

Sub-Project ID - 013

Program Based Research Grant (PBRG)

Sub-project Completion Report

on

**Development of Lean Season Fruit Varieties and
Management Packages**

Sub-project Duration

June 2018 to May 2022

Implementing Organization

**Pomology Division, Horticulture Research Centre
Bangladesh Agricultural Research Institute, Gazipur-1701**



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

April 2022



Program Based Research Grant (PBRG)

Sub-project Completion Report

on

Development of Lean Season Fruit Varieties and Management Packages

Sub-project Duration

June 2018 to May 2022

Implementing Organization

**Pomology Division, Horticulture Research Centre
Bangladesh Agricultural Research Institute, Gazipur-1701**



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

April 2022



Citation:

Sarker, B. C., J. Gomasta, M. I. Faruk and M. K. Uddin. 2022. Development of lean season fruit varieties and management packages, Project Completion Report, 155p.

Edited by:

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

Acknowledgement

The execution of PBRG sub-project has successfully been completed by Pomology Division, Horticulture Research Centre in collaboration with Plant Pathology Division and Entomology Division, Bangladesh Agricultural Research Institute, Gazipur-1701 using the research fund of WB, IFAD and GoB through Ministry of Agriculture. We would like to acknowledge to the World Bank for arranging the research fund and supervising the PBRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP-2 in respect of field implementation of the sub-project in multiple sites. Preparing the sub-project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who have made it possible, deserve appreciation. Our thanks are due to the Director PIU-BARC, NATP-2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

Published in: April, 2022

Printed by:

Abbreviation and Acronyms

Abbreviation/Acronym	Full Form
AEZ	Agro-Ecological Zone
ANOVA	Analysis of Variance
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
BSPC	Breeder Seed Production Centre
Co-PI	Co-Principal Investigator
E-W	East-West
FRG	Fertilizer Recommendation Guide
HARS	Hill Agriculture Research Station
HRC	Horticulture Research Centre
IPM	Integrated Pest Management
LDL	Low Density Lipo-protein
LSD	Least Significant Difference
LSP	Local Service Provider
MoP	Muriate of Potash
NATP	National Agricultural Technology Program
NGO	Non-Government Organization
N-S	North-South
NS	Not Significant
PBRG	Program Based Research Grant
PDA	Potato Dextrose Agar
PI	Principal Investigator
PIU	Project Implementation Unit
PP	Project Proposal
ppm	Parts per million
RARS	Regional Agricultural Research Station
RCBD	Randomized Complete Block Design
SDGs	Sustainable development Goals
TSP	Triple Super Phosphate
TSS	Total Soluble Solids
UAO	Upazila Agriculture Officer

List of Tables

Table No.	Table Title	Page No.
01	Lean season fruit germplasm collected at Pomology Division, Joydebpur, Gazipur	06
02	Germplasm collected from the hilly region of Rangamati at the Hill Agriculture Research Station, Raikhali, Rangamati	09
03	Germplasm of lean season fruit crops collected at the BSPC, Debiganj, Panchagarh	10
04	Status of lean season fruit crops in Barishal, Panchagarh, Rangamati and Gazipur region	17
05	Plant growth/vegetative characteristics of custard apple genotypes	19
06	Growth and yield contributing characters of bullock's heart genotypes	20
07	Vegetative data of Fig germplasm at Joydebpur, Gazipur during 2020-2022	21
08	Grafting success (%) in different methods of propagation practiced at different months of the year	22
09	Scion growth (cm) in different methods of propagation practiced at different months of the year	22
10	Percent transplantable grafts in different methods of propagation practiced at different months of the year	23
11	Effect of fertilizer doses on plant height and base girth of golden apple	24
12	Effect of fertilizer application methods on plant height and base girth of golden apple	24
13	Interaction effect of fertilizer doses and application methods on plant height and base girth of golden apple	25
14	Effect of fertilizer doses on flower and fruit characters of golden apple	25
15	Effect of fertilizer application methods flower and fruit characters of golden apple	26
16	Interaction effect of fertilizer doses and application methods on flowering and fruiting characteristics of BARI Amra-1	26
17	Effect of fertilizer doses on plant height and base girth of BARI Amra-2	27
18	Effect of fertilizer application methods on plant height and base girth of BARI Amra-2	28
19	Interaction effect of fertilizer doses and application methods on plant height and base girth of BARI Amra-2	28
20	Effect of fertilizer doses on flower and fruit characters of BARI Amra-2	29
21	Effect of fertilizer application methods on flower and fruit characters of BARI Amra-2	29
22	Interaction effect of fertilizer doses and application methods on flower and fruit characters of BARI Amra-2	30
23	Cost and return analysis in BDT (Tk.) of BARI Amra-2 production per hectare	31
24	Growth and yield characteristics of sweet orange upon application of fertilizers	31
25	Yield characteristics of sweet orange upon application of fertilizer	32

Table No.	Table Title	Page No.
26	Effect of pruning time and level of pruning on growth and yield of guava	33
27	Effect of GA ₃ on fruit quality of BARI Amra-2	34
28	Growth characteristics of bullock's heart germplasm at Debiganj during 2017- 2019	35
29	Flowering and fruiting behavior of bullock's heart germplasm at Debiganj during 2017- 2019	36
30	Quantitative fruit characteristics of bullock's heart germplasm at Debiganj during 2017- 2019	36
31	Qualitative fruit characteristics of bullock's heart germplasm at Debiganj during 2017- 2019	37
33	Growth and tree characteristics of Bael germplasm	38
33	Yield and yield attributes of Bael germplasm	38
34	Quantitative parameters of Bael germplasm	39
35	Qualitative characters of Bael germplasm	39
36	Growth characters of Carambola germplasm	40
37	Yield contributing characters of Carambola germplasm	41
38	Plant growth and fruiting characteristics of wood apple germplasm at BSPC, Debiganj	42
39	Yield and yield contributing characters of wood apple germplasm at BSPC, Debiganj	42
40	Plant growth and fruiting characteristics of peach fruit germplasm at BSPC, Debiganj	43
41	Yield and yield contributing characteristics of peach fruit germplasm at BSPC, Debiganj	44
42	Fruit characteristics of thirteen custard apple germplasm	45
43	Growth and yield contributing characters of wood apple genotypes in the hilly area	46
44	Yield and quality characters of wood apple genotypes in the hilly area	46
45	Growth characteristics of the wood apple germplasm at Raikhali during 2017- 2019	46
46	Flowering and fruiting behavior of wood apple germplasm at Raikhali during 2017- 2019	46
47	Quantitative fruit characteristics of wood apple germplasm at Raikhali during 2017- 2019	47
48	Qualitative fruit characteristics of wood apple germplasm at Raikhali during 2017- 2019	47
49	Growth characteristics of jamun germplasm at Raikhali during 2017- 2019	48
50	Flowering and fruiting behavior of jamun germplasm at Raikhali during 2017- 2019	48
51	Quantitative fruit characteristics of jamun germplasm at Raikhali during 2017- 2019	49
52	Qualitative fruit characteristics of jamun germplasm at Raikhali during 2017- 2019	49
53	Flesh thickness and TSS (%) of jamun at Raikhali, Rangamati	50
54	Fruit skin color and fruit apex of jamun at Raikhali, Rangamati	50
55	Performance of cleft grafts in bael at different months of the year	51
56	Plant Characteristics of Bullock's heart germplasm	52
57	Effect of vermicompost on growth and yield characteristics of sweet	53

