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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
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Volume III

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

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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 - l2l5
Bangladesh

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Contributors

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

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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, Cucmber-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 1^{st} 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 (µg/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 × 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, Inequilateteral = 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 bisesexual 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 Emarginte, 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 mtere (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 (m^2):** Leaf area was determined by using the formula L x B x 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):**

$$\%\, fruit\ pulp = \frac{Weight\ of\ pulp}{Weight\ of\ fruit} \times 100$$

30. Per cent peel (The per cent peel was calculated as follows):

$$\%\, fruit\ peel = \frac{Weight\ of\ peel}{Weight\ of\ fruit} \times 100$$

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 laidout 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. **Rhyzome length (cm):**
18. **Rhyzome breadth (cm):**
19. **Rhyzome 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. Tuberous 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 emergenc**e): 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 19. 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 ≤5 cm, 2 6-9 cm, 3 ≥10 cm
12. **Leaf area (cm^2):**
13. **Leaf measurement (cm):** Observed on 20 adult leaves.
14. **Aerial tuber diameter (cm):** 1 ≤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 ≤20 cm, 2 21 - 40 cm, 3 ≥41 cm
18. **Tuber width [cm]:** Recorded at the widest part
19. **Tuber skin thickness:** 1 <1 mm, 2 ≥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 bought 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 65^0C 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 37^0C 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 25µl of DNA Rehydration Solution and kept it over-night at 4^0C.
14. Finally, the all isolated genomic DNA samples were preserved at-20^0C 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 µl 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.

$$\text{DNA concentration (ng/µl)} = \text{Absorbance} = \text{Error} \times \text{CF } (0.05) \times 1000.$$

Table 134. Absorbance reading at 260 nm (ng/µl) of DNA samples and preparation of working sample

Sample ID	Absorbance at 260 nm	DNA concentration (ng/µl)	Working solution (100ng/µl)	
			Stock DNA (µl)	Distilled water (µl)
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_2O	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_2O	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_2O	7.50
DNA template	1.00

Reagents preparation

i) 0.5 MEDTA pH 8.0 (100 ml)

18.612 g EDTA was added to ddH_2O
pH was adjusted to 8.0 with NaOH
Sterilized ddH_2O was added to make the volume 100 ml
The solution was autoclaved

ii) 70% Ethanol (500 ml)

150 ml ddH_2O 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 ddH_2O
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 (ddH_2O) was added to make the volume up to 1000 ml.

iv) 1X TBE (1000 ml)

200 ml 5X TBE was added in 900 ml DDH_2O

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 walls.

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.

Principal of the PCR: A principal of PCR based makers 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 staring 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 one 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 ^{o}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 ^{o}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 lX 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 (Willams *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:

$$\text{Gene flow, Nm} = \frac{0.5\ (1 - Gst)}{Gst}$$

Where, Gst is the proportion of total genetic diversity attributable to subpopulation. It is also known as coefficient of gene differentiation.

The Gst values were calculated by using the following formula:

$$Gst = \frac{1\text{-}Hs}{Ht}$$

Where, Hs is the Hardy-Weinberg average heterozygosity expected in isolates and Ht 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 unfrurel 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 ul 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 µl 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 µl- 50 µl) 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 2µl (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 cm^3 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 µl 1X TBE buffer was placed on a piece of aluminum foil paper and 2 µl 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 µl). Then 2 µl 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:

DNA concentration (ηg/µl) = Absorbance x Conversion factor (0.05) X 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,

S_1 = Initial DNA concentration (ηg/µl)
V_1 = Initial volume of DNA solution (µl)
S_2 = Final DNA concentration (ηg/µl)
V_2 = 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

Sl 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) ½ 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 bought 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 µl of isolation buffer, mix well and vortex.
2. Add 100 µl of 10% SDS and then 14 µl of BME to the tissue samples.
3. Mix contents of the tubes vigorously and incubate for 15 min at 65ºC.
4. Add 350 µl of 5 M potassium acetate. Shake vigorously.
5. Cool on ice for 5 min.
6. Centrifuge at 12,000 rpm for 15 min at 20ºC.

Precipitation

7. Transfer the supernatant to a clean microcentrifuge tube, and add 535 µl 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 20ºC.
10. Carefully decant the supernatant.

11. Rinse the DNA pellet with 500 µl 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 µl of dissolution buffer to the DNA pellet. Tap gently to dislodge the pellet, and incubate for 10 min at 55ºC.
14. Mix the solution gently and cool on ice for 2 min.
15. Centrifuge at 12,000 rpm for 5 min at 20ºC to remove any undissolved material.

Precipitation with Sodium Acetate

16. Transfer the supernatant to a clean microcentrifuge tube. Add 12 µl of 3 M sodium acetate solution (pH 5.2) and 88 µl of isopropanol.
17. Centrifuge at 12,000 rpm for 5 min at 20ºC. The DNA pellet that forms is almost colorless.
18. Decant the supernatant and wash the pellet with 500 µl 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 µl of TE-RNase. Store at -80ºC

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 µl 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/µl) = Absorbance = Error×CF (0.05) ×1000.

$$\frac{\text{Volume of distilled water (µl)}}{\text{Amount of DNA sample (µl)}}$$

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 about100 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) and V_2 = Final volume of DNA solution (µl))

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 µl per sample (PCR- mixture)

Total Volm. /Sample: 20 µl

For preparation of 20µl per sample (PCR- mixture)	Amount (µl)
Master Mix	10.00
Primer	1.00
Nuclease free H_2O	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× 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 walls.

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.

Principal of the PCR

A principal of PCR based makers 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 staring 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 one 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 ^{o}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, respectably. 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 - Gst)

Gene flow, Nm = Gst Where, Gst is the proportion of total genetic diversity attributable to subpopulation. It is also known as coefficient of gene differentiation. The Gst values were calculated by using the following formula:

$$\mathrm{Gst} = \frac{1 - \mathrm{Hs}}{\mathrm{Ht}}$$

Where, Hs is the Hardy-Weinberg average heterozygosity expected in isolates and Ht 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.	Sl. No.	Acc. No.	Sl. No.	Acc. No.	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

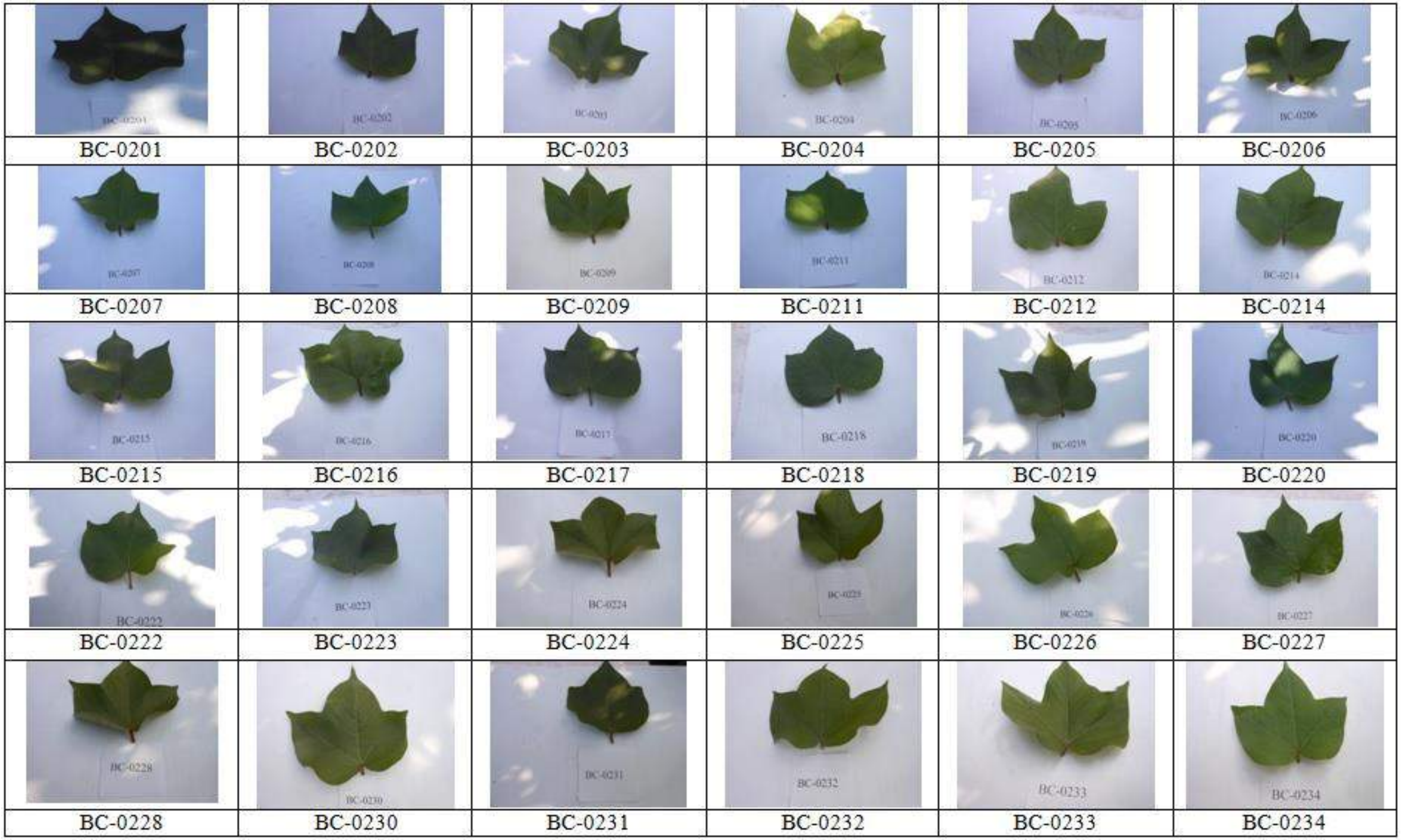
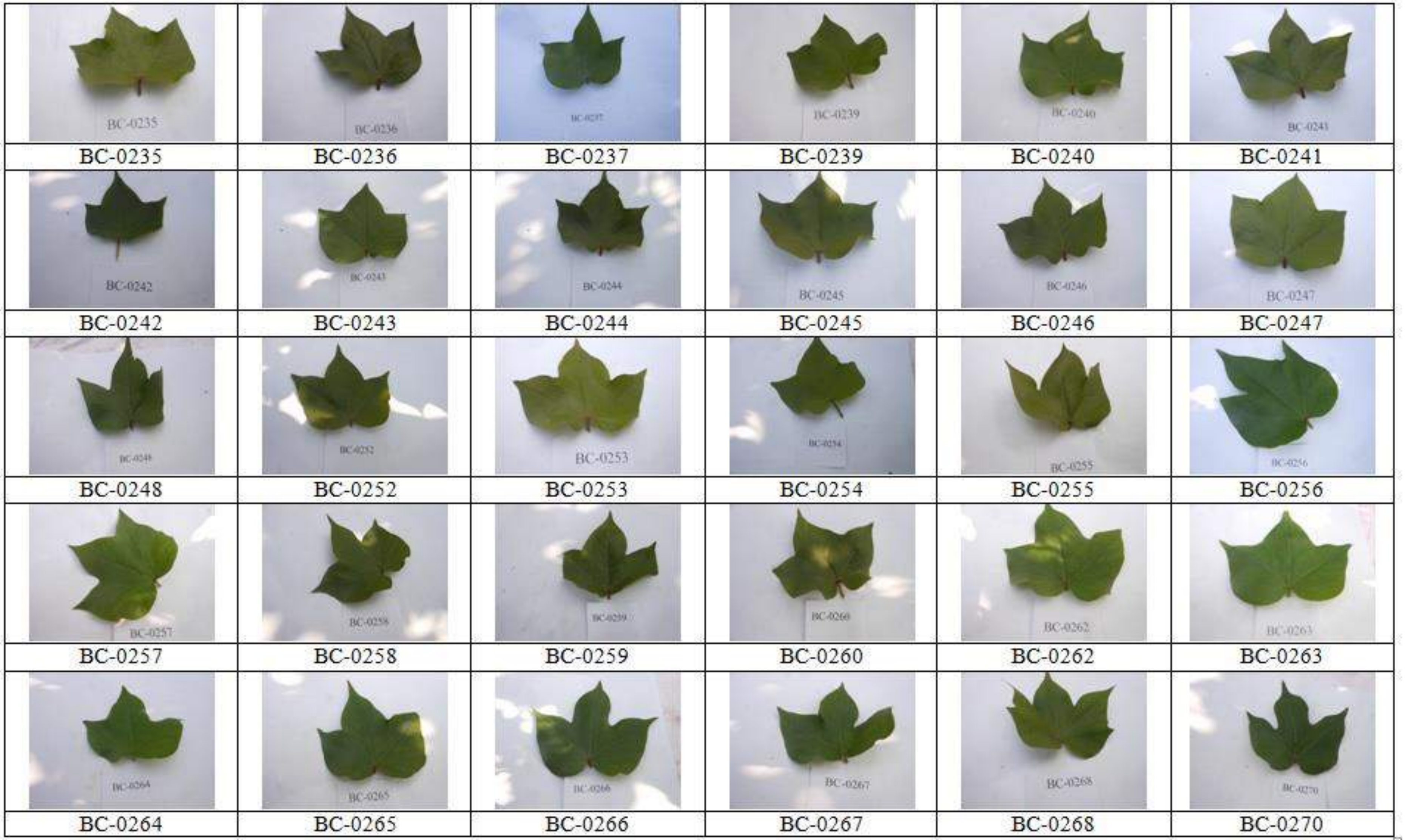


Fig. 99. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2018-2019



Cont'd. Fig. 99. Leaf shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

Fig. 100. Petal color of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

Cont'd. Fig. 100. Petal color of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

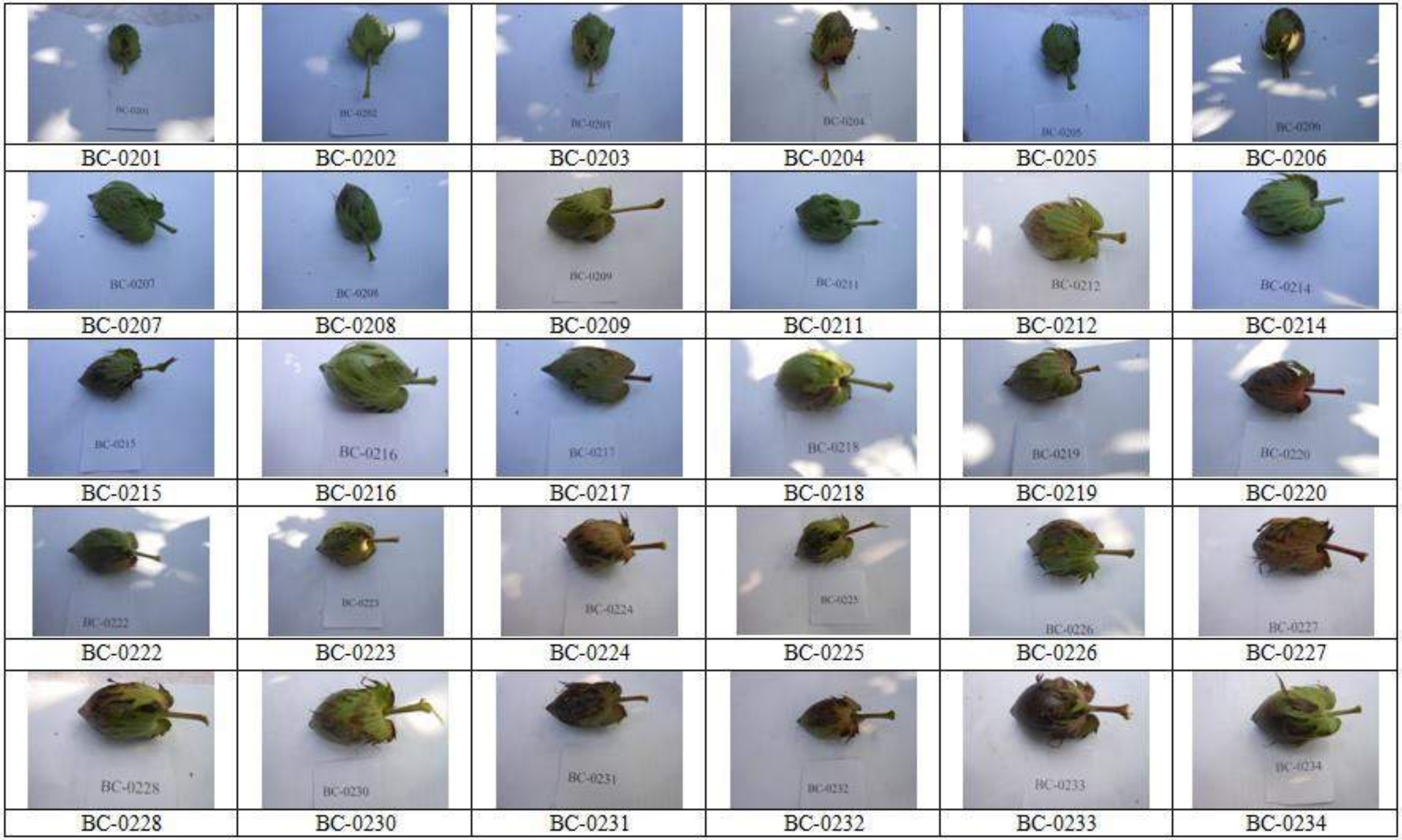
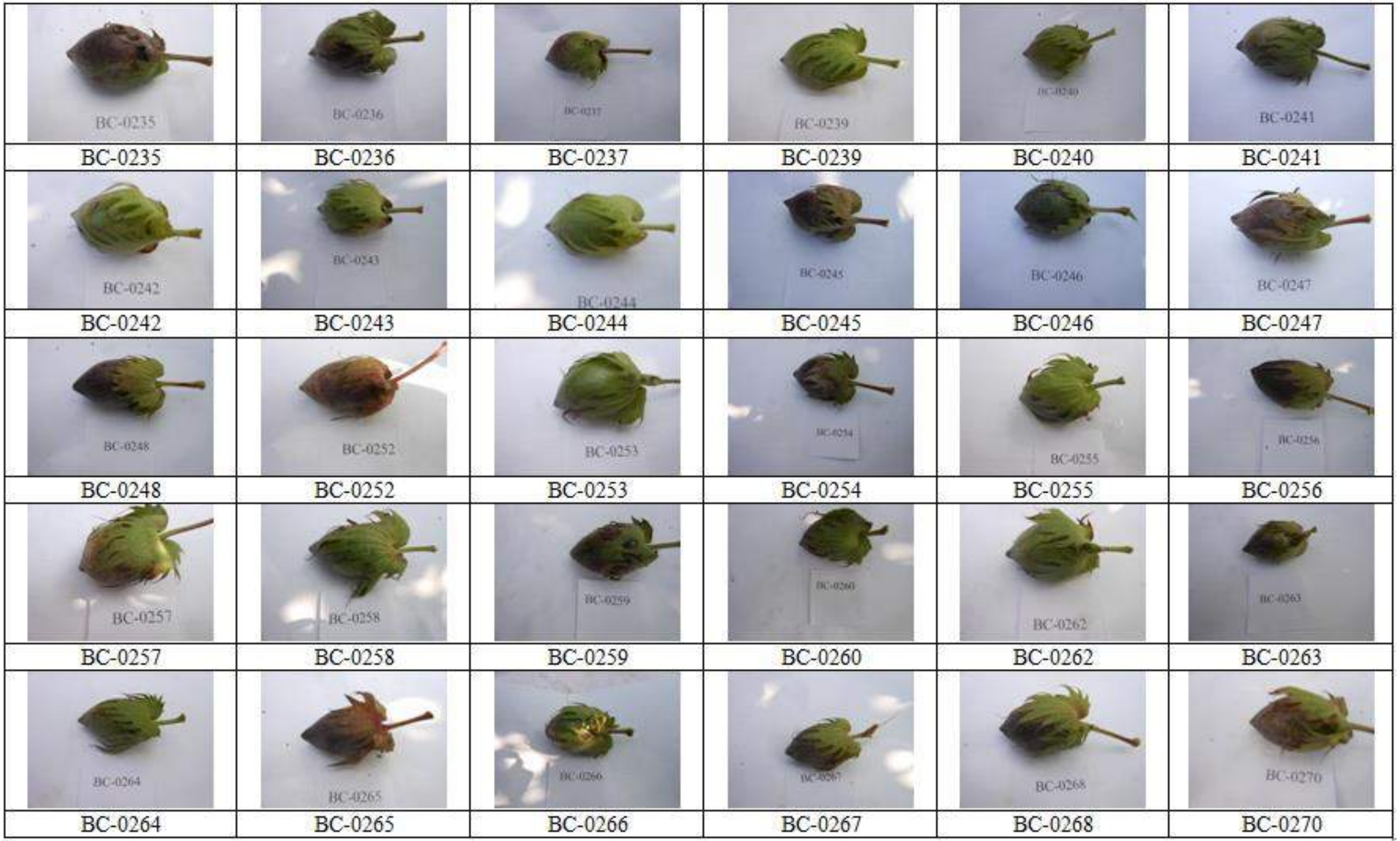
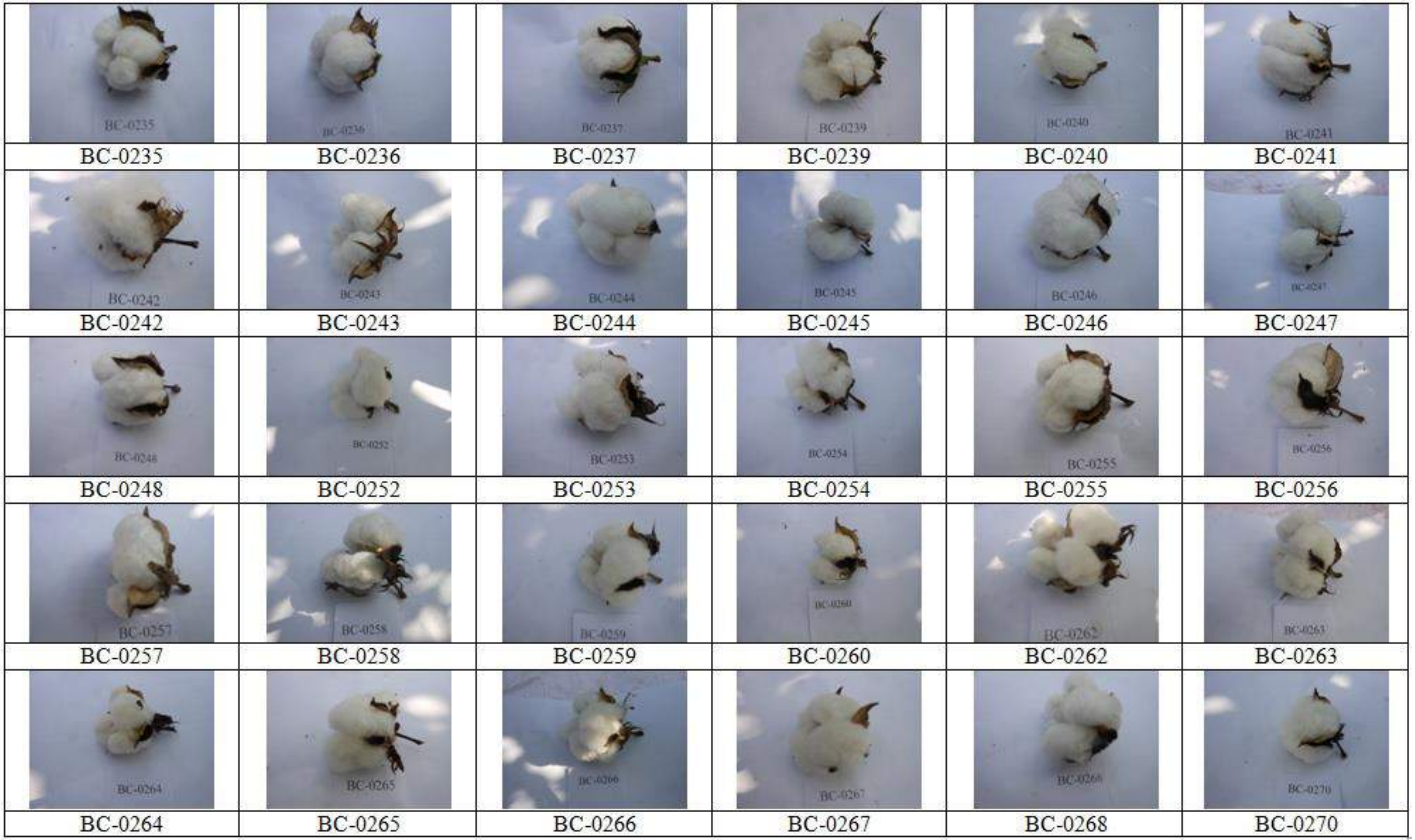


Fig. 101. Boll shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore in 2018-2019



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, Jagadishpur, Jashore in 2018-2019



Cont'd. Fig. 102. Lint color of cotton genotypes found, Cotton Research Center, Jagadishpur, Jashore in 2018-2019

Qualitative Characteristics of 59 Cotton Genotypes (2019-2020)

Qualitative characteristics of 59 cotton genotypes grown at the Cotton Research Center Jagadishpur, 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 wee 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 fund 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, Jagadishpur, 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

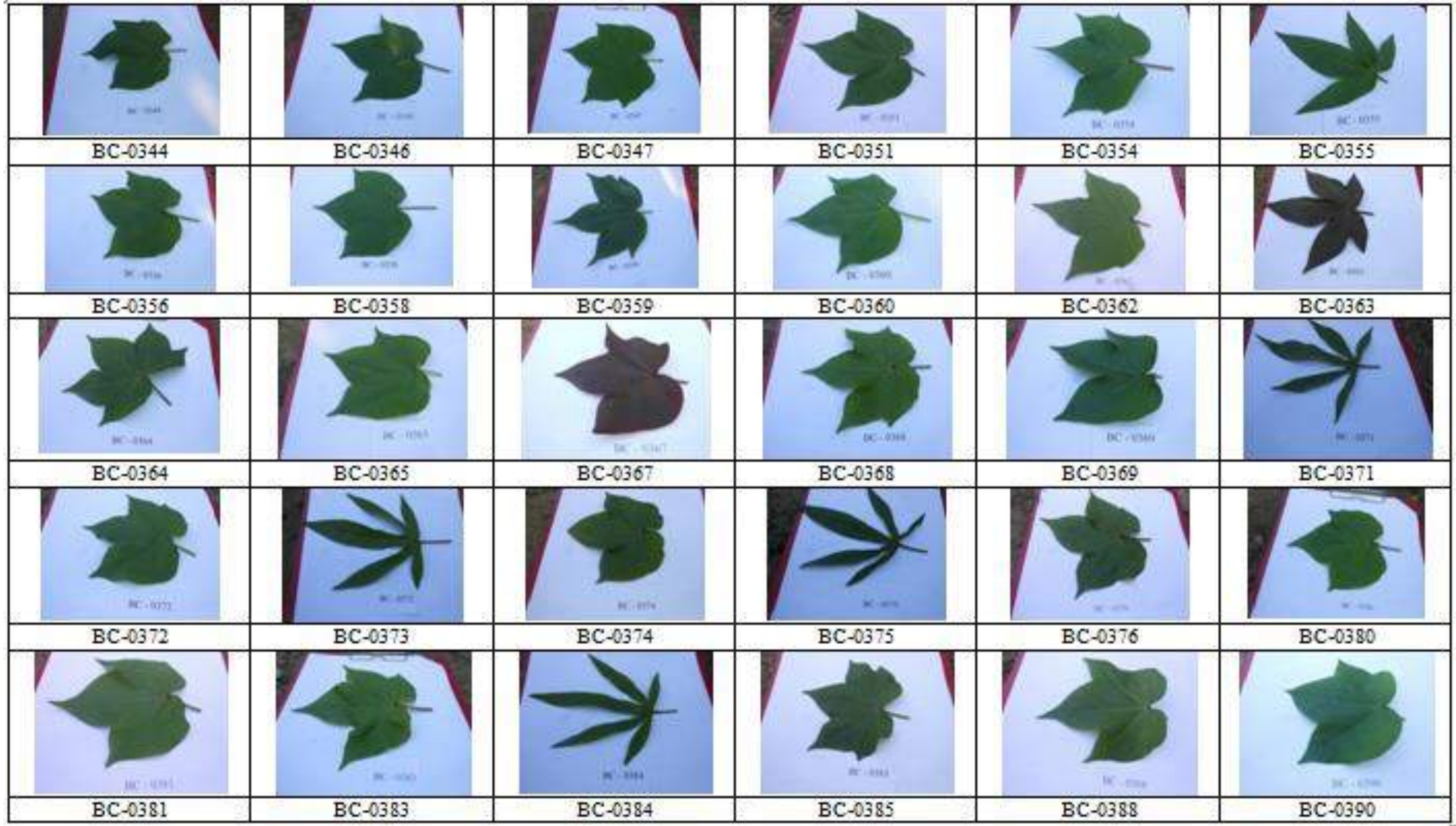
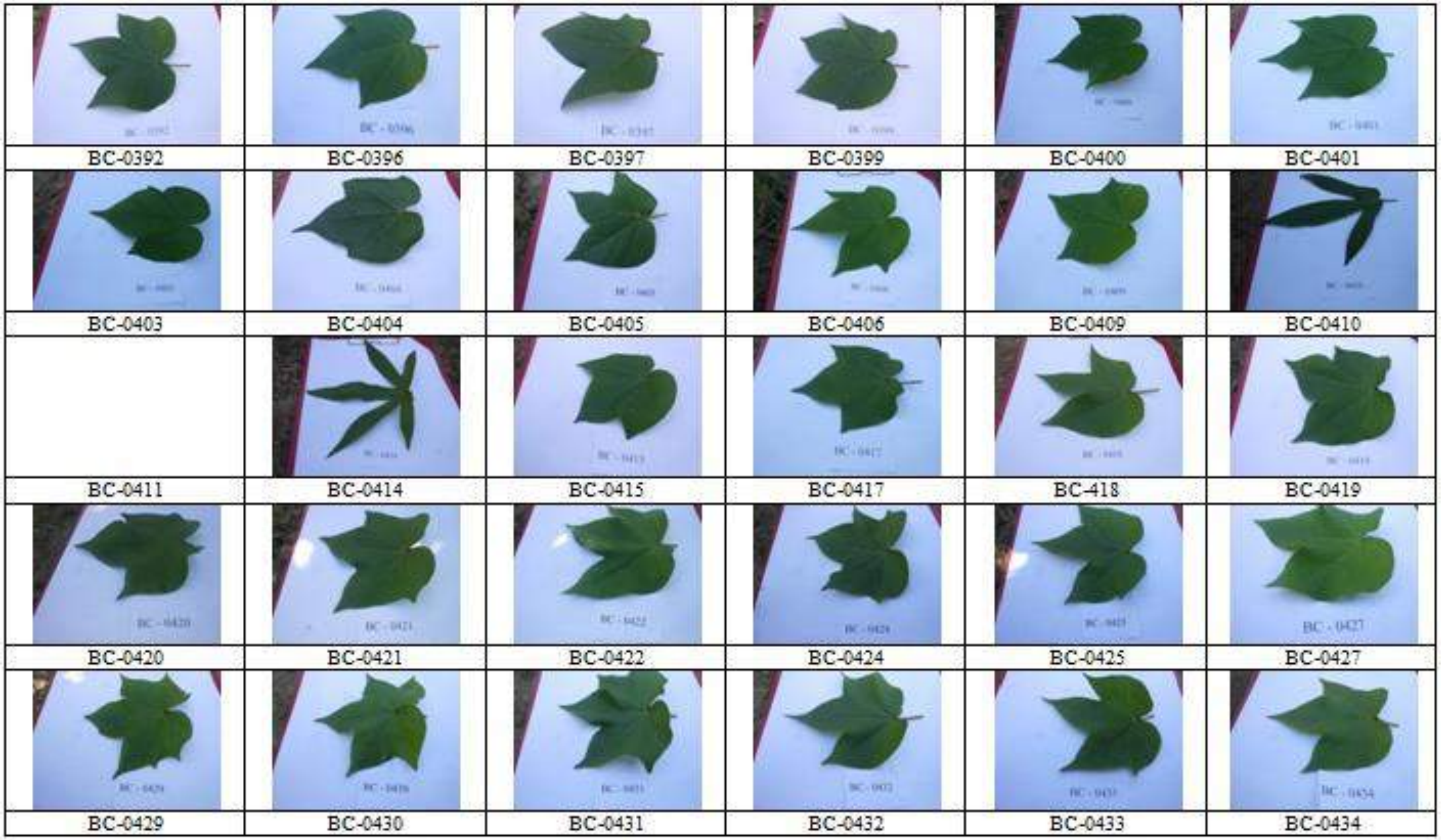


