluster. For example samples collected from Lakkhanpur, Gafargaon; MS023, MS046; MS009 and MS015, MS048 were placed in cluster I, in cluster III and in cluster IV respectively. Similarly samples collected from Dumuria; accessions MS043; MS020 and MS051, MS059 were placed into cluster I, cluster III and cluster IV respectively. Again sample collected from Velabari, Lalmonirhat; MS005 and MS042; MS026 and MS006 were placed into cluster I, cluster II and cluster III respectively. Similarly samples collected from Khagrachari MS001, MS004 and MS007 were placed in cluster I, cluster II and cluster III, respectively.

Table 184. Distribution of 40 banana germplasm in different clusters

Number of cluster	Accession
I	MS001, MS005, MS012, MS023, MS024, MS028, MS030, MS031, MS033, MS034, MS040, MS041, MS042, MS043, MS046, MS047
II	MS004, MS025, MS026, MS036, MS039
III	MS006, MS009, MS017, MS018, MS020, MS027, MS032, MS007
IV	MS015, MS019, MS051, MS058, MS059, MS053, MS054, MS050, MS055, MS060, MS048

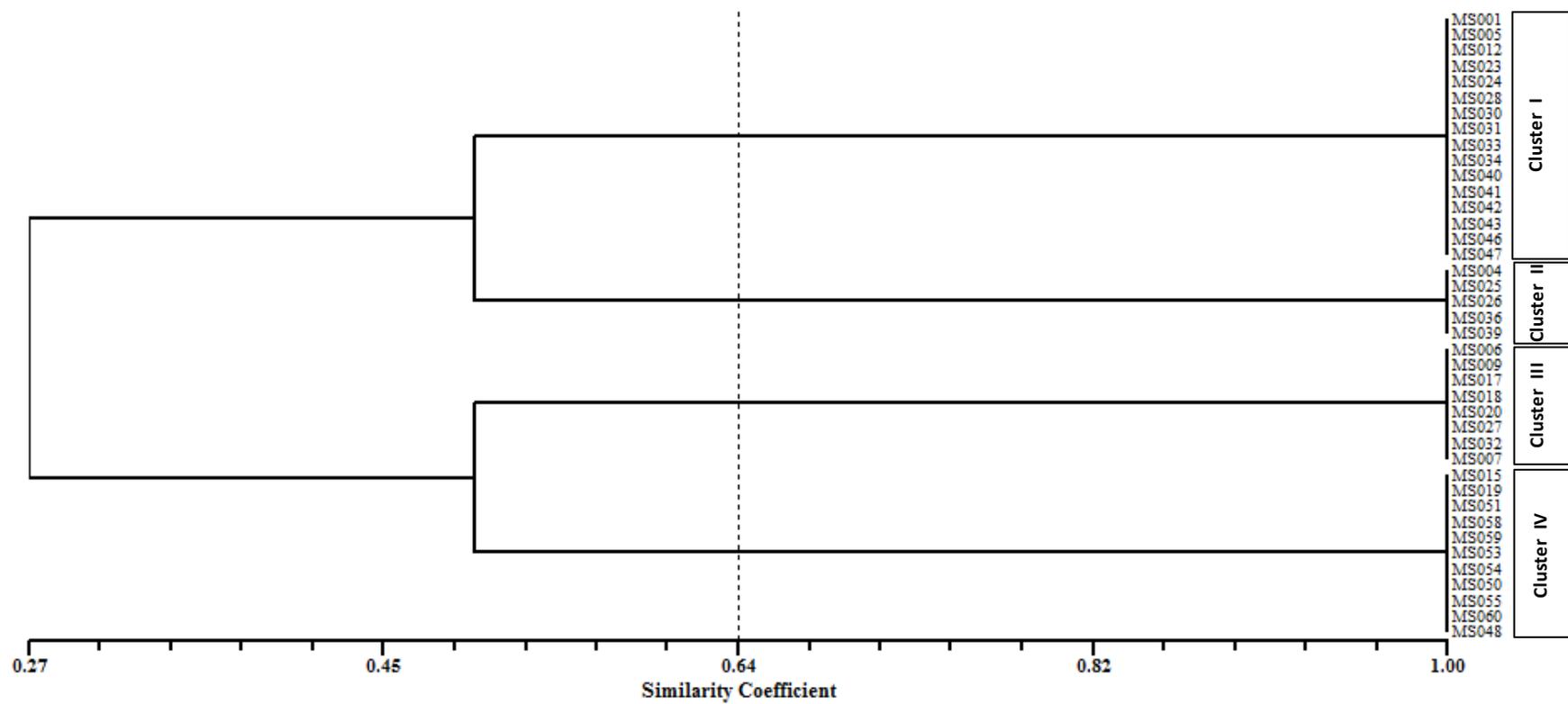


Fig. 154. Combined dendrogram constructed by unweighted pair group method of arithmetic mean (UPGMA) using mMaCIR13 and mMaCIR307 markers

Table 185. Distribution of banana germplasm revealed by cluster analysis of morphological traits, RAPD and SSR markers

Cluster Group Based on Morphological traits		Cluster Group Based on RAPD Markers		Cluster Group Based on SSR Markers	
Number of cluster	Accession (55 nos.)	Number of cluster	Accession (30 nos)	Number of cluster	Accession (40 nos)
I	MS001, MS003, MS012, MS022	I	MS001, MS005, MS003	I	MS001, MS005, MS012, MS023, MS024, MS028, MS030, MS031, MS033, MS034, MS040, MS041, MS042, MS043, MS046, MS047
II	MS002, MS004, MS008, MS009, MS023, MS028, MS034, MS035, MS036, MS037, MS038, MS043	II	MS002, MS014, MS008, MS007	II	MS004, MS025, MS026, MS036, MS039
III	MS005, MS017, MS018, MS020, MS029, MS030, MS031, MS032, MS042	III	MS010, MS016, MS011, MS013	III	MS006, MS009, MS017, MS018, MS020, MS027, MS032, MS007
IV	MS006, MS044, MS050, MS051, MS054, MS055	IV	MS004	IV	MS015, MS019, MS051, MS058, MS059, MS053, MS054, MS050, MS055, MS060, MS048
V	MS007, MS019, MS021, MS027, MS039, MS040	V	MS006, MS009, MS015, MS012		
VI	MS010, MS013, MS026, MS041, MS047, MS052	VI	MS017, MS020, MS018		
VII	MS011, MS014, MS015, MS016, MS024, MS025, MS033, MS046	VII	MS022, MS024, MS027, MS029		
VIII	MS045, MS048, MS049, MS053	VIII	MS019, MS030, MS025, MS021, MS028		
		IX	MS023, MS026		

It appeared from the above Table 185, there were little synchronization of cluster memberships using morphological traits, RAPD and SSR data. In majority cases grouping of banana accessions based on morphological traits did not match with the grouping based on RAPD and SSR markers. It is evident that classifying of different banana accessions based on phenotypic expression on the morphological traits is strongly influenced by the environment. It was also observed from the dendrogram that samples collected from the same location were placed in different cluster.

11.9.5. Morphological Characterization and Evaluation of Aroid Germplasm

In Bangladesh there are wide range of varieties of aroids, some are edible and some are very much wild as distinct by their acidity. Farmers used to cultivate only the edible aroids and on the basis of cultivation practices edible aroids were selected from different localities in the country. In the present research work characterization and evaluation were done for nine cultivars of *Colocasia* (mukhikachu), four cultivars in *Amorphophallus* (olkachu), five in *Alocasia* (maankachu), eleven in *Xanthosoma* (maulavikachu) five in *Colocasia* (stoloniferous panikachu), five panchamukhi and five poidnylkachu. Morphological characterization were done at BAU-GPC following IPGRI/CIP, 2003 descriptors for Taro during February 2018 to January 2021. A marked variation among the collected 45 aroid germplasm in different qualitative and quantitative characters was observed. Different cultivars of aroid are cultivated in Bangladesh with various local names without any uniform identity. Therefore the study on characterization and evaluation of aroid germplasm was undertaken.

A. Qualitative Characterization

Qualitative variations of 13 qualitative characters in aroids are shown in Table 186. Characterization descriptors for the study included: (i) Plant characteristics, (ii) Leaf characteristics, (iii) Inflorescence characteristics, (iv) Stolon characteristics and (v) Corm and cormel characteristics. Wide range of variations were observed within aroids group as well as among the groups in respect of qualitative traits like plant characteristics, leaf characteristics, inflorescence characteristics, stolon characteristics, and corm and cormel characteristics. Growth habit was erect and semi erect for Mukhikachu, Panikachu, Olkachu, Maankachu and Maulavikachu. It was erect for Poidnylkachu and semierect for Panchamukhikachu. Stolon formation was totally absent in all the groups except Panikachu (with stolon only) and Mukhikachu (partly absent). Plant height varied from medium to tall in Mukhikachu, Panchamukhikachu and Olkachu to tall to very tall in Panikachu, Maankachu and Maulavikachu. That of Poidnylkachu was tall. Petiole color varied from light green to dark purple in almost all the groups. Leaf color was deep green in all the Mukhikachu, Olkachu and Maulavikachu genotypes, light green in Panchamukhikachu, light green and dark green in Poidnylkachu, deep green and purple in Panikachu, and yellowish green and deep green in Maankachu. Vein junction color was light green, dark green, light purple, dark purple, whitish, yellowish and yellow in different groups of aroids. Palatability (acceptability) was good and acceptable in almost all the genotypes of all groups except a very few genotypes of Olkachu, Maankachu and Maulavikachu, which were poor in eating quality. Large variations were also recorded for flesh color, corm shape, maturity period, spathe shape and spathe color among the genotypes of different groups.

Table 186. Qualitative descriptors of various aroid groups

Group of Aroid	Growth habit	Stolon formation	Plant height	Petiole colour	Leaf colour	Vein junction colour
1	2	3	4	5	6	7
Mukhi Kachu	Erect, semi erect	Absent, Partly absent	Medium, Tall	Light green, dark green, light green + upper purple	Deep Green	Light green, dark, green, light purple
Panchamukhi	Semi Erect	Absent	Medium, Tall	Light green	Light Green	Light green
Poidnyl Kachu	Erect	Absent	Tall	Dark Green, Dark Purple	Light Green, Dark Green	Dark green, Dark purple
Pani Kachu	Erect, semi erect	With stolon only	Medium, Tall, Very tall	Light green, Dark green, Light green+ Upper purple, dark green + purple	Deep Green, Purple	Light green, Light purple,
Ol Kachu	Erect, semi erect	Absent	Medium, Tall	Light green, dark green	Deep green	Whitish, Yellowish Light green, Dark green
Maan Kachu	Erect, semi erect	Absent	Tall, Very tall	Light green, Dark green, Brown dot spotted	Yellowish green, Deep green	Whitish, Yellow Light green
Maulavi Kachu	Erect, semierect	Absent	Medium, Tall, Very tall	Light green, Dark green, Red purple	Deep green	Light green, Dark, green, Light purple

Table 186. Qualitative descriptors of various aroid groups (Cont'd)

Group of Aroid	Eating quality	Flesh colour	Corm shape	Maturity period	Spathe shape	Spathe colour
1	8	9	10	11	12	13
Mukhi Kachu	Acceptable, Good	White, Slightly pink, Slightly yellow	Conical, Round, Dumb-bell	Intermediate	Hodded	Deep yellow
Panchamukhi	Good	White	Round, more than five eyes	Intermediate	N/A	N/A
Poidnyl Kachu	Good	White	Cylindrical, Elongated	Intermediate	N/A	N/A
Pani Kachu	Acceptable, Good	White	Cylindrical, Elongated	Intermediate, Late	Keeled, flat	Deep yellow
Ol Kachu	Poor quality, Acceptable	White, Slightly Pink	Round, conical, Dumb-shell	Late, Very late	twisted	Purple, White
Maan Kachu	Poor quality, Acceptable	White	Cylindrical, Elongated	Late, Very late	Flat, rolled backward, twisted	Deep Yellow
Maulavi Kachu	Poor quality, Acceptable	White, Yellow, Slightly Purple,	Cylindrical, Elongated	Intermediate, Late	Flat, Hooded, fully open and dropping	Off white, Light yellow, Light purple

The presence of stolon was found to be often associated with undesirable traits such as poor corm shape, poor taste quality and acidity. The colour of the leaves varied from whitish yellow to very dark purple, depending on the genotype. Leaf petioles and leaf laminae did not always have the same colour. The basic colour of the petiole was extremely variable and tremendous variation of the patterns (strip, blotches, dots, patches, etc.) and secondary colour of the petioles were observed. Most of the edible accessions produced corms and cormels except maan kachu and pani kachu which did not show any secondary cormels.

The shape of the primary corm of edible aroids of which in mukhikachu (globular, elliptical, roundish), in panikachu (Dumbell, cylindrical), in olkachu (globose, round) and in maankachu (Cylindrical, dumbell). The variation of leaf shape of edible aroids were also found such as heart shaped, peltate, hastate in mukhikachu and panikachu, sagittate in maulavikachu, peltate to ovate sagittate in maankachu and bipinnated round shape in olkachu. Colour of the corm flesh of edible aroids varied with white, yellowish, brown and whitish. Palatability of cooked starch were tasted with food habit of localized aroid growing farmers through grading by not acceptable, poor and acceptable. Most of edible aroids have food and medicinal values as well as nutrition values.

B. Quantitative Descriptors

Wide ranges of variabilities were observed among the genotypes of all aroid groups in respect of most of the quantitative characters recorded. In case of Mukhikachu coefficient of variation was highest (97.27%) for inflorescence number and lowest (14.26%) for leaf length (Table 187). This indicated that there is wide scope of crop improvement through selection. In case of Panchamukhikachu, quantitative variations were not much wide. Medium variabilities were observed for Panikachu, Poidnylkachu, Maankachu and Olkachu. Quantitative characters of Maulavikachu showed much variation. Coefficient of variation was highest (149.41%) for corm weight closely followed by Inflorescence number (138.28%), peduncle length (137.96 %), spathe breadth (137.89%), inflorescence length (137.68%) and spathe length (137.22%).

Table 187. Quantitative variations in different characters of aroids

Character	Range		Mean	SD	CV (%)
	Min.	Max.			
Mukhikachu (<i>Colocasia</i>)					
Plant height (cm)	87.08	132.16	103.4	15.74	15.22
Petiole length (cm)	40.44	122.88	63.63	23.60	37.10
Leaf number	3.47	7.63	4.39	1.31	29.84
Leaf length (cm)	22.09	35.37	28.77	4.10	14.26
Leaf breadth (cm)	19.29	39.21	25.73	6.26	24.32
Inflorescence number	0.00	4.67	2.13	2.07	97.27
Inflorescence length (cm)	0.00	57.86	29.12	27.83	95.58
Peduncle length (cm)	0.00	30.67	15.43	14.75	95.58
Spathe length (cm)	0.00	24.76	11.93	11.42	95.72
Spathe breadth (cm)	0.00	3.61	1.90	1.81	94.97
Corm length (cm)	3.45	14.06	8.09	3.03	37.46
Corm breadth (cm)	3.88	11.27	6.27	2.18	34.75
Corm weight (g)	47.15	246.48	148.33	84.07	56.68
Cormel Number	0.77	8.00	5.16	2.99	57.86
Cormel Length (cm)	1.48	7.59	4.82	2.33	48.41
Cormel Weight (g)	5.69	143.96	90.98	56.97	62.62
Yield per plant (g or kg)	109.72	362.62	239.31	87.33	36.49
Panchamukhi (<i>Colocasia</i>)					
Plant height (cm)	75.00	95.17	84.00	7.70	9.17
Petiole length (cm)	44.75	65.80	56.75	9.87	17.39
Leaf number	2.67	3.00	2.81	0.14	5.09
Leaf length (cm)	45.06	52.85	47.59	4.02	8.45
Leaf breadth (cm)	23.39	29.25	26.31	2.27	8.65
Sucker number	3.93	4.80	4.24	0.34	7.92
Corm length (cm)	10.00	12.50	11.26	0.89	7.93
Corm breadth (cm)	10.51	12.00	11.27	0.53	4.70
Number of Eye	4.53	5.53	5.07	0.36	7.09
Yield per plant (g)	440.17	661.08	564.72	102.32	18.12

Table 187 (Cont'd)

Character	Range		Mean	SD	CV (%)
	Min.	Max.			
Panikachu (<i>Colocasia</i>)					
Plant height (cm)	54.54	77.31	62.74	8.56	13.64
Petiole length (cm)	20.38	43.17	33.41	11.12	33.27
Leaf number	2.53	5.00	3.60	1.28	35.64
Leaf length (cm)	16.26	25.10	20.25	3.85	19.01
Leaf breadth (cm)	13.69	31.76	21.22	8.44	39.79
Inflorescence number	3.07	4.33	3.53	0.49	13.93
Inflorescence length (cm)	57.98	84.96	73.77	12.19	16.53
Peduncle length (cm)	38.96	60.40	51.15	9.45	18.45
Spathe length (cm)	22.09	30.00	25.71	3.01	11.71
Spathe breadth (cm)	4.16	5.40	4.72	0.45	9.48
Stolon number	4.60	6.47	5.32	0.73	13.68
Rhizome length (cm)	19.55	28.67	23.37	3.62	15.48
Rhizome breadth (cm)	14.24	18.67	16.14	16.17	10.34
Yield per plant (g)	210.00	276.67	220.88	42.09	19.06
Poidnylkachu (<i>Colocasia</i>)					
Plant height (cm)	93.33	124.33	110.37	12.32	11.16
Petiole length (cm)	72.43	106.55	89.51	14.97	16.42
Leaf number	2.67	3.27	3.00	0.26	8.60
Leaf length (cm)	30.67	39.67	35.15	3.57	10.16
Leaf breadth (cm)	29.67	37.00	33.00	2.87	8.70
Corm length (cm)	15.52	23.17	19.05	3.46	18.18
Corm breadth (cm)	10.83	15.89	13.37	2.18	16.34
Corm weight (g)	390.00	648.00	495.85	120.11	24.22
Cormel Number	2.40	3.53	2.87	0.46	16.18
Cormel Length (cm)	8.93	13.15	10.98	1.83	16.64
Cormel breadth (cm)	6.97	10.20	8.61	1.39	16.13
Cormel Weight (g)	128.50	339.42	231.27	100.98	43.66
Yield per plant (g or kg)	518.50	977.67	727.12	218.56	13.06
Maankachu (<i>Alocasia</i>)					
Plant height (cm)	135.00	178.00	151.93	16.29	10.72
Petiole length (cm)	57.28	74.73	65.87	7.17	10.89
Leaf number	2.80	4.00	3.16	0.48	15.19
Leaf length (cm)	55.96	77.22	63.91	8.65	13.54
Leaf breadth (cm)	45.44	63.17	54.59	7.05	12.91
Inflorescence number	3.49	5.40	4.41	0.69	15.57
Inflorescence length (cm)	37.32	57.67	47.13	7.32	15.53
Peduncle length (cm)	15.32	23.67	19.34	3.00	15.53
Spathe length (cm)	21.87	27.67	22.61	3.51	15.53
Spathe breadth (cm)	1.90	2.93	2.40	0.37	15.45
Sucker number	4.33	5.67	5.03	0.64	12.67
Corm length (cm)	24.38	37.67	30.79	4.78	15.53
Corm breadth (cm)	15.10	23.33	19.07	2.96	15.52
Yield per plant (g)	539.32	833.33	681.12	105.77	15.53
Olkachu (<i>Amorphophallus</i>)					
Plant height (cm)	45.00	95.00	76.06	19.56	25.72
Plant breadth (cm)	5.43	11.27	9.22	2.25	24.40
Leaf length (cm)	33.00	82.50	65.05	19.28	29.64
Leaf breadth (cm)	31.82	80.70	63.67	19.14	30.06
Sucker number	1.67	2.13	1.91	0.20	10.63
Corm length (cm)	4.47	21.33	15.49	6.50	41.98
Corm breadth (cm)	5.20	13.00	9.20	3.56	38.75
Yield per plant (g)	119.00	1016.67	623.47	426.41	67.03

Maulavikachu (<i>Xanthosoma</i>)					
Plant height (cm)	58.33	153.33	94.33	32.03	33.95
Petiole length (cm)	25.67	96.67	67.27	10.67	15.86
Leaf number	2.73	6.80	4.20	0.25	8.05
Leaf length (cm)	27.53	81.33	45.77	5.57	16.11
Leaf breadth (cm)	23.18	58.00	36.38	3.72	12.09
Inflorescence number	0.00	4.73	1.71	2.36	138.28
Inflorescence length (cm)	0.00	62.33	19.84	27.32	137.68
Peduncle length (cm)	0.00	38.43	8.38	11.57	137.96
Spathe length (cm)	0.00	24.17	9.21	12.63	137.22
Spathe breadth (cm)	0.00	10.50	3.15	1.41	137.89
Sucker number	1.93	4.87	3.02	0.45	16.63
Corm length (cm)	6.77	50.76	19.65	10.30	69.00
Corm breadth (cm)	4.67	19.78	8.49	0.74	13.75
Corm weight (g)	30.87	1816.67	524.62	167.70	149.41
Cormel number	0.00	12.40	6.62	2.04	69.13
Cormel length (cm)	0.00	17.28	9.06	2.06	56.63
Cormel weight (g)	0.00	355.07	141.55	29.32	79.48
Yield per plant (g)	43.34	2171.73	666.17	872.11	130.92

Morphological characteristics of Mukhi Kachu (*Colocasia esculenta* L. Schott.)

The mean plant height of nine varieties was 103.42 cm. The highest plant height was obtained from Ce-9 (Salad Kachu) (132.16 cm). Among the edible aroids, mukhi kachu plants were short type and attained highest plant height from Ce-2 (Boya) (109.42 cm), followed by Ce-7 (Ban mukhi) (109.08 cm). The lowest plant height (87.08 cm) was observed in Ce-4 (Chara). The mean petiole length of nine varieties was (63.63 cm). Highest petiole length was obtained from Ce-9 (Salad Kachu) (122.88 cm) followed by Ce-8 (Got/Thama) (66.72 cm), Ce-5 (Meherchandi) (61.75 cm). The lowest petiole length (40.44 cm) was observed in CE-7 (Table 188).

Table 188. Quantitative descriptors of nine Mukhi Kachu cultivars

Acc./ collection no.	Plant height (cm)	Petiole length (cm)	Leaf number	Leaf length (cm)	Leaf breadth (cm)	Inflorescence number	Inflorescence length (cm)	Peduncle length (cm)	Spathe length (cm)
1	2	3	4	5	6	7	8	9	10
Ce-1	106.71	54.03	3.94	30.49	20.47	4.39	54.81	29.05	24.76
Ce-2	109.42	61.74	3.63	27.95	23.42	4.67	57.86	30.67	22.50
Ce-3	104.92	61.72	4.20	26.62	23.64	3.38	45.10	23.90	20.32
Ce-4	87.08	51.25	3.95	22.09	19.29	0.00	0.00	0.00	0.00
Ce-5	76.49	61.75	3.47	23.99	21.09	0.00	0.00	0.00	0.00
Ce-6	96.11	51.80	4.14	29.46	26.15	0.00	0.00	0.00	0.00
Ce-7	109.08	40.44	5.07	31.24	31.10	3.47	50.97	27.01	19.48
Ce-8	108.81	66.72	3.47	31.72	27.20	3.26	53.34	28.27	20.32
Ce-9	132.16	122.88	7.63	35.37	39.21	0.00	0.00	0.00	0.00
Mean	103.42	63.63	4.39	28.77	25.73	2.13	29.12	15.43	11.93
LSD _(0.05)	5.23	2.646	0.379	1.516	9.312	0.244	2.934	1.987	0.876

Table 188. Quantitative descriptors of nine Mukhi Kachu cultivars (Cont'd)

Acc./ collection no.	Spathe breadth (cm)	Corm length (cm)	Corm breadth (cm)	Corm weight (g)	Cormel number	Cormel nength (cm)	Cormel weight (g)	Yield per plant (g)
1	11	12	13	14	15	16	17	18
Ce-1	3.40	9.53	6.43	214.07	7.42	6.64	133.46	347.53
Ce-2	3.42	9.37	6.34	218.87	7.98	7.59	143.75	362.62
Ce-3	3.28	3.45	4.68	47.15	3.48	2.55	62.57	109.72
Ce-4	0.00	5.33	3.88	54.82	7.50	5.37	134.97	189.79
Ce-5	0.00	6.77	4.47	62.48	3.84	6.40	69.09	131.58
Ce-6	0.00	7.53	7.08	86.30	8.00	6.43	143.96	230.26
Ce-7	3.43	7.22	6.75	174.42	6.64	5.32	119.54	293.96
Ce-8	3.61	14.06	11.27	246.48	0.77	1.57	5.69	252.17
Ce-9	0.00	9.56	5.52	230.38	0.83	1.48	5.79	236.17
Mean	1.91	8.09	6.27	148.33	5.16	4.82	90.98	239.31
LSD (0.05)	1.77	2.36	0.54	1.03	1.27	0.27	0.63	0.29

The mean leaf number of nine varieties was 4.39. Highest plant height was obtained from Ce-9 (Salad Kachu) (7.63) followed by Ce-7 (Ban mukhi) (5.07) and the lowest plant height (3.47) was observed in Ce-5 (Meherchandi) and Ce-8 (Got/Thama). The mean leaf length of nine varieties was 28.77 cm. Highest plant height was obtained from Ce-9 (Salad Kachu) (35.37) followed by Ce-8 (Got/Thama) (31.72 cm) and the lowest plant height (22.09 cm) was observed in Ce-4 (Chara). The mean leaf breadth of nine varieties was 25.73 cm. Highest leaf breadth was obtained from Ce-9 (Salad Kachu) (39.21 cm). Among the edible aroids of mukhi kachu the highest leaf breadth was recorded in Ce-7 (Ban mukhi) (31.10 cm), followed by Ce-8 (Got/Thama) (27.20 cm) and the lowest leaf breadth (19.29 cm) was observed in Ce-4 (Chara) (Table 188).

The mean inflorescence number of nine varieties was 2.13. Among the edible aroids of mukhi kachu the highest inflorescence number from Ce-2 (Boya) (4.67), followed by Ce-1 (Poitta) (4.39 cm) and the lowest inflorescence number (3.26 cm) was observed in Ce-8 (Got/Thama). The mean inflorescence length of nine varieties was 29.12 cm. The highest inflorescence length was obtained from Ce-2 (Boya) (57.86 cm) and the lowest inflorescence length (45.10 cm) was observed in Ce-3 (Veradosa) (Table 188).

The mean peduncle length of nine varieties was 15.43 cm. The highest peduncle length was obtained from Ce-2 (Boya) (30.67 cm) and the lowest peduncle length (23.9 cm) was observed in Ce-3 (Veradosa). The mean spathe length of nine varieties were (11.93 cm). The highest spathe length was obtained from Ce-1 (Poitta) (24.76 cm) and the lowest spathe length (19.48 cm) was observed in Ce-7 (Ban Mukhi). The mean spathe breadth of nine varieties was (1.91 cm). The highest spathe breadth was obtained from Ce-8 (Got/Thama) (3.61 cm) and the lowest spathe breadth (3.28 cm) was observed in Ce-3 (Veradosa) (Table 188).

The mean corm length of nine varieties was (8.09 cm). The highest corm length was obtained from Ce-8 (Boya) (14.06 cm) and the lowest corm length (3.45 cm) was observed in Ce-3 (Veradosa). The mean corm breadth of nine varieties was (6.27 cm). The highest corm breadth was obtained from Ce-8 (Got/Thama) (11.27 cm) and the lowest corm breadth (3.88 cm) was observed in Ce-4 (Chara). The mean corm weight of nine varieties was (148.33 g). The highest corm weight was obtained from Ce-8 (Got/Thama) (246.48 g) and the lowest corm weight (47.15 g) was observed in Ce-3 (Veradosa) (Table 188).

The mean cormel number of nine varieties was (5.16). Highest cormel number was obtained from Ce-6 (Iswardi Muk) (8.00) and the lowest cormel number (0.77) was observed in Ce-8 (Got/Thama). The mean cormel length of nine varieties was 4.82 cm. Highest cormel length was obtained from Ce-2 (Boya) (7.59 cm) and the lowest cormel length (1.48 cm) was observed in Ce-9 (Salad Kachu). The mean cormel weight of nine varieties was (90.98 g). Highest cormel weight was obtained from Ce-2 (Boya) (143.75 g) and the lowest cormel weight (5.69 g) was observed in Ce-8 (Got/Thama) (Table 188).

The mean yield per plant of nine varieties was (239.31 g). The highest yield per plant was obtained from Ce-2 (Boya) (362.62 g) and the lowest yield per plant (109.72 g) was observed in Ce-3 (Veradosa) (Table 188).

			
Banmuki Plant	Chara Mukhi Plant	Poitta Plant	Iswardy Plant
			
Banmuki Leaf	Chara Mukhi Leaf	Poitta Leaf	Iswardy Leaf
			
Banmuki Petiole	Chara Mukhi Petiole	Poitta Petiole	Iswardy Petiole
			
Banmuki Folwer	Chara Mukhi Folwer	Poitta Folwer	Iswardy Folwer
			
Banmuki Root	Chara Mukhi Root	Poitta Root	Iswardy corm and cormel

Fig. 155. Leaf, flower and root of different mukhi kachu

			
Charamukhi Plant	Boya Plant	Thama Plant	Charamukhi Leaf
			
Boya Leaf	Thama Leaf	Charamukhi Petiole	Boya Petiole
			
Thama Petiole	Boya Flower	Thama Flower	Charamukhi Harvest
			
Boya Harvest	Thama Harvest	Charamukhi Root	Boya Root
			
Thama Root			

Cont'd. Fig. 155. Leaf, flower and root of different mukhi kachu

Morphological Characterization of 5 Panchamukhi Kachu cultivars

The plant height mean of five varieties was 84.00 cm. The highest plant height was obtained from Ce-11 (Gazipur) (95.17 cm) followed by Ce-10 (Madhupur) (87.50 cm) and the lowest plant height (75.00 cm) was observed in Ce-12 (Bandarban). The petiole length mean of five varieties was 56.75 cm. The highest petiole length was obtained from Ce-13 (Dumuria) (65.80 cm) followed by Ce-11 (Gazipur) (64.07 cm) and the lowest petiole length (44.75 cm) was observed in Ce-14 (Tangail). The leaf number mean of five varieties was 2.81. The highest leaf number was obtained from Ce-10 (Madhupur) (3.00) and the lowest leaf number (2.67) was observed in Ce-12 (Bandarban) and Ce-14 (Tangail) (Table 189 and Fig. 156).

Table 189. Growth Performance of five Panchamukhi Kachu cultivars

Acc. no.	Plant height (cm)	Petiole length (cm)	Leaf number	Leaf length (cm)	Leaf breadth (cm)	No. of suker	Corm length (cm)	Corm breadth (cm)	Number of eye	Yield / plant (g)
Ce 10	87.50	47.47	3.00	45.06	29.25	4.80	12.50	12.00	5.53	661.08
Ce 11	95.17	64.07	2.87	48.00	26.39	4.13	11.17	11.33	5.13	631.00
Ce 12	75.00	61.66	2.67	49.58	23.39	3.93	10.00	10.51	4.53	440.17
Ce 13	79.95	65.80	2.87	52.85	24.93	4.27	11.48	11.19	5.13	468.33
Ce 15	82.37	44.75	2.67	42.45	27.58	4.07	11.17	11.32	5.00	623.00
Mean	84.00	56.75	2.81	47.59	26.31	4.24	11.26	11.27	5.07	564.72
LSD (0.05)	3.25	1.362	0.073	1.496	1.231	0.150	0.523	0.550	0.100	19.62

The leaf length mean of five varieties was 47.59 cm. The highest leaf length was obtained from Ce-13 (Dumuria) (52.85 cm) followed by Ce-12 (Bandarban) (49.58 cm) and the lowest leaf length (45.06 cm) was observed in Ce-10 (Madhupur). The leaf breadth mean of five varieties was 26.31 cm. The highest leaf breadth was obtained from Ce-10 (Madhupur) (29.25cm) followed by Ce-14 (Tangail) (27.58 cm) and the lowest leaf breadth (23.39 cm) was observed in Ce-12 (Bandarban) (Table 189).

The sucker number mean of five varieties was 4.24 cm. The highest sucker number was obtained from Ce-10 (Madhupur) (4.80) followed by Ce-13 (Dumuria) (4.27) and the lowest sucker number (3.93) were observed in Ce-12 (Bandarban). The corm length mean of five varieties was 11.26 cm. The highest corm length was obtained from Ce-10 (Madhupur) (12.50 cm) followed by Ce-13 (Dumuria) (11.48 cm) and the lowest corm length (10.00 cm) was observed in Ce-12 (Bandarban).

The corm breadth mean of five varieties was 11.27 cm. The highest corm breadth was obtained from Ce-10 (Madhupur) (12.00 cm) followed by Ce-11 (Gazipur) (11.33 cm) and the lowest corm breadth (10.51 cm) was observed in Ce-12 (Bandarban). The number of eye per plant mean of five varieties was 5.07. The highest number of eye per plant was obtained from Ce-10 (Madhupur) (5.53) followed by Ce-11 (Gazipur, Dumuria) (5.13) and the lowest number of eye per plant (4.53) was observed in Ce-12 (Bandarban) (Table 189).

The yield per plant mean of five varieties was 564.72 cm. The highest yield per plant was obtained from Ce-10 (Madhupur) (661.08 g) followed by Ce-11 (Gazipur) (631.00 g) and the lowest yield per plant (440.17 g) was observed in Ce-12 (Bandarban). Yield (g plant^{-1}) of test 5 cultivars of Panchamukhi kachu collected from different locations is shown in (Table 189).

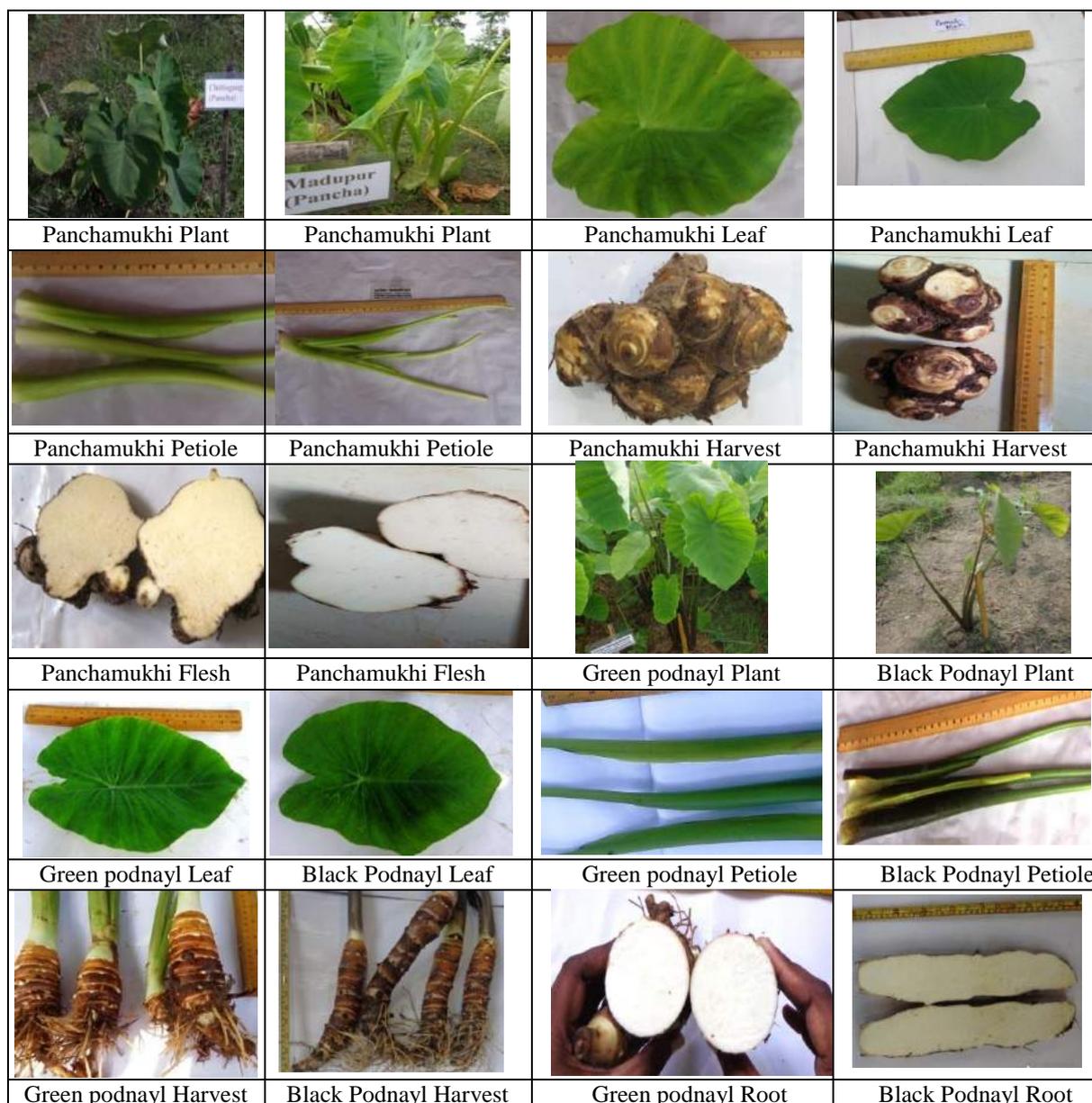


Fig. 156. Variation in plant parts of *C. esculenta* L.

Morphological characteristics of 5 Pani Kachu cultivars

The mean plant height of five varieties was 62.74 cm. The highest plant height was obtained from Ce-15 (Pani-green) (77.31 cm) followed by Ce17 (Pani-purple) (60.66). The lowest plant height (54.54 cm) was observed in Ce-19 (Pani-brown strip).

The mean petiole length of five varieties was 33.41 cm. The highest petiole length was obtained from Ce-15 (Pani-green) (43.17 cm) followed by Ce18 (Pani-pink) (43.17 cm). The lowest petiole length (20.38 cm) was observed in Ce-19 (Pani-brown strip). The mean leaf number of five varieties was 3.60. The highest leaf number was obtained from Ce-15 (Pani-green) and Ce-18 (Pani-pink) (5.00). The lowest leaf number (2.53) was observed in Ce-19 (Pani-brown strip). The mean leaf length of five varieties was 20.25 cm. Maximum leaf length was obtained from Ce-15 (Pani-green) (25.10 cm) followed by Ce18 (Pani-pink) (23.41 cm). The lowest leaf length (16.26 cm) was observed in Ce-18 (Pani-pink). The mean petiole length of five varieties was 21.22 cm. The highest petiole length was obtained from Ce-16 (Pani-brown) (31.76 cm). The lowest petiole length (13.69 cm) was observed in Ce-18 (Pani-brown strip) (Table 190).

Table 190. Growth Performance of five Pani Kachu cultivars

Acc. no.	Plant height (cm)	Petiole length (cm)	Leaf no.	Leaf length (cm)	Leaf breadth (cm)	Inflorescence no.	Inflorescence length (cm)
1	2	3	4	5	6	7	8
Ce-15	77.31	43.17	5.00	25.10	14.99	3.47	76.51
Ce-16	60.60	22.65	2.73	19.21	31.76	3.60	64.43
Ce-17	60.66	37.69	2.73	23.41	16.77	4.33	84.96
Ce-18	60.58	43.17	5.00	16.26	13.69	3.07	84.96
Ce-19	54.54	20.38	2.53	17.29	28.88	3.20	57.98
Mean	62.74	33.41	3.60	20.25	21.22	3.53	73.77
LSD (0.05)	3.51	1.71	0.16	1.09	1.83	0.25	4.19

Table 190. Growth Performance of five Pani Kachu cultivars (Cont'd)

Acc. no.	Peduncle length	Spa-the length	Spa-the breadth	No. of stolon	Rhizome length	Rhizome breadth	Yield per plant (g)
1	9	10	11	12	13	14	15
Ce-15	55.37	30.00	5.40	6.47	28.67	18.67	276.67
Ce-16	43.29	26.37	4.62	5.33	23.00	16.73	210.00
Ce-17	60.40	22.09	4.78	5.40	24.93	15.58	251.77
Ce-18	57.73	26.37	4.62	4.60	19.55	14.24	178.73
Ce-19	38.96	23.74	4.16	4.80	20.70	15.46	187.33
Mean	51.15	25.71	4.72	5.32	23.37	16.14	220.90
LSD (0.05)	2.41	1.45	0.17	0.25	1.69	1.15	8.75

The mean inflorescence number of five varieties was 3.53. The highest inflorescence number was obtained from Ce-17 (Pani-purple) (4.33). The lowest inflorescence number (3.07) was observed in Ce-18 (Pani-pink strip). The mean inflorescence length of five varieties was 73.77 cm. The highest inflorescence length was obtained from Ce-17 (Pani-purple) (84.96 cm) followed by Ce-18 (Pani-pink) (84.96 cm). The lowest inflorescence length (57.98 cm) was observed in Ce-19 (Pani-brown strip). The mean peduncle length of five varieties was 51.15 cm. The highest peduncle length was obtained from Ce-17 (Pani-purple) (60.40 cm) followed by Ce-18 (Pani-pink) (57.73 cm). The lowest peduncle length (38.96 cm) was observed in Ce-19 (Pani-brown strip) (Table 190).

The mean spathe length of five varieties was 25.71 cm. The highest spathe length was obtained from Ce-15 (Pani-green) (30.00 cm). The lowest spathe length (22.09 cm) was observed in Ce-17 (Pani-purple strip). The mean spathe breadth of five varieties was 4.72 cm. The highest spathe breadth was obtained from Ce-15 (Pani-green) (5.40 cm). The lowest spathe breadth (4.16 cm) was observed in Ce-19 (Pani-brown strip). The mean stolon number of five varieties was 5.32. The highest stolon number was obtained from Ce-15 (Pani-green) (6.47). The lowest stolon number (4.60) was observed in Ce-18 (Pani-pink strip) (Table 190).

The mean rhizome length of five varieties was 23.37 cm. The highest rhizome length was obtained from Ce-15 (Pani-green) (28.67 cm). The lowest rhizome length (19.55 cm) was observed in Ce-18 (Pani-pink strip). The mean rhizome breadth of five varieties was 16.14 cm. The highest rhizome breadth was obtained from Ce-15 (Pani-green) (18.67 cm) cm. The lowest rhizome breadth (14.24 cm) was observed in CE-18 (Pani-pink strip) (Table 190).

The mean yield per plant of five varieties was 220.88 g. The highest yield per plant was obtained from Ce-15 pani green (276.67 g) and the lowest yield per plant was observed in Ce-18 Pani brown (178.73 g). Yield (g plant⁻¹) of test 5 cultivars of Pani kachu is shown in (Table 190).

			
Ce-15 Plant	Ce-16 Plant	Ce-15 Leaf	Ce-16 Leaf
			
Ce-15 Petiole	Ce-16 Petiole	Ce-15 Flower	Ce-15 Rhizome
			
Ce-16 Rhizome	Ce-15 Flesh Color	Ce-16 Flesh Color	Ce-17 Plant
			
Ce-18 Plant	Ce-19 Plant	Ce-17 Leaf	Ce-18 Leaf
			
Ce-19 Leaf	Ce-16 Flower	Ce-17 Flower	Ce-18 Flower
			
Ce-17 Petiole	Ce-18 Petiole	Ce-19 Petiole	Ce-16 Rhizome
			
Ce-17 Rhizome	Ce-19 Rhizome	Ce-16 Flesh color	Ce-17 Flesh color
			
Ce-18 Flesh color			

Fig. 157. Morphological variation of different plant parts of Pani Kachu

Morphological characteristics of five Poidnyl Kachu cultivars

The mean plant height of five varieties was 110.37 cm. The highest plant height was obtained from CE-22 (Poidnyl- Black-M) (124.33 cm) followed by CE-21 (Poidnyl- black-G) (120.00 cm). The lowest plant height (93.33 cm) was observed in CE-20 (Poidnyl- green). The mean petiole length of five varieties was 89.51 cm. The highest petiole length was obtained from Ce-22 (Poidnyl- Black-M) (106.55 cm) followed by Ce-23 (Poidnyl- black-G) (102.28 cm). The lowest petiole length (72.43 cm) was observed in CE-20 (Poidnyl- green). The mean leaf number of five varieties was 3.00. The highest leaf number was obtained from Ce-24 (Poidnyl-green-T) (3.27) followed by Ce-22 (Poidnyl- black-M) (3.20). The lowest leaf number (2.67) was observed in Ce-23 (Poidnyl- black-T). The mean leaf length of five varieties was 35.15 cm. The highest leaf length was obtained from Ce-22 (Poidnyl- Black-M) (39.67 cm) followed by Ce-21 (Poidnyl- black-G) (37.33 cm). The lowest leaf length (30.67 cm) was observed in Ce-20 (Poidnyl- green). The mean leaf breadth of five varieties was 33.00 cm. The highest leaf breadth was obtained from Ce-22 (Poidnyl- Black-M) (37.00 cm) followed by Ce-23 (Poidnyl- black-T) (34.33 cm). The lowest leaf breadth (29.67 cm) was observed in Ce-20 (Poidnyl- green) (Table 191).

Table 191. Growth performance of five Poidnyl Kachu cultivars

Acc. no.	Plant height (cm)	Petiole length (cm)	Leaf no.	Leaf length (cm)	Leaf breadth (cm)	Corm length (cm)	Corm breadth (cm)
1	2	3	4	5	6	7	8
CE-20	93.33	72.43	3.07	30.67	29.67	15.52	10.83
CE-21	120.00	88.06	2.80	37.33	33.00	17.97	13.13
CE-22	124.33	106.55	3.20	39.67	37.00	23.17	15.89
CE-23	105.15	102.28	2.67	35.33	34.33	22.25	15.25
CE-24	109.05	78.22	3.27	32.76	30.98	16.37	11.73
Mean	110.37	89.51	3.00	35.15	33.00	19.05	13.37
LSD(0.05)	5.89	2.42	0.19	1.53	1.67	1.05	1.34

Table 191. Growth performance of five Poidnyl Kachu cultivars (Cont'd)

Acc. no.	Corm weight (g)	Cormel no.	Cormel length (cm)	Cormel breadth (cm)	Cormel wt. (g)	Yield per plant (g)
1	9	10	11	12	13	14
CE-20	390.00	2.40	8.93	6.97	128.50	518.50
CE-21	431.00	2.73	10.50	8.47	221.00	652.00
CE-22	648.00	3.53	13.15	10.20	329.67	977.67
CE-23	602.53	3.13	12.60	9.82	339.42	941.95
CE-24	407.73	2.53	9.72	7.60	137.77	545.50
Mean	495.85	2.87	10.98	8.61	231.27	727.12
LSD(0.05)	10.86	0.40	0.63	0.82	8.22	12.98

The mean corm length of five varieties was 19.05 cm. the highest corm length was obtained from Ce-22 (poidnyl- black-M) (23.17 cm) followed by Ce-23 (poidnyl- black-T) (22.25 cm). The lowest corm length (15.52 cm) was observed in Ce-20 (Poidnyl- green). The mean corm breadth of five varieties was 13.37 cm. The highest corm breadth was obtained from Ce-22 (poidnyl- black-M) (15.89 cm) followed by Ce-23 (Poidnyl- black-T) (15.25 cm). The lowest corm breadth (10.83 cm) was observed in Ce-20 (poidnyl- green). The mean corm weight of five varieties was 495.85 g. The highest corm weight was obtained from Ce-22 (Poidnyl-black-M) (648.00 g) followed by Ce-23 (Poidnyl- black-T) (602.53 g). The lowest corm weight (390.00 g) was observed in Ce-20 (Poidnyl- green) (Table 191).

The mean cormel number of five varieties was 2.87. The highest cormel number was obtained from Ce-22 (Poidnyl- Black-M) (3.53) followed by CE-23 (Poidnyl- black-T) (3.13). The lowest cormel number (2.40) was observed in Ce-20 (Poidnyl- green). The mean cormel length of five varieties was 10.98 cm. The highest cormel length was obtained from Ce-22 (Poidnyl- Black-M) (13.15 cm) followed by Ce-21 (Poidnyl- black-T) (12.60 cm). The lowest cormel length (8.93 cm) was observed in Ce-20 (Poidnyl- green). The mean cormel breath of five varieties was 8.61 cm. The highest cormel breath was obtained from Ce-22 (Poidnyl-Black-M) (10.20 cm) followed by Ce-23 (Poidnyl- black-T) (9.82 cm). The lowest cormel breath (6.97 cm) was observed in Ce-20 (Poidnyl- green) (Table 191).

The mean cormel weight of five varieties was 231.27 g. The highest cormel weight was obtained from Ce-23 (Poidnyl- Black-T) (339.42 g) followed by Ce-22 (Poidnyl- black-M) (329.67 g). The lowest cormel weight (128.50 g) was observed in Ce-20 (Poidnyl- green). The mean yield per plant of five varieties was 727.12 g. The highest yield per plant was obtained from Ce-22 (Poidnyl- Black-M) (977.67 g) followed by Ce-23 (Poidnyl- black-T) (941.95 g). The lowest yield per plant (518.50 g) was observed in Ce-20 (Poidnyl- green) (Table 191).

Morphological characteristics of five *Alocasia* cultivars

The plant height mean of five varieties was 151.93 cm. The highest plant height was obtained from Ai-5 (178.00 cm) and the lowest plant height (135.00 cm) was observed in Ai-4 (Bhola). The petiole length mean of five varieties was 65.87 cm. The highest petiole length was obtained from Ai-2 (74.73 cm) and the lowest petiole length (57.28 cm) was observed in Ai-1 (Khulna). The leaf number mean of five varieties was 3.16. The highest leaf number was obtained from Ai-2 (4.00, Shatkhira) and the lowest leaf number (2.80) was observed in Ai-4 (Bhola). The leaf length mean of five varieties was 63.91 cm. The highest leaf length was obtained from Ai-5 (Trishal) (77.22 cm) and the lowest leaf length (55.96 cm) was observed in Ai-3 (Jashore). The leaf breadth mean of five varieties was 54.59 cm. The highest leaf breadth was obtained from Ai-5 (Trishal) (63.17 cm) and the lowest leaf breadth (45.44 cm) was observed in Ai-1 (Khulna) (Table 192).

Table 192. Growth performance of five *Alocasia* cultivars

Acc. no.	Plant height (cm)	Petiole length (cm)	Leaf number	Leaf length (cm)	Leaf breadth (cm)	Inflorescence number	Inflorescence length (cm)
1	2	3	4	5	6	7	8
Ai-1	151.00	57.28	3.07	57.59	45.44	4.27	45.59
Ai-2	142.33	74.73	4.00	67.43	57.30	4.59	49.02
Ai-2	153.33	62.94	3.00	55.96	49.55	4.31	46.08
Ai-4	135.00	62.64	2.80	61.33	57.50	3.49	37.32
Ai-5	178.00	71.74	2.93	77.22	63.17	5.40	57.67
Mean	151.93	65.87	3.16	63.91	54.59	4.41	47.13
LSD _(0.05)	7.65	5.07	0.32	9.66	3.99	0.32	4.19

Table 192. Growth performance of five *Alocasia* cultivars (Cont'd)

Acc. no.	Peduncle length (cm)	Spathe length (cm)	Spathe breadth (cm)	Sucker no.	Corm length (cm)	Corm breadth (cm)	Yield / plant (g)
1	9	10	11	12	13	14	15
Ai-1	18.71	21.87	2.32	5.67	29.78	18.44	658.75
Ai-2	20.12	23.52	2.50	4.33	32.02	19.83	708.33
Ai-2	18.91	22.11	2.35	5.67	30.09	18.65	665.83
Ai-4	15.32	17.91	1.90	4.47	24.38	15.10	539.32
Ai-5	23.67	27.67	2.93	5.00	37.67	23.33	833.33
Mean	19.34	22.61	2.40	5.03	30.79	19.07	681.11
LSD (0.05)	3.36	4.20	0.84	0.80	0.98	2.36	40.89

The mean inflorescence number of five varieties was 4.41. The highest inflorescence number was obtained from Ai-5 (Trishal) (5.40) followed by Ai-2 (Shatkhira) (4.59). The lowest inflorescence number (3.49) was observed in Ai-4 (Bhola). The mean inflorescence length of five varieties was 47.13 cm. The highest Inflorescence length was obtained from Ai-5 (Trishal) (57.67 cm). The lowest inflorescence length (37.32 cm) was observed in Ai-4 (Bhola). The mean peduncle length of five varieties was 19.34 cm. The highest peduncle length was obtained from Ai-5 (Trishal) (23.67 cm). The lowest peduncle length (15.32 cm) was observed in Ai-4 (Bhola) (Table 192).

The mean spathe length of five varieties was 22.61 cm. The highest spathe length was obtained from Ai-5 (Trishal) (27.67 cm). The lowest spathe length (21.87cm) was observed in Ai-1 (Khulna). The mean spathe breadth of five varieties was 2.40 cm. The highest spathe breadth was obtained from Ai-5 (Trishal) (2.93 cm). The lowest spathe breadth (1.90 cm) was observed in Ai-4 (Bhola). The mean sucker number of five varieties was 5.03. The highest sucker number was obtained from Ai-1 (Khulna) (5.67) followed by Ai-3 (Jashore) (5.67). The lowest sucker number (4.33) was observed in Ai-2 (Satkhira) (Table 192).

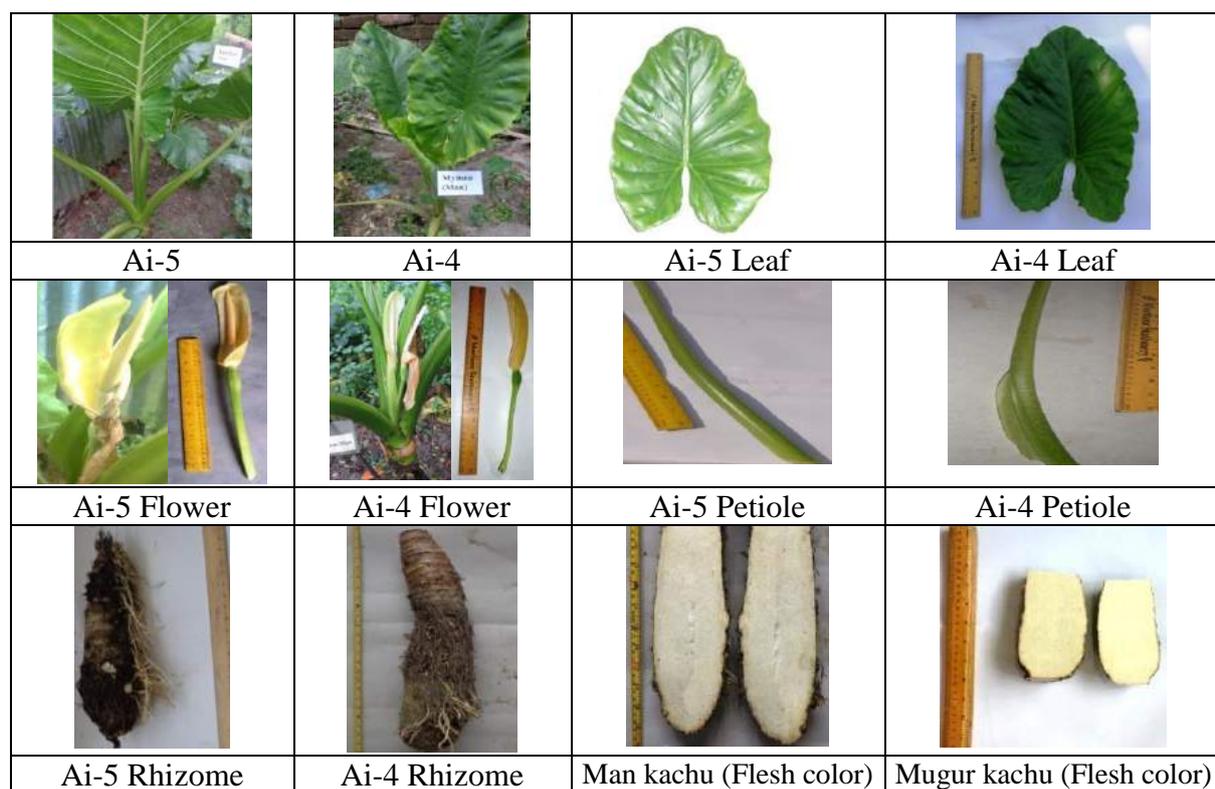


Fig. 158. Variation of different plant parts of *Alocasia*

The mean corm length of five varieties was 30.79 cm. The highest corm length was obtained from Ai-5 (Trishal) (37.67 cm). The lowest corm length (24.38 cm) was observed in Ai-4 (Bhola). The mean corm breadth of five varieties was 19.07 cm. The highest corm breadth was obtained from Ai-5 (Trishal) (23.33 cm). The lowest corm breadth (15.10 cm) was observed in Ai-4 (Bhola). The mean corm weight of five varieties was 681.12g. The highest corm weight was obtained from Ai-5 (Trishal) (833.33g). The lowest corm weight (539.32g) was observed in Ai-4 (Bhola) (Table 192).

Morphological characteristics of 5 Ol Kachu (*Amorphophallus*) Cultivars

The plant height mean of five varieties was 76.06 cm. The highest plant height was obtained from Ac-1 (Modhupur) (95.00 cm) followed by Ac-5 (Tangial) (88.35 cm) and the lowest plant height (45.00 cm) was observed in Ac-3 (Talas). The plant breadth mean of five varieties was 9.22 cm. The highest plant breadth was obtained from Ac-1 (Modhupur) (11.27 cm) followed by Ac-5 (Tangial) (10.45 cm) and the lowest plant breadth (5.43 cm) was in Ac-3 (Talas). The leaf length mean of five varieties was 65.05 cm. The highest leaf length was obtained from Ac-1 (Modhupur) (82.50 cm) followed by Ac-5 (Tangial) (76.05 cm) and the lowest leaf length (33.00 cm) was observed in Ac-3 (Talas). The leaf breadth mean of five varieties was 63.67 cm. The highest leaf breadth was 80.70 cm in Ac-1 (Modhupur) followed by Ac-5 (Tangial) (75.02 cm) and the lowest leaf breadth (31.82 cm) was observed in Ac-3 (Talas) (Table 193).