Table No.	Table Title	Page No.
	orange	
58	Effect of different fungicides on disease incidence of fruit rot/anthracnose disease of Burmese grape	55
59	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture/copper group fungicide in reducing gummosis disease of bael at BSPC, Debiganj, Panchagarh	56
60	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture/copper group fungicide in reducing gummosis disease of bael at Hill Agricultural Research Station, Raikhali, Kaptai, Ranganati	56
61	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at Fruit Research Farm, HRC, BARI, Gazipur	57
62	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at RARS, Rahmatpur, Barishal	57
63	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at BSPC, Debiganj, Panchagarh	58
64	Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at the Hill Agricultural Research Station, Raikhali, Kaptai, Ranganati	58
65	Effectiveness of integrated gummosis disease management technologies of bael at BSPC, Debiganj, Panchagarh	59
66	Effectiveness of integrated gummosis disease management technologies of bael at Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati	59
67	Infestation of different insect pests of the lean season fruit crops at Barishal region of Bangladesh	60
68	Infestation of different insect pests of lean season fruit crops at Panchagarh district of Bangladesh.	60
69	Infestation of different insect pest of lean season fruits crop at Ranghamati district of Bangladesh	61
70	Infestation of different insect pest of lean season fruits crop at Gazipur district of Bangladesh	61
71	Efficacy of different treatments on the infestation (%) by fruit borer, <i>Deudorix isocrates</i> attacking wood apple at Gazipur	62
72	Efficacy of different treatments on the infestation (%) by fruit borer, <i>Deudorix isocrates</i> attacking wood apple at Debigonj, Panchagarh.	63
73	Efficacy of different pest management packages in controlling hog-plum beetle, <i>Podontia 14-punctata</i> under field condition at HRC, Gazipur	63
74	Efficacy of different pest management packages on shoot and fruit infestation by hog-plum beetle, <i>Podontia 14-punctata</i> under field condition at HRC, Gazipur	64
75	Efficacy of different pest management packages in controlling hog-plum beetle, <i>Podontia 14-punctata</i> under field condition at Rahmatpur, Barishal	65
76	Efficacy of different pest management packages on shoot and fruit infestation by hog-plum beetle, <i>Podontia 14-punctata</i> under field condition at Rahmatpur, Barishal	

List of Figures

Figure No.	Title of Figure	Page No.
01	Interview taken on lean season fruit production	05
02	Interview taken on diseases of lean season fruit crops	12
03	Applying treatments against gummosis disease of bael	13
04	Applying treatments against gummosis disease of golden apple	14
05	Field validation of integrated disease management packages against gummosis disease of bael (previous it called wood apple) at BSPC, Debiganj and HARS, Raikhali	14
06	Farmer's interview in Panchagarh, Barishal and Rangamati	15
07	Field view of fruit borer infestation at BSPC, Debiganj, Panchagarh	16
08	Field view of management approach against hog plum beetle	16
09	Lean season fruit orchard at different project locations of Bangladesh	19
10	Custard apple genotypes at Pomology Division, HRC, Gazipur	20
11	Bullock's heart genotypes at Pomology Division, HRC, BARI, Gazipur	20
12	Fig genotypes at Pomology Division, HRC, BARI, Gazipur	21
13	Successful cleft grafts of avocado	23
14	Split fertilizer application in BARI Amra-1	27
15	Split fertilizer application in BARI Amra-2	31
16	Fertilizer application in BARI Malta-1	32
17	Pruning improved fruit quality in BARI Peyara-2	34
18	GA ₃ application on fruit quality of golden apple	35
19	Bullock's heart germplasm at BSPC, Debiganj	37
20	Bael germplasm at BSPC, Debiganj, Panchagarh	39
21	Carambola germplasm at BSPC, Debiganj, Panchagarh	41
22	Wood apple germplasm at BSPC, Debiganj, Panchagarh	43
23	Peach fruit germplasm at BSPC, Debiganj, Panchagarh	44
24	Bullock's heart germplasm at HARS, Raikhali, Ramgamati	45
25	Wood apple germplasm (FL Rai-003) released as BARI Kodbael-2	48
26	Jamun germplasm (SC Rai-008) released as BARI Jam-1	50
27	Bael sapling obtained through cleft grafting in April 2020	51
28	Custard apple germplasm at RARS, Rahmatpur, Barishal	52
29	Fruits of BARI malta-1 after vermicompost application	53
30	Effect of different fungicides on fruit rot/anthracnose of Burmese grape	55
31	Bio-rational based integrated management of gummosis of bael	56
32	Bio-rational based integrated management of gummosis of golden apple	58
33	Field validation of bio-rational based integrated management of gummosis of bael and golden apple	59
34	Infested lean season fruit tree in different region of Bangladesh during survey period	60

Figure No.	Title of Figure	Page No.
35	Fruit borer management in wood apple	62
36	Bio-rational management of hog plum beetle	65
37	BARI Jam-1	113
38	BARI Ata-1	114
39	BARI Kodbael-2	115
40	Vegetative propagation in Avocado	118
41	Fertilizer management in BARI Amra-1	120
42	Fertilizer management in BARI Amra-2	122
43	Integrated Management of Gummosis disease of bael	124
44	Integrated Management of Gummosis disease of Golden apple	125
45	Fruit borer management in wood apple	126
46	Bio-rational management of hog plum beetle	127

Table of Contents

Sl. No	Subject	Page No.
	Abbreviation and Acronyms	ii
	List of Tables	iii
	List of Figures	vi
	Executive Summary	ix
A.	Subproject Description	01
1	Title of the PBRG subproject	01
2	Implementing organization	01
3	Name and full address with phone, cell and email of Coordinator/Principal Investigator/Co-principal investigator	01
4	Sub-project budget	02
5	Duration of the sub-project	02
6	Background of the sub-project	02
7	Sub-project general objective	02
8	Sub-project specific objectives	03
9	Implementing locations	03
10	Methodology in brief	04
11	Results and Discussion	17
12	Research Highlights	66
B	Implementing Status	100
1	Procurement	100
2	Establishment/renovation facilities	100
3	Training/Study tour//Workshop/Seminar	100
C	Financial and Physical progress	101
D	Achievement of subproject by objectives	103
E	Information/knowledge/policy generated	108
F	Materials Development/Publication made	112
G	Description of generated technology/knowledge/policy	113
H	Technology/Knowledge generation/Policy Support	128
I	Information regarding desk and field monitoring	130
J	Sub-project auditing	135
K	Lesson Learned	136
L	Challenges	136
M	Suggestions for future planning	137
N	References	137
	Appendices	141

Executive Summary

A project regarding varietal improvement and management packages development of lean season fruit crops has been implemented by Pomology Division, HRC, BARI, Gazipur (Component-I) in collaboration with the Entomology Division (Component-III) and Plant Pathology Division (Component-II), BARI, Gazipur at four locations namely Pomology Division, Horticulture Research Centre, BARI, Gazipur; Breeder Seed Production Centre (BSPC), Debiganj, Panchagarh; Hill Agriculture Research Station (HARS), Raikhali, Rangamati and Regional Agricultural Research Station (RARS), Rahmatpur, Barishal. Under the sub-project; different activities like collection, characterization and evaluation of the promising lean season fruit germplasm and development of crop production packages including insect-pest and disease management technologies have been performed. Prior to commencing the sub-project activities a baseline survey on lean season fruit production along with insect and disease incidence was conducted at all the project locations under BARI. A total of 40 well established orchards of golden apple (BARI Amra-2), sweet orange (BARI Malta-1), guava (Local and Thai), Burmese grape, dragon fruit (BARI Dragonfruit-1), pine apple (Honey Queen, Joldubi), pummelo, mandarin, cashewnut and longan were noted. Besides these orchards, 1-2 plants of local fruits like bullock's heart, custard apple, Indian olive, aonla, carambola, bael, wood apple, sapota, wax apple, tamarind, jamun, Indian dillenia etc. were observed in the surveyed locations.