Fig. 103. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020



Cont'd. Fig. 103. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

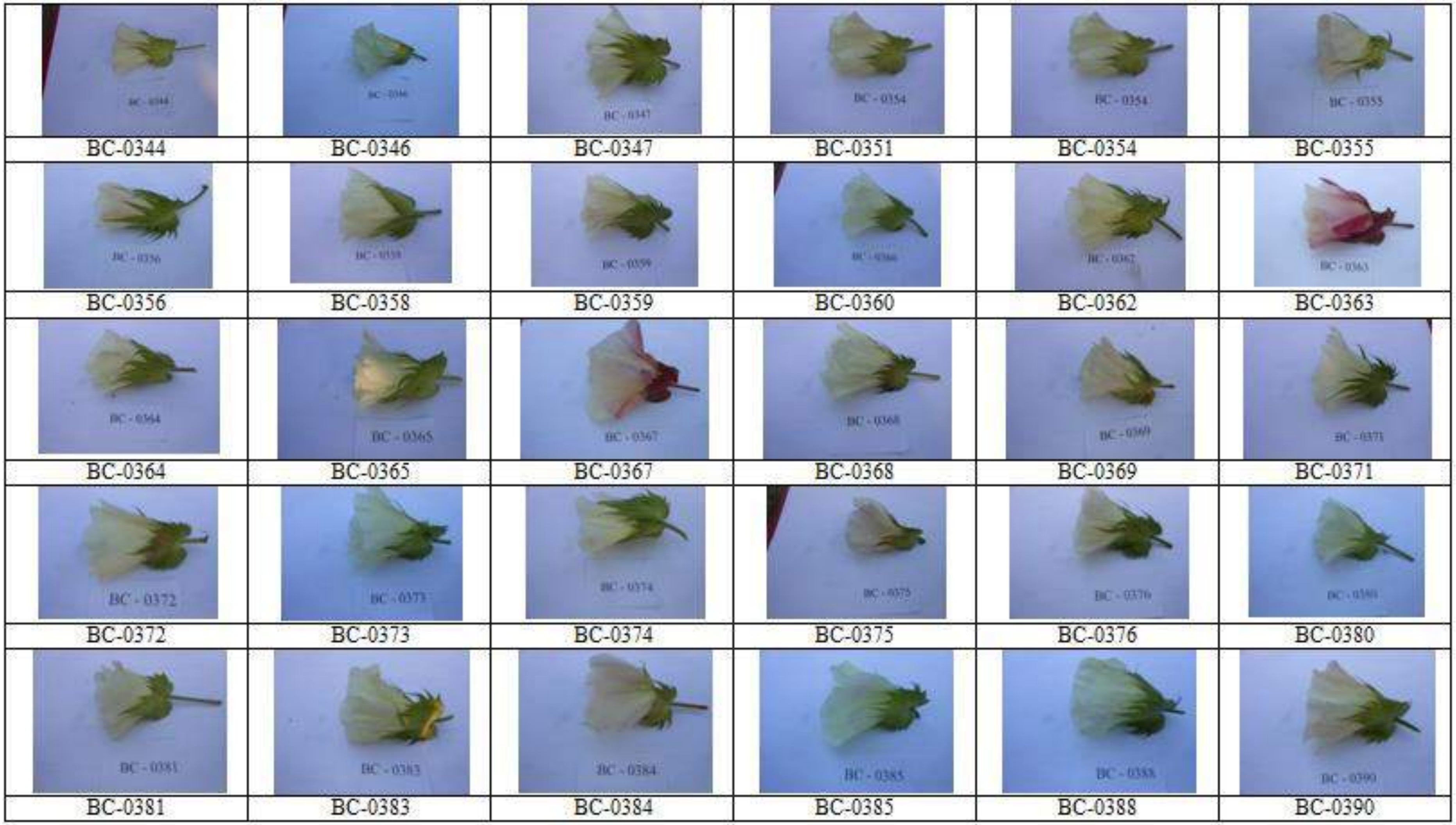


Fig. 104. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

Cont'd. Fig. 104. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

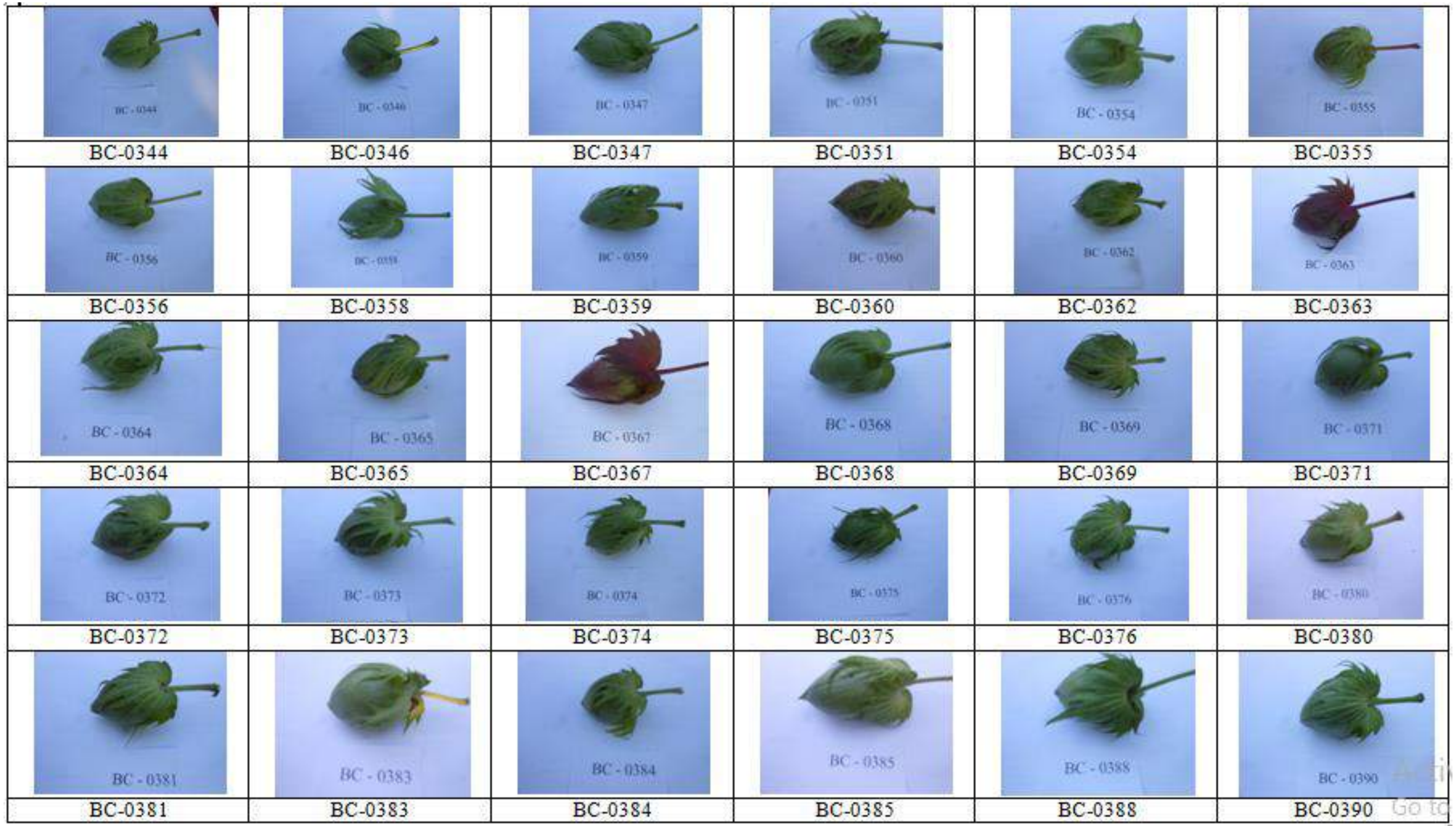


Fig. 105. Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2019-2020

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, Jagadishpur, Jashore, 2019-2020

Cont'd. Fig. 106. Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, 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

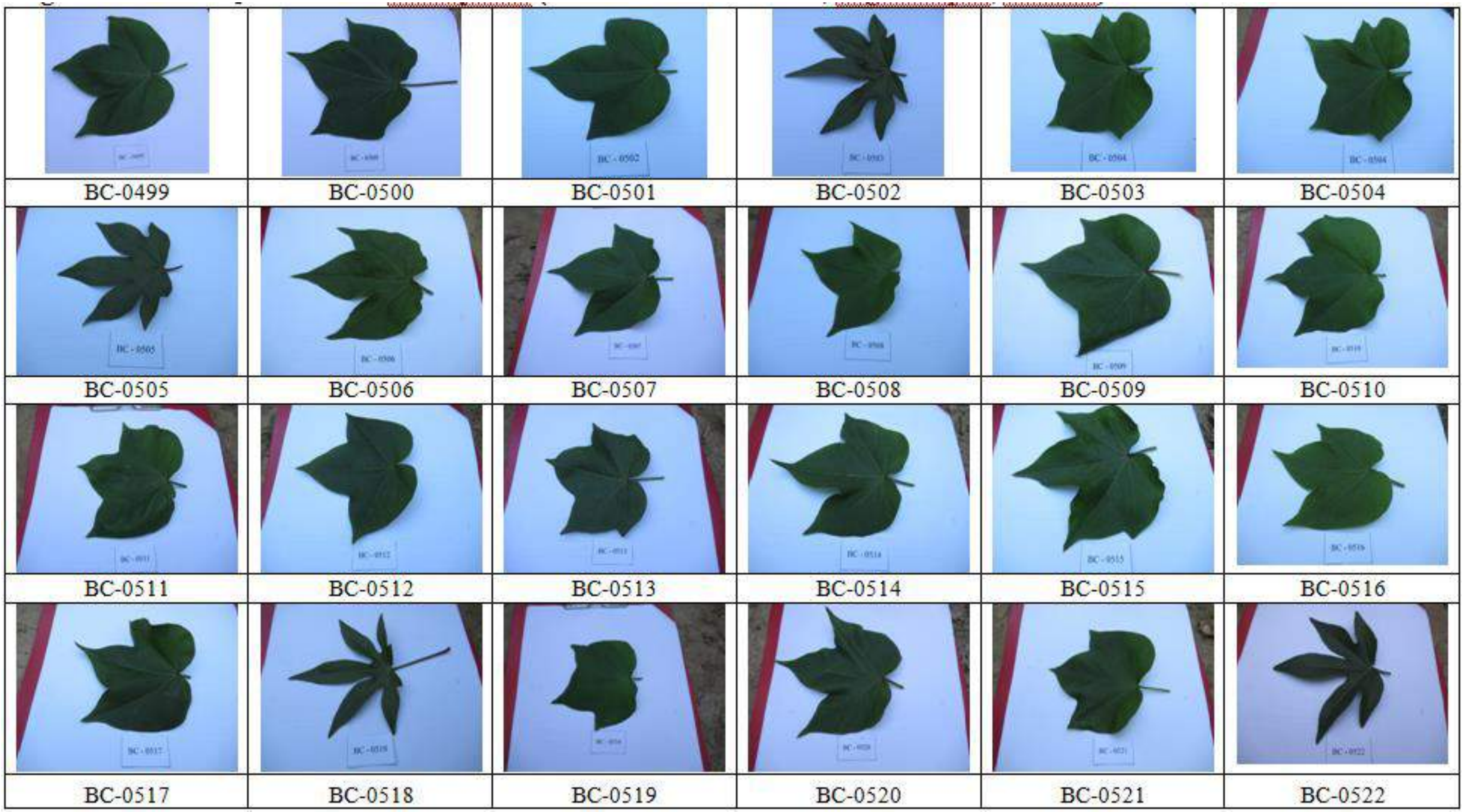
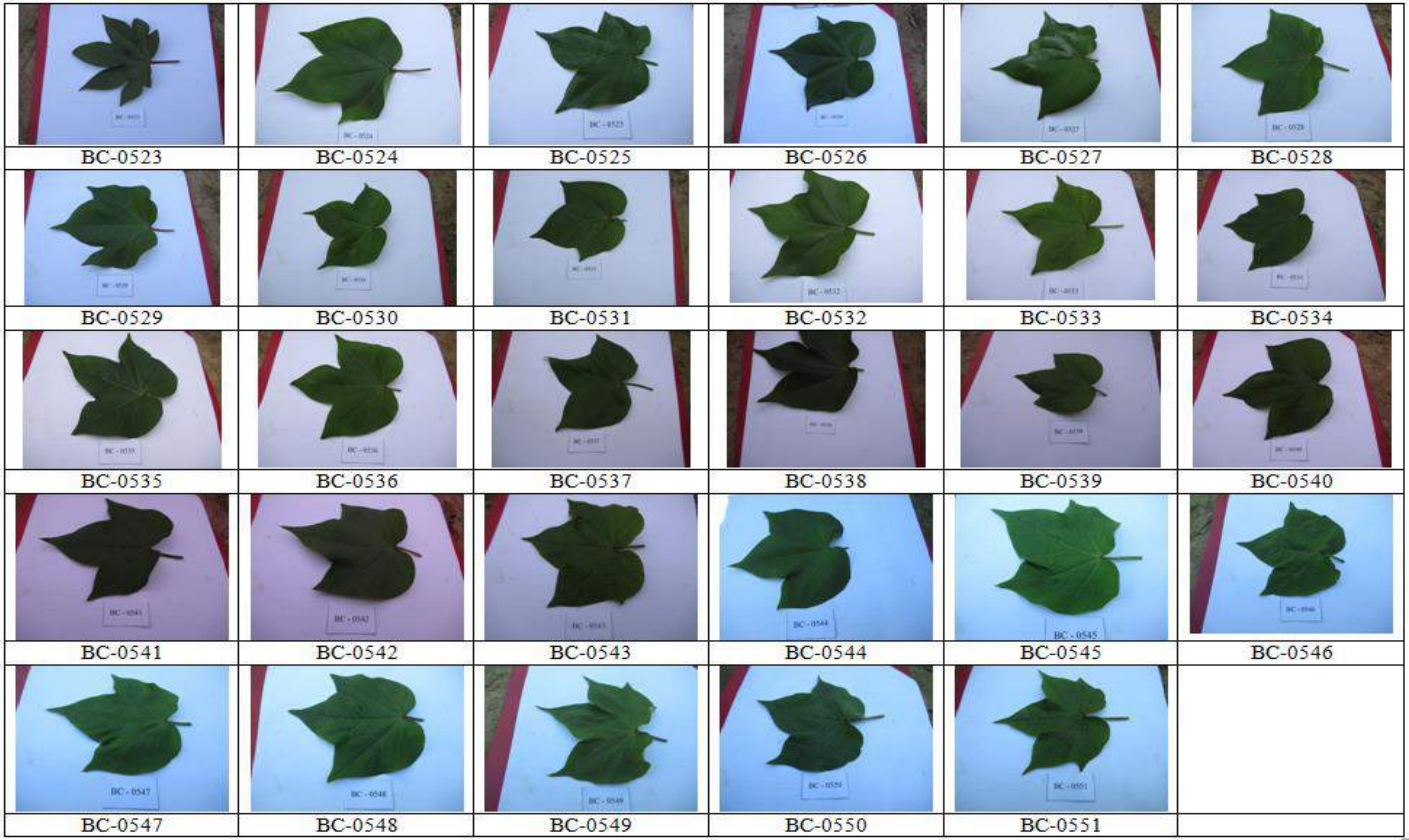


Fig. 107. Leaf shape of cotton genotypes grown, Cotton Research Center, Jagadishpur, Jashore, 2020-2021



Cont'd. Fig. 107. Leaf shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

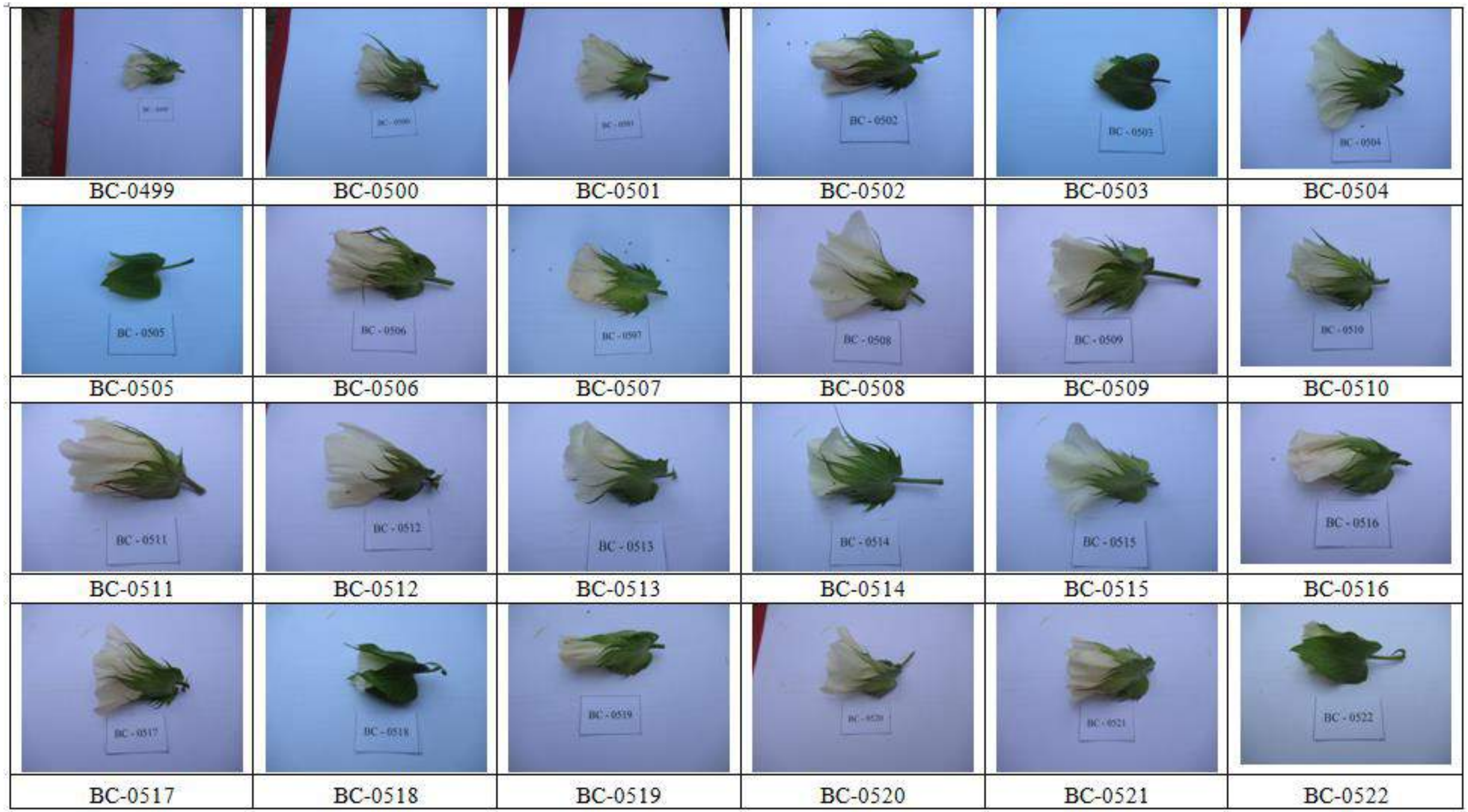


Fig. 108. Petal color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore in 2020-2021

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

					
BC-0523	BC-0524	BC-0525	BC-0526	BC-0527	BC-0528
					
BC-0529	BC-0530	BC-0531	BC-0532	BC-0533	BC-0534
					
BC-0535	BC-0536	BC-0537	BC-0538	BC-0539	BC-0540
					
BC-0541	BC-0542	BC-0543	BC-0544	BC-0545	BC-0546
					
BC-0547	BC-0548	BC-0549	BC-0550	BC-0551	

Cont'd. Fig. 109. Boll shape of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

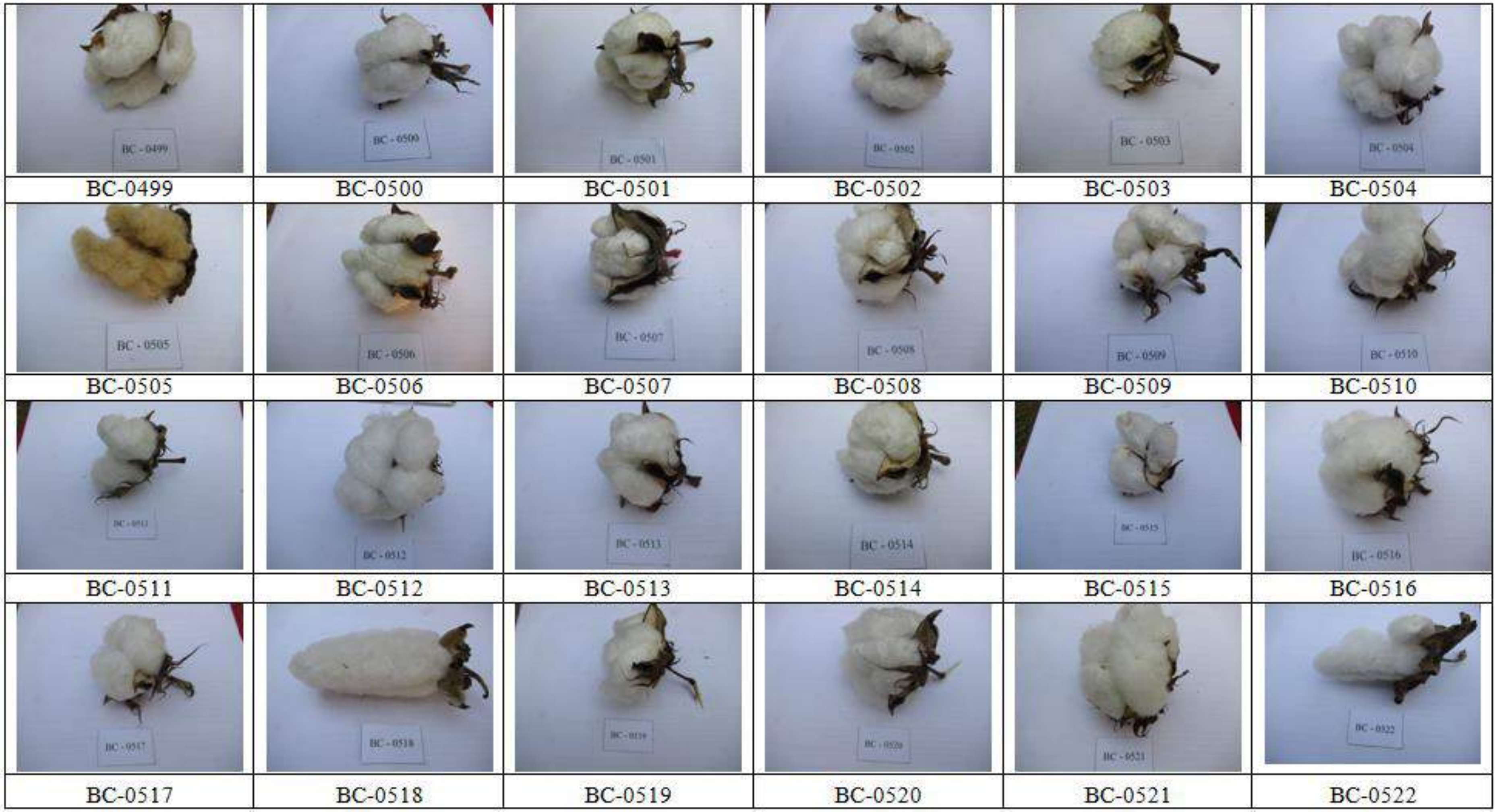


Fig. 110. Lint color of cotton genotypes, Cotton Research Center, Jagadishpur, Jashore, 2020-2021

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 1st 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 1st 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 1st 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 1st 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
Micronare 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 1st 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 1st 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 1st 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 Jagadishpur, 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 1st 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 1st 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 1st 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 1st 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.	Sl. No.	Acc. No.	Sl. No.	Acc. No.	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.	Sl. No.	Acc. No.	Sl. No.	Acc. No.	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

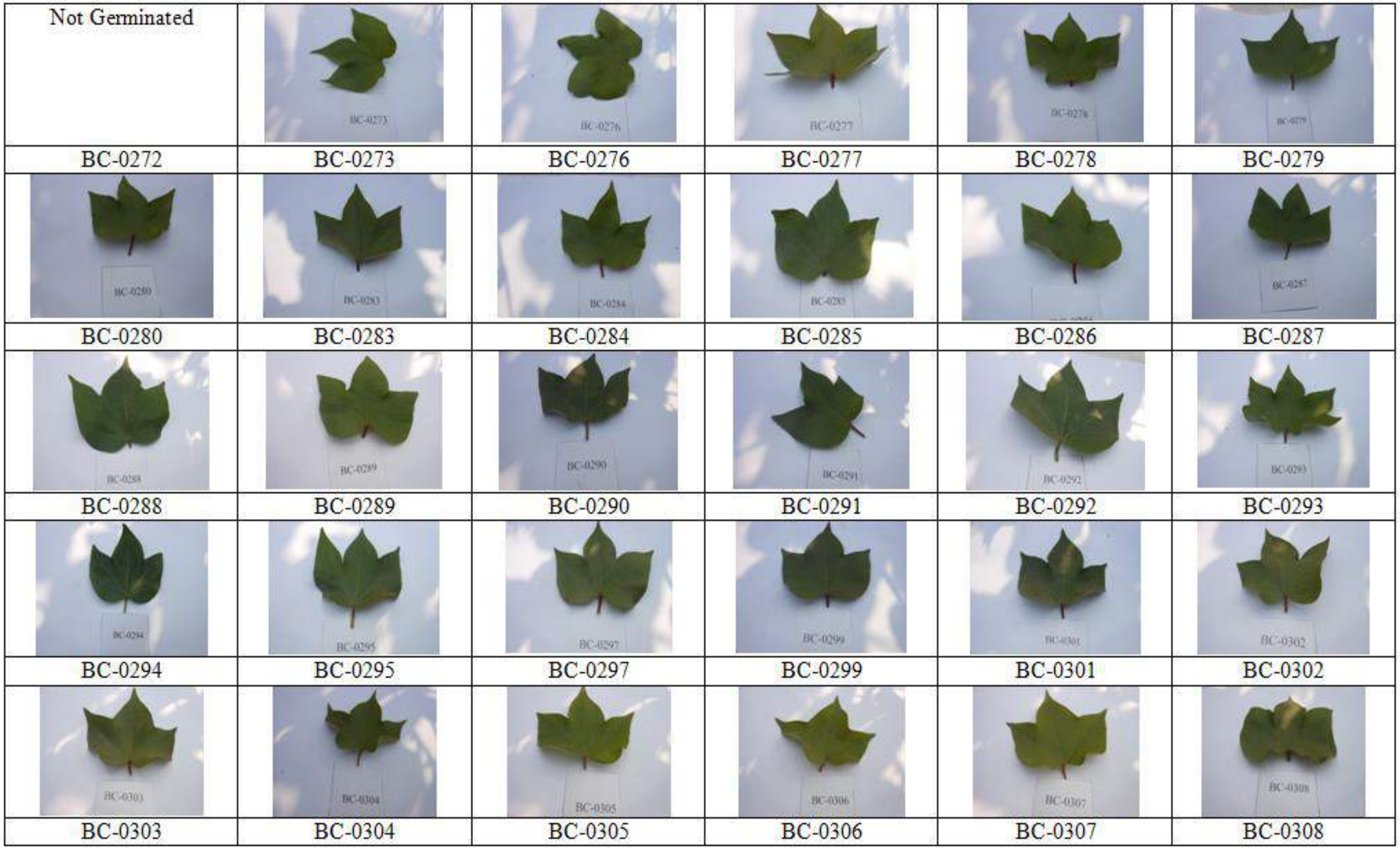
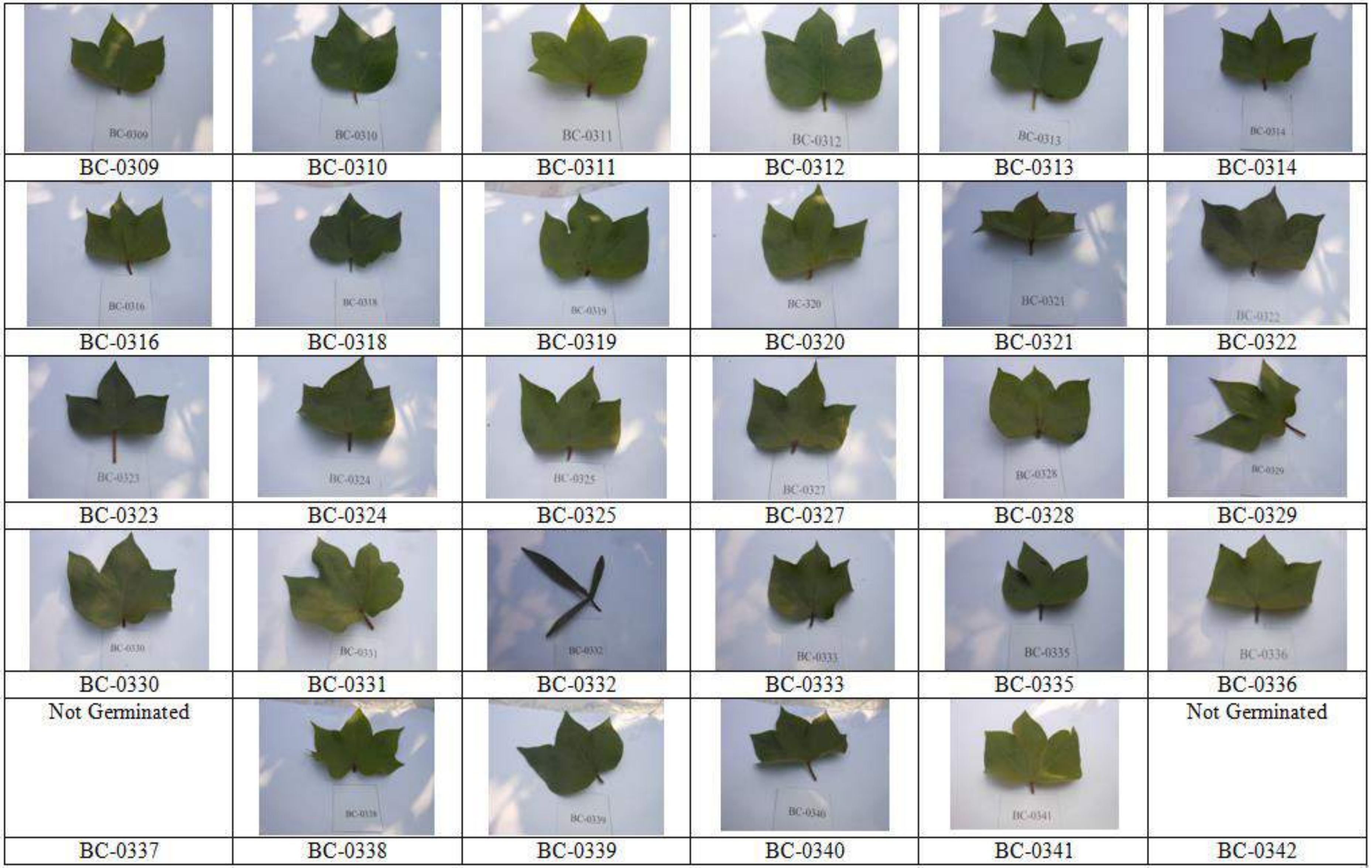