Table 193. Growth Performance of five *Amorphophallus* cultivars

Genotype	Plant height (cm)	Plant breadth (cm)	Leaf length (cm)	Leaf breadth (cm)	Sucker number	Corm length (cm)	Corm breadth (cm)	Yield per plant (g)
Ac 1	95.00	11.27	82.50	80.70	2.13	21.33	13.00	1016.67
Ac 2	70.67	9.33	63.10	61.80	2.07	15.83	5.60	230.00
Ac 3	45.00	5.43	33.00	31.82	1.67	4.47	5.20	119.00
Ac 4	81.27	9.63	70.59	69.03	1.73	16.95	10.78	869.83
Ac 5	88.35	10.45	76.05	75.02	1.93	18.85	11.42	945.17
Mean	76.06	9.22	65.05	63.67	1.91	15.49	9.20	636.13
LSD(0.05)	1.19	0.204	0.731	0.877	0.051	0.437	0.476	15.95

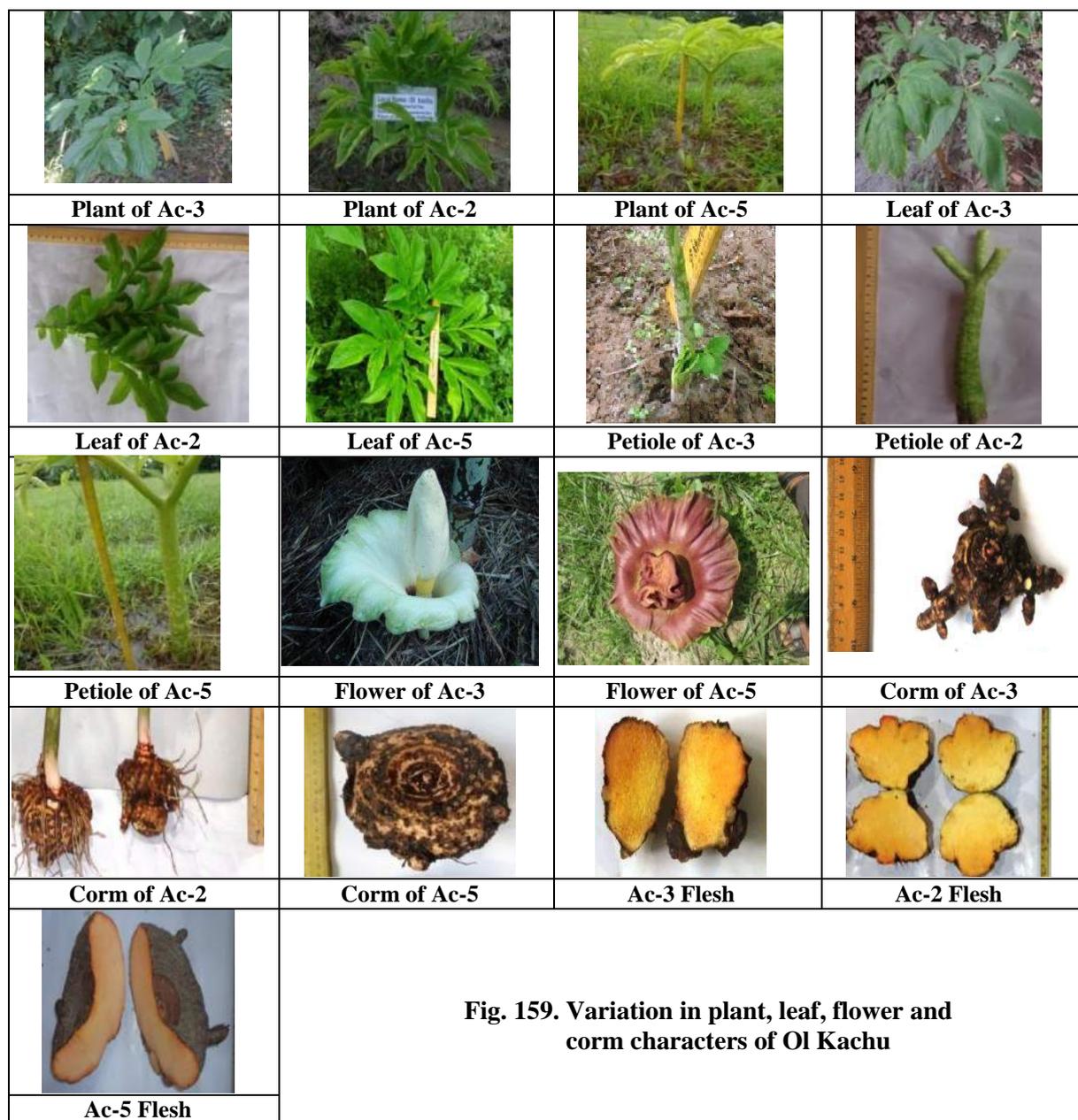


Fig. 159. Variation in plant, leaf, flower and corm characters of Ol Kachu

The sucker number mean of five varieties was 1.91. The highest sucker number was obtained from Ac-1 (Modhupur) (2.13) followed by Ac-2 (Bandarban) (2.07) and the lowest sucker number (1.67) was observed in Ac-3 (Talas). The corm length mean of five varieties was 15.49 cm. The highest corm length was obtained from Ac-1 (Modhupur) (21.33 cm) followed by Ac-5 (Tangail) (18.85 cm) and the lowest corm length (4.47 cm) was observed in Ac-3 (Talas). The corm breadth mean of five varieties was 9.20 cm. The highest corm breadth was obtained from Ac-1 (Modhupur) (13.00 cm) followed by Ac-5 (Tangail) (11.42 cm) and the lowest corm breadth (5.20 cm) was in Ac-3 (Talas) (Table 193).

The yield per plant mean of five varieties was 623.47 g. The highest yield per plant was obtained from Ac-1 (Modhupur) (1016.67 g) followed by Ac-5 (Tangail) (915.17 g) and the lowest yield per plant (119.00 g) was found in Ac-3 (Talas). Yield (g plant^{-1}) of five varieties are graphically shown in (Table 193)

Morphological characteristics of 11 *Xanthosoma* cultivars

The mean plant height of eleven varieties was 94.34 cm. The highest plant height was obtained from Xan-3 (Moulavi) (153.33 cm) followed by Xan-1 (Moulavi) (146.00 cm). The lowest plant height (58.33 cm) was observed in Xan-7 (Shaheby). The mean petiole length of eleven varieties was 64.24 cm. The highest petiole length was obtained from Xan-1 (Moulavi) (97.00 cm) followed by Xan-2 and Xan-3 (Moulavi) (96.67 cm). The lowest petiole length (25.67 cm) was observed in Xan-5 (Bombay) (Table 194).

The mean leaf number of eleven varieties was 4.20. The highest leaf number was obtained from Xan-3 (Moulavi) (6.80) followed by Xan-1 (Moulavi) (6.67). The lowest leaf number (2.73) was observed in Xan-8 (Dud Man). The mean leaf length of eleven varieties was 45.77 cm. The highest leaf length was obtained from Xan-3 (Moulavi) (81.33 cm) followed by Xan-1 (Moulavi) (80.33 cm). The lowest leaf length (27.53 cm) was observed in Xan-7 (Bombay). The mean leaf breadth of eleven varieties was 36.38 cm. The highest leaf breadth was obtained from Xan-3 (Moulavi) (58.00 cm) followed by Xan-1 (Moulavi) (57.00 cm). The lowest leaf breadth (23.18 cm) was observed in Xan-6 (Bombay) (Table 194).

The mean inflorescence number of eleven varieties was 2.01. The highest inflorescence number was obtained from Xan-1 (Moulavi) (4.80) followed by Xan-3 (Moulavi) (4.53). The lowest inflorescence number (0.00) was observed in six cultivars (Xan-4,5,6,9,10,11). The mean Inflorescence length of eleven varieties was 24.26 cm. The highest Inflorescence length was obtained from Xan-1 (Moulavi) (62.33 cm) followed by Xan-1 (Moulavi) (55.67 cm). The lowest Inflorescence length (45.59 cm) was observed in Xan-7 (Shaheby). The mean peduncle length of eleven varieties was 13.20 cm. The highest peduncle length was obtained from Xan-1 (Moulavi) (38.43 cm) followed by Xan-3 (Moulavi) (34.00 cm). The lowest peduncle length (18.97 cm) was observed in Xan-7 (Shaheby) (Table 194).

The mean spathe length of eleven varieties was 9.06 cm. The highest spathe length was obtained from Xan-8 (Dud Man) (24.17 cm) followed by Xan-7 (Shaheby) (21.87cm). The lowest spathe length (15.40 cm) was observed in Xan-2 (Moulavi). The mean spathe breadth of eleven varieties was 3.15 cm. The highest spathe breadth was obtained from Xan-3 (Moulavi) (10.50 cm) followed by Xan-2 (Moulavi) (9.93 cm). The lowest spathe breadth (2.32 cm) was observed in Xan-7 (Shaheby). The mean sucker number of eleven varieties was 3.02. The highest sucker number was obtained from Xan-1 (Moulavi) (4.87) followed by Xan-2 (Moulavi) (4.20). The lowest sucker number (1.93) was observed in Xan-7 (Shaheby) (Table 194).

The mean corm length of eleven varieties was 19.65 cm. The highest corm length was recorded in Xan-1 (Moulavi) (50.76 cm) followed by Xan-3 (Moulavi) (35.40 cm). The lowest corm length (6.77 cm) was in Xan-6 (Bombay). The mean corm breadth of eleven varieties was 8.49 cm. Corm breadth was maximum in Xan-1 (Moulavi) (19.78 cm) followed by Xan-3 (Moulavi) (16.28cm). The lowest corm breadth (4.67 cm) was observed in Xan-9 (Surma). The mean corm weight of eleven varieties was 524.62 g. The highest corm weight was obtained from Xan-1 (Moulavi) (1816.67 g) followed by Xan-3 (Moulavi) (1733.33 g). The lowest corm weight (30.87 g) was observed in Xan-8 (Dud Man) (Table 194).

The mean cormel number of eleven varieties were 6.62. The highest cormel number was obtained from Xan-1 (Moulavi) (12.40) followed by Xan-3 (Moulavi) (11.20). The lowest corm number (1.73) was observed in Xan-8 (Dud man). The mean cormel length of eleven varieties was 9.06 cm. The highest cormel length was obtained from Xan-1 (Moulavi) (17.28 cm) followed by Xan-3 (Moulavi) (16.30 cm). The lowest cormel length (4.15 cm) was observed in Xan-9 (Surma) (Table 194).

Table 194. Growth performance of eleven *Xanthosoma* cultivars

Genotype	Plant height (cm)	Petiole length (cm)	Leaf number (cm)	Leaf length (cm)	Leaf breadth (cm)	Inflorescence (no.)	Inflorescence length (cm)	Peduncle length (cm)	Spathe length (cm)
1	2	3	4	5	6	7	8	9	10
Xan-1	146.00	97.00	6.80	81.33	57.00	4.80	62.33	38.43	17.20
Xan-2	117.35	96.67	6.60	73.00	52.33	4.27	49.67	30.80	15.40
Xan-3	153.33	96.67	6.67	80.33	58.00	4.53	55.67	34.00	21.00
Xan-4	86.36	30.33	3.80	39.97	32.30	0.00	0.00	0.00	0.00
Xan-5	82.25	25.67	3.40	28.40	23.47	0.00	0.00	0.00	0.00
Xan-6	78.39	26.00	3.53	27.53	23.18	0.00	0.00	0.00	0.00
Xan-7	58.33	60.33	3.00	28.67	35.77	3.80	45.59	18.97	21.87
Xan-8	63.40	85.67	2.73	29.72	27.05	4.73	53.63	22.95	24.17
Xan-9	80.78	60.00	3.07	34.62	27.48	0.00	0.00	0.00	0.00
Xan-10	69.45	63.33	3.20	37.95	30.48	0.00	0.00	0.00	0.00
Xan-11	102.05	67.00	3.40	41.95	33.15	0.00	0.00	0.00	0.00
Mean	94.34	64.24	4.20	45.77	36.38	2.01	24.26	13.20	9.06
LSD (5%)	11.20	7.73	0.38	5.92	4.17	0.23	2.16	2.35	1.66

Table 194. Growth Performance of eleven *Xanthosoma* cultivars (Cont'd)

Genotype	Spathe breadth (cm)	Sucker number	Corm length (cm)	Corm breadth (cm)	Corm weight (g)	Cormel number	Cormel length (cm)	Cormel weight (g)	Yield / plant (g)
1	11	12	13	14	15	16	17	18	19
Xan-1	9.13	4.87	50.76	19.78	1816.67	12.40	17.28	355.07	2171.73
Xan-2	9.93	4.20	31.65	14.41	1541.67	9.67	14.97	270.67	1812.33
Xan-3	10.50	4.07	35.40	16.28	1733.33	11.20	16.30	311.67	2045.00
Xan-4	0.00	2.53	9.57	5.63	50.76	9.73	13.63	170.33	221.09
Xan-5	0.00	2.07	7.37	5.27	35.40	7.87	10.13	137.67	173.07
Xan-6	0.00	2.00	6.77	5.10	31.74	7.27	9.15	127.17	158.91
Xan-7	2.32	1.93	33.11	6.49	412.09	0.00	0.00	0.00	412.08
Xan-8	2.79	3.00	13.11	4.94	30.87	1.73	5.03	12.47	43.34
Xan-9	0.00	2.67	8.67	4.67	41.62	4.40	4.15	58.16	99.78
Xan-10	0.00	2.87	9.37	5.07	33.26	3.73	4.37	46.25	79.51
Xan-11	0.00	3.00	10.39	5.80	43.39	4.87	4.67	67.59	110.97
Mean	3.15	3.02	19.65	8.49	524.62	6.62	9.06	141.55	666.17
LSD (5%)	0.62	0.39	3.11	1.14	95.66	0.69	0.90	11.88	111.20

The mean cormel weight of eleven varieties was 141.55 g. The highest cormel weight was obtained from Xan-1 (Moulavi) (355.07 g) followed by Xan-3 (Moulavi) (311.67 g). The lowest cormel weight (12.47 g) was observed in Xan-8 (Dud Man). The mean yield per plant of eleven varieties was 666.17 g. The highest yield per plant was obtained from Xan-1 (Moulavi) (2171.73 g) followed by Xan-3 (Moulavi) (2045.00 g). The lowest yield per plant (43.34 g) was observed in Xan-8 (Dud Man) (Table 194).

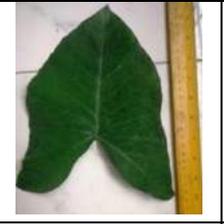
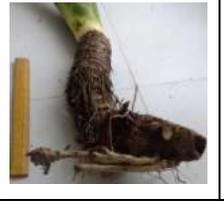
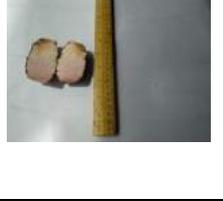
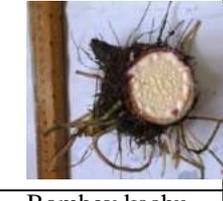
				
Dud kachu Plant	Surma kachu Plant	Shaheby kachu Plant	Bombey kachu Plant	Mowlavikachu Plant
				
Dud kachu Leaf	Surma kachu Leaf	Shaheby kachu Leaf	Bombey kachu Leaf	Mowlavikachu Leaf
				
Dud kachu Petiole	Surma kachu Petiole	Shaheby kachu Petiole	Bombey kachu Petiole	Mowlavi kachu Petiole
				
Shaheby kachu Flower	Mowlavi kachu Flower	Rhizome of Dud kachu	Corm of Surma kachu	Rhizome of Shaheby kachu
				
Corm of Bombay Kachu	Rhizome of Mowlavi kachu	Dud kachu (Flash color)	Surma Kachu (Flash color)	Shaheby kachu (Flash color)
				
Bombey kachu (Flash color)	Mowlavikachu (Flash color)			

Fig. 160. Variation of different plant parts of *Xanthosoma*

11.9.6. Molecular Characterization and Genetic Diversity of Aroid using RAPD Markers

DNA Banding pattern, size and DNA polymorphism in aroid germplasm: The selected five primers produced comparatively maximum number of high intensity band with minimal smearing, good technical resolution and sufficient variation among different accessions. These five primers (OPG-10, OPW-04, OPW-09, OPW-10 and OPW-16) generated total 46 distinct and differential amplified bands, out of which 46 were polymorphic. The average of total bands and polymorphic bands per primer was 9.2 and 9.2 respectively. The size of the bands ranged from 131 to 1188 bp. The highest number (13) of bands was generated by primer OPW-04. The primer OPW-10 produced the lowest number (6) of bands. Besides that, the primer OPG-10, OPW-09 and OPW-16 generated 11, 8 and 8 bands respectively.

Percentage of polymorphic loci in the present study was 100. The average level of polymorphism (100%) indicated the effectiveness of RAPD technique to study substantial amount of polymorphisms or diversity among the different aroids genotypes. The details of the primers were given in Table 195 and the banding pattern of 22 aroid cultivars using five primers were shown in figs. 161 to 165. Frequencies of polymorphic RAPD markers in 22 aroids germplasm is shown in Table 196.

Genetic variation: The values of Nei's (1972) gene diversity and Shannon's information index for different germplasm of aroid across all loci are shown in Table 197. The estimate mean and standard deviation of Nei's (1972) genetic diversity for entire germplasm of aroid was 0.316 and 0.134. The Nei's (1972) genetic diversity for entire germplasm of aroid ranged from 0.087 to 0.500. The mean and standard deviation Shannon's information index for entire germplasm of aroid were 0.484 and 0.160. There was a high level of genetic variation among the studied germplasm of aroid from the proportion of polymorphic loci point of view. Estimates of Nei's (1973) gene diversity (0.316) and Shannon information index (0.484) across all loci also support the existence of high level of genetic variation in 22 germplasm of aroid. High levels of genetic variation were also reported in a number of studies in taro.

Genetic distance: The values of pair-wise comparisons of Nei's (1972) genetic distance (D) germplasm were compared from combined data from the five primers ranged from 0.140 to 0.884 (Table 198). The highest genetic distance (0.884) was observed between the germplasm AI-4 and XA-1, CE-4 and XA-9 pair while the lowest genetic distance (0.091) was observed between the germplasm CE-15 and CE-16 (Table 198). The difference between the highest and lowest genetic distance indicated the presence of variability among the 22 germplasm of aroids.

Table 195. RAPD primers with corresponding bands and size range together with polymorphic bands observed in 22 aroids germplasm

Primer code	Sequence (5'-3')	G+C (%)	Total no. of bands scored	Size range (bp)	No. of polymorphic bands	Proportion of polymorphic loci (%)
OPG-10	5'AGGGCCGTCT-3'	70%	11	100-2000	11	100
OPW04	5'CAGAAGCGGA-3'	60%	13	100-2000	13	100
OPW09	5'GGCGGATAAG-3'	60%	8	100-2000	8	100
OPW10	5'TCGCATCCCT-3'	60%	6	100-2000	6	100
OPW16	5'CAGCCTACCA-3'	60%	8	100-2000	8	100
Total			46		46	-
Average			9.20		9.20	100

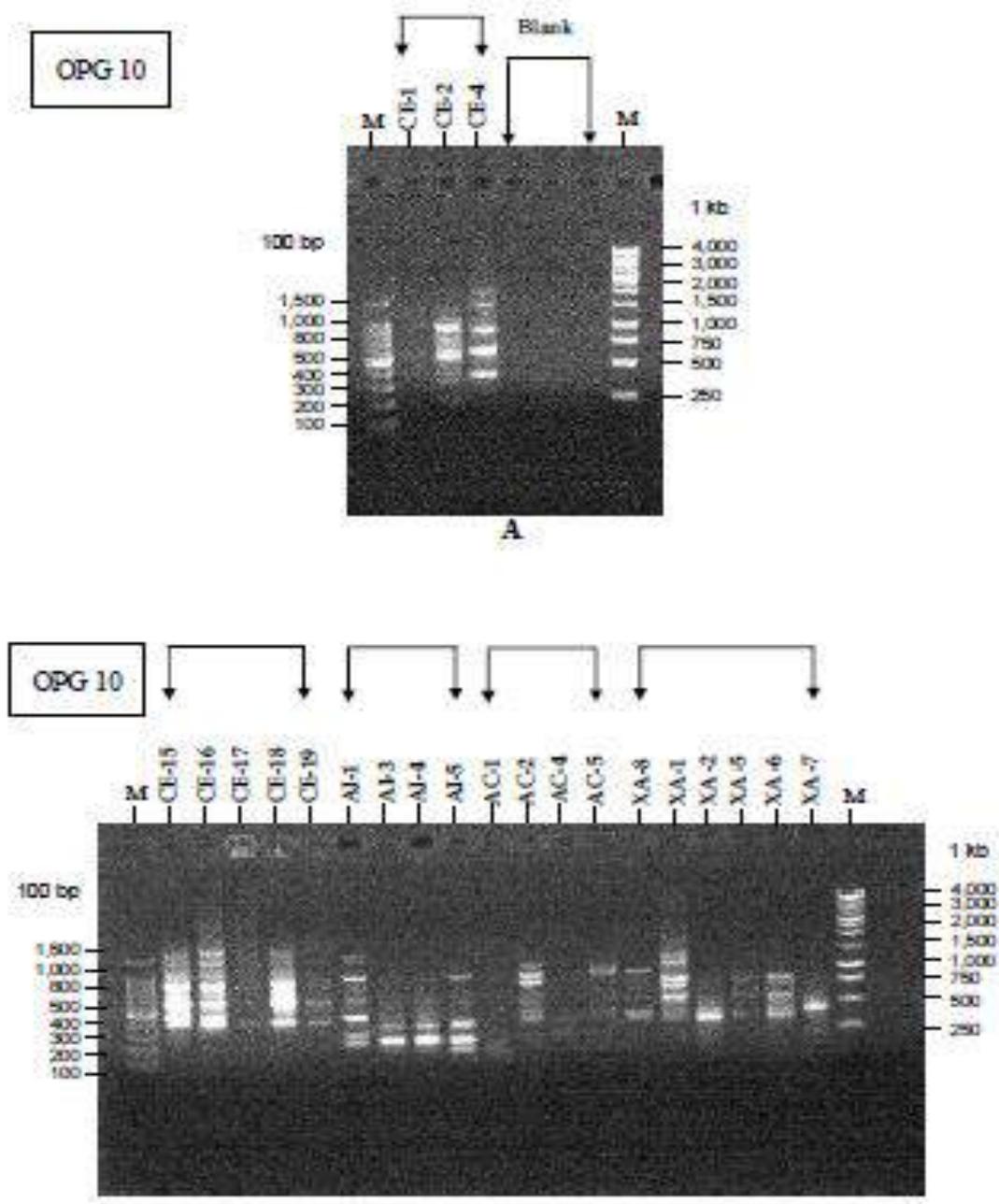


Fig. 161. RAPD profile of 22 aroid germplasm using primer OPG 10 M: Molecular weight marker (100 bp DNA ladder in left side and 1 kb DNA ladder in right side)

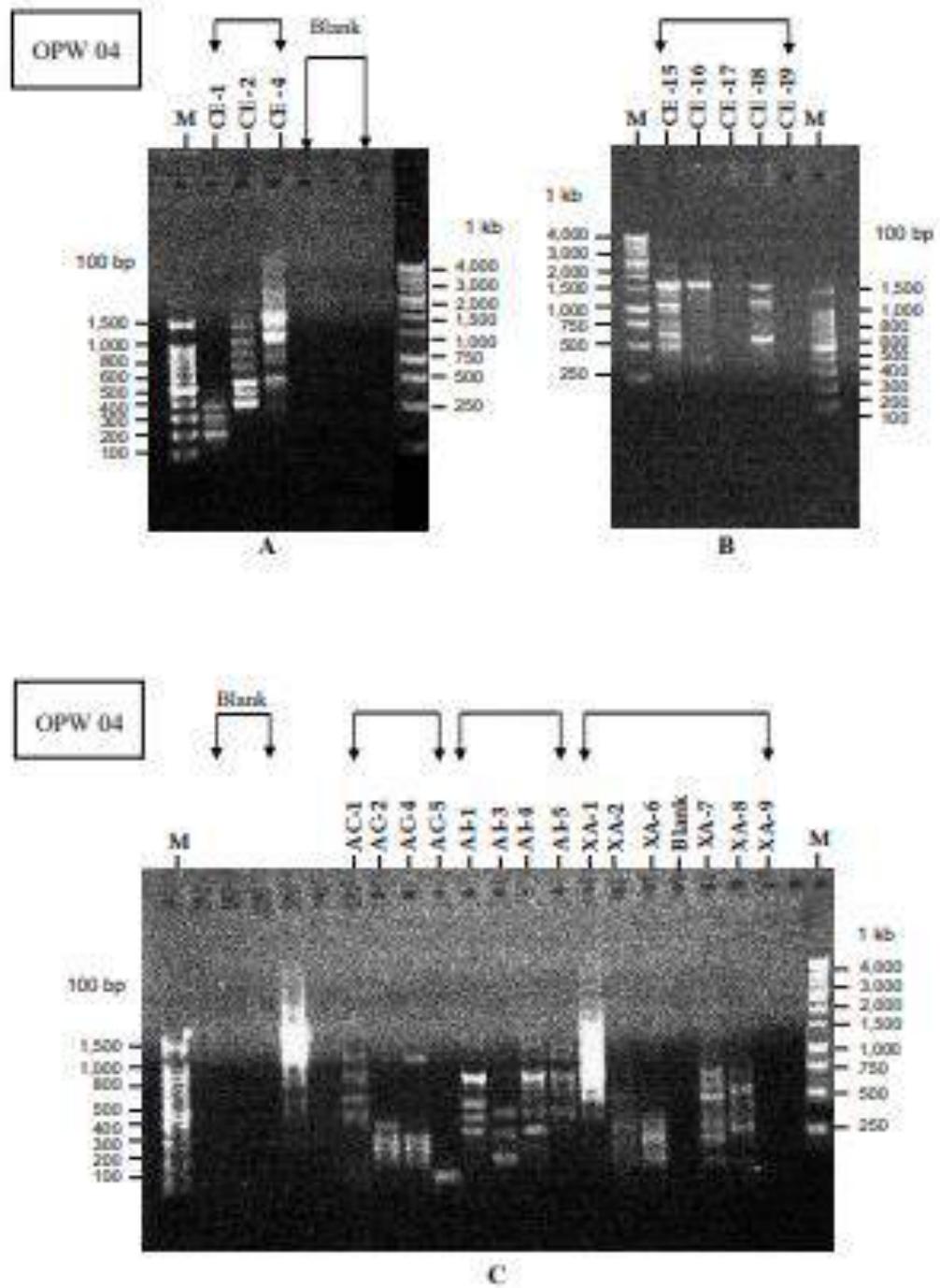
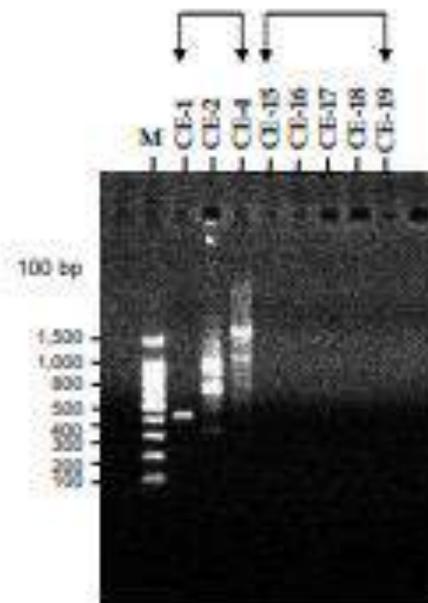


Fig. 162. RAPD profile of 22 aroid germplasm using primer OPW 04

OPW 09



OPW 09

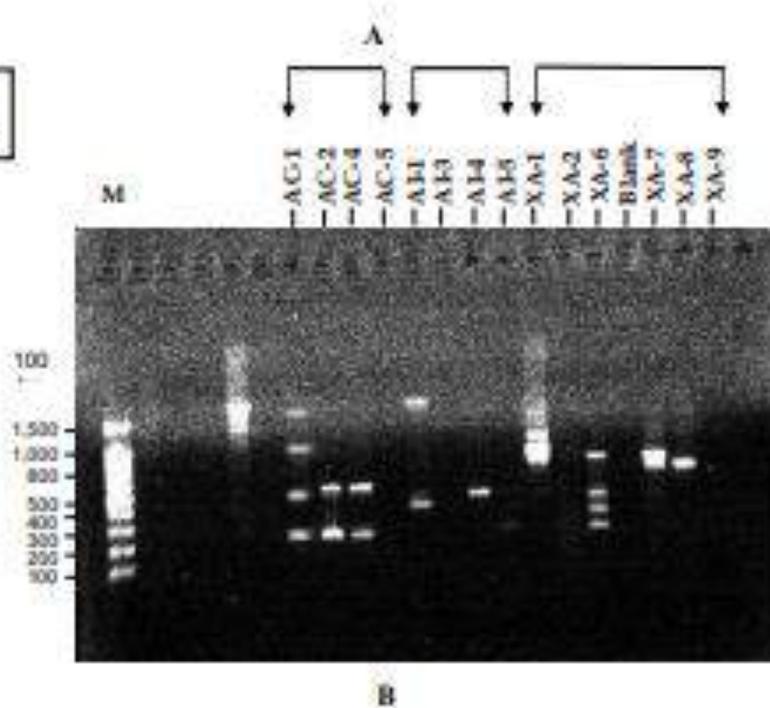


Fig. 163. RAPD profile of 22 aroid germplasm (A+B) using primer OPW 09

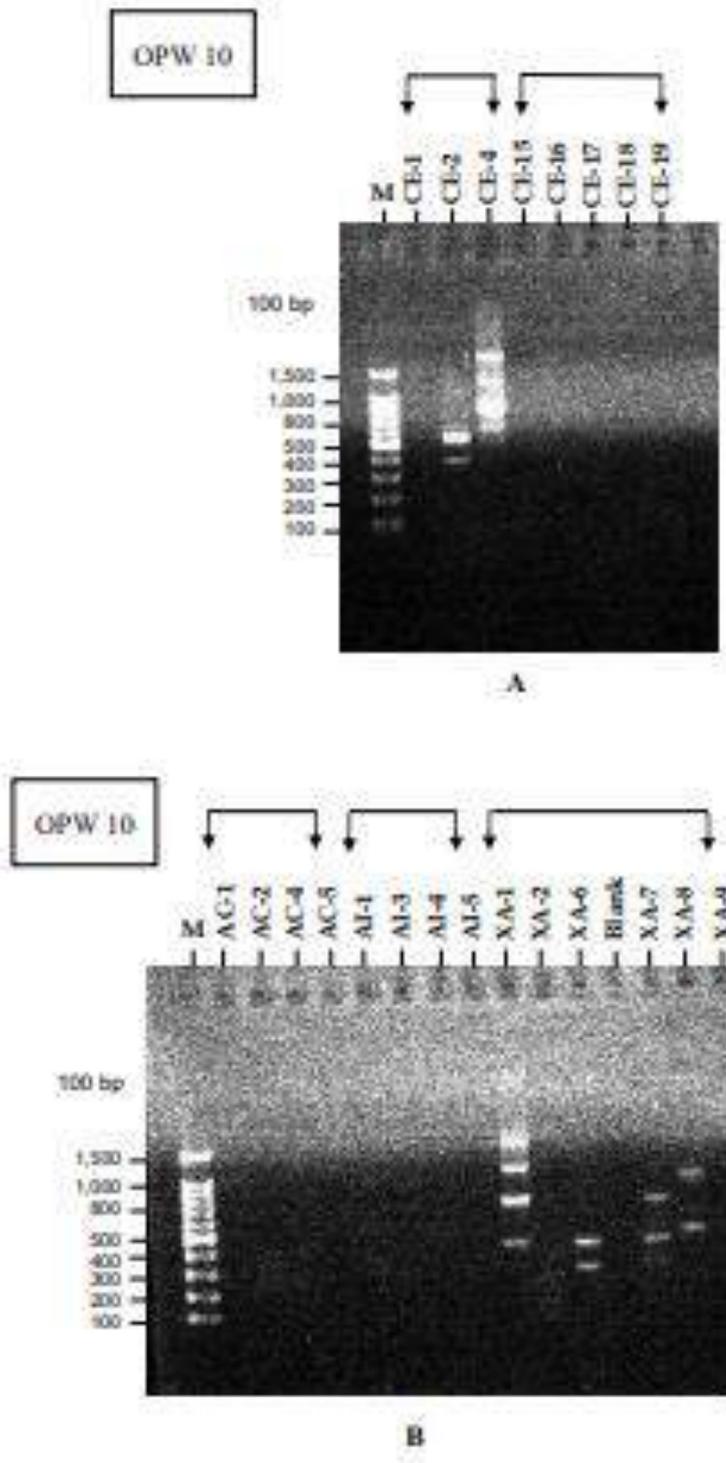


Fig. 164. RAPD profile of 22 aroid germplasm (A+B) using primer OPW 10

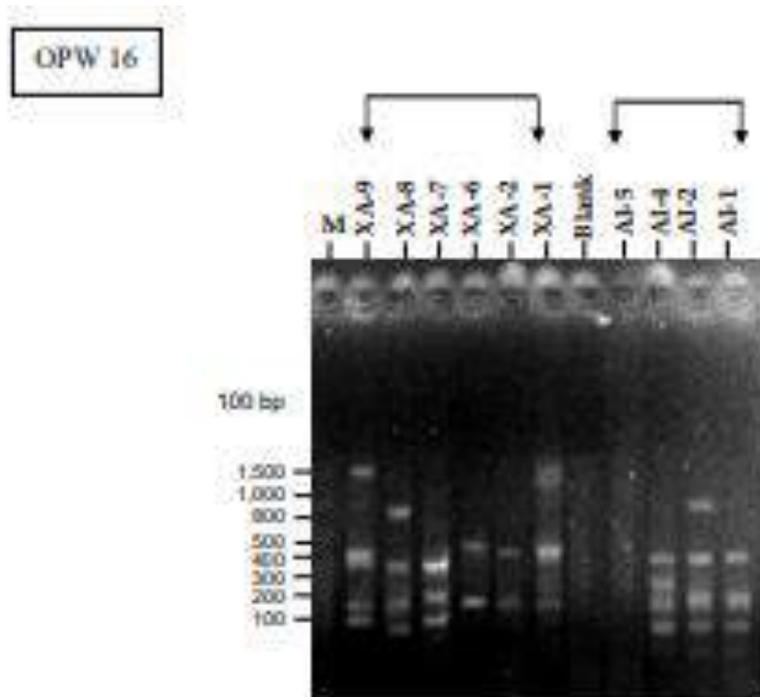


Fig. 165. RAPD profile of 10 aroid germplasm using primer OPW 16

Table 196. Frequencies of polymorphic RAPD markers in 22 aroids germplasm

RAPD Markers	Gene frequency						
OPG10-1	0.182	OPW04-2	0.227	OPW09-1	0.182	OPW10-4	0.091
OPG10-2	0.409	OPW04-3	0.273	OPW09-2	0.136	OPW10-5	0.182
OPG10-3	0.455	OPW04-4	0.227	OPW09-3	0.091	OPW10-6	0.091
OPG10-4	0.273	OPW04-5	0.091	OPW09-4	0.182	OPW16-1	0.091
OPG10-5	0.364	OPW04-6	0.273	OPW09-5	0.136	OPW16-2	0.046
OPG10-6	0.546	OPW04-7	0.500	OPW09-6	0.273	OPW16-3	0.091
OPG10-7	0.500	OPW04-8	0.455	OPW09-7	0.136	OPW16-4	0.136
OPG10-8	0.500	OPW04-9	0.546	OPW09-8	0.227	OPW16-5	0.273
OPG10-9	0.091	OPW04-10	0.455	OPW10-1	0.091	OPW16-6	0.046
OPG10-10	0.182	OPW04-11	0.273	OPW10-2	0.136	OPW16-7	0.409
OPG10-11	0.136	OPW04-12	0.273	OPW10-3	0.136	OPW16-8	0.273
OPW04-1	0.046	OPW04-13	0.091				

Dendrogram analysis: The binary matrix obtained by scoring the presence and absence of amplification products was subjected to UPGMA. In the Dendrogram, based on Nei's (1972) genetic distance unweighted pair grouped method of arithmetic means (UPGMA) all the taro 22 germplasm were distinctly divided into two major clusters, 'A' and 'B'. Cluster 'A' comprised the largest number (20) of germplasm. In this cluster, germplasm CE-2 separate cluster-A-IV and the rest of 19 germplasm are divided into 3 sub-clusters A-I, A-II and A-III. Germplasm CE-15, CE-18 and CE-16 formed sub-cluster A-I with similar morphological characters. Germplasm AI-1, AI-3, AI-4, AI-5, XA-7 and XA-8 all were assigned to sub-cluster A-II. In sub-cluster A-III, CE-1, CE-17, CE-19, AC-5, AC-4, XA-2, XA-9, AC-2 and XA-6 were grouped together. Group 'B' was divided into one sub-cluster 'B-I'. In sub-cluster CE-4 and XA-1 formed one sub cluster (Fig. 166).

Table 197. Summary of genetic diversity and Shanon Information Index

Loci	Sample Size	Observed number of alleles (ea)	Effective number of alleles (ne)	Gene diversity (h)	Shanon information index (i)
OPG10-1	22	2	1.424	0.298	0.474
OPG10-2	22	2	1.936	0.484	0.677
OPG10-3	22	2	1.984	0.496	0.689
OPG10-4	22	2	1.658	0.397	0.586
OPG10-5	22	2	1.862	0.463	0.656
OPG10-6	22	2	1.984	0.496	0.689
OPG10-7	22	2	2.000	0.500	0.693
OPG10-8	22	2	2.000	0.500	0.693
OPG10-9	22	2	1.198	0.165	0.305
OPG10-10	22	2	1.424	0.298	0.474
OPG10-11	22	2	1.308	0.236	0.398
OPW04-1	22	2	1.095	0.087	0.185
OPW04-2	22	2	1.541	0.351	0.536
OPW04-3	22	2	1.658	0.397	0.586
OPW04-4	22	2	1.541	0.351	0.536
OPW04-5	22	2	1.198	0.165	0.305
OPW04-6	22	2	1.658	0.397	0.586
OPW04-7	22	2	2.000	0.500	0.693
OPW04-8	22	2	1.984	0.496	0.689
OPW04-9	22	2	1.984	0.496	0.689
OPW04-10	22	2	1.984	0.496	0.689
OPW04-11	22	2	1.658	0.397	0.586
OPW04-12	22	2	1.658	0.397	0.586
OPW04-13	22	2	1.198	0.165	0.305
OPW09-1	22	2	1.424	0.298	0.474
OPW09-2	22	2	1.308	0.236	0.398
OPW09-3	22	2	1.198	0.165	0.305
OPW09-4	22	2	1.424	0.298	0.474
OPW09-5	22	2	1.308	0.236	0.398
OPW09-6	22	2	1.658	0.397	0.586
OPW09-7	22	2	1.308	0.236	0.398
OPW09-8	22	2	1.541	0.351	0.536
OPW10-1	22	2	1.198	0.165	0.305
OPW10-2	22	2	1.308	0.236	0.398
OPW10-3	22	2	1.308	0.236	0.398
OPW10-4	22	2	1.198	0.165	0.305
OPW10-5	22	2	1.424	0.298	0.474
OPW10-6	22	2	1.198	0.165	0.305
OPW16-1	22	2	1.198	0.165	0.305
OPW16-2	22	2	1.095	0.087	0.185
OPW16-3	22	2	1.198	0.165	0.305
OPW16-4	22	2	1.308	0.236	0.398
OPW16-5	22	2	1.658	0.397	0.586
OPW16-6	22	2	1.095	0.087	0.185
OPW16-7	22	2	1.936	0.484	0.677
OPW16-8	22	2	1.658	0.397	0.586
Mean	22	2	1.519	0.316	0.484
St. Dev		0	0.306	0.134	0.160

* na = Observed number of alleles

* ne = Effective number of alleles (Kimura and Crow; 1964)

* h = Gene diversity (Nei's; 1972)

* i = Shannon's Information index (Lewontin; 1972)

Table 198. Summary of Nei's genetic identity (above diagonal) and distance (below diagonal) values among 22 germplasm of aroid

	CE-1	CE-2	CE-4	CE-15	CE-16	CE-17	CE-18	CE-19	AC-1	AC-2	AC-4	AC-5	AI-1	AI-2	AI-4	AI-5	XA-1	XA-2	XA-6	XA-7	XA-8	XA-9
CE-1	***	0.544	0.522	0.609	0.652	0.848	0.630	0.848	0.739	0.826	0.848	0.870	0.652	0.804	0.696	0.739	0.457	0.804	0.783	0.717	0.652	0.761
CE-2	0.610	***	0.544	0.587	0.544	0.565	0.609	0.652	0.717	0.587	0.609	0.544	0.630	0.522	0.630	0.630	0.435	0.565	0.587	0.609	0.587	0.522
CE-4	0.651	0.610	***	0.696	0.609	0.630	0.630	0.587	0.609	0.522	0.500	0.565	0.565	0.457	0.522	0.652	0.544	0.457	0.348	0.457	0.565	0.413
CE-15	0.496	0.533	0.363	***	0.913	0.761	0.935	0.761	0.652	0.696	0.630	0.696	0.652	0.544	0.609	0.739	0.630	0.674	0.522	0.500	0.609	0.674
CE-16	0.427	0.610	0.496	0.091	***	0.804	0.891	0.804	0.609	0.739	0.630	0.739	0.652	0.630	0.609	0.739	0.674	0.761	0.565	0.500	0.609	0.717
CE-17	0.165	0.571	0.461	0.273	0.218	***	0.696	0.913	0.761	0.717	0.826	0.891	0.630	0.783	0.717	0.804	0.565	0.783	0.630	0.609	0.630	0.783
CE-18	0.461	0.496	0.461	0.067	0.115	0.363	***	0.739	0.674	0.717	0.609	0.674	0.674	0.565	0.630	0.761	0.609	0.739	0.544	0.565	0.630	0.652
CE-19	0.165	0.427	0.533	0.273	0.218	0.091	0.302	***	0.761	0.804	0.826	0.891	0.717	0.783	0.761	0.848	0.478	0.826	0.674	0.652	0.717	0.826
AC-1	0.302	0.332	0.496	0.427	0.496	0.273	0.395	0.273	***	0.696	0.848	0.783	0.609	0.674	0.739	0.826	0.457	0.717	0.609	0.630	0.652	0.674
AC-2	0.191	0.533	0.651	0.363	0.302	0.332	0.332	0.218	0.363	***	0.804	0.783	0.652	0.674	0.652	0.696	0.457	0.761	0.783	0.630	0.652	0.717
AC-4	0.165	0.496	0.693	0.461	0.461	0.191	0.496	0.191	0.165	0.218	***	0.891	0.544	0.739	0.674	0.717	0.435	0.739	0.717	0.609	0.587	0.739
AC-5	0.140	0.610	0.571	0.363	0.302	0.115	0.395	0.115	0.245	0.245	0.115	***	0.652	0.761	0.696	0.783	0.544	0.804	0.652	0.630	0.696	0.804
AI-1	0.427	0.461	0.571	0.427	0.427	0.461	0.395	0.332	0.496	0.427	0.610	0.427	***	0.761	0.826	0.783	0.457	0.674	0.565	0.674	0.783	0.674
AI-2	0.218	0.651	0.784	0.610	0.461	0.245	0.571	0.245	0.395	0.395	0.302	0.273	0.273	***	0.848	0.761	0.435	0.739	0.630	0.739	0.761	0.783
AI-4	0.363	0.461	0.651	0.496	0.496	0.332	0.461	0.273	0.302	0.427	0.395	0.363	0.191	0.165	***	0.826	0.413	0.674	0.565	0.761	0.783	0.717
AI-5	0.302	0.461	0.427	0.302	0.302	0.218	0.273	0.165	0.191	0.363	0.332	0.245	0.245	0.273	0.191	***	0.500	0.761	0.565	0.674	0.696	0.674
XA-1	0.784	0.833	0.610	0.461	0.395	0.571	0.496	0.738	0.784	0.784	0.833	0.610	0.784	0.833	0.884	0.693	***	0.609	0.500	0.478	0.457	0.565
XA-2	0.218	0.571	0.784	0.395	0.273	0.245	0.302	0.191	0.332	0.273	0.302	0.218	0.395	0.302	0.395	0.273	0.496	***	0.804	0.652	0.674	0.826
XA-6	0.245	0.533	0.156	0.651	0.571	0.461	0.610	0.395	0.496	0.245	0.332	0.427	0.571	0.461	0.571	0.571	0.693	0.218	***	0.674	0.522	0.674
XA-7	0.332	0.496	0.784	0.693	0.693	0.496	0.571	0.427	0.461	0.461	0.496	0.461	0.395	0.302	0.273	0.395	0.738	0.427	0.395	***	0.761	0.652
XA-8	0.427	0.533	0.571	0.496	0.496	0.461	0.461	0.332	0.427	0.427	0.533	0.363	0.245	0.273	0.245	0.363	0.784	0.395	0.651	0.273	***	0.717
XA-9	0.273	0.651	0.884	0.395	0.332	0.245	0.427	0.191	0.395	0.332	0.302	0.218	0.395	0.245	0.332	0.395	0.571	0.191	0.395	0.427	0.332	***

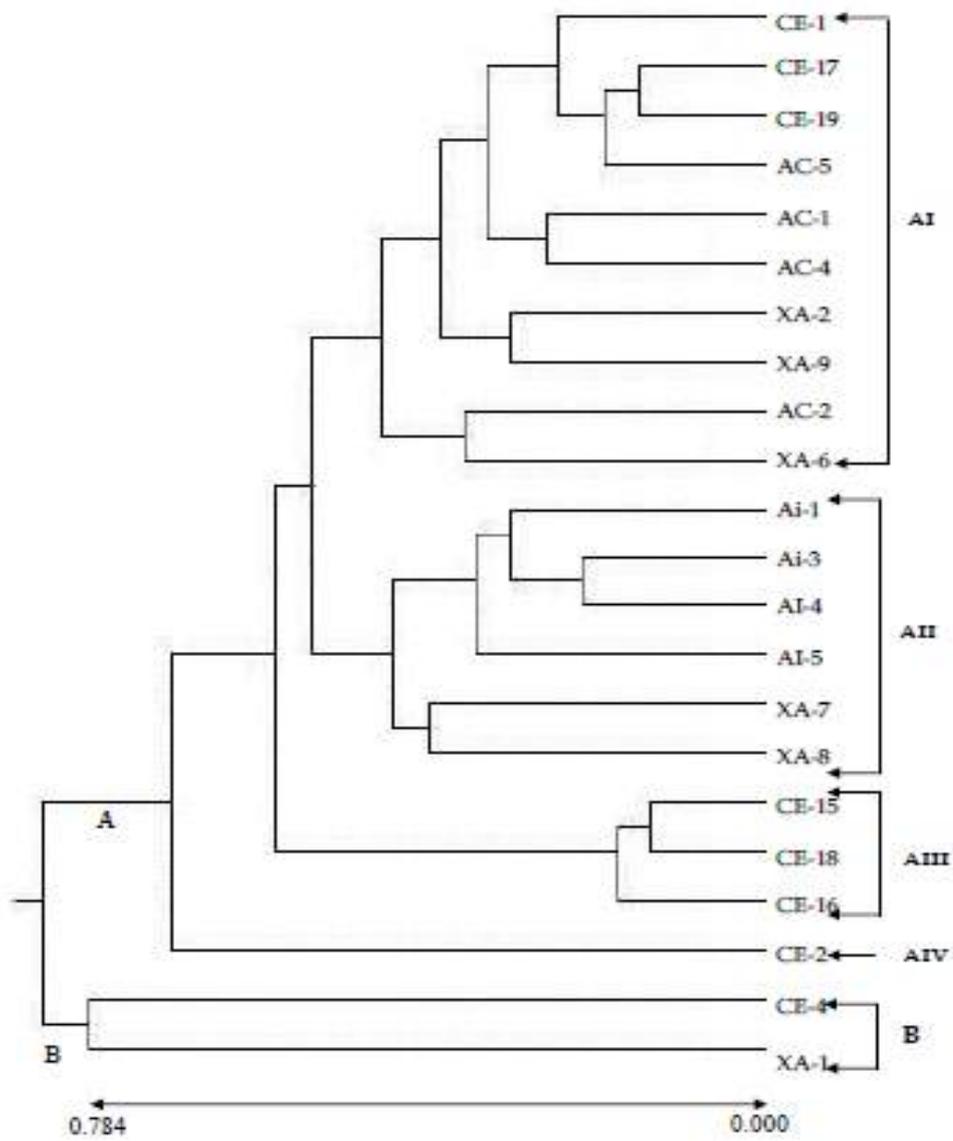


Fig. 166. Unweighted pair group method of Arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

11.9.7. Morphological Characterization and Evaluation of Yam Germplasm

Morphological characterization of 31 yam germplasm collected from various part of Bangladesh were done at BAU-GPC following IPGRI/CIP, 2003 descriptors. The morphological descriptions applied for the characterization include the characters those are usually highly heritable, easily seen by eye and equally expressed in all environments. Characterization of descriptors for the study included: (i) Plant descriptors and (ii) Evaluation.

Measurements of qualitative and quantitative characters were made for 31 accessions of *Dioscorea* species. Quantitative characters were determined by measuring and counting, while the qualitative characters were determined visually, feeling or touching and scored by nominal codes (barky patches, young stem, presence or absence of scale leaves, mature stem spine on stem base, mature stem-color of spot at spine base, etc.). A Descriptor List for *Dioscorea* spp. (IPGRI/IITA, 1997) was followed as guide for phenotypic characterizations. To determine the plant descriptors, a number of parameters were identified and accordingly. The current research emphasized on characterization of native yam germplasm based on typical features of (i) stem, (ii) leaf, (iii) aerial tubers (bulbil) and (iv) underground tuber.

A. Qualitative descriptors

As per IPGRI Descriptors for Yams qualitative characters were recorded under different subheads based on growth stages of different plant parts like young stem, mature stem, young leaves, mature leaves, aerial tubers, underground tubers and quality characteristics of tubers (aerial and underground). Qualitative variations of 99 characters in yams are shown in Table 199.

All the qualitative characteristics of young stem showed distinct variation among the germplasm. The maximum variation was observed in stem color and wing color. Stem color of maximum germplasm was green (45.16%) followed by purplish green (35.48%). Purple stem color was observed in minimum percentage of the germplasm (6.45%). Waxiness, wings, hairs, spines, and barky patches in young stem were present or absent among the studied germplasm (Table 199).

Wide variations were observed among the yam germplasm under study in respect of qualitative characteristics of matured stem (Table 199). Maximum variation was found in stem color where the percentage of yam germplasm with green, purplish green, brownish green and dark brown stem color were 38.71, 22.58, 22.58 and 16.13, respectively. Plant type was shrub-like (16.13%) and climbing (83.87%). Twining direction of the studied germplasm was clockwise (35.48%) and anticlockwise (64.52%). Waxiness and coalescent spine were present or absent among the germplasm. Variations were also observed among the germplasm in other qualitative characters studied (Table 199).

First leaf emergence was early in maximum germplasm (67.74%) and late in the minimum (32.26%). The germplasm varied widely in respect of young leaf color. Maximum germplasm (35.48%) had purplish green leaf color followed by pale green (22.58%). Only 9.68% germplasm had purple young leaf color. Petiole color, petiole wing color and vein color of young leaf also varied widely among the germplasm. Various states of descriptors for these characters were noticed in different germplasm studied (Table 199).

Table 199. Qualitative variation of different characters in yam

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
A.1. Qualitative characteristics of Young stem			
Stem colour	Green	14	45.16
	Purplish green	11	35.48
	Brownish green	4	12.90
	Purple	2	6.45
Waxiness	Absent	5	16.13
	Present	26	83.87
Wings	Absent	18	58.06
	Present	13	41.94
Wing colour	Green	3	9.68
	Green with purple edges	8	25.81
	Purple	2	6.45
Hairs	Absent	23	74.19
	Present	8	25.81
Spines	Absent	24	77.42
	Present	7	22.58
Barky patches	Absent	15	48.39
	Present	16	51.61
A.2. Qualitative characteristics of Matured stem			
Plant type	Shrub-like	05	16.13
	Climbing	26	83.87
Twining direction	Clockwise	11	35.48
	Anticlockwise	20	64.52
Stem color	Green	12	38.71
	Purplish green	07	22.58
	Brownish green	07	22.58
	Dark brown	05	16.13
Absence/presence of waxiness	Absent	10	32.26
	Present	21	67.74
Wing colour	Green	18	58.06
	Green with purple edge	13	41.94
Hairiness	Sparse	10	32.26
	Dense	06	19.35
Spines on stem base	Few	01	3.23
	Many	06	19.35
Spines on stem above base	Few	04	12.90
	Many	03	9.68
Spine position	Wings	24	77.42
	Ridges	04	12.90
	Stem	03	9.68
Spine shape	Straight	02	6.45
	Curved upwards	02	6.45
	Curved downwards	03	9.68
Absence/presence of coalescent spines	Absent	24	77.42
	Present	07	22.58
Colour of spot at spine base	Red	01	3.23
	Purple	01	3.23
	Maroon	05	16.13

Cont'd. Table 199.

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
A.3. Qualitative characteristics of Young leaves			
First leaf emergence	Early	21	67.74
	Late	10	32.26
Leaf colour	Yellowish	05	16.13
	Pale green	07	22.58
	Dark green	05	16.13
	Purplish green	11	35.48
	Purple	03	9.68
Vein colour	Yellowish	05	16.13
	Green	24	77.42
	Pale purple	02	6.45
Petiole colour	All green with purple base	02	6.45
	All green with purple leaf junction	01	3.23
	All green with purple at both ends	02	6.45
	All purplish green with purple base	01	3.23
	All purplish green with purple leaf junction	03	9.68
	Green	22	70.97
Petiole wing colour	Green	04	12.90
	Green with purple edges	13	41.94
	Purple	01	3.23
	Other	13	41.94
A.4. Qualitative characteristics of Matured leaves			
Position of leaves	Alternate	16	51.61
	Opposite	13	41.94
	Alternate at base/opposite above	02	6.45
Leaf density	Low	14	45.16
	Intermediate	10	32.26
	High	07	22.58
Leaf type	Simple	30	96.77
	Compound	01	3.23
Leaf margin	Entire	30	96.77
	Serrate	01	3.23
Leaf margin color	Green	21	67.74
	Purple	08	25.81
	Yellowish	02	6.45
Leaf lobation	Shallowly lobed	17	54.84
	Deeply lobed	14	45.16
No. of leaflets in compound leaf	Mainly 3 (trifoliate)	01	3.23
	Mainly 5 (quinate)	30	96.77
Leatheriness	No	02	6.45
	Yes	29	93.55
Leaf colour	Yellowish	07	22.58
	Pale green	06	19.35
	Dark green	18	58.06
Leaf vein colour (upper surface)	Yellowish	23	74.19
	Green	08	25.81
Leaf vein colour (lower surface)	Yellowish	26	83.87
	Green	05	16.13
Hairiness of upper surface	Sparse	04	12.90
	Dense	05	16.13
Hairiness of lower surface	Sparse	05	16.13
	Dense	04	12.90
Waxiness of upper/lower surface	Waxy upper surface	03	9.68
	Waxy lower surface	04	12.90
	Both	17	54.84

Cont'd. Table 199.

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
Leaf shape	Ovate	01	3.23
	Cordate	10	32.26
	Cordate broad	01	3.23
	Sagittate long	03	9.68
	Sagittate broad	10	32.26
	Hastate	06	19.35
Leaf apex shape	Obtuse	14	45.16
	Acute	14	45.16
	Other	03	9.68
Undulation of leaf	Few	23	74.19
	Many	08	25.81
Distance between lobes	No measurable distance	02	6.45
	Intermediate	21	67.74
	Very distant	08	25.81
Upward folding of leaf along main vein	Weak	11	35.48
	Strong	20	64.52
Downward arching of leaf along main vein	No	14	45.16
	Yes	17	54.84
Upward folding of leaf lobes to form a cup	No	13	41.94
	Yes	18	58.06
Position of the widest part of the leaf	Third upper	24	77.42
	Middle	07	22.58
Tip colour	Light green	11	35.48
	Dark green	16	51.61
	Purple/green	03	9.68
	Red	01	3.23
Petiole length in correlation to leaf blade	Short (<2 cm)	03	9.68
	Medium (=2 cm)	03	9.68
	Long (>2 cm)	25	80.65
Hairiness of petiole	Sparse	09	29.03
	Dense	05	16.13
Petiole colour	All green with purple base	06	19.35
	All green with purple leaf junction	01	3.23
	Green	22	70.97
	Purple	01	3.23
	Brownish green	01	3.23
Petiole wing colour	Green	03	9.68
	Green with purple edges	09	29.03
	Purple	01	3.23
	Other	18	58.06
A.5. Qualitative characteristics of Aerial tubers			
Absence/presence of aerial tuber	Absent	12	38.71
	Present	19	61.29
Aerial tuber shape	Round	09	29.03
	Oval	02	6.45
	Irregular (not uniform)	06	19.35
	Elongate	02	6.45
Skin colour	Greyish	13	41.94
	Light brown	02	6.45
	Dark brown	04	12.90
	Other	12	38.71
Surface texture	Smooth	07	22.58
	Wrinkled	07	22.58
	Rough	05	16.13
Skin thickness	Thin	09	29.03
	Thick	10	32.26

Cont'd. Table 199.

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
Flesh colour	Yellowish white or off-white	09	29.03
	Yellow	05	16.13
	Orange	03	9.68
	Outer purple/inner yellowish	02	6.45
A.6.1. Underground tubers at harvest time			
Relationship of tubers	Completely separate and distant	10	32.26
	Completely separate but close together	13	41.94
	Fused at neck	08	25.81
Spininess of roots	Sparse	29	93.55
	Dense	02	6.45
Absence/presence of anchor roots	Absent	18	58.06
	Present	13	41.94
A.6.2. Underground tubers a few days after harvest			
Tuber shape	Round	05	16.13
	Oval	04	12.90
	Oval-oblong	02	6.45
	Cylindrical	05	16.13
	Flattened	01	3.23
	Irregular	09	29.03
	Other	05	16.13
Tendency of tuber to branch	Slightly branched	07	22.58
	Branched	03	9.68
	Highly branched	06	19.35
Place where tuber branches	Upper third	07	22.58
	Middle	01	3.23
	Lower third	07	22.58
Roots on the tuber surface	Few	21	67.74
	Many	10	32.26
Place of roots on the tuber	Upper	11	35.48
	Entire tuber	20	64.52
Prickly appearance of the tuber	No	19	61.29
	Yes	12	38.71
Wrinkles on tuber surface	Few	12	38.71
	Many	19	61.29
Absence/presence of blisters on tuber surface	Absent	18	58.06
	Present	13	41.94
Absence/presence of cracks on the tuber surface	Absent	19	61.29
	Present	12	38.71
Tuber skin colour (beneath the bark)	Light maroon	08	25.81
	Dark maroon	14	45.16
	Greyish	09	29.03
A.6.3. Underground tubers at planting time			
Hardness of tuber (When cut with a knife)	Hard	04	12.90
	Easy	27	87.10
Skin colour at head of the tuber	Yellowish white or off-white	07	22.58
	Yellow	04	12.90
	Orange	03	9.68
	Light purple	05	16.13
	Purple	02	6.45
	Purple with white	05	16.13
	Outer purple/inner yellowish	02	6.45
Flesh colour at central transverse cross-section	White	07	22.58
	Yellowish white or offwhite	13	41.94
	Yellow	04	12.90
	Orange	04	12.90

Cont'd. Table 199.

Descriptor	Descriptor state	No. of germplasm	Frequency (%)
	Purple with white	01	3.23
	White with purple	02	6.45
Flesh colour of lower part of tuber	White	07	22.58
	Yellowish white or off-white	13	41.94
	Yellow	04	12.90
	Orange	04	12.90
	Purple with white	03	9.68
Uniformity of flesh colour in cross-section (From cortex to centre)	No	11	35.48
	Yes	20	64.52
Texture of flesh	Smooth	15	48.39
	Grainy	09	29.03
	Very grainy	07	22.58
Amount of gum released by cut tuber	Low, 5, 7	12	38.71
	Intermediate	09	29.03
	High	10	32.26
Ability of cut tuber to irritate human skin (When tuber is rubbed on the arm)	Low	29	93.55
	High	02	6.45
Quality characteristics of tubers (Aerial and underground)			
Ease of peeling	Difficult	07	22.58
	Easy	24	77.42
Poundability of boiled tuber	Poor	11	35.48
	Good	20	64.52
Discolouration of cooking water	Very low	13	41.94
	Intermediate	05	16.13
	Very high	13	41.94
Appearance of tuber after cooking	Poor	07	22.58
	Fair	08	25.81
	Good	16	51.61
Colour of tuber after cooking	White, not coloured	15	48.39
	Intermediate	07	22.58
	Highly coloured	09	29.03
Attractiveness of cooked tuber (With respect to colour alone)	Low	05	16.13
	Intermediate	10	32.26
	High	16	51.61
Erosion of tuber upon cooking	No	20	64.52
	Yes	11	35.48
Texture of cooked tuber	Smooth	14	45.16
	Grainy	09	29.03
	Fibrous	08	25.81
Stickiness of cooked tuber	Sticky	24	77.42
	Very sticky	05	16.13
Flavour of cooked tuber	Very acceptable	03	9.68
Bitterness of cooked tuber	Not bitter	26	83.87
	Bitter	03	9.68
	Very bitter	02	6.45
Sweetness of cooked tuber	Not sweet 1 2	15	48.39
	Sweet	14	45.16
	Very sweet	02	6.45
Overall assessment of cooked tuber	Low	08	25.81
	Intermediate	09	29.03
	High	14	45.16

Yam germplasm of this study showed three types of matured leaf position viz. alternate (51.61%), opposite (41.94%) and alternate at base/opposite above (6.45%). Maximum variation in matured leaf characters was observed for leaf shape. Leaf shape of most of the germplasm was cordate (32.26%) and sagitate broad (32.26%). Leaf color varied from yellowish green (in 22.58% germplasm) to dark green (in 58.06% germplasm). The testes germplasm also showed wide range of variability for other characteristics of matured leaves studied. Most of the characterized germplasm of yam (61.29%) produced aerial tubers, which varied from round to elongate in shape. Skin color, surface texture, skin thickness and flesh color of aerial tubers varied widely among the tested germplasm of yam (Table 199).