Under component-I, 3 fruit varieties (BARI Jam-1, BARI Ata-1 and BARI Kodbael-2), one vegetative propagation technique for Avocado and 2 fertilizer management technologies for BARI Amra-1 and BARI Amra-2 have been developed. During the course, as many as 28 germplasm of bullock's heart, custard apple, ber, bael, wood apple and apple were collected and planted at the Fruit Research Farm of Pomology Division, BARI, Gazipur; 10 germplasm of bullock's heart, ber, pummelo, pear, strawberry, avocado and custard apple at HARS, Raikhali, Rangamati; 10 germplasm of Burmese grape, sapota, pummelo, ber, jaboticaba, river ebony and phalsa (*Grewia asiatica*) at BSPC, Debiganj, Panchagarh and 29 lean season fruit germplasm were collected and planted at the fruit research field of RARS, Rahmatpur, Barishal. Besides these, characterization and evaluation have been conducted in the existing minor fruit repository. Upon evaluation, among 4 bael germplasm one (1) was found promising at HARS, Raikhali. At BSPC, Debiganj; 2 germplasm of bullock's heart, 2 of bael, 2 of carambola, 1 of wood apple and 2 germplasm of peach fruit were noticed promising. While, at Pomology Division, BARI, Gazipur; 2 bullock's heart and 2 custard apple germplasm were found auspicious. Furthermore, studies on cultural management practices like fertilizer management, propagation standardization, irrigation management, hormonal management etc. were executed on golden apple, sweet orange, guava, ber, avocado, bullock's heart, bael, wood apple and custard apple under the component-I. Fertilizer studies with three doses (F₁: 100 %; F₂: 150 % and F₃: 200 % of the dose per plant mentioned in the FRG, 2018) applying for once (September-October), twice (September and April), thrice (September, March-April and May-June) and four times (September, November, March-April and May-June) were conducted with BARI Amra-1 and BARI Amra-2. In BARI Amra-1, the highest number of panicles per plant (10.00) and fruits retained per panicle (11.53) were counted in plants received 200 % of the fertilizer dose per plant (FRG, 2018) in combination with urea and MoP were applied twice. Again, in BARI Amra-2, maximum number of fruits per plant and the heaviest fruit were noticed in plants treated with 200% of the recommended fertilizer dose in combination with urea and MoP were applied for twice (387.0) and thrice (142.1 g), respectively. Again, 200% of the recommended fertilizer dose in combination with urea and MoP were applied for twice exhibited the highest fruit yield per plant (54.48 kg) and yield per hectare (8.50 t). Therefore, a BCR of 1.36 was obtained from cultivating BARI Amra-2 with developed fertilizer management packages. In another experiment with BARI Malta-1, the highest number of fruit set per plant (174.53) and fruits retained per plant (87.00) were recorded in plants treated with 175 % of the recommended dose at Gazipur. At RARS, Rahmatpur, significantly maximum

number of fruits per plant (104.00), the highest fruit yields (15.35kg/plant) and TSS (10.70%) were registered in plants treated with 100 % of the recommended dose plus 30 kg vermicompost. In BARI Peyara-2, pruning in March by 20 cm and 30 cm tip removal increased the leaf number and area both in the rainy and winter seasons and maximum number of fruits (87.0) was harvested in the winter season where the fruit size and fruit weight (227.7 g) were increased. In BARI Amra-2, GA₃ at 0.25, 0.50, 0.75, 1.00 and 1.50 mmolL⁻¹ concentration had exhibited no statistical difference in terms of yield and fruit quality. While, among different vegetative propagation methods performed at all the months of the year, cleft grafting in the month of June, July and September exhibited the highest success (70%) in avocado and maximum 70% graft success was recorded in the month of April in bael.

Under component-II, gummosis disease of golden apple, bael and wood apple was noted as the major problems; while anthracnose/fruit rot of Burmese grape, leaf spot, leaf blight and die back diseases were recorded as minor disease. Foliar application of different group of fungicides viz. Tilt (Propiconazole), Autostin (Carbendazim), Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) was proved effective in controlling fruit rot/anthracnose of Burmese grape. For the development of bio-rational based integrated disease management packages against gummosis of bael and golden apple, several experiments were conducted at all the locations. Scooping the disease infected areas using chisel and then covering the scooped area with Bordeaux paste (prepared by 1:1:10, CuSO₄: Lime: Water) or coaltar and then spraying the whole plant with Bordeaux mixture (prepared by 1:1:50, CuSO₄: Lime: Water) or copper fungicide for three times at 10-12 days interval showed the best management result against the gummosis of bael (68.75-83.33% reduction) and golden apple (66.67-100.00% reduction). The technology developed for gummosis disease management of bael has been selected for validation trials owing to disseminate in the farmers' field.

Under Component-III, bael and wood apple fruit borer, hog-plum beetle, trunk borer of golden apple, pomegranate fruit borer, custard apple pink mealy bug, ber fruit borer and Burmese grape fruit borer were noted as the major pests in all the four project locations. A technology regarding the bio-rational management approach against fruit borer, *Deudorix isocrates* attacking bael and wood apple has been developed where spraying of bio-pesticide group Spinosad; Tracer 45 SC, 0.4 ml/L of water or Success 2.5SC, 1.2 ml/L of water to the whole tree at 7-10 days interval for 4-5 times had the best result. Again, for controlling hog plum beetle, *Podontia 14-punctata*, it was observed that Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) treated plants exhibited successful control of this pest. The technology of management approaches against fruit borer, *Deudorix isocrates* attacking wood apple has been selected for dissemination in the farmers' field for validation trials.

Keywords: Lean Season Fruit, Varietal Improvement, Production Technology Development, Insect and Disease Management

PBRG Sub-project Completion Report (PCR)

A. Sub-project Description

- 1. Title of the PBRG sub-project:** Development of lean season fruit varieties and management packages
- 2. Implementing organization (s):** Bangladesh Agricultural Research Institute (BARI), Gazipur-1701
- 3. Name and full address with phone, cell and E-mail of Coordinator, Associate Coordinator and PI/Co-PI (s)**

Coordinator

Dr. Babul Chanra Sarker
Chief Scientific Officer
Pomology Division
Horticulture Research Centre
BARI, Gazipur-1701
Cell Phone: 01716-009319
E-mail: bsarker_64@yahoo.com

Principal Investigator (s)

- i. Dr. Babul Chandra Sarker
Chief Scientific Officer
Pomology Division, Horticulture Research Centre
BARI, Gazipur-1701
Cell Phone: 01716-009319
E-mail: bsarker_64@yahoo.com
- ii. Dr. Md. Iqbal Faruk
Principal Scientific Officer
Plant Pathology Division, BARI, Gazipur-1701
Cell Phone: 01963-533118
E-mail: mifaruk2013@gmail.com
- iii. Dr. Md. Kafil Uddin
Senior Scientific Officer
Entomology Division
BARI, Gazipur-1701
Cell Phone: 01552-334879
E-mail: mkafil77@yahoo.com

Co-Principal Investigator (s)

- i) Dr. Md. Altaf Hossain
Principal Scientific Officer
Hill Agriculture Research Station, BARI, Raikhali, Rangamati
Cell Phone: 01711-398674
E-mail: arsinchargeraikhali@gmail.com

- ii) Mst. Marufa Khatun
Senior Scientific Officer
Pomology Division, Horticulture Research Centre
BARI, Gazipur-1701
Cell Phone: 01712-464916
E-mail: marufa_07@yahoo.com
- iii) Sharmila Das Setu
Scientific Officer
Regional Agricultural Research Station, Rahmatpur, Barishal
Cell Phone: 01727-981227
E-mail: sharmilasetu@gmail.com

4. Sub-project budget (Tk.):

4.1 **Total (in Tk. as approved)** 20000000.00

4.2 **Latest Revised (if any):** 20000000.00

5. Duration of the sub-project:

5.1 **Start date (based on LoA signed):** 25 June 2018

5.2 **End date:** 31 May 2022

6. Background of the sub-project:

Nutrition is an integral component of food security. Fruits provide adequate quantity of vitamins, minerals, phytochemicals, organic acids, enzymes etc. The present annual production of fruits is about 51.0 lakh metric tons from an area of 5.1 lakh hectares (BBS, 2020), which is far behind of our requirement. The present availability of fruits is only 82 g as against the requirement of 200 g, which is too short fulfilling the national demand. Bangladesh has an immense diversity of 70 various fruit species. Except banana and papaya, most of the fruit species are seasonal. As a result, more than 54% fruits are available during mid-May to mid-August and less than 46% fruits are available during the rest eight months. People get fairly adequate quantities of fruits during the four summer months. In the other months, there is an acute shortage of native fruits. At that time, Bangladesh imports a huge quantity of fruits at a cost of hard earned foreign currency.