Fig. 111. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019



Cont'd. Fig. 111. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

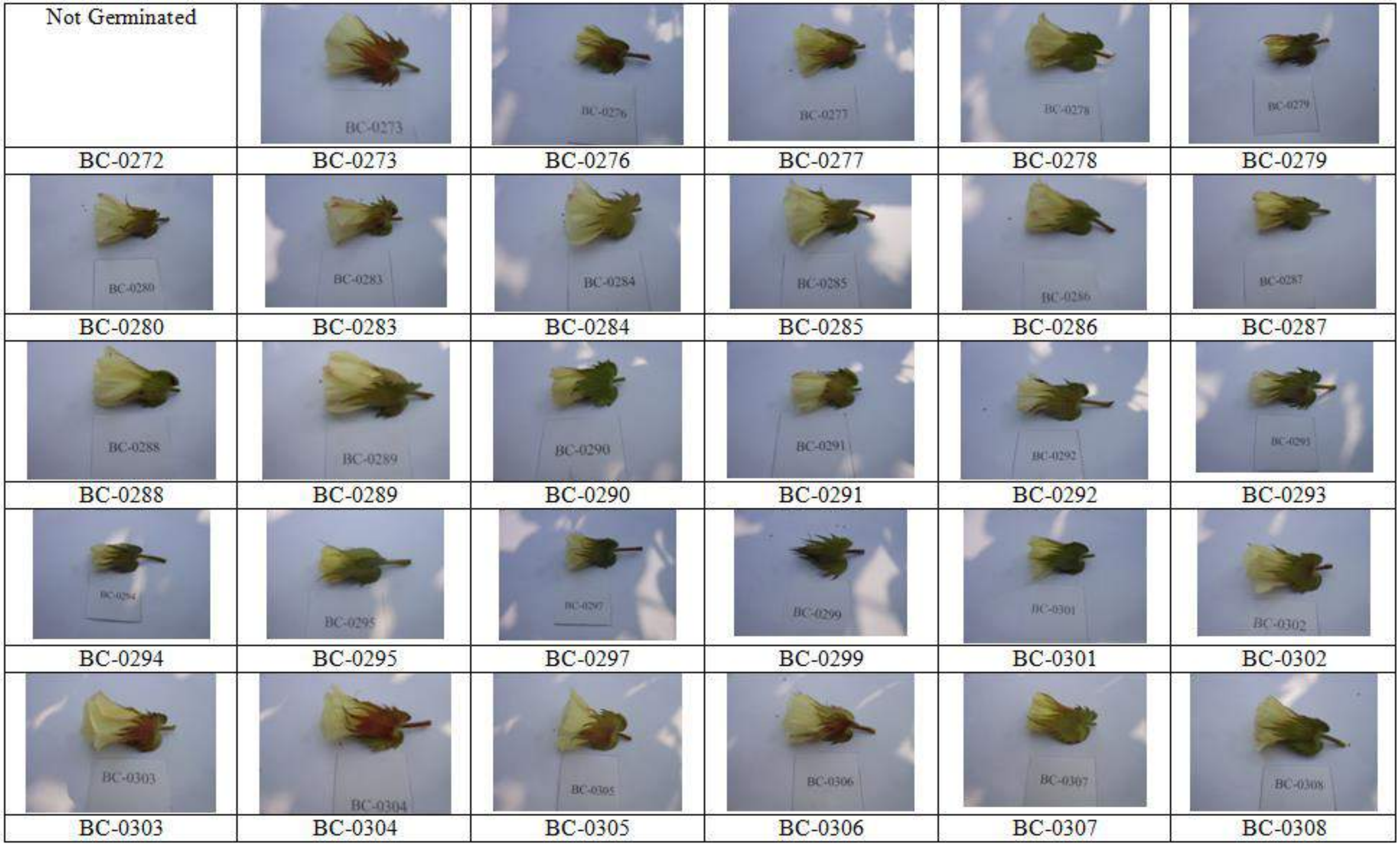
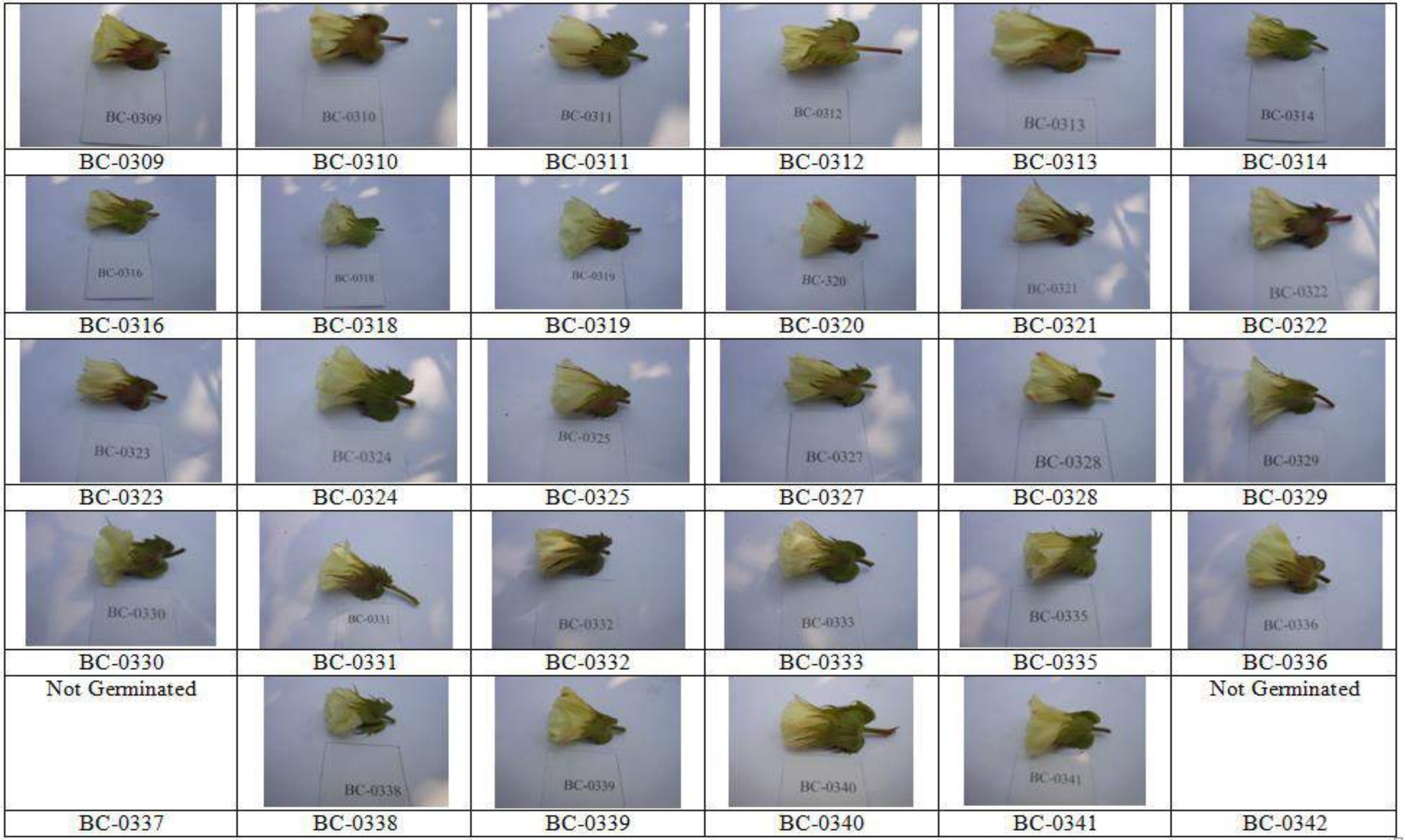
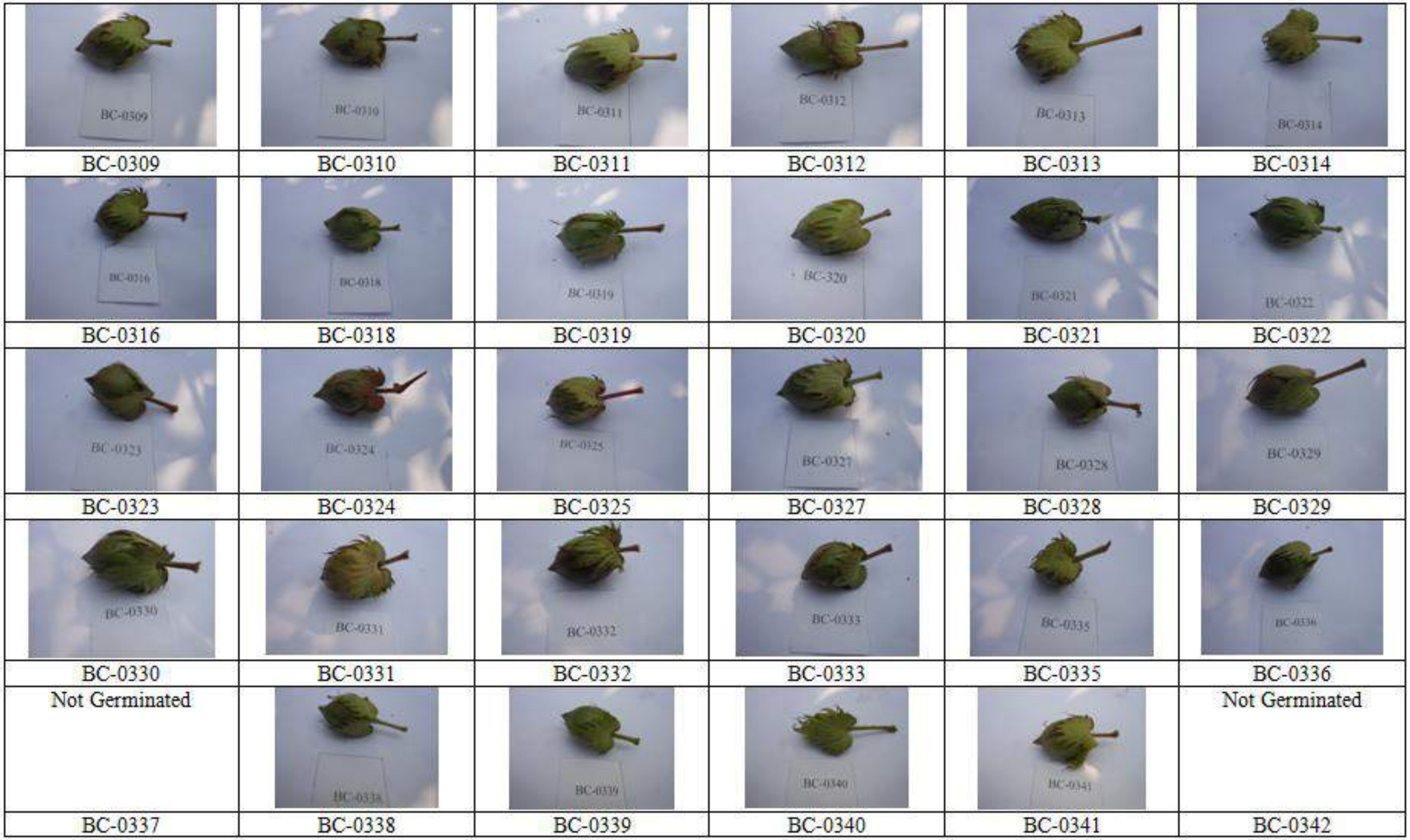


Fig. 112. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019



Cont'd. Fig. 112. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019

Fig. 113. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2018-2019



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	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-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

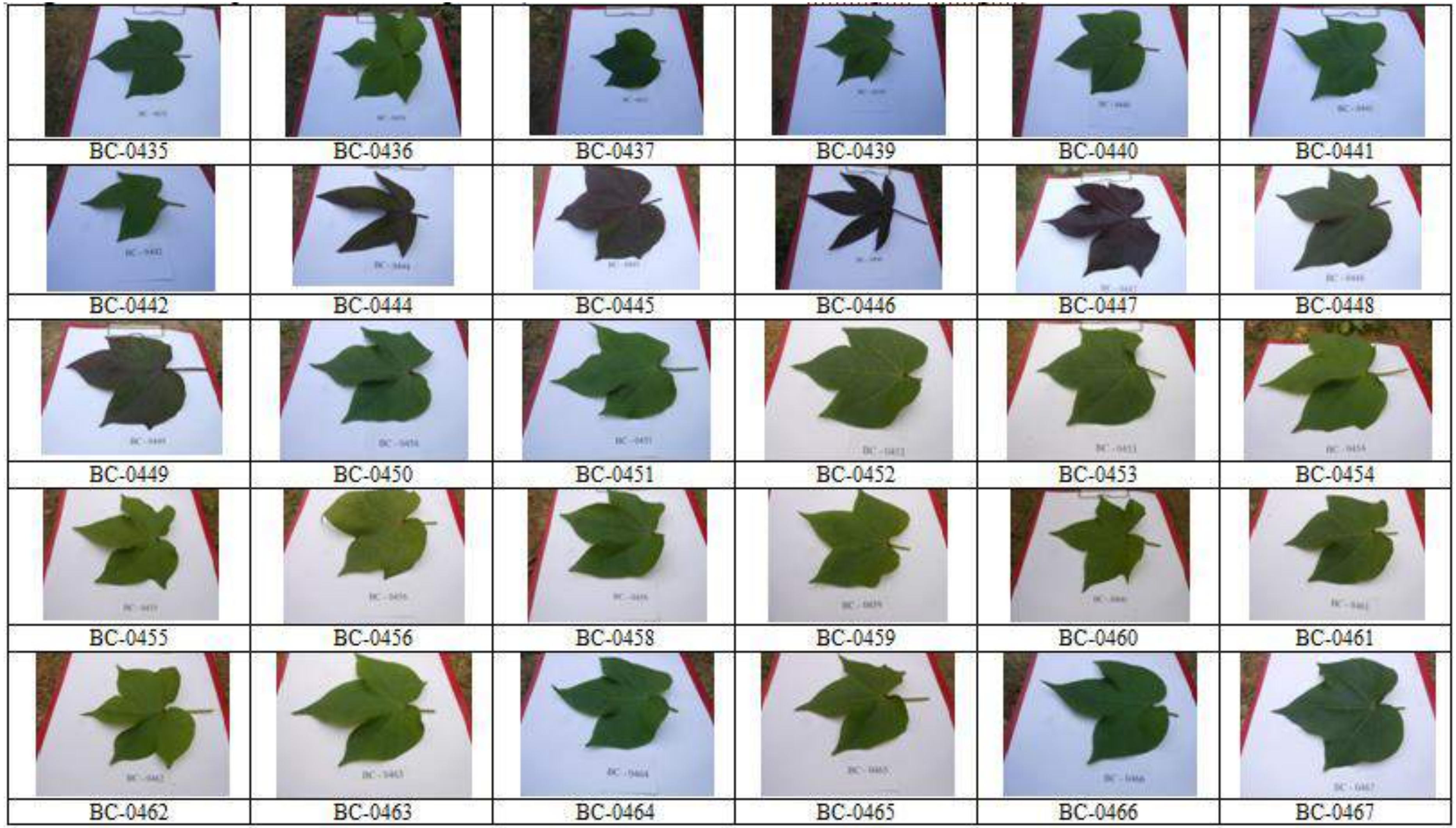
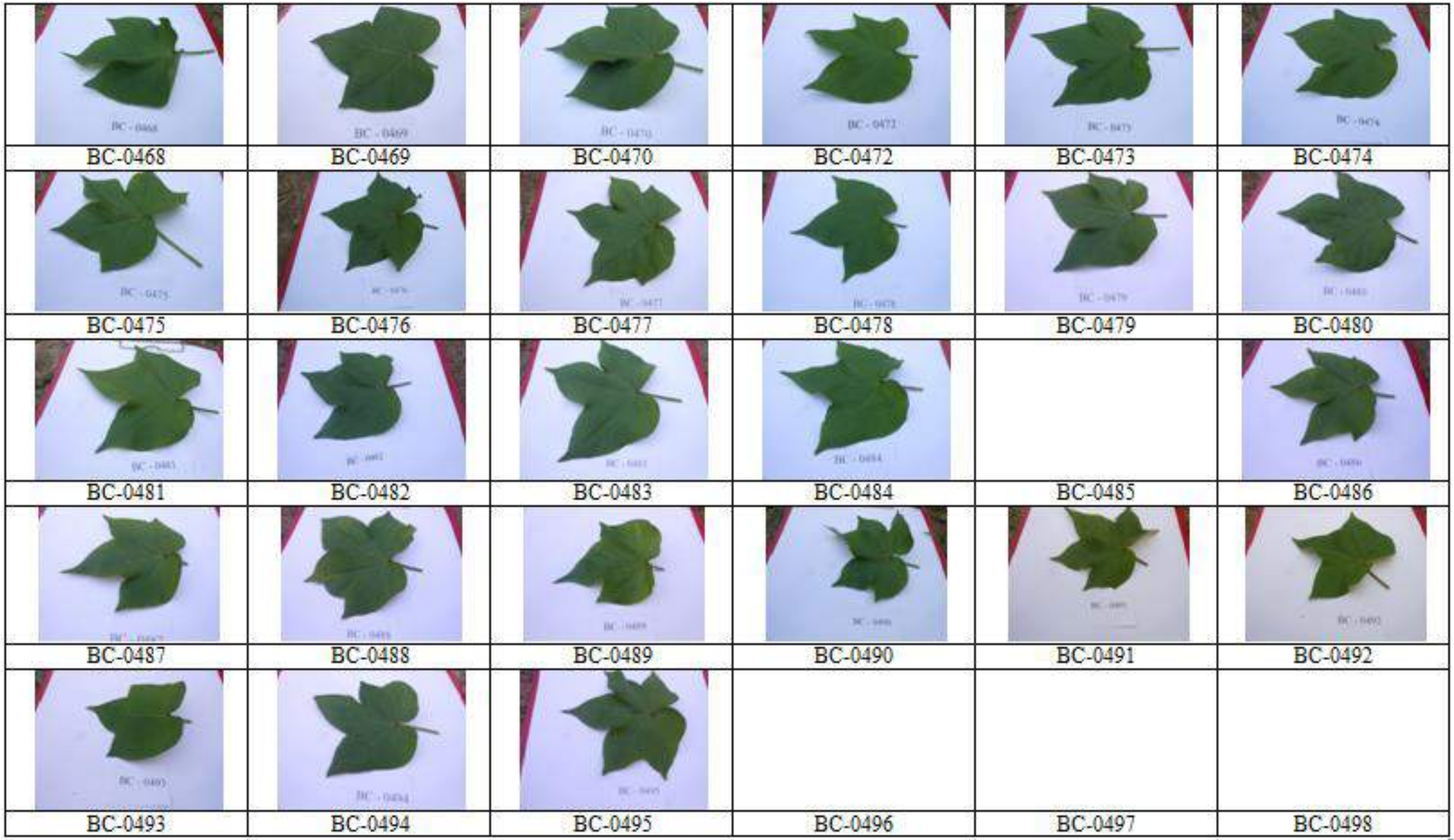


Fig. 115. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020



Cont'd. Fig. 115. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

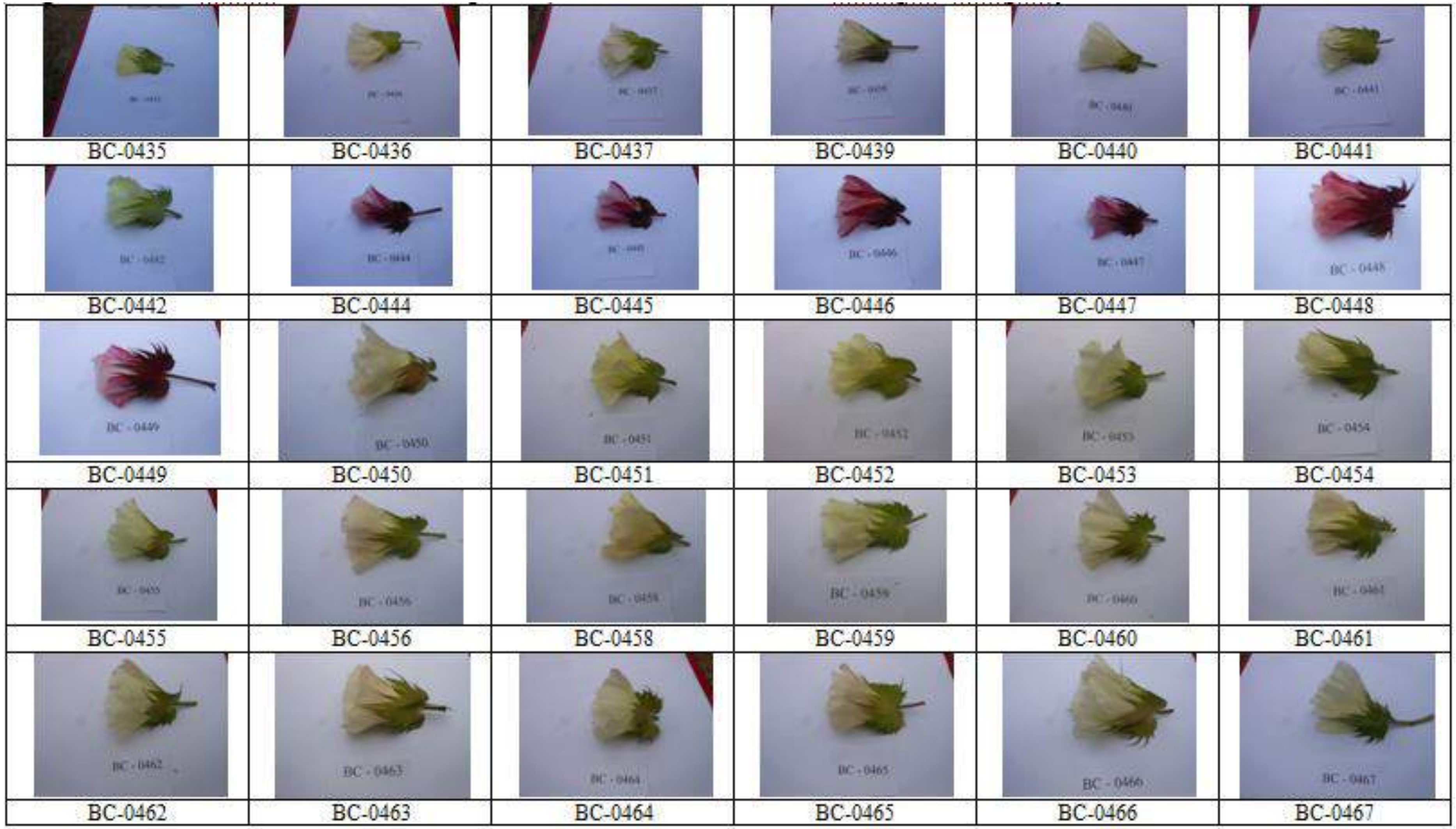
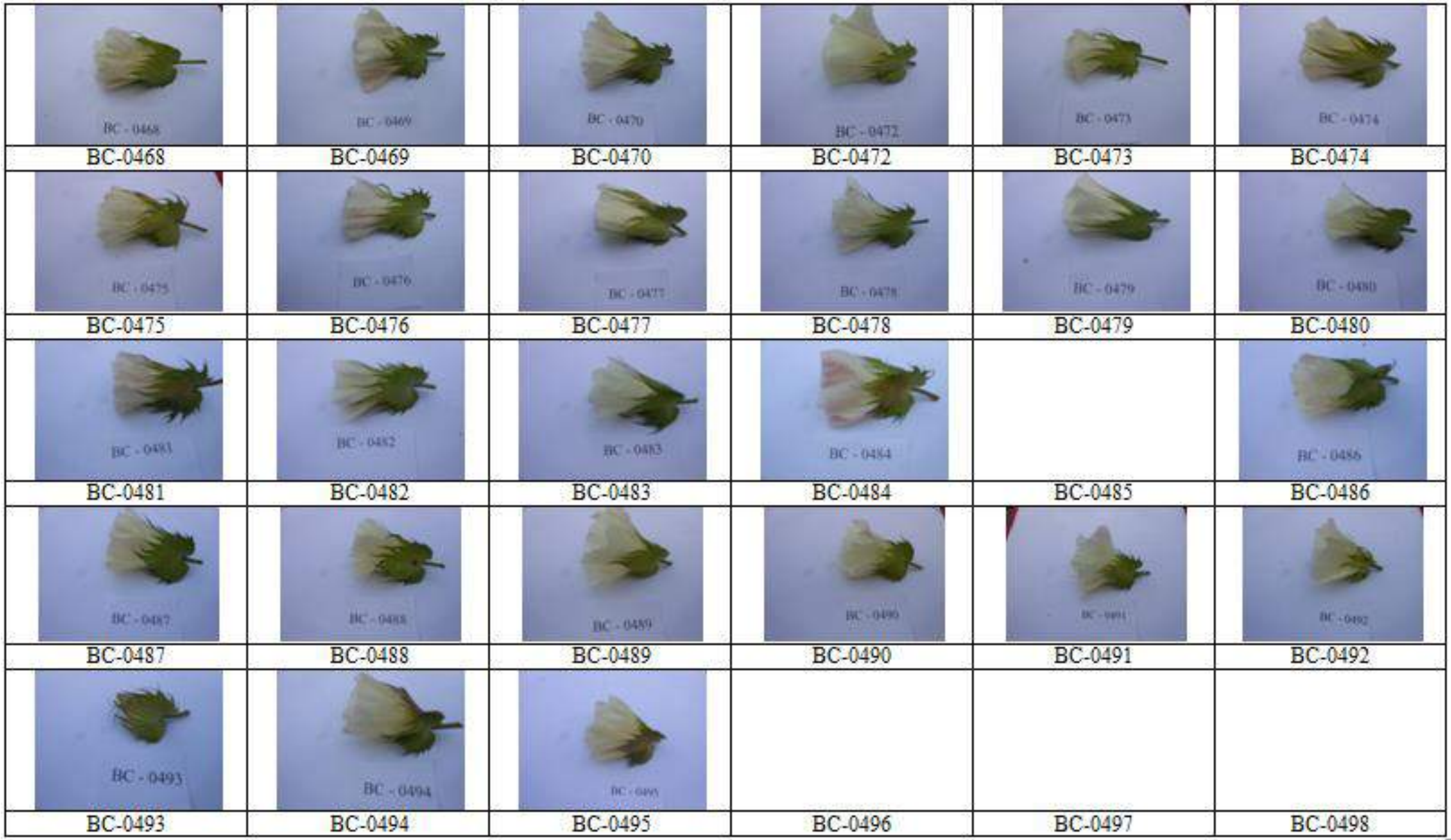


Fig. 116. Petal color cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020



Cont'd. Fig. 116. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

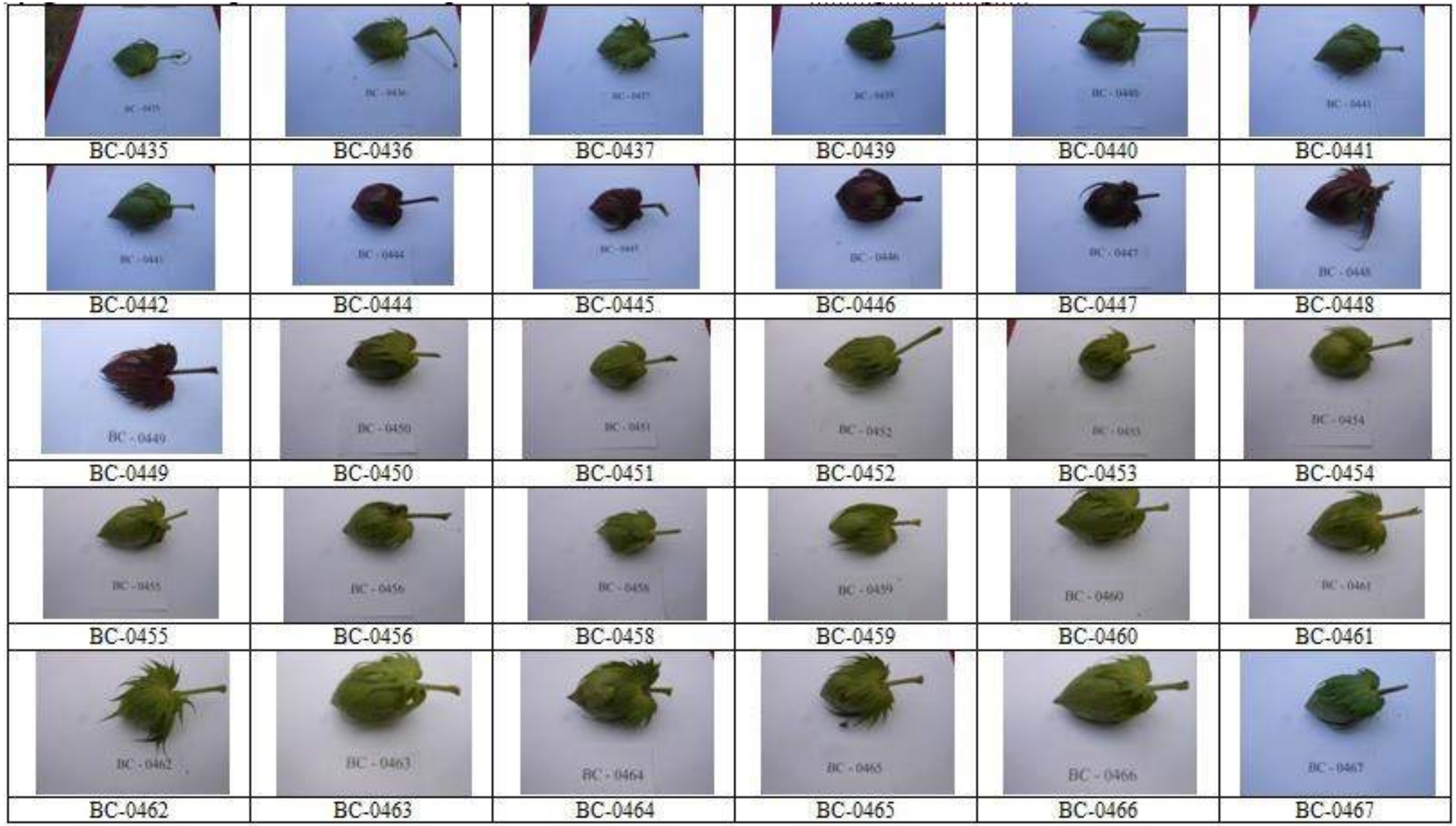
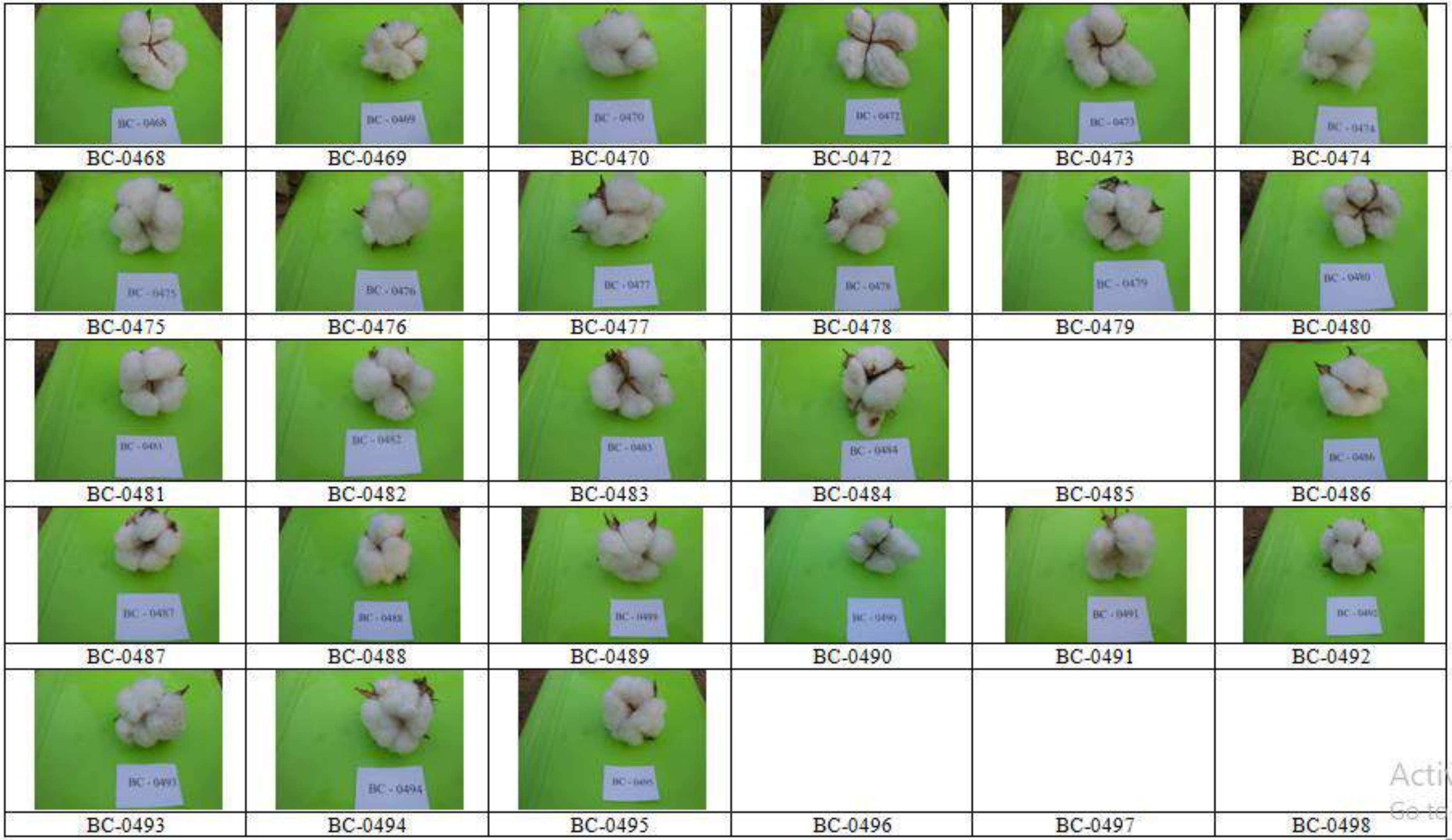