Underground tubers at harvest time were completely separate and distant in 32.26% germplasm, completely separate but close together in 41.94% and fused at neck in 25.81% germplasm. Spininess of roots was sparse in most of the germplasm (93.55%) and dense in the rest. Anchor root was absent in 58.06% and present in 41.94% germplasm. Shape of underground tubers a few days after harvest showed wide variation among the germplasm of yam. These were round, oval, oval oblong, cylindrical, flattened, irregular and other. Maximum germplasm had irregular tuber shape (29.03%) while minimum had flattened shape (Table 199).

Wide variations were also found in characteristics of underground tubers at planting time. Hardness of tuber (when cut with a knife) was hard (12.90%) and easy (87.10%). Skin color at head of the tuber varied from off-white to purple. Flesh color at central transverse cross-section and lower part of the tuber varied from white to purple with white. Variations were also noticed for uniformity of flesh color, flesh texture, quantity of gum released by cut tuber and ability of cut tuber to irritate human skin. Quality parameters of aerial and underground tubers also varied greatly among the tested germplasm of yam.

B. Quantitative descriptor

The difference between minimum and maximum values of the studied traits reflected the existence of diversity among the accessions (Table 200). Wide range of diversity was observed in tuber length (6.00 to 58.67 cm), tuber width (4.67 to 89.00 cm), 'days to emergence' (38.33 to 74.33 days), stem height (3.27 to 14.20 m), internodes length (7.33 to 28.33 cm), yield of aerial tuber (0.00 to 15.37 kg), yield of underground tuber (1.23 to 13.14 kg), stem diameter (2.07 to 10.14 mm). Coefficient of variation was highest for number of tubers per hill (CV-95.42%) followed by number of internodes to first branching (CV 89.28%) and time for flesh oxidation after cutting (CV 85.88%). Minimum qualitative variation was observed for days to emergence (range 38.33 to 74.33 days and CV- 20.05%).

Table 200. Quantitative variation of different descriptors in yam

Descriptor	Range		Mean	SD	CV (%)
	Min	Max			
Days to emergence	38.33	74.33	52.45	10.52	20.05
Stem length (cm)	111.00	310.00	190.15	61.90	32.55
Internode number	4.33	20.33	7.72	3.59	46.52
Stem height (m)	3.26	14.20	9.65	3.04	31.55
Stem diameter (cm)	2.06	10.14	6.01	2.22	36.89
Internode length (cm)	7.33	28.33	17.93	5.10	28.46
Wing size (mm)	1.43	2.90	1.95	0.45	23.17
Spine length (cm)	1.23	5.86	2.78	1.50	53.91
No of internodes to first branching	1.66	89.33	35.34	31.55	89.28
No. of leaves at 30 DAE	2.66	36.00	13.72	9.29	67.72

Descriptor	Range		Mean	SD	CV (%)
	Min	Max			
Tip length (mm)	1.30	35.30	10.97	8.69	79.22
Petiole length (cm)	3.76	19.16	9.30	3.43	36.84
Leaf area (cm ²)	82.80	255.23	176.46	49.92	28.29
Aerial tuber diameter (cm)	1.60	12.25	7.04	3.36	47.68
Number of tubers per hill	1.00	12.00	2.76	2.63	95.42
Tuber length (cm)	6.00	58.66	25.09	17.62	70.21
Tuber skin thickness (mm)	0.45	1.70	0.78	0.29	37.29
Tuber width (cm)	4.67	89.00	33.19	5.95	44.63
Time for flesh oxidation after cutting (min.)	0.20	2.37	1.13	0.97	85.88
Yield of aerial tuber per plant (kg)	0.00	15.37	4.12	1.25	45.24
Yield of underground tuber per plant (kg)	1.23	13.14	4.84	1.21	38.20

Morphological characteristics of young and matured Stem

Qualitative characteristics of young stem

Stem and wing color at young stage showed wide variation among the studied accessions of *Dioscorea* (Table 201). Stem color at young stage varied from green to brownish green and wing color was green, purple and green with purple edges in the accessions having wing. Waxiness, wings, hairiness, spines and barkly patches were absent or present in young stem of the accessions.

Qualitative characteristics of matured stem

The accessions showed difference on morphological characters of matured stem based on plant type, twining direction (right side – anticlockwise and left side-clockwise), stem color, wing color, ridges (absence or presence), hairiness, wrinkled surface, waxiness (absence or presence), scale leaves (absence or presence), scale leaf position, spines on stem base (few/many), spines on stem above base (few/many), spine position, spine shape, coalescent spines (absence or presence), color of spot at spine base (Table 201).

Table 201. Qualitative characters of young and matured stem of yam

Acc. No.	Young stem							Matured stem													
	Stem color	Waxiness	Wings	Wing color	Hairiness	Spines	Barkly patches	Plant type	Twining direction	Stem color	Wing color	Ridges	Hairiness	Waxiness	Spines on stem base	Spines on stem above base	Spine position	Spine shape	Coalescent spines	Color spot at spine base	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
RMHF001	3	0	0	-	1	0	0	3	2	3	-	0	7	0	0	0	-	-	0	-	
RHMF002	1	1	0	-	1	1	0	2	1	1	-	0	7	0	7	7	3	2	1	99	
RHMF003	3	0	0	-	1	1	0	3	1	4	-	1	7	0	3	7	3	2	1	3	
RHMF004	3	1	0	-	0	0	1	2	2	2	-	1	-	1	0	0	-	-	0	-	
RMHF005	2	1	1	2	0	0	1	3	2	2	2	1	-	1	0	0	-	-	0	-	
RMHF006	1	0	0	-	1	0	0	3	2	3	-	0	7	0	0	0	-	-	0	-	
RMHF007	3	1	1	1	0	1	1	3	2	3	2	1	-	1	7	3	3	2	1	2	
RMHF008	2	1	0	-	1	0	0	3	1	2	-	0	3	1	0	0	-	-	0	-	
RMHF009	2	0	0	-	1	0	0	3	2	3	-	0	7	0	0	0	-	-	0	-	
RMHF010	2	1	1	1	0	0	1	3	2	1	1	1	-	1	0	0	-	-	0	-	
RMHF011	1	1	0	-	0	0	0	3	1	1	-	1	3	1	0	0	-	-	0	-	
RMHF012	1	0	0	-	1	0	0	3	2	3	-	0	7	0	0	0	-	-	0	-	
RMHF013	1	1	1	1	0	0	0	3	2	1	1	1	-	1	0	0	-	-	0	-	

Acc. No.	Young stem							Matured stem													
	Stem color	Waxiness	Wings	Wing color	Hairiness	Spines	Bark patches	Plant type	Twining direction	Stem color	Wing color	Ridges	Hairiness	Waxiness	Spines on stem base	Spines on stem above base	Spine position	Spine shape	Coalescent spines	Color spot at spine base	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
RMHF014	1	1	1	2	0	0	1	3	2	1	1	1	-	1	0	0	-	-	0	-	
RMHF015	1	1	1	2	0	0	1	3	2	2	2	1	-	1	0	0	-	-	0	-	
RHMF016	2	1	0	-	0	0	0	2	1	1	-	1	-	1	0	0	-	-	0	-	
RMHF017	1	1	0	-	0	0	0	3	1	1	-	1	-	1	0	0	-	-	0	-	
RMHF018	1	1	0	-	0	0	0	3	1	1	-	1	-	1	0	0	-	-	0	-	
RMHF019	1	1	0	-	0	0	0	3	1	1	-	1	-	1	0	0	-	-	0	-	
RMHF020	5	1	1	3	0	0	1	2	2	2	2	1	-	1	0	0	-	-	0	-	
RMHF021	5	1	1	3	0	0	1	3	2	2	2	1	-	1	0	0	-	-	0	-	
RMHF023	2	1	0	-	0	0	1	3	2	1	-	1	-	1	0	0	-	-	0	-	
RMHF025	1	1	0	-	1	0	0	3	1	3	-	0	3	1	0	0	-	-	0	-	
RMHF026	1	1	0	-	0	0	1	2	2	2	-	1	3	1	0	0	-	-	0	-	
RMHF027	1	1	0	-	0	0	0	3	1	1	-	1	-	1	0	0	-	-	0	-	
RMHF028	2	1	1	2	0	1	1	3	2	3	2	1	3	0	7	3	2	3	1	3	
RMHF029	2	1	1	2	0	1	1	3	2	3	2	1	3	0	7	7	2	3	1	3	
RMHF030	2	1	1	2	0	1	1	3	2	2	2	1	3	0	7	3	2	1	1	3	
RMHF031	2	1	1	2	0	1	1	3	2	3	2	1	3	0	7	3	2	1	1	3	
RMHF032	1	1	0	-	0	0	1	3	1	3	-	1	3	1	0	0	-	-	0	-	
RMHF033	2	1	1	2	0	0	1	3	2	2	2	1	3	1	0	0	-	-	0	-	

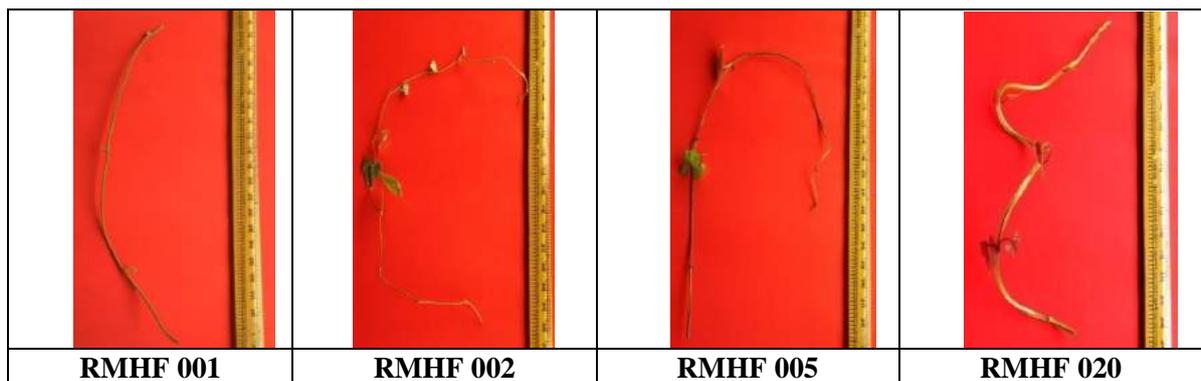


Fig. 167. Young stem of *Dioscorea* spp.

Quantitative characteristics of young stem

All the 31 accessions of yam accessions were subjected to quantitative analysis pertaining to young stem on Days of emergence (days), Stem length (cm), Internode number. The data generated were further statistically analyzed applying standard (MSTAT) tools. Number of days to emergence varied significantly among the genotypes. RMHF010 took minimum time for emergence (38.33 days) closely proceeded by RMHF014 (39.33 days) and RMHF013 (40.66 days). Maximum time to emergence were taken by RMHF 006 and RMHF009 (74.33 days) closely followed by RMHF001 (72.33 days) and RMHF003 (71.66 days). Length of young stem ranged from 111.00 cm in RMHF028 to 310.00 cm in RMHF006. Number of internode in young stem was highest (20.33) in RMHF 010 followed by RMHF 002 (17.33). The minimum number of internode (4.33) was found in RMHF009.

Quantitative characteristics of matured stem

All the accession of yam accessions were evaluated for stem height (m), stem diameter (mm), internodes length (cm), wing size (mm), spine length (mm) and no of internodes to first branching. Albeit, stem height was recorded after 8 months of cultivation, while rest of the parameters linked with matured stem were recorded after 6 months. The details values for the different characteristics feature of mature stem are presented in Table 202.

Table 202. Quantitative characters of young and matured stem of yam

Acc. no	Days to emergence (days)	Stem length (cm)	Internode number	Stem height (m)	Stem diameter (mm)	Internodes length (cm)	Wing size (mm)	Spine length (mm)	No of internodes to first branching
RMHF001	72.33	250.00	4.66	11.83	4.61	27.66	-	-	87.00
RHMF002	43.66	176.66	17.33	5.60	2.06	7.33	-	1.60	2.33
RHMF003	71.66	223.33	5.66	8.96	6.90	28.33	-	5.86	78.00
RHMF004	63.66	116.66	9.00	3.26	2.20	10.03	-	-	14.00
RMHF005	46.66	280.00	7.66	10.33	9.46	21.00	2.26	-	62.00
RMHF006	74.33	310.00	6.00	6.66	8.40	27.00	-	-	50.66
RMHF007	47.66	303.33	5.66	9.23	5.50	21.33	1.66	1.23	33.00
RMHF008	63.33	136.66	7.00	9.66	7.50	16.00	-	-	33.66
RMHF009	74.33	291.66	4.33	10.96	3.76	13.93	-	-	72.66
RMHF010	38.33	192.66	20.33	11.33	5.24	15.00	1.53	-	2.33
RMHF011	45.66	113.33	5.66	9.56	4.33	11.66	-	-	9.00
RMHF012	47.66	151.33	5.33	13.10	4.10	22.00	-	-	46.00
RMHF013	40.66	169.33	12.66	14.20	9.13	12.83	1.73	-	2.66
RMHF014	39.33	220.00	10.66	9.66	6.15	13.33	1.53	-	2.33
RMHF015	45.00	283.33	6.33	13.23	10.14	20.00	2.63	-	2.66
RHMF016	43.33	201.00	11.00	5.50	4.96	21.33	-	-	5.66
RHMF017	47.33	206.33	6.00	12.00	4.96	21.33	-	-	47.66
RHMF018	50.33	161.33	5.66	11.33	4.96	21.33	-	-	66.33
RHMF019	43.00	220.33	6.00	13.56	7.63	19.33	-	-	65.00
RMHF020	51.66	114.00	7.33	3.40	8.53	10.33	1.43	-	2.33
RMHF021	50.00	202.66	6.33	11.83	9.46	21.00	1.86	-	2.66
RMHF023	68.00	149.00	6.66	8.83	6.76	18.66	-	-	2.33
RMHF025	49.33	145.33	8.66	9.73	4.86	23.00	-	-	41.33
RMHF026	51.66	116.00	9.33	3.50	3.63	15.50	-	-	1.66
RMHF027	49.00	128.00	5.00	9.83	3.80	16.66	-	-	2.00
RMHF028	53.00	111.00	5.33	9.83	5.53	15.00	2.05	2.50	51.66
RMHF029	48.33	145.00	6.33	10.66	5.40	17.33	1.58	2.93	89.33
RMHF030	56.00	115.66	4.66	11.66	5.53	15.00	2.21	2.83	80.00
RMHF031	54.00	207.33	8.00	10.50	5.70	16.00	1.93	2.50	52.66
RMHF032	43.66	247.66	6.00	6.00	5.00	16.66	-	-	9.00
RMHF033	53.00	205.66	8.66	13.33	10.13	20.00	2.90	-	77.66
LSD _{0.05}	2.98	27.07	1.89	2.38	0.77	2.43	0.21	0.33	2.61
LSD _{0.01}	3.96	36.01	2.51	3.16	1.02	3.23	0.28	0.45	3.48

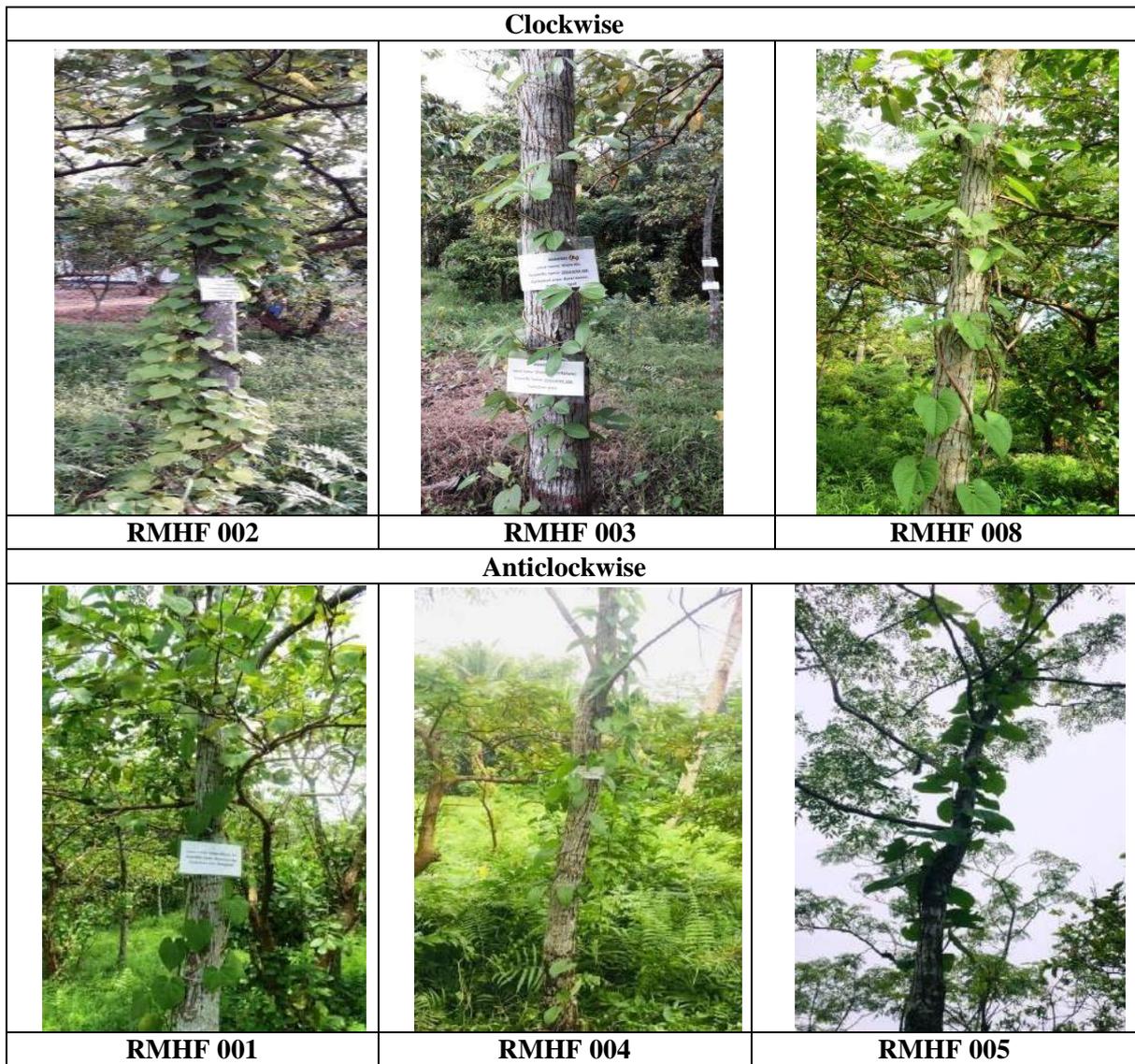


Fig. 168. Twining direction of matured stem of yam



Fig. 169. Spine of matured yam stem

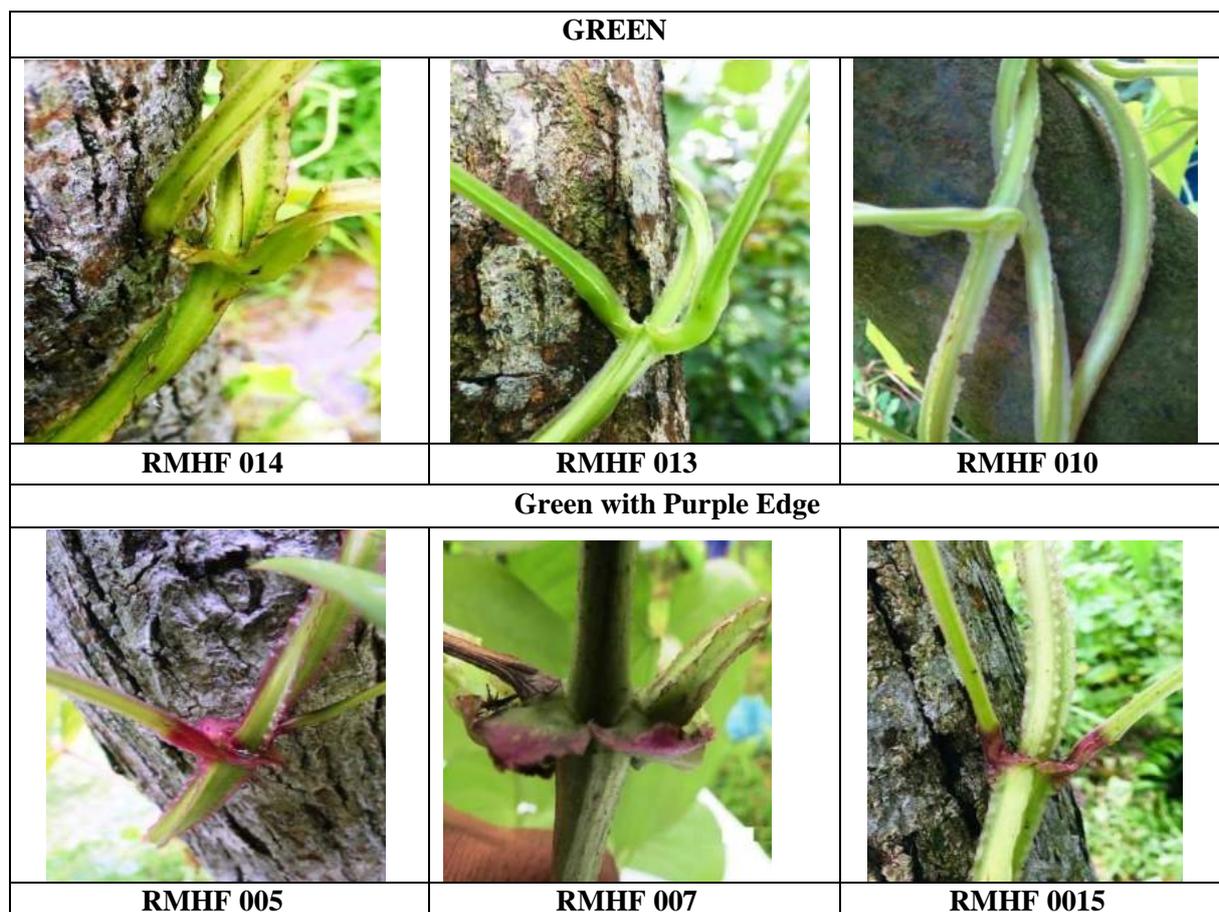


Fig. 170. Wing color of matured yam stem

Morphological characteristics of young and matured leaves

Qualitative characteristics of young leaf

It clearly substantiated the noticeable variation with respect to the qualitative characteristics of young leaf especially first leaf emergence, leaf color, leaf margin color, vein color, petiole color, petiole wing color, hairiness of upper/lower surface of leaf (Table 203).

Qualitative characteristics of matured leaf

The variation in qualitative characters of matured leaves of *Dioscorea spp.* are presented in Table 203. Morphological analysis of matured leaf of the *Dioscorea* accessions was undertaken for several parameters including position of leaves, leaf density, leaf type, leaf margin, leaf lobation, number of leaflets in compound leaf, leatheriness, leaf color, leaf vein color (upper surface and lower surface), Leaf margin colour, Hairiness of upper surface, Hairiness of lower surface, Waxiness upper/lower surface, Leaf shape, Leaf apex shape, Undulation of leaf, Distance between lobes, Upward folding of leaf along main vein, Downward arching of leaf along main vein, Upward folding of leaf lobes to form a cup, Position of the widest part of the leaf, Tip color, Petiole length in correlation to leaf blade, Hairiness of petiole, Petiole color, Petiole wing color.

Table 203. Qualitative characters of young and matured leaf of yam accessions

Acc. No.	Young leaf					Matured leaf										
	First leaf emergence	Leaf color	Vein color	Petiole color	Petiole wing color	Position of leaves	Leaf density	Leaf type	Leaf margin	Leaf lobation	No. of leaflets in compound leaf	Leatheriness	Leaf color	Leaf vein color (upper surface)	Leaf vein color (lower surface)	Leaf margin colour
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
RMHF001	2	2	2	7	-	1	3	1	1	1	-	0	2	2	1	2
RHMF002	1	2	2	7	-	1	7	1	1	2	-	1	2	2	2	1
RHMF003	2	3	2	7	-	1	3	2	2	1	1	1	3	2	1	2
RHMF004	1	5	2	3	-	1	3	1	1	1	-	1	3	2	2	1
RMHF005	1	1	2	3	3	2	3	1	1	2	-	1	3	1	1	2
RMHF006	2	4	2	7	-	1	3	1	1	1	-	1	1	1	1	1
RMHF007	2	2	1	7	2	2	7	1	1	1	-	1	1	1	1	99
RMHF008	2	3	2	2	-	1	5	1	1	2	-	1	3	1	1	1
RMHF009	1	2	2	7	-	1	3	1	1	1	-	1	2	1	1	1
RMHF010	1	3	1	7	2	2	3	1	1	1	-	1	2	1	1	1
RMHF011	1	3	1	7	1	1	5	1	1	1	-	1	2	1	1	1
RMHF012	1	2	2	7	-	3	3	1	1	1	-	1	1	1	1	1
RMHF013	1	2	2	7	1	2	5	1	1	2	-	1	3	1	1	1
RMHF014	1	2	2	7	2	2	7	1	1	1	-	1	1	1	1	1
RMHF015	1	5	2	2	1	2	3	1	1	2	-	1	3	2	1	1
RHMF016	1	4	2	7	-	1	3	1	1	1	-	1	3	2	1	99
RHMF017	1	1	2	7	-	1	3	1	1	1	-	1	3	1	1	1
RHMF018	1	5	2	7	-	1	3	1	1	1	-	1	3	1	1	1
RHMF019	1	5	2	7	-	1	3	1	1	1	-	1	3	1	1	1
RMHF020	1	4	3	2	2	2	7	1	1	2	-	1	1	1	2	2
RMHF021	1	3	3	2	2	3	7	1	1	2	-	1	1	1	2	2
RMHF023	1	5	2	7	1	2	5	1	1	1	-	1	3	1	1	1
RMHF025	2	1	2	1	2	1	3	1	1	2	-	1	1	2	2	2
RMHF026	1	1	1	7	-	1	7	1	1	1	-	1	3	2	1	1
RMHF027	1	1	2	7	-	1	5	1	1	2	-	1	3	1	1	1
RMHF028	2	3	1	7	2	2	5	1	1	2	-	1	3	1	1	1
RMHF029	2	3	2	7	2	2	5	1	1	2	-	1	3	1	1	1
RMHF030	2	3	2	7	2	2	5	1	1	2	-	1	3	1	1	1
RMHF031	2	3	2	7	2	2	5	1	1	2	-	1	3	1	1	1
RMHF032	2	3	2	1	2	1	5	1	1	1	-	1	3	1	1	2
RMHF033	2	3	2	1	2	2	7	1	1	2	-	1	2	1	1	2

Table 203. Qualitative characters of young and matured leaves (Cont'd)

Accession No.	Hairiness of upper surface	Hairiness of lower surface	Waxiness upper/lower surface	Leaf shape	Undulation of leaf	Distance between lobes	Upward folding of leaf along main vein	Downward arching of leaf along main vein	Upward folding of leaf lobes to form a cup	Position of the widest part of the leaf	Tip color	Petiole length in correlation to leaf blade	Hairiness of petiole	Petiole color	Petiole wing color
1	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
RMHF001	7	3	3	2	3	5	3	0	1	2	1	3	7	7	-
RHMF002	3	3	2	1	7	5	3	0	1	1	1	7	3	7	-
RHMF003	7	7	0	99	7	1	7	0	1	2	1	7	7	9	-
RHMF004	3	3	2	5	3	5	3	1	0	1	1	7	0	5	-
RMHF005	0	0	1	8	3	5	7	0	1	2	2	7	3	3	3
RMHF006	7	7	3	2	3	5	3	0	0	1	2	3	7	7	-
RMHF007	0	0	3	6	3	5	7	0	1	1	2	5	0	7	2

Accession No.	Hairiness of upper surface	Hairiness of lower surface	Waxiness upper/lower surface	Leaf shape	Undulation of leaf	Distance between lobes	Upward folding of leaf along main vein	Downward arching of leaf along main vein	Upward folding of leaf lobes to form a cup	Position of the widest part of the leaf	Tip color	Petiole length in correlation to leaf blade	Hairiness of petiole	Petiole color	Petiole wing color
1	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
RMHF008	0	0	3	2	3	5	3	0	1	1	3	5	0	8	-
RMHF009	7	7	2	2	3	5	3	1	1	2	1	3	7	7	-
RMHF010	0	0	3	5	3	9	7	0	0	1	3	5	0	7	1
RMHF011	0	0	1	4	3	5	3	0	1	1	1	7	0	7	-
RMHF012	7	7	2	2	3	1	3	1	0	1	2	7	7	7	-
RMHF013	0	0	3	5	3	9	7	1	0	1	2	7	3	7	1
RMHF014	0	0	3	6	3	5	3	1	0	2	2	7	0	7	1
RMHF015	3	7	3	6	3	5	7	1	1	1	2	7	0	3	2
RHMF016	0	0	0	8	3	5	7	1	1	1	3	7	3	7	-
RHMF017	0	0	0	8	3	5	7	1	1	1	1	7	3	7	-
RHMF018	0	0	0	8	3	5	7	1	1	1	1	7	3	7	-
RHMF019	0	0	3	8	3	5	7	1	0	1	1	7	3	7	-
RMHF020	0	0	3	6	3	5	7	0	1	1	2	7	0	3	2
RMHF021	0	0	3	6	3	5	7	0	1	1	2	7	0	3	2
RMHF023	0	0	3	2	3	5	3	0	1	2	2	7	0	7	-
RMHF025	0	0	3	2	7	9	7	1	0	1	1	7	3	3	-
RMHF026	3	0	1	2	3	5	3	0	1	1	2	7	3	7	-
RMHF027	0	0	3	2	7	9	7	1	0	1	2	7	0	7	-
RMHF028	0	0	0	6	7	9	7	1	0	1	2	7	0	7	2
RMHF029	0	0	3	6	7	9	7	1	0	1	2	7	0	7	2
RMHF030	0	0	0	6	7	9	7	1	0	1	2	7	0	7	2
RMHF031	0	0	0	6	7	9	7	1	0	1	2	7	0	7	2
RMHF032	0	0	3	2	3	5	7	0	1	1	1	7	0	7	-
RMHF033	0	0	3	8	3	5	7	1	1	2	1	7	0	3	2

Quantitative characteristics of young leaf

The number of young leaves on 30 days after of stem emergence of the *Dioscorea* accessions were examined and recoded. The variation in number of the leaves across the yam accession is presented in Table 204. The highest number (36.00) of leaves was recorded in RMHF013 and it was lowest (2.66) in RHMF003. The statistical analysis highlighted significant variation ($P < 0.01$) among thirty three accessions.

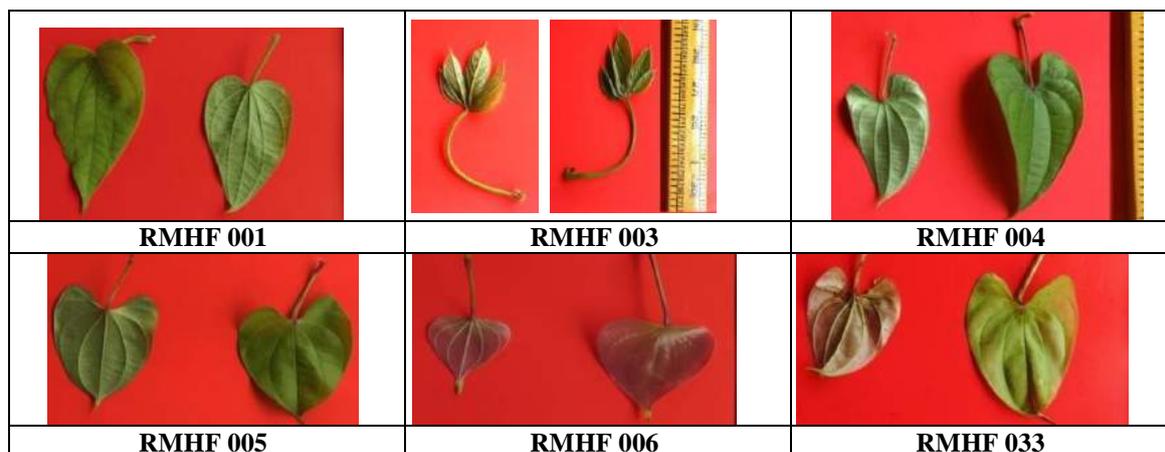


Fig. 171. Young leaf of *Dioscorea* spp

Quantitative characteristics of matured leaf

To determine the quantitative characters of matured leaf, tip length, petiole length and leaf area were recorded (Table 204). Wide variations were observed among the genotypes for all these traits. The genotype RMHF011 had the longest tip (35.30 mm) closely followed by RMHF032 (32.20 mm) and RMHF014 (29.46 mm). Shortest tip (1.30 mm) was observed in RMHF003. Petiole length of matured leaf was maximum (19.16 cm) in RMHF019 followed by RMHF018 (15.70 cm), RMHF014 (14.36 cm), RMHF002 (13.93 cm) and RMHF011 (13.00 cm). The petiole (3.76 cm) was produced by RMHF006. Area of matured leaf varied from 82.80 to 255.23 cm². The maximum leaf area was recorded in RMHF019 followed by RMHF013 (247.76 cm²), RMHF014 (239.80 cm²) and RMHF012 (235.53 cm²).

Table 204. Quantitative characters of young and matured leaf of yam

Acc.no.	Young leaf	Matured leaf		
	No. of leaves	Tip length (mm)	Petiole length (cm)	Leaf Area (cm ²)
RMHF001	3.33	5.23	10.10	234.50
RHMF002	17.33	1.76	13.93	144.03
RHMF003	2.66	1.30	7.73	230.13
RHMF004	9.33	3.03	9.13	82.80
RMHF005	18.00	8.90	9.23	210.50
RMHF006	3.33	2.83	3.76	171.33
RMHF007	3.00	3.76	9.96	192.43
RMHF008	3.00	5.76	7.43	165.66
RMHF009	3.66	4.36	4.80	233.30
RMHF010	31.66	9.06	10.63	93.36
RMHF011	16.00	35.30	13.00	137.20
RMHF012	5.00	16.20	11.33	235.53
RMHF013	36.00	3.60	7.00	247.76
RMHF014	25.00	29.46	14.36	239.80
RMHF015	26.66	15.20	10.00	141.93
RHMF016	26.66	3.00	8.00	134.26
RHMF017	10.00	4.90	5.66	189.73
RHMF018	12.66	12.70	15.70	203.86
RHMF019	14.33	13.83	19.16	255.23
RMHF020	19.00	17.06	6.83	171.13
RMHF021	18.33	10.30	10.00	207.60
RMHF023	16.66	6.80	12.66	127.36
RMHF025	21.66	14.20	8.00	107.60
RMHF026	19.66	5.83	7.33	135.83
RMHF027	6.33	4.73	6.33	110.06
RMHF028	10.66	16.60	4.50	211.66
RMHF029	4.66	13.46	9.16	215.46
RMHF030	4.66	14.63	8.50	178.76
RMHF031	5.33	14.93	7.83	120.40
RMHF032	11.33	32.20	6.16	134.60
RMHF033	19.33	9.30	10.00	206.50
LSD_{0.05}	4.98	2.48	1.43	18.51

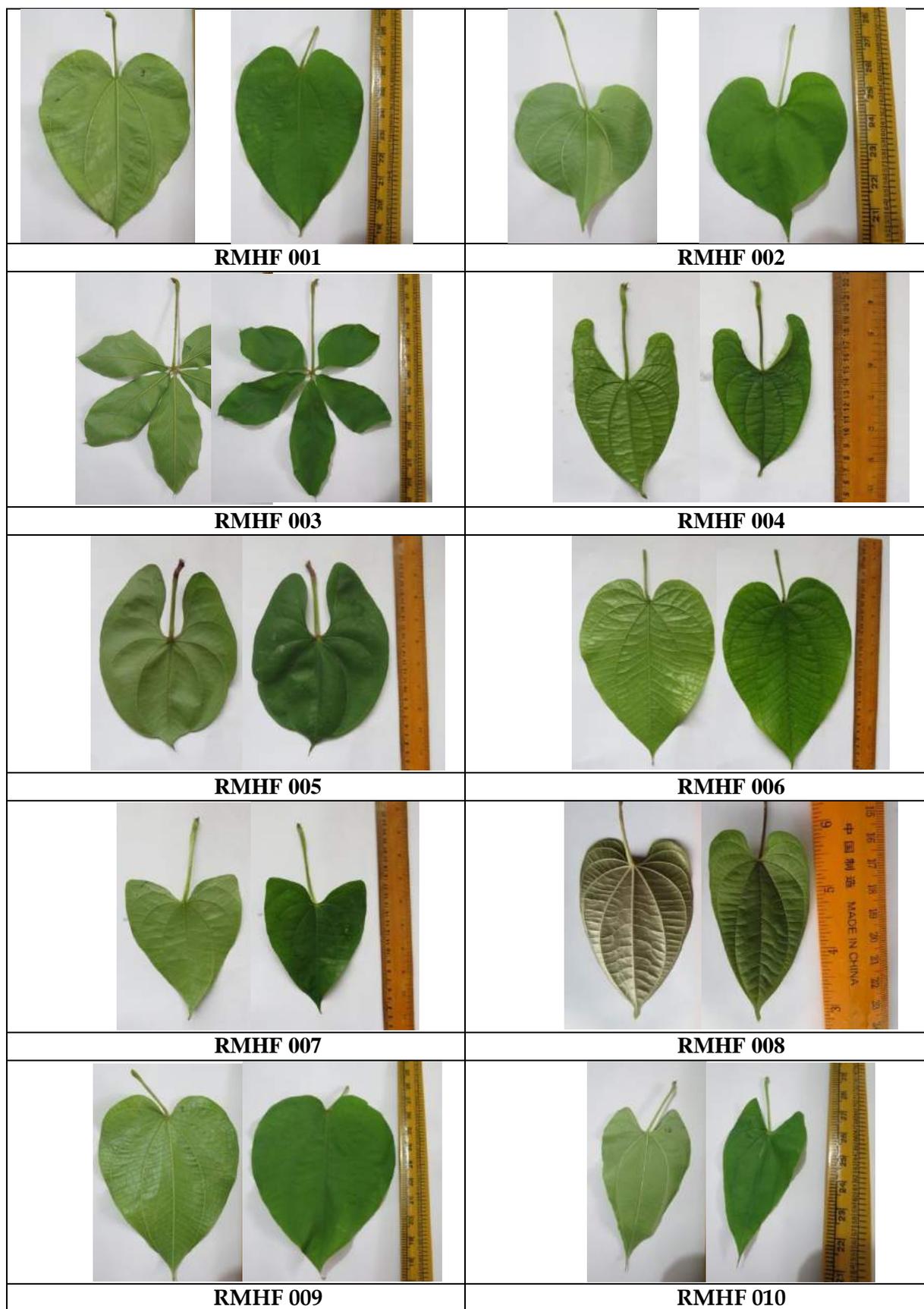


Fig. 172. Matured leaf (Upper and lower surface) of *Dioscorea* spp

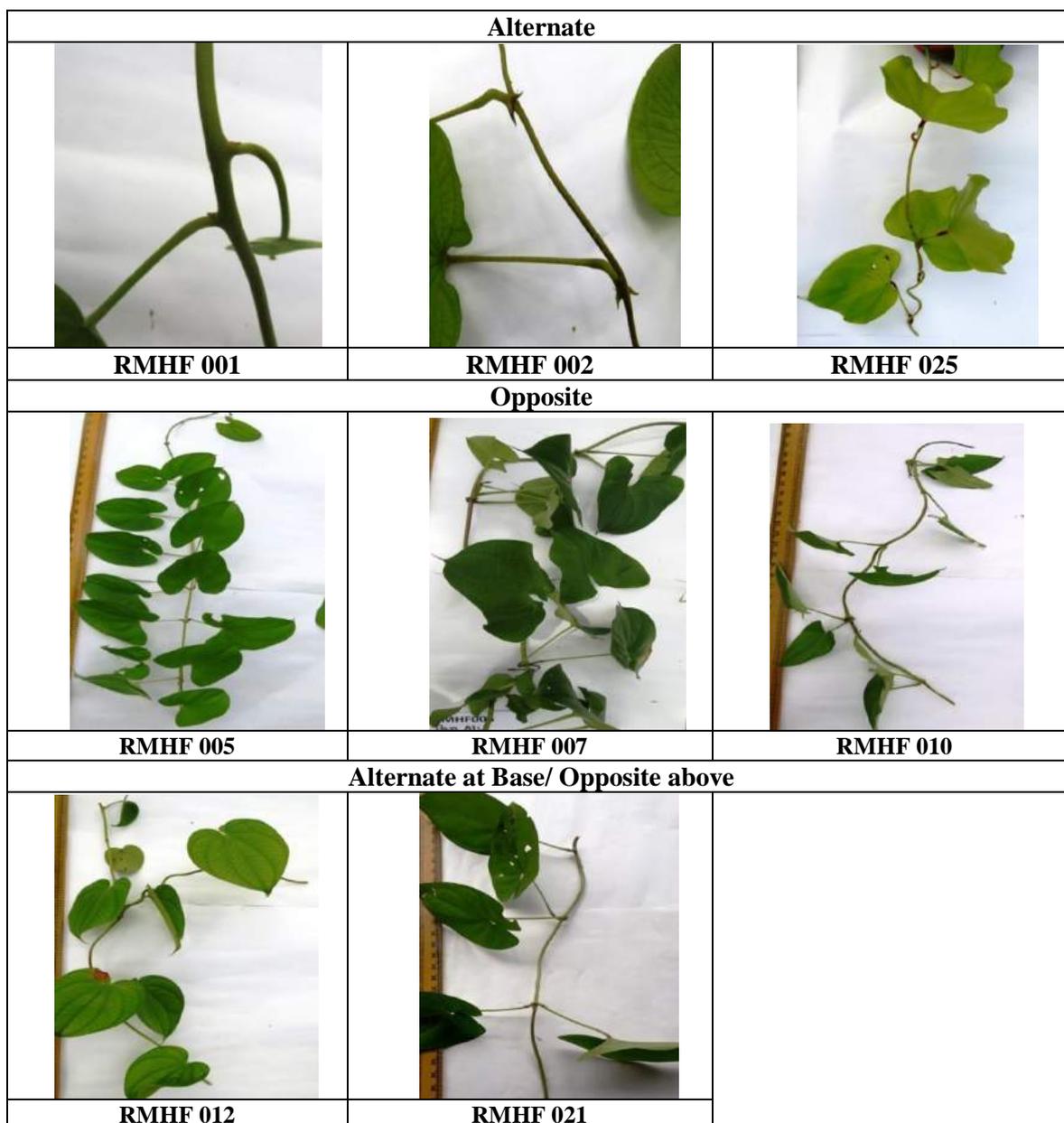


Fig. 173. Position of leaf of *Dioscorea spp.*

Morphological characteristics of aerial and underground tubers

Qualitative characteristics of aerial tubers (bulbil)

Some of the accessions of yam inherently produce aerial tubers in addition to underground tuber production. The aerial tubers of yam are also known as ‘air potato’ or ‘bulbils’. Often, these are small in size with different shapes, such as oblong, round or irregular. Albeit, aerial tubers of all *Dioscorea spp.* are not edible because of the presence of undesirable phytochemicals, nevertheless, few accessions of yam produce bulbils, which are fit for human consumption and are very popular among the farmers, especially the indigenous population. Bulbils are also called ‘offsets’, when these are full-sized and are used to grow new crop. Detailed characteristic features of the aerial tubers observed in the present investigation are presented in Table 205. Aerial tuber and transverse section of aerial tubers of yam are shown in Fig. 174.

Qualitative characteristics of underground tuber at harvest time

In the present experiment, thirty one accessions were yam accessions produce underground tubers. The investigation noticed 1 to 3 tubers per season among the different native germplasm of yam plants. The qualitative characteristics pertaining to tuber growth, relationships of tubers, absence/presence of corms, absence/presence of rhizomes, spininess of roots, absence/presence anchor roots were recorded at the time of harvest and data are presented in Table 205. In fact, all the yam accessions of the current experimental module displayed development of underground tuber characterized by annual growth pattern. Further, corms and rhizome were absent on the underground tubers of all the accessions.

Table 205. Qualitative characteristics of aerial and underground tubers of yam

Acc. no.	Aerial tubers							Underground tubers at harvest time				
	Aerial tuber	Shape	Skin color	Surface texture	Bumps	Skin thickness	Flesh color	Relationship of tubers	Corms	Rhizome	Spininess of roots	Anchor roots
1	2	3	4	5	6	7	8	9	10	11	12	13
RMHF001	1	1	2	1	1	3	3	1	0	0	0	0
RHMF002	0	-	-	-	0	-	-	2	0	0	7	1
RHMF003	1	3	3	3	1	7	2	1	0	0	3	1
RHMF004	0	-	-	-	0	-	-	2	0	0	0	0
RMHF005	1	4	3	2	1	7	1	1	0	0	0	1
RMHF006	0	-	-	-	0	-	-	1	0	0	0	0
RMHF007	1	3	1	2	1	7	2	3	0	0	0	1
RMHF008	1	1	3	3	1	7	2	1	0	0	0	1
RMHF009	1	1	2	1	1	3	3	1	0	0	0	0
RMHF010	0	-	-	-	0	-	-	2	0	0	0	0
RMHF011	1	1	3	3	1	3	2	2	0	0	0	0
RMHF012	0	-	-	-	0	-	-	2	0	0	0	1
RMHF013	0	-	-	-	0	-	-	3	0	0	0	0
RMHF014	0	-	-	-	0	-	-	3	0	0	0	0
RMHF015	1	2	1	3	1	7	1	1	0	0	0	1
RHMF016	0	-	-	-	0	-	-	2	0	0	0	0
RHMF017	1	1	1	1	1	3	2	2	0	0	0	0
RHMF018	1	1	1	1	1	3	2	2	0	0	0	0
RHMF019	1	1	1	1	1	3	2	2	0	0	0	0
RMHF020	1	2	1	3	1	3	9	2	0	0	0	1
RMHF021	0	-	-	-	0	-	-	2	0	0	0	1
RMHF023	0	-	-	-	0	-	-	1	0	0	0	0
RMHF025	0	-	-	-	0	-	-	1	0	0	0	0
RMHF026	0	-	-	-	0	-	-	2	0	0	0	0
RMHF027	1	1	1	1	1	3	2	2	0	0	0	0
RMHF028	1	3	1	2	1	7	2	3	0	0	0	1
RMHF029	1	3	1	2	1	7	2	3	0	0	0	1
RMHF030	1	3	1	2	1	7	2	3	0	0	0	1
RMHF031	1	3	1	2	1	7	2	3	0	0	0	1
RMHF032	1	1	1	1	1	3	2	2	0	0	0	0
RMHF033	1	4	3	2	1	7	2	3	0	0	0	0

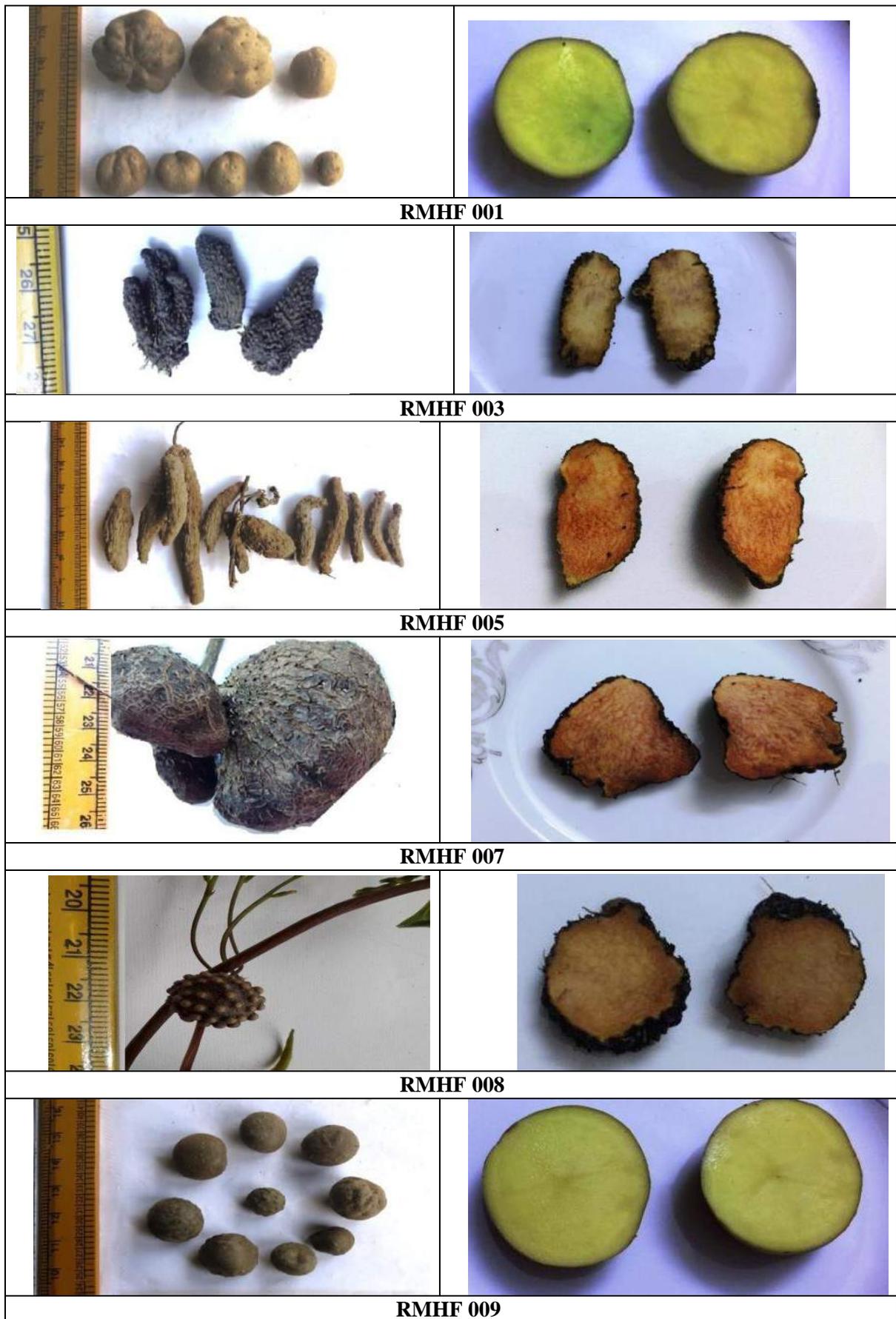
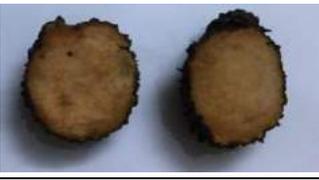
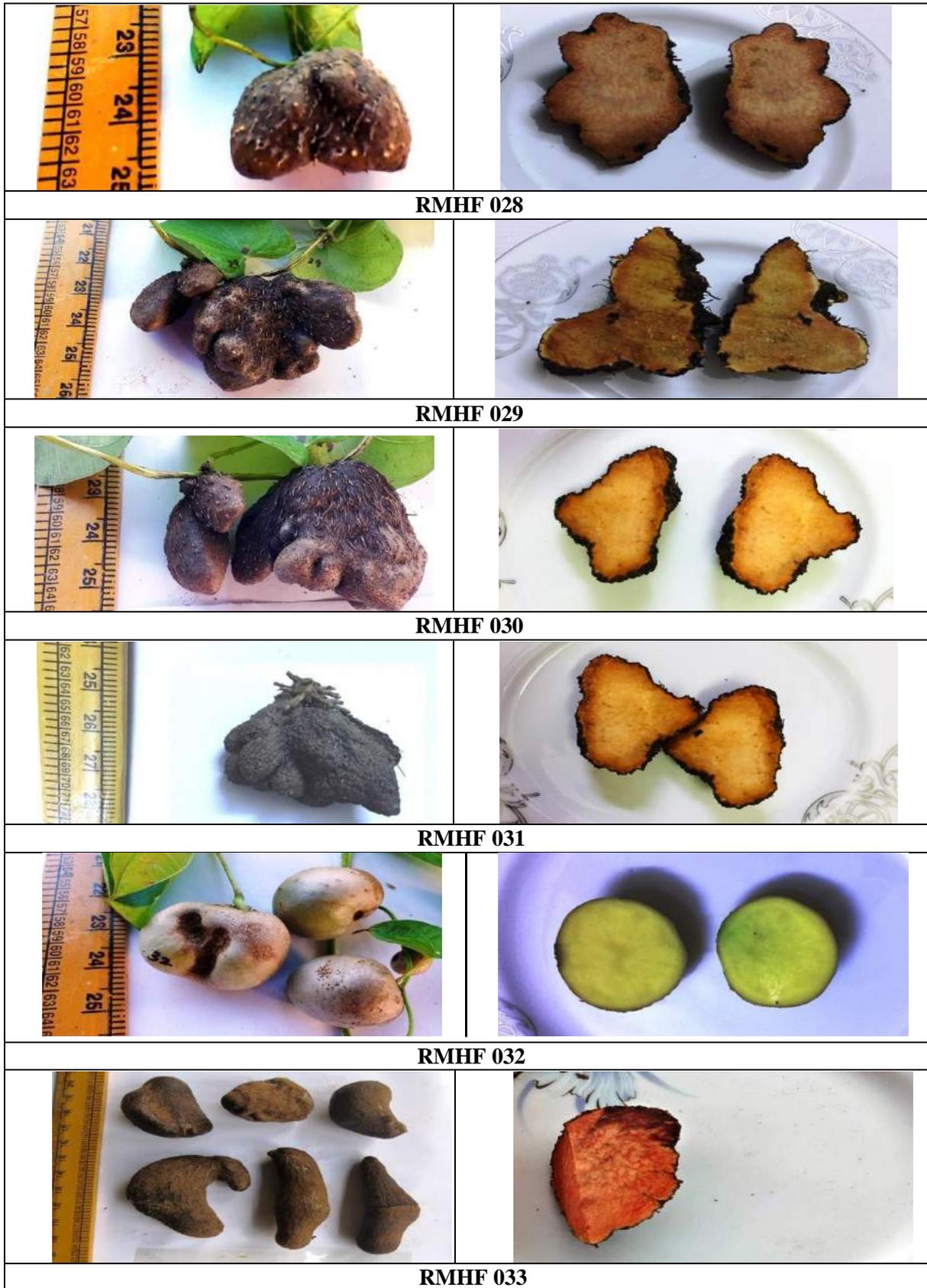


Fig. 174. Aerial tuber and transverse section of aerial tubers of yam

	
RMHF 011	
	
RMHF 015	
	
RMHF 017	
	
RMHF 18	
	
RMHF 019	
	
RMHF 020	
	
RMHF 027	

Cont'd. Fig. 174. Aerial tuber and transverse section of aerial tubers of yam



Cont'd. Fig. 174. Aerial tuber and transverse section aerial tubers of yam

Quantitative characteristics of aerial tubers of Yam

Aerial tuber is one of the most important identical morphological features of *Dioscorea spp.* Not all species borne aerial tuber or bulbil. Some specific genotypes have these characters. The details values for aerial tuber diameter (cm) and yield of aerial tuber per plant (kg) are presented in Table 206. There were different types and shape of aerial tuber was found in current experiment. The recorded values showed that the aerial tuber diameter was lowest for RHMf003 (1.60 cm), followed by RMHF020 (2.33 cm). The highest value was recorded for RMHF007 (12.25 cm) followed by RMHF033 (12.10 cm) (Table 206).

Morphological characteristics of underground tubers

The tubers of *Dioscorea spp.* is one of the important energy sources among the large population in several countries of Asia, Africa and America. It produces shallow fibrous root systems, normally un-branched and concentrated within the top layer of the soil, and very few actually penetrate up to one meter depth. The tuber is the storage organ and shrivels away simultaneously when the re-growth is induced.