Therefore, year round particularly off-season fruit production has been considered urgent to make fruits available all over the year and meet the nutrition demand of the population. Among the 70 types of fruit crops, many of them have the characteristics of bearing fruits in the lean period (September to April). Improvement of those fruit crops could enhance the fruit production as well as availability in the lean season. So, the target of producing fruit beyond the normal available period can be obtained not only by developing newer variety but also by incorporating different management packages. Several researchers reported that crop management practices significantly improves the production and quality fruits. Sadhu and Ghosh (1976) obtained best growth in custard apple with the highest rate of nitrogen; flowering was advanced by 10-15 days with high dose of nitrogen and phosphorus, but low nitrogen delayed flowering by over two months. The highest yield was recorded when the recommended doses of chemical fertilizer and cowdung @15 t/ha was used in strawberry (Anonymous, 2014). Moreover,

production period can be expanded through developing modern production technologies. In mango, 150% of the fertilizer dose (100% of the dose: N: 230.41 g, P: 50.00 g K: 100 g, S: 35.97 g, Zinc: 3.60, Boron: 3.40) applied at three installments exhibited delayed harvest (07 July 2007) by 11 days as compared to control plants (26 June 2007), which can be tested in other fruit species as well (Sarker and Rahim, 2010a). Irrespective of frequency the irrigation treatments had delayed harvest by 10 days as compared to control plants (Sarker and Rahim, 2010b). On the other hand, when pruning early in November was done, after which the trees were irrigated, trees produced fruits which were harvested in May, several months earlier than the normal season (Subhadrabandhu and Tongumpai, 1990). George and Nissen (1988) reported reduced flowering and fruit set in custard apple at high temperature due to soil moisture stress. Black polythene mulch with irrigation up to field capacity at 5 days interval after plant establishment of strawberry, showed superior performance with respect to yield as well as benefit cost ratio (Anonymous, 2014). Again, insect-pest and disease management has profound impact on the production of lean season fruit and thereby mitigating nutrition demand. Maximum reduction of disease and increased yield were achieved with Thiovit 80 WP followed by Score 250 EC and Baking Soda over control in Ber. The ber mealy bug started infestation to ber twig in the first week of May, and the mean population density was 184/plant, which was increased up to 249/plant in the next week and then it was gradually decreased up to 1/plant at last week of July. Hand picking of egg masses, larvae, and adult and destruction at 5 days interval+Sumithion 50 EC @ 1.5 ml/L of water at 10 days interval manifested maximum golden apple beetle population reduction (92%) (Anonymous, 2014).

Horticulture Research Centre, BARI has 19 research sub-stations at different agro-ecological conditions across the country. In the existing minor fruit repository at Breeder Seed Production Centre, Debiganj, Phanchagarh, unique collections of various minor as well as major fruit germplasm were maintained. Moreover, at Hill Agriculture Research Station, Raikhali there had an enriched collections of minor fruit germplasm and at Joydebpur there was an organized fruit repository. In the southern region, Regional Agricultural Research Station, Rahmat, Barishal had superior minor fruits germplasm. So, through the project, characterization and evaluation of the existing resources of minor fruit germplasm were accomplished with a view to immediate releasing few good quality lean season (beyond May to August) fruit varieties. Thereafter, through validation as well as dissemination of these varieties, extended availability period as well as increased production of fruits throughout the year has certainly been achieved.

7. Sub-project general objective (s):

- i) Development of lean season, high yielding and good quality fruit varieties and management technologies including insects and diseases
- ii) Collection, characterization, evaluation, conservation and utilization of fruit germplasm grown in the lean season
- iii) Mitigating the nutritional deficiency, production as well as increase the availability of fruits round the year
- iv) Improve income as well as livelihood of the people

8. Sub-project specific objectives (component wise):

Component-I: Pomology Division, HRC, BARI, Gazipur-1701

- i) Development of lean season (September-April), high yielding and good quality fruit varieties and management technologies
- ii) Collection, characterization, evaluation, conservation and utilization of lean season fruit germplasm
- iii) Standardization of propagation and other management techniques for major and minor fruit crops
- iv) Knowledge development through training
- v) Validation and dissemination of developed technologies to the fruit growers /farmers /NGOs/extension personnel/other stakeholders
- vi) Upliftment of income as well as livelihood of the people

Component-II: Plant Pathology Division, BARI, Gazipur-1701

- i) Identification of important diseases and their incidence and severity of predominant lean season fruit crops
- ii) Determination of protective measures taken by the growers against major diseases of lean season fruits
- iii) Development of suitable disease management packages against major diseases of lean season fruit crops
- iv) Validation and dissemination of developed technologies

Component-III: Entomology Division, BARI, Gazipur-1701

- i) Documentation of pest status and its' severity
- ii) Development of an effective and suitable management approach(es) against major pests of important lean season fruit crops
- iii) Validation and dissemination of developed insect management technologies

9. Implementing location (s):

The sub-project activities like collection and evaluation of lean season fruit germplasm, varietal improvement, molecular characterization, research works on production and management technologies, pest and diseases management technologies were performed in four different locations. The locations include different AEZs having ecological, environmental and edaphological variations. All the three components executed their experiments in all the four locations. The sub-project locations are described as follows-

Location-1. Pomology Division, HRC, BARI, Joydebpur, Gazipur

The premier research activities were conducted in the fruit research farm of Pomology Division, BARI, Joydebpur, Gazipur. Sub-project Coordinator and Principal Investigator also performed their duties from here. Geographically the location is in 23°59'30.0"N latitude and 90°24'47.2"E longitude. The field was distinguished by silty-clay soil with average pH 7.4 under the Madhupur Tract (AEZ 28)



characterize by mean annual temperature varies from maximum 36°C in summer to minimum 12.7°C in winter with average annual rainfall of 2376 mm.

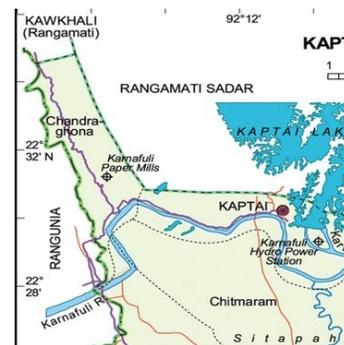
Location-2. Breeder Seed Production Centre, BARI, Debiganj, Panchagarh

Breeder seed production Centre, Debiganj, Panchagarh is in the northern territory of Bangladesh and had a fruit repository where previously planted fruit germplasm existed. Geographically the location is situated in between 26°05'56.4"N latitude and 88°46'02.2"E longitude. The location is under the AEZ no. 1 which is characterized by high to medium high land with sandy loam, loamy and silty clay-loam soil.



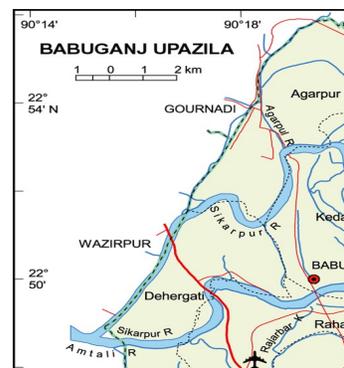
Location-3. Hill Agricultural Research Station, BARI, Raikhali, Kaptai, Rangamati

The location is under the Chittagong Hill Tract. The Hill Agricultural Research Station is situated in the south-eastern part of Bangladesh. Performances of different germplasm, research activities of different components had been performed here. The geographic position of this station is in between 22°28'06.2"N latitude and 92°08'26.6"E longitude. The area is under the AEZ no. 29 where the land topography is high having yellow brown to strong brown soil.



Location-4. Regional Agricultural Research Station, BARI, Rahmatpur, Barishal

Regional Agricultural Research Station is situated in Rahmatpur union of Babuganj upazila under Barishal district. The location is in the southern part of Bangladesh. The area is characterized by short winter, heavy shower and soil salinity to some extent. Geographically the area is in between 22°47'02.0"N latitude and 90°17'39.1"E longitude. This is under the AEZ no. 13 where the land is characteristically medium low to low and the soil is heavy silty clay and alkaline.