Fig. 117. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2019-2020

					
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. 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



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

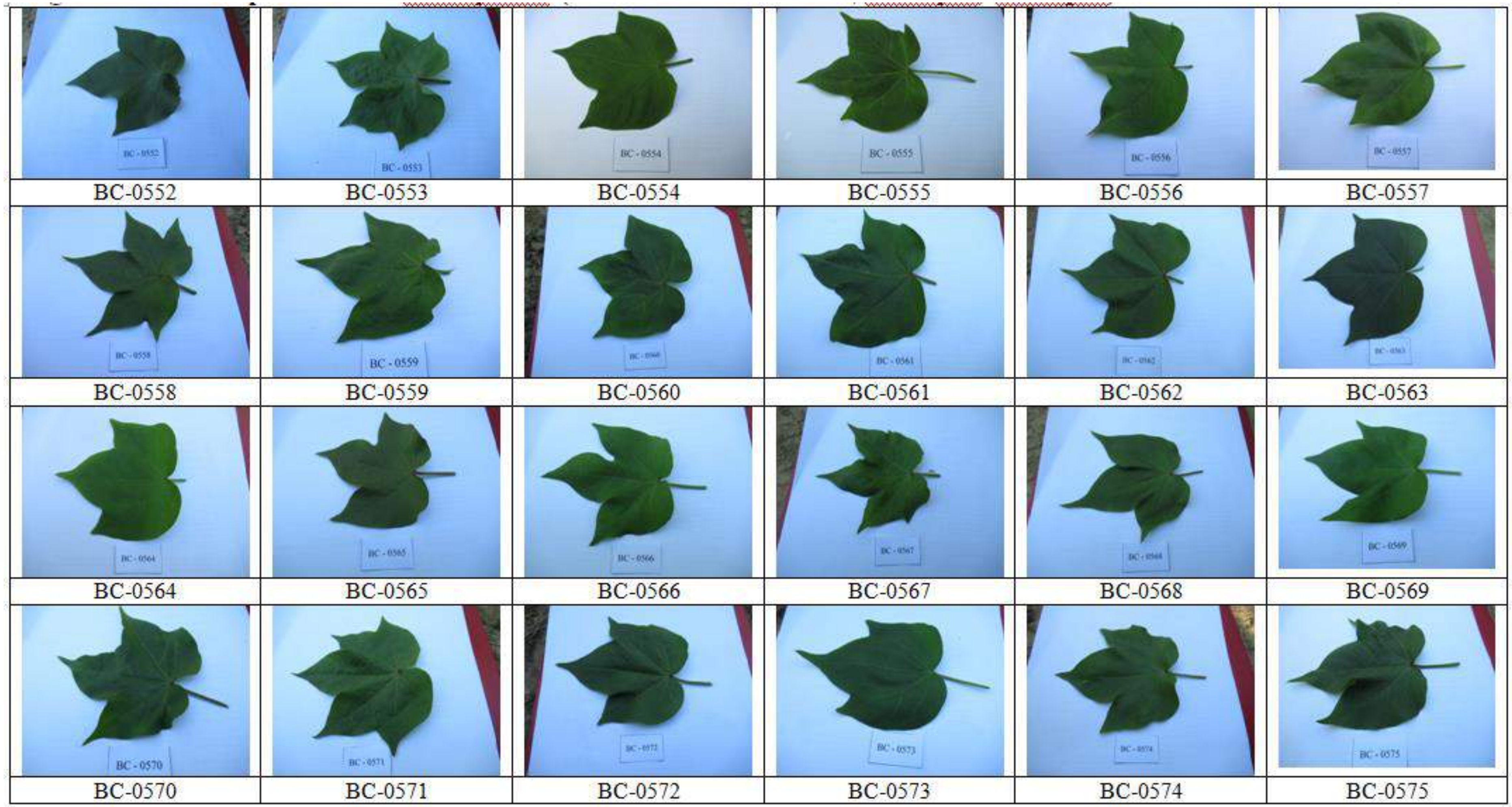


Fig. 119. Leaf shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

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

					
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. 120. Petal color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

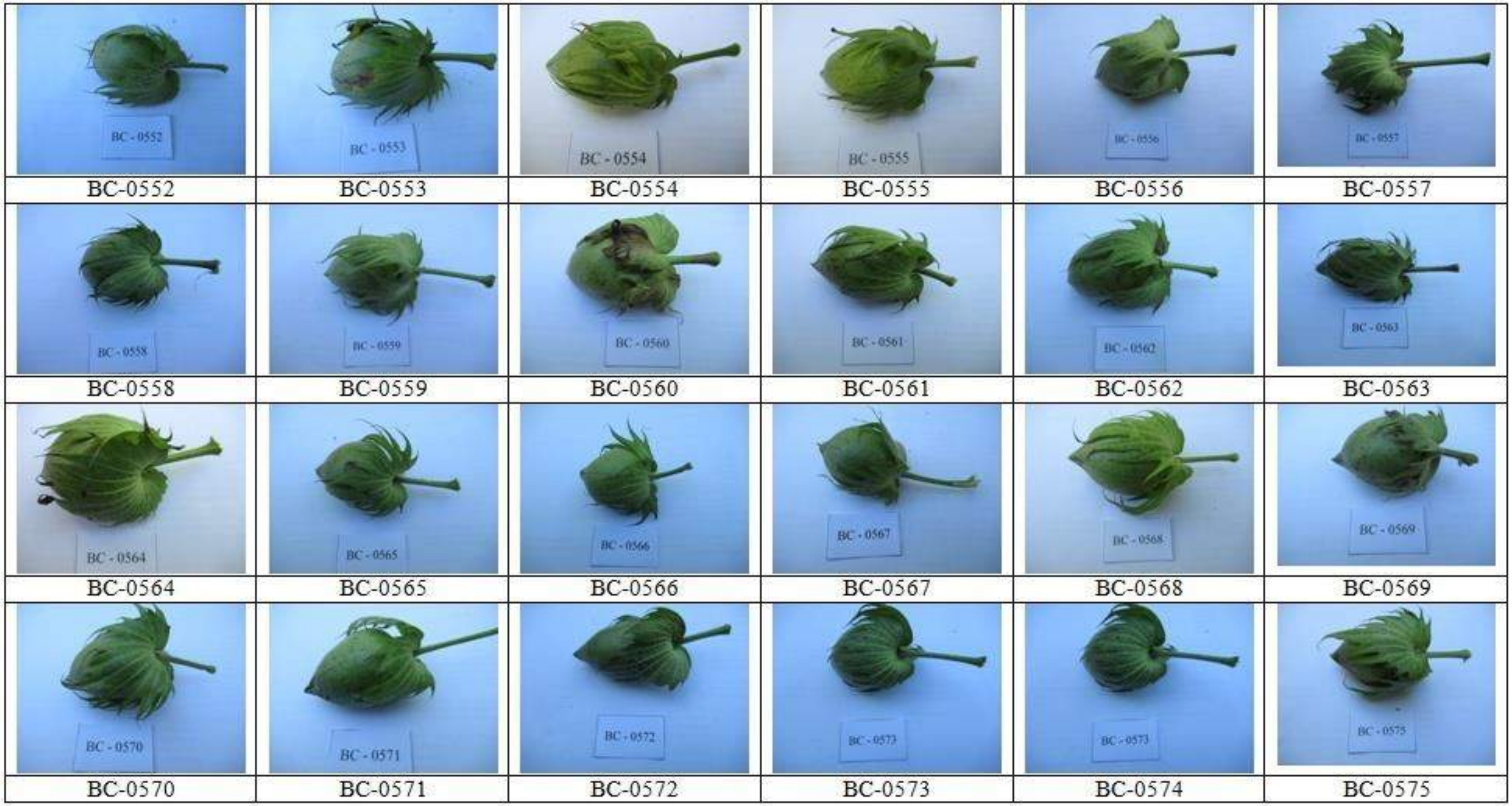


Fig. 121. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

					
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. 121. Boll shape of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

					
BC-0552	BC-0553	BC-0554	BC-0555	BC-0556	BC-0557
					
BC-0558	BC-0559	BC-0560	BC-0561	BC-0562	BC-0563
					
BC-0564	BC-0565	BC-0566	BC-0567	BC-0568	BC-0569
					
BC-0570	BC-0571	BC-0572	BC-0573	BC-0574	BC-0575

Fig. 122. Lint color of cotton genotypes, Cotton Research Center, Sreepur, Gazipur, 2020-2021

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 (Table152). 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 1st 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 (µg/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 1st 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 1st 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 (µg/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 Table154. 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 µg/inch (BC-0489) to 6.16µg/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 1st 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 1st 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 1st 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 1st 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 micronare 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 1st 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
Micronare 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 1st 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 1st 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	Idian 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.	*Moruslaevigata*	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 germplam, 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

SI. 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)

SI. 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)

SI. 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
		Radish	1	1.67	60
18.	Fruit test	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
		Deep sweet	3	5.00	19, 37, 54
19.	Seed color	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

Slightly wrinkles

Smooth

Wrinkled

Fig. 124. Leaf wrinkles of Mulberry plant

Aristae

Cordate

Palmate

Ovate

Narrow ovate

Deltoid

Wide ovate

Fig.125. Leaf shape of Mulberry plant

Acute

Acuminate

Fig. 126. Leaf apex of Mulberry plant

Cordate

Inequlateral

Truncate

Fig. 127. Leaf base of Mulberry plant

Plane | **Shallow lobed** | **Medium lobed** | **Deeply lobed**

Fig. 128. Leaf lobation type of Mulberry plant

Acute triangle | **Round** | **Long triangle**

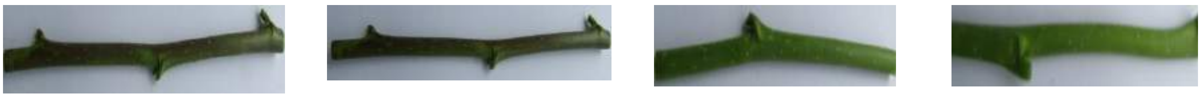
Fig. 129. Bud shape of Mulberry plant

0 Lobed | **Multilobed** | **3-4 lobed** | **1-2 lobed**

Fig. 130. Leaf lobation of Mulberry plant

Dark brown | **Light yellow** | **Light brown** | **Yellowish brown** | **Blackish brown**

Fig. 131. Seed color of Mulberry



Greenish purple | **Purple** | **Green** | **Light Green**

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 m^2 in BSRM-53 and the minimum leaf area was 0.0006 m^2 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

SI. 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 (cm2)	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 bisesexual 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 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-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 germplasam (Cont'd)

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 bisexualinflorenc e/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-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 bisesexualinflorence/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 breath (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 breath (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 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 (*Musa sapientum*)		
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 (*Musa sapientum*)		
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 (*Musa paradisiaca*)		
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 (*Colocasia antiquiram*)					
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 (*Colocasia esculenta*)					
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 (*Colocasia esculenta*)					
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 (*Colocasia esculenta*)					
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 (*Amorpholus*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 (*Alocasia*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 (*Xanthosoma*spp.)					
35.	Xan-1	Mowlavi	Ishwardi	Upland	Acceptable
36.	Xan-2	Mowlavi	Moulvibazar	Upland	Acceptable
37.	Xan-3	Mowlavi	Mymensigh	Upland	Acceptable
	Xan-4	Bombay/Mowlavi	Ishwardi	Upland	Acceptable
38.	Xan-5	Bombay/Mowlavi	Gazipur	Upland	Acceptable
39.	Xan-6	Bombay/Mowlavi	Bandarbon	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^{0}5’ E-92^{0}6’	
2	RHMF002	Mou Alu	Name: Mrs. Hafiza Village: Hatirled Union: Ghatail Upazila: Ghatail District: Tangail	07.07.2017 N-24^{0}28’ E-89^{0}58’	
3	RHMF003	Shore Alu	Name: Mrs. Hafiza Village: Hatirled Union: Ghatail Upazila: Ghatail District:Tangail	07.07.2017 N-24^{0}28’ E-89^{0}58’	

Table 166 (Cont'd)

Sl. no.	Collector's No.	Cultivar/ local name/ cultural practice	Donors name and address	Geographical location and date	Photograph
4	RHMF004	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' 59.2428" 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-$21^0$5' E-$92^0$6'	
13	RMHF013	Koeng Alu	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-$21^0$5' E-$92^0$6'	
14	RMHF014	Gudey Alu	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.2018 N-$21^0$5' E-$92^0$6'	
15	RMHF015	Gati Alu	Sufia Begum Union: Hossanpursadar Upazila: Hossanpur Dist: Kishoregonj	14.12.2017 N-24^0 25' 59.2428" E-90^0 47' 11.6448" (Check)	
16	RHMF016	Pesta Alu (Nandail)	Tara Mia Village: Nandail Union: Nandail Upazila: Nandail Dist: Mymensingh	14.12.2017 N-24^0 44' 36.4128" E-90^0 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^{0}5’ E-92^{0}6’	
23	RMHF023	Gati Alu (Ghatail)	Mrs. Hafiza Village: Garo bazar Union: Ghatail Upazila: Ghatail District:Tangail	09.07.2017 N-21^{0}5’ E-92^{0}6’	
24	RMHF024	Unidentified	lalnunlom Village: bompara Union: Rumasadar Upazila: Ruma District: Bandarban	15.1.2018 N-21^{0}5’ E-92^{0}6’	
25	RMHF025	Unidentified	Lalnunlom Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21^{0}5’ E-92^{0}6’	
26	RMHF026	Unidentified	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21^{0}5’ E-92^{0}6’	
27	RMHF027	Unidentified	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21^{0}5’ E-92^{0}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^{0}5’ E-92^{0}6’	
29	RMHF029	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21^{0}5’ E-92^{0}6’	
30	RMHF030	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21^{0}5’ E-92^{0}6’	
31	RMHF031	Unidentified	Trina Chakma Village: Kapalipara Union: Naniarchar Upazila: Naniarchar District: Rangamati	17.1.18 N-21^{0}5’ E-92^{0}6’	
32	RMHF032	Munshi Alu	Mostafizur Rahman Village: Bompara Union: Ruma sadar Upazila: Ruma District: Bandarban	15.1.18 N-21^{0}5’ E-92^{0}6’	
33	RMHF033	Edo Teng Alu	Mr. A. Khalek Village: Kathaligram Union: Chnadraganj Upazila: Chnadraganj 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^{0}5’ E-92^{0}6’	
35	RMHF035	Unidentified	Lalnunlom Village: Bompara Union: Ruma Sadar Upazila: Ruma District: Bandarban	15.1.2018 N-21^{0}5’ E-92^{0}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
	Emarginte	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

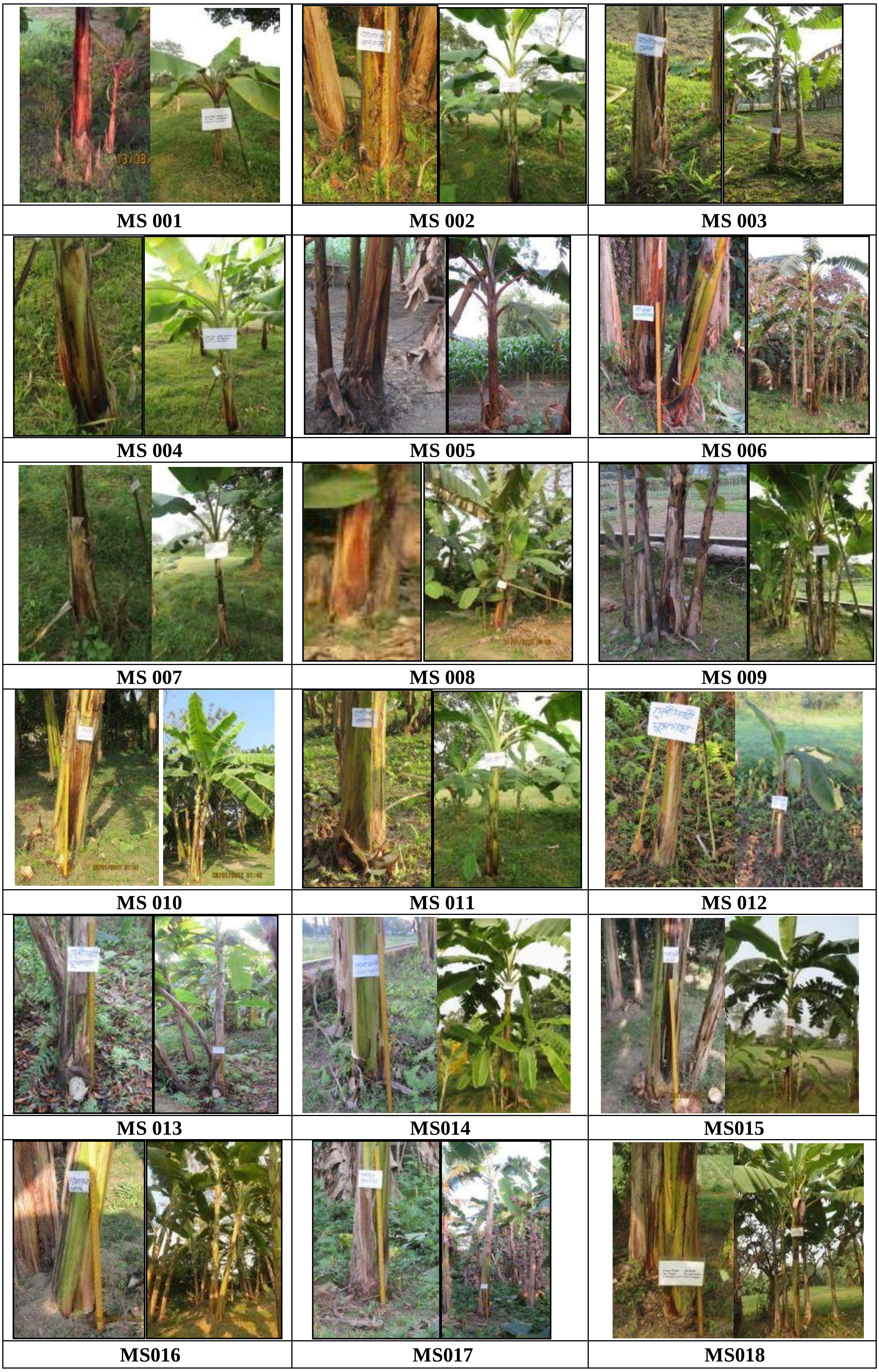


Fig.135. Plant characters of indigenous banana germplasm


MS019

MS 020

MS021

MS022

MS023

MS024

MS025

MS026

MS027

MS028

MS029

MS030

MS031

MS032

MS033

MS034

MS035

MS036

Cont'd. Fig.135. Plant characters of indigenous banana germplasm

		
MS037	**MS038**	**MS039**
		
MS040	**MS041**	**MS042**
		
MS043	**MS044**	**MS045**
		
MS046	**MS047**	**MS048**
		
MS049	**MS056**	**MS057**
		
MS058	**MS059**	**MS060**

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%) (Table168). 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 shows 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 conent 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
Breath 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 relicts 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 relicts 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)	Brea-dth (m)	Length of leaf (Petiole + Blade) (m)	Petiole (m)	Length of leaf blade (m)	Breath 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)	Brea-dth (m)	Length of leaf (Petiole + Blade) (m)	Petiole (m)	Length of leaf blade (m)	Breath 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

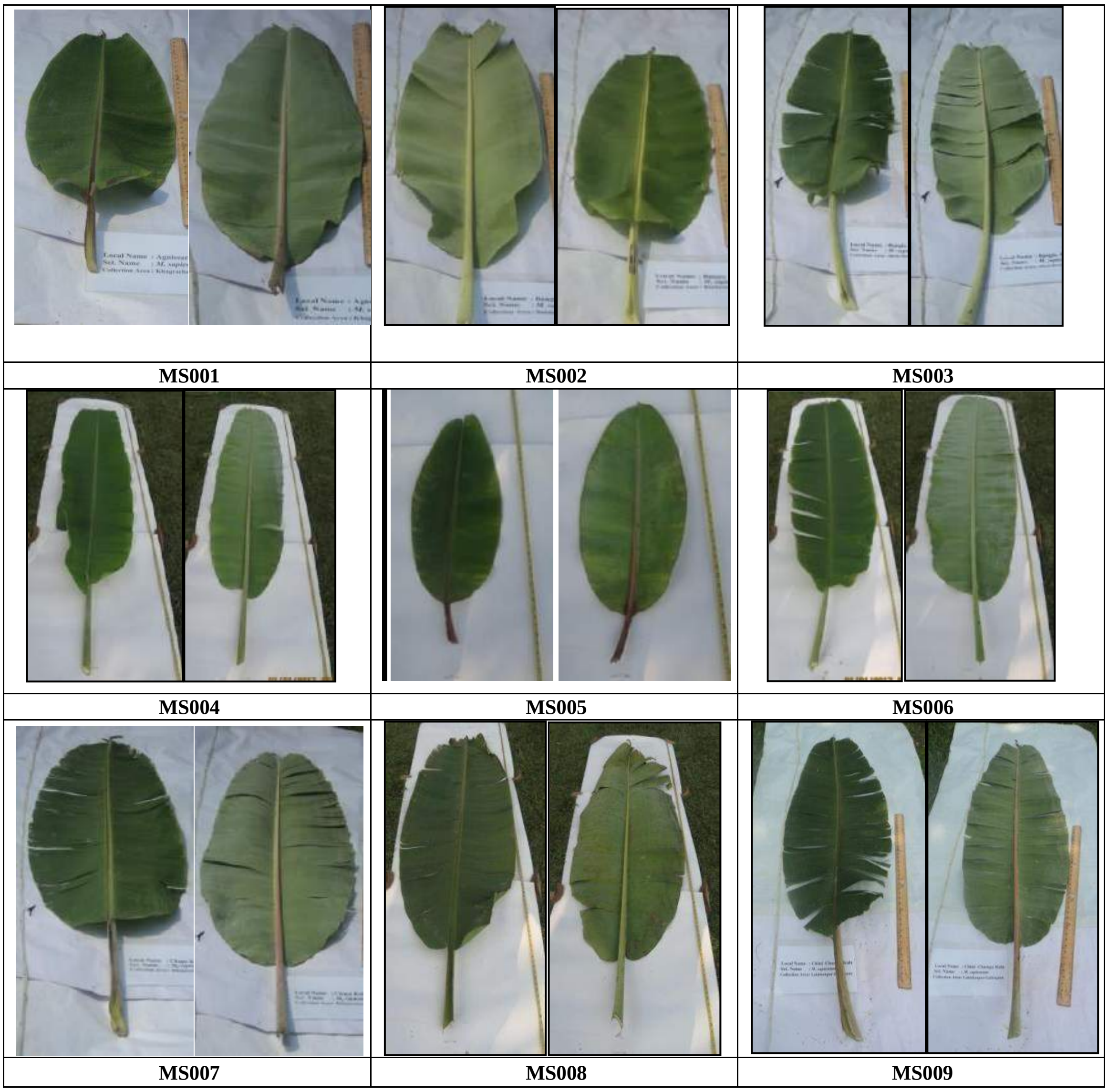
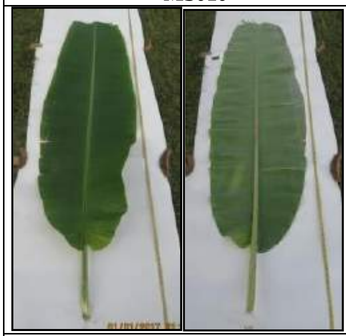


Fig. 136. Leaf character of indigenous banana germplasm

MS010

MS011

MS012



MS013

MS014

MS015

MS 016

MS 017

MS 018

MS 019

MS 020

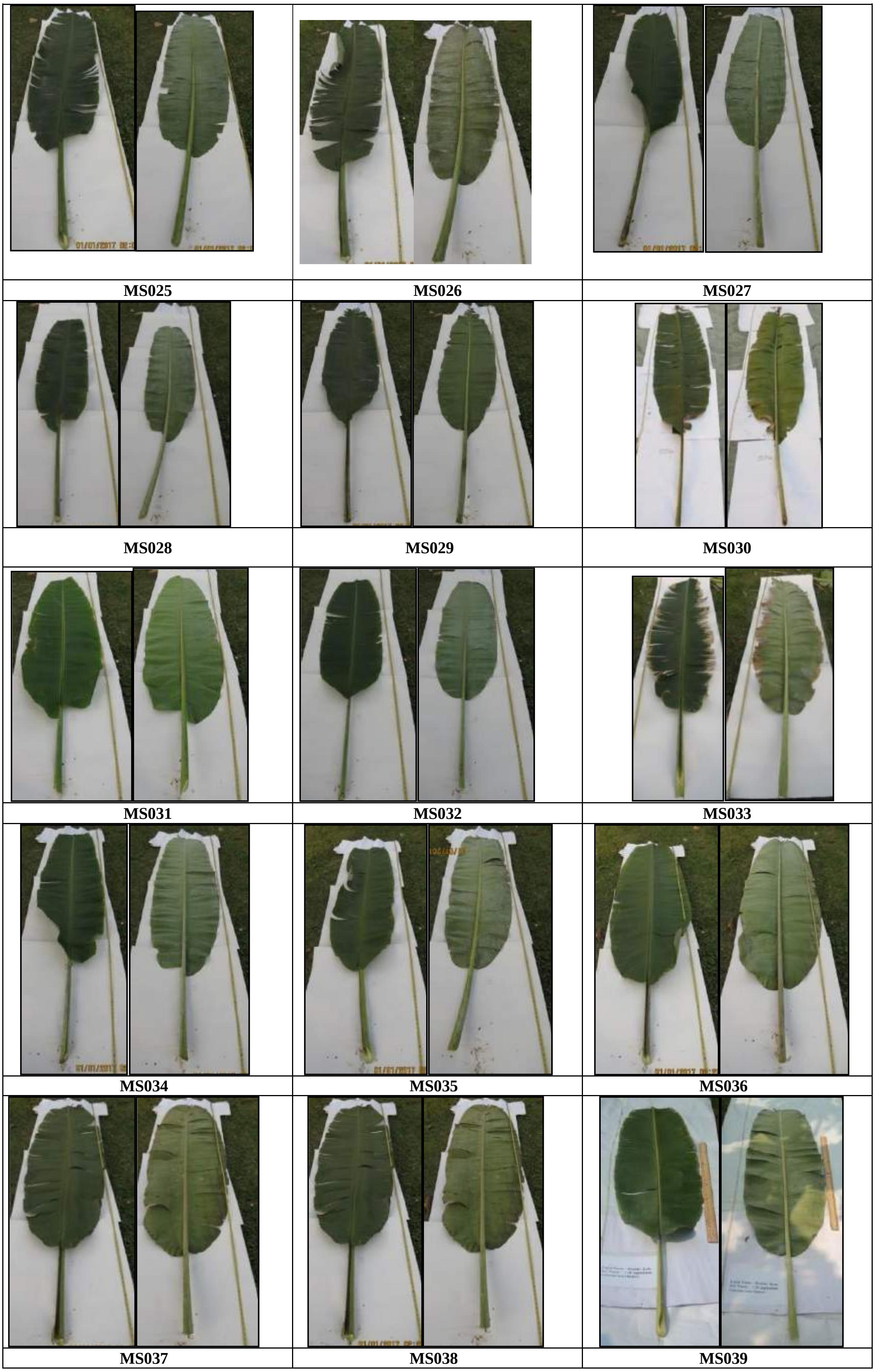
MS 021

MS 022

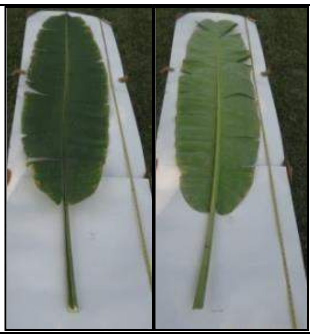
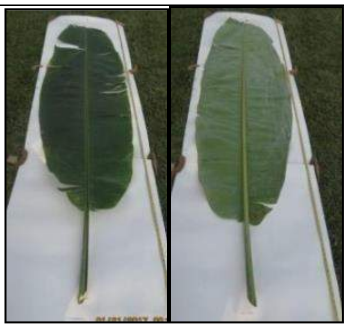
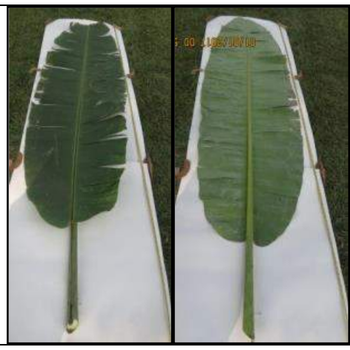
MS 023