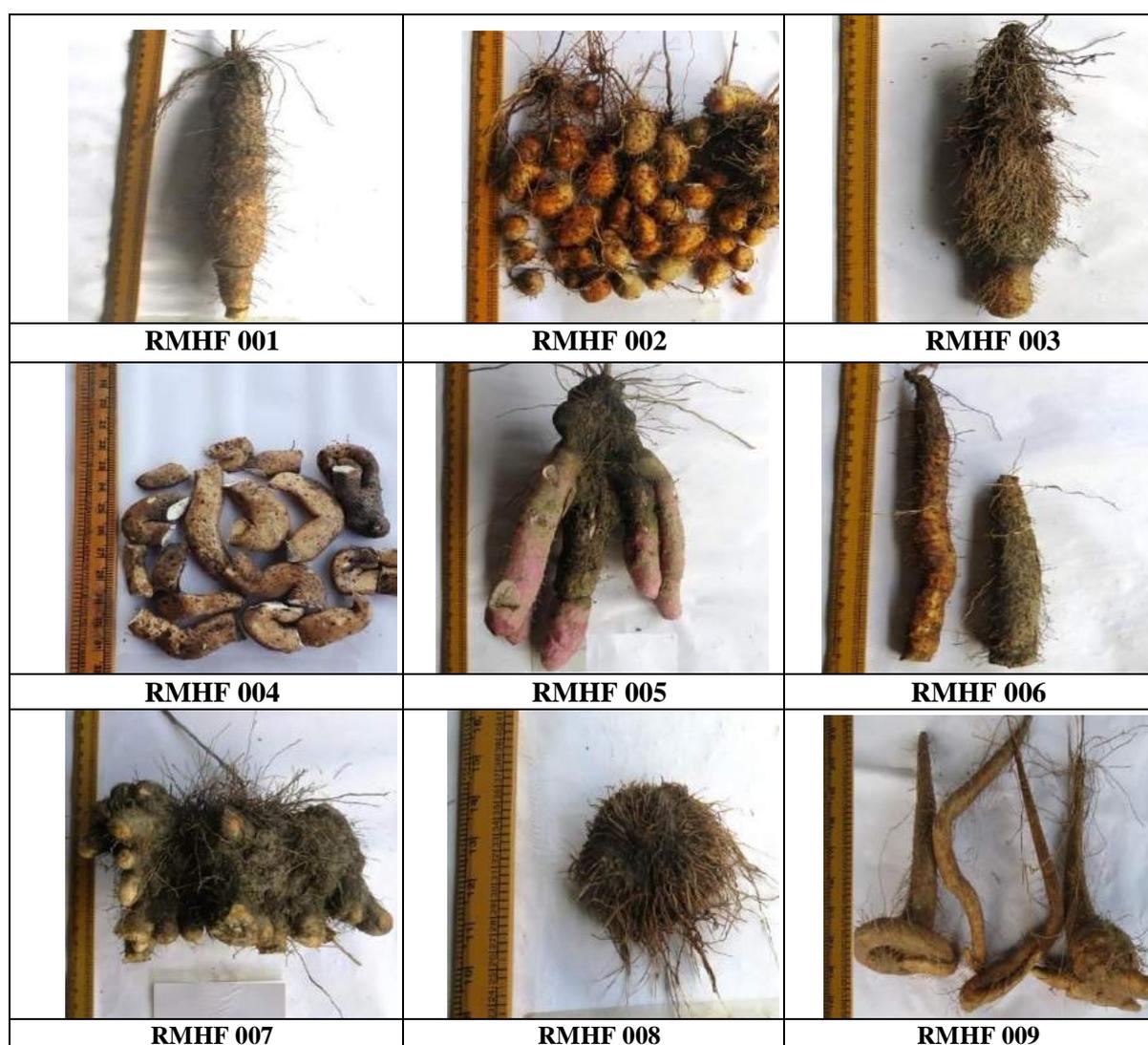
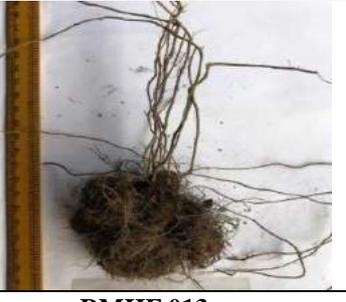
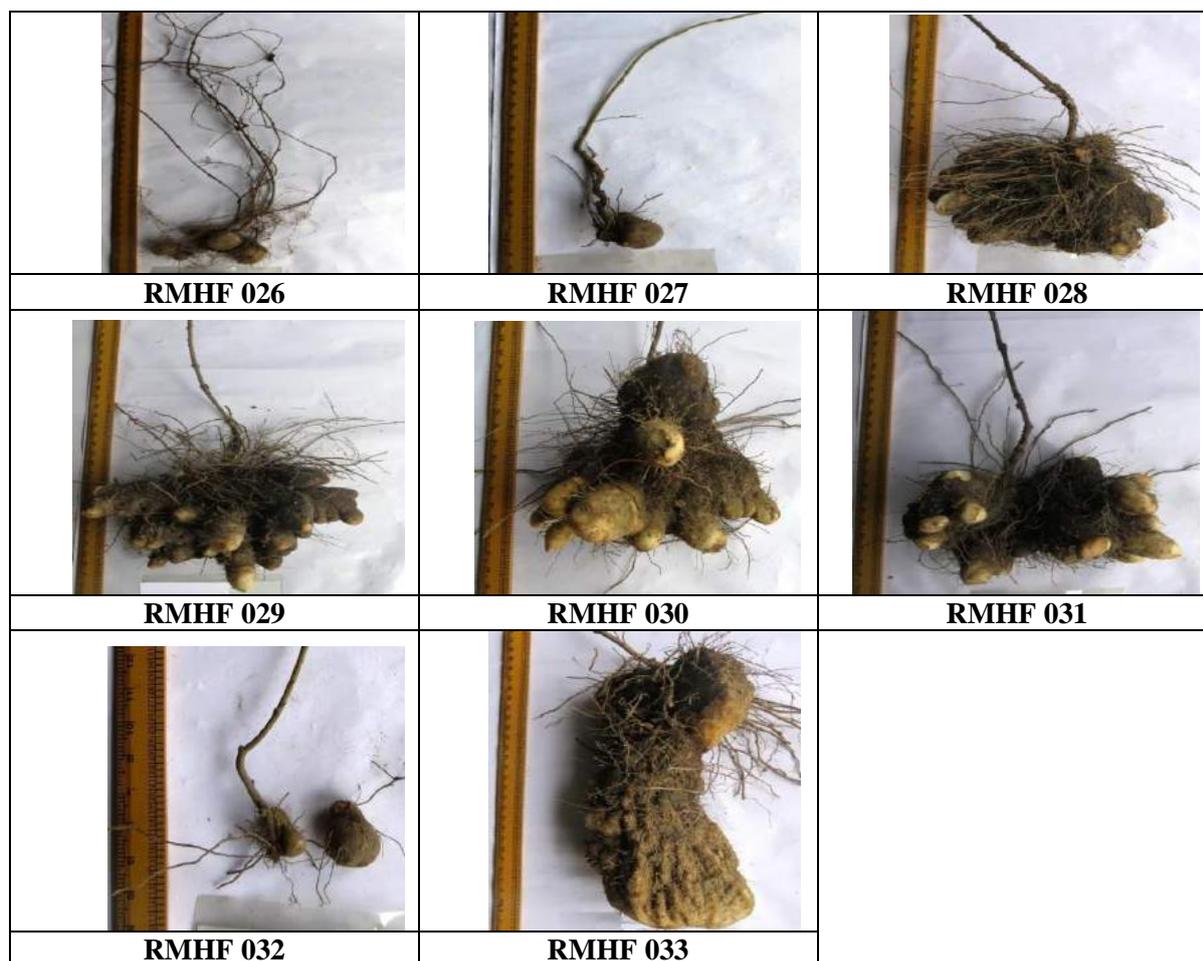


Fig. 175. Underground tuber of yam

		
RMHF 010	RMHF 011	RMHF 012
		
RMHF 013	RMHF 014	RMHF 015
		
RMHF 016	RMHF 017	RMHF 018
		
RMHF 019	RMHF 020	RMHF 021
		
RMHF 022	RMHF 023	RMHF 025



Cont'd. Fig. 175. Underground tuber of yam

Characteristics of underground tuber few days after harvest

Morphological characteristics of underground tuber at 5 to 7 days after harvest were thoroughly investigated among the native yam germplasm. The characteristic features which were considered for the underground tuber analysis were shape, tendency of tuber to branch, place where tuber branches, roots on the tuber surface, place of roots on the tuber. The features typical to the accessions pertaining to post harvest morphological characteristics is presented in Table 205, Fig. 176 and Fig. 177.

Table 205. Qualitative characters of aerial and underground Yam Tubers (Cont'd)

Acc. no	Underground tubers after a few days of harvest											Underground tubers at planting time							
	Tuber shape	Tendency of tuber to branch	Place where tuber branches	Roots on the tuber surface	Place of roots on the tuber	Prickly appearance of the tuber	Wrinkles on tuber surface	Blisters on tuber surface	Cracks on the tuber surface	Tuber skin color (beneath the bark)	Hardness of tuber	Skin colour at head of the tuber	Flesh colour at central transverse cross-section	Flesh colour of lower part of tuber	Uniformity of flesh colour in cross-section	Texture of flesh	Flesh oxidation colour	Amount of gum released by cut tuber	Ability of cut tuber to irritate human skin
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RMHF001	4	0	-	3	4	1	3	0	0	3	2	99	2	2	1	1	1	3	0
RHMF002	2	0	-	3	4	0	3	1	0	3	2	3	1	3	1	1	1	5	0
RHMF003	99	3	2	7	4	1	3	1	0	3	1	99	4	4	1	3	1	3	3
RHMF004	7	3	1	3	4	1	3	1	0	3	2	10	1	10	1	1	1	3	0
RMHF005	6	7	2	3	4	0	7	0	1	2	2	6	7	6	1	2	1	5	0
RMHF006	4	0	-	3	4	1	3	0	0	3	2	99	2	3	1	3	1	3	0

Acc. no	Underground tubers after a few days of harvest											Underground tubers at planting time							
	Tuber shape	Tendency of tuber to branch	Place where tuber branches	Roots on the tuber surface	Place of roots on the tuber	Prickly appearance of the tuber	Wrinkles on tuber surface	Blisters on tuber surface	Cracks on the tuber surface	Tuber skin color (beneath the bark)	Hardness of tuber	Skin colour at head of the tuber	Flesh colour at central transverse cross-section	Flesh colour of lower part of tuber	Uniformity of flesh colour in cross-section	Texture of flesh	Flesh oxidation colour	Amount of gum released by cut tuber	Ability of cut tuber to irritate human skin
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RMHF007	6	3	3	7	4	0	7	1	1	2	2	3	2	3	1	2	1	5	0
RMHF008	99	3	3	7	4	1	7	1	0	2	1	99	2	99	1	3	1	3	3
RMHF009	4	0	-	3	4	0	3	1	1	2	2	99	2	4	1	3	1	3	0
RMHF010	6	5	1	3	3	0	7	1	0	3	2	2	1	10	0	2	1	7	0
RMHF011	2	0	-	3	3	0	3	1	0	3	2	6	3	99	1	1	1	3	0
RMHF012	4	0	-	7	4	1	3	0	0	3	2	10	4	10	1	2	1	3	0
RMHF013	6	0	-	3	3	0	7	0	0	2	2	99	1	4	0	1	1	3	0
RMHF014	8	3	1	3	3	0	7	0	0	2	2	10	1	2	1	2	1	7	0
RMHF015	6	7	1	7	3	0	7	1	1	2	1	99	4	99	0	3	1	3	0
RHMF016	1	0	-	3	4	1	3	0	0	1	2	5	2	5	1	1	1	5	0
RHMF017	1	0	-	3	4	1	3	0	0	1	2	5	2	5	1	1	1	5	0
RHMF018	1	0	-	3	4	1	3	0	0	1	2	5	2	5	1	1	1	5	0
RHMF019	1	0	-	3	4	1	3	0	0	1	2	5	2	5	1	1	1	5	0
RMHF020	3	5	1	3	4	0	7	1	1	1	2	9	8	6	1	2	99	3	0
RMHF021	3	5	1	3	4	0	7	1	0	2	2	9	8	6	0	2	2	5	0
RMHF023	5	3	1	3	4	0	7	1	1	1	2	99	3	99	0	3	1	7	0
RMHF025	4	0	-	7	4	1	7	1	1	2	1	3	4	4	1	3	1	3	0
RMHF026	1	0	-	3	3	0	3	0	0	1	2	2	1	10	1	1	1	5	0
RMHF027	2	0	-	3	3	0	3	0	0	2	2	2	1	10	0	2	1	7	0
RMHF028	6	7	3	7	3	0	7	0	1	2	2	2	2	3	0	1	1	7	0
RMHF029	6	7	3	7	3	0	7	0	1	2	2	2	2	3	0	1	1	7	0
RMHF030	6	7	3	7	3	0	7	0	1	2	2	2	2	3	0	1	1	7	0
RMHF031	6	7	3	7	3	0	7	0	1	2	2	2	2	3	0	1	1	7	0
RMHF032	2	0	-	3	4	1	3	0	0	1	2	5	3	10	1	1	1	3	0
RMHF033	3	3	1	3	4	0	7	1	1	3	2	3	3	2	0	2	1	7	0

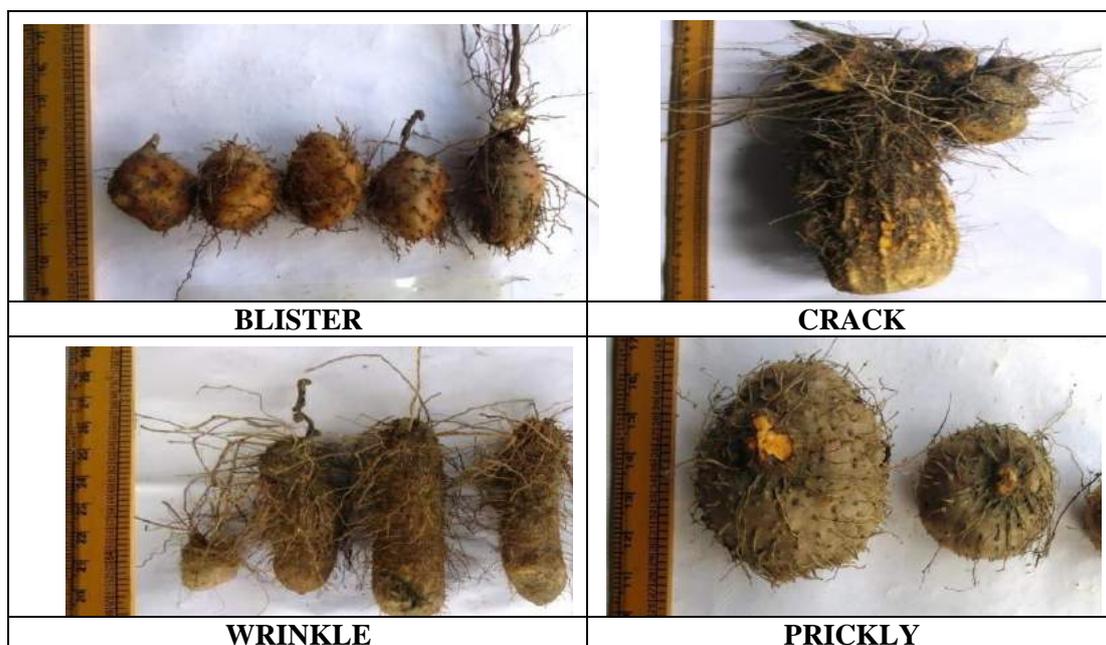


Fig. 176. Blister, crack, wrinkle and prickly appearance of underground yam tuber

Characteristics of underground tuber at before planting time

Morphological characters of underground tubers were assessed by following dissection. The tubers of the collected native germplasm of yam were subjected to evaluation before planting at BAU-GPC. The following descriptor were used, namely: hardness of tuber, skin colour at head of the tuber, flesh colour at central transverse cross-section, flesh colour of lower part of tuber, uniformity of flesh colour in cross-section, texture of flesh, flesh oxidation colour, amount of gum released by cut tuber, ability of cut tuber to irritate human skin (Fig. 177).

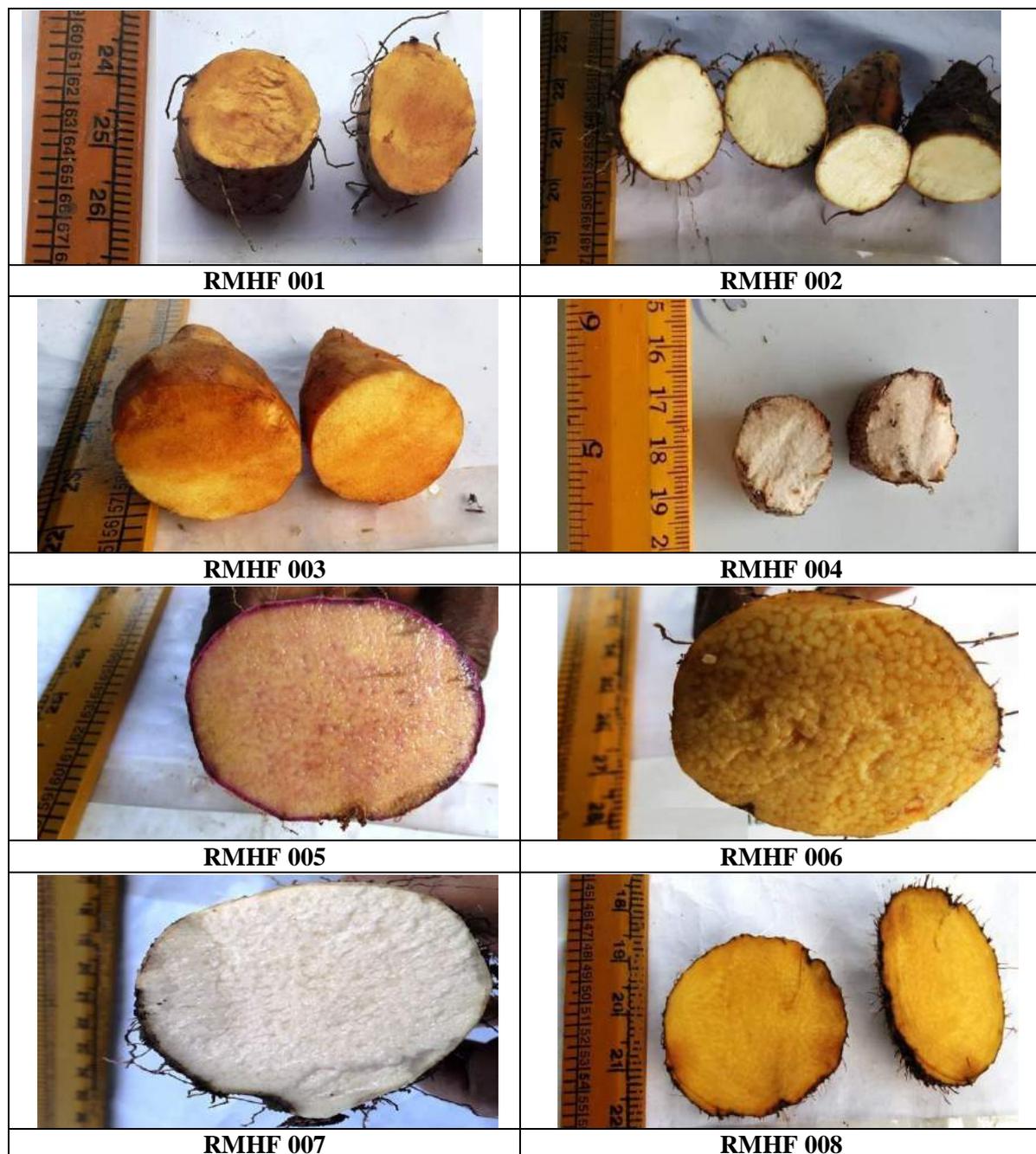
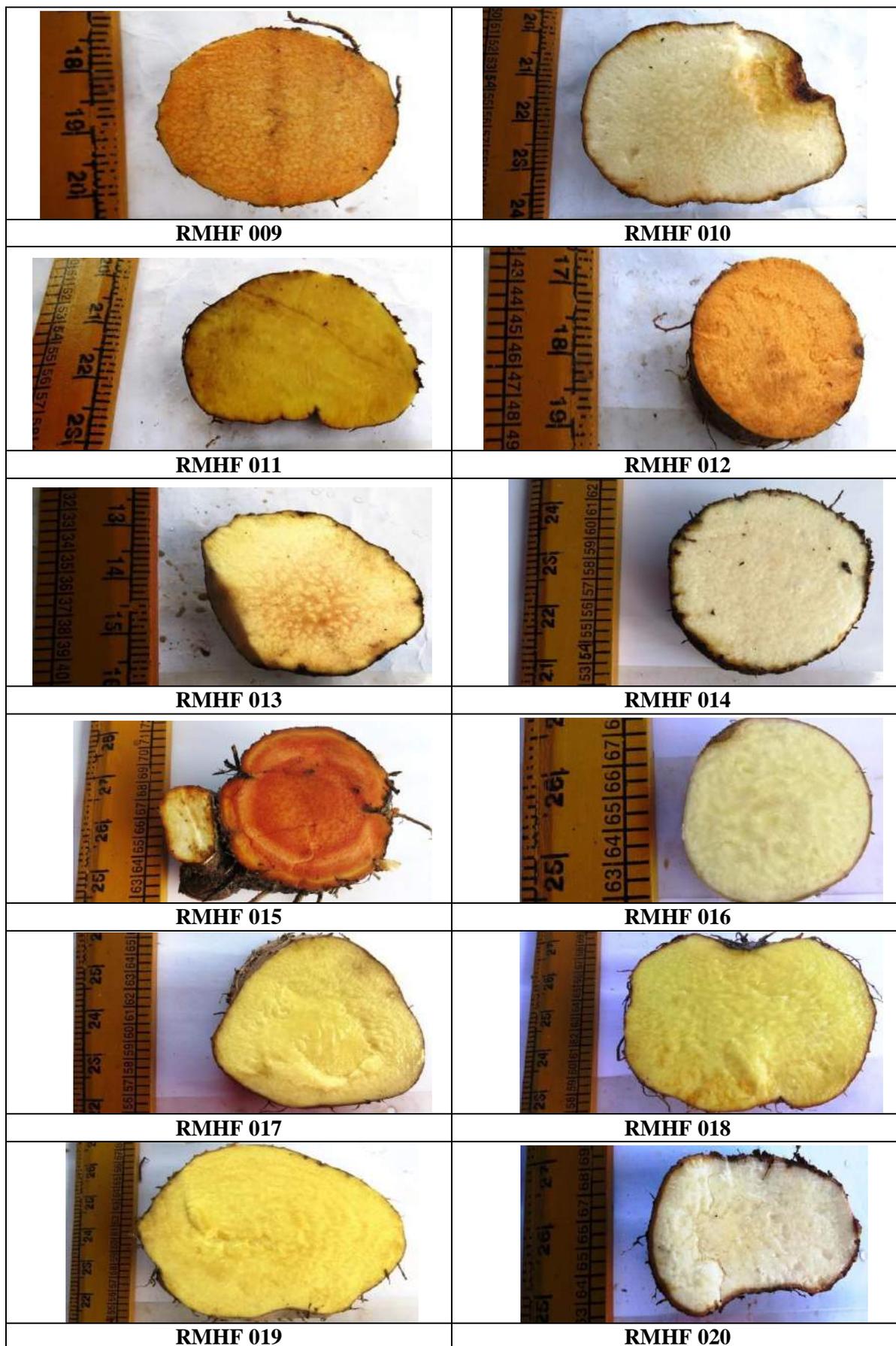
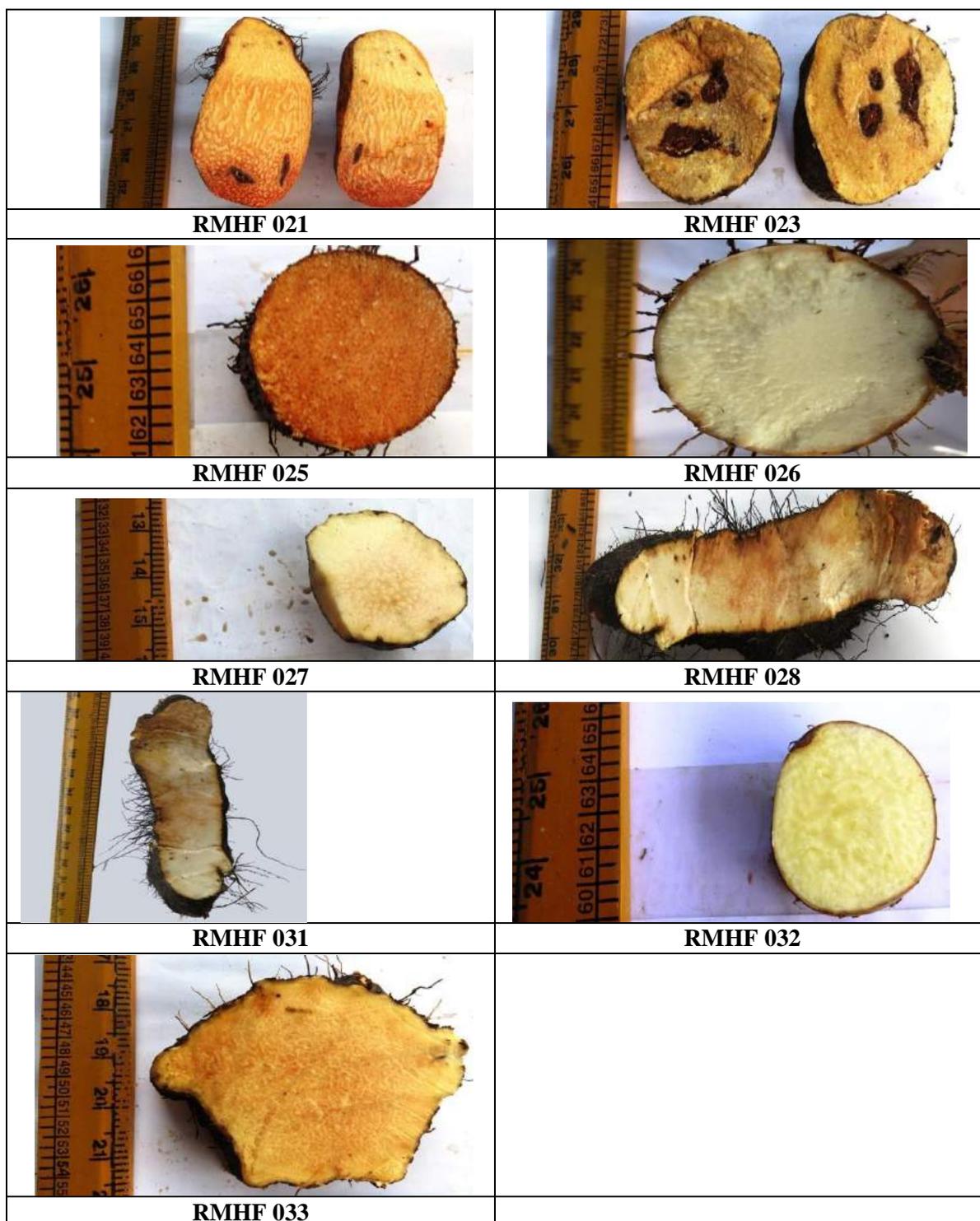


Fig. 177. Transverse section of underground yam tuber



Cont'd. Fig. 177. Transverse section of underground yam tuber



Cont'd. Fig. 177. Transverse section of underground yam tuber

Quantitative characteristics of underground tuber

To determine the quantitative characters of underground tuber, a number of parameters were identified and accordingly the data were recorded in tables. The parameters included number of tubers per hill, tuber length (cm), tuber skin thickness (mm), time for flesh oxidation after cutting (min) and tuber width (cm). The set of numerical description of underground tubers encompassing other parameters is presented in Table 206.

Yield of aerial tuber per plant

From the recorded measurements of Table 206, it was observed the highest yield of aerial tuber was found 4.71kg for RMHF011 and the lowest yield was observed 1 kg for the accession no RMHF008 of yam plant.

Yield of underground tuber per plant

From the recorded measurements of Table 206, it was observed the lowest yield of underground tuber was 0.98 kg for RMHF011 followed by 1.22 kg for RMHF008 and yield of underground tuber was found 9.96 kg for RMHF033 followed by 6.57 kg for RMHF005.

Quality characteristics of underground tubers

The organoleptic evaluation of yam tubers after boiling was carried out by the panel of evaluators at BAU-GPC. The quality parameters that were considered for evaluation of boiled yam tubers were ease of peeling, poundability, discoloration of water after boiling, Appearance of tuber after cooking, colour of tuber after cooking, Attractiveness of cooked tuber, Erosion of tuber upon cooking, Texture of cooked tuber, stickiness, flavor of cooked tuber, bitterness, sweetness, overall assessment etc. Evidently, it was possible to judge the quality of yams based on the sensory evaluation as it is one of the important steps for acceptability of foods and their subsequent usages (Table 207) (Fig. 178).

Table 206. Quantitative characteristics of aerial and underground tubers of yam

Acc. no	Aerial tuber diameter (cm)	No. of tubers perhill	Tuber length (cm)	Tuberskin thickness(mm)	Tuber width (cm)	Time for flesh oxidation after cutting (min)	Yield of aerial tuber per plant (Kg)	Yield of underground tuber/plant (kg)
RMHF001	9.46	1.66	58.66	0.69	10.33	2.05	2.66	3.05
RHMF002	-	12.00	6.00	0.55	8.66	0.24	-	3.00
RHMF003	1.60	1.00	36.00	1.70	13.66	2.08	2.00	3.09
RHMF004	-	4.00	42.66	0.48	2.33	0.34	-	2.77
RMHF005	3.71	1.00	56.66	0.94	20.00	0.20	1.60	6.57
RMHF006	-	1.66	45.66	0.93	7.83	1.97	-	2.40
RMHF007	12.25	1.00	31.00	0.64	28.16	0.55	2.90	5.20
RMHF008	3.76	1.00	18.00	1.34	12.50	2.31	1.00	1.22
RMHF009	7.00	1.66	50.00	0.55	11.33	2.26	2.76	2.30
RMHF010	-	5.00	14.33	0.87	12.50	0.24	-	4.34
RMHF011	4.86	3.33	11.66	0.45	10.16	2.28	4.71	0.98
RMHF012	-	1.00	42.00	0.72	7.00	2.34	-	3.11
RMHF013	-	1.00	13.00	0.76	12.16	0.24	-	2.64
RMHF014	-	1.00	22.00	0.83	11.33	0.53	-	2.92
RMHF015	2.78	1.00	16.66	0.95	16.16	0.25	2.00	3.35
RHMF016	-	2.33	10.66	0.61	11.16	0.22	-	3.31
RHMF017	7.5	2.66	13.00	0.67	16.00	0.28	3.56	3.58
RHMF018	8.6	2.33	9.66	0.65	16.50	0.32	4.66	3.17
RHMF019	10.62	2.00	7.00	0.53	14.00	0.38	4.02	3.17
RMHF020	2.33	6.00	6.33	0.87	12.00	2.37	1.35	2.30
RMHF021	-	5.33	16.00	0.75	26.33	2.22	-	4.02
RMHF023	-	1.00	48.33	0.88	16.33	1.36	-	2.42
RMHF025	-	1.00	36.33	0.80	6.33	0.81	-	2.76
RMHF026	-	2.33	6.00	0.47	7.66	0.42	-	1.04
RMHF027	10.53	1.66	6.33	0.54	10.33	0.80	4.34	1.21
RMHF028	6.90	1.00	36.00	0.82	36.66	0.26	2.83	4.70

Acc. no	Aerial tuber diameter (cm)	No. of tubers perhill	Tuber length (cm)	Tuberskin thickness(mm)	Tuber width (cm)	Time for flesh oxidation after cutting (min)	Yield of aerial tuber per plant (Kg)	Yield of underground tuber/plant (kg)
RMHF029	6.33	1.00	39.00	0.57	38.66	0.19	3.10	4.23
RMHF030	6.40	1.00	25.00	0.89	38.66	0.32	2.43	4.63
RMHF031	5.78	1.00	26.00	0.73	44.50	0.29	2.63	4.96
RMHF032	11.21	3.00	5.33	0.43	7.00	2.17	5.48	2.12
RMHF033	12.10	1.00	57.00	0.75	33.16	0.17	1.91	9.96
LSD _{0.05}	1.78	0.86	10.80	0.28	7.38	0.19	1.06	1.21
LSD _{0.01}	2.40	1.15	14.36	0.37	9.82	0.26	1.43	1.61

Table 207. Quality characteristics of Yam tubers

Acc. no	Ease of peeling	Preferred cooking method	Poundability of boiled tuber	Discolouration of cooking water	Appearance of tuber after cooking	Colour of tuber after cooking	Attractiveness of cooked tuber	Erosion of tuber upon cooking	Texture of cooked tuber	Stickiness of cooked tuber	Flavour of cooked tuber	Bitterness of cooked tuber	Sweetness of cooked tuber	Overall assessment of cooked tuber
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RMHF001	2	2	2	9	7	1	7	0	3	1	1	0	1	7
RHMF002	2	2	2	1	7	1	7	0	1	2	2	0	2	5
RHMF003	1	2	1	9	3	9	5	0	3	1	1	2	0	3
RHMF004	2	2	2	9	7	1	7	0	1	2	2	0	1	5
RMHF005	2	2	2	5	5	9	5	1	2	2	1	0	0	5
RMHF006	2	2	1	9	5	9	5	0	3	1	1	1	0	3
RMHF007	2	2	1	9	5	9	5	1	1	2	1	0	1	5
RMHF008	1	2	1	1	5	9	3	0	1	1	1	2	0	3
RMHF009	2	2	1	9	3	9	3	0	3	0	1	0	0	3
RMHF010	2	2	2	5	7	1	7	1	2	1	2	0	2	7
RMHF011	2	2	2	9	5	5	5	0	1	1	1	0	0	5
RMHF012	2	2	1	9	5	9	3	0	3	0	1	1	0	3
RMHF013	2	2	2	1	5	1	7	1	1	1	1	0	1	5
RMHF014	2	2	2	1	7	1	7	0	2	1	1	0	0	3
RMHF015	1	2	1	9	3	9	3	0	2	1	1	0	0	5
RHMF016	2	2	2	1	7	1	7	0	2	1	1	0	0	5
RHMF017	2	2	2	1	7	1	7	0	2	1	1	0	1	5
RHMF018	2	2	2	1	7	1	7	0	2	1	1	0	1	5
RHMF019	2	2	2	1	7	1	7	0	2	2	1	0	1	5
RMHF020	2	2	2	1	7	5	7	1	3	1	1	0	1	5
RMHF021	2	2	2	5	5	9	5	1	1	1	1	0	1	5
RMHF023	1	2	1	9	3	9	3	0	3	1	1	0	0	3
RMHF025	1	2	1	9	3	9	5	0	3	1	1	0	0	5
RMHF026	2	2	2	5	5	1	5	0	2	1	1	0	0	5
RMHF027	1	2	1	9	3	5	5	0	1	1	1	0	0	5
RMHF028	2	2	2	1	7	1	7	1	1	1	1	0	1	7
RMHF029	2	2	2	1	7	1	7	1	1	1	1	0	1	7
RMHF030	2	2	2	1	7	1	7	1	1	1	1	0	1	7
RMHF031	2	2	2	1	7	1	7	1	1	1	1	0	1	7
RMHF032	1	2	1	5	3	5	5	0	1	1	1	0	0	3
RMHF033	2	2	2	9	7	5	7	1	1	1	1	0	1	7

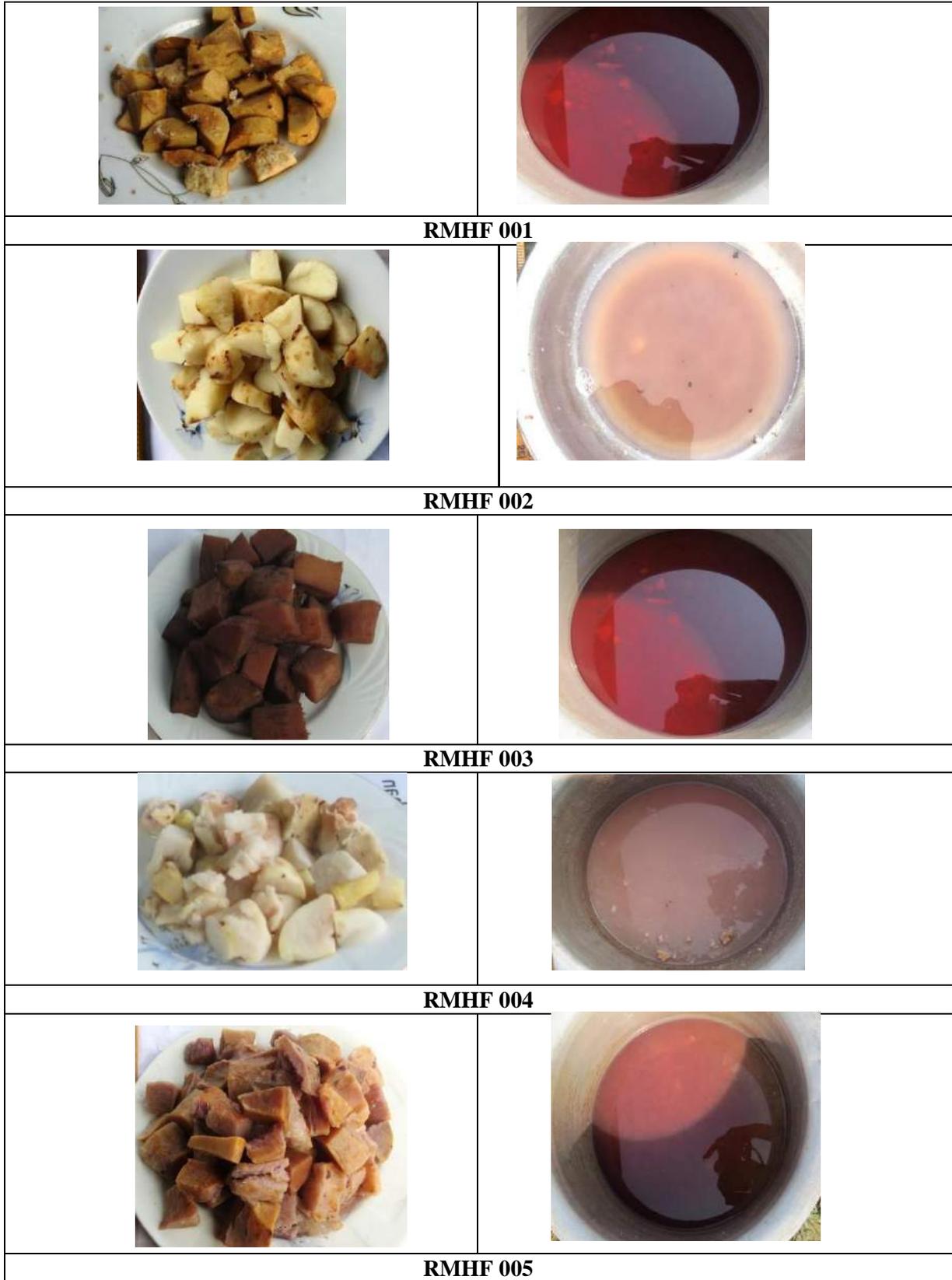
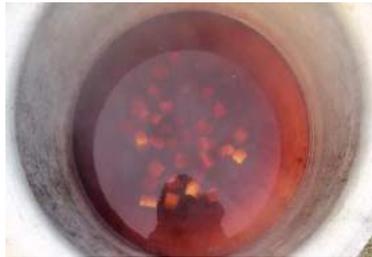
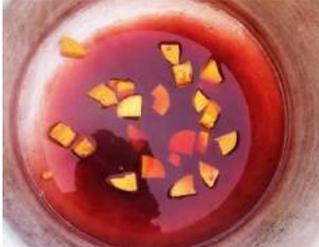


Fig. 178. Boiled tuber and water discoloration

	
RMHF 006	
	
RMHF 007	
	
RMHF 008	
	
RMHF 009	
	
RMHF 010	

Cont'd. Fig. 178. Boiled tuber and water discoloration

	
RMHF 011	
	
RMHF 012	
	
RMHF 013	
	
RMHF 014	
	
RMHF 015	

Cont'd. Fig. 178. Boiled tuber and water discoloration



RMHF 016



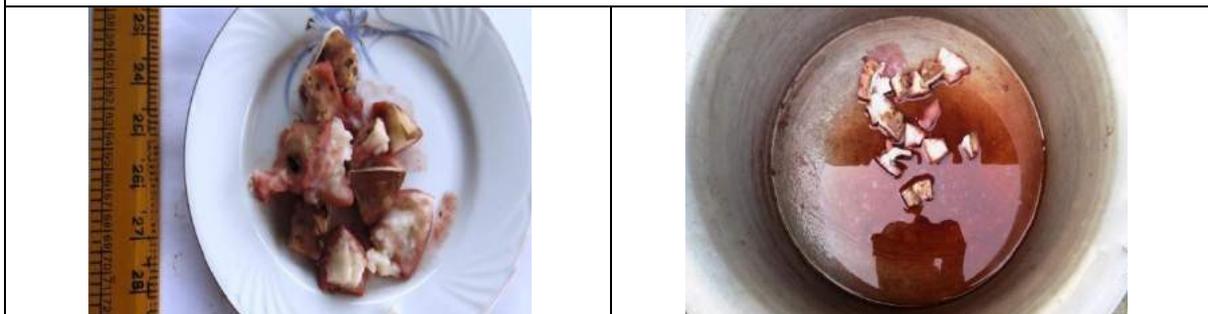
RMHF 017



RMHF 018



RMHF 019



RMHF 020

Cont'd. Fig. 178. Boiled tuber and water discoloration



RMHF 021



RMHF 023



RMHF 025

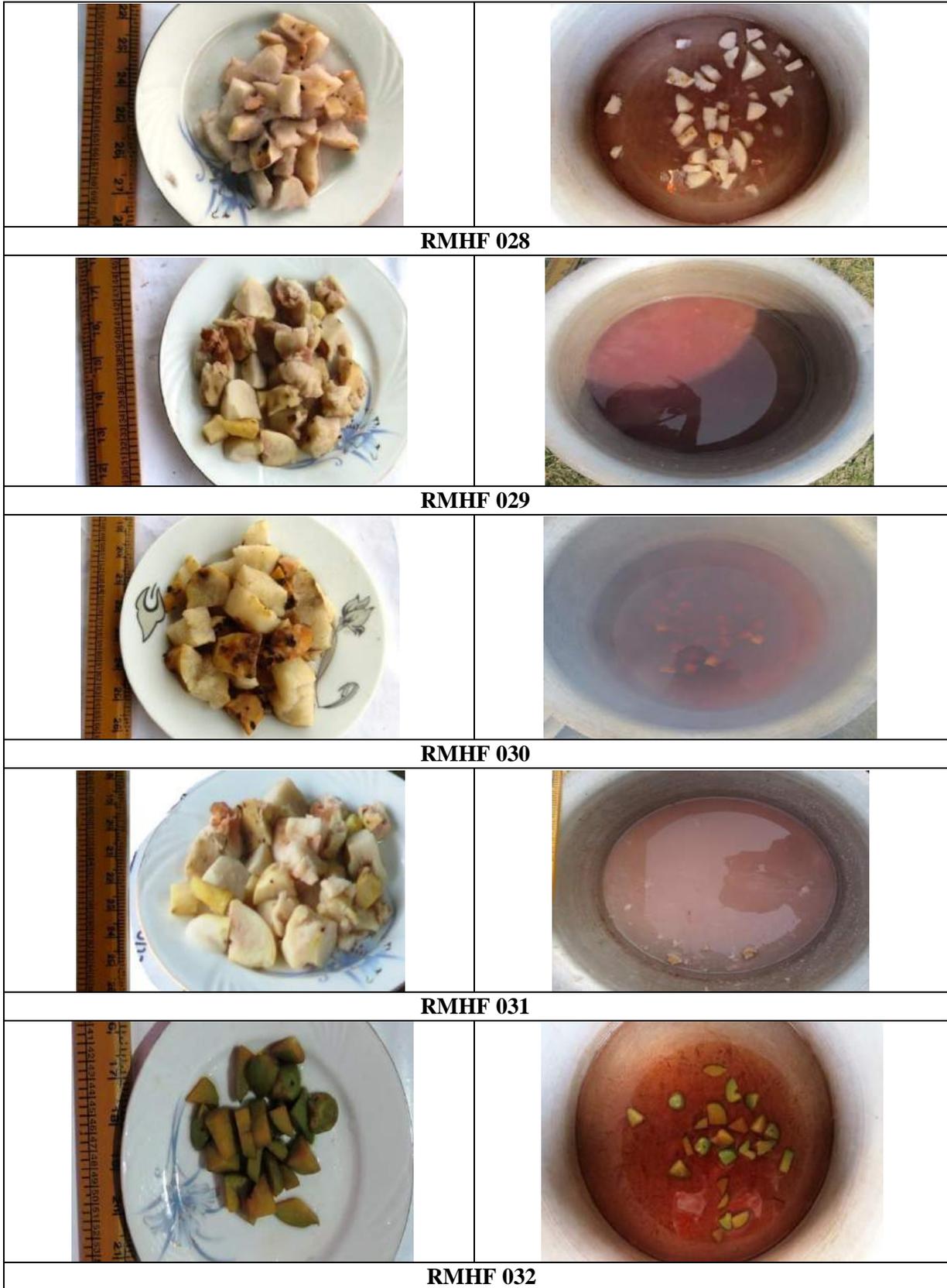


RMHF 026



RMHF 027

Cont'd. Fig. 178. Boiled tuber and water discoloration



Cont'd. Fig. 178. Boiled tuber and water discoloration

Genetic diversity of indigenous yam accessions using multivariate technique

a) Non- hierarchical clustering

Clustering was done for 31 yam accessions using covariance matrix by which accessions were grouped into seven different clusters. These results confirmed the clustering pattern of the accessions according to the principal component analysis (PCA). Similarly, the D² analysis also grouped thirty-one yam accessions into seven different clusters based on morphological characters. The cluster composition with different accessions is presented in Table 208 and 209.

It was observed from the distribution pattern that the maximum number six (6) and highest percent (19.35%) of accessions were included in cluster V and VI, followed by cluster I (5 and 16.13% respectively). Both cluster II and III showed the same result (4 and 12.90%). Again, cluster IV and VII showed the same result (3 and 09.68%, respectively) (Table 208).

Table 208. Distribution of 31 yam accessions in seven clusters

Cluster	No. of acc.	Percent	Accessions
I	5	16.13	RMHF001, RMHF006, RMHF009, RMHF012 and RMHF023
II	4	12.90	RMHF002, RMHF004, RMHF016 and RMHF026
III	4	12.90	RMHF003, RMHF008, RMHF015 and RMHF025
IV	3	9.68	RMHF005, RMHF020 and RMHF021
V	6	19.35	RMHF007, RMHF028, RMHF029, RMHF030, RMHF031 and RMHF033
VI	6	19.35	RMHF010, RMHF013, RMHF014, RMHF017, RMHF018 and RMHF019
VII	3	9.68	RMHF011, RMHF027 and RMHF032

Table 209. Average Intra and Inter cluster (data in parenthesis) distances among 31 yam accessions in seven clusters

Cluster	I	II	III	IV	V	VI	VII
I	319.98 (17.89)	884.08 (29.73)	442.54 (21.04)	670.19 (25.89)	559.32 (23.65)	816.33 (28.57)	502.25 (22.41)
II		224.37 (14.98)	756.35 (27.50)	901.08 (30.02)	407.49 (20.19)	290.55 (17.05)	614.99 (24.80)
III			535.47 (23.14)	555.40 (23.57)	473.32 (21.76)	565.39 (23.78)	494.05 (22.23)
IV				458.50 (21.41)	593.43 (24.36)	565.00 (23.77)	664.24 (25.77)
V					129.35 (11.37)	294.42 (17.16)	408.67 (20.22)
VI						122.39 (11.06)	523.45 (22.88)
VII							196.15 (14.01)

The intra cluster distance varied from 122.39 to 535.47, the highest value observed for cluster III, which was composed of four accessions and the lowest value obtained in cluster VI that was composed of six accessions (Table 209).

The highest order of inter cluster distance was observed between cluster II and cluster IV (901.08), which indicate more diverse accessions belong to these two clusters, followed by cluster I and II (884.08), cluster I and VI (816.33), cluster II and III (756.35) and cluster IV and VII (664.24). The lowest distance was found in between cluster VI (122.39). The second lowest was found between cluster V (129.35) and third lowest between cluster VII (319.98) (Table 209).

b) Cluster means

The mean performances of different clusters for 15 characters are presented in Table 210. The data revealed that different clusters exhibited different mean values for almost all the characters. Out of all cluster, cluster V composed of 6 accessions and scored highest mean value for tuber width (69.94 cm). The result was followed by days of emergence (67.33) in cluster I. Further the lowest cluster mean (0.30) was observed in yield of aerial tuber (kg)/plant in cluster II and VI. The second lowest (0.30) observed in cluster V for 'time for flesh oxidation after cutting'. Simultaneously the highest result cluster mean was found 'days of emergence' (57.33, 52.00, 50.59 and 49.45) in cluster III, V, II and IV respectively. Another highest result was observed in Tuber length (48.93 cm) in cluster I.

The cluster II comprised four number of germplasm (RMHF002, RMHF004, RMHF016 and RMHF026). Aerial tuber (bulbil) was not found in any of the germplasm of cluster II. Therefore, the lowest (0.00) cluster mean was found in cluster II regarding the yield of aerial tuber (Kg/plant). The highest cluster mean was found in 'days of emergence' (50.59), followed by tuber length (16.34 cm), tuber width (14.92 cm) and internodes length (13.55 cm). Similar result was found in cluster III. The second lowest (0.31 min) cluster mean was observed in 'time for flesh oxidation after cutting' (min), followed by tuber skin thickness (mm) (0.53) and texture of tuber flesh (1.00).

Cluster III encompassed four numbers of accessions. The lowest cluster mean value was observed in 'hardness of tuber when cutting with knife' (1.00), followed by tuber skin thickness (1.20 mm) and 'time for flesh oxidation after cutting' (1.37 minute).

Cluster IV was comprised three (3) numbers of germplasm. The highest cluster mean was found 'days of emergence' (49.45), followed by tuber width (38.89 cm), tuber length (26.33) and internodes length (17.44). Similar result was found in cluster V and VI. Both cluster V and VI, the highest cluster mean was 'days of emergence' (52.00 cm and 43.17 cm), followed by tuber width (69.94 and 27.50), tuber length (35.67 and 13.17), internodes length (17.44 and 17.19), respectively. In cluster IV, the lowest cluster mean was found with tuber skin thickness (0.85 mm), followed by leaf density (1.00) and 'time for flesh oxidation after cutting' (1.60 min).

Cluster V consisted of six accessions and comprising the lowest cluster mean value in 'time for flesh oxidation after cutting' (0.30 min), whereas, cluster VI consists of six accessions and found similar result as cluster V.

Cluster VII comprised of three germplasm, where the highest (46.11) was found for 'days of emergence' (46.11), followed by tuber width (18.33 cm). Nevertheless, the lowest value was observed in tuber skin thickness (0.48 mm), followed by texture of tuber flesh (1.33).

Table 210. Cluster mean values of 15 characters of 31 yam accessions

Characters	I	II	III	IV	V	VI	VII
Days of emergence	67.33	50.59	57.33	49.45	52.00	43.17	46.11
stem height (m)	10.28	4.47	10.40	8.52	10.87	12.02	8.47
Stem diameter (mm)	5.53	3.22	7.35	9.16	6.30	6.35	4.38
Stem color	2.67	1.50	2.75	2.00	2.67	1.00	1.67
internodes length (cm)	21.85	13.55	21.83	17.44	17.44	17.19	15.00
Leaf density	2.20	5.50	1.50	1.00	3.67	2.17	2.00
Hardness of tuber when cutting with knife	2.00	2.00	1.00	2.00	2.00	2.00	2.00
Tuber flesh color	1.80	1.25	3.00	7.67	1.83	2.33	2.00

Characters	I	II	III	IV	V	VI	VII
Texture of tuber flesh	2.40	1.00	3.00	2.00	1.33	1.33	1.33
Tuber length	48.93	16.34	26.75	26.33	35.67	13.17	7.78
Tuber width [cm]	23.14	14.92	24.33	38.89	69.94	27.50	18.33
Tuber skin thickness (mm)	0.76	0.53	1.20	0.85	0.74	0.72	0.48
Time for flesh oxidation after cutting (min)	2.00	0.31	1.37	1.60	0.30	0.34	1.75
Aerial tuber yield kg/ plant	2.89	0.00	3.75	2.95	7.96	0.00	13.91
Underground tuber yield kg/ plant	5.22	4.50	3.38	8.62	5.73	4.28	2.17

c) Principal component analysis

Fifteen characters were considered for genetic diversity analysis. So, eigen values of fifteen principal component axis and percentage of total variation accounted for them obtained from the principal component analysis are presented in Table 211.

The results of the principal component analysis revealed that the first principal axis; days of emergence largely accounted for the variation among the accessions, which alone contributed 26.316% of the total variations. The first seven characters of the principal component axis with Eigen values above unity accounted for 83.952% of total variation among 15 characters describing 31 yam accessions. The rest eight characters contributed remaining 16.048% of total variation.

Table 211. Eigen values and percentage of variation for corresponding 15 characters in 31 yam accessions

Characters	Eigen values	% of total variation accounted for	% of Cumulative
Days of emergence	3.95	26.316	26.316
Stem height (m)	2.20	14.639	40.955
Stem diameter (mm)	1.93	12.892	53.847
Stem color	1.46	9.711	63.558
Internodes length (cm)	1.32	8.8	72.358
Leaf density	1.02	6.823	79.181
Hardness of tuber when cutting with knife	0.72	4.771	83.952
Tuber flesh color	0.62	4.155	88.107
Texture of tuber flesh	0.52	3.491	91.598
Tuber length	0.33	2.221	93.819
Tuber width [cm]	0.31	2.091	95.91
Tuber skin thickness (mm)	0.29	1.937	97.847
Time for flesh oxidation after cutting (min)	0.18	1.202	99.05
Yield of aerial tuber (Kg)/ plant	0.11	0.706	99.755
Yield of underground tuber (Kg)/ plant	0.04	0.245	100

d) Principal Coordinate analysis (PCO)

Ten of each lower and higher inter-accessions distance between pairs of 31 yam accessions is presented in Table 212. The highest inter genotypic distance obtained from principal coordinate analysis was 1513.82, which was observed between accession RHMF009 and RHMF016, followed by the distance 1473.95 and 1346.52 between the accession RHMF002 x RHMF003 and RHMF003 x RHMF016, respectively. The lowest distance (3.30) was found between RHMF017 and RHMF018, followed by the distance 7.42 and 8.88 between the accession RHMF017 x RHMF018 and RHMF028 x RHMF031, respectively (Fig. 189).

Table 212. Ten lower and higher inter-accessions distance between pairs of 31 yam accessions

10 lower D² values	Accessions combination	10 higher D² values	Accessions combination
3.30	RHMF017 x RHMF018	1513.82	RHMF009 x RHMF016
7.42	RHMF028 x RHMF031	1473.95	RHMF002 x RHMF003
8.88	RHMF030 x RHMF031	1346.52	RHMF003 x RHMF016
11.99	RHMF028 x RHMF030	1335.41	RHMF002 x RHMF009
16.05	RHMF028 x RHMF029	1320.69	RHMF009 x RHMF014
26.00	RHMF029 x RHMF031	1314.60	RHMF005 x RHMF009
40.88	RHMF017 x RHMF019	1271.87	RHMF009 x RHMF010
42.22	RHMF013 x RHMF019	1271.46	RHMF009 x RHMF013
42.98	RHMF029 x RHMF030	1248.28	RHMF003 x RHMF014
51.32	RHMF018 x RHMF019	1234.83	RHMF001 x RHMF002

The agglomerative hierarchical clustering dendrogram revealed the relationship among the thirty-one accessions of indigenous yam (Fig. 189). At highest level of similarity (>40), almost all the thirty-one accessions were distinct from each other, while at lower levels (>10), almost half of the accessions were similar to each other. The cluster analysis separated all thirty-one experimental accessions as different genotypes with Euclidean similarity distance ranging from 1 to 33. The pruned dendrogram at similarity distance equal to 33 identified seven main clusters, namely I, II, III, IV, V, VI, and VII according to the major morphological descriptors associated with accessions. Cluster I included five yam accessions, which were again sub-cluster into three subgroups. In first sub group, accession no. RMHF001 and RMHF012 closely associated with RMHF009. Whereas, RMHF006 and RMHF023 formed separate sub-group. The cluster II included four accessions (RHMF002, RHMF004, RMHF016, and RMHF0026) and again it grouped into three sub-groups. RMHF016 and RMHF026 formed one sub-group, while RMHF002 and RMHF004 constituted separate sub-group. Cluster III was found to accommodate four indigenous yam accessions (RMHF003, RMHF008, RMHF015 and RMHF025) with three sub-groups. Lowest number (three) of yam accessions were found to be recorded in cluster IV (RMHF005, RMHF021 and RMHF020) and VII (RMHF011, RMHF027 and RMHF032). Both cluster V (RMHF007, RMHF033, RMHF028, RMHF031, RMHF029 and RMHF030) and VI (RMHF010, RMHF013, RMHF014, RMHF017, RMHF018 and RMHF019) accommodated six yam accessions.

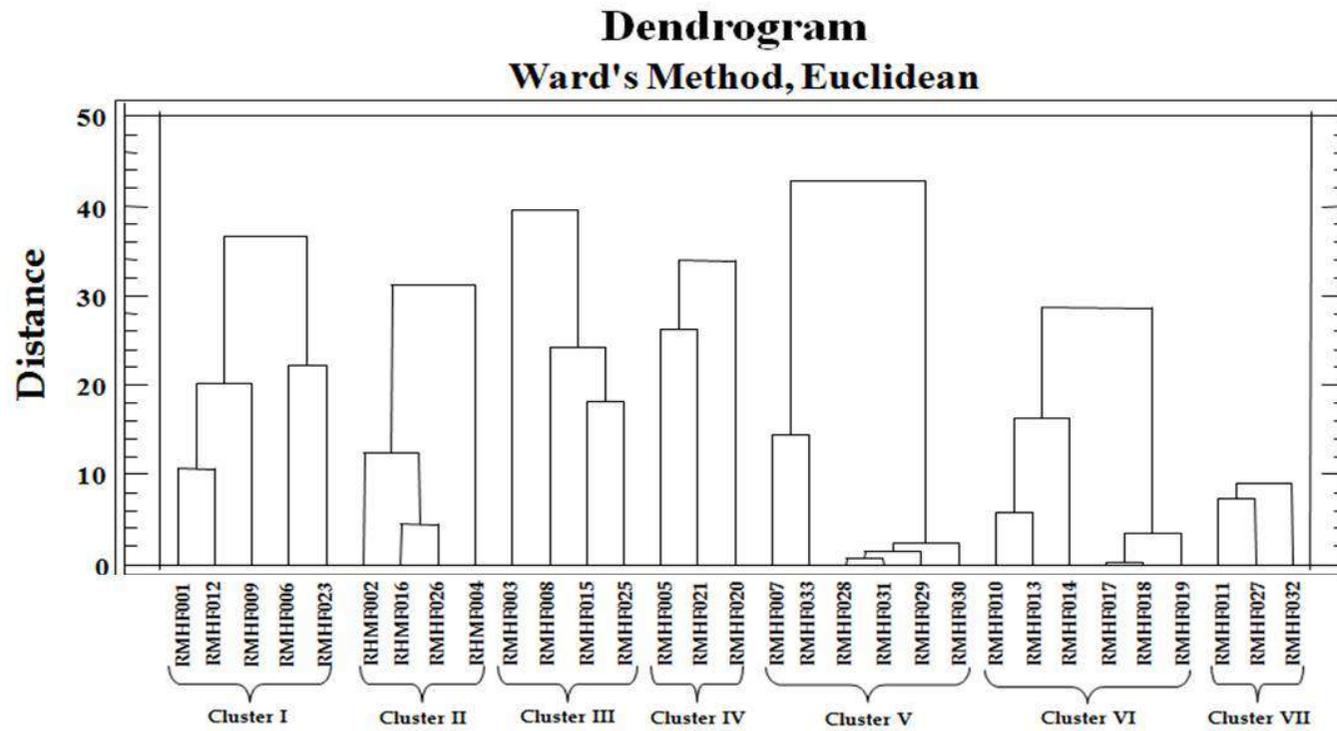


Fig. 179. Dendrogram based on Ward's method using Euclidean Distance

11.9.8. Molecular Characterization of Yam Accessions using RAPD Markers

Selection of RAPD primer

Ten decemer primers were initially screened for their ability to produce polymorphic patterns. Out of those, four decemer primers (OPA-02, OPG-13, OPW-08 and OPW-16) gave reproducible and distinct polymorphic amplified products and were selected for evaluation of diversity across 6 species of *dioscorea* viz; RMHF001 (*D. cayenensis*), RMHF011 (*D. bulbifera*), RHMf003 (*D. pentaphylla*), RMHF007 (*D. alata*), RHMf002 (*D. esculenta*), RMHF015 (*D. oppositifolia*). A total of 40 polymorphic amplification products were obtained by using these arbitrary primers. The size of the amplification products ranged from 100-1100bp (Table 213). The selected four primers produced comparatively maximum number of high intensity band with minimal smearing. Those primers showing good technical resolution and sufficient variation among different genotypes produced a total of four RAPD markers of which 40 (90.48%) were considered as polymorphic. The highest number of bands (14) was generated by primer OPA-02 and OPW-16, whereas; the least number (6) of bands were produced by primer OPW-08. Besides, the primer OPW-16 amplified proportion of polymorphic loci (92.86%) and the primer OPW-08 generated 83.33%. The polymorphic amplification bands ranged from 6 to 14 and were amounted to be 11.00 on average (Table 213). Using primers OPA-02, OPG-13, OPW-08 and OPW-16, the banding patterns of six *Dioscorea* species genotypes are shown in Fig. 180, 181, 182 and 183.

Table 213. RAPD primers with corresponding bands and size range together with polymorphic bands observed in six *Dioscorea* species

Primer code	Sequence (5'-3')	Band size	Total number of bands scored	No. of polymorphic bands	Proportion of polymorphic loci (%)
OPA-02		100-1000	14	12	85.71
OPG-13		100-900	10	10	100.00
OPW-08		300-600	6	5	83.33
OPW-16		100-1100	14	13	92.86
Total			44	40	361.90
Average			11	10	90.48

Frequency of polymorphic loci

On the basis of presence and absence of the bands of the PCR product with OPA-02, OPG-13, OPW-08 and OPW-16 primer, the polymorphisms of the collected samples were detected. Absence of bands may be caused by failure of primers to anneal a site in some individuals due to nucleotide sequence differences or by insertions or deletions in primer sites. Results showed that the highest gene frequency observed in OPA-02, OPG-13, OPW-08 and OPW-16 were 0.6667, 0.8333, 0.8333 and 0.8333, respectively. The lowest gene frequency observed in OPA-02, OPG-13, OPW-08 and OPW-16 were 0.000, 0.1667, 0.000 and 0.000 respectively (Table 214).

Table 214. Frequencies of polymorphic RAPD markers in six *Dioscorea* spp.