10. Methodology in brief (with appropriate pictures):

Component-I: Pomology Division, HRC, BARI, Gazipur-1701

The prime focus of this project was to ensure fruit availability throughout the year. Pomology Division, HRC in collaboration with Entomology and Plant Pathology Division, BARI, Gazipur has been implemented the project activities. Research on collection of new germplasm and characterization as well as evaluation of the existing and new lean season

fruit germplasm and development of improved propagation and management technologies were performed at the Breeder Seed production Centre, Debiganj, Phanchagarh; Hill Agriculture Research Station, Raikhali; RARS, Rahmatpur, Barishal and Pomology Division, HRC, BARI, Joydebpur, Gazipur in order to develop the modern varieties and management technologies ensuring quality fruit production in the lean season (September-April).

Briefly, the following research activities were performed through the implementation of the proposed research project:

- Germplasm collection, characterization, evaluation, conservation, documentation and utilization of lean season fruit crops
- Standardize propagation techniques and develop other management packages for major and minor fruit crops growing beyond the peak season (May-August)
- Validate and disseminate the developed technologies to the fruit growers/farmers/NGOs/Extension personnel/other stakeholders

As per requirements of the proposed research project the following research programs were implemented:

Experiment No 1. Survey on lean season fruit production in Bangladesh

Baseline survey is an important task in conducting any research work. Under the present research project a base line survey was planned and executed in four project locations; Barishal, Panchagarh, Rangamati and Gazipur during 2018-2019. For conducting survey a questionnaire was prepared. At each location production and management related information of lean season fruit crops were collected from 50 participants. The participants were selected randomly from 5 Upazilas each of Barishal, Panchagarh, Rangamati and Gazipur districts with the help of Upazila Agriculture Officer (UAO). The collected information was compiled and reported.



Figure 1. Interview taken on lean season fruit production

Experiment No 2. Collection and evaluation of lean season fruit germplasm at Joydebpur, Gazipur

At Pomology Division, Joydebpur, Gazipur; 8 germplasm of bullock's heart, 12 of custard apple, 3 of ber, 2 each of bael and wood apple and one of apple were collected and the collected superior germplasm have been planted in the Fruit Research Farm (Table 1) during 2018-2019. The characterization and evaluation of those germplasm are going on.

Table 1. Lean season fruit germplasm collected at Pomology Division, Joydebpur, Gazipur

SL. No.	English name	Scientific name	Accession number
1	Bullock's heart	<i>Annona reticulata</i>	AR Joy-007, AR Joy-008, AR Joy-009, AR Joy-010, AR Joy-011, AR Joy-012, AR Joy-013, AR Joy-014
2.	Custard apple	<i>Annona squamosa</i>	AS Joy-005, AS Joy-006, AS Joy-007, AS Joy-008, AS Joy-009, AS Joy-010, AS Joy-011, AS Joy-012, AS Joy-013, AS Joy-014, AS Joy-015, AS Joy-016
3.	Bael	<i>Aegle marmelos</i>	AM Joy-006, AM Joy-007
4.	Wood apple	<i>Dillenia indica</i>	DI Joy-007, DI Joy-008
5.	Apple	<i>Malus domestica</i>	MD Joy-001

Experiment No 3. Standardization of propagation technique for avocado (*Persea Americana* L.)

The experiment was conducted at the Research Field of Pomology Division, HRC, BARI, Gazipur during 2018-2019. The climate is humid tropical with moderate temperature. Four method of propagation namely T₁: cleft grafting, T₂: veneer grafting, T₃: patch budding and T₄: T - budding were tried in all twelve months of the year starting from January to December with three replications and 10 plants were maintained each replication. For raising rootstocks, large sized fruits from vigorous trees were collected and the seedlings were raised in the potting medium of 1:1:1 (soil: sand: Farmyard Manure) for rootstock purpose. Four to six months old vigorous seedlings were used as rootstock for grafting/budding. The shoots of current season's growth of three to four months age from elite trees were used as scion material. The leaves from the scion shoots were removed 3 days prior to grafting. The grafting/budding was done on 15th of every month. The survival and growth of scion was recorded after 3 months of budding/grafting. The number of transplantable grafts/budlings was recorded after one year of budding/grafting. The data were analyzed using standard statistical procedures as described by Gomez and Gomez (1984).

Experiment No 4. Effect of split application of fertilizer on manipulating harvest time, yield and quality of BARI Amra-1

Golden apple is one of the most popular and market demanding minor fruit in Bangladesh. Besides normal bearing season (April-June), BARI Amra-1 possesses the feature of bearing fruits in the lean season; but due to nutrient deficiency and inadequate cultural practices, it bears less fruits beyond the normal period. The experiment was performed at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2018 to June 2021. BARI Amra-1 was used in this study as variety. The experiment was laid out in Randomized Complete Block Design (Factorial) with 3 replications. Here, single plant was considered as an experimental unit which was replicated for three times. The fertilizer doses i. e., F₁: 100 % of the dose (N: 100 g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018 in combination with four application methods

were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and urea and MoP were applied in splits as per treatments. Urea and MoP were splitted I₁: twice (September and April), I₂: thrice (September, March-April and May-June) and I₃: four times (September, November, March-April and May-June) and the other application method was I₀: the application of whole urea and MoP at a time (September-October). Weeding was done before each of the fertilizer application and light irrigation was applied immediately after fertilizer application for better uptake of nutrient by the plants. Insecticide (Cypermethrin @ 2 ml per litre) was sprayed once after fruit set and fungicide (Carbendazim @ 2 g per litre) was also applied once after a five day long rain in May 2021. The data on the following parameters like plant height, base girth, canopy spread (N-S & E-W), final canopy spread (N-S and E-W), panicle per plant, fruit set per panicle, fruits retained per panicle were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Experiment No 5. Effect of split application of fertilizer on manipulating harvest time, yield and quality of BARI Amra-2

BARI Amra-2 bears flowers in March-April and subsequently fruit is harvested during June-July. Rarely, it bears fruits in the winter. But fertilizer management may help in bearing flowers as well as fruits in the off-season. That is why the experiment was designed to ensure vitamin-C enriched fruits throughout the year. The experiment was performed at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2018 to June 2021. BARI Amra-2 is used in this study as variety. The experiment was laid out in a Randomized Complete Block Design (Factorial) with 3 replications. Here, single plant was treated with individual treatment which was replicated for three times. The fertilizer doses i. e., F₁: 100 % of the dose (N: 100 g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018 in combination with four application methods were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and the rest of urea and MoP are being applied in splits as per treatments. Urea and MoP were splitted I₁: twice (September and April), I₂: thrice (September, March-April and May-June) and I₃: four times (September, November, March-April and May-June) and the other application method was I₀: the application of whole urea and MoP at a time (September-October). Weeding was done before each of the fertilizer application and light irrigation was applied immediately after fertilizer application for better uptake of nutrient by the plants. Insecticide (Cypermethrin @ 2 ml per litre) was sprayed once after fruit set and fungicide (Carbendazim @ 2 g per litre) was also applied once after a five day long rain in May 2021. The data on the following parameters like plant height, base girth, canopy spread (N-S & E-W), final canopy spread (N-S and E-W), panicle per plant, fruit set per panicle, fruits retained per panicle were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Experiment No 6. Effect of leaf to fruit ratio on yield and quality of sweet orange

BARI Malta-1 is a widely accepted and cultivated sweet orange variety throughout the country especially in the southern region of Bangladesh. It is a profusely bearing variety. Huge bearing leads to deteriorate plant energy. Again, after a heavy flash in a year results in a poor fruiting in the next year. And thus, the plants loss its potentiality to produce favorable yield. Furthermore, quality of fruits can be reduced if huge number of fruits are retained continuously. Therefore, the present investigation was undertaken to find out suitable leaf to fruit ratio for optimum yield and to observe the quality of fruits in respect to leaf-fruit ratio.