MS 024

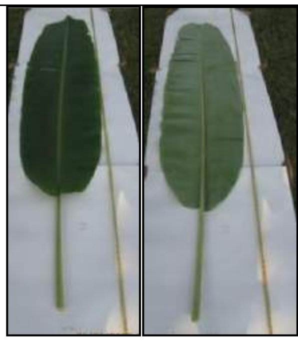
Cont'd. Fig. 136. Leaf character of indigenous banana germplasm



Cont'd. Fig. 136. Leaf character of indigenous banana germplasm

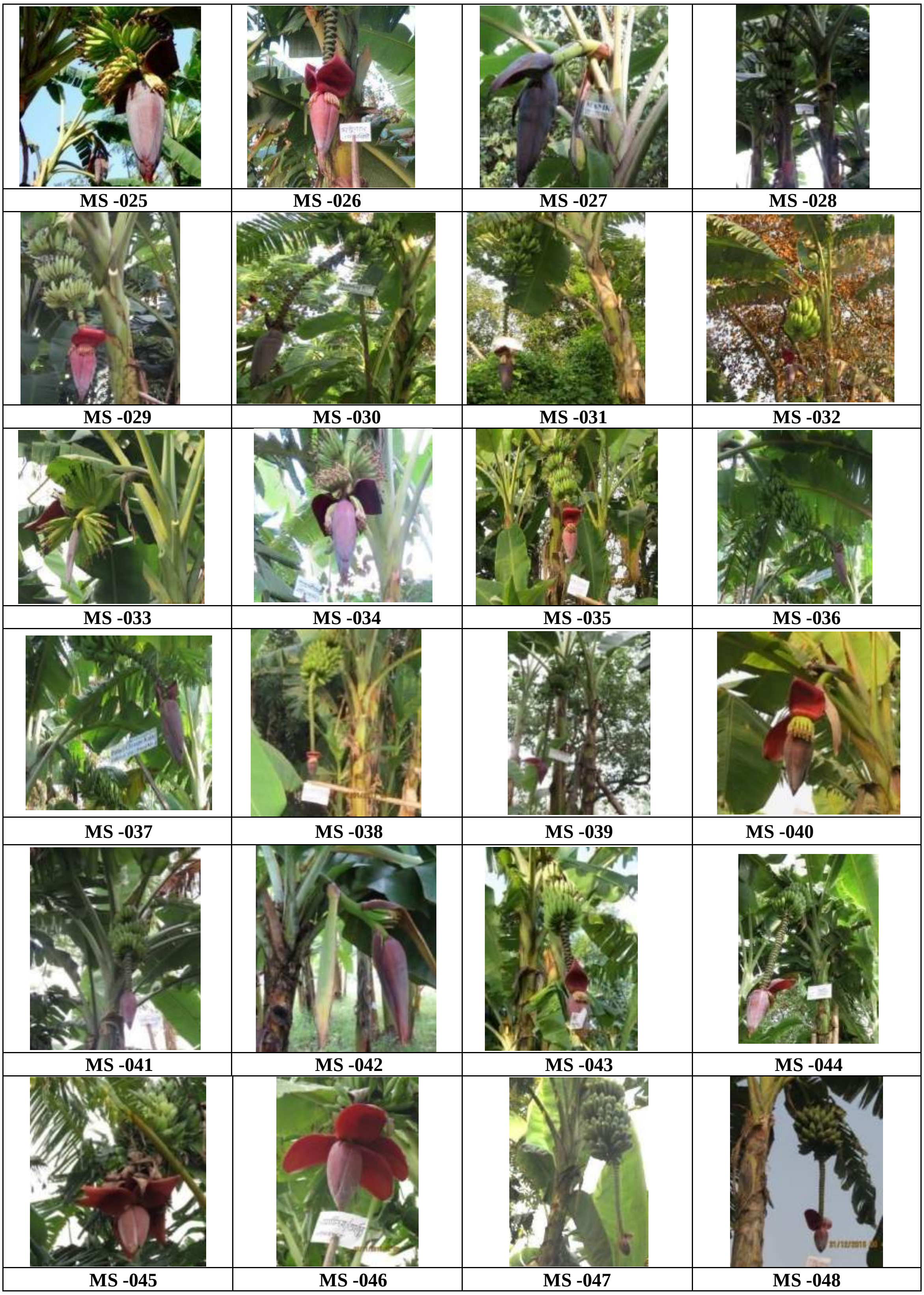
		
MS040	**MS041**	**MS042**
		
MS043	**MS044**	**MS045**
		
MS046	**MS047**	**MS048**
		
MS049	**MS050**	**MS051**
		
MS052	**MS053**	**MS054**

Cont'd. Fig. 136. Leaf character of indigenous banana germplasm

		
MS055	**MS -056**	**MS -057**
		
MS -058	**MS-059**	**MS -060**

Cont'd. Fig. 136. Leaf character of indigenous banana germplasm

Fig. 137. Male bud characters of indigenous banana germplasm



MS -025 | MS -026 | MS -027 | MS -028
MS -029 | MS -030 | MS -031 | MS -032
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

Cont'd. Fig. 137. Male bud characters of indigenous banana germplasm

			
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. 137. Male bud characters of indigenous banana germplasm

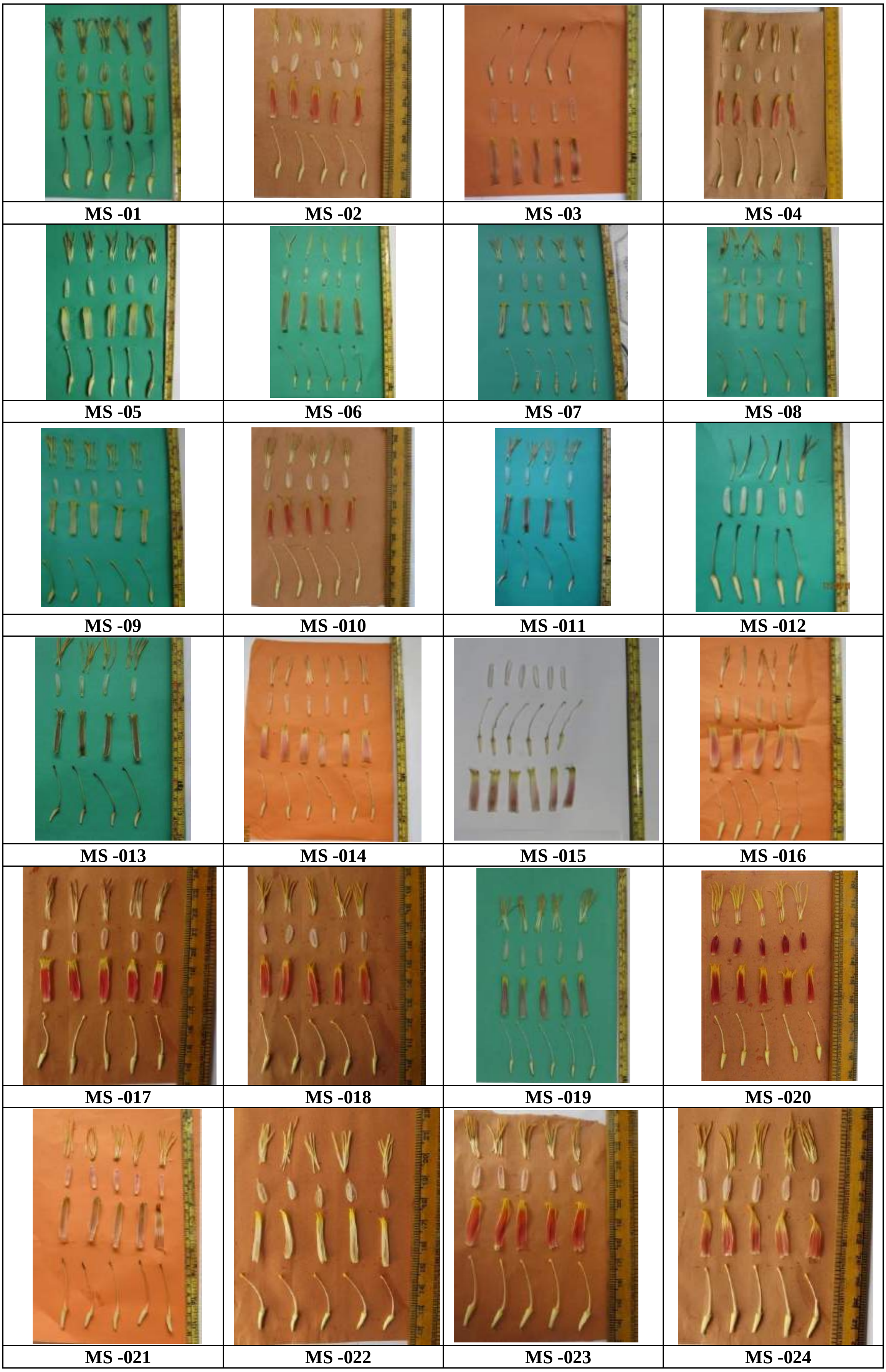
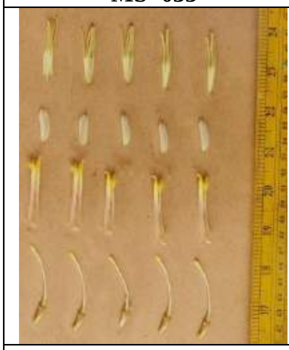
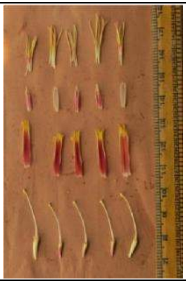


Fig. 138. Style shape of indigenous banana germplasm

			
MS -025	**MS -026**	**MS -027**	**MS -028**
			
MS -029	**MS -030**	**MS -031**	**MS -032**
			
MS -033	**MS -034**	**MS -035**	**MS -036**
			
MS -037	**MS -038**	**MS -039**	**MS -040**
			
MS -041	**MS -042**	**MS -043**	**MS -044**

Cont'd. Fig. 138. Style shape of indigenous banana germplasm

			
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	MS058	MS059	MS -060

Cont'd. Fig. 138. Style shape of indigenous banana germplasm

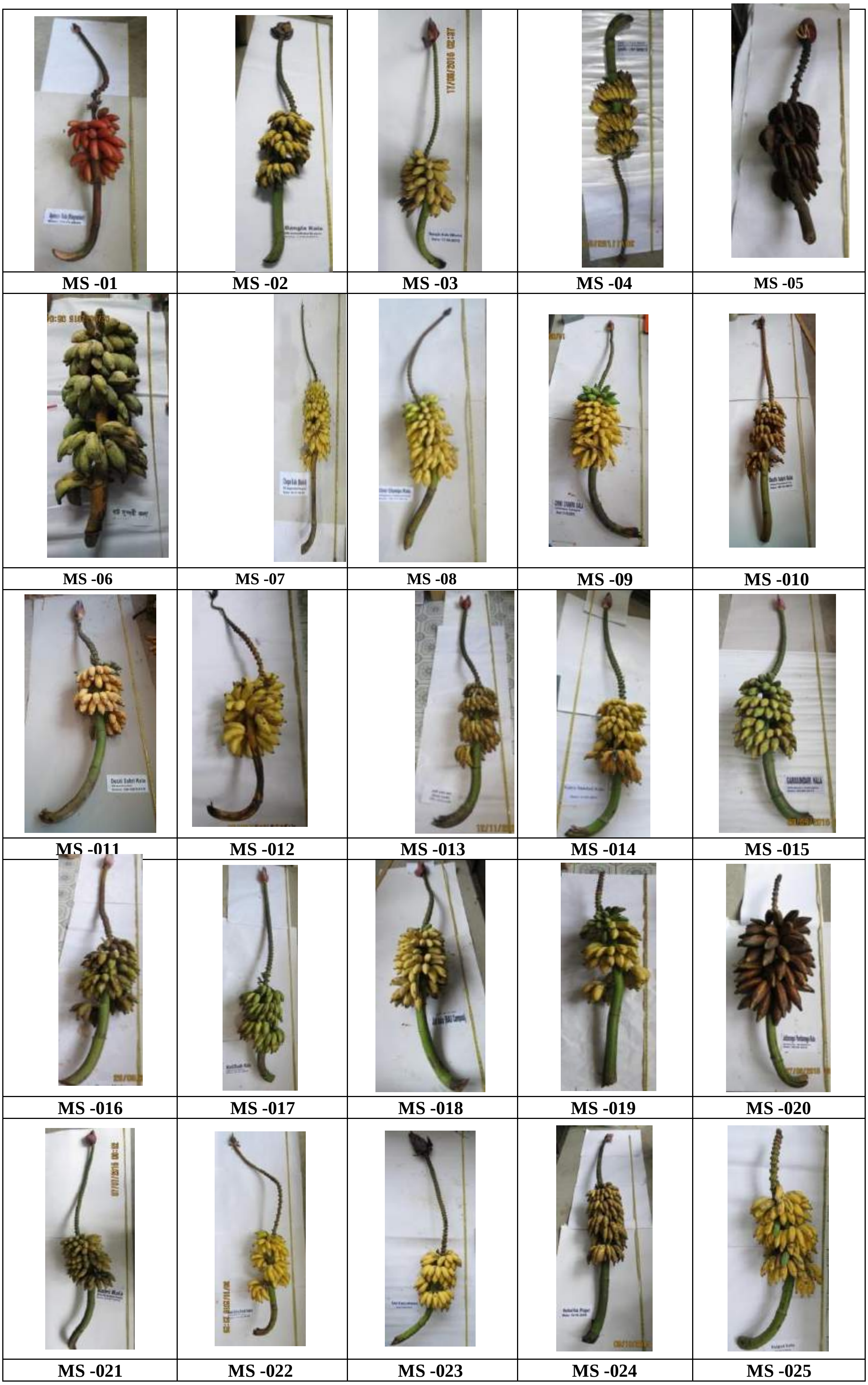
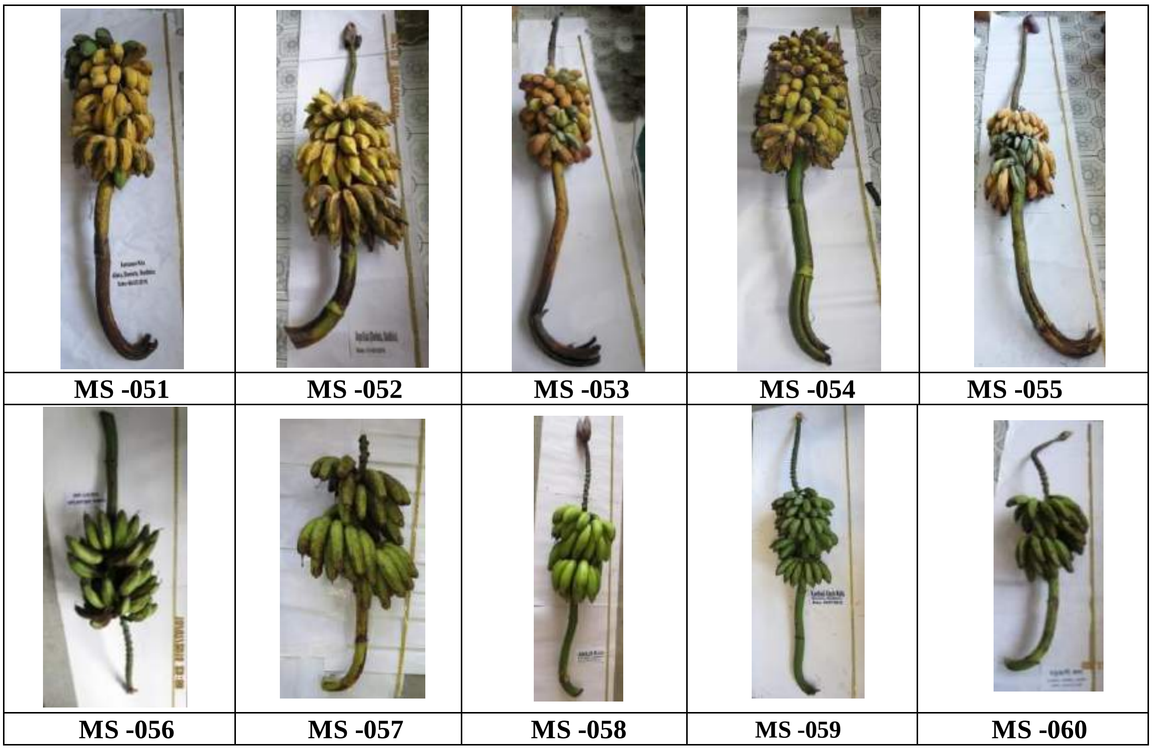


Fig. 139. Bunch characters of indigenous banana germplasm

Cont'd. Fig. 139. Bunch characters of indigenous banana germplasm



Cont'd.Fig. 139. Showing bunch characters of indigenous banana germplasm

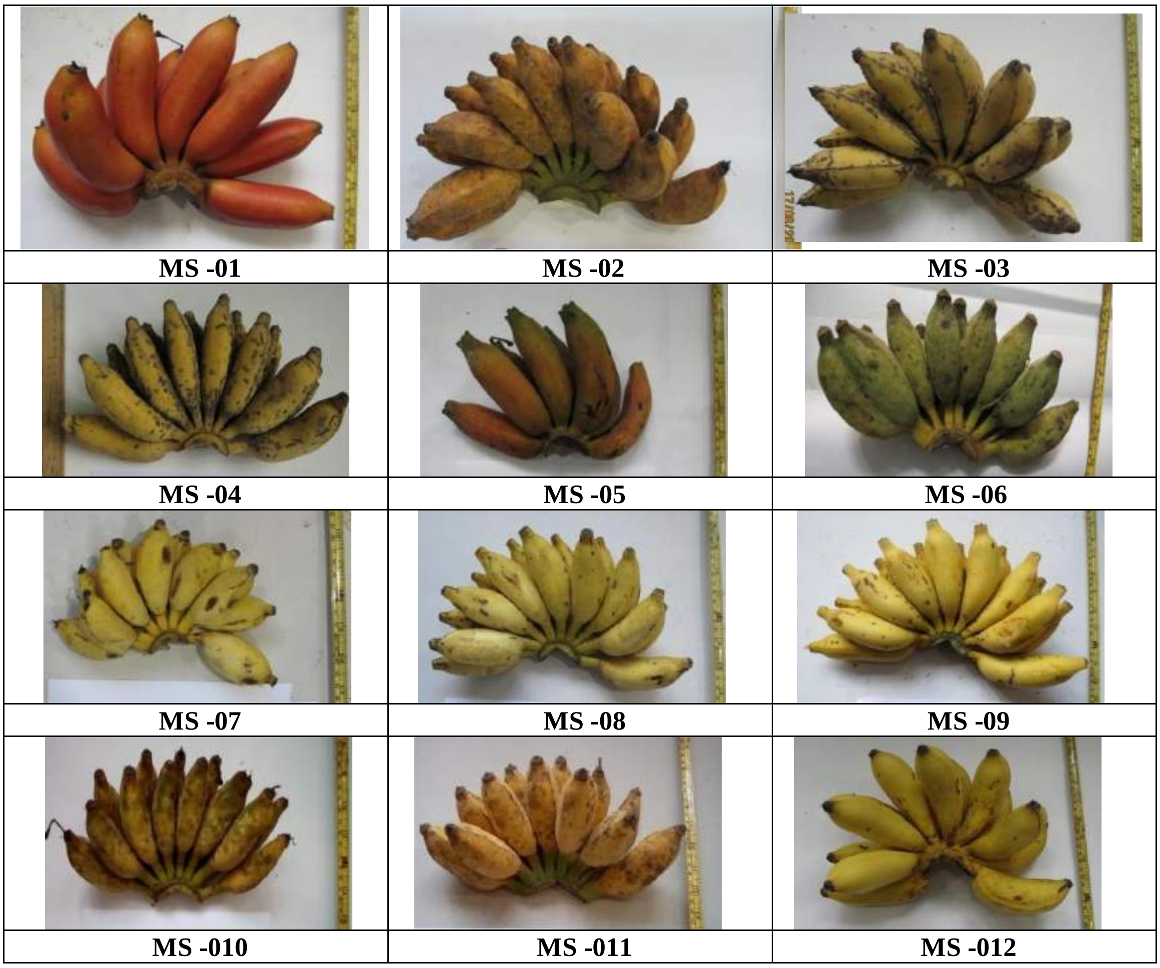


Fig. 140. Hand characters of indigenous banana germplasm

		
MS -013	**MS -014**	**MS -015**
		
MS -016	**MS -017**	**MS -018**
		
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**	**MS -033**
		
MS -034	**MS -035**	**MS -036**

Cont'd. Fig. 140. Hand characters of indigenous banana germplasm

		
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. 140. Hand characters of indigenous banana germplasm

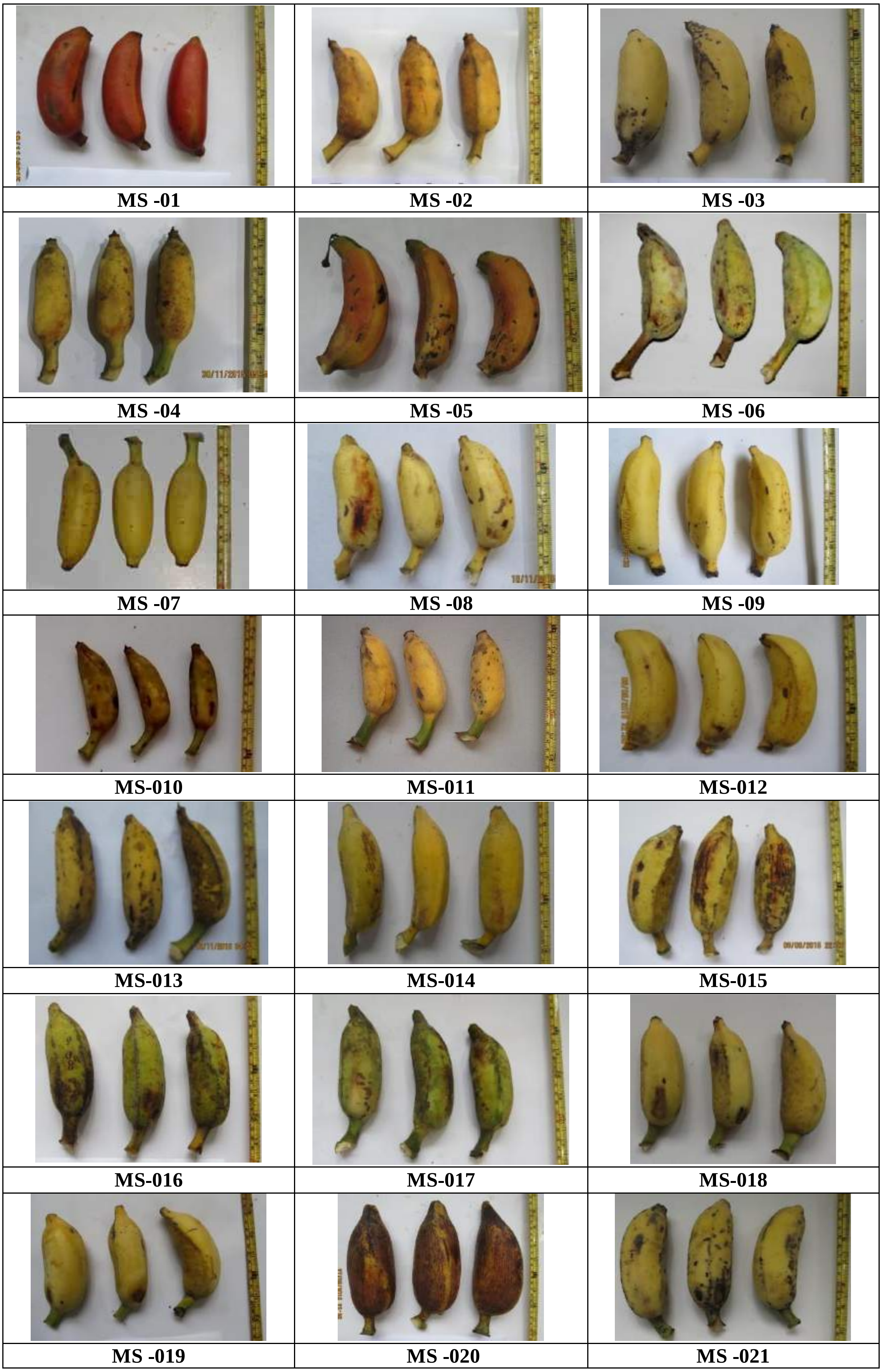


Fig. 141. Finger characteristics indigenous banana germplasm

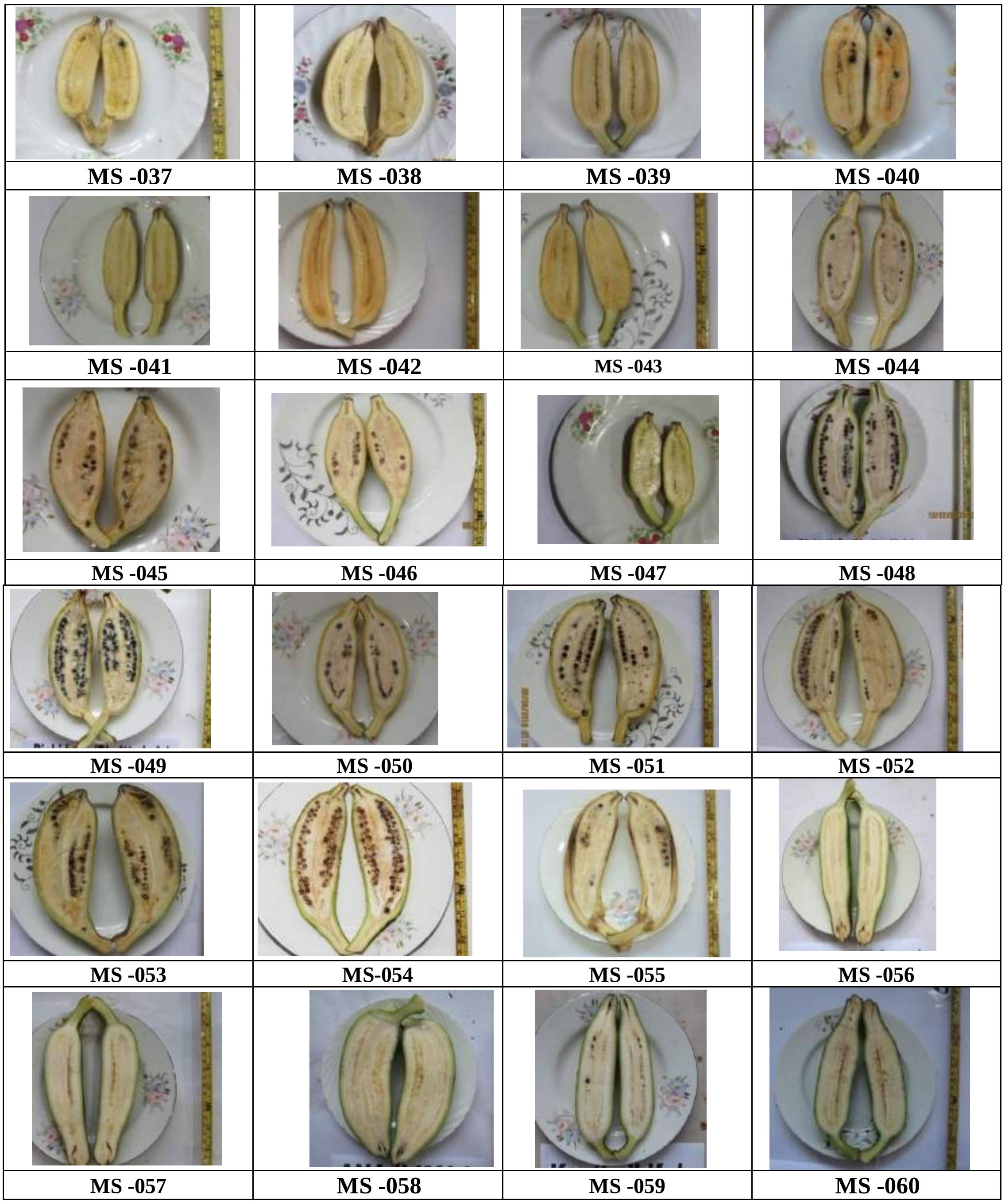
		
MS -022	**MS -023**	**MS -024**
		
MS -025	**MS -026**	**MS -027**
		
MS -028	**MS -029**	**MS -030**
		
MS -031	**MS -032**	**MS -033**
		
MS -034	**MS -035**	**MS -036**
		
MS -037	**MS -038**	**MS -039**
		
MS -040	**MS -041**	**MS -042**
		
MS -043	**MS -044**	**MS -045**

Cont'd. Fig. 141. Finger characteristics indigenous banana germplasm

		
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. 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

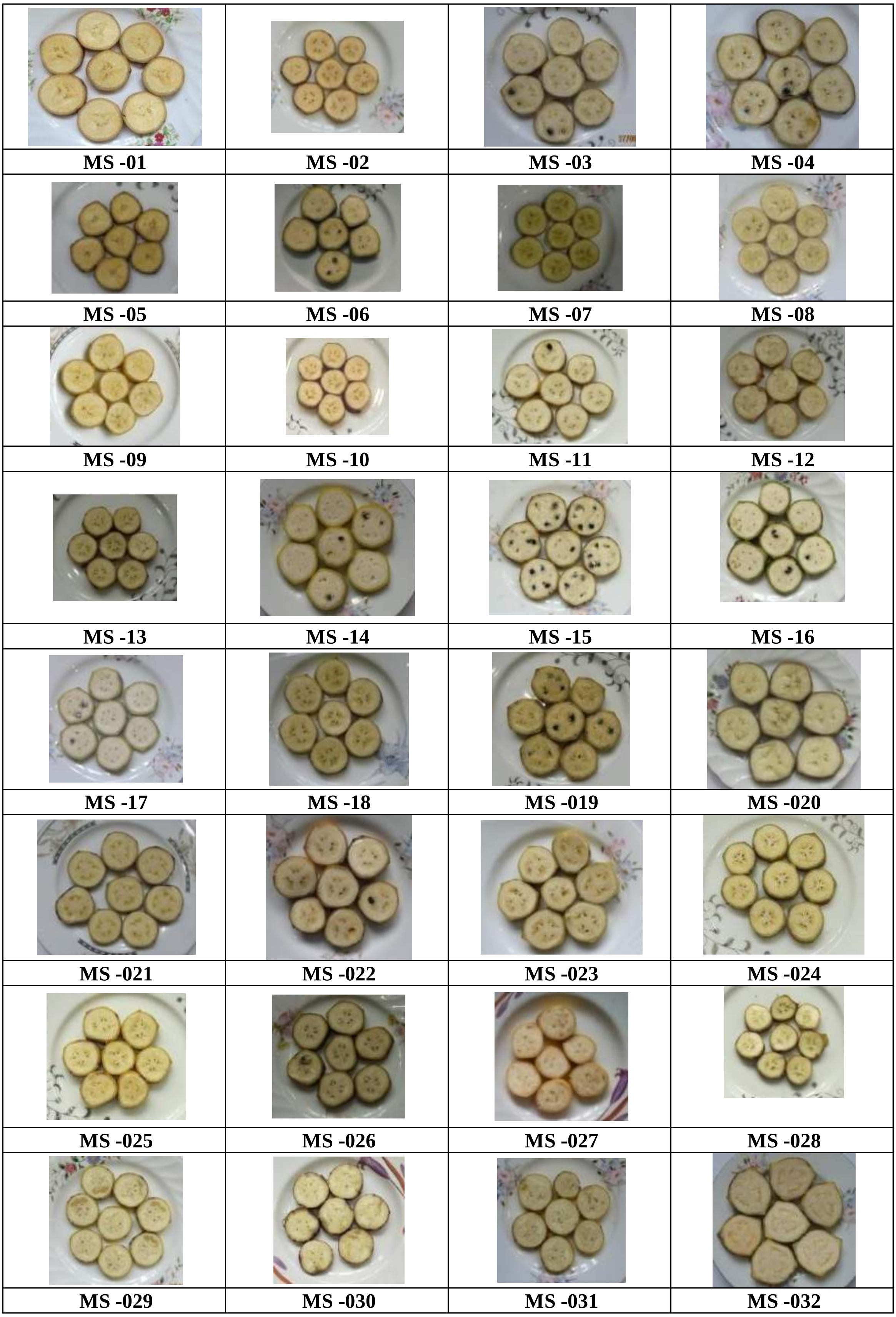
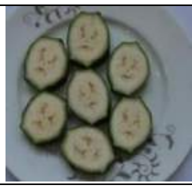