RAPD Markers	Gene frequency						
OPA02-1	0.1667	OPA02-12	0.0000	OPG13-9	0.6667	OPW16-4	0.6667
OPA02-2	0.1667	OPA02-13	0.3333	OPG13-10	0.1667	OPW16-5	0.5000
OPA02-3	0.3333	OPA02-14	0.1667	OPW08-1	0.1667	OPW16-6	0.5000
OPA02-4	0.6667	OPG13-1	0.5000	OPW08-2	0.6667	OPW16-7	0.0000
OPA02-5	0.5000	OPG13-2	0.1667	OPW08-3	0.0000	OPW16-8	0.6667
OPA02-6	0.6667	OPG13-3	0.8333	OPW08-4	0.3333	OPW16-9	0.8333
OPA02-7	0.3333	OPG13-4	0.5000	OPW08-5	0.8333	OPW16-10	0.3333
OPA02-8	0.6667	OPG13-5	0.6667	OPW08-6	0.0000	OPW16-11	0.8333
OPA02-9	0.0000	OPG13-6	0.5000	OPW16-1	0.5000	OPW16-12	0.3333
OPA02-10	0.6667	OPG13-7	0.8333	OPW16-2	0.6667	OPW16-13	0.3333
OPA02-11	0.5000	OPG13-8	0.8333	OPW16-3	0.6667	OPW16-14	0.3333

Genetic Diversity

Genetic diversity for the primer OPA-2, OPG-13, OPW-08 and OPW-16 primer is presented in (Table 215). The mean of Nei's (1973) gene diversity and Shannon's Information index (Lewontin, 1972), in six yam accessions were 0.3586 and 0.5238 respectively. Higher level of gene diversity (0.50) was observed in OPA02-5, OPG13-1, OPW16-1, OPW16-5, OPW16-6. The higher values (0.6931) for Shannon's Information index were noticed in OPA02-5, OPA02-11, OPG13-1, OPG13-4, OPG13-6, OPW16-1, OPW16-5, OPW16-6.

Table 215. Summary of genetic diversity and Shanon Information Index statistics

Loci	Sample Size	Observed no. of alleles	Effective no. of alleles	Gene diversity (h)	Shanon information index (i)
OPA02-1	6	2.0000	1.3846	0.2778	0.4506
OPA02-2	6	2.0000	1.3846	0.2778	0.4506
OPA02-3	6	2.0000	1.8000	0.4444	0.6365
OPA02-4	6	2.0000	1.8000	0.4444	0.6365
OPA02-5	6	2.0000	2.0000	0.5000	0.6931
OPA02-6	6	2.0000	1.8000	0.4444	0.6365
OPA02-7	6	2.0000	1.8000	0.4444	0.6365
OPA02-8	6	2.0000	1.8000	0.4444	0.6365
OPA02-9	6	1.0000	1.0000	0.0000	0.0000
OPA02-10	6	2.0000	1.8000	0.4444	0.6365
OPA02-11	6	2.0000	2.0000	0.5000	0.6931
OPA02-12	6	1.0000	1.0000	0.0000	0.0000
OPA02-13	6	2.0000	1.8000	0.4444	0.6365
OPA02-14	6	2.0000	1.3846	0.2778	0.4506
OPG13-1	6	2.0000	2.0000	0.5000	0.6931
OPG13-2	6	2.0000	1.3846	0.2778	0.4506
OPG13-3	6	2.0000	1.3846	0.2778	0.4506
OPG13-4	6	2.0000	2.0000	0.5000	0.6931
OPG13-5	6	2.0000	1.8000	0.4444	0.6365
OPG13-6	6	2.0000	2.0000	0.5000	0.6931
OPG13-7	6	2.0000	1.3846	0.2778	0.4506
OPG13-8	6	2.0000	1.3846	0.2778	0.4506
OPG13-9	6	2.0000	1.8000	0.4444	0.6365
OPG13-10	6	2.0000	1.3846	0.2778	0.4506
OPW08-1	6	2.0000	1.3846	0.2778	0.4506
OPW08-2	6	2.0000	1.8000	0.4444	0.6365
OPW08-3	6	1.0000	1.0000	0.0000	0.0000
OPW08-4	6	2.0000	1.8000	0.4444	0.6365
OPW08-5	6	2.0000	1.3846	0.2778	0.4506
OPW08-6	6	1.0000	1.0000	0.0000	0.0000
OPW16-1	6	2.0000	2.0000	0.5000	0.6931
OPW16-2	6	2.0000	1.8000	0.4444	0.6365
OPW16-3	6	2.0000	1.8000	0.4444	0.6365
OPW16-4	6	2.0000	1.8000	0.4444	0.6365
OPW16-5	6	2.0000	2.0000	0.5000	0.6931
OPW16-6	6	2.0000	2.0000	0.5000	0.6931
OPW16-7	6	1.0000	1.0000	0.0000	0.0000
OPW16-8	6	2.0000	1.8000	0.4444	0.6365
OPW16-9	6	2.0000	1.3846	0.2778	0.4506
OPW16-10	6	2.0000	1.8000	0.4444	0.6365
OPW16-11	6	2.0000	1.3846	0.2778	0.4506
OPW16-12	6	2.0000	1.8000	0.4444	0.6365
OPW16-13	6	2.0000	1.8000	0.4444	0.6365
OPW16-14	6	2.0000	1.8000	0.4444	0.6365
Mean	6	1.8864	1.6322	0.3586	0.5238
St. Dev		0.3210	0.3181	0.1541	0.2106

- * na = Observed number of alleles
- * ne = Effective number of alleles [Kimura and Crow (1964)]
- * h = Nei's (1972) gene diversity
- * I = Shannon's Information index [Lewontin (1972)]

Genetic differentiation and rate of migration among subdivided population

Gene flow and population differentiation in six yam accessions is presented in Table 216. For OPA-02, OPG-13, OPW-08 and OPW-16 primer, the average estimated gene flow (Nm) value was 0.0 and co-efficient of gene differentiation (Gst) was 1.0 across all loci. Hardy Weinberg expectation of average heterozygosity (Ht) in the accession was 0.3586, while average heterozygosity (Hs) of Hardy-Weinberg for those accessions was 0.0. The highest level of co-efficient of gene differentiation was 1.00. RAPD marker revealed high level of differentiation (Gst=1.00) that supports the presence of sufficient polymorphisms in yam accessions.

Table 216. Summary of genetic variation statistics across loci

Loci	Sample Size	Ht	Hs	Gst	Nm*
OPA02-1	6	0.2778	0.0000	1.0000	0.0000
OPA02-2	6	0.2778	0.0000	1.0000	0.0000
OPA02-3	6	0.4444	0.0000	1.0000	0.0000
OPA02-4	6	0.4444	0.0000	1.0000	0.0000
OPA02-5	6	0.5000	0.0000	1.0000	0.0000
OPA02-6	6	0.4444	0.0000	1.0000	0.0000
OPA02-7	6	0.4444	0.0000	1.0000	0.0000
OPA02-8	6	0.4444	0.0000	1.0000	0.0000
OPA02-9	6	0.0000	0.0000	****	****
OPA02-10	6	0.4444	0.0000	1.0000	0.0000
OPA02-11	6	0.5000	0.0000	1.0000	0.0000
OPA02-12	6	0.0000	0.0000	****	****
OPA02-13	6	0.4444	0.0000	1.0000	0.0000
OPA02-14	6	0.2778	0.0000	1.0000	0.0000
OPG13-1	6	0.5000	0.0000	1.0000	0.0000
OPG13-2	6	0.2778	0.0000	1.0000	0.0000
OPG13-3	6	0.2778	0.0000	1.0000	0.0000
OPG13-4	6	0.5000	0.0000	1.0000	0.0000
OPG13-5	6	0.4444	0.0000	1.0000	0.0000
OPG13-6	6	0.5000	0.0000	1.0000	0.0000
OPG13-7	6	0.2778	0.0000	1.0000	0.0000
OPG13-8	6	0.2778	0.0000	1.0000	0.0000
OPG13-9	6	0.4444	0.0000	1.0000	0.0000
OPG13-10	6	0.2778	0.0000	1.0000	0.0000
OPW08-1	6	0.2778	0.0000	1.0000	0.0000
OPW08-2	6	0.4444	0.0000	1.0000	0.0000
OPW08-3	6	0.0000	0.0000	****	****
OPW08-4	6	0.4444	0.0000	1.0000	0.0000
OPW08-5	6	0.2778	0.0000	1.0000	0.0000
OPW08-6	6	0.0000	0.0000	****	****
OPW16-1	6	0.5000	0.0000	1.0000	0.0000
OPW16-2	6	0.4444	0.0000	1.0000	0.0000
OPW16-3	6	0.4444	0.0000	1.0000	0.0000
OPW16-4	6	0.4444	0.0000	1.0000	0.0000
OPW16-5	6	0.5000	0.0000	1.0000	0.0000
OPW16-6	6	0.5000	0.0000	1.0000	0.0000
OPW16-7	6	0.0000	0.0000	****	****
OPW16-8	6	0.4444	0.0000	1.0000	0.0000
OPW16-9	6	0.2778	0.0000	1.0000	0.0000

Loci	Sample Size	Ht	Hs	Gst	Nm*
OPW16-10	6	0.4444	0.0000	1.0000	0.0000
OPW16-11	6	0.2778	0.0000	1.0000	0.0000
OPW16-12	6	0.4444	0.0000	1.0000	0.0000
OPW16-13	6	0.4444	0.0000	1.0000	0.0000
OPW16-14	6	0.4444	0.0000	1.0000	0.0000
Mean	6	0.3586	0.0000	1.0000	0.0000
SD		0.0238	0.0000		

* Nm = estimate of gene flow from Gst or Gcs. E.g., $Nm = 0.5(1 - Gst)/Gst$;

See McDermott and McDonald, Ann. Rev. Phytopathol. 31:353-373 (1993).

The number of polymorphic loci is: 40

The percentage of polymorphic loci is: 90.91

Nei's (1972) genetic identity and genetic distance

Nei's (1972) genetic identity (above diagonal) and genetic distance (below diagonal) in six different *Dioscorea spp.* for four primers is presented in Table 217. The values of pair-wise comparisons of Nei's genetic identity (above diagonal) were calculated from combined data sets for four primers ranging from 0.4091 to 0.7955. The highest genetic identity (0.7955) was found between RMHF015 (*D. oppositifolia*) and RHMf002 (*D. esculenta*). Second highest (0.6818) positive correlation was found between RHMf002 (*D. esculenta*) and RMHF007 (*D. alata*). Another positive correlation (0.6364) was found between RMHF001 (*D. cayenensis*) and RMHF011 (*D. bulbifera*), RMHF015 (*D. oppositifolia*) and RMHF003 (*D. pentaphyla*). Between RMHF007 (*D. alata*) and RMHF003 (*D. pentaphyla*) found low genetic identity (0.5227).

The values of pair-wise comparisons of Nei's genetic distance (below diagonal) were calculated from combined data sets for four primers ranging from 0.2288 to 0.8938. The highest genetic distance (0.8938) was found between RMHF011 (*D. bulbifera*) and RMHF007 (*D. alata*). The second highest (0.7885) genetic distance observed between RMHF001 (*D. cayenensis*) and RMHF007 (*D. alata*). Also, between RMHF011 (*D. bulbifera*) and RMHF015 (*D. oppositifolia*) with genetic distance (0.7397). The lowest genetic distance (0.2288) was observed between RHMf002 (*D. esculenta*) and RMHF015 (*D. oppositifolia*). Again, high genetic distance was found between RMHF003 (*D. pentaphyla*) and RMHF007 (*D. alata*).

Table 217. Summary of Nei's genetic identity (above diagonal) and genetic distance (below diagonal) values

	Acc.01 RMHF001 (<i>D. cayenensis</i>)	Acc.2 RMHF011 (<i>D. bulbifera</i>)	Acc.3 RHMf003 (<i>D. pentaphylla</i>)	Acc.4 RMHF007 (<i>D. alata</i>)	Acc.5 RHMf002 (<i>D. esculenta</i>)	Acc.6 RMHF015 (<i>D. oppositifolia</i>)
Acc.1 RMHF001 (<i>D. cayenensis</i>)	****	0.6364	0.5227	0.4545	0.6364	0.6136
Acc.2 RMHF011 (<i>D. bulbifera</i>)	0.4520	****	0.4773	0.4091	0.5455	0.4773
Acc.3 RHMf003 (<i>D. pentaphylla</i>)	0.6487	0.7397	****	0.5227	0.6136	0.6364
Acc.4 RMHF007 (<i>D. alata</i>)	0.7885	0.8938	0.6487	****	0.6818	0.5227
Acc.5 RHMf002 (<i>D. esculenta</i>)	0.4520	0.6061	0.4884	0.3830	****	0.7955
Acc.6 RMHF015 (<i>D. oppositifolia</i>)	0.4884	0.7397	0.4520	0.6487	0.2288	****

Dendrogram of Molecular analysis

Dendrogram based on Nei's (1972) genetic distance using Unweighted Group Method of Arithmetic Means (UPGMA) indicated segregation of six yam accessions into four main clusters: RMHF001 and RMHF011 grouped in cluster 1, while RHMf003, RMHF007, RMHF002 and RMHF015 in cluster 2 (Fig. 184). In cluster 2, RMHF007 alone formed sub-cluster I; rest accessions formed sub-cluster II of cluster-I. The sub-cluster II further divided into two sub-cluster and RHMf003 alone formed sub-cluster III, while RHMf002 and RHMf015 grouped in sub-cluster IV (184).

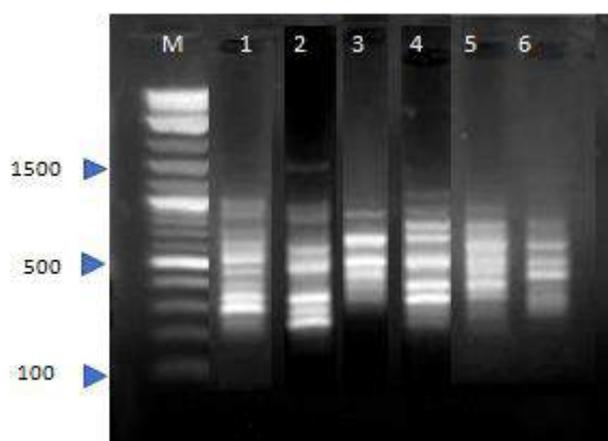


Fig. 180. RAPD profile of six yam germplasm using primer OPA-02

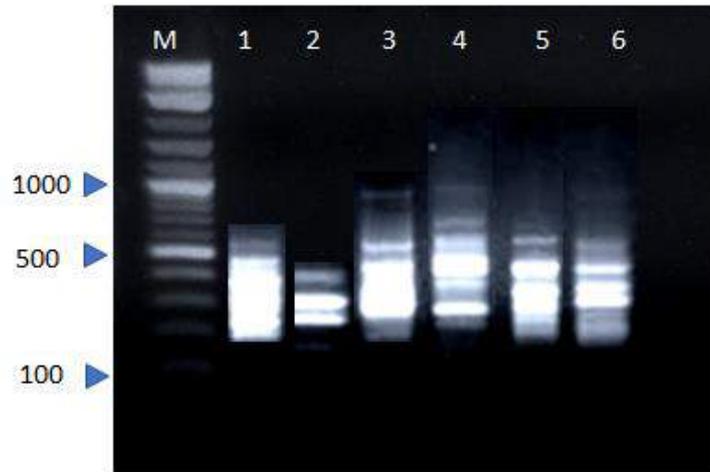


Fig. 181. RAPD profile of six yam germplasm using primer OPG-13

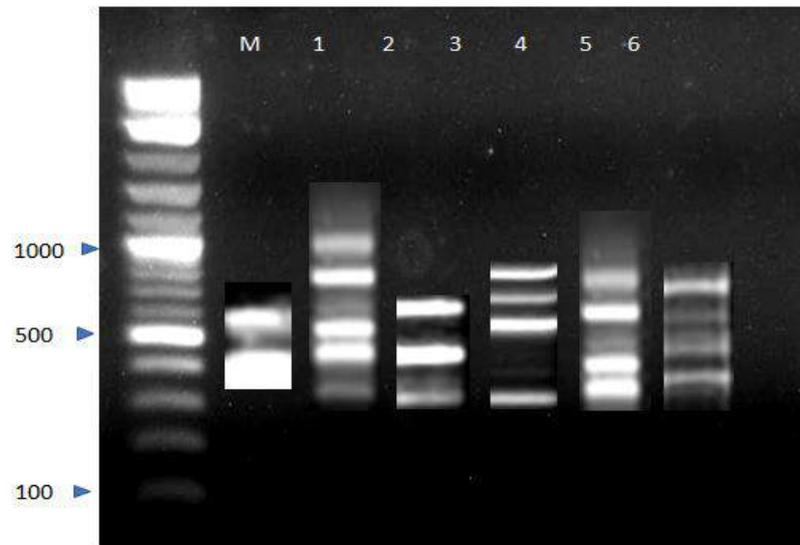


Fig. 182. RAPD profile of six yam germplasm using primer OPW-08

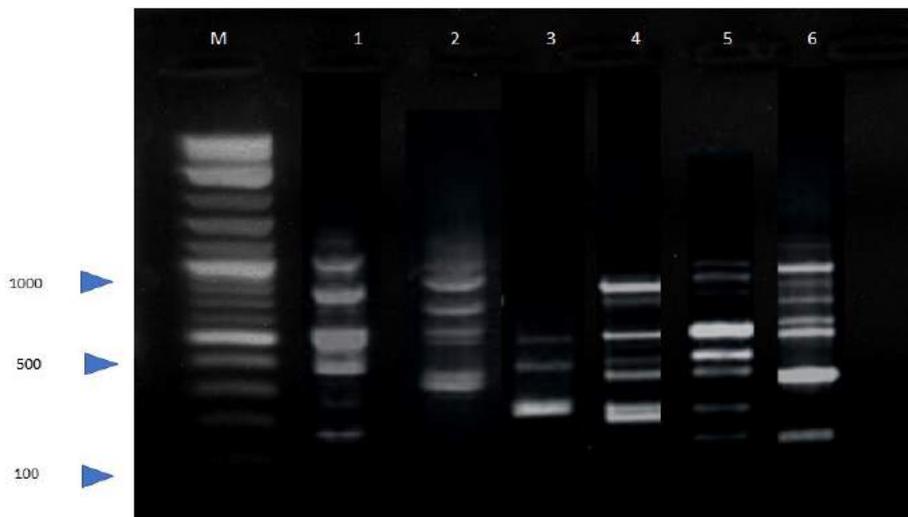


Fig. 183. RAPD profile of six yam germplasm using primer OPW-16

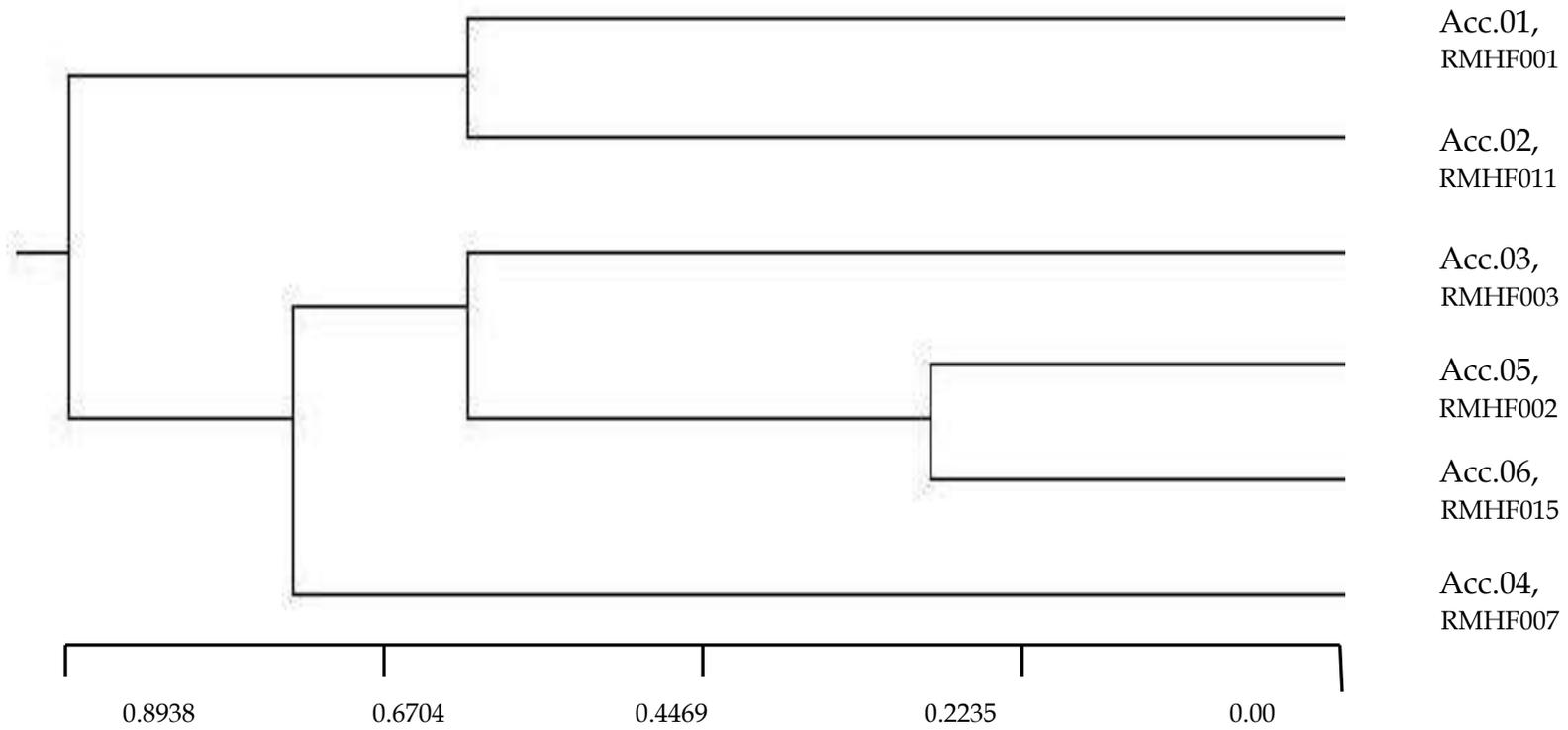


Fig. 184. Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

12. Research Highlights:

12.7. Cotton Development Board

12.7.1. Title: Characterization of cotton genotypes at Cotton Research Center, Jagadishpur, Jashore and Sreepur, Gazipur (2018 to 2021)

Background: Cotton Development Board (CDB) has 520 accessions of cotton in its collection. Among those 200 accessions were characterized with the support from NATP-I. The remaining germplasm are yet to be characterized. Due to lack of information most of those germplasm are not used in breeding program. For judicious exploitation of the conserved germplasm, characterization both at morphological and molecular level is essential. With this view, a three-year sub-project has been undertaken with the financial support of NAP-II to characterize cotton germplasm at morphological level.

Objectives:

- i. to evaluate the phenotypic and genotypic variation of yield, yield components, and fiber properties;
- ii. to investigate phenotypic variation of morphological characters and
- iii. to analyze interrelationships among yield, yield components, and fiber properties for their potential to contribute to future plant improvement efforts of CDB germplasm center.

Methodology: Three hundred thirty five (335) cotton genotypes have been characterized morphologically at the Cotton Research Center, Jagadishpur, Jashore (172) during 2018-19 (60), 2019-20 (59) and 2020-21 (53) growing seasons, and at the Cotton Research Center, Sreepur, Gazipur (163) during 2018-19 (57), 2019-20 (56) and 2020-21 (50) growing seasons. Seeds of each line were spaced 45 cm within the row and 90 cm apart from the other row. Recommended agronomic and plant protection measures were followed from sowing till harvest of the crop. Thirty two qualitative (11) and quantitative (21) characters were recorded following the Cotton Descriptor published by the International Plant Genetic Resources Institute (IPGRI).

Key findings:

- i. Wide variations were recorded among the germplasm in respect of qualitative and quantitative traits studied.
- ii. Considering higher seed cotton yield, boll weight, GOT and lint length, lower micronaire value and other desirable traits BC-0239, BC-0220, BC-0232, BC-0206, BC-0256, BC-0358, BC-0367, BC-0392, BC-0397, BC-0399, BC-0430 and BC-0425 were selected as promising genotypes from Jagadishpur, Jashore and BC-0312, BC-0295, BC-0309, BC-0292, BC-0305, Bc-448, BC-0453, BC-0462 and BC-0477 from Sreepur, Gazipur.

Key words: Characterization, Cotton genotypes, Variability

12.8. Bangladesh Sericulture Research and Training Institute

12.8.1. Title: Morphological Characterization of 60 Mulberry Genotypes

Background: Germplasm is the raw material of crop improvement program and considered as the living museum of the sum total variability. Scientists all over the world are given more importance on collection, conservation and systematic evaluation of existing gene pool. Though mulberry is the sole food plant of silkworm it has not received adequate due attention in this direction. Bangladesh Sericulture Research and Training Institute is maintaining 83 mulberry varieties both indigenous and exotic origin in its germplasm bank. But the characterization of these important plant genetic materials has not been conducted till now. Each variety possesses distinct features and different from each other but not systematically characterized. That's why, the present piece of work was conducted to make an in-depth study for morphological characterization of 60 mulberry germplasm and their documentation to provide information at the aim to use in breeding program.

Objectives: i. Morphological characterization of 60 mulberry genotypes maintaining in the germplasm bank and

ii. To document the varietal information of mulberry germplasm.

Methodology: The experiment was conducted at the germplasm bank of Bangladesh Sericulture Research and Training Institute, Rajshahi during the year of 2018-2020. Total 60 mulberry genotypes consisting of 41 indigenous and 19 exotic were used in this study. The plants were raised under row to row and plant to plant spacing of 3ft ×3ft and plantation system was high bush. The experimental design was randomized completely block design (RCBD) with three replications. Cultural practices like pruning, digging cum weeding and irrigation will be given normally as and when needed. The plot was fertilized by organic manure at the rate of 15 mt/ha/yr as well as inorganic fertilizer viz. NPK in the ratio of 300:150:100/ha/yr in the form of urea, triple super phosphate (TSP) and muriate of potash (MP) respectively in four split doses. Total sixty (60) observations on qualitative (19) and quantitative (41) characters were recorded following the descriptor and acceptable to International Compendium Program and International Board of Plant Genetic Resources (IBPGR) of Hackett (1979a) and CSRTI (1986). During this period the range, mean, SD and mean coefficient of variation (CV%) of quantitative characters were calculated using the Microsoft Excel and Statistic 10 software.

Key findings:

- On the basis of leaf yield performance Acc. no. BSRM-56, BSRM-55, BSRM-47, BSRM-2, BSRM-54 and BSRM-57 were superior and the maximum leaf yield per plant was 2410 g produced by BSRM-56 followed by BSRM-55 (1909 g), BSRM-47 (1839.5 g), (1754.6 g), Black mulberry (1677 g) and (1590 g).
- 100 leaves weight was maximum (600 g) in BSRM-53 and BSRM-61.
- The germplasm BSRM-60, BSRM-55, BSRM-56, BSRM-21, BSRM-57 and BSRM-50 respectively are the best fruit producer.
- The leaf of BSRM-24, BSRM-50, BSRM-39, BSRM-23, BSRM-16 and BSRM-4 germplasm contained higher moisture.
- The germplasm BSRM-56, BSRM-60, BSRM-50, BSRM-54, BSRM-54, BSRM-34, BSRM-42, BSRM-40 and BSRM-1 are better for breeding program due to maximum number of female inflorescence produced.

Key words: Morphological Characterization, Mulberry, Sericulture, Genotype.

12.9. Bangladesh Agricultural University

12.9.1. Title: Morphological Characterization of Indigenous Banana Germplasm

Background: Banana is one of the major fruits in Bangladesh. It is consumed both as desert and vegetable. As it is originated in Indo-Malayan region including Bangladesh, huge variability in landraces and wild relatives of banana are available in the country. Only a few of these variability are commercially cultivated. The remaining landraces are in the verge of extinction. The present investigation was done with 60 indigenous germplasm of banana (55 deserts and 5 plantain) collected from different regions of Bangladesh.

Objectives:

- i. to study the genetic diversity in indigenous banana germplasm;
- ii. to identify the salient features that distinguish germplasm from one another and
- iii. to identify promising germplasm having high yield potential and superior quality.

Methodology: Morphological characterization of banana germplasm was done at Bangladesh Agricultural University Germplasm Centre (BAU-GPC), Mymensingh during February 2014 to June 2017. Sixty indigenous banana germplasm collected from different locations of Bangladesh were included in this study. Pits of 50x 50 x50 cm were prepared 10 days before planting of suckers. Manures and fertilizers were applied as per recommendation. The basal doses of manures and fertilizers were mixed well with the soil of the pits. The experiment was conducted in randomized complete block design with three replications. The suckers were planted on 22 February 2014 in the pits. Irrigation, weeding, staking, pest and disease control and other cultural operations were done as and when necessary. Fifty-four qualitative (24) and quantitative (30) characters were recorded following IPGRI-INIBAP-CIRAD Descriptors for Banana (*Musa spp.*) (2003).

Key findings: Wide ranges of variations were observed among the germplasm studied in respect of qualitative and quantitative traits recorded. Several land races were found promising in respect of yield, quality and tolerance to biotic and abiotic stresses. Five of these superior landraces have been registered as BAU Kala-1, BAU Kala-2, BAU Kala-3, BAU Kala-4 and BAU Kala-5 by NSB, MoA.

Key words: Indigenous germplasm, Landraces, Characterization, Banana



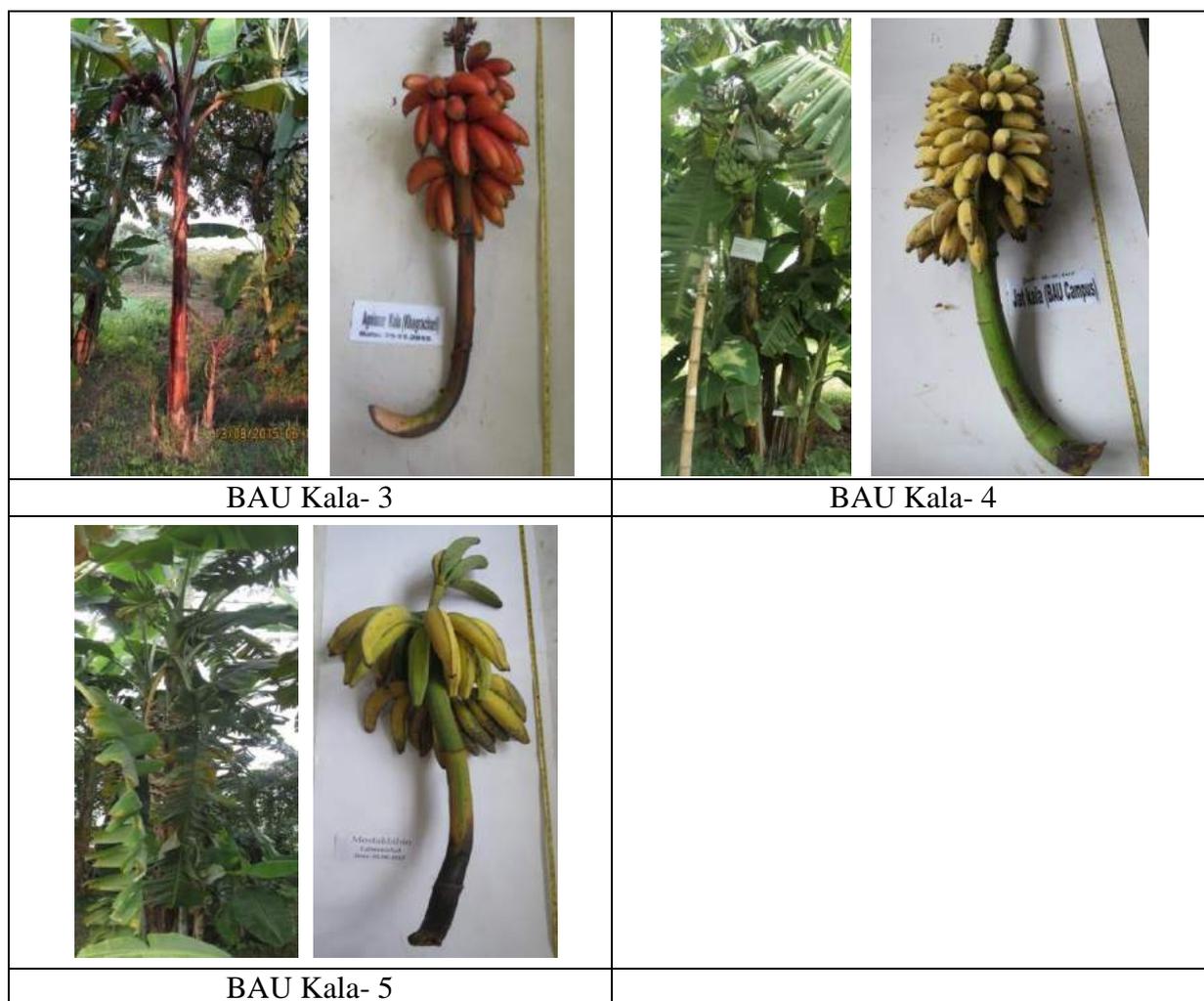


Fig. 185. Indigenous banana varieties released by BAU

12.9.2. Title: Morphological Characterization and Evaluation of Aroid germplasm

Background: In Bangladesh there are wide range of varieties of aroids, some are edible and some are very much wild as distinct by their acidity. Farmers used to cultivate only the edible aroids and on the basis of cultivation practices edible aroids were selected from different localities in the country. In the present research work characterization and evaluation were done for nine cultivars of *Colocasia* (mukhi kachu), four cultivars in *Amorphophallus* (ol kachu), five in *Alocasia* (maan kachu), eleven in *Xanthosoma* (maulavi kachu), five in *Colocasia* (stoloniferous, pani kachu), five panchamukhi kachu and five poidny lkachu.

Objectives:

- i. to find out qualitative and quantitative variation among and within the groups of aroids
- ii. to identify superior germplasm for releasing as variety

Methodology: Edible aroids under seven groups (Mukhi kachu, Panchamukhi kachu, Poidnyl kachu, Pani kachu, Ol kachu, Maan kachu and Maulavi kachu) were characterized at morphological level in the experimental field of BAU-GPC, Mymensingh during February 2018 to January 2021. A total of 45 aroids germplasm (*Colocasia*-24, *Amorphophallus*-5, *Alocasia*-5 and *Xanthosoma*-11) collected during first phase of NATP were included in this study. The experiment was laid out in randomized complete block design with three replications. The crops were fertilized with recommended doses of manures and fertilizers.

Weeding, irrigation, pest and disease control and other cultural operations were done as required. Thirty-two qualitative (13) and quantitative (19) characters were recorded as per IPGRI Descriptors for Taro.

Key findings: Wide ranges of variations were observed within aroids group as well as among the groups in respect of qualitative traits like plant characteristics, leaf, inflorescence, stolon, and corm and cormel characteristics. Four varieties of aroids under different groups have been released as variety viz. BAU Kachu-1 (Panchamukhi kachu), BAU Kachu-2 (Poidnyl kachu), BAU Oi Kachu-1 and BAU Maan Kachu-1.

Key words: Characterization, Quantitative, Qualitative, Diversity, Aroids



BAU Kachu- 1 (Panchamukhi Kachu)



BAU Kachu- 2 (Poidnyl Kachu)



BAU Oi Kachu- 1



BAU Maan Kachu- 1

Fig. 186. Aroid varieties released by BAU

12.9.3. Title: Morphological Characterization and Evaluation of Yam Germplasm

Background: Bangladesh is a hub of plant genetic resources. A huge number of fruits and vegetables are being growing around the country since many decades. Many varieties of different crops are growing in specific climate and in a specific zone of climate. This particular climate and soil types are responsible for acquiring some unique characteristics to the particular variety of fruit and vegetable crops. A geographical indication (GI) refers to sign or symbols that are used to denote a certain product which corresponds to a particular geographical location or origin. The use of GI may act a certification that the crop variety possesses certain qualities. Bangladesh has recently enacted the Geographical Indication Act 2013 (Act No. 54 of 2013). Through this act Bangladesh would be able to protect valuable plant genetic resources (PGRs). Yams are generally grown in waste land of homesteads. Still it give a reasonable return. Moreover it is very rich in vitamins and minerals as well as antioxidants and protective properties. In BAU-GPC 31 germplasm are being conserved. The present investigation was carried out with these germplasm.

Objectives:

- i. to verify existence of qualitative and quantitative variation among the germplasm and
- ii. to identify superior germplasm for releasing as variety

Methodology: Morphological characterization of 31 Yam germplasm collected from various parts of Bangladesh was done at BAU-GPC following IPGRI/CIP, 2003 descriptors. Characterization of descriptors for the study included: (i) Plant descriptors and (ii) Evaluation. Final land was prepared 15 days before pit preparation. 45 cm x 45 cm x 45 cm size pits were prepared, and 3 m x 3 m distance was maintained between pits. Tuberos root, bulbil or stem cutting was used as planting material. Yams were planted separately with a woody and semi woody perennial plants (e.g. Neem, Mahogany etc.). The recommended doses of manure and fertilizers were applied in the experimental field (FRG, 2012). One hundred and nineteen observations on qualitative (99) and quantitative (20) characters were recorded as per Descriptor List for *Dioscorea spp.* (IPGRI / IITA, 1997).

Key findings: Qualitative and quantitative variations among the germplasm were observed in the characteristics regarding young stem, matured stem, young leaves, matured leaves, aerial tubers (bulbil), underground tubers at harvest, underground tubers a few days after harvest, underground tubers at planting time and quality of aerial and underground tubers. Five varieties of yam have been registered by MoA.

Key words: Characterization, Germplasm, Yams

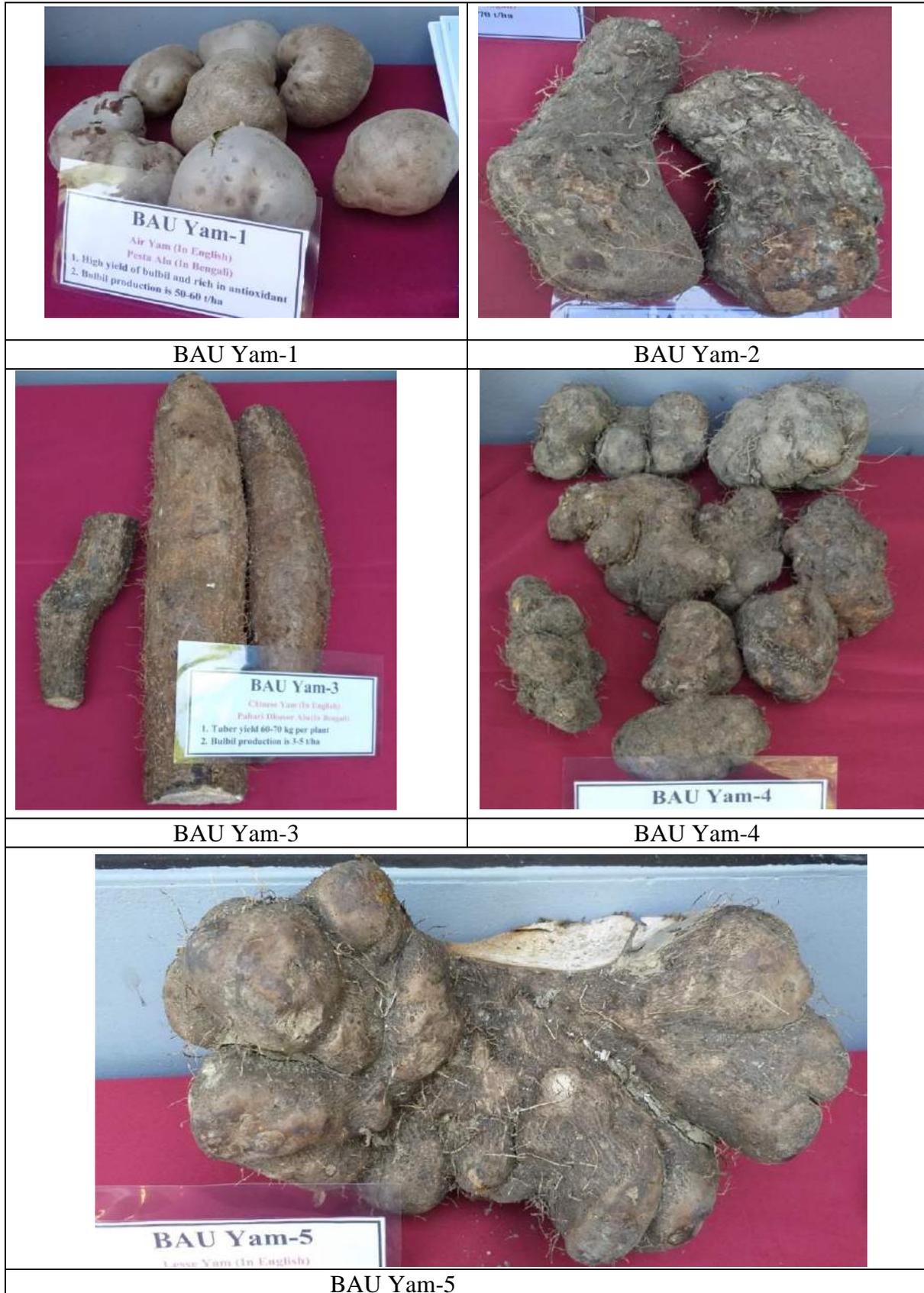


Fig. 187. Yam varieties released by BAU

B. Implementation Status

1. Procurement:

Bangladesh Agricultural Research Council

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
Desktop computer	3	179700	3	179700	
Laptop computer	2	119600	2	119600	
UPS offline	3	26100	3	26100	
Lesser printer	3	72000	3	72000	
Digital camera	1	25000	1	25000	
Scanner	3	27000	3	27000	
AC	1	145000	1	145000	
(b) Lab & field equipment	-	-	-	-	
(c) Other capital items	-	-	-	-	

Bangladesh Agricultural Research Institute

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
Desktop computer	2	140000	2	139900	
Digital camera	1	110000	1	109900	
Scanner	1	10000	1	9900	
UPS	2	20000	2	19900	
(b) Lab & field equipment					
Vacuum polythene sealer	1	40000	1	39900	
Moisture meter	1	80000	1	79900	
Digital slide calipers	5	10000	5	9950	
Seed drier	1	300000	1	299900	
Electric balance	1	150000	1	149900	
Seed germinator	1	400000	1	399900	
Lawn mower	1	70000	1	69980	
Bush cutter	1	35000	1	34980	
(c) Other capital items	-	-	-	-	-

Bangladesh Rice Research Institute

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
(b) Lab & field equipments and chemicals: Gel electrophoresis comb, gasket, spacer, PCR plates, plate sealer, micropipette tips, primers, Mastermix, acrylamide, bisacrylamide, EDTA, Boric acid, etc.	04	1156050	04	1055353	
(c) Other capital items	-	-	-	-	-

Bangladesh Jute Research Institute

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
i. Desktop computer	1	60000	1	59900	100%
(b) Lab & field equipment (Chemicals) Show list of chemicals	-	500000	-	498700	100%
(c) Other capital items	-	-	-	-	-

Bangladesh Sugarcrop Research Institute

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment	-	-	-	-	N/A
(b) Lab & field equipment		740000		739630	Completed
<u>Apparatus</u>					
Eppendorf Research Plus Single Channel Adjustable Pipette	03pc	90000	03pc	85500	
Micro pipette rack	-	-	02 pc	33980	Extra
Micro centrifuge tube	5 pack	15000	5 pack	20975	
Micro Centrifuge Tube rack	-	-	02 pc	9980	Extra
PCR Tubes (0.2µl)-1000nos/pack	5 pack	60000			Rev budget
<u>Chemicals</u>					
Acrylamide (Ultra pure)	500 g	60000	500 g	60390	
BIS Acrylamide (Ultra pure)	250 g	30000	250 g	30110	
SSR Primer 50 nmole	800 bp	104000	800 bp	80000	
Tag DNA Polymerase-1000 Unit/Pack	4 pack	100000	4pack	103010	
dNTP	3 pack	60000	3 pack	72000	
PCR Buffer	3 pack	30000	3 pack	56960	
Ladder	4 pack	40000	4 pack	67950	
Loading dye	6ml	12000	6 ml	9000	
Glycerol (Ultra pure)	500ml	5000	500 ml	7875	
RNase A	2pack	25000	2 pack	40000	
Agarose (Ultra pure)	100g	35000	100 g	21900	
Tris Ultrapure	250g	10000	-	-	Rev budget
Ammonium persulphate	25g	5000	-	-	Do
TEMED	25ml	9000	-	-	Do
SDS	250g	10000	-	-	Do
<u>Fertilizers and pesticides</u>	LS	40000		40000	
Mustard oil cake			200kg	11000	
Pila round (insecticide)			5L	3000	
Saco 20SL			5L	3400	
Virtaco			220gm	3300	
Nitro			3L	3900	
Calaryx extra (Herbicide)			20L	15400	
(c) Other capital items					
Micro centrifuge with keypad version, rotor 24×1.5/2.0 ml	01pc	444000	01pc	443900	Completed

Bangladesh Institute of Nuclear Agriculture

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment i. Camera	1	29900	1	29900	Completed
(b) Lab & field equipment i. Glass Jar	50	147500	50	147500	
ii. Sealer	2	14200	2	14200	

Cotton Development Board

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment	-	-	-	-	
(b) Lab & field equipment	-	-	-	-	
(c) Other capital items					
1. Desktop Computer with Accessories	1	59900	1	59900	100% Achieved
2. Laptop Computer	1	59900	1	59900	
3. Laser printer	1	25000	1	25000	
4. Scanner	1	14950	1	14950	
5. UPS	1	9950	1	9950	
6. Digital Camera with Accessories	1	24900	1	24900	
7. LCD Handled Microscope	1	49900	1	49900	

Bangladesh Sericulture Research & Training Institute

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment	-	-	-	-	
(b) Lab & field equipment 1. Electric Balance	01	65000	01	64000	100% Achieved
2. Digital Camera	01	25000	01	23680	

Bangladesh Agricultural University

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No)	Financial (Tk.)	Physical (No)	Financial (Tk.)	
(a) Office equipment	-	-	-	-	
(b) Lab & field equipment i. Photochlorimeter	1	78000	1	77800	Procured

2. Establishment/renovation facilities: Not applicable

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/seminar/workshop/conference organized:

Description	Number of participants			Duration Days /weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	34	06	40	2 days	
(b) Workshop					
i. Inception workshop	45	08	53	1 day	
ii. 1 st Annual review workshop	29	07	36	1 day	
ii. 2 nd Annual review workshop	43	08	51	1 day	
(c) Others (if any)					

C. Financial and physical progress

Financial and physical progress (Combined)

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	12419410	11039515	10234177	805338	92.70	
b. Field research/lab expenses and supplies	11486311	11036525	10920446.47	116078.53	98.95	
c. Operating expenses	3873548	2492462	2374393.25	118068.75	95.26	
d. Vehicle hire and fuel, oil & maintenance	2500880	1958588	1916382	42206	99.92	
e. Training/workshop /seminar etc.	787036	655224	635389	19835	96.97	
f. Publications and printing	2014000	91265	25500	65765	27.94	
g. Miscellaneous	1691309	1003612	856628	146984	85.35	
h. Capital expenses	2962600	2953066	2952766	300	99.99	
Total	37735094	31230257	29915681.72	1314575.28	95.79	

Bangladesh Agricultural Research Council

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	4815414	4626650	4121996	504654	89.09	
b. Field research/lab expenses and supplies	-	-	-	-	-	
c. Operating expenses	1817061	803739	793353.5	10385.5	98.71	
d. Vehicle hire and fuel, oil & maintenance	439449	152097	138192	13905	90.86	
e. Training/workshop /seminar etc.	787036	655224	635389	19835	96.97	
f. Publications and printing	1800000	-	-			
g. Miscellaneous	1141350	482670	442280	40390	91.63	
h. Capital expenses	594000	594000	594000	0	100.00	
Total	11394310	7314380	6725211	589169.5	91.95	

Bangladesh Agricultural Research Institute

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	2674406	2375905	2375905	0	100	
b. Field research/lab expenses and supplies	4133219	4132251	4132251	0		
c. Operating expenses	487628	484848	484848	0		
d. Vehicle hire and fuel, oil & maintenance	564634	564478	564478	0		
e. Training/workshop/seminar etc.	0	0	0	0		
f. Publications and printing	0	0	0	0		
g. Miscellaneous	120987	120900	120900	0		
h. Capital expenses	1260000	1259050	1259050	0		
Total	9240874	8973432	8973432		100	

Bangladesh Rice Research Institute

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	1981640	1846145	1629452	216693	88.26	
b. Field research/lab expenses and supplies	2280000	2124105	2171480	-47375	102.23	
c. Operating expenses	330000	307436	266070	41366	86.54	
d. Vehicle hire and fuel, oil & maintenance	285000	265513	217450	48063	81.90	
e. Training/ workshop /seminar etc.	0	0	0	0	0	
f. Publications and printing	40000	37265	1500	35765	4.03	
g. Miscellaneous	83360	77660	50375	27285	64.87	
h. Capital expenses	0	0	0	0	0	
Total	5000000	4658125	4336327	321797	93.09	

Bangladesh Jute Research Institute

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	390250	390250	390250	0	100	
b. Field research/lab expenses and supplies	639698	623238	623238	0	100	
c. Operating expenses	174052	96678	96678	0	100	
d. Vehicle hire and fuel, oil & maintenance	143000	93000	93000	0	100	
e. Training/workshop /seminar etc.	-	-	-	-	-	
f. Publications and printing	24000	24000	24000	0	0	
g. Miscellaneous	69000	46100	46100	0	100	
h. Capital expenses	60000	59900	59900	0	100	
Total	1500000	1333166	1333166	0	100	

Bangladesh Sugarcrop Research Institute

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund Received	Actual expenditure	Balance	Physical progress (%)	Remarks
a. Contractual Staff Salary	403990	257110	246914	10196	96.03	
b. Field Research / Lab expenses and supplies	740000	740000	739630	370	99.95	
c. Operating expenses	216000	216000	145342	70658	67.29	
d. Vehicle hire and fuel, oil & maintenance	160000	149000	103515	45485	69.47	
e. Training/ workshop/ seminar etc.	-	-	-	-	-	
f. Publications and printing	-	-	-	-	-	
g. Miscellaneous	36000	36000	29777	6223	82.71	
h. Capital Expenses	444000	444000	443900	100	99.98	
Grand Total	1999990	1842110	1709078	133032	92.78	

Bangladesh Institute of Nuclear Agriculture

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund Received	Actual expenditure	Balance /up sent	Physical progress (%)	Remarks for deviation
A. Contractual Staff Salary	738510	568475	549670	18805	96.69	
B. Field Research / Lab expenses and supplies	1495650	1382085	1382832	-747	100.05	
C. Operating Expenses	228859	142450	138082	4368	88.09	
D. Vehicle Hire and Fuel, Oil & Maintenance	528697	450000	526661	-76661	117.04	
E. Training/Workshop/ Seminar etc.	-	-	-	-	-	
F. Publications and printing	25000	0	0	0	-	
G. Miscellaneous	91604.00	93500.00	52307.00	41193	55.94	
H. Capital Expenses	191600.00	191600.00	191600.00	0	100.00	
Total	3299920	2842410	2841152	1258	99.96	

Cotton Development Board

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	414130	319980	319980	0	100	
b. Field research/lab expenses and supplies	464834	420526	420526	0	100	
c. Operating expenses	179948	154781	154788	-7.00	100	
d. Vehicle hire and fuel, oil & maintenance	114500	114500	114500	0	100	
e. Training/workshop/seminar etc.	-	-	-	-	-	
f. Publications and printing	40000	0	0	0	-	
g. Miscellaneous	41588	41588	41550	38	99.91	
h. Capital expenses	245000	244500	244500	500	100	
Total	1500000	1295875	1295844	31	99.99	

Bangladesh Sericulture Research & Training Institute

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	324580	200520	175520	00.00	87.53	
b. Field research/lab expenses and supplies	803000	803000	783845.47	6596.78	97.61	
c. Operating expenses	195000	134530	175097.75	00.00	130.16	
d. Vehicle hire and fuel, oil & maintenance	-	-	-	-	-	
e. Training/workshop/ seminar etc.	-	-	-	-	-	
f. Publications and printing	25000	0	0	0	-	
g. Miscellaneous	62420	60194	57184.00	00.00	95.00	
h. Capital expenses	90000	82016	82016.00	00.00	100	
Total	1500000	1280260	1273663.22	6596.78	99.48	

Bangladesh Agricultural University

Fig in Tk.

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	676490	454480	424490	29990	93.40	
b. Field research/lab expenses and supplies	929910	811320	666644	144676	82.17	
c. Operating expenses	245000	152000	120134	31866	79.04	
d. Vehicle hire and fuel, oil & maintenance	265600	170000	158586	11414	93.29	
e. Training/workshop/seminar etc.	-	-	-	-	-	
f. Publications and printing	60000	30000	0	30000	0.00	
g. Miscellaneous	45000	45000	16155	28845	35.90	
h. Capital expenses	78000	78000	77800	200	99.74	
Total	2300000	1740800	1463809	276991	84.09	

D. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed:

Bangladesh Agricultural Research Council

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
i. Finalize work plan of component institutes	Organized Inception Workshop to finalize work program of implementing organizations	Work plan was finalized: 1. Crops were distributed among the component institutes 2. Germplasm collection, characterization, conservation targets for each institute were fixed	
ii. Capacity building of working scientists	Organized Training Workshop for sub-project personnel for judicious running of sub-project activities	40 working scientists were trained on collection and management of PGR	
iii. Solve evolving problem	Arranged coordination meeting periodically with all component institutes	8 coordination meetings were organized	
iv. Performing monitoring and evaluation	Performing monitoring and evaluation of technical activities of the implementing organizations at field and laboratories	18 monitoring and evaluation expeditions were done	
v. To review progress of sub-project activities	Organized Annual Review Workshop	2 annual review workshop was organized	
vi. Compiling and editing coordinated yearly reports	Compiling and editing coordinated yearly reports of the sub-project	2 coordinated annual reports were compiled covering completed activities of all components during 1 st and 2 nd years	
vii. Compiling, editing and printing coordinated Sub-project Completion Reports	Compiling, editing and printing coordinated Sub-project Completion Reports		

Bangladesh Agricultural Research Institute

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e., product obtained, visible, measurable)	Outcome (short term effect of the research)
To collect and characterize geographical indication (GI) crops, landraces of important crops	Germplasm were collected from 69 upazilas of 30 districts in Bangladesh. A grid map of Bangladesh was used for demarcating the survey area and collecting sites. Germplasm was collected directly from the farmers during farm and home visiting.	Six hundred (600) germplasm of 66 crop species were collected - The germplasm were cereals-14, pulses-39, oilseeds-26, vegetables-455, spices-36, fruits-14, medicinal-12 and other crops-4.	Gene bank of PGRC, BARI has been enriched by newly collected germplasm of different crop species.
	Germplasm were characterized on the basis of quantitative and qualitative traits following standard descriptor for identification of desirable traits -Molecular	832 germplasm (collected and conserved) of 8 crops (pumpkin, cucumber, brinjal, bitter gourd, mung bean, bottle gourd, amaranth and guava) were characterized at morphological level. Some promising germplasm were selected for using further crop improvement program. Pumpkin: AHI-63, RAI-87, RAI-254, RAI-279 and AC-512, AHI-63, AC-73, MAH-44, ATR-45	Germplasm identified with special and desirable traits could be used in future research and breeding for crop improvement.

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e., product obtained, visible, measurable)	Outcome (short term effect of the research)
	characterization was done using SSR markers.	Cucumber: RAI-209 Brinjal: AC-285, K-12, K-19, K-28, K-20, K-47, NSR-26, SM Ish-010, SM Ish-015, SM Ish-025 Bitter gourd: AC-204, AR-18, IA-13, AHI-85, AC-204, AC-296, RAI-32, TT-40, AHI-28, AHI-85, AHI-98, ATR-42 Mung bean: BD-9743, BD-10586, BD-10588, BD-10589, BD-6926, BD-6927, BD-6927 Bottle gourd: BD-390, BD-448, BD-9617, BD-1453, KASI-54, BD-4542 , RAI-15 Leaf amaranth: BD-2961, BD-9790, BD-9795, BD-9825 Stem amaranth: BD-9822, BD-9941, BD-9942 Guava: PG Pah 05, PG Hat 015, PG Hat 016, PG Pah 07, PG Hat 012, PG Hat 017 -23 germplasm of mustard were characterized molecular level	
To conserve the collected GP and BARI released varieties in active and base collection	The collected and characterized germplasm conserved as active (4-6 ⁰ C) and base collection (-20 to -22 ⁰ C).	600 germplasm were registered in germplasm collection register and conserved in active collection	The conserved germplasm will be used in future breeding program
Germplasm documentation	The passport and characterization information have been documenting in Excel and computerized data base system.	-All information regarding collection, and characterization has been documented -Web portal www.pgrcbari.org has been developed for data uploading -BARI PGR Passport App	Researcher, breeder even anyone can access in web site for benefit sharing (ABS)

Bangladesh Rice Research Institute

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Collection of rice landraces from unexplored areas especially from hilly, coastal and haor/beel areas	Total 29 upazilas of 14 districts of Bangladesh were explored for rice germplasm collection.	A total of 247 rice germplasm (04 Aus, 118 Aman, 03 Boro and 122 Jhum) collected from 29 upazilas of 14 districts of Bangladesh.	BRRI genebank has been enriched by newly collected rice germplasm and as well as indigenous rice landraces are protected from extinction.
Characterization of rice genetic resources for identification of desirable traits for varietal development	Total 216 rice germplasm were characterized on the basis of 21 quantitative and 31 qualitative traits of rice for identification of desirable traits	High yielding germplasm for Boro season: Boro 40/2 (Acc. no. 2215), Mi-Pajang (Acc. no. 149), Boro 275 (Acc. no. 2242), Boro 471 (Acc. no. 2233), Boro 40/1 (Acc. no. 2214), Boro 475 (Acc. no. 2234) Kali Boro 208 (Acc. no. 2200), Kali Boro 704 (Acc. no. 2205) High yielding germplasm for T. Aman season: Abchaya (Acc. no. 102), Bawoi Jhak (5) (Acc. no. 145), Laksmi Bilash (Acc. no. 211), Indra Sail (Acc. no. 238), Blue Stick (Acc. no. 08)	Would be used as parents for breeding program

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
		<p>Scented/lightly scented germplasm: Rupsail (Acc. no.58), Borail (Acc. no. 940), Madhabsail (Acc. no.1651), Boro (sunga) (Acc. no.1861), Kataktara (Acc. no. 39)</p> <p>Most slender type grain:Lal binni (Acc.no.209), Badkalamkati (Acc.no.2), Charnock (Acc.no.11) and Lal Soru (Acc. no. 281)</p> <p>Goodphenotypical acceptability:Mi-pajang (Acc. no. 149)</p> <p>Higher thousand grain weight (TGW):Bora Dudh Kalam (Acc. no. 280), Sunadigha (Acc. no. 126), Dud Saita (Acc. no. 1795), Achar Bhog (Acc. no. 566)</p>	

Salient features of suitable/ desired rice germplasm with photographs by BRRI

Acc. No.	Name	Description	Photograph
Acc. 102	Abchaya	T. Aman rice germplasm Phenotypic acceptability (PAcp): fair Yield: 19.6 g/hill Growth duration: 118 days	
Acc. 149	Mi-pajang	Boro rice germplasm Phenotypic acceptability (PAcp): good Yield: 23.51 g/hill Growth duration: 168 days	
Acc. 2215	Boro 40/2	Boro rice germplasm Phenotypical acceptability (PAcp): good Yield: 26.88 g/hill Growth duration: 148 days	

List of desirable trait(s) identified by BRRRI

Promising Trait	Genotype	Accession No.	Season & Growth Duration	Photograph
Scented red rice & short growth duration	Rupsail	Acc. no. 058	T. Aman (108 days)	
Very slender Grain (L: W= 4.35)	Lal Binni	Acc. no.209	T. Aman (138 days)	
Erect flag leaf and culm strength strong (no bending or lodging)	Mi- Pajang	Acc. no. 149	Boro (168 days)	
Higher thousand grains weight (TGW) 36.31 g	Bora Dudh Kalam	Acc. no. 280	T. Aman (140 days)	

Bangladesh Jute Research Institute

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Collection of jute and allied fibre germplasm.	Germplasm were collected from 20 upazilas of 9 districts in Bangladesh during February 2018-November 2020. At least 2-4 sites in each region were sampled for collecting germplasm.	35 jute and allied fibre crop germplasm were collected of which 23 was Deshi jute (<i>C. capsularis</i>), 9 was Tossa jute (<i>C. olitorius</i>) and 3 was Mesta (<i>Hibiscus sabdariffa</i>).	Collected and selected germplasm helps to develop new varieties of jute and allied fibre corps.
Morphological Characterization of JAF germplasm	97 jute germplasm were morphologically characterized on the basis of qualitative and quantitative traits.	Morphological characterization of 97 germplasm was completed. Range, mean, standard deviation and coefficient of variation of quantitative characters were done.	Selected germplasm will be used as parents in crop improvement program
Characterization of germplasm at molecular level using molecular markers.	Molecular characterization of 66 jute germplasm including 15 varieties was done during 2018-2020 by using SSR primer. Based on Nei's Genetic distance of the germplasm UPGMA dendrogram were constructed.	Molecular characterization and diversity analysis of 66 jute germplasm were completed.	Germplasm with higher genetic distance indicates higher diversity of material which is better for using as parents in developing new superior varieties.
Conservation: To conserve the germplasm in active and base collection for future use.	Germination test was performed in the lab. The collected and characterized germplasm conserved as active (+4 ⁰ C) and base collection -20 ⁰ C).	90 germplasm conserved as active (+4 ⁰ C) and base collection -20 ⁰ C).	The conserved germplasm will be used for future breeding program.