Planting material: BARI Malta-1

Treatments: Different leaf to fruit ratio

Control, 25:1, 50:1, 75:1, 100:1 and 125:1

Design: RCBD; Replication: 3

Experiment No 7. Effect of fertilizer application on yield and quality of sweet orange

In Bangladesh where the monsoon climate has relatively high annual mean temperature and large annual mean rainfall, favors the mineralization of soil organic matter and minerals, and thus increases the risk of nutrients leaching, which has become one of the predominant degradation processes of soil fertility (Sun *et al.*, 2000). Sweet orange var. BARI Malta-1 is one of the most important members among citrus fruits grown in the country. Best fertilization strategies to increase yields and quality of the two crop is of great significance to economical growth. Citrus is perennial and evergreen plant with many flowers and requires a large amount of nutrients. Applying proper compound fertilizers has been shown to enhance the growth, increase yield and improve quality of citrus (Yu, 2000; Wen and Cai, 2001). The experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to March 2022 and onward to find out a suitable fertilizer dose with respect to growth, yield and fruit quality of sweet orange. BARI Malta-1 was used in the study as variety. The experiment was laid out in Randomized Complete Block Design with 4 replications. Four different levels of fertilizer i.e., T₁: 100 % of the dose (N: 179 g, P: 79 g, K: 88 g, S: 18 g, Zn: 32 g, B: 1.0 g and cowdung: 15 kg); T₂: 125 % of the dose; T₃: 150% of the dose and T₄: 175% of the dose per plant mentioned in the FRG, 2018 were used as treatments of the experiment. In control plants only 30 kg cowdung was used in two equal splits; one in October and the other in May. Fertilizers like cowdung, P, S, Zn and B were applied as basal dose on October just after fruit harvest and urea and Mop were applied in three splits, October, March and May. The data on the following parameters like plant height, base girth, number of fruits set per plant, fruits retained per plant were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Experiment No 8. Effect of time and level of pruning on growth, yield, and quality of guava

BARI Peyara-2 is a widely accepted and cultivated guava variety throughout the country. It is a variety of profuse bearing with the yield potentiality of about 25-30 t/ha. It has year-round production characteristics. But due to heavy bearing in regular season (June to August) and lack of new shoots during the month of September to April, it fails to bear optimum level of fruits in the lean period when there is a huge demand of fruits throughout the country. Sahar and Abdel-Hameed (2014) mentioned that pruning is required to stimulate the growth of productive shoots and eliminate unproductive shoots or shoots that point inward, facilitate the plants' maintenance and form tree canopies (young plants). Severity of insect-pest attack is much in the monsoon but low in the dry period. Fruit quality is also better in fruits obtained in the dry period. The experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to July 2021 and onward to find out a suitable pruning time and level of pruning with respect to sustainable growth, yield and fruit quality of guava. BARI Peyara-2 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design with 3 replications. Three different pruning times i.e., Mid-March, mid-July and mid-October and four pruning levels (tip removal) viz., 0-cm, 10-cm, 20-cm and 30-cm were used as treatments of the experiment. Regular fertilization, irrigation and weeding were done as and when necessary. Insects and diseases were controlled by applying biological and chemical pesticides and fungicides. The data on the following parameters like number of main branch, number of leaves at new shoot, number of fruits harvested in summer (May-September) and winter (October-April), individual fruit weight, fruit yield per plant and TSS content of fruits were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Experiment No 9. Effect of GA₃ on fruit quality of golden apple

Plant growth regulators have the potentiality to manipulate the quality of fruits when applied exogenously. Gibberellic acid (GA₃) is one of the plant growth regulators, which can improve fruit quality by minimizing seed size as well as increasing the fruit size and edible portion of fruit. Besides, other fruit traits like TSS, shelf life, nutrient and vitamin content of fruits can be manipulated through the application of GA₃ at different concentrations and stages of fruit development. So, the experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to July 2021 and onward to find out an appropriate dose of GA₃ and fruit development stages when the influence of the growth regulator was the most with respect to fruit quality of golden apple. BARI Amra-2 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design with 3 replications. Three different fruit development stages i.e., pre-flowering stage, full bloom stage and fruit set stage and five different concentrations GA₃ viz., 0.25 mmol/L, 0.50 mmol/L, 0.75 mmol/L, 1.00 mmol/L and 1.50 mmol/L along with control (only distilled water or 0 mmolL⁻¹) were used as treatments of the experiment. Regular fertilization, irrigation and weeding were done as and when

necessary. Insects and diseases were controlled by applying biological and chemical pesticides and fungicides. The data on the following parameters like individual fruit weight, seed weight, skin weight, edible portion and TSS content of fruits were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Experiment No 10. Collection and evaluation of lean season fruit germplasm in the hilly region of Rangamati hill district

Various promising fruit germplasm having off-season fruit bearing characteristics are being collected from the hilly region of Rangamati district. The collected germplasm have been planted in the research field of Hill Agriculture Research Station, BARI, Raikhali, Rangamati under the project. The characterization, evaluation and conservation of those germplasm are being continued.

Table 2. Germplasm collected from the hilly region of Rangamati at the Hill Agriculture Research Station, Raikhali, Rangamati

SL. No.	Local name	English name	Scientific name	Accession number
1	Aata	Bullock's heart	<i>Annona reticulata</i>	AR Rai-003 AR Rai-004 AR Rai-005
2	Kul	Ber	<i>Ziziphus mauritiana</i>	ZJ Rai-010
3	Jambura	Pummelo	<i>Citrus grandis</i>	CG Rai-030 CG Rai-031
4	Nashpati	Pear	<i>Pyrus communis</i>	PC Rai-001
5	Strawberry	Strawberry	<i>Fragaria × ananassa</i>	FA Rai-001
6	Avocado	Avocado	<i>Persea americana</i>	PA Rai-001
7	Sharifa	Custard apple	<i>Annona squamosa</i>	AS Rai-001

Experiment No 11. Evaluation of wood apple (*Feronia limonia*) germplasm in the hilly areas of Rangamati

Wood apple is an important minor fruit. It is also a potential and promising lean season fruit crop. Again, Rangamati hilly area has a good diversity of wood apple germplasm. The experiment was conducted at the Research Farm, HARS, Raikhali, Rangamati during 2017-2020. Four wood apple germplasm viz. FL Rai-001, FL Rai-002, FL Rai-003 and FL Rai-004 were evaluated. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g MoP and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer.

Experiment No 12. Evaluation and characterization of jamun germplasm at the hill valley of Rangamati district

Jamun is one of the important nutritious and antioxidant enriched minor fruits in Bangladesh. It is a good source of iron, apart from the usual contents, e.g., minerals, sugars, protein and others (Bose *et al.*, 2001). In Bangladesh, there is no named or standard cultivar of jamun under cultivation. Due to the lack of variety, it is losing area under cultivation in Bangladesh. There is a lot of superior germplasm of jamun available in Chittagong Hill Tracts. During 2012 a total of 9 jamun germplasm were collected from different parts of hill districts and planted in the research field of HARS, Raikhali, Rangamati. After 5 years of consecutive evaluation and characterization, 2 were selected for further close supervision. The screened 2 germplasm were Sc Rai-002 and SC Rai-008. The two germplasm were then evaluated for 3 years (2017-2020) for releasing as variety. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g MoP and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. Plant growth, yield and yield contributing characters were recorded and tabulated. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer.

Experiment No 13. Study on propagation technique in bael with cleft grafting

Vegetative propagation is the method of fruit tree propagation where true to type plants having the characters of mother plant can be developed. An experiment on vegetative propagation techniques through cleft grafting was performed at HARS, Raikhali, Rangamati during 2019-2021. Grafting was performed in all the twelve months of the year starting from January to December with three replications and 10 plants were maintained each replication. Ten to twelve months old healthy seedlings were used as rootstock for grafting. The shoots of current season's growth of three to four months age from elite trees were used as scion material. The grafting was done on the 1st week of every month. The survival and growth of scion was recorded after 3 months of grafting. The number of transplantable grafts was recorded after one year of grafting. The data were analyzed using standard statistical procedures as described by Gomez and Gomez (1984).