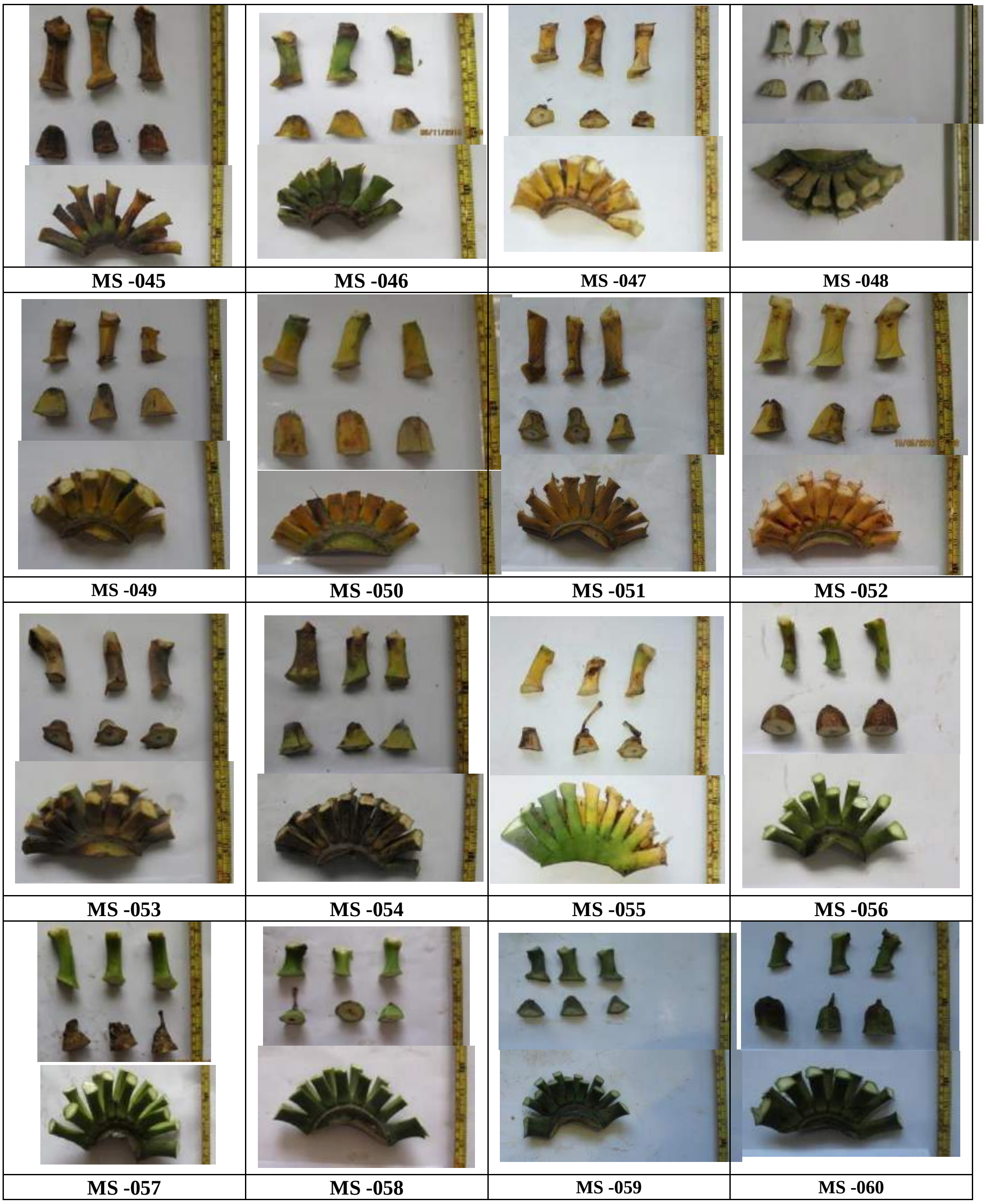
Fig. 143. Transverse section of fruits of indigenous banana

			
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 and 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 germplsm 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-efficinent 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.

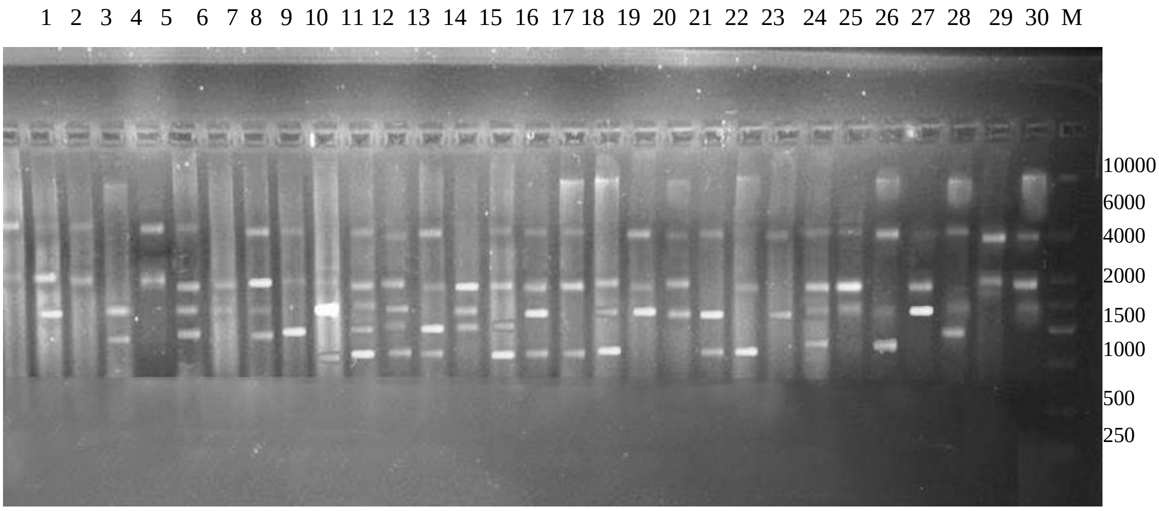


Fig. 145. RAPD profile of 30 banana germplasm using primer OPA-03

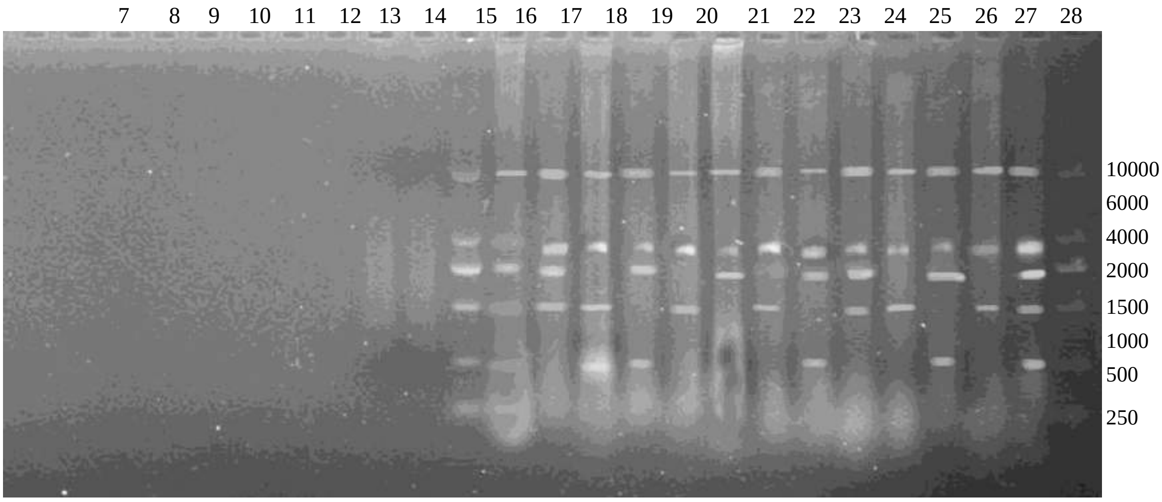


Fig. 146. RAPD profile of 30 banana germplasm using primer OPA-14

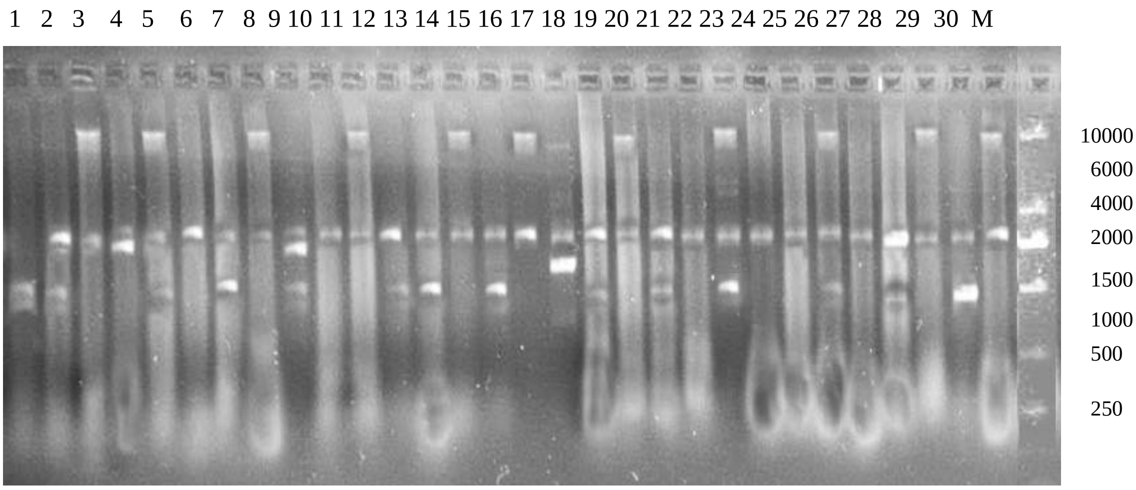


Fig. 147. RAPD profile of 30 banana germplasm using primer OPA-19

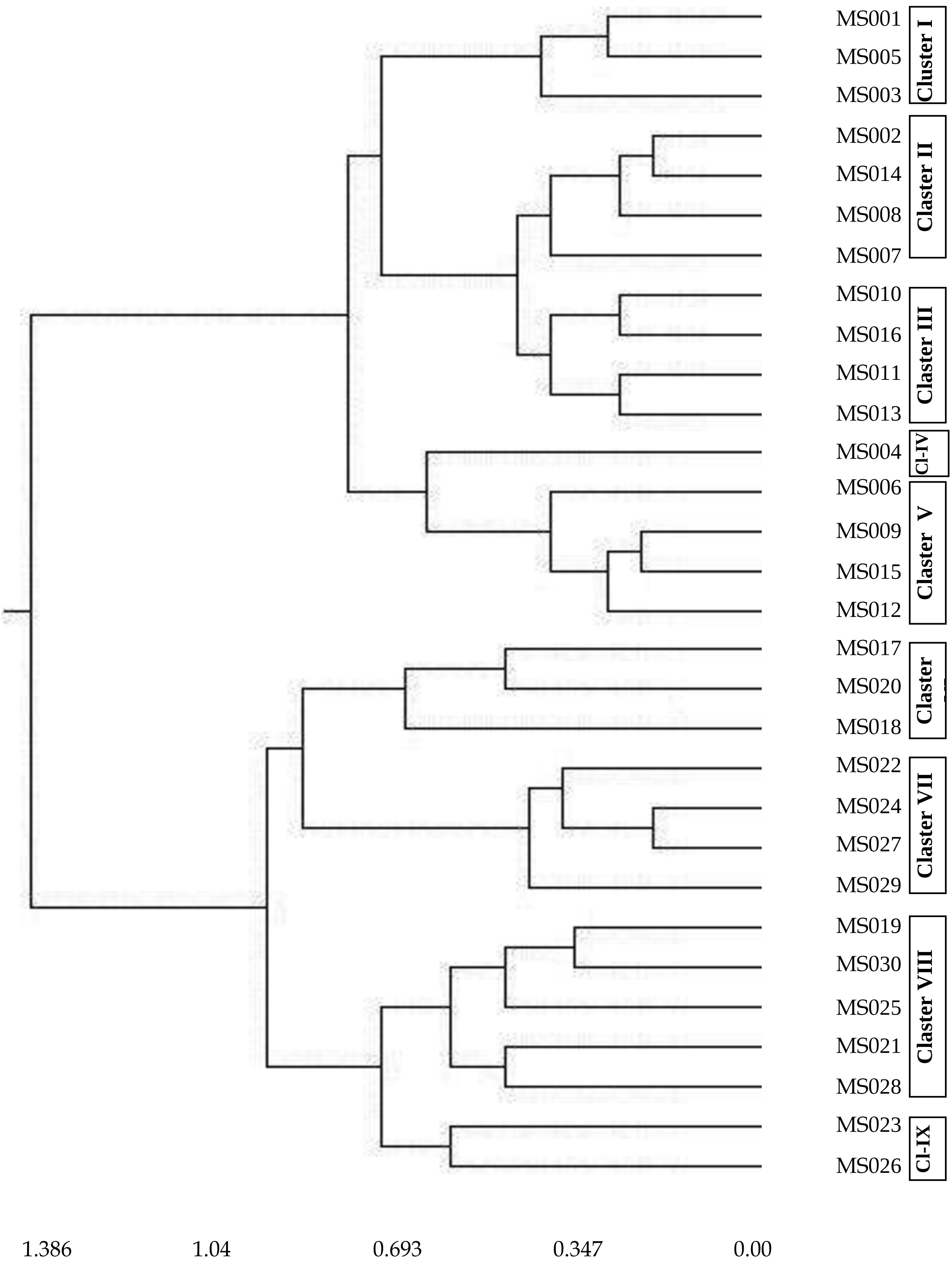


Fig. 148. Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

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 groupd 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 Sequnce	Reverse Sequence	Annealing temperature (^{0}C)
mMaCIR13	TCCCAACCCCTGCAA CCACT	ATGACCTGT CG AACATCCTTT	53
mMaCIR307	CACTCTCGCACCATTACGG	CACAAGAATTTGACCCCACC	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).

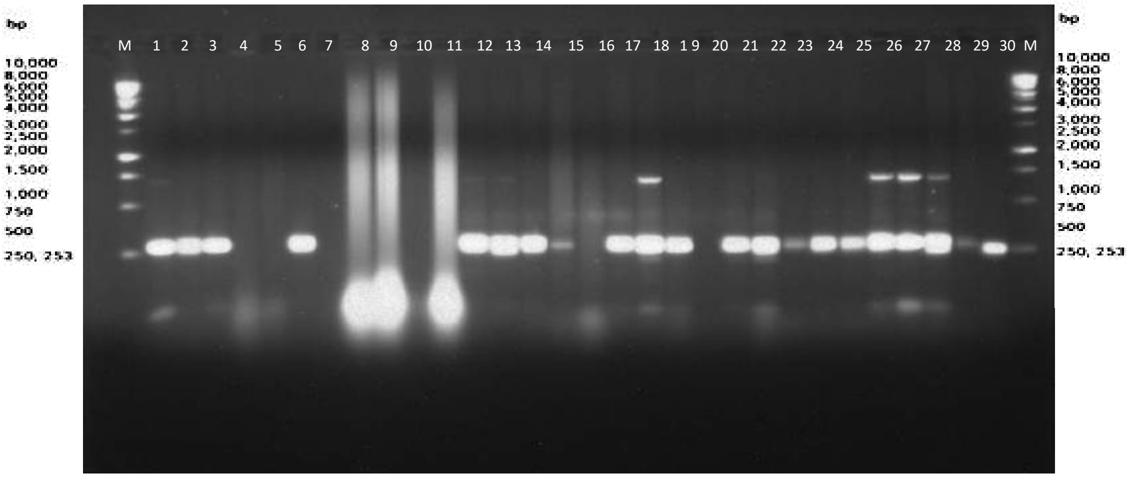


Fig.149. Microsatellite profiles of 30 banana accession with primer mMaCIR13

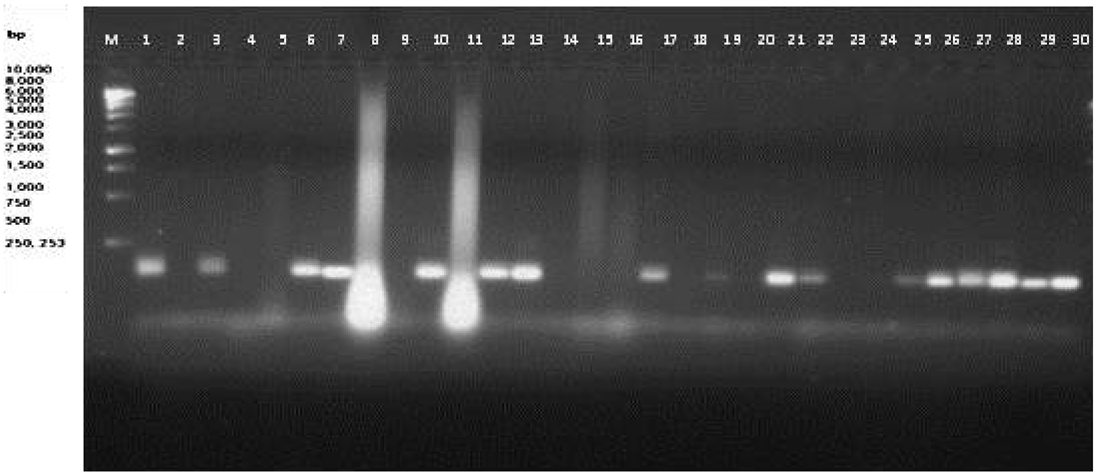


Fig.150. Microsatellite profiles of 30 banana germplasm with primer mMaCIR307

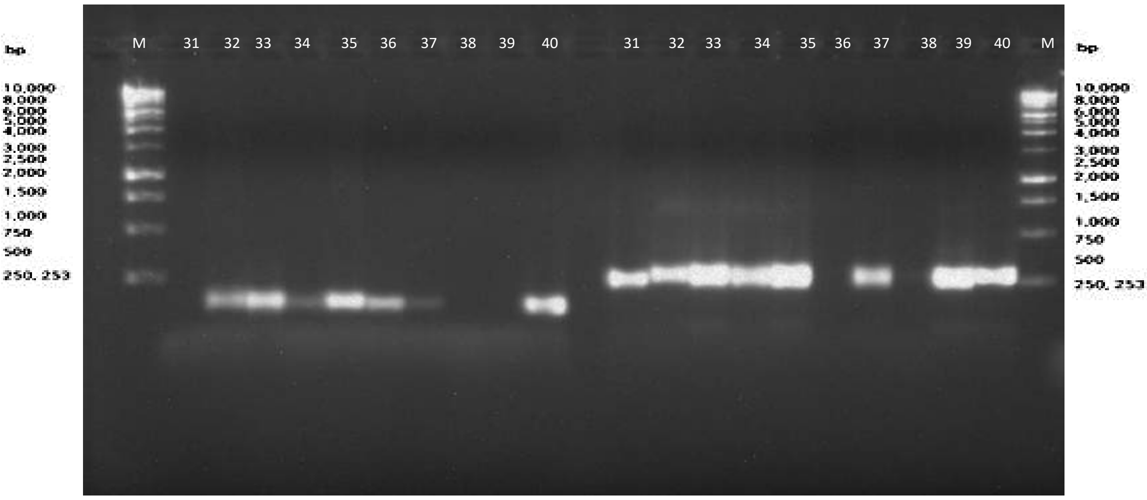


Fig.151. Microsatellite profiles of 10 banana germplasm with primer mMaCIR307 (Left side) and mMaCIR13 (Right side)

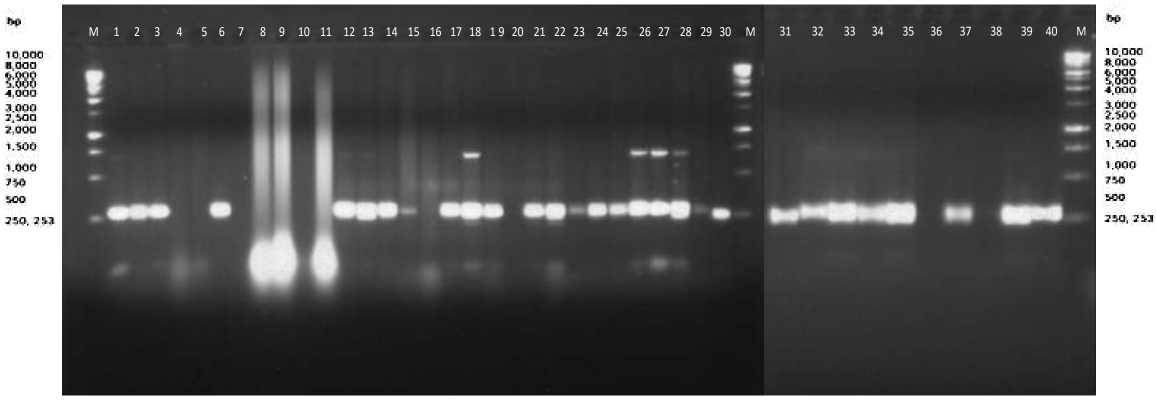


Fig.152. Microsatellite profiles of 40 banana germplasm with primer mMaCIR13

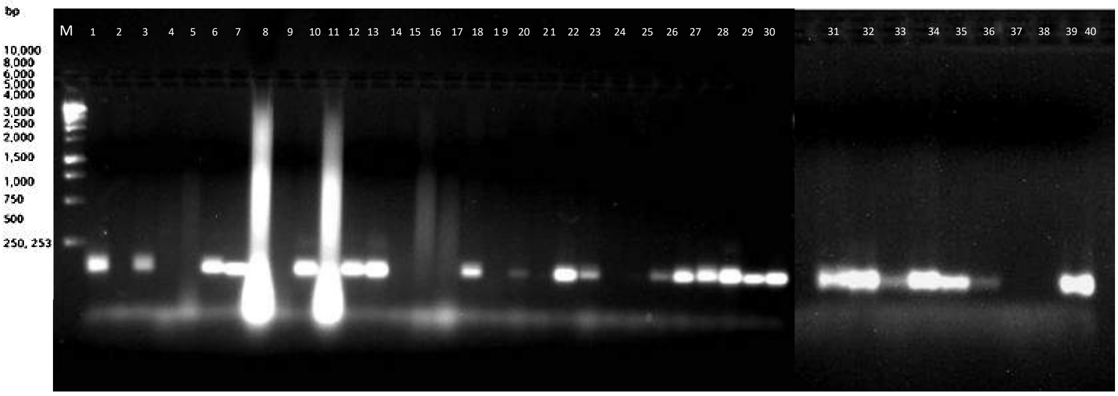


Fig.153. Microsatellite profiles of 40 banana germplasm with primer mMaCIR307

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

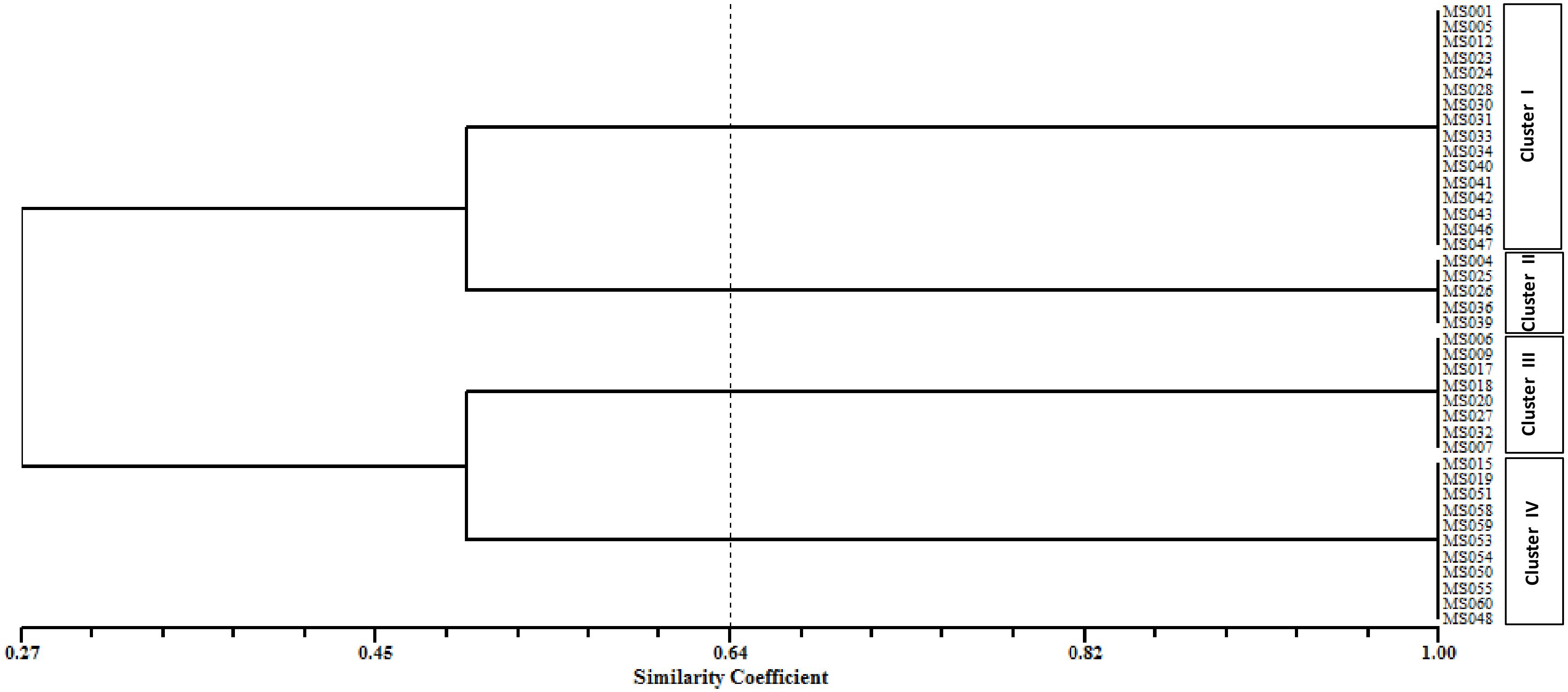


Fig. 154. Combined dendrogram constructed by unweighted pair group method of arithmetic mean (UPGMA) using mMaCIR13 and mMaCIR307 markers

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 acridity. 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. Palatibility (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 acridity. The colour of the leaves varied from whitish yellow to very dark purple, depending on the genotype. Leaf petioles and leaf laminas 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 (*Colocasia*)					
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 (*Colocasia*)					
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 (*Colocasia*)					
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
Rhyzome length (cm)	19.55	28.67	23.37	3.62	15.48
Rhyzome 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 (*Colocasia*)					
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 (*Alocasia*)					
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 (*Amorphophallus*)					
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 (*Xanthosoma*)					
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).

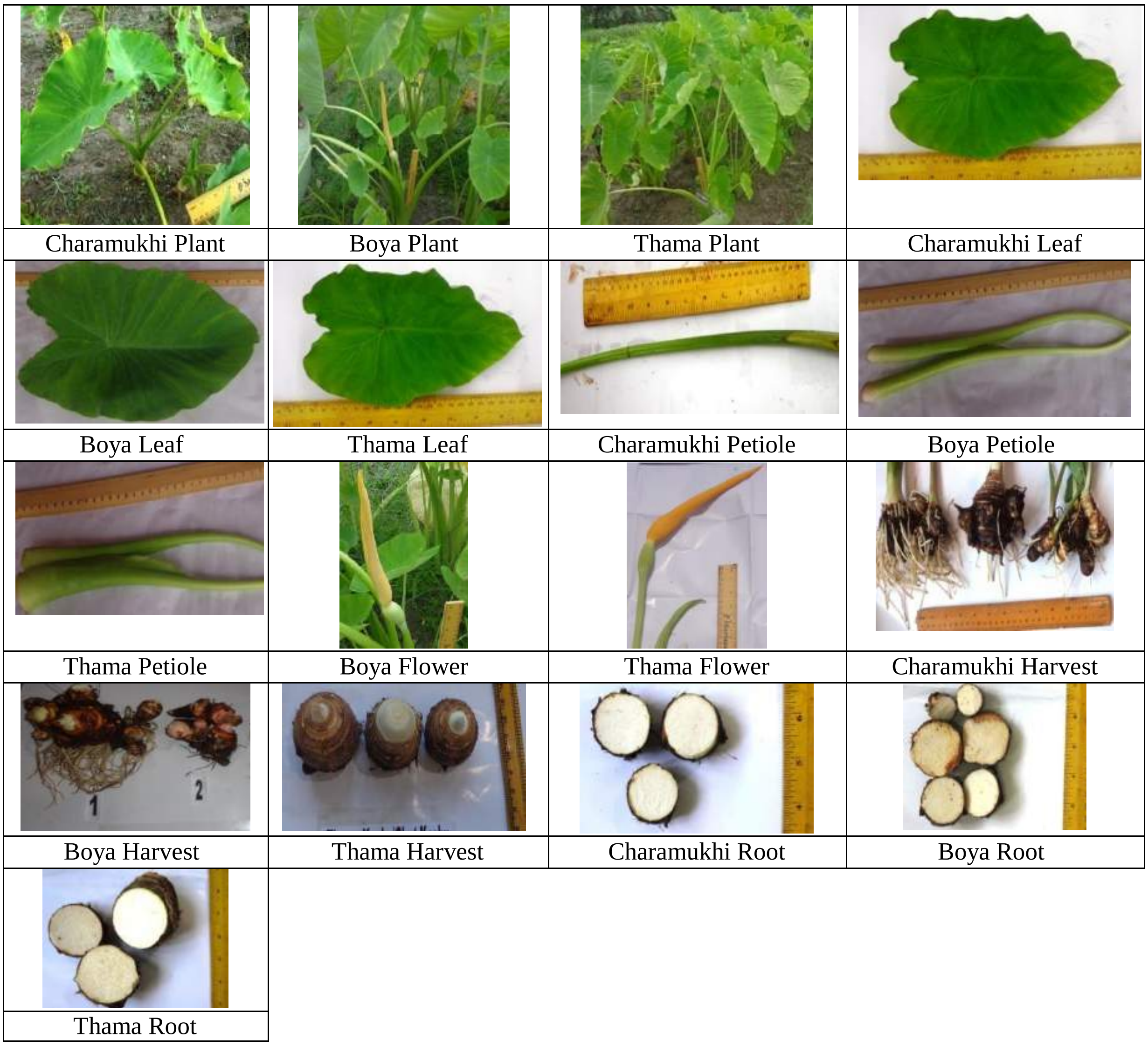
The mean corm length of nine varieties was (8.09 cm). The highest corm length was obtained from Ce-8 (Boya) (14.06 cm) and the lowest corm length (3.45 cm) was observed in Ce-3 (Veradosa). The mean corm breadth of nine varieties was (6.27 cm). The highest corm breadth was obtained from Ce-8 (Got/Thama) (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



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 (Bandarbon) (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).