Bangladesh Sugarcrop Research Institute

General/Specific Objectives of the Sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
To collect & conserve sugarcane germplasm with new accessions of cultivated and wild genotypes.	Three field trip were performed throughout the country for sugarcane germplasm collection Collected germplasm were planted and maintained at Field Gene Bank of BSRI	Sixty eight sugarcane germplasm were collected and conserved against the target of 50.	Three flowering germplasm will be utilized in hybridization program of BSRI
To characterize selected sugarcane germplasm using morphological and molecular markers for identification of the genotypes on the basis of morphology and DNA fingerprinting	Morphological characterization Molecular characterization	Fifty one sugarcane germplasm were characterized morphologically. Molecular characterization work is going on.	One outstanding clone was released by NSB as chewing cane variety.
To investigate the extent of genetic diversity among sugarcane germplasm in order to provide more information to facilitate breeding program	Diversity analysis Flowering and special feature records Reporting	An immense diversity found among collected clones. Three of them are flowering. Many of them having special features.	Five promising clones and two new traits (attractive pink and variegated color) will be utilized in future. One journal article and one variety booklet will be published soon.

Technology generated/developed by BSRI

Upon successful field evaluation, the locally collected clone Chandpuri Ganderi have been released as chewing cane variety named BSRI Akh 47 approved by 103rd NSB meeting held on 08 September 2020.

Salient features of BSRI Akh 47 are as follows

- Good for chewing and drinking of its juice
- Early maturing (Mature in 9 -10 months)
- High yielding (Average yield 183 tha⁻¹)
- Number of chewable cane (98×10³ ha⁻¹)
- Tall, erect, medium thick, non-lodging and fibre: 11.69%
- Non-flowering
- Sugar content: 11.5% and reducing sugar: 0.99%



Fig. 188. Field picture and morphological characteristics of BSRI Akh47

Some promising genotype(s) identified by BSRI

Local name	Special feature(s)	Photopgraphs
Madhumala	High yield Soft & juicy Good for goor production	<p>a- internode, b- top, c- cross section, d- bud</p>
Black Ruby	Attractive color Soft & juicy Good peeling quality	<p>Interno Top Bud Cross Bud Auricl Ivorv Ligul</p>

Chitra	Attractive variegated color Soft & juicy Good peeling quality			
		Internode	Ligule	Dewlap
				
		Auricle	Cross section	Bud

Local name	Special feature(s)	Photographs		
Turag	High yield Soft & juicy Good peeling quality			
		Internode	Top	Dewlap
				
		Bud	Cross section	Auricle & Ligule

Promising trait(s) identified by BSRI

Special Trait	Genotype	Photograph
Attractive color	Black Ruby	
Attractive variegated color	Chitra	

Bangladesh Institute of Nuclear Agriculture

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Collection of germplasm	Collection	199 (Rice -151, Vegetables- 31, Spices-9, Pulses-1, Oil seeds-7)	Could be used in future breeding programme
Morphological characterization of germplasm	Characterization at morphological level	143 (Rice-73 Sesame- 30 Groundnut-33 Chilli-5 Bittergourd-2)	Facilitate selection of parents for hybridization program.
Molecular characterization of germplasm	Characterization at molecular level	Rice- 83	i. Help protecting landraces from piracy. ii. Facilitate parent selection for crossing based on their genetic distance iii. Provide information for establishing IPR of GI crops.
Conservation	Conservation at short term storage of BINA	198	Rescue endangered PGR and minimize genetic erosion

Cotton Development Board

To characterize 320 cotton genotypes from CDB germplasm	Undertaken morphological characterization program at Cotton Research Centers, Jagadishpur, Jashore and Sreepur, Gazipur	Morphological characterization of 335 cotton genotypes of CDB have been completed	Facilitate parent selection for hybridization program
To facilitate future use of the available GP	Data on agronomic traits were recorded.	Several promising lines and desirable traits were identified.	Facilitate fixation of breeding target
To facilitate in establishing IP rights cotton germplasm	None	None	None

Bangladesh Sericulture Research & Training Institute

To characterize mulberry germplasm at morphological level	Morphological characterization of mulberry germplasm	60 mulberry genotypes were morphologically characterized on the basis of 19 qualitative and 41 quantitative traits.	Generated information like promising genotypes and desirable traits can be exploited in crop improvement program
To document the varietal information of mulberry germplasm	Morphological information of 60 mulberry genotypes have been collected and computerized	Documentation of morphological information of 60 is completed	Male and female parents can be selected for hybridization program

Bangladesh Agricultural University

Collections	Visited various location of the country including hilly areas	Banana 65, Aroids 30 and Yams 35	Can be exploited in crop improvement program
Characterization	Both at morphological and molecular level	Banana 60, Aroids 45 and Yams 31 Note: 5 banana, 4 aroids and 5 yam varieties have already been released	Facilitate plant breeders to plan crop improvement program, Production of the respective crops and farmers' income will be promoted
Conservation	All the collected germplasm are conserved at BAU-GPC	Banana, aroids, yams are conserving at BAU-GPC	Multiplying all the released varieties

E. Information/knowledge generated/policy generated:

Bangladesh Agricultural Research Institute

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
Collection and Characterization of germplasm: To choose the sampling area of collection and quantify the collected sample for characterization	Germplasm were collected from 69 upazilas of 30 districts in Bangladesh during February 2018- November 2020. Germplasm were collected directly from the farmers during farm and home visiting	A total of six hundred (600) germplasm of 66 crop species (cereals-14, pulses-39, oilseeds-26, vegetables-455, spices-36, fruits-14, medicinal-12 and other crops-4) were collected	Gene bank of PGRC, BARI has been enriched by newly collected germplasm of different crop species.
Characterization of germplasm: To characterize the collected germplasm by morphological and biochemical / molecular means	Germplasm were characterized on the basis of quantitative and qualitative traits following standard descriptor for identification of desirable traits -Molecular characterization was done using SSR markers.	A total of 832 germplasm of 8 crops (pumpkin, cucumber, brinjal, bitter gourd, mung bean, bottle gourd, amaranth and guava) were characterized at morphological level. Some promising germplasm were selected for using further crop improvement program.	Selected germplasm of desirable traits will be used as a parent for crop improvement program.
Conservation: To conserve the collected germplasm in active and base collection for future use	The collected and characterized germplasm conserved as mid-term (4-6 ⁰ C) and long-term (-20 to - 22 ⁰ C) conservation unit	600 germplasm were registered in germplasm collection register and conserved.	The conserved germplasm will be used for future breeding program
Germplasm documentation: Documentation should include passport information, conservation information (active & base), characterization information and distribution information	The passport and characterization information have been documenting in Excel and computerized data base system.	All information regarding collection, characterization and characterization has been documented Web portal www.pgrcbari.org has been developed for data uploading	Data is available for researcher, teacher or even any one

Bangladesh Rice Research Institute

Collection and conservation of rice germplasm from unexplored areas especially from hilly, coastal and haor/beel areas.	Total 29 upazilas of 14 districts of Bangladesh were explored for rice germplasm collection.	A total of 247 rice germplasm were collected and conserved in short term storage of BRRRI genebank	BRRRI genebank has been enriched by newly collected rice germplasm and as well as indigenous rice landraces are protected from extinction.
Morphological characterization of important local rice germplasm.	Total 264 rice germplasm from BRRRI genebank have been characterized based on 31 qualitative characters and 21 quantitative characters.	Morphological characterization of 120 T. Aman, 96 Boro and 48 Aus rice germplasm completed.	Germplasm identified with special and desirable traits could be used in future research and breeding for crop improvement.
Molecular characterization and diversity analysis of important local rice germplasm.	Total 216 rice germplasm from BRRRI genebank have been characterized in molecular level by using SSR markers and diversity analysis done by using molecular data.	Molecular characterization and diversity analysis of 120T. Aman, 48 Boro and 48 Aus rice germplasm completed.	Germplasm with higher value of PIC and higher genetic distance indicates higher diversity of genotypes which is better for using as

			parents in developing new superior varieties.
Photo-documentation of rice germplasm from BRR genebank based on agromorphological characters.	Data recorded on 52 morpho-agronomic characters for photo-documentation using 'Bangladesh Rice Research Institute Germplasm Descriptors & Evaluation Form and photographs of every germplasm were taken.	Photo-documentation of 144 germplasm (48 T. Aman-2018, 48 Boro-2018/19 and 48 Aus-2019) were completed.	Documentation and develop database of germplasm are helpful for establishing varietal rights and IPR issues.

Bangladesh Jute Research Institute

i. Generation of new knowledge that help in developing more technology in future:

Information of germplasm will be made available to the breeders through standard documentation process.

ii. Policy Support:

Policy support needed for Automation and strengthen the PBRC Research in Bangladesh.

Bangladesh Sugarcrop Research Institute

General/Specific Objectives of the Sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
To collect & conserve sugarcane germplasm with new accessions of cultivated and wild genotypes.	Three field trip were performed throughout the country for sugarcane germplasm collection. Collected germplasm were planted and maintained at Field Gene Bank of BSRI	Sixty eight sugarcane germplasm were collected and conserved.	Three flowering germplasm will be utilized in hybridization program of BSRI
To characterize selected sugarcane germplasm using morphological and molecular markers for identification of the genotypes on the basis of morphology and DNA fingerprinting	<ul style="list-style-type: none"> ➤ Morphological characterization ➤ Molecular characterization 	Fifty one sugarcane germplasm were characterized morphologically. Molecular characterization work is going on.	One outstanding clone was released by NSB as chewing cane variety.
To investigate the extent of genetic diversity among sugarcane germplasm in order to provide more information to facilitate breeding program	<ul style="list-style-type: none"> ➤ Diversity analysis ➤ Flowering and special feature records ➤ Reporting 	An immense diversity found among collected clones. Three of them are flowering. Many of them having special features.	Five promising clones and two new traits (attractive pink and variegated color) will be utilized in future.

Bangladesh Institute of Nuclear Agriculture

Characterization	Morphological characterization of rice	Higher yield (9.8-13.33g/plant) : Ranishail, Sentu-16, Ojanabirun, Pajam Short duration: Sentu-17, Bashiraj, Deshi-32 Short and Scented grain: Parbotjira, Kalojira, Chinishail, Hasa sada, Hasakalo	Could be used for future breeding program
	Morphological characterization of sesame	Higher yield(32-58g/plant) with hairiness in stem, leaf and capsule: Kalotil, BD-	Could be used by breeder for biotic stress tolerant

General/Specific Objectives of the Sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
		6979, BD-6981	varietal development
	Morphological characterization of peanut	7112-4-4-1, 9112-2-1-1, 7112-4-3-1 and ICGV-347 produce higher yield (16g/plant)	Could be used for future breeding program
Cotton Development Board			
To characterize 320 cotton genotypes from CDB germplasm	335 cotton genotypes were evaluated in 2 Cotton Research Centers for 3 consecutive years viz. 2018-2019, 2019-2020 and 2020-2021	Qualitative, quantitative, ginning and fiber properties of 335 cotton genotypes were documented.	Diversity of 335 cotton genotypes known for further use.
To facilitate future use of the available germplasm	Preparation of annual progress report as well as PCR	Genotypes characteristics are documented	Best performing genotypes are identified
To facilitate in establishing IP rights cotton germplasm	Determination of qualitative, quantitative, ginning and fiber properties	Required data for IP right establishment are generated	IP application will be generated
Bangladesh Sericulture Research & Training Institute			
To characterize mulberry germplasm at morphological level	Morphological characterization of mulberry germplasm	60 mulberry genotypes were morphologically characterized on the basis of 19 qualitative and 41 quantitative traits.	Promising genotypes and desirable traits identified through this activity can be used in variety development program
Bangladesh Agricultural University			
Collections	Visited various location of the country including hilly areas	Banana 65, Aroids 30 and Yams 35	Can be exploited in crop improvement program
Characterization	Both at morphological and molecular level	Banana 60, Aroids 45 and Yams 31 Note: 5 banana, 4 aroids and 5 yam varieties have already been released	Facilitate plant breeders to plan crop improvement program, Production of the respective crops and farmers' income will be promoted
Conservation	All the collected germplasm are conserved at BAU-GPC	Banana, aroids, yams are conserved at BAU-GPC	Multiplying all the released varieties

F. Materials Development/Publication made under the Sub-project:

Bangladesh Agricultural Research Institute

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	1-leaflet	-	-
Journal publication	3 Journal paper	1	Morphological Diversity in Indigenous Cucumber Genotypes of Bangladesh, [S.I.], Jan. 2019. ISSN 2249-4626. Available at: < https://journalofscience.org/index.php/GJSFR/article/view/2399 >.
Information development	-	-	-
Other publications, if any	Abstract in conference	3	Bangladesh Plant Breeding and Genetics Society conference 2020

Bangladesh Rice Research Institute

Technology bulletin/ booklet/leaflet/flyer etc.	-	-	-
Book	-	1	Morphological and Molecular Characterization of Important Rice Germplasm of Bangladesh (Published by: Bangladesh Rice Research Institute)
Journal publication	2	-	1. Genetic Diversity and Population Structure of Boro Rice Germplasm of Bangladesh (Journal of Rice Research) 2. Microsatellite Marker Based Genetic Diversity Analysis of Aman Rice (<i>Oryza Sativa</i> L.) Germplasm (Bangladesh Journal of Plant Breeding and Genetics)
Other publications, if any			

Bangladesh Jute Research Institute

Technology bulletin/ booklet/leaflet/flyer etc.	-	-	
Journal publication	1	Submitted	Scientific paper- Molecular diversity assessment of some jute germplasm using SSR primers. Plant Science Today.
Other publications, if any	1	Submitted	Gene bank Manual for Jute, Kenaf and Mesta Germplasm Collection, Conservation Evaluation and Documentation.

Bangladesh Sugarcrop Research Institute

Technology bulletin/ booklet/leaflet/flyer etc.	1	-	BSRI Akh 47 An early maturing chewing cane variety
Journal publication	1	-	Morphological diversity of sugarcane germplasm collected from different parts of Bangladesh
Other publications, if any	-	-	-

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Bangladesh Institute of Nuclear Agriculture			
Technology bulletin/ booklet/leaflet/flyer etc.	-	-	-
Journal publication	2	-	1. Morphological characterization of rice landraces using DUS descriptors 2. Molecular Characterization and Genetic Diversity Analysis of Rice (<i>Oryza sativa</i> L.) Using SSR Markers
Video clip/TV program	-	-	-
News Paper/Popular Article	-	-	-
Other publications, if any	-	-	-
Bangladesh Agricultural University			
Journal publication	-	4	1. Potentiality of Underutilized Crop <i>Dioscorea</i> spp.: A Source of Nutraceutical. 2019. SAARC J. Agric. 17(2): 113 2. Assessment of Quality Characteristics of Boiled Yam Tubers. 2020. SAARC J. Agric. 18(1): 173-182. (Accepted for publication) 3. Morphological characterization of indigenous banana and plantains. J. Agrof. Env., 20(1&2) 4. Molecular characterization of indigenous banana and plantains. J. Agrof. Env., 20(1&2)
Other publications, if any	-	-	-

G. Description of Generated Technology/Knowledge/Policy:

- i. Technology Fact Sheet (title of the technology, introduction, description, suitable location/ecosystem, benefits, name and contact address of author)

Bangladesh Sugarcrop Research Institute

BSRI Akh 47: A potential chewing type sugarcane variety

Introduction: Sugarcane is one of the notified crops of the country, but due to long duration sugar purposes cane area and production is declining. On the other hand demand for chewing type sugarcane is increasing day by day. In 2019-2020 cropping season, sugarcane was cultivated in 74,310 hectares of land (Mill zones: 47,310 ha and non-mill zones: 27,000 ha) producing 37,14,000 tons (Mill zones: 21,51,000 tons and non-mill zones: 15,63,000 tons) of cane by which 82,140 tons white sugar and 300,000 tons brown sugar (gur) was produced. Cultivation of chewing type sugarcane is highly profitable because of high market price. As such, as an early maturing chewing cane variety BSRI Akh 47 is released.

Description of the Technology: BSRI Akh 47 sugarcane is a non-flowering and early maturing (9-10 months) chewing type variety. It is equally good for chewing and juice purposes. It is a high yielding (183 t/ha) variety, producing 98×10^3 ha⁻¹ chewable cane. The plants are tall, soft, erect, medium thick and non-lodging.

Suitable location/ecosystem: The variety is suitable for cultivation throughout the country, under upland ecosystem including all types of high and medium high lands of Bangladesh having irrigation and drainage facilities. Especially clay loams to sandy loam soil free from any type of inundation are suitable for its cultivation.

Benefit of the technology: Farmer would be benefitted economically cultivating soft, juicy and attractive colored chewing cane variety. One can earn a net income of Tk. 7,00,000 to 15,00,000 per hectare having BCR 2.00-3.88.



BSRI Akh 47

Name and address of author(s): Dr. Md. Anisur Rahman

Chief Scientific Officer, Breeding Division
Bangladesh Sugarcrop Research Institute
Ishurdi, Pabna,
Email: anisurbreedingbsri@gmail.com

Bangladesh Agricultural University:

BAU Kala-1 (Kulpat Kala)

Introduction: Banana (*Musa spp.*) is one of the world's oldest cultivated tropical fruit and most important member of the *Musaceae* family. It is one of the important food crops and ranks second in terms of calorie production after date. In Asian and Pacific regions, banana has a great socio-economic significance. It is the most essential and important fruit crop sharing around 20% of total fruit production with 36% share in area.

Description of the Technology: BAU Kala-1 is collected from Bagherhat and known as 'Kulpat Kala'. This cultivar is locally popular for its softness, sweetness and generally cultivated in southern districts. Pseudostem is tall and yellowish green, leaves are large and dark green, intermediate type male bud, revolute falling vertically, fruits are straight, rounded, bottle-necked and seedless. Its fruit production ranges from 70 to 110 t/ha. Usually 45 cm x 45 cm x 45 cm size pits with 2 m x 2 m spacing is required for its cultivation.

Suitable location/ecosystem: BAU Kala-1 can be grown all over the country. The suitable soil for banana should be fertile, well drained and moisture retentive containing plenty of organic matter with pH ranging from 6.5-7.5. Banana is essentially tropical plant requiring a warm and humid climate. However, it can be grown from sea level to altitude of 1200 meters. It can be cultivated in a temperature ranging from 10°C to 40°C with high humidity but growth is retarded at temperature less than 20°C and more than 35°C. It yields higher when temperature is above 24°C for a considerable period. It requires on an average 1700 mm rainfall distributed throughout the year for its satisfactory growth. Water stagnation is injurious which enhances panama disease.

Benefit of the technology: In general bananas are grown in tropical regions and plays a key role in the economies of many developing countries as a staple, it contribute to the food security of millions of people in much of the developing world and also provide income and employment opportunity to rural populations. As a rich source of calorie and essential vitamins, the variety, BAU Kala-1, could contribute in improving human nutrition supplying carbohydrate, potassium and vitamins.



BAU Kala-1 (Kulpat Kala)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kala-2 (Garasundari Kala)

Introduction: Banana (*Musa spp.*) is one of the world's oldest cultivated tropical fruit and most important member of the Musaceae family. It is one of the important food crops and ranks second in terms of calorie production after date. In Asia Pacific region, banana has a great socio-economic significance. It is the most essential and important fruit crop sharing around 20% of total fruit production with 36% share in area. It tops the list of fruits produced in the country and supplies 42% of the total fruit requirements having higher margin compared to other fruit and field crops.

Description of the Technology: BAU Kala-2, locally known as Garasundari Kala, collected from Mymensingh region. The plants are tall having strong blackish green pseudostem, leaves are dark green, ovoid, male bud revolute type, falling vertically. Fruits are medium in size, slightly curved and ridged, bottle-necked, having sweet soft cream pulp with few seeds. Its yield ranges from 50 to 80 t/ha.

Suitable location/ecosystem: BAU Kala-2 can be grown all over the country. However, the suitable soil for banana should be fertile, well drained, moisture retentive, containing plenty of organic matter. The optimum pH ranges from 6.5-7.5. It is a tropical plant requiring a hot and humid climate. However, it can be grown from sea level to altitudes of 1200 meters. It can be cultivated with temperature ranging from 10°C to 40°C with high humidity. But its growth is retarded at less than 20°C and more than 35°C. It yields higher when temperature is above 24°C for a considerable period. It requires on an average 1700 mm rainfall distributed throughout the year for its satisfactory growth. Stagnation of water is injurious and may enhance panama disease.

Benefit of the technology: In general bananas are grown in the tropics and play a important role in the economy of many developing countries as a staple food. It contributes towards food security of millions of people in many developing countries and provides income and employment to rural populations. As a rich source of calorie and essential vitamins and minerals, especially potassium, BAU Kala-2 could contribute improving human nutrition.



BAU Kala-2 (Garasundari Kala)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kala-3 (Agnissar Kala)

Introduction: Banana (*Musa spp.*) is one of the world's oldest cultivated tropical fruit and the most important members of the Musaceae family. It is one of the most important staple foods in some African countries. It has great socio-economic impacts in Asia Pacific region. BAU Kala-3 (Agnissar) is grown as noncommercial cultivar in homestead areas mostly for family consumption. Banana is the most important fruit crop sharing about 20% total fruit production with 36% area coverage. It stands first, provides 42% of the total fruit consumption and also earns high compared to other crops.

Description of the Technology: BAU Kala-3 is prevalent to hilly areas, locally known as Agnissar Kala, usually propagated by suckers. It grows 2.5 m – 3.0 m in height with weak pseudostem, cannot stand strong wind or storm. Pseudostem and fruits are red in color; leaves are dark green with red-purple midrib and edge, lanceolate shaped male bud, bract behavior before falling is revolute (rolling). Fruits are straight, rounded and blunt-tipped, soft and seedless orange pulp. Above all, it has an ornamental value as fruits are brilliant red, yield ranges from 50 to 60 t/ha.

Suitable location/ecosystem: BAU Kala-3 can be grown throughout the country. Well drained, fertile, moisture retentive containing high organic matter content with soil pH from 6.5 to 7.5 is suitable for banana cultivation. Like other variety it requires a hot and humid climate. However, it can be cultivated in a temperature ranging from 10°C to 40°C but growth is retarded at temperatures less than 20°C and more than 35°C. A high yield could be expected when temperature is more than 24°C for a considerable period. It can be grown from sea level to 1200 meters elevation. An average 1700 mm rainfall distributed throughout the year ensures satisfactory growth and yield. Water stagnation is not desirable as it promotes panama disease development.

Benefit of the technology: In general bananas are grown around the tropics and provides nutrition and employment opportunities of rural peoples. As a rich source of calorie, minerals and vitamins, BAU Kala-3 can contribute towards improved nutrition supplying carbohydrate, potassium and vitamins (A, C and B6).



BAU Kala-3 (Agnissar Kala)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kala-4 (Jat Kala)

Introduction: Banana (*Musa spp.*) is the cultivated tropical fruit belonging to Musaceae family. It is an important staple in many African countries but is a common around the globe. The BAU Kala-4 (Jat kala) is a cultivar being grown in household gardens by small growers mostly for family consumption. As important fruit crop it shares about 20% of total fruits production with 36% share in acreage. It stands first and supplies 42% of the total fruit requirements having higher financial return compared to other fruits and field crops.

Description of the Technology: BAU Kala-4 is a traditional variety collected from Mymensingh region, locally known as 'Jat Kala'. Plants are medium in height, pseudostem is yellowish green with shiny appearance having dark green medium sized leaves and bract behaviour before falling is revolute type. Fruits are yellow in color, small in size, straight, rounded, soft and light cream colored pulp, bottle-necked, good flavor, sweet and fairly seeded. Its yield ranges from 60 to 80 t/ha.

Suitable location/ecosystem: BAU Kala-4 can be grown all over the country. Like other varieties the suitable soil for BAU Kala-4 (Jat kala) cultivation should be rich, well drained, fertile, moisture retentive, containing ample organic matter with pH ranging from 6.5-7.5. As a tropical fruit it requires warm and humid climate. However, it can be cultivated with a temperature ranging from 10°C to 40°C but growth is retarded at temperatures less than 20°C and more than 35°C. A higher yield is expected at 24°C and above for a substantial period. On an average, 1700 mm rainfall distributed throughout the year could ensure a good harvest. Water stagnation is not desirable as it induces development of panama disease.

Benefit of the technology: Bananas are commonly grown in the tropics and playing a vital role in the economies of developing countries. It contributes to the food security of millions of people in the developing world and earns income and increases employment opportunity. It is a fruit rich in calorie and carbohydrate, vitamins (A, C and B6), dietary fibers and potassium good for human health and nutrition.



BAU Kala-4 (Jat kala)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kala-5 (Mostakbihin Kala)

Introduction: Banana (*Musa spp.*) is a cultivated tropical fruit as important member of the Musaceae family. It is an important staple food in Asia Pacific region, having a great socio-economic significance. As an important fruit crop it shares about 20% of total fruits production with 36% share in area. It stands first and supplies 42% of the total fruit requirements in Bangladesh giving high return compared to other fruits and field crops.

Description of the Technology: BAU Kala-5 is grown in the North-Western region of Bangladesh, locally known as 'Mostakbihin Kala'. Its inflorescence gradually and completely evolves with fruit development having no male bud. For this reason locally it called as 'Mostakbihin', the meaning 'headless'. It has tall blackish green pseudostem with large dark green leaves. Fruits are long, irregular in size and shape, slightly straight with pronounced ridges, lengthily pointed, very sweet with soft pulp, but peel is very thick and greenish yellow in color. Its yield ranges from 50 to 60 t/ha.

Suitable location/ecosystem: BAU Kala-5 can be grown all over the country. Successful cultivation requires soil having well drained, fertile, moisture retentive with optimum organic matter. The soil pH ranging from 6.5-7.5 is optimum for a good crop. As a tropical plant it requires hot and humid climate. It can be cultivated with temperature ranging 10°C to 40°C but growth is retarded at less than 20°C and above 35°C. Yields are higher when temperatures fluctuate above 24°C for a considerable period. However, it can be grown from sea level to an altitude of about 1200 meters requiring 1700 mm rainfall on an average distributed throughout the year for satisfactory yield and growth. Water stagnation is undesirable and may favor Panama diseases development.

Benefit of the technology: Usually bananas are grown in hot and humid tropics and plays an important role in the economy and nutrition of developing countries. As a staple, bananas contribute towards food security of millions of people in many developing countries. Banana as rich in calorie, carbohydrate, vitamins (including A, C and B6), potassium and dietary fibers is good for keeping human health and nutrition.



BAU Kala-5 (Mostakbihin Kala)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kachu-1 (Panchamukhi Kachu)

Introduction: BAU Kachu-1 (Panchamukhi Kachu) (*Colocasia esculenta* var. *esculenta*) is an important tuber crop, commercially cultivated in rainfed upland, homestead areas and as inter crops with other crops like pineapple in hills. It is primarily used as vegetable in the scarce period of Kharif season when availability of other vegetables are limited. It could withstand diversified challenges like drought, salinity, flood and other disaster prevailing in Bangladesh.

Description of the Technology: BAU Kachu-1, locally known as Panchamukhi Kachu, monocotyledonous herbaceous plant of Araceae family. Plants are semi-erect in nature while leaves are heart and sometimes peltate shaped. The petioles are yellowish-green. Tuber produces five or more cormels. Corm yield ranges from 40-50 t/ha. BAU Kachu-1 is a palatable tuber crop. This species mainly concentrated in northern and southern districts including Chattogram and South Eastern Hill districts.

Suitable location/ecosystem: Panchamukhi Kachu is usually cultivated in tropics with 25-30°C. Sufficient rainfall is needed otherwise irrigation is required for a good yield. Sandy loam, loose and well-drained soil with soil pH ranging 6.5 to 6.7 is suitable for cultivation. The field should be fertilized at 15 tons/ha cowdung, 200 kg/ha urea, 125 kg/ha triple super phosphate and muriate of potash 175 kg/ha are to be used. Cutting of corms are to be planted during February to March with 60 x 45 cm spacing for commercial cultivation. Weeding and drainage should be practiced as and when necessary. Crop is harvested during October to November when the leaves turned yellow or die back around 300 days after planting.

Benefit of the technology: Panchamukhi Kachu is an important tuber crop since time immemorial in several countries for its nutritional value along with industrial and medicinal worth for ulcers, diabetes, anti-fungal, anti-rheumatism, anti-cancer, anti-inflammatory. Beside carbohydrate and minerals, it is rich in anti-oxidants. It can play a major role towards food security, poverty alleviation and foreign exchange earnings. The processed products from taro flour like biscuits, bread, pudding, baby foods and food for people allergic to cereals are marketed in Hawaii and India. It can be used as fodder for cattle and other domestic animals. It can contribute to improve nutrition level of rural people.



BAU Kachu-1 (Panchamukhi Kachu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Kachu-2 (Poidnyl Kachu)

Introduction: BAU Kachu-2 (Poidnyl Kachu) (*Colocasia esculenta* var. *esculenta*) is an underutilized upland taro that can be commercially cultivated in high land and hilly areas under rainfed condition. It is an endemic crop of Madhupur tract. Tubers (corm and cormels) are used as vegetables having potentials to contribute in reducing malnutrition and poverty alleviation.

Description of the Technology: BAU Kachu-2, locally known as Poidnyl, Bansh Kachu, Chinn Kachu and Garokachu, is monocotyledonous herbaceous plants of Araceae family. This species mainly concentrated in Madhupur, Gazipur and due to prevailing high land in the areas. The petiole of this crop is tall and tan in colour. Leaves are deep green in colour. Plant produces cylindrical/elongated corm and cormels. Cormel cutting and apical portion of corm with two or more eyes are used as seed. Corm yield ranges from 35-50 t/ha.

Suitable location/ecosystem: Poidnyl Kachu is suitable for cultivation in tropics with temperature ranging from 23-31°C. The total rainfall requirement is approximately 2362 mm, otherwise irrigation is a must. It cannot withstand water logging situation. Sandy loam and loose soil with pH 6.6 having good drainage is best for its cultivation. The optimum planting distance is 60 x 45 cm. It can produce 35-50 t/ha tubers. Optimum planting time is February to March. The field should be fertilized with 15 tons cowdung, 200 kg urea, 125 kg TSP and 175 kg MoP per hectare.

Benefit of the technology: BAU Kachu-2 (Poidnyl Kachu) is cultivated as an indigenous summer vegetable in Bangladesh and can be grown as inter crop with pineapple in hills. It is a palatable and tasty tuber. With Poidnyl Kachu our food production system can be diversified as an attempt to provide healthy and nutritious diet for distressed people.



BAU Kachu-2 (Poidnyl Kachu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Ol Kachu-1 (Ol Kachu)

Introduction: BAU Ol Kachu-1 (*Amorphophallus campanulatus*) is an important tuber crop that can be commercially cultivated in upland under rainfed condition and also as an inter crops. It is cultivated in South-Western coastal districts of Bangladesh as cash crop.

Description of the Technology: BAU Ol Kachu-1 belongs to Araceae family locally known as Ol Kachu, monocotyledonous annual herbs with rounded tuberous root. Pseudostem height is medium and leaves are bipinnated. The petioles are light green in colour with white spots. Tubers are round and conical shaped often produces two or more cormels. Corms and cormels are used as seed. BAU Ol Kachu-1 is palatable, soft and good in taste tuber. It may produce 40-60 t/ha yield.

Suitable location/ecosystem: Ol Kachu is suitable for cultivation in tropics at 25-35°C with sufficient rainfall, if not, then irrigation becomes an indispensable effort. This crop cannot tolerate water logging condition. Silty loam and well-drained soil with pH ranging from 5.5 to 6.8 is suitable for its cultivation. Optimum planting time varies from February to March. Cowdung 15 tons/ha, Urea 200 kg/ha, TSP 125 kg/ha and MoP 175 kg/ha are to be applied in the field for a good crop. For commercial cultivation 75 x 60 cm spacing should followed. The crop is harvested during November to December when the plants turned yellow or die.

Benefit of the technology: Ol Kachu is an important tuber crop since time immemorial in several countries because of its nutritional and medicinal benefits as anti-fungal, anti-rheumatism, anti-cancer, anti-inflammatory, tumors, treatment of piles and abdominal pain etc. The agricultural food production system can be diversified with Ol Kachu in order to feed the people with healthy and nutritious diet of impoverished peoples.



BAU Ol Kachu-1 (Ol Kachu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Maan Kachu-1 (Maan Kachu)

Introduction: BAU Maan Kachu-1 (*Alocasia indica*) is an underutilized tuber crop and can be commercially cultivated in rainfed areas, home gardens, paddy fields' levee and as inter crops with banana, coconut and pineapples in hills.

Description of the Technology: BAU Maan Kachu-1, locally known as Maan Kachu and Mugar Kachu. It is a monocotyledonous herbaceous plant of Araceae family. Its cultivation is concentrated in southern districts viz. Jashore, Khulna, Bagerhat, Sathkhira, Barishal and Patuakhali but it can be grown all over Bangladesh. It is good in taste with low acidity. Plants are erect or semi-erect in growth habit, leaves are peltate, ovate and sagittate in shape. The petioles are light-green in colour with brown dots or spotting. A plant often produces a number of suckers which are used for propagation. It can produce 40-50 t/ha yield annually.

Suitable location/ecosystem: Maan Kachu is usually cultivated in the tropics at 25-30°C with sufficient rainfall. This crop cannot tolerate low temperature and water logging. Sandy loam and slightly saline, loose, deep and well-drained soil having pH from 5.5 to 6.5 is best for its cultivation. The crop can be planted round the year avoiding winter with spacing 75 x 60 cm. Cowdung 15 tons/ha, urea 200 kg/ha, TSP 125 kg/ha and MoP 175 kg/ha are to be applied for a good crop. Optimum harvesting time coincides when old leaves turned yellow.

Benefit of the technology: Maan Kachu is an underutilized tuber crop in several countries for its nutritional and health advantages like anti-fungal, anti-bacterial, anti-rheumatism, anti-cancer, anti-inflammatory, etc. As an effort towards crop diversification its cultivation may be expanded in the marginal field.



BAU Maan Kachu-1 (Maan Kachu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Yam-1 (Pesta Alu)

Introduction: Yams (*Dioscorea spp.*) belongs to Dioscoreaceae family, an underutilized crop in spite of immense significance at particular locality to poor people not only as food but also as integral part of culture and heritage. It is collected from Mymensingh region but found almost all over Bangladesh and primarily used as vegetable and have potentials to improve nutrition through diversifying food production system with the crop. The crop produces edible tubers and or bulbils.

Description of the Technology: BAU Yam-1, locally known as “Chupri Alu”, “Pesta Alu”, “Jhum Pesta Alu”, “Kanta Alu”, “Machh Alu” etc. Stems are smooth, curled to the left. The leaves are relatively large and heart-shaped. It produces tennis ball shaped smooth bulbils at leaf axils. One or two small round underground tubers are also produced. Cutting of tuber or bulbils are used as seed for cropping while vine cuttings are not found good for propagation. The variety mainly produces smooth and round bulbils with minimum underground tubers. Bulbil yield ranges from 50 to 60 t/ha.

Suitable location/ecosystem: Yam is usually cultivated in tropical areas at 25-30°C with annual rainfall around 1000 mm or more for a good harvest. This species cannot tolerate water logging. Sandy loam, loose, deep and well-drained soil is best for yam cultivation. Mound system is good for yam cultivation than high valley and flat system. As a creeping plant, it requires support tree or trellis for normal growth and development. About 1.5 to 2.00 tons bulbils is required per hectare as planting material. The bulbils are planted at 2.5-3.0 x 2.0- 3.0 m spacing during February to May (before one and half month of rainy season). Cowdung 20 tons and ash 2 tons per hectare are to be applied one week before planting for a successful harvest. Field must be kept free from weeds for 4-5 months after planting. During rainy season, care should be undertaken to avoid water logging. The bulbils are harvested during October to December, when the plants turned yellow or die.

Benefit of the technology: It is one of the most important food crops since time immemorial in several parts of the world because of its high nutritional value coupled with known traditional health benefits such as anticancer, anti-inflammatory, antifungal, anti-rheumatism, hypoglycaemic, estrogenic, androgenic, contraceptives, gastropathy protective, antifungal, immuno-stimulant etc. Beside carbohydrates and essential minerals, the yam (tubers) also contains variable fraction of protein and rich in essential amino acids and antioxidant. It is a high value crop and handsome profits can be achieved cultivating in non-arable lands of homestead areas.



BAU Yam-1 (Pesta Alu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Yam-2 (Mete Alu/Gas Alu)

Introduction: Yam is a tuber crops (*Dioscorea spp.*) belong to Dioscoreaceae family being neglected despite of immense significance to local people at particular locality as food and as integral part of culture and heritage. It is endemic to 'Madhupur tract' but found almost all around Bangladesh, primarily used as vegetable and could be useful in meeting the diversified nutrition challenges. The crop produces both edible underground tubers and bulbils and at leaf axils.

Description of the Technology: BAU Yam-2, locally known as 'Gas Alu', 'Golapi Alu', 'Machhranga Alu', 'Pan Alu', 'Gointa Alu,' 'Goiza Alu' etc. The petiole of BAU Yam-2 has wings and stems are curved with a bend to the right. The crop produces both underground tuber and bulbils and underground tubers are white or sometimes pink colored and often branched. Underground tuber and bulbil yield ranges from 80-100 t/ha and 5-10 t/ha, respectively.

Suitable location/ecosystem: Yam is usually cultivated in tropical areas with temperatures ranging 25-30°C. An annual rainfall totaling 1000 mm or more is better for good production. This is a water logging sensitive crop. Sandy loam, loose, deep and well-drained soil is best for yam cultivation. Mound system is found good for yam cultivation compared to high valley or flat system. As a creeping plant, it is necessary to arrange support tree or trellis for good growth and yield. Cutting of tuber or bulbils are used for production while vine cuttings are not suitable. Cowdung 20 tons and two tons of ash/ha are to be applied in pits one week before planting. Bulbils at the rate of 200-250 kg/ha are to be planted per hectare during February to May at a spacing, 2.5-3.0 x 2.5-3.0 m. The field must be kept free from weeds for 4-5 months and during rainy season care should be taken to keep the bed free from inundation. The crop (both underground tubers and bulbils) is harvested during October to December, when the plants turned yellow or started to die.

Benefit of the technology: It is one of the most important food crops since prehistoric time in several parts of the world due to its rich nutritional value coupled with traditional health advantages like anticancer, anti-inflammatory, antifungal, anti-rheumatism, hypoglycaemic, estrogenic, androgenic, contraceptives, gastropathy protective, antifungal, immuno-stimulant etc. In addition to carbohydrates and essential minerals, the yam tubers contain variable amount of protein, rich in essential amino acids and antioxidants. Food, nutrition and agricultural food production system could be diversified through increased cultivation of underutilized BAU Yam-2 for an ever growing population together with a rise in livelihood.



BAU Yam-2 (Mete Alu/Gas Alu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Yam-3 (Pahari Dhusor Alu)

Introduction: Yam (*Dioscorea spp.*) is an underutilized tuber crops, belongs to Dioscoreaceae family, though it is important to local people in specific locality as food and as essential part of culture and heritage. It is endemic in South-Eastern hill districts but found almost all over the country. The tuber is mainly used as vegetable having a potential to face challenges out of nutrition including the crop for diversification. The crop produces edible underground tubers and bulbils.

Description of the Technology: BAU Yam-3, locally known as “Lomba Alu”, “Pahari Alu” etc. mainly grown in Chattogram and South-Eastern hill districts. Its stems are curved to the right. Both underground and aerial tubers (bulbils) are produced. Length of underground tubers ranges from 50-58 cm with tasty flesh and varying color from yellowish to whitish with thin outer layer. Bulbils are mainly irregular round with yellowish flesh. The variety produces 60-70 tons underground tubers along with 3-5 tons bulbils per hectare.

Suitable location/ecosystem: Yam is usually cultivated in tropics at 25-30° C with 1000 mm annual rainfall or more for good yield. This species does tolerate water logging. Sandy loam, loose, deep and well-drained soil is suitable for yam cultivation. Tuber cutting or bulbils are used as seed. Twenty and two tons of cowdung and ash, respectively, per hectare are to be applied in pits one week before planting. Bulbils @100-200 kg/ha are to be planted during February to May at a spacing of 2.5-3.0 m in both ways. The field should be kept weed free for 4-5 months after planting. Care should be taken to avoid water stagnation during the rainy season. The crop is harvested during October to December, when plants turned yellow or dry up.

Benefit of the technology: It is one of the most important food crops since long back in some parts of the world for its rich nutritional and health benefits such as anticancer, anti-inflammatory, antifungal, anti-rheumatism, hypoglycaemic, estrogenic, androgenic, contraceptives, gastropathy protective, antifungal, immuno-stimulant etc. Beside carbohydrates and essential minerals, yam tubers contains variable amount of protein and essential amino acids and antioxidants. Attempts to improve nutrition could be tried including with this variety in food production system and hereby increasing income and livelihood of farm families.



BAU Yam-3 (Pahari Dhusor Alu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Yam-4 (Sagol Dudh Alu)

Introduction: Yam is a traditional tuber crops (*Dioscorea spp.*) belonging to Dioscoreaceae family, and regarded as a neglected crops despite of its magnificent worth for its various utility as food, culture and custom. It is collected from Kishoregonj are but seen to grown almost all over the country as vegetable having potentials to contribute in reducing nutrition deficiencies out of vegetable consumption. It produces edible tubers and bulbils.

Description of the Technology: BAU Yam-4, locally known as ‘Gas Alu’, ‘Dudh Alu’, ‘Munshi Alu’, ‘Hatir pa Alu’ etc. Its stems are curved and curls to right having petiole with green wings. This species does not produce bulbils. Underground tubers are white in color, often branched with tasty flesh. The variety possesses high yield potential with 80-100 t/ha underground tuber.

Suitable location/ecosystem: Yam is usually cultivated in tropical areas at 25-30°C. Annual rainfall is 1000 mm or more is better for good crop. This species cannot tolerate water logging. Sandy loam, loose, deep and well-drained soil is best suited for yam cultivation. Cutting of tuber is used as seed. Cowdung and ash at 20 and 2 t/ha are to be applied in pits one week before planting. 200-250 kg bulbils/ha are to be planted during February to May at 2.5-3.0 x 2.5-3.0 m row x plant spacing. Field must be kept free from weeds for 4-5 months and care should be taken to avoid water logging. The crop is harvested during October to December, when the plants turned yellow or started dyeing.

Benefit of the technology: It is one of the most important food crops since long back in some parts of the world because of its nutritional worth and traditional medicinal values like anticancer, anti-inflammatory, antifungal, anti-rheumatism, hypoglycemic, estrogenic, androgenic, contraceptives, gastropathy protective, antifungal, immuno-stimulant etc. In addition to carbohydrates and essential minerals, it also contains variable amount of proteins and loaded in essential amino acids and antioxidant. However, in context of nutrition demand, food production system can be diversified with BAU Yam-4 and improving profit and livelihood of the grower.



BAU Yam-4 (Sagol Dudh Alu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

BAU Yam-5 (Mou Alu)

Introduction: As food and indispensable part of culture and heritage yam as a tuber crop like (*Dioscorea spp.*) belongs to family Dioscoreaceae is a dilapidated crop even their importance in some areas. It is endemic to 'Madhupur tract' but found almost all over Bangladesh, primarily as vegetable and could be a potential item in meeting diversified vegetable requirement. It produces edible tubers having high value nutrients.

Description of the Technology: BAU Yam-5, locally known as "Mou Alu", "Mom Alu", "Mon Alu", "Gol Alu" etc. It is usually smooth, spiny and curved to the left with no wings and bulbils. It grows not more than 7-10 feet and produces underground spindle or long round tubers in a cluster. It has whitish flesh and golden outer skin. Flesh is very soft and tasty. Underground tuber yield is 80-100 t/ha.

Suitable location/ecosystem: It is usually cultivated in the tropics with temperature ranging 25-30°C with 1000 mm or more annual rainfall for a successful crop. Sandy loam, loose, deep and well-drained soil is best suited for yam cultivation. Cutting of tuber or bulbils are used as seed while vine cuttings are not generally used for cultivation. Cowdung at 20 ton and ash 2 ton per hectare are to be applied in pits one week before planting. Optimum seed rate is 200-250 kg tuber/ha. It should be planted during February to May with 2.5-3.0 x 2.5 x 3.0 plant to row distance. Field should be kept free from weeds for 4-5 months after planting and the base of the plant should be saved from water stagnation. Crop may be harvested during October to December, when the plants turned yellow or dry up.

Benefit of the technology: Yam is one of the most noteworthy food crops from long back in various parts of the world due to its rich food and well known traditional medical value with various advantages viz. anticancer, anti-inflammatory, antifungal, anti-rheumatism, hypoglycaemic, estrogenic, androgenic, contraceptives, gastropathy protective, antifungal, immuno-stimulant etc. Its tubers are bestowed with variable quantities of proteins being rich in essential amino acids and antioxidants other than carbohydrate and essential minerals. However, BAU Yam-5 (Mou Alu) could be brought under cultivation to diversify our food production system to improve nutrition of poor and middle income people.



BAU Yam-5 (Mou Alu)

Name and contact address of the author: Professor Dr. M. A. Rahim

Department of Horticulture
Bangladesh Agricultural University
Mymensingh-2202
Email: marahim1956@yahoo.com

H. Technology/Knowledge generation/Policy Support (as applied):

Bangladesh Agricultural Research Institute

i. Immediate impact of Generation of technology (Commodity & Non-commodity):

- a. One web porter was developed for passport data stored locally and enable third party data sharing and
- b. One mobile application was developed for passport data collection

ii. Generation of new knowledge that help in developing more technology in future:

Information of germplasm will be made available to the breeders through standard documentation process and the web porter will be used for precision agriculture.

iii. Technology transferred that help increased agricultural productivity and farmers' income:

- a. Based on information regarding status, variability and potentialities of existing indigenous PGR, development and improvement program on indigenous crops can be undertaken.
- b. Germplasm exchange program with other countries will also be facilitated.

iv. Policy Support:

Policy support needed for Automation and strengthen the PGRC Research in Bangladesh

Bangladesh Rice Research Institute

i. Immediate impact on generated technology (commodity & non-commodity):

Not applicable

ii. Generation of new knowledge that help in developing more technology in future

The germplasm having higher yield and higher 1000-grain weight (>30 g) would be utilized in hybridization program, if other characters are satisfactory to the rice breeder. The rest of the rice accessions which have desired/suitable traits would be used as parents for breeding program with respective objectives. It is expected that the newly developed data from morphological and molecular characterization would be useful for selecting source materials in future breeding program. Characterization both at morphological and molecular levels is essential prior to apply for registration of any plant material for establishment of rights. These results could be a great potential to establish Intellectual Property Rights (IPR) of Bangladeshi rice germplasm to protect from any bio-piracy.

iii. Technology transferred that help increased agricultural productivity and farmers' income: Not applicable

iv. Policy Support: Not applicable

Bangladesh Jute Research Institute

i. Immediate impact on generated technology (commodity & non-commodity):

Collected germplasm helps to prevent genetic erosion as well as increase the genetic resources.

ii. Generation of new knowledge that help in developing more technology in future:

Collected jute and allied fibre germplasm increase the genetic stock which ultimately helps to develop high yielding good fibre quality varieties by the breeders. Thus farmers will be benefited.

iii. Technology transferred that help increased agricultural productivity and farmers' income:

Not applicable

- iv. Policy Support:**
Farmers will be economically benefited through cultivated new variety.

Bangladesh Sugarcrop Research Institute

- i. Immediate impact on generated technology (commodity & non-commodity):**
Farmer will be benefitted economically cultivating soft, juicy and attractive color chewing cane variety. One can earn a net income around 7,00,000.00 to 15, 00,000.00 Tk. per hectare annually having BCR 2.0 to 3.88. Cultivation of chewing type sugarcane will be enhanced.
- ii. Generation of new knowledge that help in developing more technology in future:**
Five promising clones and two new traits (attractive pink and variegated color) will be utilized in future.
- iii. Technology transferred that help increased agricultural productivity and farmers' income:**
BSRI Akh 47 will increase the productivity and farmers' income
- iv. Policy Support:** Not applicable

Bangladesh Institute of Nuclear Agriculture

- i. Immediate impact on generated technology (commodity & non-commodity):**
Several important yield contributing traits such as higher yield, short duration, and grain quality of rice, sesame, and peanut have been identified in some landraces, several promising genotypes were also identified, which could be utilized in breeding program. Characterization both at morphological and molecular levels is essential prior to apply for registration of any plant material for establishment of IPR. These results could be a great potential to establish Intellectual Property Rights (IPR) of GI crops to protect from any bio-piracy.

Bangladesh Sericulture Research & Training Institute

- i. Generation of new knowledge that help in developing more technology in future:**
Generation of new knowledge that help in developing more technology in future.

Bangladesh Agricultural University

- i. Immediate impact on generated technology (commodity & non-commodity)**
All the collected varieties of banana, aroids and yams are being conserved at BAU-GPC with proper care attention. Distribution of released varieties has been started mainly through DAE, BADC, NGOs, private farms, personal (see annex 3 for distribution by honorable Secretary, MoA and all head of the argil research and extension organizations).
- ii. Generation of new knowledge that help in developing more technology in future:**
- iii. Technology transferred that help increased agricultural productivity and farmers' income:**
Seeds and sapling distribution is going on.
- iv. Policy Support:**
Released varieties of banana, aroids and yam will help increasing the productivity and income.

Overall Sub-project achievement at a glance

PIU-BARC, NATP-2 funded PBRG sub-project titled ‘Collection, Conservation and Characterization of Important Plant Genetic Resources’ coordinated by Crops Division, BARC with eight components viz., BARI, BRRI, BINA, BJRI, BSRI, BSRTI, CDB and BAU was implemented during February 2018 to February 2022.

Major activities performed by the implementing organizations

Organization	*GP Collection		*GP Conservation		Morphological Characterization		Molecular Characterization	
	Target	Achievement	Target	Achievement	Target	Achievement	Target	Achievement
BARI	600	600	600	600	250	844	76	121
BRRI	300	247	300	247	300	264	300	25
BJRI	90	35	90	35	90	97	60	66
BSRI	50	68	50	68	50	51	40	-
BINA	198	199	198	199	98	141	53	83
CDB	-	-	-	-	360	335	-	-
BSRTI	-	-	-	-	60	60	-	-
BAU	30	35	120	136	120	136	90	136
Total	1268	1184	1358	1285	1328	1928	619	526

* GP: Germplasm

Major achievement:

The striking achievement of the sub-project embarked with release of 14 varieties by BAU (Banana: 5, Aroids: 4 and Yam: 5) and one chewing type sugarcane variety by BSRI from germplasm collected and evaluated during NATP Phase I and II.

Output of the sub-project:

BARI

A total of 832 germplasm (collected and conserved) of 8 crops (pumpkin, cucumber, brinjal, bitter gourd, mung bean, bottle gourd, amaranth and guava) were characterized at morphological level. Some promising germplasm were identified for using further crop improvement program.

Crop	Special features	Germplasm with traits
Pumpkin	Sweetness of fruit on brix % (TSS%)	AHI-63 (10%), RAI-87 (10%), RAI-254 (10%), RAI-279 (8%) and AC-512 (8%)
	Flesh thickness (cm)	AC-46 (4.5), ATR-2 (4.5), AMA-106
	No. of fruits/plant	AHI-63 (11), AC-73 (10), MAH-44 (12), ATR-45 (11)
Cucumber	No. of fruits/plant at edible stage	RAI-209 (8)
Brinjal	Fruit length (cm)	BD-7320 (22.93), K-23-21.89, TRMR-102 (21.80), SM Ish-013 (29.10), SM Ish-020 (23.70), SM Ish-020 (22.45)
	Fruit width (cm)	NSR-53 (127.15), K-28 (124.82), K-20 (149.49), NSR-26 (212.07), NSR-4 (229.67)
	Yield/plant (kg)	AC-285 (6.64), K-12 (6.19), K-19 (6.19), K-28 (6.0), K-20 (6.53), K-47 (6.36), NSR-26 (6.58), SM Ish-010 (4.98), SM Ish-015 (5.38), SM Ish-025 (5.05)
Bitter gourd	Days to first fruit harvest	AC-204 (48), AR-18 (49), IA-13 (42), AHI-85 (48)
	No. of fruits/plant	AC-204 (28), AC-296 (28), RAI-32 (36), TT-40 (28), AHI-28 (36), AHI-85 (38), AHI-98 (30), ATR-42 (36)
Mung bean	Days to 50% flowering	BD-9743 (40), BD-10586 (40), BD-10588 (40), BD-10589 (40)

Crop	Special features	Germplasm with traits
	Pods/plant	BD-6926 (42), BD-6927 (38), BD-6927 (41)
	Yield/plant (g)	BD-6926 (341), BD-6927 (345), BD-6927 (290)
Bottle gourd	Days to 1 st female flower	BD-4570 (81), BD-8957 (81), BD-8958 (83), IA-61 (81)
	Fruit wt. at mature stage (kg)	BD-390 (13.67), BD-448 (15.20), BD-9617 (13.10), BD-1453 (13.23), KASI-54 (14.43)
	No. of fruits/plant	BD-4542 (5), RAI-15 (5)
Leaf amaranth	Leaf content, softness, boiling time	BD-2961, BD-9790, BD-9795, BD-9825
Seem amaranth	Stem diameter, softness, boiling time	BD-9822, BD-9941, BD-9942
Guava	Pulp colour	PG Pah 05 (Light red)
	Sweetness of fruit on brix % (TSS%)	PG Hat 015 (13.0), PG Hat 016 (13.6)
	Yield/plant (kg)	PG Pah 07 (115.5), PG Hat 012 (110.0), PG Hat 017 (105.0)

BRR

Total 216 rice germplasm were characterized morphologically for identification of desirable traits and have selected for crop improvement based on following characters.

High yielding germplasm for Boro season: Boro 40/2 (Acc. no. 2215), Mi-Pajang (Acc. no. 149), Boro 275 (Acc. no. 2242), Boro 471 (Acc. no. 2233), Boro 40/1 (Acc. no. 2214), Boro 475 (Acc. no. 2234) Kali Boro 208 (Acc. no. 2200), Kali Boro 704 (Acc. no. 2205)

High yielding germplasm for T. Aman season: Abchaya (Acc. no. 102), Bawoi Jhak (5) (Acc. no. 145), Laksmi Bilash (Acc. no. 211), Indra Sail (Acc. no. 238), Blue Stick (Acc. no. 08)

Scented/lightly scented germplasm: Rupsail (Acc. no.58), Borail (Acc. no. 940), Madhabsail (Acc. no.1651), Boro (sunga) (Acc. no.1861), Kataktara (Acc. no. 39)

Long slender type grain: Lal binni (Acc.no.209), Badkalamkati (Acc.no.2), Charnock (Acc.no.11) and Lal Soru (Acc. no. 281)

Goodphenotypical acceptability: Mi-pajang (Acc. no. 149)

Higher thousand grain weight (TGW): Bora Dudh Kalam (Acc. no. 280), Sunadigha (Acc. no. 126), Dud Saita (Acc. no. 1795), Achar Bhog (Acc. no. 566).

BSRI

Fifty-one sugarcane germplasm were characterized morphologically. Among them four promising clones Madhumala, Black Ruby, Chitra and Turag and 2 new traits (Black Ruby and Chitra)(attractive pink and variegated color)have selected and will be utilized in future.

BINA

In total 73 rice germplasm were characterized and selected four germplasm (Ranishail, Sentu-16, Ojanabirun, Paijam) based on higher yield, three germplasm (Sentu-17, Bashiraj, Deshi-32) selected for short duration and five were selected based on short and scented grain. Thirty sesame germplasm were characterized and 3 (Kalotil, BD-6979 and BD-6981) were selected based on high yield with hairiness in stem, leaf and capsule. Thirty three groundnut germplasm were characterized and 4 (7112-4-4-1,9112-2-1-1, 7112-4-3-1 and ICGV-347) were selected based on higher yield.