Experiment No 14. Survey, collection and evaluation of lean season fruit germplasm

Considering vegetative and fruiting characters, yield of plants and pests as well as disease infestation, some promising fruit germplasm of Burmese grape, sapota, pummelo, ber, jaboticaba, river ebony and phalsa are being collected and planted in the research field of BSPC, Debiganj, Panchagarh during 2019-2022. Moreover, the evaluation of the existing promising germplasm (bael, aonla, bullock's heart, custard apple and wood apple) is being performed with good care and management.

Table 3. Germplasm of lean season fruit crops collected at the BSPC, Debiganj, Panchagarh

SL. No.	Local name	English name	Scientific name	Accession number
1	Burmese grape	Burmese grape	<i>Baccaure aramiflora</i>	BR Deb-001
2	Safeda	Sapota	<i>Manilkara zapota</i>	MZ Deb-001 MZ Deb-002

SL. No.	Local name	English name	Scientific name	Accession number
3	Jambura	Pummelo	<i>Citrus grandis</i>	CG Deb-001 CG Deb-002
4	Boroi	Ber	<i>Ziziphus mauritiana</i>	ZJ Deb-001
5	Jaboticaba	Jaboticaba	<i>Plinia cauliflora</i>	PC Deb-001 PC Deb-002
6	River ebony	River ebony	<i>Diospyros mespiliformis</i>	DM Deb-001
7	Phalsa	Phalsa	<i>Grewia asiatica</i>	GA Deb-001

Experiment No 15. Evaluation of bullock's heart (*Annona reticulata*) germplasm

Bullock's heart is one of the popular off-season fruit crops grown in Bangladesh. It has important nutritional value. For its appealing taste its popularity is well known. Five bullock's heart germplasm has been grown well at BSPC, Debiganj, Panchagarh. Out of 5, two produced flower as well as fruits from the year of 2018. Therefore, evaluation and characterization of those germplasm were conducted. Data on vegetative and reproductive status like plant height, base girth, date of flowering, number fruits per plant, yield and other yield contributing characteristics were recorded and analyzed statistically.

Experiment No 16. Variability estimation among bael (*Aegle marmelos*) germplasm in northern region of Bangladesh

The experiment was conducted at the Horticulture Research Farm, BSPC, Debiganj, Panchagarh during 2018-2021. There were 49 plants of 7 different germplasm in the farm. Four germplasm was selected as treatment during the experiment viz., AM Deb-001, AM Deb-002, AM Deb-003, and AM Deb-005. The treatment (germplasm) was replicated thrice considering each plant as one replication following RCB Design. Planting distance was maintained as 5×5 m in both ways. Data on plant height, fruit length, fruit diameter, individual fruit weight, seed weight, rind weight and pulp weight were recorded. The qualitative data were noted on the basis of organoleptic test with a panel of 10 persons. The data were recorded and statistically analyzed.

Experiment No 17. Evaluation of carambola germplasm

Carambola is a juicy minor fruits containing proportional amount of vitamin-C. At BSPC, Debiganj, Panchagarh 23 germplasm of carambola was collected and planted in the research field. The germplasm were evaluated and characterized during 2019-2021. Data on vegetative growth characteristics and yield characteristics were recorded and analyzed.

Experiment No 18. Collection and evaluation of wood apple (*Feronia limonia*) germplasm

The experiment was conducted at the Horticulture Research Farm, BSPC, BARI, Debiganj, Panchagarh during 2019-2021. Six woodapple germplasm viz. FL Deb-001, FL Deb-002, FL Deb-003, FL Deb-004, FL Deb-005 and FL Deb-006 were evaluated. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g M_oP and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid

(TSS) of fruit pulp was determined with the help of hand refractometer. The recorded data on different parameters were statistically analyzed by using MS excel 2013.

Experiment No 19. Collection and evaluation of peach fruit germplasm

Peach fruit is an exotic fruit. But it grows well in Bangladesh. The experiment was conducted at the Horticulture Research Farm, BSPC, BARI, Debiganj, Panchagarh during 2018-2021. Five peach fruit germplasm viz. PP Deb-001, PP Deb-002, PP Deb-003, PP Deb-004 and PP Deb-005 were included in evaluation. Intercultural operations were done as and when necessary. All trees of the germplasm were of 5-7 years age and PP Deb-005 germplasm was 3 years old. Observations were recorded on plant height, base girth, canopy spread, days of flowering, days of full bloom (at 80% flowers open), days to fruit set and harvest of fruit (tree-ripe stage), fruit length and diameter, fruit weight, pulp weight, peel weight, fruit thickness, total soluble solids (TSS), seed per fruit, seed weight, edible portion (%) and yield per plant status. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit by slide calipers. Pulp, skin and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer. The recorded data on different parameters were statistically analyzed by MS excel 2013.

Experiment No 20. Standardizing of propagation technique of important lean season fruit crops

In this experiment, bullock's heart and wood apple are being used as plant material. Propagation techniques i.e., grafting, budding, layering and cutting were used as treatments. The experiment has been laid out in RCBD design with three replications.

Experiment No 21. Collection and evaluation of lean season fruit germplasm in the southern region of Bangladesh

Twenty nine germplasm of 7 lean season fruits have been collected and planted in the Horticulture Research Farm of RARS, Barishal. Only the vegetative parameters of the germplasm were characterized and compared.

Experiment No 22. Effect of vermi-compost on growth, yield and quality of sweet orange

Sweet orange is now one of the most demanding citrus fruits especially in the southern region of Bangladesh. Among the varieties released by different organizations the variety BARI Malta-1 is the leading citrus fruits cultivated throughout the country. It is a profuse bearing fruit variety. But one of the major problems is that due to lack of nutrient availability it fails to give potential yield when the plants become 7-8 years old. So, nutrient supply is a must to sustain the productivity of BARI Malta-1. Hence, the present experiment was undertaken to develop a nutritional package to attain long term sustainability for fruit production as well as for maintaining soil health and productivity. The experiment was conducted at Regional Agricultural Research Station, Rahmatpur, Barishal during March 2019 to February 2022. BARI Malta-1 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The fertilizer doses i. e., T₁: 100 % of the recommended fertilizer dose; T₂: 100 % of the recommended

fertilizer dose plus 10 kg vermicompost, T₃: 100 % of the recommended fertilizer dose plus 20 kg vermicompost and T₄: 100 % of the recommended fertilizer dose plus 30 kg vermicompost were used as treatments of the experiment. All fertilizer doses of cowdung, P, S, Zn, B was applied as basal dose and urea and MoP and vermicompost was applied in three splits, March, May and October (just after harvest of fruits). The data on the following parameters like plant height, base girth, canopy spread, number of fruits per plant, individual fruit weight, yield and TSS were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme R. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance

Component-II. Plant Pathology Division, BARI, Gazipur-1701

Experiment No 23. Survey and identification of major diseases of lean season fruit crops in the RARS, Basishal, Breeder Seed Production Centre, BARI, Debiganj, Panchagarh; Hill Agriculture Research Station (HARS), Raikhali and Gazipur regions of the country

Three upazila namely Barishal Sadar, Uzirpur and Nesarabad and RARS, BARI, Rahmatpur farm of Barisal district; Three upazila namely Sadar, Debiganj and Boda of Panchagarh; Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and in Gazipur district only Gazipur sadar upazilla and BARI head office Fruit Research Farm, BARI, Gazipur, Bangladesh were surveyed. Farmers home orchards of each location, fruit orchards at BARI head office, RARS, BARI, Rahmatpur, Barishal, Breeder Seed Production Centre of BARI, Debiganj, Panchagarh and Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati were also surveyed and noted the percent disease and representing disease samples along with the soil brought to Plant Pathology Laboratory for the identification of the causal pathogen. Pieces of the diseased tissues were sterilized by 10% chlorox for 2-3 minutes, followed by several rinses with sterile distilled water and placed on Potato dextrose agar (PDA). After a day single spore was collected using sterilized glass needle under a dissecting microscope and transferred to Petri plates containing PDA media and incubate at 25±5°C up to 12 days. After incubation the appearance of the colonies and the vegetative and reproductive structures of fungus were examined under sterio as well as compound microscope.