			
Panchamukhi Plant	Panchamukhi Plant	Panchamukhi Leaf	Panchamukhi Leaf
			
Panchamukhi Petiole	Panchamukhi Petiole	Panchamukhi Harvest	Panchamukhi Harvest
			
Panchamukhi Flesh	Panchamukhi Flesh	Green podnayl Plant	Black Podnayl Plant
			
Green podnayl Leaf	Black Podnayl Leaf	Green podnayl Petiole	Black Podnayl Petiole
			
Green podnayl Harvest	Black Podnayl Harvest	Green podnayl Root	Black Podnayl Root

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 stolen 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 rhyzome length of five varieties was 23.37 cm. The highest rhyzome length was obtained from Ce-15 (Pani-green) (28.67 cm). The lowest rhyzome length (19.55 cm) was observed in Ce-18 (Pani-pink strip). The mean rhyzome breadth of five varieties was 16.14 cm. The highest rhyzome breadth was obtained from Ce-15 (Pani-green) (18.67 cm) cm). The lowest rhyzome 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 cultivers of Pani kachu is shown in (Table 190).

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) (Table191).

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**

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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).

			
Ai-5	Ai-4	Ai-5 Leaf	Ai-4 Leaf
			
Ai-5 Flower	Ai-4 Flower	Ai-5 Petiole	Ai-4 Petiole
			
Ai-5 Rhizome	Ai-4 Rhizome	Man kachu (Flesh color)	Mugur kachu (Flesh color)

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**


Plant of Ac-3


Plant of Ac-2


Plant of Ac-5


Leaf of Ac-3


Leaf of Ac-2


Leaf of Ac-5


Petiole of Ac-3


Petiole of Ac-2


Petiole of Ac-5


Flower of Ac-3


Flower of Ac-5


Corm of Ac-3


Corm of Ac-2


Corm of Ac-5


Ac-3 Flesh


Ac-2 Flesh


Ac-5 Flesh

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 (Tangial) (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)

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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 inXan-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)	Inflore-scence (no.)	Inflore-scence 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).

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.

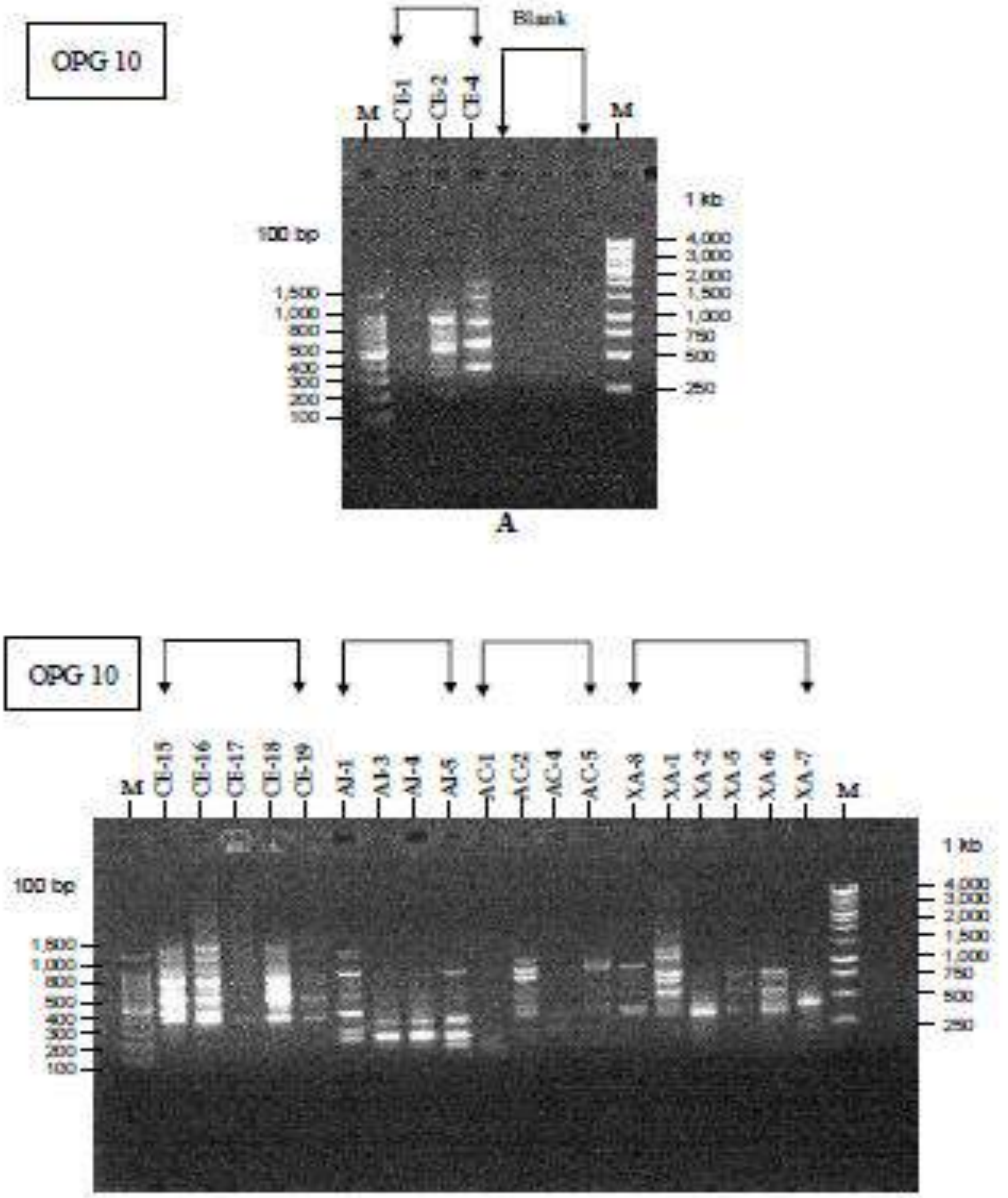
Percentage of polymorphic loci in the present study was 100. The average level of polymorphism (100%) indicated the effectiveness of RAPD technique to study substantial amount of polymorphisms or diversity among the different aroids genotypes. The details of the primers were given in Table 195 and the 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 Table197. 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 poymorphic 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**



A

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)

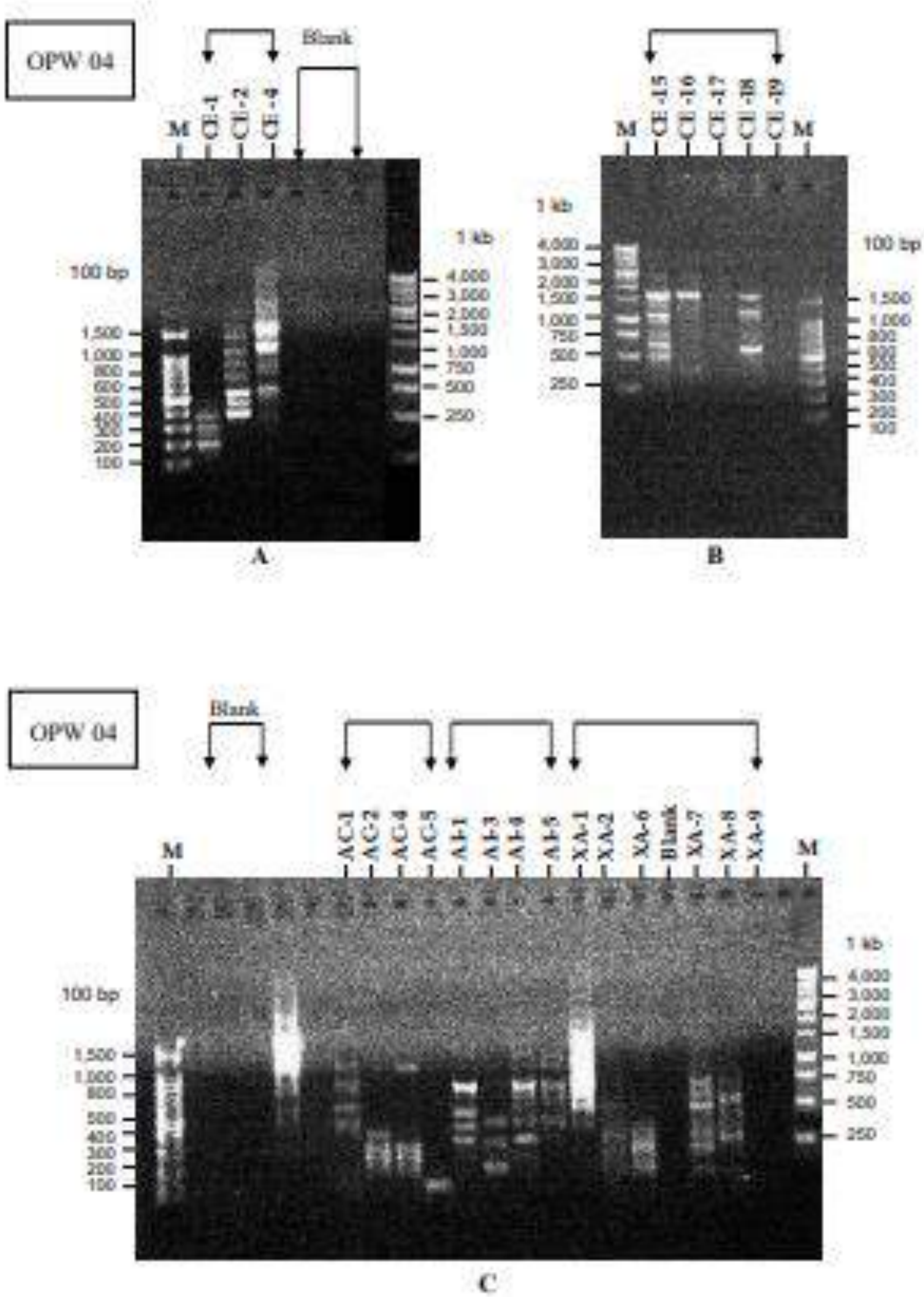


Fig. 162. RAPD profile of 22 aroid germplasm using primer OPW 04

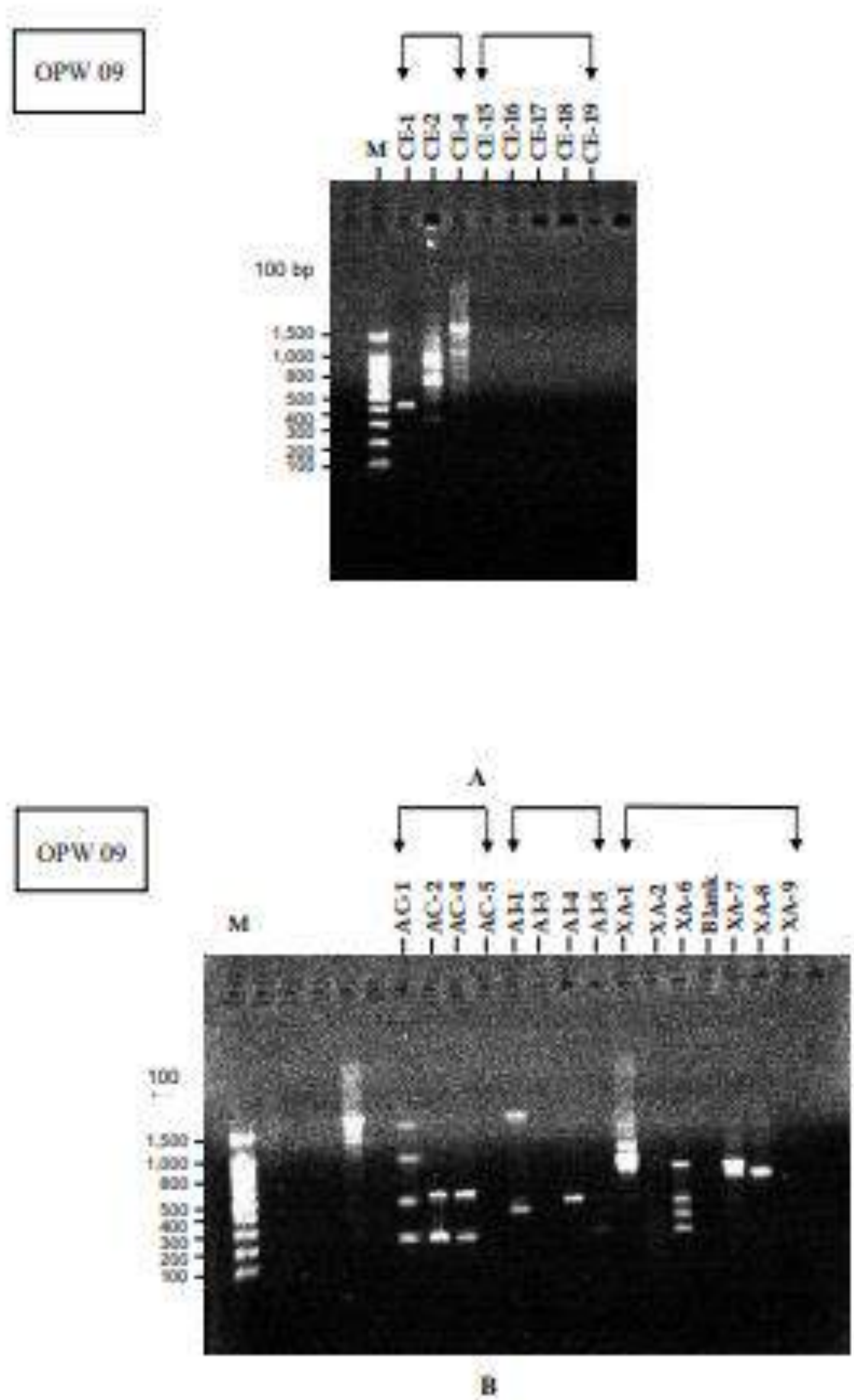
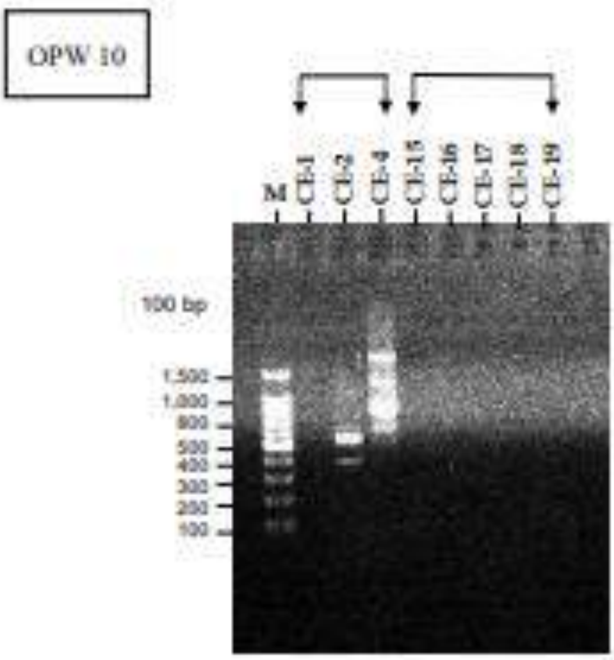
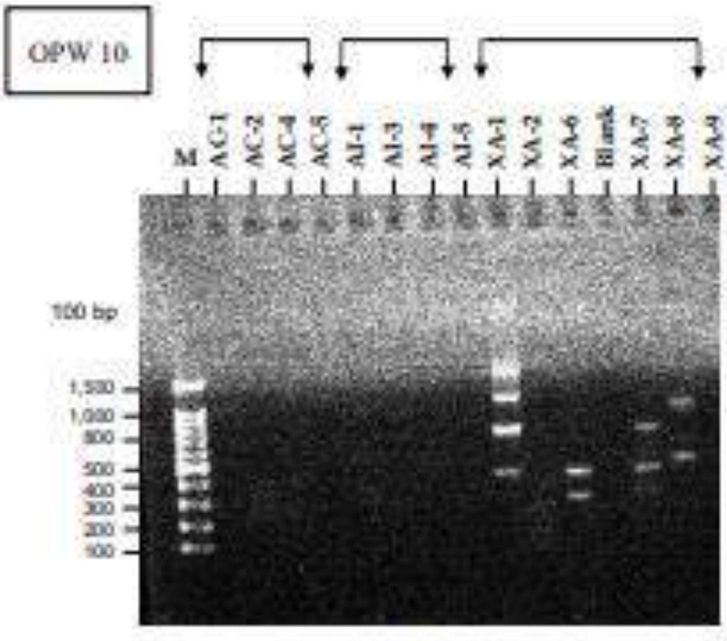


Fig. 163. RAPD profile of 22 aroid germplasm (A+B) using primer OPW 09



A



B

Fig. 164. RAPD profile of 22 aroid germplasm (A+B) using primer OPW 10

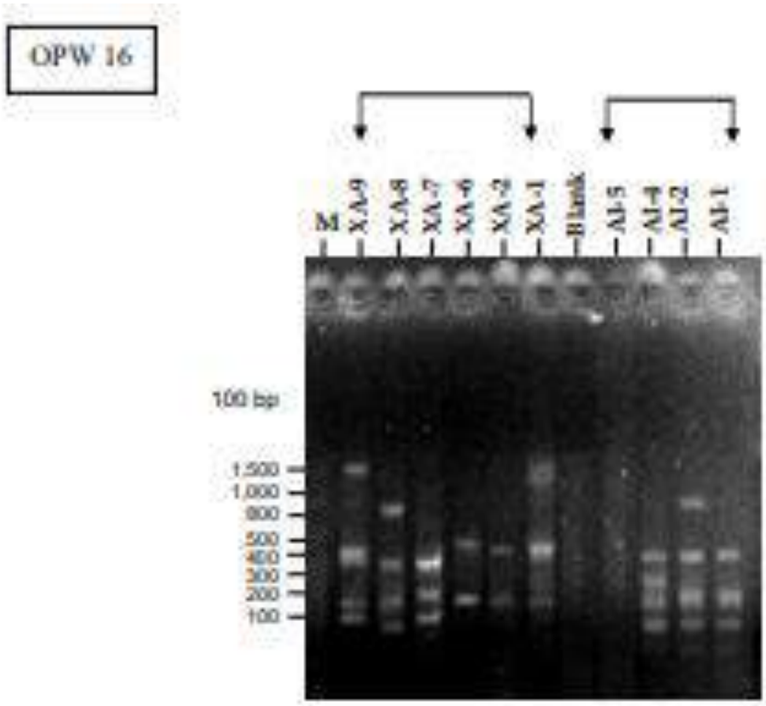


Fig. 165. RAPD profile of 10 aroid germplasm using primer OPW 16

Table 196. Frequencies of polymorphic RAPD markers in 22 aroids germplasm

RAPD Markers	Gene frequency	RAPD Markers	Gene frequency	RAPD Markers	Gene frequency	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	***

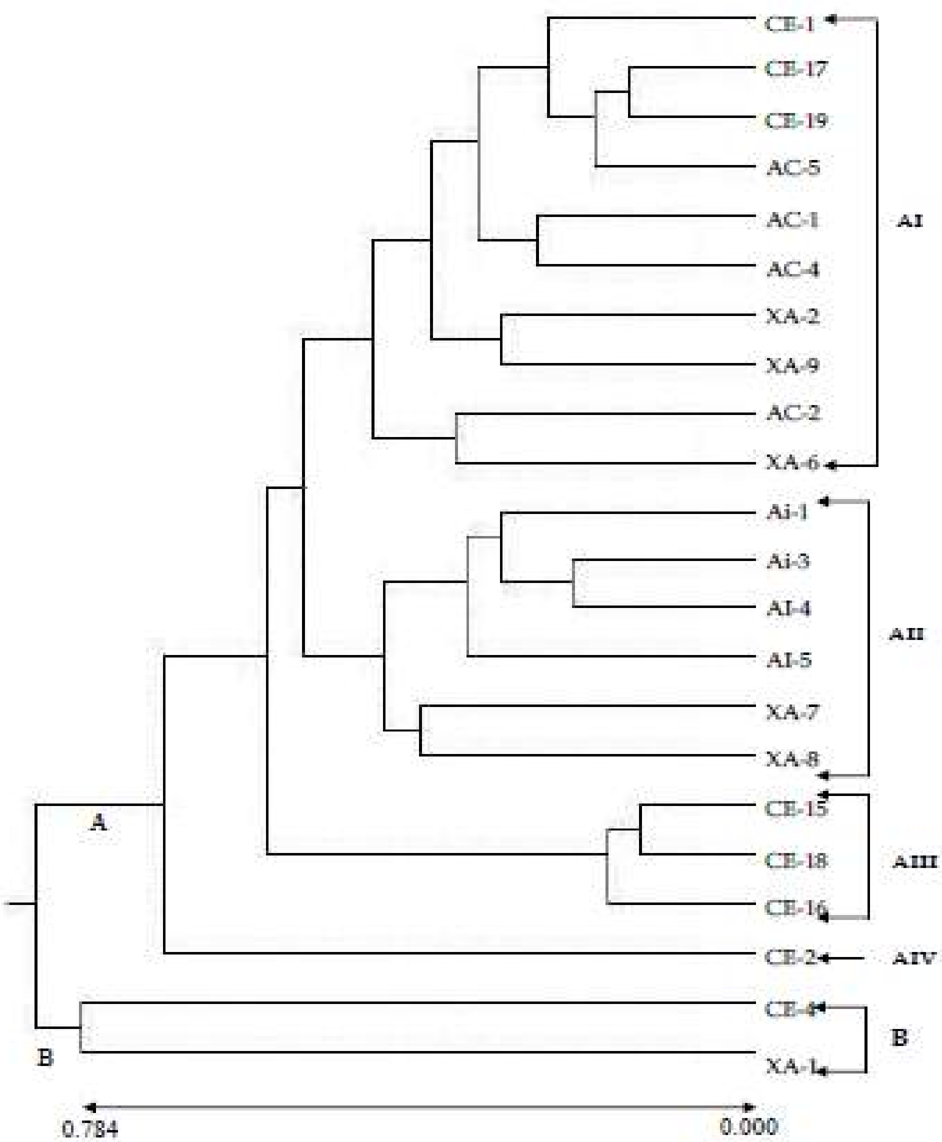


Fig. 166. Unweighted pair group method of Arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

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
	Intermidiate	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 barky patches were absent or present in young stem of the accessions.

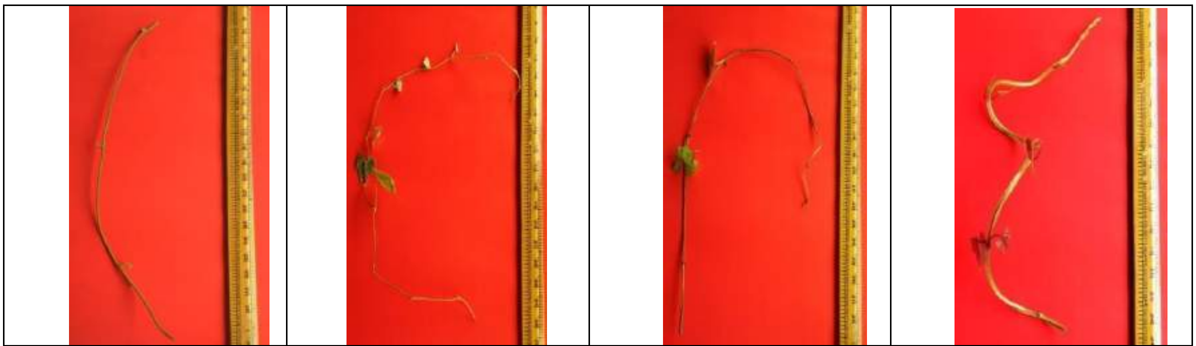
Qualitative characteristics of matured stem

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	Barky 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	Barky 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	-



RMHF 001	RMHF 002	RMHF 005	RMHF 020

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
LSD0.05	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

Clockwise		
		
RMHF 002	RMHF 003	RMHF 008
Anticlockwise		
		
RMHF 001	RMHF 004	RMHF 005

Fig. 168. Twining direction of matured stem of yam

		
RMHF 002	RMHF 003	RMHF 007

Fig. 169. Spine of matured yam stem

GREEN		
		
RMHF 014	**RMHF 013**	**RMHF 010**
Green with Purple Edge		
		
RMHF 005	**RMHF 007**	**RMHF 0015**

Fig. 170. Wing colorof 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.

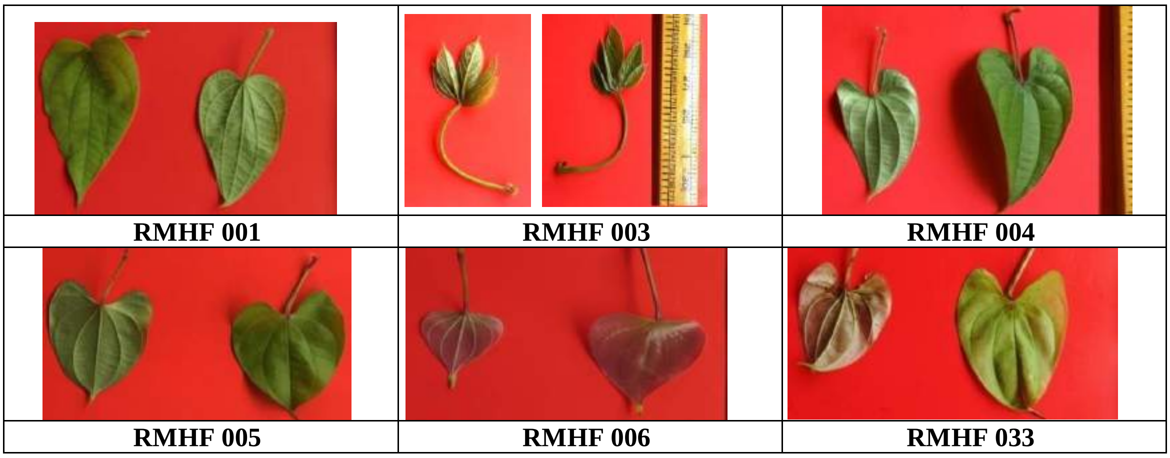


Fig. 171. Young leaf of *Dioscorea spp*

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 82.80to 255.23 cm^2. The maximum leaf area was recorded in RMHF019 followed by RMHF013 (247.76 cm^2), RMHF014 (239.80 cm^2 and RMHF012 (235.53 cm^2).

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**

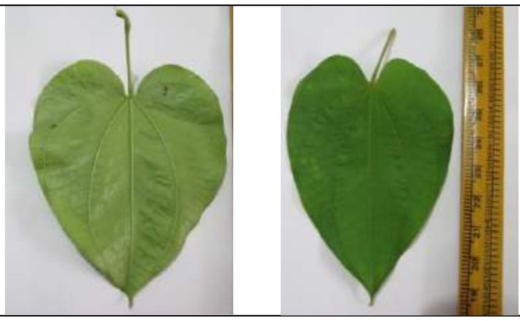
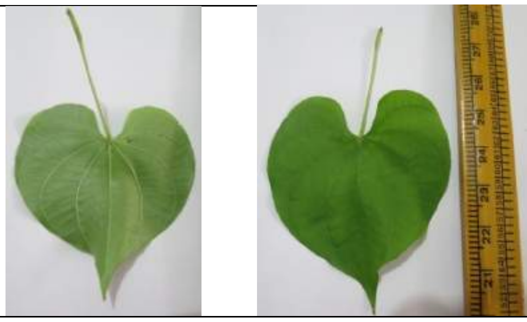
	
RMHF 001	**RMHF 002**
	
RMHF 003	**RMHF 004**
	
RMHF 005	**RMHF 006**
	
RMHF 007	**RMHF 008**
	
RMHF 009	**RMHF 010**

Fig. 172. Matured leaf (Upper and lower surface) of *Dioscorea spp*

<table>
<tr><th colspan="3">Alternate</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>RMHF 001</td><td>RMHF 002</td><td>RMHF 025</td></tr>
<tr><th colspan="3">Opposite</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>RMHF 005</td><td>RMHF 007</td><td>RMHF 010</td></tr>
<tr><th colspan="3">Alternate at Base/ Opposite above</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>RMHF 012</td><td>RMHF 021</td><td></td></tr>
</table>

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

	Aerial tubers							Underground tubers at harvest time				
Acc. no.	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

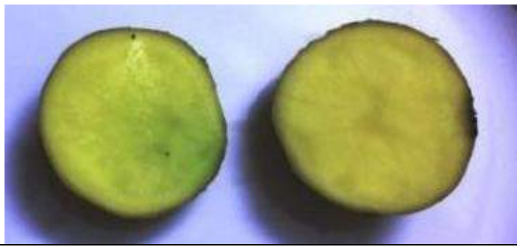
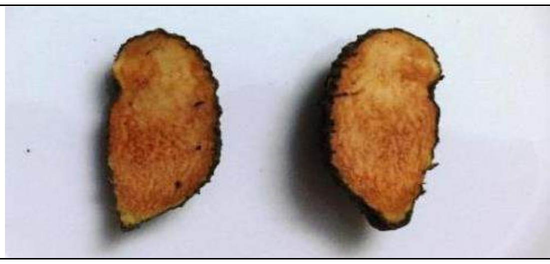
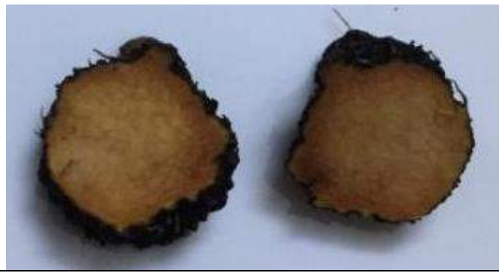
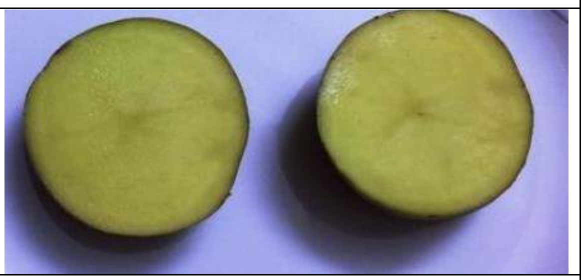
	
RMHF 001	
	
RMHF 003	
	
RMHF 005	
	
RMHF 007	
	
RMHF 008	
	
RMHF 009	

Fig. 174. Aerial tuber and transverse section of aerial tubers of yam

RMHF 011

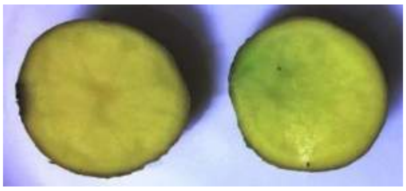
RMHF 015

RMHF 017

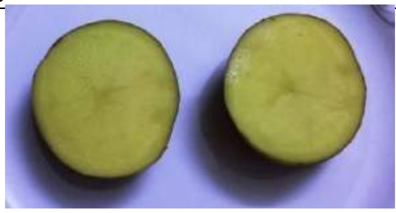
RMHF 18

RMHF 019

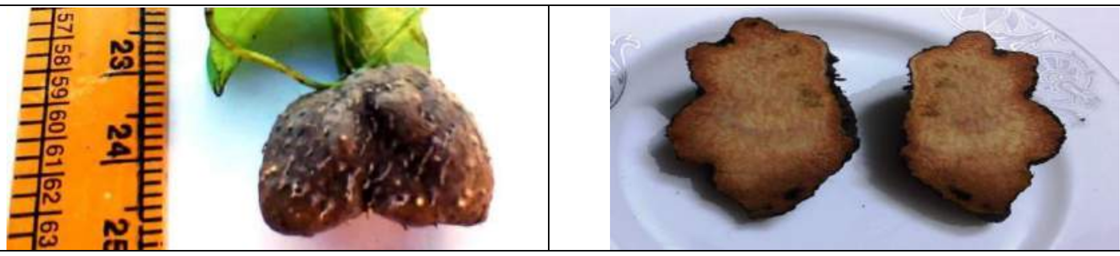
 

RMHF 020

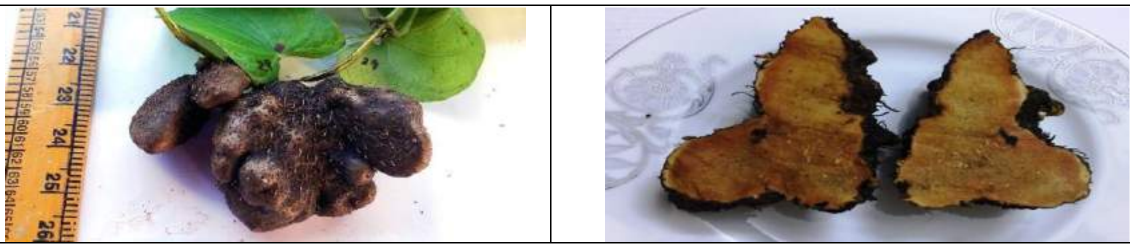
 

RMHF 027

Cont'd. Fig. 174. Aerial tuber and transverse section of aerial tubers of yam



RMHF 028



RMHF 029

RMHF 030

RMHF 031

RMHF 032

RMHF 033

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.