Variety developed with salient feature under this sub-project (ID: 128)

Organ-ization	Crop	Variety/ technology	Special characteristics	Crop duration	Yield t/ha	Approval date
BSRI	Sugar-cane	BSRI AKh-47	a. Number of chewable cane (98×10^3 ha-1) b. Tall, erect, medium thick, non-lodging and fiber: 11.69% c. Non-flowering d. Sugar content: 11.5% and reducing sugar: 0.99%	9-10 months	183	Approved by 103rd NSB meeting on 08 September 2020
BAU	Banana	BAU Kala-1	a. Well tasted and large brunched of banana b. Each banana weight (30-35) gm. c. Sweetness: 15-18 cm (TSS) d. Thin spell	Around 1 year	70-100	Registration by Seed Wing, Ministry of Agriculture (2020)
		BAU Kala-2	a. High yielder & resistance to disease b. Each banana weight 80-120 gm c. Seed (1-2) may found in each banana		50-80	
		BAU Kala-3	a. High yielder b. Grown in everywhere	Around 1 year	50-60	Registration by Seed Wing, Ministry of Agriculture (2020)
		BAU Kala-4	a. Nice to taste b. High yielding variety		60-80	
		BAU Kala-5	a. Grown in everywhere b. Well tasted		50-60	
	Yam	BAU Yam-1	a. Stem round & growth in twist towards left b. Smooth bulbils produce in leaf axis c. Small tuber produce under ground d. High yielder and rich in Anti-oxidant	Around 1 year	50-60	Registration by Seed Wing, Ministry of Agriculture (2020)
		BAU Yam-2	a. High yielder and popular variety b. Produce tuber/bulbils both c. Stem threaded and growth in twist towards right d. Rich in anti-oxidant and well tasted		80-100	
		BAU Yam-3	a. Stem threaded and growth in twist towards right b. Well cultivatable at hilly area c. Bulbils naturally round & flash color yellow. d. Rich in Anti-oxidant		60-70	
		BAU Yam-4	a. Fast growing climber plant. b. Stem treated and growth in twist towards right c. Produced tuber but absent bulbils d. Rich in anti-oxidant and nice to taste		80-100	
		BAU Yam-5	a. Stem round, cylinder and growth in twist towards right. b. Plant height (1-10) feet c. Tuber produced under ground d. High yielder and rich in anti-oxidant		60-100	
Aroids	BAU OI Kachu-1	a. Less calcium oxalate b. Use as leafy vegetable	360 days	40-60	Registration by Seed Wing, Ministry of Agriculture (Jan 2021)	
	BAU Man Kachu-1	a. Less calcium oxalate b. Cultivable at hilly, salt and plan lands	300 days	25-35		
	BAU Kachu-3	a. Less calcium oxalate b. Use as leafy vegetable	300 days	40-50		

Organ-ization	Crop	Variety/ technology	Special characteristics	Crop duration	Yield t/ha	Approval date
		BAU Kachu-4	a. Less calcium oxalate b. Use as leafy vegetable c. Use as processing in industrial purpose	365 days	35-50	

I. Information regarding Desk and Field Monitoring:

i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

Bangladesh Agricultural Research Institute

Report type	Date of submission as per Plan/schedule	Actual date of submission
a. Inception report	-	-
b. Statement of expdts (SoE)	On the 3 rd day of each month	On the 3 rd day of each month
c. Quarterly report(s)	-	-
d. Six monthly report	15/07/2019	18/08/2019
e. Procurement plan	-	-
f. Field Monitoring Report(s)	08/12/2019	10/12/2019
g. Annual report	03/02/2020	03/02/2020

ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output):

Bangladesh Agricultural Research Institute

Monitoring team	Date(s) of visit	Total visit
Technical Division/ Unit, BARC Team members: Dr. Md. Aziz Zilani Chowdhury, Member Director (Crops) and Coordinator, PBRG-PGR Sub-project, BARC, Dr. Md. Helal Uddin, Consultant, PBRG-PGR Sub-project, Crops Division, BARC, Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Sub-project, Crops Division, BARC, Dr. Md. Abdus Salam, PSO (Crops), BARC and Amal Chandra Manidas, SO, PBRG-PGR Sub-project, Crops Division, BARC)	22/02/2018 and 04/11/2019	2
PIU-BARC, NATP-2 Team members: Dr. Md. Helal Uddin, Consultant, PBRG-PGR Sub-project, Crops Division, BARC, Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Sub-project, Crops Division, BARC and Amal Chandra Manidas, SO, PBRG-PGR Sub-project, Crops Division, BARC)	14/03/2018, 25/06/2019 and 12/03/2020	3
Internal Monitoring Team members: Dr. Md. Abdul Wohab, Director, Research, Dr. Md. Ashraf Hossain, CSO, Farm Division, BARI, Dr. Amiruzzaman CSO, Plant Breeding Division, BARI, Dr. Babul Chandra Sarkar, PSO, Pomology Div. HRC, BARI, Dr. Faruque Ahmed, CSO, Regional Wheat Research Centre, BARI	19/12/2018, 17/12/2019 and 12/12/2020	3



Fig. 189. Research progress workshop and monitoring of research activities of PGRC, BARI by different monitoring teams

Bangladesh Rice Research Institute

Monitoring team	Date visited	Total visit
1. Technical Division/Unit, BARC Team members: Dr. Md. Aziz Zilani Chowdhury, Member Director (Crops) and Coordinator, PBRG-PGR Sub-project, BARC, Dr. Amjad Hossain, Consultant, PBRG-PGR Sub-project, Crops Division, BARC, Dr. Md. Abdus Salam, PSO (Crops), BARC and Amal Chandra Manidas, SO, PBRG-PGR Sub-project, Crops Division, BARC)	04/11/2019	1
2. PIU-BARC, NATP-2 Team members: Dr. Amjad Hossain, Consultant, PBRG-PGR Sub-project, Crops Division, BARC and Amal Chandra Manidas, SO, PBRG-PGR Sub-project, Crops Division, BARC)	25/06/2019 and 12/03/2020	2
3. Internal monitoring Team members: Dr. Tamal Lata Aditya, Director (Research), BRRI, Dr. Munnujan Khanam, Co-ordinator of Advanced Studies and Research, D(R) Office, BRRI, Dr. Mohammad Khalequzzaman, CSO and Head, GRS Division, Dr. Ebna Syod Md. Harunur Rashid, SSO, GRS Division, Dr. Mohammad Zahidul Islam, SSO, GRS Division, BRRI Regional Station, Bhanga)	05/12/2019 and 10/03/2020	2



Fig. 190. Monitoring of research work of BRRI by different monitoring teams

Bangladesh Jute Research Institute

Monitoring team	Date visited	Total visit	Remarks
Technical Division/ Unit, BARC	17/10/2020	1	1. Dr. Md. Amjad Hossain, Former Director General, BINA and Consultant PBRG sub-project. 2. Dr. Shah Md. Monir Hossain, PSO (crops) and PI, PBRG, sub-project. 3. Amal Chandra Manidas, SO, PBRG, sub-project.
PIU-BARC, NATP-2	12/06/2019	1	1. Dr. Nowsher Ali Sarder M&E Consultant, PIU 2. Dr. Suraya Parvin PSO (P&E), BARC
Internal Monitoring	03/04/2018 15/07/2019 28/07/2020 27/09/2020	4	Director Agriculture and other senior scientists of BJRI



Fig. 191. Field monitoring of BJRI for sub-project evaluation

Bangladesh Sugarcrop Research Institute

Monitoring Team	Date visited	Total visit	Remarks
Dr. Abdul Razzak, Ex EC, BARC Md. ATM Salauddin, Ex DG, BSRI Dr. PK Das, Ex Director, BARI	04/08/2019	1	Both desk and Field monitoring
Internal Monitoring: Director General, Director (Res.) and Director (TOT) of BSRI	04/10/2019	1	Both desk and Field monitoring
PIU-BARC, NATP-2	03/12/2019	1	Both desk and Field monitoring
Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Dr. Md. Monir Hossain, PSO, BARC and PI, PBRG-PGR Sub-Project Amal Chandra Manidas, SO, PBRG-PGR	07/11/2020 – 08/11/2020	1	Both desk and Field monitoring



Fig. 192. Field monitoring by NATP team, BARC and MoA



Fig. 193. Field monitoring by PBRG team, BARC

Bangladesh Institute of Nuclear Agriculture

Monitoring team	Date visited	Total visit
Crops divisions, BARC	9 th November 2019	1
PIU-BARC, NATP-2	7 th April 2019 14 th December 2019 28 th November 2020	3
Internal monitoring	7 th March 2018 14 th December 2019	2
Others		

Cotton Development Board

Monitoring team	Date of visit	Total visit
Crops Division, BARC	08/11/2019 and 17/01/2020	2
PIU-BARC, NATP-2	23/03/2019	1
Internal Monitoring	27/09./019	1 (Sreepur)
	26/10/2019	1 (Jagodishpur)
Other visitors (if any)	27/09/2019	1 (Sreepur)

Bangladesh Sericulture Research & Training Institute

Monitoring team	Date visited	Total visit
Munshi Mamunur Rahman, Documentation Associate, PIU-BARC, NATP-2	05/01/2018	01
Munshi Mamunur Rahman, Documentation Associate, PIU-BARC, NATP-2	12/04/2019	01
Md. Ashequr Rahman, Assistant Manager (Account), PIU- BARC, NATP-2,	22/09/2019	01
Md. Abdus Salam, CSO (Crops) and PI, BARC Component; Dr. Md. Amjad Hossain, Consultant, NATP-2, BARC and Amal Chandra Manidas, Scientific Officer, BARC	18/06/2019	01
Dr. Harun Rashid, Director, PIU-BARC Md. Zahid Hossain, CSO, BRRRI Regional Station, Rajshahi	07/11/2020	01

Bangladesh Agricultural University

Monitoring team	Date visited	Total visit
1. Technical Division/Unit, BARC Team members: Dr. Md. Harunur Rashid, PSO, Crops Division and Dr. Helal Uddin Ahmed, Consultant, PBRG-PGR Sub Project	08/04/2019	01
Dr. Md. Aziz Zilani Chowdhury, Member Director (Crops) and Coordinator, PBRG-PGR Sub-project, BARC, Dr. Amjad Hossain, Consultant, PBRG-PGR Sub-project, Crops Division, BARC, Dr. Shah Md. Monir Hossain, PSO (Crops), BARC and Amal Chandra Manidas, SO, PBRG-PGR Sub-project, Crops Division, BARC.	29/11/2020	01
2. PIU-BARC, NATP-2 Team members: Dr. Mian Sayeed Hasan, Director, PIU and Dr. M.A. Jalil Bhuyan, Research Management Specialist, NATP, PIU-BARC	25/06/2019	01
3. Internal monitoring	22/05/2019	01

iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities:

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID128; Collection, Conservation and Characterization of Important Plant Genetic Resources

Name of the Component: **BARI Component**

Name of the PI: Dr. Mossamat Shamsunnahar

(1) Gender integration in research program

Number of participants under different events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs	-	-	-	-
Workshops	-	-	-	-
Any other sub-project activity (farmers' group/field day/field visit/laborers, etc.)	75	75	100	250

(2) Grievance Redress Mechanisms (GRM): Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: **None**

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number: Germplasm collected of different crop (600)	√Yes/No/Not applicable

Serial no.	Crop name	No. of germplasm	Serial no.	Crop name	No. of germplasm
1	Different <i>shak</i>	6	18	Custard apple	2
2	Amaranth	30	19	Fennel	2
3	Ash gourd	19	20	Fenugreek	3
4	Taro	4	21	Field pea	5
5	Banana	1	22	Foxtail millet	6
6	Barley	1	23	French bean	6
7	Bitter gourd	12	24	Garlic	1
8	Black cumin	4	25	Grass pea	9
9	Black gram	2	26	Indian spinach	7
10	Black pea	1	27	Indigo	1
11	Bottle gourd	32	28	Jute leaf	4
12	Brinjal	76	29	Kangkong	4
13	Chinese mallow	5	30	Kidney bean	1
14	Coriander	11	31	Lentil	4
15	Country bean	75	32	Linseed	1
16	Cowpea	8	33	Mung bean	6
17	Cucumber	14	34	Musk melon	5

Serial no.	Crop name	No. of germplasm	Serial no.	Crop name	No. of germplasm
35	Mustard	13	51	Spinach	14
36	Okra	16	52	Sponge gourd	16
37	Onion	2	53	Sword bean	3
38	Papaya	6	54	Teasle gourd	3
39	Pigeon pea	3	55	Turmeric	4
40	Potato	1	56	Turnip	1
41	Pumpkin	28	57	Wheat	1
42	Radish	6	58	White pea	1
43	Red amaranth	23	59	Yam	5
44	Red chilli	13	60	Yard long bean	24
45	Ridge gourd	13	61	Carrot	1
46	Roselle	1	62	Yam bean	1
47	Safflower	1	63	Broom corn	2
48	Sesame	7	64	Maize	3
49	Sesbania	1	65	Coffee	1
50	Snake gourd	7	66	Medicinal	12
Total = 600					

2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event: Extreme rainfall in June-July (During kharif II season), Extreme low temperature in December-January (During winter season)	√Yes/No/Not applicable
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions: Pheromone trap and Poison bate trap (in characterization of pumpkin, cucumber, brinjal, bitter gourd and bottle gourd experiment).	√Yes/No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/√No/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/√No/Not applicable
6	Soil organic matter content increased due to sub-project interventions; if yes, please mention the interventions:	Yes/√No/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s): 08	√Yes/No/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/√No/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/√No/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	Yes/√No/Not applicable

SN	Activity/environmental and social safeguard issue	Tick one
11	<p>Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:</p> <p>1. During exploration and collection of germplasm interaction among indigenous people and scientist occurred. A good relation has been developed in between scientist and indigenous people and also among themselves.</p> <p>2. Awareness about importance of local germplasm has been raised among the indigenous people.</p> <p>3. Scientists have learnt about local cultivation technology of different crop from the indigenous people, in the similar way local people have learnt about the modern cultivation technology from the scientists.</p>	√Yes/No/Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project Title and ID: ID:128; Collection, Conservation and Characterization of Important Plant Genetic Resources

Name of the Component: **BRRRI component**

Name of the PI: Dr. Mohammad Khalequzzaman

(1) Gender integration in research program

Number of participants under different events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs				
Workshops				
Any other sub-project activity (farmers' group/field day/field visit/laborers, etc.)				
➤ Collection of rice germplasm from local farmers	126	11	81 (tribal people from hill tracts)	137
➤ Field laborers	45	-	-	45

(3) **Grievance Redress Mechanisms (GRM):** Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None

(4) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	<p>No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number:</p> <p>➤ Two hundred and forty-seven (247) rice germplasm were collected from different locations (29 Upazilas of 14 Districts) of Bangladesh.</p>	Yes [√] /No/Not applicable
2	<p>Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event:</p> <p>➤ Pandemic corona virus badly affected the activities of the sub-project, especially germplasm collection were not possible during the entire year 2020. Only some indirect / lateral collections were</p>	Yes [√] /No/Not applicable

SN	Activity/environmental and social safeguard issue	Please tick one
	done. But laboratory works were continued under this pandemic.	
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions: ➤ Light trap and perching were practiced in the experimental field to control insects.	Yes [√] /No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/No [√] /Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/No [√] /Not applicable
6	Soil organic matter content increased due to sub-project interventions ; if yes, please mention the interventions: ➤ After harvesting only the rice panicles, remaining maximum portion of rice straw in the field were mixed with soil during next tillage operations that ultimately increase the soil organic matter after decomposition.	Yes [√] /No/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s): ➤ Balanced fertilizers were used in five (5) field experiments	Yes [√] /No/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions ➤ No environmental pollutions were happened due to sub-project interventions as no pesticides were used in the experimental fields.	Yes/No [√] /Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/No [√] /Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Indigenous rice ecosystem were maintained as well as improved 2. Improvement of soil health by allowing decomposition of rice straw in the experimental field 3. Enhanced microbial activity due to balanced use of fertilizer in the soil which is good for soil health.	Yes [√] /No/Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Farmers and other associated people know about the importance of local rice germplasm 2. Awareness increased regarding safe conservation of rice genetic resources 3. Collection, conservation and characterization of rice germplasm helps in protecting biopiracy and geographical indications and issues related to IPR etc.	Yes [√] /No/Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID:128; Collection, Conservation and Characterization of Important Plant Genetic Resources

Name of the Component: **BJRI Component**

Name of the PI: Md. Rafiqul Islam

(1) Gender integration in research program

Number of participants under different events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs	-	-	-	-
Workshops	-	-	-	-
Any other sub-project activity (field visits)	20	10	-	30

(2) Grievance Redress Mechanisms (GRM):Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None

(3) Information related to environmental and social safeguards as below:

Sl.No.	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed/collected under the sub-project; if yes, please mention the type and number: Species type & Number: <i>Corchorus capsularis</i> -23, <i>Corchorus olitorius</i> -9 and <i>Hibiscus sabdariffa</i> -3	√Yes/No/Not applicable
2	Observed any extreme climatic event (extreme rainfall) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event: Extreme rainfall: Place: Manikganj, Date: 26 July, 2020.	√Yes/No/Not applicable
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions:	Yes/√No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/√No/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/√No/Not applicable
6	Soil organic matter content increased due to sub-project interventions; if yes, please mention the interventions:	Yes/√No/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s):	Yes/√No/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/√No/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/√No/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	Yes/√No/Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Farmers are motivated to conserve Jute and allied fiber (JAF) germplasm. 2. Awareness building for JAF germplasm collection. 3. Skill have been developed for JAF germplasm collection.	√Yes/No/Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID: 128; Collection, conservation and characterization of important plant genetic resources

Name of the Component: **BSRI Component**

Name of the PI: Dr. Md. Anisur Rahman

(1) Gender integration in research program

Number of participants under different events: No training/workshop/such events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs				
Workshops				
Any other sub-project activity (farmers' group/field day/field visit/laborers, etc.)				

(2) Grievance Redress Mechanisms (GRM): Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None.

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number: Germplasm collection: 68. Releasing of chewing cane variety: 01	√Yes
2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event:	√No
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions: Conservation and maintenance of collected germplasm were practiced through IPM approach. Activities: Sett treatment Stubble burning Collecting and destroying of insect-pests Roughing out infected clum Weeding, mulching, irrigation and fertilizer management Earthing up and detrashing of older leaves Clean cultivation Application of insecticides as and when required	√Yes
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	√Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	√Not applicable
6	Soil organic matter content increased due to sub-project interventions ; if yes, please mention the interventions:	√Yes

SN	Activity/environmental and social safeguard issue	Please tick one
	Interventions: Application of cowdung and mustard oil cake in field experimentation regarding conservation and maintenance of collected germplasm Incorporation of green manure in field gene bank of sugarcane	
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s): Application of organic manures and balanced fertilizers in field experimentation regarding conservation and maintenance of collected germplasm	√Yes
8	Created environmental pollution (air, soil, water) due to sub-project interventions	√No
9	Observed any negative social impact due to sub-project interventions	√No
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	√Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Farmers' income has been increased through cultivating newly released chewing cane variety 2. Sixty eight local sugarcane germplasm has been collected which enriched BSRI germplasm bank 3. Fifty one germplasm has been characterized and evaluated; of them a few promising outstanding ones have been selected for releasing as new variety in future.	√Yes

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID:128; Collection, conservation and characterization of important plant genetic resources

Name of the Component: **BINA Component**

Name of the PI: Dr. Shamsun Nahar Begum

(1) Gender integration in research program

Number of participants under different events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs				
Workshops				
Any other sub-project activity (farmers' group/field day/field visit/laborers, etc.)				

(2) **Grievance Redress Mechanisms (GRM):** Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: Not Applicable

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number:	Yes/No/√Not applicable
2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low	Yes/No/√Not applicable

SN	Activity/environmental and social safeguard issue	Please tick one
	temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event:	
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions:	Yes/No/√/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/No/√/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/No/√/Not applicable
6	Soil organic matter content increased due to sub-project interventions ; if yes, please mention the interventions:	Yes/No/√/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s):	Yes/No/√/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/No/√/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/No/√/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: <ul style="list-style-type: none"> • Rescue endangered PGR and minimizes genetic erosion • Facilitate selection of parents for hybridization program • Important traits which are identified from local germplasm could be utilized for future breeding program. 	√/Yes/No/Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: <ul style="list-style-type: none"> • Facilitate compensation of local communities and farmers for their contribution to the conservation and development of plant genetic resources • Promote the sharing of benefits derived from plant genetic resources between the donors and users of germplasm • Promote the conservation, collection and use of plant genetic resources from their nature habitats or surrounding, in ways that respect the environment and local traditions and cultures 	√/Yes/No/Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID:128; Collection, Conservation and Characterization of Important Plant Genetic Resources.

Name of the Component: **CDB Component**

Name of the PI: M. M. Abed Ali

(1) Gender integration in research program

Number of participants under different events: N/A

(2) Grievance Redress Mechanisms (GRM): Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number: 343 germplasm were characterized.	√Yes/No/Not applicable
2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event:	Yes/√No/Not applicable
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions:	Yes/√No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/No/√Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/No/√Not applicable
6	Soil organic matter content increased due to sub-project interventions ; if yes, please mention the interventions:	Yes/No/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s):	Yes/No/√Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/√No/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/√No/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	Yes/No/√Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	Yes/No/√Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID128; Collection, Conservation and Characterization of Important Plant Genetic Resources

Name of the Component: **BSRTI component**

Name of the PI: Md. Abdul Alim

(1) Gender integration in research program: Not Applicable

(2) Grievance Redress Mechanisms (GRM): Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed/collected under the sub-project; if yes, please mention the type and number:	Yes/No/√Not applicable
2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/thunder storm/nor wester/extreme high & low temperatures/arsenic contamination/salinity intrusion, etc.) to affect the sub-	Yes/No/√Not applicable

SN	Activity/environmental and social safeguard issue	Please tick one
	project activity during the sub-project period; if yes, please mention the name and date of event:	
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions:	Yes/No/ <input type="checkbox"/> Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/ <input type="checkbox"/> No/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/No/ <input type="checkbox"/> Not applicable
6	Soil organic matter content increased due to sub-project interventions; if yes, please mention the interventions:	Yes/No/ <input type="checkbox"/> Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s): 02	<input checked="" type="checkbox"/> Yes/No/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/ <input type="checkbox"/> No/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/ <input type="checkbox"/> No/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: i. Reduce the environmental pollution as well as temperature through cultivation of mulberry plant. ii. Help the environment to absorbed CO ₂ and release the O ₂ through mulberry garden. iii. Reduce the soil erosion through establishment of mulberry garden.	<input checked="" type="checkbox"/> Yes/No/Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3:	Yes/No/ <input type="checkbox"/> Not applicable

Data collection format for Environmental and Social Safeguards

PBRG Sub-Project ID and Title: ID128; Collection, Conservation and Characterization of Important Plant Genetic Resources

Name of the Component: **BAU component**

Name of the PI: Prof. Dr. M. A. Rahim

(1) Gender integration in research program

Number of participants under different events

Name of Events	Male (No.)	Female (No.)	Indigenous People (No.)	Total (No.)
Training programs	122	100	10	232
Workshops	145	77	15	237
Any other sub-project activity (farmers' group/field day/field visit/laborers, etc.)	510	442	50	1002

(2) **Grievance Redress Mechanisms (GRM):** Received any suggestion/complaint from any stakeholder regarding any activity of the sub-project during the sub-project period. If yes, please describe as below: None

(3) Information related to environmental and social safeguards as below:

SN	Activity/environmental and social safeguard issue	Please tick one
1	No. of variety (s)/breeding lines/fish species/cattle & poultry species developed /collected under the sub-project; if yes, please mention the type and number: 14 varieties	√Yes/No/Not applicable
2	Observed any extreme climatic event (extreme rainfall/dry spells/flood/drought/ thunder storm/nor wester/extreme high & low temperatures/ arsenic contamination/salinity intrusion, etc.) to affect the sub-project activity during the sub-project period; if yes, please mention the name and date of event:	Yes/√No/Not applicable
3	Adopted IPM approach to control the pest in the number of field experiment (s) under the sub-projects; if yes, please mention the activities/interventions: PEN (Pest exclusion net), Pheromone trap	√Yes/No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number: BAU banana 1-5 resistant to fruits and leaf beetle	√Yes/No/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number: BAU Maan Kachu; BAU Olkachu, BAU Yam 3; salinity upto 16 ds	√Yes/No/Not applicable
6	Soil organic matter content increased due to sub-project interventions ; if yes, please mention the interventions:	Yes/√No/Not applicable
7	Used balanced fertilizers in the no. of field experiment (s) under the sub-project; if yes, please mention the number of field experiment (s): No chemical fertilizers used during experimentation only organic fertilizers like compost, cowdung etc.	√Yes/No/Not applicable
8	Created environmental pollution (air, soil, water) due to sub-project interventions	Yes/√No/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/√No/Not applicable
10	Positive environmental impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Environmental friendly varieties developed which can grow under natural conditions without any pesticides and chemical fertilizers 2. Most of varieties developed are broad leafed sinking more carbon di oxide and releasing more oxygen 3. Most of the varieties are stress tolerant (Drought, salinity and poor soils)	√Yes/No/Not applicable
11	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: 1. Through adopting the varieties which are mostly highly nutrition, antioxidant rich and high yielding will serve for nutritional food security specially for the poor and pro-poor of rural areas of Bangladesh 2. All varieties are indigenous, well adopted to our climate does not need more attention and cost of production is minimal 3. Since locally produced it has great impact on socio-economic conditions of the rural peoples	√Yes/No/Not applicable

J. Sub-project auditing (covers all types of audit performed):

Bangladesh Agricultural Research Council

Types of audit	Major observation/ issues /objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
2019-20 (Govt.)	No objection	1596152.50	30-11-2019	Satisfactory
2020-21 (Govt.)	No objection	1383151.50	09-12-2020	Satisfactory

Bangladesh Agricultural Research Institute

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
Yearly (Year 1)	Bill, voucher, cash memo, stock register, cash book, RFQ bill file, bank statement, budget allocation, SoE, Bill and check register, VAT and chalan	1749178.85 (up to 30/06/2019)	-	Satisfactory
Yearly (Year 2)	Bill, voucher, cash memo, stock register, cash book, RFQ bill file, bank statement, budget allocation, SoE, Bill and check register, VAT and chalan	2158070.85 (up to 30/06/2020)	-	

Bangladesh Rice Research Institute

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
2018-19 fiscal year (by FAPAD)	No	133108.00	-	-
2019-20 fiscal year (by FAPAD)	yes	1985603.00	Reviewing	Procurement plan was passed for spent for laboratory chemicals and equipment in the AWP: 2018-19 but due to lack of enough funds (delay in fund release) the payment (1,32,850 BDT) was made in AWP: 2019-2020.

Bangladesh Jute Research Institute

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
Yearly AG Audit	Bill, voucher, cash, memo, stock register, cash book, RFQ bill file, Bank statement budget allocation, SoE, Bill and check register, VAT and chalan.	4,42,730.00 (up to 30/06/2019)		Satisfactory, no objection was made by the audit team.
Yearly AG Audit	Bill, voucher, cash, memo, stock register, cash book, RFQ bill file, Bank statement budget allocation, SoE, Bill and check register, VAT and chalan.	709210.00 (up to 09/12/2019)		
M.I. Chowdhury & Co.	Bill, voucher, cash, memo, stock register, cash book, RFQ bill file, Bank statement budget allocation, SoE, Bill and check register, VAT and chalan.	709210.00 (up to 24/12/2020)		

Bangladesh Sugarcrop Research Institute

Internal	None	1709078.00	No audit objection	
FAPAD	None	1480185.00	No audit objection	

Bangladesh Institute of Nuclear Agriculture

Govt.	No objection	1307197.00	20-11-2019	Satisfactory
Govt.	No objection	1136577.00	16-11-2020	Satisfactory

Cotton Development Board				
FAPAD	No observation/ issues/ objections	510294.00	1 st Year	Satisfactory
FAPAD	No observation/ issues/ objections	580805.00	2 nd Year	Satisfactory
Bangladesh Sericulture Research & Training Institute				
Yearly (1 st year)	Satisfactory, no objection were made by the audit team	505000.00	-	
Yearly (2 nd year)	Satisfactory, no objection were made by the audit team	555200.00	-	

K. Lessons Learned:

Bangladesh Agricultural Research Council

- i) Scientists of NARS institutes except BARI and BRRI are not much acquainted with systematic germplasm collection and PGR management activities, and report preparation.
- ii) Huge genetic resources are still available in less accessible areas, which are in the verge of extinction because of rapid development of road communication network and abiotic stress tolerant HYVs of major and under-utilized crops.
- iii) All the institutes are lagging far behind in respect of establishment of Intellectual Property Rights on potential GI crops and commercially important technologies.

Bangladesh Agricultural Research Institute

- i) Multiple traits have been identified
- ii) Core collection has enriched
- iii) On-farm and in-situ conservation has enhanced
- iv) Institutional knowledge sharing has improved
- v) Through morphological and molecular characterization, we can easily detect the germplasm duplication.
- vi) In case of natural disaster(s) PGRC can support farmer/researcher with climate smart germplasm.

Bangladesh Rice Research Institute

- i) Understanding about how to behave with farmers and how to handle them during the collection program (the attitude of the farmers).
- ii) Local rice germplasm/landraces are being gradually replaced by hybrids/HYVs.
- iii) Farmers are not much aware about importance of local rice landraces.
- iv) Deforestation was also observed in hilly areas, which is causing genetic erosion of wild relatives of rice.
- v) Traditional rice varieties /landraces are still available in remote areas. If these PGR are not be collected immediately these will be lost forever.

Bangladesh Jute Research Institute

- i) Unexpected attitude of natives during germplasm collection.
- ii) Tips helps to germplasm accusation

Bangladesh Sugarcrop Research Institute

- i) There are enormous local cultivar/landraces of sugarcane exist throughout the country.
- ii) Availability of traditional local germplasm is higher in ethnic community and peripheral areas of the country.
- iii) Inter institutional knowledge sharing is very essential regarding germplasm management approaches.
- iv) Core collection is enhanced and location specific genotypes broaden their utilization arena.

Bangladesh Institute of Nuclear Agriculture

- i) Methods of collection of landraces from farmers and recording the passport information of germplasm
- ii) Learnt about the morphological characterization procedures of germplasm of different crops
- iii) Characterization of germplasm may help for protection of bio-piracy and may help to breeder for varietal development
- iv) Conservation and documentation system for germplasms in genebank

Cotton Development Board

- i) Location-wise collection is needed
- ii) Understanding project implementation system
- iii) To gather institutional knowledge sharing

Bangladesh Sericulture Research & Training Institute

- i) Understanding about a successful project monitoring and auditing process.
- ii) Management process and techniques for executing a project.
- iii) Learned about the morphological characterization procedure and states for mulberry germplasm.
- iv) Characterization at morphological and molecular level is very much essential prior to breeding program for achieving success.

Bangladesh Agricultural University

- i) Characterization may help for protection of piracy
- ii) Variety development
- iii) Conservation

L. Challenges (if any):

- Rescue important PGR from extinction.
- Collection and conservation of endangered invaluable traditional PGR like Muslin cotton, Sonamung, Cape yellow wood (Bajna), etc.
- Lack of availability of GI crops
- Collection of all PGR including rice is a great challenge for scientific community. In addition corona pandemic would create extra wrangle for collection of germplasm including rice.
- Due to COVID-19 pandemic situation, collection and research work was difficult.
- Unavailability and sharing problem of germplasm
- Rescue and conserve all the landraces still available in different locations of the country.

M. Suggestions for future planning (if any):

- The sub-project should be continued including other institutes viz. BTRI, BFRI and NIB.
- Human resource development program on PGR management system is to be strengthened.
- Capacity building and physical facility development for Cryopreservation should be initiated.
- Numerous germplasm of indigenous underutilized crops are still available in less accessible areas of the country, which are in the verge of erosion.

N. References:

- Adolkar, V.V., S.K. Raina and D.M. Kimbu. 2007. Evaluation of various mulberry *Morus* spp. (Moraceae) cultivars for the rearing of the bivoltine hybrid race Shaashi BV-333 of the silkworm *Bombyxmori* (Lepidoptera: Bombycidae). *Int. J. Trop. Insect Sci.* 27: 6-14.
- Agrama, H.A., and M.R. Tuinstra. 2003. Phylogenetic diversity and relationships among sorghum accessions using SSRs and RAPDs. *Afr J Biotechnol*, 2: 334-340.
- Akter, L., M.S. Islam, M.N. Uddin and S. Ahmed. 2009. Evaluation of new bitter gourd germplasm. Research Report, 2008-2009. Horticulture Research Centre, BARI, Gazipur. p.16
- Ali, M.A., M. Hossain and A.S.M. Yahiya. 2014. Characterization of important plant genetic resources: BJRI component. SPGR Coordinated Sub-Project Completion Report.
- Anderson, J.A., G.A. Churchill, J.E. Autrique, S.D. Tanksley and M. E. Sorrels. 1993. Optimizing parental selection for genetic linkage maps. *Genome*, 36:181–186.
- Arora, R.K., 1991. Plant exploration and germplasm collection. Important plant genetic resources. Conservation and Management. Eds. New Delhi, India. p.392
- Aubriot, X. and M.C. Daunay. 2019. Eggplants and Relatives: From exploring their diversity and phylogenetic relationships to conservation challenges. In the Eggplant Genome. pp. 91-134.
- Azeredo, H.M.C. 2009. Betalains: properties, sources, applications, and stability a review. *Int. J. Food Sci. Tech.* 44:2365-2376.
- BBS. 2014. Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics, Ministry of Planning, GoB, Dhaka. p. 95,142&143.
- BBS. 2017. Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, Ministry of Planning, GoB, Dhaka.
- BBS. 2019. Yearbook of Agricultural Statistics of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, GoB, Dhaka.
- BBS. 2020. Bangladesh Bureau of Statistics, Yearbook of agricultural statistics, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.
- Begum, S.N. and M.M. Islam. 2014. Characterization of important plant genetic resources: BINA component. SPGR Coordinated Sub-Project Completion Report.

- Bose L.K. and S.K. Pradhan. 2005. Genetic divergence in deep water rice genotypes European J. Cont. 6(4): 635-640.
- BRRI. 2018. Descriptors for cultivated rice (*Oryzae sativa* L.). Genetic resources and seed division, Bangladesh Rice Research Institute, Gazipur, Bangladesh.
- Cansian, R. L. and S. Echeverrigaray. 2002. Discrimination among cultivars of cabbage using randomly amplified polymorphic DNA markers. *Hort Sci*, **35**: 1155-1158.
- Chanotra, S., R.K. Bali and B. Kamlesh. 2019. Morpho-physiological characterization of mulberry genotypes (*Morus spp.*) for inheritance in future breeding programme, J. Pharmacognosy and Phytochemistry. 8(1): 2695-2701.
- Chatfield, C. and A.J. Collin. 1980. Introduction to multivariate analysis. Chapman and Hall, Methuen, Inc., New York. <http://dx.doi.org/10.1007/s10681-012-0661-9>
- Chaudhary, R. R. 2001. "Genetic variability and heritability in sugarcane," Nepal Agri. Res. J. 4(5): 56–59.
- Chen X., S. Temnykh, Y. Xu, Y.G. Cho and S.R. McCouch. 1997. Development of a microsatellite framework map providing genome-wide coverage in rice (*Oryza sativa* L.). *Theor Appl Genet.* 95: 553-567.
- Chowdhury, M.A.H. and M.S. Hassan. 2013. Hand book of agricultural technology Bangladesh Agricultural Research Council, Dhaka, Bangladesh.
- Cox, M., M. Hogarth and G. Smith. 2000. Cane breeding and improvement. In "Manual of cane growing", M Hogarth, P Allsopp, (eds). Bureau of Sugar Experimental Stations, Indooroopilly, Australia. pp. 91-108.
- Crouch J.H., H.K. Crouch, H. Constandt, A.Van Gysel, P. Bretne, M.Van. Montagu, R.I. Jarret, and R. Ortiz. 1999. Comparison of PCT-based molecular marker analyses of *Musa* breeding populations. *Molecular Breeding* 5: 233-244.
- Das R.S.J., S. Bhatia, P.S. Srivastava and M. Lakshmikumaran. 1999. Assessment of genetic variation within *Brassica campestris* cultivars using AFLP and RAPD markers. *J Bio Sci*, 24: 433-440.
- Doyle, J.J. and J.L. Doyle. 1987. A rapid DNA isolation procedure for small quantities of fresh leaf tissue. *Phytochemical Bulletin*, 19: 11-15.
- Elo, K.S., Ivanoff, J.A. Vuorinen, J. Piironen. 1997. Inheritance of RAPD markers and detection of inter-specific hybridization with brown trout and Atlantic salmon. *Aquaculture* 152 55-65.
- Engles, J.M.M., V.R. Rao, A.H.D. Brown and M.T. Jackson. 2002. Managing plant genetic diversity; CABI Publishing: Oxford, UK, p. 487.
- Ferdous, J., M.M. Hanafi, M.Y. Rafii and K. Muhammad. 2012. A quick DNA extraction protocol. *African J. Biotech.* 11(27): 6956-6964.
- FRG. 2012. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), Farmgate, New Airport road, Dhaka-1205.
- FRG. 2018. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), Farmgate, New Airport Road, Dhaka- 1205.

- Furumuto, T., R. Wang, K. Okazaki, F.A. Hasan and I.M. Ali. 2002. Antitumor promoters in leaves of jute (*Corchorus capsularis* and *Corchorus olitorius*). Food Sci. Technol. Res. 8 (3):239-243.
- Galli, J.A., D.M. Michelotto, M.B.B. Soares, A.L.M. Martins, M.C.D.A. Palharini and I.H. Fischer. 2015. Characterization of guava plants belonging to a germplasm bank and cultivated in an organic system. Acta Horticulturae. 1137: 213–218.
- Ghafoor, A., Z. Ahmad and R. Anwar. 2005. Genetic diversity in *Pisum sativum* and a strategy for indigenous biodiversity conservation. Pakistan J. Bot. 37: 71-77.
- Hair, J.F., J.R. Anderson, R.E. Tatham, W.C. Black 1998. Multivariate Data Analysis. 5th Edition, Prentice-Hall International Inc. London.
- Halton T.A., J.T. Christopher, L. McClure, N. Harker and R.J. Henry. 2002. Identification and mapping of polymorphic SSR marker from expressed gene sequence of barley and wheat. Mol. Breed. 9: 63-71.
- Haque, M. and M.R. Biswas. 2014. Characterization of commercially cultivated hybrid rice in Bangladesh. World J. Agril. Sci. 10 (6): 300-307.
- Heckenberger, M.M. Bohn, J. Ziegler, L.K. Joe, J.D. Hauser, M. Hutton and A.E. Melchinger. 2002. Variation of DNA fingerprinting among accessions within maize inbred lines and implications for identification of essentially derived varieties. I. Genetic and technical sources of variation in SSR data. *Mol Breed*, 10: 181-191.
- Heywood, V.H., R.K. Brummitt, A. Culham and O. Seberg. 2007. Flowering plant families of the world. Royal Botanical Gardens Kew publications, London, England.
- Hossain, M.A., I. Ahmed, M.R. Molla. 2014. Characterization of important plant genetic resources: BARI component. SPGR Coordinated Sub-Project Completion Report.
- IBPGR (International Board for Plant Genetic Resources). 1990. Descriptors for Eggplant. Rome, Italy. pp. 11-15.
- IBPGR. 1985. Sesame Descriptors. International Board for Plant Genetic Resources, Rome, Italy (AGPG: IBPGR/85/132, November 1985).
- IBPGR. 1990. Descriptors for Mung Bean. International Board for Plant Genetic Resources. Commission of the European Communities. Rome.
- IPGRI/CIP 2003. Descriptors of Aroids. Instituto Internacional de Recursos Fitogenéticos, Roma, Italia; Centro Internacional de la Papa, Lima, Peru.
- IPGRI/IITA 1997. Descriptors for yam (*Dioscorea spp.*). International Institute of Tropical Agriculture, Ibadan, Nigeria/International Plant Genetic Resources References 202 Institutes, Rome, Italy.
- IRRI. The International Rice Genebank. 2018. Available from: <http://irri.org/our-work/research/genetic-diversity/international-rice-genebank>.
- Islam, M.R. and M.Z. Uddin, 2015, Ann. Res. Rpt. Olericulture Division. HRC, BARI pp. 26-27.
- Kallo, V., CRC Press Inc. Florida, 1988. USA, pp. 1-40.

- Islam, M.Z., M. Khalequzzaman, M.F.R.K. Prince, M.A. Siddique, E.S.M.H. Rashid, M.S.U. Ahmed, B.R. Pittendrigh and M.P. Ali. 2018. Diversity and population structure of red rice germplasm in Bangladesh. *Plos One* 13(5): 1-20.
- Joshi, M.A., N.K. Sarao, R.C. Sharma, P. Singh and T.S. Bharaj. 2007. Varietal characterization of rice (*Oryza sativa* L.) based on morphological descriptors. *Seed Research* 35(2): 188-192.
- Jun, H., C. Lee, G. Song and Y. Kim. 2014. Characterization of pectin and polysaccharides from pumpkin peel. *Lebensmittel-Wissenschaft und-Technologie*, 39.
- Junjian N, PM Colowit and D Mackill. 2002. Evaluation of genetic diversity in rice subspecies by microsatellite markers. *Crop Sci*, 42: 601-607.
- Karim, K.M.R. and M.A. Hossain. 2014. Characterization of important plant genetic resources: BSRI component. SPGR Coordinated Sub-Project Completion Report.
- Khalequzzaman, M. and M. A. Siddique. 2014. Characterization of important plant genetic resources: BRRRI component. SPRG Sub-Project Completion Report.
- Khan, M.S. et al. (Eds.). 2001. Red Data Book of Vascular Plants Bangladesh. Bangladesh Agricultural Research Council/Bangladesh National Herbarium, Dhaka.
- Kumar, S. S. H. L. 2013. Assessment of genetic diversity in *Brassica juncea* (Brassicaceae) genotypes using phenotypic differences and SSR markers. *Revista De Biología Tropical*. 61(4): 1919-1934.
- Lee, Y.K., W.I. Chung and H. Ezura. 2003. Efficient plant regeneration via organogenesis in winter Squash.
- Lin, M.S. 1991. Genetic base of japonica rice varieties released in Taiwan. *Euphytica*.56: 43-46.
- Liu, K. and S. V. Muse, 2005. Power Marker: Integrated analysis environment for genetic marker data. *Bioinformatics* 21: 2128–2129.
- Lowe, A.J., C. Moule, M. Trick and K.J. Edwards. 2004. Efficient large-scale development of microsatellites for marker and mapping applications in *Brassica* crop species. *Theor. Appl. Genet.* 108: 1101-1112.
- Lower, R.L. and M.D. Edwards. 1986. Cucumber breeding. In: Bassett, M.J. (ed.), *Breeding Vegetable Crops*. p: 173–207.
- Malik, S.R., A. Bakhsh, M.A. Asif, U. Iqbal, S.M. Iqbal. 2010. Assessment of genetic variability and interrelationship among some agronomic traits in chickpea. *Int. J. Agric. Biol.*12:81–85.
- McCouch, S.R., L. Teytelman, Y. Xu, K.B. Lobos, K. Clare, M. Walton, B. Fu, R. Maghirang, Z. Li and Y. Xing. 2002. Development and mapping of 2240 new SSR markers for rice (*Oryza sativa* L.). *DNA Res.* 9: 199-207.
- Mehmood, A., M.J. Jaskani, S. Ahmad and R. Ahmad. 2013. Evaluation of genetic diversity in open pollinated guava by iPBS primers. *Pakistan J. Agril. Sci.* 50: 591–597.

- Mehmood, A., S. Luo, N.M. Ahmad, C. Dong, T. Mahmood, Y. Sajjad, M.J. Jaskani, and P. Sharp. 2015. Molecular variability and phylogenetic relationships of guava (*Psidium guajava* L.) cultivars using inter-primer binding site (iPBS) and microsatellite (SSR) markers. *Genetic Resources and Crop Evolution* 63: 1345–1361.
- Moghaddam M, SA Mohammadi, N Mohebalipour, M Toorchi, S Aharizad and F Javidfar. 2009. Assessment of genetic diversity in rapeseed cultivars as revealed by RAPD and microsatellite markers. *African J of Biotech*, 8(14): 3160-3167.
- Mohammadi, S.A. and B.M. Prasanna. 2003. Analysis of genetic diversity in crop plants-salient statistical tools and considerations. *Crop Sci.* 43(4):1235-1248.
- Molla MR, MN Islam, MM Rohman and L Rahman. 2010. Microsatellite allele size profiling to determine varietal identity and genetic diversity among groundnut varieties in Bangladesh. *Nat. Sci.*, 8(12): 123-129.
- Mondal, M. R. I., M.S. Islam, M.A.J. Bhuiyan, M.M. Rahman, M.S Alam and M.H.H Rahman. 2011. *Krishi Project Hatboi* (5th edition). Bangladesh Agricultural Research Institute, Gazipur-1701.
- Nash JHE. 1991. DNAfrag, Version 3.03. Institute for biological sciences, National Research Council of Canada, Ottawa, Ontario, Canada.
- NBPGR. 2000. Minimal Descriptors of Agri-Horticultural Crops. Part-ÍÍ, Vegetable Crops. National Bureau of Plant Genetic Resources, India.
- Neeraja, C.N., R. Maghirang-Rodriguez, A. Pamplona, S. Heuer, B.C.Y. Collard, E.M. Septiningsih, G. Vergara, D. Sanchez, K. Xu, A.M. Ismail and D.J. Mackill. 2007. A marker-assisted backcross approach for developing submergence-tolerant rice cultivars. *Theor. Appl. Genet.* 115: 767-776.
- Nei, M. 1972. Genetic Distance between populations. *American Naturalist* 106: 283-292.
- Nei, M. 1973: Analysis of gene diversity in subdivided populations. *Proceedings of the National Academy Sciences of the United States of America* 70: 3321-3323.
- Nogueira, A.M., M. Ferreira, J. Guilhen, and A. Ferreira. 2014. Multivariate analysis in a genetic divergence study of *Psidium guajava*. *Genetics and Molecular Research.* 13: 10657–10668.
- Ogunbodede, B.A. and S.R. Ajibade. 2001. Variation in agronomic characteristics and their effect on fibre yield of kenaf (*Hibiscus cannabinus*). *J. Agril. Res.* 2: 31-34.
- Padi, K.F. 2003. Genetic analyses of pigmentation in Cowpea. *Pakistan J. Biol. Sci.* 6:1655-1659.
- Perera, M., M. Arias, D. Costilla, A. Luque, M. García and C. Romero. 2012. Genetic diversity assessment and genotype identification in sugarcane based on DNA markers and morphological traits. *Euphytica*, 185: 491-514.
- Peris, N. W., K.M. Gacheri¹, M.M. Theophillus and N. Lucas. 2014. Morphological characterization of mulberry (*Morus* spp.) Accessions Grown in Kenya, *Sustainable Agriculture Research*, 3(1): 10-17.
- Plieske, J. and D. Struss. 2001. Microsatellite markers for genome analysis in *Brassica*. I. development in *Brassica napus* and abundance in Brassicaceae species. *Theor. Appl. Genet. Springer-Verlag*, 102: 689-694.

- Pommer, C.V. and K.R.N. Murakami. 2009. Breeding Guava (*Psidium guajava* L.). In: Breeding plantation tree crops: Tropical Species. Springer, pp. 83-120
- Priolli, R.H.G., C.T.M. Junior, N.E. Arantes and E.P.B. Contel. 2002. Characterization of Brazilian soybean cultivars using microsatellite markers. *Genet. Mol. Biol.*, 25: 185-193.
- Rahim, M.A., M.H. Rahman, M.M. Hossain, Setara-E Bilkis and S. Begum. 2014. Characterization of important plant genetic resources: BAU component. SPGR Coordinated Sub-Project Completion Report.
- Rashid, M.M.1999. Sabji Biggan (In Bangali). Rashid publishing house. Dhaka. p. 303.
- Razzaque, M.A. and M.G. Hossain. 2007. The Second Report on Plant Genetic Resources for Food and Agriculture of Bangladesh: the State of Activities. A Cooperative Programme of Bangladesh Agricultural Research Council and Food and Agriculture Organization of the United Nations. Dhaka, Bangladesh. 74p.
- Ren, J.R., L.R. Mcferson, S. Kresovich and W.F. Lamboy. 1995. Identities and relationship among Chinese vegetable *Brassic*s as determined by random amplified polymorphic DNA markers. *J. Am. Soc. Hort. Sci.* 120: 548-555.
- Rohlf, F. 2002. NTSYS-pc: Numarical taxonomy and multivariate analysis system, 2.2 Department of Ecology and Evolution, State University of NY, Stony Brook.
- Roy, S. and K.K. Ghoshdastidar. 2006. Genetic analysis of leaf characters of some induced macromutants of jute (*Corchorus olitorius* L.). *Indian J. Genet.* 66(1): 55-56.
- Sadia, M., M.A. Rabbani, M.S. Masood, S.R. Pearce and S.A. Malik. 2010. Inter species testing of *Brassica* microsatellites available in public domain and their potential utilization for comparative genomics in Cruciferae. *Pak. J. Bot.* 42: 3875-3885.
- Sandip, S., M. N. Ali and B.G. Sasmol. 2005. Genetic divergence in tossa jute (*C. olitorius* L.). *J. Environment and Ecology.* 23(3): 668-670.
- Sarkar, D., R. Mandal, P. Roy, J. Taradar and B. Dasgupta. 2014. Management of brown spot disease of rice by using safer fungicides and some bioagents. *The Bioscane.* 9(1): 437-441.
- Särkinen, T., P. Poczai, G. E. Barboza, G. M. Weerden, M. Baden and S. Knapp. 2018. A revision of the Old World black nightshades (Morelloid clade of *Solanum* L., Solanaceae). *PhytoKeys.* 106: 1.
- Shaha, S., M. Islam, M. Jahiruddin, M.T. Akhter, and A. Siddique. 2018. Efficacy of deep placement of nitrogen fertilizers on N use efficiency and yield of boro rice (cv. BRRI Dhan29). *Amer. J. Agril. Res.* 3:21.
- Sharmin, D., M.B. Meah and M. Moniruzzaman. 2010. Inheritance of resistance to phomopsis blight and fruit rot in brinjal. *J. Agroforestry Environ.* 3 (2): 135-140.
- Shetty, A.K., G.S. Kumar, K. Sambaiah and P.V. Salimath. 2005. Effect of bitter gourd (*Momordica charantia*) on glycemic status in streptozotocin induced diabetic rats. *Plant Foods Hum. Nutr.* 60:109-112

- Siegismund, H.R. 1995. G-stat, version 3.1, Genetical statistical programs for the analysis of population data. Department of Plant Ecology, Botanical Institute, Oester Farimagsgade 2D, DK-1353 Copenhagen K, Denmark.
- Singh, D.P. and B.S.R. Krishna Prasad. 1992. Combining ability through line β tester analysis in cucumber (*Cucumis sativus* L.). *Indian J. Hort.* 49(4): 358-362.
- Singh, R.K., D.N. Singh, S.K. Singh, and H.N. Singh, 1994. Genetic variability and correlation studies in foreign commercial hybrids of sugarcane. *Agricultural Science Digest.* 14:103–107.
- Singh, V. and F. Singh. 1989. Genetic Diversity and Stability in Chickpea. *Indian J. Genet.* 49: 349-353.
- Srivastava, U., R.K. Mahajan, K.K. Gangopadhyay, M. Singh and B.S. Dhillon. 2011. Minimal Descriptors of Agri Horticultural Crops. Part II: Vegetable Crops. National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi, p. 262
- Sumanth V., B.G. Suresh, B.J. Ram and G. Srujana. 2017. Estimation of genetic variability, heritability and genetic advance for grain yield components in rice (*Oryzae sativa* L.). *J. Pharmacognosy and Phytochemistry.* 6(4): 1437-1439.
- Tareq, M.Z., K.K. Bashir, M.R. Amin, M.D.H. Sarker, M. Moniruzzaman, M.S.A. Sarker and M.D. Islam. 2019. Nutritional composition of some jute genotypes. *International J. Veg. Sci.* 26 (5): 506-515.
- Tatlioglu, Y. 1993. Cucumber *Cucumis sativus* L. In: Kalloo G. and B.O. Begh (eds). *Genetic Improvement of Vegetable Crop.* Pergamon press Ltd. Tarrytown, New York. p.197-623.
- Temnykh, S., G. DeClerck, A. Lukashova, L. Lipovich, S. Cartinhour and S.R. McCouch. 2001. Computational and experimental analysis of microsatellites in rice (*Oryza sativa* L.), frequency, length variation, transposon associations and genetic marker potential. *Genome Res.* 11: 1441–1452.
- Thangavelu, K., A. Tikader, S.R. Ramesh, A.A. Rao, G.K. Naik, S. Sedak and A.L. Deole. 2000. Catalogue on mulberry (*Morus* spp). *Germplasm.* 2: 1-225.
- Thomas, T.A. and P.N. Mathur. 1991. Germplasm evaluation and utilization. *Plant Genetic Resources Conservation and Management, IBPGR, Regional Office, New Delhi-11012, India.* pp. 149-181.
- Tikader, A. and A.A. Rao. 2002. Intra and interspecific hybridization studies in mulberry. *Ind. Acad. Seric.* 6: 17-22.
- Tommasini, L., J. Batley, G.M. Arnold, R.J. Cooke, P. Donini, D. Lee, J.R. Law, C. Lowe, C. Moule, M. Trick and K.J. Edwards. 2003. The development of multiplex simple sequence repeats (SSR) markers to complement distinctness, uniformity and stability testing of rape (*Brassica napus* L.) varieties. *Theor. Appl. Genet.* 106: 1091-1101.
- Turi, N.A., Farhatullah, M.A. Rabbani and Z.K. Shinwari. 2012. Genetic diversity in the locally collected *Brassica* species of Pakistan based on microsatellite marker. *Pak. J. Bot.* 44(3): 1029-1035.
- Vaz Patta, M.C., Z. Satovic, S. Pego and P. Feveireiro. 2004. Assessing the genetic diversity of Portuguese maize germplasm using microsatellite markers. *Euphytica,* 137: 63-72.

- Valera-Montero, L., P. Muñoz-Rodríguez, H. Silos-Espino and S. Flores Benítez. 2016. Genetic diversity of guava (*Psidium guajava* L.) from Central Mexico revealed by morphological and RAPD markers. *Int. J. Experimental Bot.* 85: 176–183.
- Vigoruroux, Y., S. Mitchell, Y. Matsuoka, M. Hamblin, S. Kresovich, J.S.C. Smith, J. Jaqueth, O.S. Smith and J. Doebley. 2005. An analysis of genetic diversity across the maize genome using microsatellite. *Genet.* 169: 1617-1630.
- Vijayan, K., A. Tikader, Z. Weiguo, C.V. Nair, S. Ercisli and C. Tsou. 2011. Wild Crop Relatives: Genomic and Breeding Resources, Tropical and Subtropical Fruits, DOI 10.1007/978-3-642-20447-0_5, # Springer-Verlag Berlin Heidelberg.
- Ward, J. H. 1963. Hierarchical grouping to optimize an objective function. *J. Amer. Statistical Association.* 58(301): 236–244.
- Welsh, J. and M. McClelland. 1990. Fingerprinting genomes using PCR with arbitrary primers. *Nucleic Acids Research*, 18: 7213-7218.
- Williams, J.G.K., A.R. Kubelik, K.J. Livak, J.A. Rafalski and S.V. Tingey. 1990. DNA polymorphisms amplified by arbitrary primers are useful as genetic markers. *Nucleic Acids Research.* 18: 6531-6535.
- Yeh, F.C., R.C. Yang and T. Boyle. 1999. POPGENE VERSION 1.31: Microsoft Window based Free Software for Population Genetic Analysis. <ftp://ftp.microsoft.com/softlib/HPGL.EXE/>.
- Zhao, J.X., B. Deng, P. Lou, J. Wu, R. Sun, Z. Xu, J. Vromans, M. Koornneef and G. Bonnema. 2005. Genetic relationships with *Brassica rapa* as inferred from AFLP fingerprints. *Theor. Appl. Genet.*, 110: 1301-1314.



Signature of the Coordinator

Date: 20-12-2021

Seal:

Dr. Md. Aziz Zilahi Chowdhury
Member Director Crops &
Co-ordinator, FBRG-PGR, Sub Project
BARC, Farmgate, Dhaka.



Counter Signature of the Head of
the organization/authorized
representative

Date: 20-12-2021

Seal:

Dr. Shaikh Mohammad Bokhtiar
Executive Chairman
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

Annexure 1. Reports on field monitoring and evaluation of field and laboratory experimentations of implementing components as per reporting format of NATP-2

i. Field monitoring and evaluation report on visit to CDB on 23 March 2019

Duration of Field Visit: 23/03/2019

Coverage of Monitoring Report: From February 2018 to January 2019

1. Sub-Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources (ID-128)
2. Institute Name: Cotton Development Board (CDB)
3. Principal Investigator: M M Abed Ali, Senior Scientific Officer, Cotton Research Farm, CDB, Jagadishpur, Jashore
4. Duration: Start : February 2018, Completion : December 2020
5. Location(s) of the Program: Cotton Research Farm, Jagadishpur, Jashore and Sreepur, Gazipur.
6. Name of Person(s) with address interviewed/met/discussed:
 - a. Sheikh Al Mamun, Cotton Agronomist, Cotton Research Farm, Jagadishpur, Jashore
 - b. M M Abed Ali, Senior Scientific Officer, Cotton Research Farm, Jagadishpur, Jashore

7. Technical Information:

- Methodology and its Appropriateness: Morphological characterization of conserved cotton germplasm is being performed following standard descriptor of cotton.
- Adherence to Original Plan: Methodology was strictly followed as stated in the proposal
- Reason for Deviation (if any): Not applicable

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good/average/below/average/poor)
		Planned	Actual		
1. To characterize 320 cotton genotypes from CDB germplasm 2. To facilitate future use of the available germplasm 3. To facilitate establishment of IPR on cotton germplasm	Morphological characterization of conserved cotton germplasm	120	117	3 germplasm (due to germination failure 3 GP in 1 st year could not be characterized)	Good

ii) Technology Generation:

Sl. #	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research /Academic Institution: N/A

9. Training: Not Applicable

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/ Status	Remarks
				Suggested to take initiative for publication of scientific article in reputed journal

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1500000	
b. Funds Received till to date:	264910	
c. Delay (if any) in receipt of funds:	-	
d. Expenditure till to date:	262869	
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit		

12. Procurement: Not applicable

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i)				
b. Works				
(i)				
c. Services				
(i)				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	01/07/2018	01/07/2018	
b. Six monthly report (last 01 year)	19/12/2018 21/01/2019	19/12/2018 21/01/2019	
c Annual report	14/02/2019	14/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
1. Targeted number of germplasm were not characterized	Seed germination failure of some germplasm causes this phenomenon.	Include 10-20 more germplasm for next year trial than planned target for characterization

15. Any other comments & suggestions by the visiting team:

- Include 5-10 more germplasm for next year trial than planned target for characterization.
- Take research program for developing short duration cotton variety(s) to fit in rice based cropping pattern.

16. Overall Assessment

- Continue the Sub-Project as Planned: Overall progress of the sub-project activities is satisfactory. It should be continued as per work plan.
- Modify (specify areas of modification) the Sub-Project: Not applicable
- Terminate the Project: Not applicable

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Harunur Rashid PSO, Crops Division	BARC
2. Dr. Helal Uddin Ahmed, Consultant PBRG-PGR Sub-Project	BARC

ii. Field monitoring and evaluation report on visit to BINA on 08 April 2019

Duration of Field Visit: From 08/04/2019 to 08/04/2019

Coverage of Monitoring Report: From February 2019 to January 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Institute of Nuclear Agriculture (BINA)
3. Principal Investigator: Dr. Md. Mirza Mofazzal Islam, Chief Scientific Officer & Head Plant Breeding Division, BINA
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Bangladesh Institute of Nuclear Agriculture, Mymensingh
6. Name of Person(s) with address interviewed/ met/ discussed:
 - i. Dr. Md. Mirza Mofazzal Islam, CSO & Head Plant Breeding Division, BINA
 - ii. Dr. Shamsun Nahar Begum, PSO, Plant Breeding Division, BINA
 - iii. Dr. Fahmina Yasmine, SSO, Plant Breeding Division, BINA

7. Technical Information:

- Methodology and its Appropriateness: Following GIS Map, Mission oriented collection, exploration was done.
- Adherence to Original Plan:
- Reason for Deviation (if any): No

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviati on (if any)	Performance (Good/average /below average/poor)
		Planne d	Actual		
Collection of germplasm of rice, oilseeds, pulses, spices and vegetables	Collection	50	48 (Rice-33, brinjal & groundnut-3, bittergourd-2, chilli-5, and blackgram & turmeric-2)		
Characterization of selected germplasm	Morphological	36	25		
To conserve collected germplasm	Conservation	48	48		

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1308420	
b. Funds Received till to date:	1308420	
c. Delay (if any) in receipt of funds:		
d. Expenditure till to date:		
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit		

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(ii) Camera	01	01	100	
(iii) Sealer	02	02	100	
(iv) Clear seed storage, glass jar	50	50	Work order has given	

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21/05/2018	21/05/2018	
b. Six monthly report (last 01 year)	01/08/2018	23/01/2019	
c Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Some landraces of vegetables, spices and pulses are not available		

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- a. Continue the sub-Project as Planned
- b. Modify (specify areas of modification) the sub-Project
- c. Terminate the Project

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Harunur Rashid, PSO, Crops Division	BARC	
2. Dr. Helal Uddin Ahmed Consultant, PBRG-PGR Sub Project	BARC	



Fig. 194. Field Visit to BINA, Mymensingh, 08 April 2019

iii. Field monitoring and evaluation report on visit to BAU on 08 April 2019

Duration of Field Visit: From 08/04/2019 to 08/04/2019

Coverage of Monitoring Report: From February 2019 to July 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Agricultural University (BAU)
3. Principal Investigator: Dr. M. A. Rahim, Professor, Department of Horticulture, BAU
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Germplasm Centre, BAU, Mymensingh
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. M. A. Rahim, Professor, Dept. of Horticulture, BAU
 - b. Dr. Md. Habibur Rahman, Professor, Dept. of Horticulture, BAU
 - c. Dr. Md. Mokter Hossain, Professor, Dept. of Horticulture, BAU
 - d. Fatema Nasrin Jahan, Phd student

7. Technical Information:

- Methodology and its Appropriateness:

The germplasm was collected from different places (Bandarban, Tangail, Ghatail, idilpur, Modhupur, Mymensingh, Rajshahi, Dhaka etc.) of Bangladesh. After collecting the germplasm, all are conserved and planted in BAU Germplasm collection centre. We planted the collection both in ground and drum system with judicious and appropriate application fertilizer and watering. Now the data record is collecting by IPGRI descriptor for YAM was used to study the morphological characters. Molecular characterization will be carried out applying RAPD marker. The standard protocol will be followed for establishment, cultivation, evaluation, conservation of (*Dioscorea spp.*) at BAU-GPC.