		
RMHF 001	**RMHF 002**	**RMHF 003**
		
RMHF 004	**RMHF 005**	**RMHF 006**
		
RMHF 007	**RMHF 008**	**RMHF 009**

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**

RMHF 026

RMHF 027

RMHF 028

RMHF 029

RMHF 030

RMHF 031

RMHF 032

RMHF 033

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

BLISTER

CRACK

WRINKLE

PRICKLY

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).

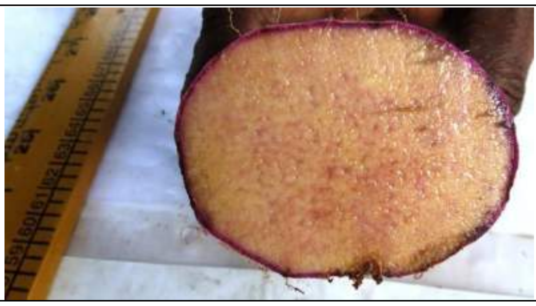
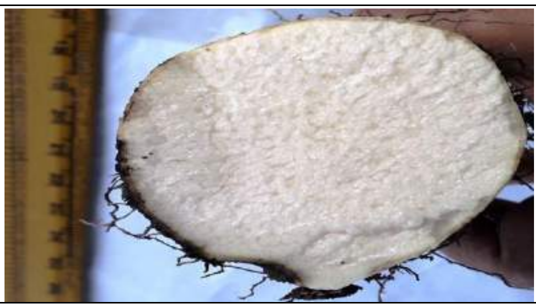
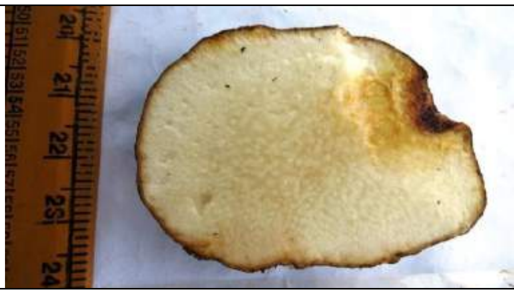
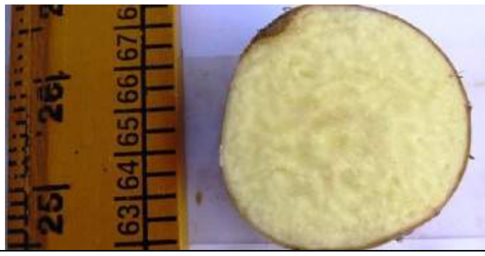
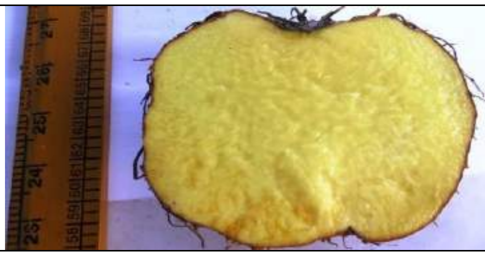
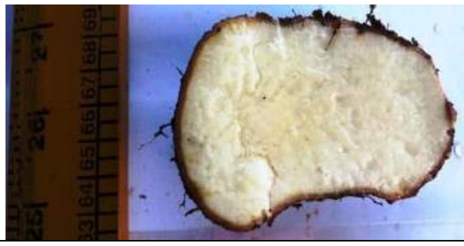
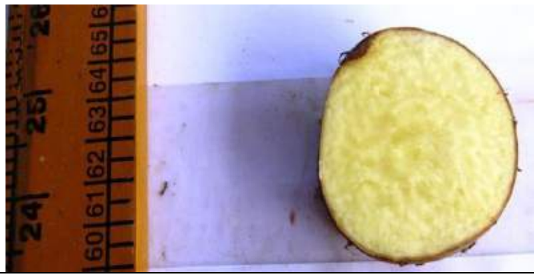
	
RMHF 001	**RMHF 002**
	
RMHF 003	**RMHF 004**
	
RMHF 005	**RMHF 006**
	
RMHF 007	**RMHF 008**

Fig. 177. Transverse section of underground yam tuber

	
RMHF 009	**RMHF 010**
	
RMHF 011	**RMHF 012**
	
RMHF 013	**RMHF 014**
	
RMHF 015	**RMHF 016**
	
RMHF 017	**RMHF 018**
	
RMHF 019	**RMHF 020**

Cont'd. Fig. 177. Transverse section of underground yam tuber

	
RMHF 021	**RMHF 023**
	
RMHF 025	**RMHF 026**
	
RMHF 027	**RMHF 028**
	
RMHF 031	**RMHF 032**
	
RMHF 033	

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

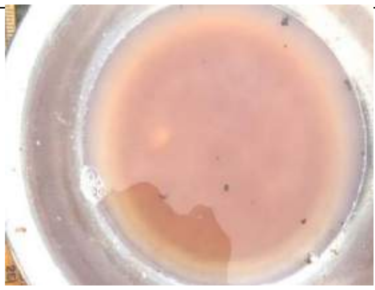
	
RMHF 001	
	
RMHF 002	
	
RMHF 003	
	
RMHF 004	
	
RMHF 005	

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	

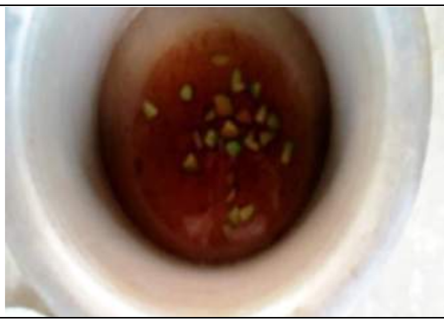
Cont'd. Fig. 178. Boiled tuber and water discoloration


RMHF 021


RMHF 023


RMHF 025


RMHF 026

RMHF 027

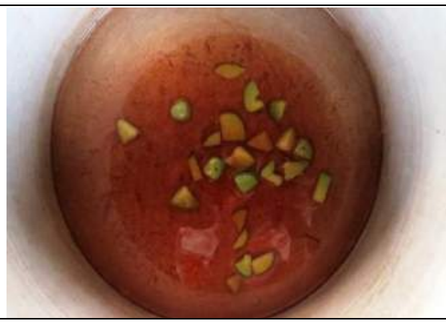
Cont'd. Fig. 178. Boiled tuber and water discoloration


RMHF 028


RMHF 029


RMHF 030


RMHF 031

RMHF 032

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 D^2 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 D^2 values	Accessions combination	10 higher D^2 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 dendogram 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, RMHF021and 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.

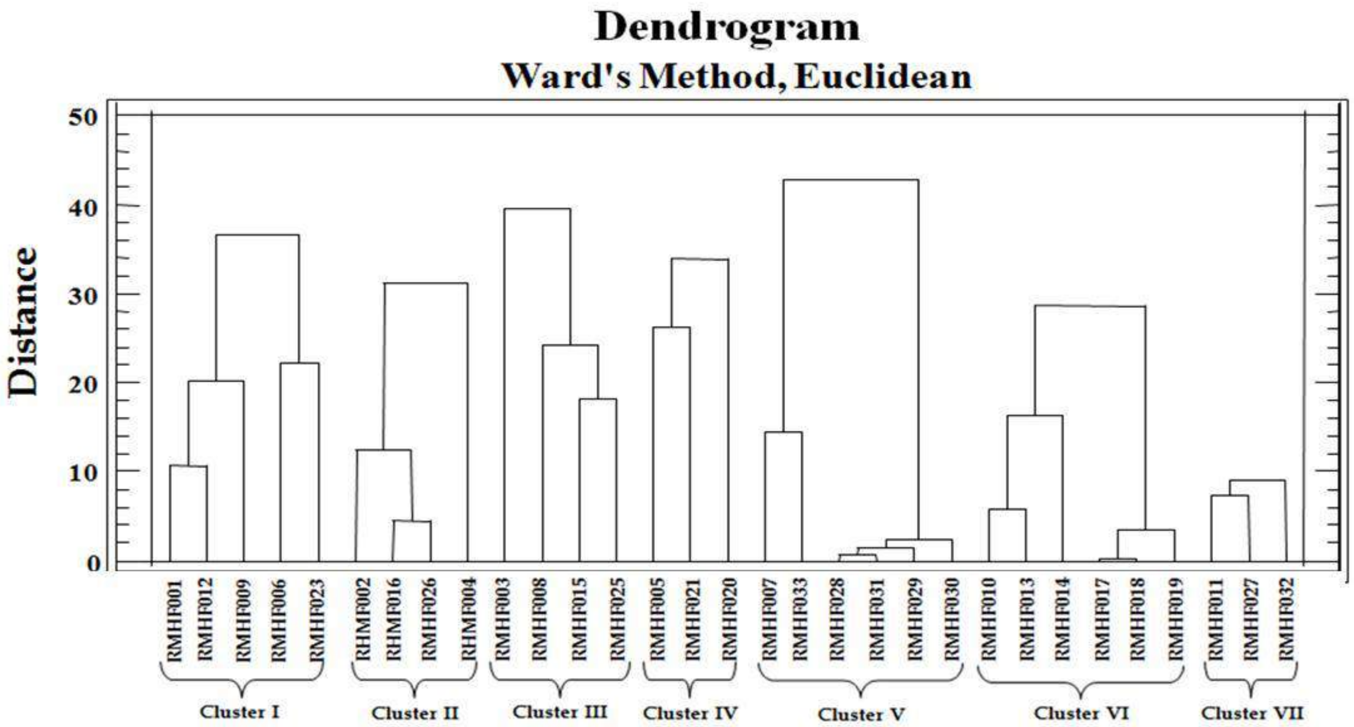


Fig. 179. Dendrogram based on Ward's method using Euclidean Distance

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. oppositifolea*). 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	RAPD Markers	Gene frequency	RAPD Markers	Gene frequency	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. oppositifolea)* 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. oppositifolea) 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. oppositifolea)* with genetic distance (0.7397). The lowest genetic distance (0.2288) was observed between RHMF002 *(D. esculenta)* and RMHF015 *(D. oppositifolea).* 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 (*D. cayenensis*)	**Acc.2 RMHF011 (*D. bulbifera*)**	**Acc.3 RHMF003 (*D. pentaphylla*)**	**Acc.4 RMHF007 (*D. alata*)**	**Acc.5 RHMF002 (*D. esculenta*)**	**Acc.6 RMHF015 (*D. oppositifolea*)**
Acc.1 RMHF001 (*D. cayenensis*)	****	0.6364	0.5227	0.4545	0.6364	0.6136
Acc.2 RMHF011 (*D. bulbifera*)	0.4520	****	0.4773	0.4091	0.5455	0.4773
Acc.3 RHMF003 (*D. pentaphylla*)	0.6487	0.7397	****	0.5227	0.6136	0.6364
Acc.4 RMHF007 (*D. alata*)	0.7885	0.8938	0.6487	****	0.6818	0.5227
Acc.5 RHMF002 (*D. esculenta*)	0.4520	0.6061	0.4884	0.3830	****	0.7955
Acc.6 RMHF015 (*D. oppositifolea*)	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).

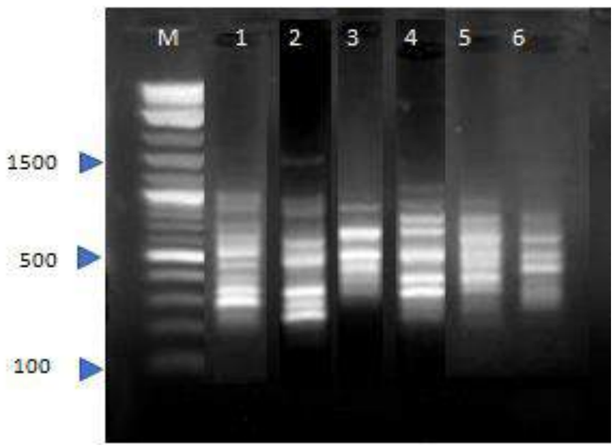


Fig. 180. RAPD profile of six yam germplasm using primer OPA-02

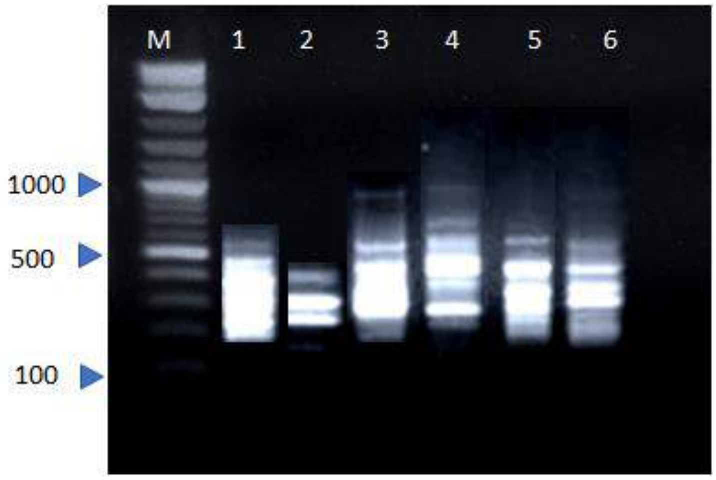


Fig. 181. RAPD profile of six yam germplasm using primer OPG-13

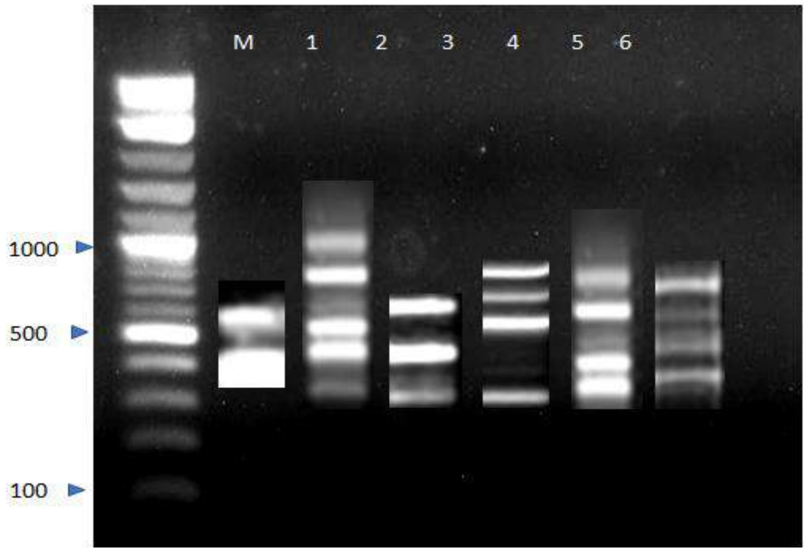


Fig. 182. RAPD profile of six yam germplasm using primer OPW-08

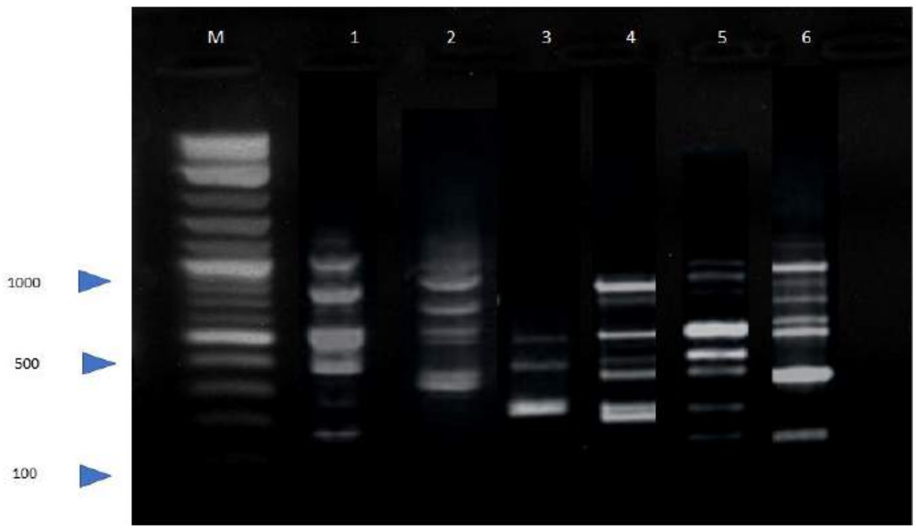


Fig. 183. RAPD profile of six yam germplasm using primer OPW-16

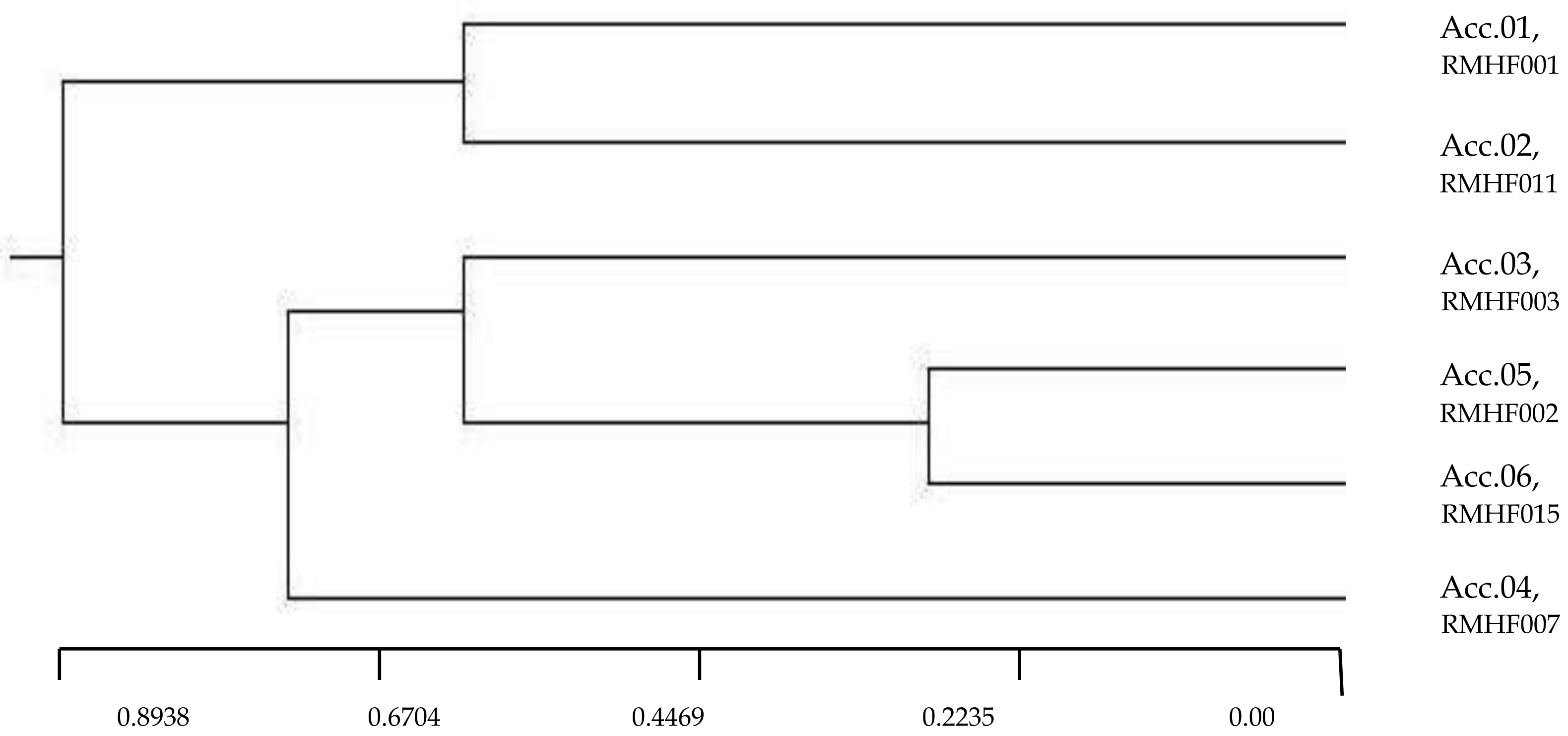


Fig. 184. Unweighted pair group method of arithmetic mean (UPGMA) dendrogram based on Nei's (1972) genetic distance

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 micronire 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

 	 
BAU Kala- 1	BAU Kala- 2

	
BAU Kala- 3	BAU Kala- 4
	
BAU Kala- 5	

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 acridity. 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 Ol 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 Ol 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. Tuberous 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

BAU Yam-1

BAU Yam-2

BAU Yam-3

BAU Yam-4

BAU Yam-5

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
Apparatus					
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
Chemicals					
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
Fertilizers and pesticides	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					Completed
i. Camera	1	29900	1	29900	
(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					100% Achieved
1. Electric Balance	01	65000	01	64000	
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. 1st Annual review workshop	29	07	36	1 day	
ii. 2nd 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 1st and 2nd 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)
		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) **Most 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)	

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 BRRI

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 *(C. capsularis)*, 9 was Tossa jute *(C. olitorius)* and 3 was Mesta (*Hibiscus sabdariffa)*.	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 dendogram 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

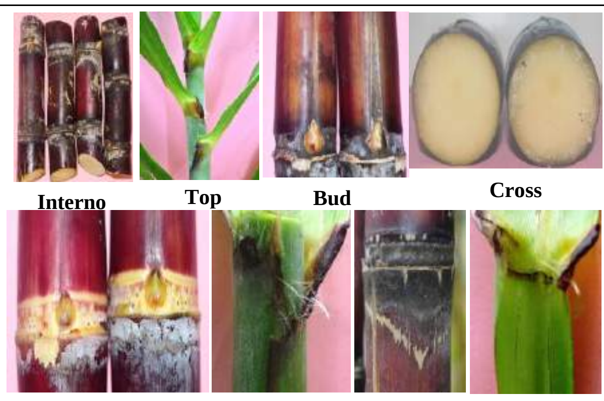
Upon successful field evaluation, the locally collected clone Chandpuri Ganderi have been released as chewing cane variety named BSRI Akh 47 approved by 103rd NSB meeting held on 08 September'2020.

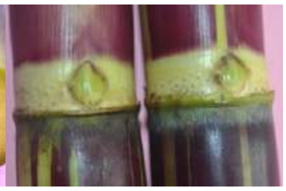
Salient features of BSRI Akh 47 are as follows

- 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 (98×10^{3} 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	 a- internode, b- top, c- cross section, d- bud
Black Ruby	Attractive color Soft & juicy Good peeling quality	

Chitra	Attractive variegated color Soft & juicy Good peeling quality	   **Internode** **Ligule** **Dewlap**    **Auricle** **Cross section** **Bud**

Local name	Special feature(s)	Photopgraphs
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 Sessame- 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 bio-chemical / 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 desireable 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 BRRI genebank	BRRI 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 BRRI genebank have been characterized based on 31 qualitative characters and 21 quantitaive 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 impotant local rice germplasm.	Total 216 rice germplasm from BRRI 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 BRRI genebank based on agro-morphological 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	➢ 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.
Bangladesh Institute of Nuclear Agriculture			
Characterization	Morphological characterization of rice	Higher yield (9.8-13.33g/plant) : Ranishail, Sentu-16, Ojanabirun, Paijam 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.l.], 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 (*Oryza Sativa* 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 (*Oryza sativa* 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 *Dioscorea* 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

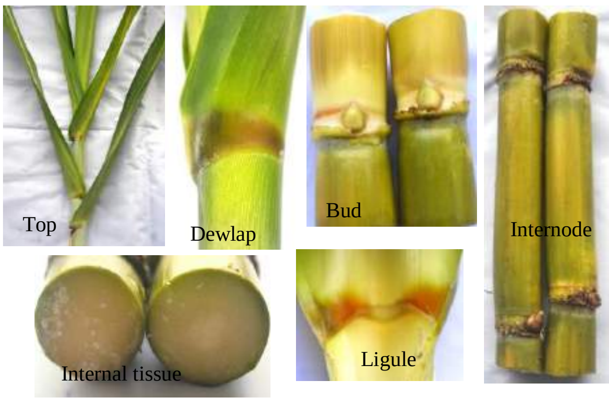
BSRI Akh 47: A potential chewing type sugarcane variety

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.

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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 evolutes 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 25-30ºC. 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: Panchuamukhi 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 23-31ºC. 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 an as 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 25-35ºC with sufficient rainfall, if not, then irrigation becomes an indispensible 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 to 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 Mugur Kachu. It is a monocotyledonous herbaceous plant of Araceae family. Its cultivation is concentrated in southern districts viz. Jashore, Khulna, Bagerhut, Sathkhira, Barishal and Patuakhali but it can be grown all over Bangladesh. It is good in taste with low acridity. 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 25-30ºC 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 is 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 Dud 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 highs 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 at 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 1st 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)

BRRI

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 Ol 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 3rd day of each month	On the 3rd 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	9th November 2019	1
PIU-BARC, NATP-2	7th April 2019 14th December 2019 28th November 2020	3
Internal monitoring	7th March 2018 14th 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, BRRI 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. Mossammat 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 *shak*	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	Positive social impacts occurred due to intervention of the sub-project activities; if yes, please mention at least 3: **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. **2.** Awareness about importance of local germplasm has been raised among the indigenous people. **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.	√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: **BRRI 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	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: ➢ Two hundred and forty-seven (247) rice germplasm were collected from different locations (29 Upazilas of 14 Districts) of Bangladesh.	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: ➢ 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	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$^{\surd}$/No/Not applicable
4	Pest tolerant varieties developed/released from the sub-project; if yes, please mention the pest, variety and number:	Yes/No$^{\surd}$/Not applicable
5	Salinity tolerant varieties developed/released from the sub-project; if yes, please mention the salinity level, variety and number:	Yes/No$^{\surd}$/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$^{\surd}$/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$^{\surd}$/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$^{\surd}$/Not applicable
9	Observed any negative social impact due to sub-project interventions	Yes/No$^{\surd}$/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$^{\surd}$/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$^{\surd}$/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 safeguardsas 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: ***Corchorus capsularis*** -23, ***Corchorus olitorius***-9 and ***Hibiscus sabdariffa***-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: • Rescue endangered PGR and minimizes genetic erosion • Facilitate selection of parents for hybridization program • Important traits which are idenfied 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: • 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 habitants 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/√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/releasedfrom 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): 02	√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: 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.	√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: **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	1st Year	Satisfactory
FAPAD	No observation/ issues/ objections	580805.00	2nd Year	Satisfactory
Bangladesh Sericulture Research & Training Institute				
Yearly (1st year)	Satisfactory, no objection were made by the audit team	505000.00	-	
Yearly (2nd 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.

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Signature of the Coordinator

Date: 20-12-2021

Seal: Dr. Md. Aziz Zilani Chowdhury
Member Director Crops &
Co-ordinator, PBRG=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 1st 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:

a. Include 5-10 more germplasm for next year trial than planned target for characterization.

b. Take research program for developing short duration cotton variety(s) to fit in rice based cropping pattern.

16. Overall Assessment

a. Continue the Sub-Project as Planned: Overall progress of the sub-project activities is satisfactory. It should be continued as per work plan.

b. Modify (specify areas of modification) the Sub-Project: Not applicable

c. 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)		Deviation (if any)	Performance (Good/average /below average/poor
		Planned	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 (*Dioscoea 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	30	N/A	Good
	Plantation of germplasm	30	33	N/A	Good
	Characterization of germplasm	30	33	N/A	Good
Characterization of germplasm	Morpphological characterization of Banana and Aroids	90	92 (Banana-62 & Aroids -30		

ii) Technology Generation: Not Applicable

Sl. No.	Description of the Technology	Number	Achievem-ents/status	Remarks
1	Germplasm of *Dioscorea spp.* 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 Appliable

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 *Dioscorea 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

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. 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

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 project	BARC	
2. Amal Chandra Manidas, SO, PBRG-PGR Priject	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

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 : January 2021
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. Ebna Syod Md. Harunur Rashid, SSO, GRS Division, BRRI
   c. Dr. Mohammad Zahidul Islam, SSO, GRS Division, BRRI
   d. 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 Quatation		
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 polymerage, 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 Rezwan 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

a. Continue the sub-Project as Planned: Overall progress of the sub-project activities is quite satisfactory. It should be continued as per original plan.
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 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:

a) Internal monitoring is to be done by the institutional monitoring.

b) Target crops are to be collected from particular team area with a good plan.

16. **Overall Assessment**

a. Continue the sub-Project as Planned: Overall progress of the sub-project activities 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. 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

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: BAU 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, 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 *Dioscoea 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 *Dioscorea spp.* 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 1st year and 5 GP in 2nd 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 Hawlader	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:

a. Include 10-20 more germplasm for next year trial than planned target for characterization.

b. Select promising germplasm in respect of yield and quality (larger boll, higher G.O.T. (%), Micronare value (µg/inch) etc.)

c. Take research program for developing short duration cotton variety(s) to fit in rice based cropping pattern.

d. Take cropping pattern based research program in different AEZs of Bangladesh.

16. Overall Assessment

a. Continue the sub-Project as Planned: Overall progress of the sub-project activities is satisfactory. It should be continued as per work plan.

b. Modify (specify areas of modification) the sub-Project: Not applicable

c. 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 polymerage, 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:

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
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 Rezwan 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:

a. Report need to be revised according to the suggestions from Consultant

b. Result should be presented season/year wise

c. 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

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
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 Dr. Md. Mahabub Hussain Dr. Ayub Khan	Director Agriculture and other senior scientists of BJRI	03/04/2018 15/07/2019 28/07/2020 27/09/2020	4	Activities performed accordingly.

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:

a. Summary table of collected germplasm should be added in collection and exploration report.
b. Black and white map should be added collection part of the report.
c. Char land area should be selected for germplasm collection because those areas are the sources of minor crops.
d. Only photographs of collected sample should be added in passport data form.
e. Materials and methods of reports should clearly mention the collection system/procedure.

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. 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	

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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 *Dioscorea spp.* 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 *Dioscorea* 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

a. Continue the Sub-Project as Planned
b. Modify (specify areas of modification) the Sub-Project
c. 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

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