- Adherence to Original Plan: Pursuing research as per the approved work plan.
- Reason for Deviation (if any): Not Applicable.

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviati on (if any)	Performance (Good/average/ below average /poor)
		Planned	Actual		
To collect and characterize morphological features of yam	Collection of diversified yams from different areas of Bangladesh and conservation of collected yams germplasm at BAU-GPC	30	30	N/A	Good
	Plantation of germplasm	30	33	N/A	Good
	Characterization of germplasm	30	33	N/A	Good
Characterization of germplasm	Morphological characterization of Banana and Aroids	90	92 (Bana na-62 & Aroids -30)		

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/status	Remarks
1	Germplasm of <i>Dioscorea spp.</i> were collected from different location of Bangladesh and under observation for their performance analysis at BAU-GPC centre	33	Planted and under evaluation	Growing as expected particularly flowering and fruiting of different Germplasm (2 seasons)

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution: N/A

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1124300	
b. Funds Received till to date:	-	
c. Delay (if any) in receipt of funds:	-	
d. Expenditure till to date:		
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit		

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i) Colorimeter	21.04.19		Under Process	
(ii) chemicals	21.04.19		Under Process	
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	26/08/2018	5/8/18	
b. Six monthly report (last 01 year)	5/2/19	25/2/19	
c Annual report			
d. Internal Monitoring Report(s) (Last 01 year)			
f. Project Completion Report			

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Molecular analysis will be done by using RAPD marker	There is no fund for molecular level analysis of <i>Dioscorea spp.</i> as it has national demand to collect and conserve the germplasm in a molecular level analysis	Fund need for molecular analysis. Application has submitted.

15. Any other comments & suggestions by the visiting team:**16. Overall Assessment**

- Continue the sub-Project as Planned
- Modify (specify areas of modification) the sub-Project
- Terminate the Project

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Harunur Rashid PSO, Crops Division	BARC
2. Dr. Helal Uddin Ahmed Consultant, PBRG-PGR Sub Project	BARC

iv. Field monitoring and evaluation report on visit to BARI on 25 June 2019

Duration of Field Visit: From 25/06/2019 to 25/06/2019

Coverage of Monitoring Report: From February 2018 to January 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Agricultural Research Institute (BARI)
3. Principal Investigator: Dr. Md. Nazirul Islam, Chief Scientific Officer, Plant Genetic Resources Centre, BARI, Gazipur
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Plant Genetic Resources Centre (PGRC), BARI, Gazipur
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. Nazirul Islam, CSO, PGRC and PI, BARI Component
 - b. Dr. Rozina Afroz, SSO, PGRC and CO-PI, BARI Component

7. Technical Information:

- Methodology and its Appropriateness: Mission oriented collection exploration was carried out following GIS Map; Appropriate Descriptors were followed during morphological characterization, which were completely appropriate for these activities.
- Adherence to Original Plan: Adhered to original plan.
- Reason for Deviation (if any): None

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good /average/ below average/poor)
		Planned	Actual		
To collect and characterize Geographical Indication (GI) Crops, landraces of important crops	Collection	200	285	None	Good
	Characterization (GI & Landrace)	70	64 (Pumpkin) 140 (Cucumber)	None	Good
To conserve collected germplasm and BARI released varieties	Conservation	200	285	None	Good
To develop database of germplasm conserving at PGRC/BARI	Database development	-	-	None	Good

ii) Technology Generation:

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: N/A

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support /services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Dr. Amiruz Zamman	CSO, Breeding Division, BARI	December 2018	01	
Dr. Babul Chandra Sarkar	PSO			
Dr. Faruque Ahmed	CSO			

9. Training: Not applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks
01.	Scientific Paper	01	Published	

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	4050965	
b. Funds Received till to date:	1569232	
c. Delay (if any) in receipt of funds:	2481733	
d. Expenditure till to date:	1384464	
i) Incurred	-	
ii) Committed	-	
iii) Anticipated/Actual Balance/Deficit	-	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i) Chemicals			Under Processing	
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21/05/2018	21/05/2018	
b. Six monthly report (last 01 year)	18/09/2018	19/09/2018	
c Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Delay fund released	Fund should be released in time	-
Insufficient budget in relation to activities	To execute the activities properly budget allocation should be increased	-
Unrealistic expenditure procedure specially all payment through cross check	It will be difficult to run the project activities smoothly	Convey the matter to BARC

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- Continue the sub-Project as Planned
- Modify (specify areas of modification) the sub-Project
- Terminate the Project

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR project	BARC	
2. Amal Chandra Manidas, SO, PBRG-PGR Project	BARC	



Fig. 195. Field Visit to BARI, Gazipur, 25 June 2019

v. Field monitoring and evaluation report on visit to BRRI on 25 June 2019

Duration of Field Visit: From 25/06/2019 to 25/06/2019

Coverage of Monitoring Report: From February 2018 to January 2019

- Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
- Institute Name: Bangladesh Rice Research Institute (BRRI)
- Principal Investigator: Dr. Mohammad Khalequzzaman, Chief Scientific Officer, GRS Division, BRRI
- Duration: Start : February 2018 Completion : January 2021
- Location(s) of the Program: GRS Division, BRRI, Gazipur

6. Name of Person(s) with address interviewed/ met/ discussed:
- Dr. Mohammad Khalequzzaman, CSO, GRS Division, BRRI
 - Dr. Ebna Syod Md. Harunur Rashid, SSO, GRS Division, BRRI
 - Dr. Mohammad Zahidul Islam, SSO, GRS Division, BRRI
 - Md. Ferdous Rezwan Khan Prince, SO, PBRG Sub-Project, GRS Division, BRRI

7. Technical Information:

- Methodology and its Appropriateness: Mission oriented collection exploration was carried out following GIS Map; Appropriate Descriptors were followed during morphological characterization, which were completely appropriate for these activities.
- Adherence to Original Plan:
- Reason for Deviation (if any): None

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good /average/below average/poor)
		Planned	Actual		
To collect rice landraces from unexplored areas especially from hilly, coastal and haor areas	Germplasm collection	100	108		Good
To characterize important local germplasm at morphological and molecular level.	Characterization	48 (T.Aman germplasm)	48		Good
		48 (Boro germplasm)	48		Good
To analyze the genetic diversity of Bangladeshi rice germplasm in comparison to global rice varieties	Molecular Characterization	48	48		Good
To document and develop database of germplasm for establishing varietal rights and IPR Issues.	Documentation	48	48		Good

ii) Technology Generation:

Sl. No.	Description of the Technology	Number	Achievements/ Status	Remarks
	Morphological and molecular Characterization of rice germplasm: Newly developed data on morphological (some special qualitative traits) and molecular characterization (unique allele, rare allele, PIC value) were documented with photographs which might be used as source materials for the future breeding program	Morphological and molecular Characterization of 48 T. Aman rice germplasm		

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.):

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	5000000	
b. Funds Received till to date:	1705270	
c. Delay (if any) in receipt of funds:	950000	
d. Expenditure till to date:	433259	
i) Incurred		
ii) Committed	591550	for purchasing chemicals
iii) Anticipated/Actual Balance/Deficit	33395	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i) Primers, Mastermix	02.12.2018	Supplier received the work order. They provided some chemicals without primers and mastermix.		
(ii) Chemicals	02.12.2018	Supplier submitted the Quotation		
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21/05/2018	03/09/2018	
b. Six monthly report (last 01 year)	180 days interval	07/10/2018	
c. Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Delay fund released	Fund should be released in time	-
Insufficient budget in relation to activities	To execute the activities properly budget allocation should be increased	-
Unrealistic expenditure procedure specially all payment through cross cheque	It will be difficult to run the project activities smoothly	Convey the matter to BARC

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- a. Continue the sub-Project as Planned
- b. Modify (specify areas of modification) the Sub-Project
- c. Terminate the Project

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR project	BARC
2. Amal Chandra Manidas, SO, PBRG-PGR Project	BARC



Fig. 196. Field and Lab Visit to GRSD, BRRI, Gazipur, 25 June 2019

vi. Field monitoring and evaluation report on visit to BARI on 04 November 2019

Duration of Field Visit: From 04/11/2019 to 04/11/2019

Coverage of Monitoring Report: From February 2019 to July 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Agricultural Research Institute (BARI)
3. Principal Investigator: Dr. Md. Nazirul Islam, Chief Scientific Officer, Plant Genetic Resources Centre, BARI
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Plant Genetic Resources Centre, BARI, Gazipur.
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. Md. Nazirul Islam, CSO, Plant Genetic Resources Centre, BARI
 - b. Dr. Md. Shalim Uddin, SSO, Plant Genetic Resources Centre, BARI
 - c. Dr. Rozina Afroz, SSO, Plant Genetic Resources Centre, BARI

7. Technical Information:

- Methodology and its Appropriateness: Mission oriented collection, exploration was done. Collection of GIs and landraces of assigned BARI mandate crops from selected areas is being done following GIS Map. Morphological characterization of collected germplasm is being performed according to standard descriptor of respective crops.
- Adherence to Original Plan: Methodology was strictly followed as stated in the proposal.
- Reason for Deviation (if any): Procurement plan was not followed properly because of unavailability of fund and nature of chemical properties (primer supply by company also selection and optimization in taking time).

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/poor)
		Planned	Actual		
Collection of germplasm of GIs, landraces and wild relatives	Collection	125	125		Good
Characterization of germplasm of GIs and landraces	Morphological	40	40		Good
	Molecular	23	23 (Mustard)		Good
To conserve collected germplasm and BARI released varieties	Conservation	125	125		Good

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support /services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	
Training workshop on germplasm collection and access to information system for benefits sharing	24 June 2019	20	20	10	10	Funded by BARI
Training workshop on application of GIS tools in plant genetic resources studies	13 May 2019	20	20	10	10	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/ Status	Remarks
01.	Scientific Paper	01	Published	Global Journal of Frontier Research: Agriculture & Veterinary Doi: 10.17406/GJSFR
02.	Print (Newspaper)	01	Printed on 16 October 2019	Published in “Daily Amader Orthoniti” Reported By: Motinuzzaman Mithu

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	5597847	
b. Funds Received till to date:	2481732	
c. Delay (if any) in receipt of funds:	3116115	
d. Expenditure till to date:		
i) Incurred	2004983	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	476749	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
i) Taq DNA polymerase, dNTP set, PCR Buffer, Ladder, Agarose, Micro pipette, PCR tubes, RNAs, Micro centrifuge tube.	June 2019	November 2019	-	20%
(ii) Office and Lab Equipment	June 2019	On-going		
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report			
b. Six monthly report (last 01 year)	15/07/2019	19/09/2018	
c Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Delay fund released		
Insufficient budget in relation to activities		
Unrealistic expenditure procedure specially all payment through cross check		

15. Any other comments & suggestions by the visiting team:

a) Visiting team commented that the availability of PGRC, BARI conservation facilities can be used for national conservation of plant genetic resources.

16. Overall Assessment

- a) Continue the sub-Project as Planned: The Sub-project is running as per plan. Overall progresses of the sub-project activities are quite satisfactory.
- b) Modify (specify areas of modification) the Sub-Project: No
- c) Terminate the Project: No

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Aziz Zilani Chowdhury Member Director (Crops)	BARC
2. Dr. Md. Abdus Salam Chief Scientific Officer, Crops Division	BARC
3. Dr. Md. Amjad Hossain Consultant, PBRG-PGR Sub Project	BARC
4. Amal Chandra Manidas Scientific Officer, PBRG-PGR Sub Project	BARC



Fig. 197. Field Visit to PGRC, BARI, Gazipur, 04 November 2019

vii. Field monitoring and evaluation report on visit to BRRI on 04 November 2019

Duration of Field Visit: From 04/11/2019 to 04/11/2019

Coverage of Monitoring Report: February 2019 to July 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Rice Research Institute (BRRI)
3. Principal Investigator: Dr. Mohammad Khalequzzaman, Chief Scientific Officer, GRS Division, BRRI
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: GRS Division, BRRI, Gazipur
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a) Dr. Mohammad Khalequzzaman CSO, GRS Division, BRRI
 - b) Dr. Mohammad Zahidul Islam, SSO, GRS Division, BRRI
 - c) Md. Ferdous Rezwana Khan Prince, SO, PBRG Project, GRS Division, BRRI

7. Technical Information:

- Methodology and its Appropriateness: Mission oriented collection, exploration was done. Collection of GIs and landraces of rice from selected areas is being done following GIS Map. Morphological characterization of collected germplasm is being performed according to standard descriptor of rice.
- Adherence to Original Plan: Activities are being performed following original plan
- Reason for Deviation (if any): None

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/ poor)
		Planned	Actual		
To collect rice landraces from unexplored areas especially from hilly, coastal and haor areas	Collection	100	11		
To characterize important local germplasm at morphological and molecular level.	Characterization	48 (Boro rice)	48		
		48 (Aus rice)	48		
		72 (T. Aman rice)	72		
To analyze the genetic diversity of Bangladeshi rice germplasm in comparison to global rice varieties	Molecular Characterization	48	48		
To document and develop database of germplasm for establishing varietal rights and IPR Issues.	Documentation	48(Boro rice)	48		

ii) Technology Generation:

Sl. no.	Description of the Technology	Number	Achievements /Status	Remarks
	Morphological and molecular Characterization of rice germplasm: Newly developed data on morphological (some special qualitative traits) and molecular characterization (unique allele, rare allele, PIC value) were documented with photographs which might be used as source materials for the future breeding program	Morphological and molecular Characterization of 72 T. Aman rice germplasm		

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	2668885	
b. Funds Received till to date:	1705270	
c. Delay (if any) in receipt of funds:	963615	
d. Expenditure till to date:		
i) Incurred	1699559	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	5711	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i)				
(ii)				
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21/05/2018	03/09/2018	
b. Six monthly report (last 01 year)	180 days interval	16/10/2019	
c Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Delay in fund released		
Insufficient budget in relation to activities		
Unrealistic expenditure procedure specially all payment through cross check		

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- Continue the sub-Project as Planned: Overall progress of the sub-project activities is quite satisfactory. It should be continued as per original plan.
- Modify (specify areas of modification) the sub-Project: No
- Terminate the Project: No

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Aziz Zilani Chowdhury MD (Crops)	BARC
2. Dr. Md. Abdus Salam CSO, Crops Division	BARC
3. Dr. Md. Amjad Hossain Consultant, PBRG-PGR Sub-Project	BARC
4. Amal Chandra Manidas SO, PBRG-PGR Sub-Project	BARC



Fig. 198. Field Visit to GRSD, BRRI, Gazipur, 04 November 2019

viii. Field monitoring and evaluation report on visit to BINA on 08 November 2019

Duration of Field Visit: From 08/11/2019 to 08/11/2019

Coverage of Monitoring Report: From February 2019 to July 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Institute of Nuclear Agriculture (BINA)
3. Principal Investigator: Dr. Md. Mirza Mofazzal Islam, Chief Scientific Officer & Head Plant Breeding Division, BINA
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Bangladesh Institute of Nuclear Agriculture, Mymensingh
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a) Dr. Shamsun Nahar Begum, PSO, Plant Breeding Division, BINA
 - b) Dr. Fahmina Yasmine, SSO, Plant Breeding Division, BINA
 - c) Md. Nazmul Hasan Mehedi, SO, Horticulture Division, BINA

7. Technical Information:

- Methodology and its Appropriateness: Collection exploration is being done following GIS Map. Collection of GIs and landraces of assigned crops from selected areas is being done following GIS Map. Morphological characterization of collected germplasm is being performed according to standard descriptor of respective crops.
- Adherence to Original Plan: Yes
- Reason for Deviation (if any): No

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average /poor)
		Planned	Actual		
Collection of germplasm of rice, oilseeds, pulses, spices and vegetables	Germplasm collection	68	73 (Rice-51, French & hyacinth bean-8, Brinjal-3, and White gourd, sweet gourd & bottle gourd-11)		Good
Characterization of selected germplasm	Morphological	67	65		Good
	Molecular	23	20 (Rice)		Good
To conserve collected germplasm	Conservation	15	15		Good

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1875475	
b. Funds Received till to date:	1308420	
c. Delay (if any) in receipt of funds:	567055	
d. Expenditure till to date:		
i) Incurred	1303997	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	4423.00	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(v) Camera	01	01	100	
(vi) Sealer	02	02	100	
(vii) Clear seed storage glass jar	50	50	100	
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21/05/2018	21/05/2018	
b. Six monthly report (last 01 year)	01/09/2019	18/09/2018	
c Annual report	25/02/2019	25/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Some landraces of vegetables, spices and pulses are not available	It will be difficult to achieve collection target	Visit remote areas like hills, chars, haors etc.

15. Any other comments & suggestions by the visiting team:

- Internal monitoring is to be done by the institutional monitoring.
- Target crops are to be collected from particular team area with a good plan.

16. Overall Assessment

- Continue the sub-Project as Planned: Overall progress of the sub-project activities quite satisfactory.
- Modify (specify areas of modification) the sub-Project: No
- Terminate the Project: No

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Aziz Zilani Chowdhury MD (Crops)	BARC	
2. Dr. Md. Harunur Rasid CSO (CC), Crops Division	BARC	
3. Dr. Md. Amjad Hossain Consultant, PBRG-PGR Sub Project	BARC	
4. Amal Chandra Manidas SO, PBRG-PGR Sub Project	BARC	



Fig. 199. Field Visit to BINA, Mymensingh, 08 November, 2019

ix. Field monitoring and evaluation report on visit to BAU on 08 November 2019

Duration of Field Visit: From 08/11/2019 to 08/11/2019

Coverage of Monitoring Report: From February 2019 to July 2019

- Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
- Institute Name: Bangladesh Agricultural University (BAU)
- Principal Investigator: Dr. M. A. Rahim, Professor, Department of Horticulture, BAU
- Duration: Start : February 2018 Completion : December 2020
- Location(s) of the Program: BAU Germplasm Centre, BAU, Mymensingh
- Name of Person(s) with address interviewed/ met/ discussed:
 - Dr. M. A. Rahim, Professor, Dept. of Horticulture, BAU
 - Dr. Md. Habibur Rahman, Professor, Dept. of Horticulture, BAU
 - Dr. Md. Mokter Hossain, Professor, Dept. of Horticulture, BAU
 - Fatema Nasrin Jahan, Phd student, Dept. of Horticulture, BAU

7. Technical Information:

- Methodology and its Appropriateness:

The germplasm of Yam (*Dioscorea spp.*) was collected from different places (Bandarban, Tangail, Ghatail, idilpur, Modhupur, Mymensingh, Rajshahi and Dhaka etc.) of Bangladesh. After collecting the germplasm, have been conserved and planted in BAU Germplasm collection centre. Collected germplasm were planted both in ground and drum system with judicious and appropriate application of fertilizer and watering. Data recording is going on following IPGRI descriptor of YAM for studying the morphological characters. Molecular characterization will be carried out with RAPD markers. The standard protocol is being followed for establishment, cultivation, evaluation, conservation of *Dioscorea spp.* at BAU-GPC.

- Adherence to Original Plan: Pursuing research as per the approved work plan.
- Reason for Deviation (if any): Not Applicable.

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good /average/ below average/poor)
		Planned	Actual		
To collect and characterize morphological features of yam	Collection of diversified yams from different areas of Bangladesh and conservation of collected yams germplasm at BAU-GPC	30	33	N/A	Good
	Plantation of germplasm	30	33	N/A	Good
	Characterization of germplasm	30	33	N/A	Good
To characterize yam at molecular level using RAPD	Sample is prepared for Molecular analysis	30	27	N/A	Good

ii) Technology Generation:

Sl. No.	Description of the Technology	Number	Achievements/ Status	Remarks
1	Germplasm of <i>Dioscorea spp.</i> were collected from different locations of Bangladesh and under observation for their performance analysis at BAU-GPC centre	33	Planted and under evaluation	Growing as expected particularly flowering and fruiting of different Germplasm (2 seasons)

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support /services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Prof. Dr. Subash Charaborty	Coordinator, CASR, BAU	22/05/19	02	
Prof. Dr. Md. Abu Hadi Noor Ali Khan	Director, BAURES	08/11/19		

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl.No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1124300.00	
b. Funds Received till to date:	1124300.00	
c. Delay (if any) in receipt of funds:	-	
d. Expenditure till to date:		
i) Incurred	874196.00	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	250104.00	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(iii) Colorimeter	21.04.19	14.05.19	100%	100%
(iv) chemicals	21.04.19	14.05.19	100%	100%
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	26/08/2018	05/09/2018	
b. Six monthly report (last 01 year)	05/02/2019 21/08/2019	25/20/2019 21/08/2019	
c. Annual report			
d. Internal Monitoring Report(s) (Last 01 year)			
f. Project Completion Report			

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
1. Lack of fund for Molecular characterization of yam using RAPD marker	If required fund is allotted from the project, molecular characterization of yam could be completed as it has national demand.	Suggested to apply BARC authority to allot required fund for molecular characterization of Yam

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- a. Continue the sub-Project as Planned: The sub-project is running as per plan. Overall progresses of the sub-project activities are quite satisfactory.
- b. Modify (specify areas of modification) the sub-Project: No
- c. Terminate the Project: No

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Aziz Zilani Chowdhury MD (Crops)	BARC	
2. Dr. Md. Harunur Rasid CSO (CC), Crops Division	BARC	
3. Dr. Md. Amjad Hossain Consultant, PBRG-PGR Sub Project	BARC	
4. Amal Chandra Manidas SO, PBRG-PGR Sub Project	BARC	



Fig. 200: Field visit to Germplasm Centre, BAU, Mymensingh; 08 November, 2019

x. Field monitoring and evaluation report on visit to CDB on 08 November 2019

Duration of Field Visit: From 08/11/2019 to 08/11/2019

Coverage of Monitoring Report: From February 2019 to July 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Cotton Development Board (CDB)
3. Principal Investigator: M M Abed Ali, Senior Scientific Officer, CDB
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Cotton Research Farm, Sreepur, Gazipur.
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a) M. M. Abed Ali, Senior Scientific Officer, CDB
 - b) M. Khalequzzaman, Senior Scientific Officer, Soil Science Division, CDB

7. Technical Information:

- Methodology and its Appropriateness: Morphological characterization of conserved cotton germplasm is being performed following standard descriptor of cotton.
- Adherence to Original Plan: Methodology was followed as stated in the proposal.
- Reason for Deviation (if any): No

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/poor)
		Planned	Actual		
Characterization of Cotton germplasm	Morphological characterization of conserved cotton germplasm	120	115		Good

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Dr. Md. Farid Uddin	Executive Director, CDB	27/09/19 and 26/10/2019	2	
Jafor Ali	Deputy Director, CDB			
Sheikh Al Mamun	Cotton Agronomist, CDB			

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	759135.00	
b. Funds Received till to date:	759135.00	
c. Delay (if any) in receipt of funds:	-	
d. Expenditure till to date:		
i) Incurred	579957.00	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	179178.00	

12. Procurement

Major Activity *	Activity status(No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i)				
(ii)				
b. Works				
(i)				
(ii)				
c. Services				
(i)				
(ii)				

13. Reporting

Report type	Planned/schedule	Actual submission date	Remarks
a. Inception report	-	-	
b. Six monthly report (last 01 year)	19/12/2018 21/01/2019	19/12/2018 21/01/2019	
c Annual report	14/02/2019	14/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation: Not remarkable

Description	Implementers opinion	Suggested solution by the Monitoring Team

15. Any other comments & suggestions by the visiting team:

a) Distinct characters are to be captured with photograph.

16. Overall Assessment

- a) Continue the sub-Project as Planned: The sub-project is running as per plan. Overall progress of the sub-project activities is quite satisfactory.
- b) Modify (specify areas of modification) the sub-Project: No
- c) Terminate the Project: No

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Harunur Rasid CSO (CC), Crops Division	BARC	
2. Dr. Md. Amjad Hossain Consultant, PBRG-PGR Sub Project	BARC	
3. Amal Chandra Manidas SO, PBRG-PGR Sub Project	BARC	



Fig. 201. Field visit to Research farm of CDB, Sreepur, Gazipur; 08 November, 2019

xi. Field monitoring and evaluation report on visit to CDB on 17 January 2020

Duration of Field Visit: 17/01/2020

Coverage of Monitoring Report: From February 2019 to December 2019

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources (ID-128)
2. Institute Name: Cotton Development Board (CDB)
3. Principal Investigator: M M Abed Ali, Senior Scientific Officer, Cotton Research Farm, CDB, Jagadishpur, Jashore
4. Duration: Start : February 2018, Completion : December 2020
5. Location(s) of the Program: Cotton Research Farm, Jagadishpur, Jashore and Sreepur, Gazipur.
6. Name of Person(s) with address interviewed/met/discussed:
 - a. Sheikh Al Mamun, Cotton Agronomist, Cotton Research Farm, Jagadishpur, Jashore
 - b. M M Abed Ali, Senior Scientific Officer, Cotton Research Farm, Jagadishpur, Jashore

7. Technical Information:

- Methodology and its Appropriateness: Morphological characterization of conserved cotton germplasm is being performed following standard descriptor of cotton.
- Adherence to Original Plan: Methodology was strictly followed as stated in the proposal
- Reason for Deviation (if any): Not applicable

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status(Use appropriate unit)		Deviation (if any)	Performance (Good/average/below average/poor)
		Planned	Actual		
1. To characterize 320 cotton genotypes from CDB germplasm 2. To facilitate future use of the available germplasm 3. To facilitate establishment of IPR on cotton germplasm	Morphological characterization of conserved cotton germplasm	120 + 120	117 + 115	3 + 5 germplasm (due to germination failure 3 GP in 1 st year and 5 GP in 2 nd year could not be characterized)	Good

ii) Technology Generation:

Sl. #	Description of the Technology	Number	Achievements/Status	Remarks
1.	Promising cotton lines in respect of higher yield and better quality[boll size, G.O.T. (%) and Micronare value (µg/inch)]	6 (BC-0239, BC-0220, BC-0232, BC-0312, BC-0295, BC-0309)	Preliminarily selected as promising cotton lines	It is expected that one more variety(s) of cotton can be released from the genotypes included in this project.

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/services provided for adoption	Scope/possibility of market linkage	Remarks

8. Internal Monitoring by the Research /Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
1. Dr. Md. Monowar Karim Khan 2. Dr. Helal Uddin Ahmed 3. Md. Ashakur Rahman	Member Director, BARC Consultant, PBRG-PGR Assistant Manager, PIU-BARC, NATP-2	23/03/19	4	
4. Dr. Md. Farid Uddin 5. Jafor Ali	Executive Director, CDB Deputy Director, CDB, Jashore	26/10/19		
6. Dr. M. Tofazzal Hossain Hawladar	Professor, BAU, Mymensingh	24/11/19		
7. Hoore Jannat	Senior Asstt. Secretary, Prime Minister's Office	11/12/19		

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/Publicity	Number	Achievements/ Status	Remarks
				Suggested to take initiative for publication of scientific article in reputed journal

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	15,00,000.00	
b. Funds Received till to date:	759135.00	
c. Delay (if any) in receipt of funds:	-	
d. Expenditure till to date:	6,58,522.00	
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	1,00,613.00	

12. Procurement: Not applicable

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i)				
b. Works				
(i)				
c. Services				
(i)				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	01/07/2018	01/07/2018	
b. Six monthly report (last 01 year)	19/12/2018 21/01/2019 04/09/2019	19/12/2018 21/01/2019 04/09/2019	
c Annual report	14/02/2019	14/02/2019	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
1. Targeted number of germplasm were not characterized	Seed germination failure of some germplasm causes this phenomenon.	Include 10-20 more germplasm for next year trial than planned target for characterization

15. Any other comments & suggestions by the visiting team:

- Include 10-20 more germplasm for next year trial than planned target for characterization.
- Select promising germplasm in respect of yield and quality (larger boll, higher G.O.T. (%), Micronare value ($\mu\text{g}/\text{inch}$) etc.)
- Take research program for developing short duration cotton variety(s) to fit in rice based cropping pattern.
- Take cropping pattern based research program in different AEZs of Bangladesh.

16. Overall Assessment

- Continue the sub-Project as Planned: Overall progress of the sub-project activities is satisfactory. It should be continued as per work plan.
- Modify (specify areas of modification) the sub-Project: Not applicable
- Terminate the Project: Not applicable

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Aziz Zilani Chowdhury Member Director Crops Division	BARC	
2. Dr. Md. Abdus Salam Chief Scientific Officer Crops Division	BARC	
3. Dr. Md. Amjad Hossain, Consultant PBRG-PGR Sub Project Crops Division	BARC	



Fig.202. Field visit to Research farm of CDB, Jagodishpur, Jashore; 17 January, 2020

xii. Field monitoring and evaluation report on visit to BARI on 12 March 2020

Duration of Field Visit: From 12/03/2020 to 12/03/2020

Coverage of Monitoring Report: From February 2020 to July 2020

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Agricultural Research Institute (BARI)
3. Principal Investigator: Dr. Mst. Shamsunnahar, Chief Scientific Officer, Plant Genetic Resources Centre, BARI
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Plant Genetic Resources Centre, BARI, Gazipur.
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. Mst. Shamsunnahar, CSO, Plant Genetic Resources Centre, BARI
 - b. Dr. Md. Shalim Uddin, SSO, Plant Genetic Resources Centre, BARI
 - c. Dr. Rozina Afroz, SSO, Plant Genetic Resources Centre, BARI
7. **Technical Information:**
 - Methodology and its Appropriateness: Following GIS Map, Mission oriented collection, exploration was done.
 - Adherence to Original Plan: Methodology was strictly followed as stated in the proposal

- Reason for Deviation (if any): Procurement plan was not followed properly because of unavailability of fund and nature of chemical properties (primer supply by company also selection and optimization in taking time).

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/poor)
		Planned	Actual		
Collection of germplasm	Collection	450	450		
Characterization of germplasm of GI and landraces	Morphological	200	200		On-going
	Molecular	23	23 (Mustard)		On-going
To conserve collected germplasm and BARI released varieties	Conservation	125	125		

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/ Status	Remarks
01.	Scientific Paper	01	Published	Global Journal of Frontier Research: Agriculture & Veterinary Doi: 10.17406/GJSFR
02.	Print (Newspaper)	01	Printed on 16 October 2019	Published in “Daily Amader Orthoniti” Reported By: Motinuzzaman Mithu

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	5597847	
b. Funds Received till to date:	2481732	
c. Delay (if any) in receipt of funds:	3116115	
d. Expenditure till to date:	2004983	
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit		

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
i) Taq DNA polymerase, dNTP set, PCR Buffer, Ladder, Agarose, Micro pipette, PCR tubes, RNAs, Micro centrifuge tube.	June 2019	November 2019	-	20%
(ii) Office and Lab Equipment	June 2019	On-going		
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report			
b. Six monthly report (last 01 year)	18/02/2020	30/01/2020	
c Annual report	25/02/2020	25/02/2020	
d. Internal Monitoring Report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Delay in fund released		
Insufficient budget in relation to activities		
Unrealistic expenditure procedure specially all payment through cross check		

15. Any other comments & suggestions by the visiting team:

- Visiting team commented that the availability of PGRC, BARI conservation facilities can be used for national conservation of plant genetic resources.

16. Overall Assessment

- a. Continue the Sub-Project as Planned
- b. Modify (specify areas of modification) the sub-Project
- c. Terminate the Project

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Sub Project		
2. Amal Chandra Manidas, SO, PBRG-PGR Sub Project		



Fig. 203. Field Visit to PGRC, BARI, Gazipur, 12 March 2020

xiii. Field monitoring and evaluation report on visit to BRRI on 12 March 2020

Duration of Field Visit: From 12/03/2020 to 12/03/2020

Coverage of Monitoring Report: From February 2018 to February 2020

1. Sub-Project Title with ID: Collection, Conservation and Characterization of Important Plant Genetic Resources: BRRI component, ID: 128

2. Name of Implementing (Component) Institute: Bangladesh Rice Research Institute

3. Coordinator/Principal Investigator/ Co-Principal Investigator (as applicable):

Coordinator (Full address with phone and e-mail):

Dr. Md. Aziz Zilani Chowdhury, Member Director (Crops); BARC, Farmgate, Dhaka; Mobile: 01552355393; E-mail: zilani71@gmail.com

Principal Investigator (Full address with phone and e-mail):

Dr. Mohammad Khalequzzaman, Chief Scientific Officer and Head, GRS Division, BRRI, Gazipur- 1701, Bangladesh, phone: +88-02-49272068 and +88-02-49272005-14 ext. 524, Mobile: 01715752595 e-mail: zamanmk64@yahoo.co.uk

Co-principal investigator (Full address with phone and e-mail):

Dr. Ebna Syod Md. Harunur Rashid, Senior Scientific Officer, GRS Division, BRRI, Gazipur- 1701, Bangladesh, Phone-+88-02-49272005-14 ext. 597, Mobile: 01716226599 e-mail: esmhrashid74@gmail.com

Dr. Mohammad Zahidul Islam, Senior Scientific Officer, GRS Division, BRRI, Gazipur 1701, Bangladesh, Phone-+88-02-49272005-14 ext. 205, Mobile: 01818819295 e-mail: zahid.grs@gmail.com

4. Sub-Project Duration (as per approval/LoA/revision): **Start:** February, 2018 **Completion:** December 2020

5. Location (s) of the Sub-Project: Bangladesh Rice Research Institute, Gazipur-1701

6. Name of project Personnel(s) interviewed/ met/ discussed with address:

- a. Dr. Munnujan Khanam, Chief of Advanced Studies and Research & CSO, D(R) Office, BRRI, Gazipur-1701
- b. Dr. Mohammad Khalequzzaman, Chief Scientific Officer and Head, GRS Division, BRRI, Gazipur- 1701.
- c. Dr. Ebna Syod Md. Harunur Rashid, Senior Scientific Officer, GRS Division, BRRI, Gazipur- 1701.
- d. Md. Ferdous Rezwon Khan Prince, Scientific Officer, PBRG-NATP-2, GRS Division, BRRI, Gazipur- 1701.

7. Technical Information:

i. Lab/Field Experimentation:

Objective wise major Activities/milestones accomplished		Status	Remarks
Objective 1	to collect rice cultivars from unexplored areas of Bangladesh especially from hilly, coastal and haor/beel areas	Collection target was 200 and the actual collection was 241.	This is a continuous job for a genebank. Passport data forms were filled in for documentation during collection. Collected germplasm were conserved in short term storage for multiplication in respective season.
Objective 2	to characterize important local rice germplasm at morphological and molecular level	Target was achieved (144 Aus, Aman and Boro germplasm)	Morphological and molecular characterization of 144 (48 Aus, 48 Aman and 48 Boro) was completed. Forty eight (48) Boro germplasm has been transplanted in the field in current Boro 2019-20season. The crop is in heading stage. Molecular characterization of 72 T. Aman (2019) rice germplasm is ongoing.
Objective 3	to analyze the genetic diversity of Bangladeshi rice germplasm in comparison to global rice varieties	Target: 200 Achieved: 144	Completed
Objective 4	to document and develop database of germplasm for establishing varietal rights and IPR issues.	Target: 200 Achieved: 144	Photographs of qualitative descriptor states of all of the studied germplasm has been taken and documented.

ii. Technology intended to be generated/updated/validated:

Sl. No.	Description of the Technology	Number	Achievements /Status	Remarks
1	Morphological and molecular characterization of rice germplasm: Newly developed data on morphological (some special qualitative and quantitative traits) and molecular characterization (unique allele, rare allele, PIC value) were documented with photographs which might be used as source materials for the future breeding program.	Morphological and molecular characterization of 144 (48 Aus, 48 Aman and 48 Boro) rice germplasm	144	Completed and submitted to NATP authority as half yearly/ annual/ biennial progress report

8. Internal Monitoring by the Research / Academic Institution: Not applicable

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)

9. Training: Not applicable

Training Title	Training duration (days)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (Journal, article, Manual, Booklet, Media coverage, dissemination etc.):

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial updates

Item	Amount (Tk.)	Remarks
a. Total Budget :	5000000.00	
b. Funds Received till to date:	26,68,885.00	
c. Expenditure till to date:	27,00,323.00	
Actual Balance	-31,438.00	

12. Reporting

Report type	Planned/schedule	Actual submission date	Remarks
a. Inception report	30 days after inception meeting	03/09/2018	
b. Six monthly report (last 01 year)	180 days interval	01/09/2019	
c Annual report	One year interval	26/02/2019 and 03/02/2020	
d. Internal monitoring report(s) (Last 01 year)	-	-	
f. Project Completion Report	-	-	

13. Procurement status

Item *	Type (Goods/works/service)	Activity status (No./ date)	
		Planned	Actual
Chemicals			
i).GD1 (Primers, Mastermix)	Goods	23.12.2018	Received
ii) GD2 (Chemicals)	Goods	23.12.2018	Received
iii) GD3 (Primers, Mastermix)	Goods	23.12.2018	Quotation submitted
iv) GD4 (Chemicals)	Goods	23.12.2018	Quotation submitted

*as per approved procurement plan

14. Problems/Constraints/ Limitation: N/A

Description	Implementers opinion	Suggested solution by the Monitoring Team

15. Overall Observation/comments & suggestions by the Monitoring team:

- Report need to be revised according to the suggestions from Consultant
- Result should be presented season/year wise
- Photographs of newly collected germplasm need to be added

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Coordinated Subproject, Crops Division.	BARC
2. Amal Chandra Manidas, Scientific Officer, PBRG-PGR Coordinated Subproject, Crops Division.	BARC



Fig. 204. Field Visit to GRSD, BRRI, Gazipur, 12 March 2020

xiv. Field monitoring and evaluation report on visit to BSRTI on 19-20 March 2020

Duration of Field Visit: From 20.03.2020 to 20.03.2020

Coverage of Monitoring Report: From February 2018 to February 2020

Sub-Project Project Title: Collection and Characterization of Important Plant Genetic Resources (BSRTI, Component)

1. Institute Name: Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi
2. Coordinator/Principal Investigator/Co-Principal Investigator (as applicable): Md. Abdul Alim, Senior Research Officer, BSRTI, Rajshahi.
3. Duration: Start: February, 2018 Completion: December, 2020
4. Location(s) of the Program: Germplasm Bank of BSRTI, Rajshahi.
5. Name of Person(s) with address interviewed/ met/ discussed:
 - iv. Md. Munsur Ali, Director, BSRTI, Rajshahi.
 - v. Faruque Ahmed, Senior Research Officer, BSRTI, Rajshahi.
 - vi. Md. Shakawat Hossain, Senior Research Officer, BSRTI, Rajshahi.
 - vii. Md. Aftab Uddin, Senior Research Officer, BSRTI, Rajshahi.
 - viii. Md. Abdul Alim, Senior Research Officer, BSRTI, Rajshahi.

6. Technical Information:

- Methodology and its Appropriateness:

Methodology: This experiment is conducted in the mulberry germplasm bank of BSRTI, Rajshahi. Total 60 mulberry genotypes are to be morphologically characterized through this project. For this purposes Qualitative and Quantitative characters are being recorded following the IPGRI descriptors of mulberry.

Appropriateness: Germplasm is the basic raw material for further varietal improvement. But in case of mulberry plant the characterization of mulberry genotypes has not been conducted previously. That is why this study has been conducted.

- Adherence to Original Plan: 60 mulberry genotypes are being characterized morphologically as per original plan.
- Reason for Deviation (if any): Not applicable

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/poor)
		Planned	Actual		
To characterize the mulberry genotypes	Morphological characterization is being done	60 genotypes	60 genotypes	None	Good

ii) Technology Generation:

Sl. no.	Description of the Technology	Number	Achievements/Status	Remarks
1.	Promising mulberry genotypes will be indentified.	At least 3- 4	Activities on 60 mulberry genotypes characterization are being conducted	

iii) Technology Adoption: N/A

No. of farmers involved	No. of farmers motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
. PIU-BARC, NATP-2		17.07.2018 04.12.2019	02	-
Internal Monitoring: 2. Md. Jamal Uddin Shah 3. Md. Munsur Ali	Director of BSRTI, Rajshahi	18.06.2018 10.09.2018 18.12.2018 11.02.2019 16.07.2019 20. 11.2019	06	-
Other Visitors: 1. Dr. Md. Firoz Alam and his students 2. Dr. Md. Shaiful Islam	Professor, Department of Genetic & Breeding, Rajshahi University Professor, Department of Crops Science, Rajshahi University	10.12.2019 13.05.2019	02	-

9. Training: N/A

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.): N/A

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1500000.00	
b. Funds Received till to date:	782760.00	
c. Delay (if any) in receipt of funds:		
d. Expenditure till to date:		
i) Incurred	782369.50	
ii) Committed	300000.00	
iii) Anticipated/Actual Balance/Deficit	390.50	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i) Digital Camera	(01) 21.08.2018	Procured	100	
(ii) Electric Balance	(01) 04.12.2019	Procured	100	
b. Works	N/A			
c. Services	N/A			

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	01.02.2018	01.02.2018	
b. Six monthly report (last 01 year)	30.06.2019 31.12.2019	30.06.2019 31.12.2019	
c Annual report	31.01.2019 28.02.2019	31.01.2019 28.02.2019	
d. Internal Monitoring Report(s) (Last 01 year)			
f. Project Completion Report			

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
1. The approved budget of this project is limited for conducting this research activity.	-	-
2. Sometimes delay to the fund release	-	-

15. Any other comments & suggestions by the visiting team:

16. Overall Assessment

- Continue the sub-Project as Planned
- Modify (specify areas of modification) the sub-Project
- Terminate the Project

Field Monitoring Members:

Name with position	Organization
Dr. Md. Abdus Salam, CSO (Crops) and PI	BARC, Dhaka
Dr. Md. Amjad Hossain, Consultant	BARC, Dhaka
Amal Chandra Manidas, Scientific Officer	BARC, Dhaka



Fig. 205. Field Visit to BSRTI, Rajshahi, 20 March 2020

xv. Field monitoring and evaluation report on visit to BJRI on 17 October 2020

Duration of Field Visit: From 17/10/2020 to 17/10/2020

Coverage of Monitoring Report: From February 2019 to September 2020

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Jute Research Institute (BJRI)
3. Principal Investigator: Md. Rafiqul Islam, Chief Scientific Officer, GRSD, BJRI
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Jute Agriculture Experimental Station, BJRI, Jagir, Manikganj
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Md. Rafiqul Islam, CSO, GRSD, BJRI
 - b. Dr. Md. Lutfur Rahman, PSO & In Charge, Jute Agriculture Experimental Station, BJRI, Jagir, Manikgonj
 - c. Dr. A.K.M Shahadat Hossain, PSO, GRSD, BJRI
7. **Technical Information:**
 - Methodology and its Appropriateness: Following GIS Map, Mission orientate collection, exploration was done.
 - Adherence to Original Plan: Yes
 - Reason for Deviation (if any): No

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/poor)
		Planned	Actual		
1. Collection of jute and allied fibre germplasm.	90	90	35	55	
2. Morphological Characterization of JAF germplasm.	90	90	97	+7	
3. Characterization germplasm at molecular level using molecular markers.	60	60	66	+6	
4. Conservation	90	90	90		

ii) Technology Generation:

Sl. no.	Description of the Technology	Number	Achievements/Status	Remarks
1.	Collected JAF germplasm increase the genetic stock which ultimately helps developing improved varieties		35 jutes allied germplasm is collected.	

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Dr. Md. Mujibur Rahman	Director Agriculture and other senior scientists of BJRI	03/04/2018	4	Activities performed accordingly.
Dr. Md. Mahabub Hussain		15/07/2019		
Dr. Ayub Khan		28/07/2020 27/09/2020		

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. no	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks
1	Scientific paper- Molecular diversity assessment of some jute germplasm using SSR primers.	1	Submitted	Plant Science Today

11. Financial

	Amount (Tk.)	Remarks
a. Total Budget :	1500000/-	
b. Funds Received till to date:	1288307/-	
c. Delay (if any) in receipt of funds:		
d. Expenditure till to date:	1056750.50/-	
i) Incurred	211693/-	
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	231556.50/-	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
i. Desktop Computer	1	1	100	
ii. Chemicals and Apparatus	1	1	100	
b. Works				
c. Services				

13. Reporting

Report type	Date of submission as per Plan/ schedule	Actual date of submission	Remarks
a. Inception report		July/2018	
b. Statement of expenditure.(SoE)*		20/09/2018	
c. Quarterly report(s)*		20/09/2018	
d. Six monthly report		20/09/2018	
e. Procurement plan		29/10/2018	
f. Field Monitoring Report(s)**		12/06/2019	
g. Half yearly report		20/10/2019	
h. Second year report		18/03/2020	
i. Two years report		06/07/2020	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Collection of germplasm is difficult because donor/farmers of some areas did not give germplasm easily.		Should motivate the donor
Progress of Molecular characterization is poor because expertise manpower is not available.		Try to complete molecular activities within time frame.

15. Any other comments & suggestions by the visiting team:

- Summary table of collected germplasm should be added in collection and exploration report.
- Black and white map should be added collection part of the report.
- Char land area should be selected for germplasm collection because those areas are the sources of minor crops.
- Only photographs of collected sample should be added in passport data form.
- Materials and methods of reports should clearly mention the collection system/procedure.

16. Overall Assessment

- Continue the sub-Project as Planned
- Modify (specify areas of modification) the sub-Project
- Terminate the Project

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Shah Md. Monir Hossain, PSO (Crops) & PI, PBRG-PGR Sub-Project	BARC	
2. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Sub-Project	BARC	
3. Amal Chandra Manidas, SO, PBRG-PGR Sub-Project	BARC	



Fig. 206. Field Visit to BJRI, Jagir, Manikgonj, 17 October 2020

xvi. Field monitoring and evaluation report on visit to BSRI on 07-08 November 2020

Duration of Field Visit: 07/11/2020 to 08/11/2020

Coverage of Monitoring Report: From February 2018 to October 2020

1. Sub-Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources: BSRI Component
2. Institute Name: Bangladesh Sugarcrop Research Institute, Ishurdi, Pabna
Coordinator/Principal Investigator/Co-Principal Investigator: Dr. Md. Anisur Rahman, Principal Scientific Officer, Breeding Division, Bangladesh Sugarcrop Research Institute, Ishurdi, Pabna, Mobile: 01703488606, e-mail: anisurbreedbsri@gmail.com
3. Duration: Start-February 2018; Completion: January 2021
4. Location(s) of the Program: Bangladesh Sugarcrop Research Institute, Ishurdi, Pabna
5. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. Samajit Kumar Pal, Director (Research), BSRI, Ishurdi, Pabna
 - b. Dr. Md. Anisur Rahman, PSO, Breeding Division, BSRI, Ishurdi, Pabna
 - c. Md. Mostake Ahmed, SSO, Breeding Division, BSRI, Ishurdi, Pabna

Technical Information:

- Methodology and its Appropriateness: Overall good
- Adherence to Original Plan: Germplasm collection, maintenance and morphological characterization were practiced as per original plan though some problems faced in molecular characterization during pandemic COVID-19 situation.
- Reason for Deviation (if any): N/A

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average/ poor)
		Planned	Actual		
To collect & conserve sugarcane germplasm	Collection of germplasm with passport information	50	61	N/A	Good
	Maintenance in field gene bank	50	61	N/A	Good
To characterize selected sugarcane germplasm at morphological and molecular level	Characterization of Collected germplasm	50	47	N/A	Good
	Characterization of Collected germplasm with SSR profiling	40	-	-	Poor (DNA extraction and marker screening is going on.)

ii) Technology Generation:

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks
01	BSRI Akh 47 (As chewing cane variety)	01	Released	Very good

iii) Technology Adoption: N/A

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Remarks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Dr. Abdul Razzak Md. ATM Salauddin Dr. PK Das	Ex EC, BARC Ex DG, BSRI Ex Director, BARI	04.08.2019	01	
Internal Monitoring:	Director General, Director (Res.) Director (TOT) of BSRI	04.10.2019	01	
PIU-BARC, NATP-2		03.12.2019	01	

9. Training: N/A

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks
01	Journal article	01	Under processing	

11. Financial (Up to September 2020)

	Amount (Tk.)	Remarks
a. Total Budget :	19,99,990.00	
b. Funds Received till to date:	16,84,230.00	
c. Delay (if any) in receipt of funds:		
d. Expenditure till to date:	15,45,760.00	
i) Incurred		
ii) Committed		
iii) Anticipated/Actual Balance/Deficit	1,38,470.00	

12. Procurement

Major Activity *	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(i) Apparatus	01	01	100	
(ii) Chemicals	03	03	100	
(iii) Equipments	01	01	100	
b. Works	N/A			
c. Services	N/A			

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report		31.07.2018 08.01.2019	
b. Six monthly report (last 01 year)		28.10.2019 15.10.2020	
c. Annual report		07.10.2020	
d. Internal Monitoring Report(s) (Last 01 year)		-	
f. Project Completion Report		-	

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Trait specific primer for molecular identification of sugarcane is not available	For proper molecular identification, trait specific primer is essential. But in sugarcane it was very limited and not performed well.	
Procurement of chemicals has been hindered due to COVID-19 situation	We preserve our sample in -86°C freezer and try to characterize after getting all required chemicals.	

15. Any other comments & suggestions by the visiting team:

- a. In passport information table, Collector's information should be written in right way, local name and cultural practices should also written and photographs should be clear & close to observe the special characters.
- b. Collection should be driven to harvest total gene pool and it will be GIS grid oriented.
- c. In field gene bank, plot board should be written according to collectors name or accession name rather than using local common name.
- d. A summary table should be prepared referring district and upazila to record area coverage and to facilitate further collecting mission.
- e. Next reports will be prepared focused on PCR format.

16. Overall Assessment

- a. Continue the sub-Project as Planned
- b. Modify (specify areas of modification) the sub-Project
- c. Terminate the Project

Field Monitoring Members:

Name with position	Organization	Signature with date
1. Dr. Shah Md. Monir Hossain, PSO (Crops) & PI, PBRG-PGR Sub Project	BARC	
2. Dr. Md. Amjad Hossain, Consultant, PBRG-PGR Sub Project	BARC	
3. Amal Chandra Manidas, SO, PBRG-PGR Sub Project	BARC	



Fig. 207. Field Visit to BSRI, Ishwardi, 7-8 November 2020

xvii. Field monitoring and evaluation report on visit to BINA on 28-29 November 2020

Duration of Field Visit: From 28/11/2020 to 28/11/2020

Coverage of Monitoring Report: February 2020 to October 2020

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Institute of Nuclear Agriculture (BINA)
3. Principal Investigator: Dr. Shamsun Nahar Begum, Principal Scientific Officer Breeding Division, BINA
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Bangladesh Institute of Nuclear Agriculture, Mymensingh
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Dr. Shamsun Nahar Begum, PSO, Plant Breeding Division, BINA
 - b. Dr. Fahmina Yasmine, SSO, Plant Breeding Division, BINA

7. Technical Information:

- Methodology and its Appropriateness: Following GIS Map, Mission oriented collection, exploration was done.
- Adherence to Original Plan: Totally adhered to original plan
- Reason for Deviation (if any): None

i. Lab/ Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Deviation (if any)	Performance (Good/average/ below average /poor)
		Planned	Actual		
Collection of germplasm (rice, oilseeds, pulses, spices and vegetables)	Germplasm Collection	198	198	-	
Characterization of selected germplasm	Morphological	98	98		
	Molecular	53	105		
To conserve collected germplasm	Conservation	198	159		

ii. Technology Generation: Not applicable

Sl. No.	Description of the Technology	Number	Achievements/Status	Remarks

iii. Technology Adoption: Not applicable**8. Internal Monitoring by the research / Academic Institution**

Name of Visitors	Designation	Date of Visits	Total visit till date	Remarks (Activities performed / modification suggested)

9. Training: Not applicable

Training Title	Training duration (days)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (Journal, article, Manual, Booklet, Media coverage, dissemination etc.) :

Sl. No	Type of Documentation/Publicity	Number	Achievements/Status	Remarks
	-	-	-	-

11. Financial

Item	Amount (Tk.)	Remarks
a. Total Budget :	32,99,920/-	
b. Funds Received till to date:	2842410/-	
c. Expenditure till to date:	2841152/-	
i) Incurred		
ii) Committed		
iii) Anticipated/ Actual Balance		

12. Procurement

Major activity	Activity status (No./ date)		% completion in the current year	Cumulative % completion from start
	Planned	Actual		
a. Goods				
1. Chemicals and consumables	09.08.2018 14.08.2019	17.02.2019 30.01.2020	100 100	100 100
2. Camera	14.06.2018	28.06.2018	100	100
3. Sealer	14.06.2018	28.06.2018	100	100
4. Jar	14.06.2018	28.06.2018	100	100
b. Works				
c. Services				
Vehicle hiring	14.08.2019		100	100

13. Reporting

Report type	Planned/ schedule	Actual submission date	Remarks
a. Inception report	21 May 2018	24 July 2018	
b. Six monthly report (last 01 year)	August 2019 August 2020	August 2019 November 2020	
c Annual report	February 2019	March 2019	
d. Internal Monitoring Report(s) (Last 01 year)	December 2019	15 December 2019	
f. Project Completion Report	December 2020		

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Germination problem of collected seeds. The accession number cannot be given because of germination problem.	We could communicate with other farmers for the same germplasm if available.	
Lack of availability of some local germplasm like onion, mungbean in the project site.	To fulfill the project objectives, we can collect the other crop / vegetable's germplasm.	

15. Overall Observation/comments & suggestions by the Monitoring team:

Field Monitoring Members:

Name with position	Organization	Signature with date
Dr. Md. Aziz Zilani Chowdhury, Member Director, Crops Division and Coordinator PBRG-PGR (ID:128) Sub-project	BARC	
Dr. Shah Md. Monir Hossain Principal Scientific Officer (Crops) and PI PBRG-PGR (ID:128) Sub-project	BARC	
Dr. Md. Amjad Hossain, Consultant, PBRG-PGR (ID:128) Sub-project	BARC	
Mr. Amal Chandra Manidas Scientific Officer, PBRG-PGR (ID:128) Sub-project	BARC	



Fig. 208. Field Visit to BINA, Mymensingh, 28 November 2020

xviii. Field monitoring and evaluation report on visit to BAU on 28-29 November 2020

Duration of Field Visit: From 29/11/2020 to 29/11/2020

Coverage of Monitoring Report: From February 2020 to November 2020

1. Sub-Project Project Title: Collection, Conservation and Characterization of Important Plant Genetic Resources
2. Institute Name: Bangladesh Agricultural University (BAU)
3. Principal Investigator: Prof. Dr. M. A. Rahim, Dean Faculty of Agriculture, BAU
4. Duration: Start : February 2018 Completion : December 2020
5. Location(s) of the Program: Germplasm Centre, BAU, Mymensingh
6. Name of Person(s) with address interviewed/ met/ discussed:
 - a. Prof. Dr. M. A. Rahim, Dean, Faculty of Agriculture, BAU
 - b. Dr. Md. Habibur Rahman, Professor, Dept. of Horticulture, BAU
 - c. Dr. Md. Mokter Hossain, Professor, Dept. of Horticulture, BAU
 - d. Fatema Nasrin Jahan, Phd student

7. Technical Information:

- Methodology and its Appropriateness:
Germplasm was collected from different places (Bandarban, Tangail, Ghatail, idilpur, Modhupur, Mymensingh, Rajshahi, Dhaka etc.) of Bangladesh. After collecting the germplasm, all are conserved and planted in BAU Germplasm Centre. We planted the collection both in ground and drum system with judicious and appropriate application fertilizer and watering. Now the data recording is going on following IPGRI descriptor for YAM. Molecular characterization will be carried out applying RAPD marker. The standard protocol will be followed for establishment, cultivation, evaluation, conservation of (*Dioscoea spp.*) at BAU-GPC.
- Adherence to Original Plan: Pursuing research as per the approved work plan.
- Reason for Deviation (if any): None

i) Lab/Field Experimentation:

Objectives	Activities in relation to objectives	Status (Use appropriate unit)		Devi- ation (if any)	Performance (Good/average/ below average /poor)
		Pla- nned	Actual		
To collect and characterize morphological features of yam	Collection of diversified yams from different areas of Bangladesh and conservation of collected yams germplasm at BAU-GPC	30	33	N/A	Good
	Morphogical character- ization of Banana, Aroids and Yam	125	125 (Ban-62, Aroids-30 Yam-33)		Good
	Molecular characterization of Banana and Aroids	92	92 (Banana- 62, Aroids- 30)		

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievements/ Status	Remarks
1	Germplasm of <i>Dioscorea spp.</i> were collected from different location of Bangladesh and under observation for their performance analysis at BAU-GPC centre	33	Planted and under evaluation	Growing as expected particularly flowering and fruiting of different Germplasm (2 seasons)

iii) Technology Adoption: Not Applicable

No. of farmers involved	No. of farmers Motivated	No. of farmers adopting/ willing to adopt technology	Local level suitability of the technology	Total area covered	Project support/ services provided for adoption	Scope/ possibility of market linkage	Re- marks

8. Internal Monitoring by the Research / Academic Institution:

Name of visitor(s)	Designation	Date(s) of visit	Total visit till date (No.)	Remarks (Activities performed/ modification suggested)
Prof. Dr. Subash Chakraborty,	Coordinator, CASR, BAU	22/05/19		
Prof. Dr. Md. Abu Hadi Noor Ali Khan	Director, BAURES	08/11/19		

9. Training: Not Applicable

Training Title	Training duration (From – to –)	No. of participants and batch		No. trained		Remarks
		Target	Achievement	Male	Female	

10. Knowledge management (e.g. Journal article, Manual, Booklet, Media coverage, dissemination activity etc.)

Sl. No	Type of Documentation/ Publicity	Number	Achievements/Status	Remarks

11. Financial

	Amount (Tk.)
a. Total Budget :	2000000
b. Funds Received till to date:	1740800
c. Delay (if any) in receipt of funds:	259200
d. Expenditure till to date:	1450445
i) Incurred	
ii) Committed	
iii) Anticipated/Actual Balance/Deficit	

12. Procurement

Major Activity	Activity status (No./ date)		% of completion in the current year	Cumulative % of completion from start
	Planned	Actual		
a. Goods				
(v) Colorimeter	21.04.19	14.05.19	100%	100%
(vi) chemicals	21.04.19	14.05.19	100%	100%
b. Works				
c. Services				

13. Reporting

Report type	Planned/ schedule	Actual submission date
a. Inception report	26/8/2018	5/8/2018
b. Six monthly report (last 01 year)	5/2/2019, 21/8/19 &19/10/2019	25/2/2019, 21/8/2019 &19/10/2019
c Annual report		
d. Internal Monitoring Report(s) (Last 01 year)		
f. Project Completion Report		

14. Problems/Constraints/ Limitation:

Description	Implementers opinion	Suggested solution by the Monitoring Team
Molecular analysis will be done using RAPD marker	There is no fund for molecular level analysis of <i>Dioscorea</i> spp. as it has national demand to collect and conserve the germplasm in a molecular level analysis	Fund need for molecular analysis. Application has submitted.

15. Any other comments & suggestions by the visiting team:**16. Overall Assessment**

- Continue the Sub-Project as Planned
- Modify (specify areas of modification) the Sub-Project
- Terminate the Sub-Project

Field Monitoring Members:

Name with position	Organization
1. Dr. Md. Aziz Zilani Chowdhury, MD (Crops)	BARC
2. Dr. Shah. Md. Monir Hossianid PSO, Crops Division	BARC
3. Dr. Md. Amjad Hossain, Consultant PBRG-PGR Sub Project	BARC
4. Amal Chandra Manidas, SO PBRG-PGR Sub Project	BARC