Debiganj, Panchagarh



Rahmatpur, Barishal

Figure 2. Interview taken on diseases of lean season fruit crops

Experiment No 24. Screening of the chemical fungicides against fruit rot/anthracnose disease of Burmese grape

For screening of chemical fungicides against fruit rot/anthracnose disease of Burmese grape, one experiment for the management of fruit dropping and foliar disease of Burmese grape has been conducted at the Fruit Research Farm, Horticulture Research Centre, BARI, Gazipur. There are 5 treatments viz. T₁: Foliar spray of Autostin @ 1 g/L water, T₂: Foliar spray of Secure @ 2 g/L water, T₃: Foliar spray of Dithane M 45 @ 2 g/L water, T₄: Foliar spray of Tilt @ 0.5 ml/L water and T₅: Control. All the fungicides were sprayed after initiation of disease and three sprays were applied at 12-15 days interval. Data were recorded on disease incidence 15 days after final spraying.

Experiment No 25. Development of bio-rational based integrated management packages against gummosis disease of bael

For the development of bio-rational based integrated management packages against gummosis of bael the experiments were conducted at the Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh and Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati. There were 3 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide, T₂: Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide and T₃: Control. The treatments were added three times viz. 1st application was done during February-March 2020, 2nd application was done during May-June 2020 and 3rd application was done during September-October 2020. The experiment was laid out in RCBD with three replications. Data were collected on the reduction of disease severity after 3rd time application of treatments.



Gummosis diseased plant

Scooping the disease infected areas with sounding some healthy barks

Covered the scooping area with Bordeaux paste/coal tar+ Foliar application of Bordeaux mixture/ copper fungicide

Figure 3. Applying treatments against gummosis disease of bael

Experiment No 26. Development of bio-rational based integrated disease management packages against gummosis disease of golden apple

For the development of bio-rational based integrated management packages against gummosis of golden apple the experiments were conducted at the Fruits Research Farm, HRC, BARI, Gazipur; RARS, Rahmatpur, Barisal; Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati and Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh. There were 3 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide, T₂:

Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide and T₃: Control. The treatments were added three time viz. 1st application was done during February-March 2020, 2nd application was done during May-June 2020 and 3rd application was done during September-October 2020. The experiment was laid out in RCBD with three replications. Data were collected on the reduction of disease severity after 3rd time application of treatments.



Gummosis disease infected golden apple plant

Scoping the disease infected areas with sounding some healthy barks

Covered the scooping area with Bordeaux paste/coal tar+ Foliar application of Bordeaux mixture/ copper fungicide

Figure 4. Applying treatments against gummosis disease of golden apple

Experiment No 27. Field validation of integrated disease management packages against gummosis disease of bael

For the field validation of integrated disease management packages against gummosis of bael the experiments were conducted at the Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh and Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati. There were 2 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/copper group of fungicide and T₂: Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/copper group of fungicide. The treatments were added three time viz. 1st application was done during February-March 2021, 2nd application was done during May-June 2021 and 3rd application was done during August-September 2021. The experiment was laid out in RCBD with three replications. Data were collected on the reduction of gummosis disease severity after 3rd time application of treatments.



Figure 5. Field validation of integrated disease management packages against gummosis disease of bael (previous it called wood apple) at BSPC, Debiganj and HARS, Raikhali

Component-III. Entomology Division, BARI, Gazipur-1701

Experiment No 28. Survey and monitoring of insect pests of lean season fruit crops

Three upazilas namely; Barishal Sadar, Uzirpur and Swarupkati and RARS, BARI, Rahmatpur farm of Barishal district. Three Upazilas namely Panchagarh Sadar, Debiganj and Boda of Panchagarh district as well as, Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and Gazipur Sadar upozilla including BARI Head Farm of Gazipur district were surveyed. Farmers home orchards of each location, fruit orchards at BARI head office, RARS, BARI, Rahmatpur, Barishal, Breeder Seed Production Centre of BARI, Debiganj, Panchagarh and the Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati have been surveyed visually checked to count all the insects pests populations to identify the insects noted to the notebook. In the farmer's field, surveys on the lean season fruit crops (Bael, custard apple, ber, golden apple, Burmese grape, strawberry, tamarind etc.) were done several times during the cropping season.



Figure 6. Farmer's interview in Panchagarh, Barishal and Rangamati

Experiment No. 29. Management approaches against fruit borer, *Deudorix isocrates* attacking wood apple

The experiments were conducted to develop management approaches against fruit borer, *Deudorix isocrates* attacking wood apple at the Fruit Research Farm, HRC, BARI, Gazipur and Breeder Seed Production Centre (BSPC), Debigonj, Panchgarh during 2020 to 2021. The experiment was laid out in RCBD with three replications. The age of the plant around 8-10 years old and plant to plant distance three meter. Five treatment packages for fruit borer, *Deudorix isocrates* management including untreated control were undertaken, such as T₁: Sanitation+ Polythene bagging when the fruits were up to 5 cm, T₂: Sanitation + Bio-pesticide Minto plus (Bt+Spinosad) @ 1g/ litre of water, T₃: Sanitation +Spraying of Spinosad (Success 2.5SC) @ 1.2 ml/L of water, T₄: Sanitation +Spraying of Azadirachtin (Fytomax 3 EC) @ 1.0 ml/litre of water, T₅: Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water, T₆: untreated control. The experiment data were collected before treatments, 15, 30 and 45 days after application of treatments. Total number of fruit, healthy and infested fruit in whole tree were also recorded insitu for visible fruit infestation of wood apple. The fruit infestation was calculated on the basis of weight, based on total number of fruits and infested fruits in different treatments and the per cent of fruit infestation was worked out. The data were analyzed by R software. The fruit infestation was subjected to arcsine transformation before the analysis of variance (ANOVA) and means were separated by turkey's multiple range tests.



Figure 7. Field view of fruit borer infestation at BSPC, Debiganj, Panchagarh

Experiment No. 30. Development of management approach against hog plum beetle, *Podontia 14-punctata* attacking golden apple

The experiment was conducted at the golden apple orchard of Fruit Research Farm, BARI, Gazipur and Regional Agricultural Research Station (RARS), BARI, Rahmatpur, Barishal during 2019 to 2020. The experiment was laid out in randomized complete block design (RCBD) with 5 treatments and 3 replications. A total of 15 trees of around 5-7 years old were used for this study. One golden apple tree was considered as one treatment replication. Plant to plant distance was 4m × 4m. The treatments were assigned as follows : T₁: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape, T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water), T₃: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval, T₄: Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @2.0 ml/litre of water and T₅: Untreated Control. Sanitation was done twice in a week. Each spray was done by manually driven foot pump sprayer as a full cover spray for the golden apple tree. The leaves, branches and the main trunk of each tree were sprayed with spray mixture through the outlet of the nozzle. Application was made in such a way that the spray pressure would not knock down the pest from the tree. The pre treatment data were recorded on the number of 1st, 2nd, 3rd and 4th instars larvae and adults. One square meter (1 m²) quadrat was placed in the central position of the east side canopy structure. The number of adults and larvae was counted from inside each quadrat under different treatments at one day before the first spray and 1 week after each spray. The number of healthy and infested leaves was counted from inside each quadrat under different treatments at one day before the first spray and one week after each spray.



Figure 8. Field view of management approach against hog plum beetle

11. Results and Discussion: (With appropriate pictures)

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

At Pomology Division, BARI, Joydebpur, Gazipur

Experiment No 1. Survey on production and management of lean season fruit crops in Bangladesh

At Barishal location, among 50 participants 8 planned orchards of golden apple, 5 orchards of sweet orange (BARI Malta-1) and 3 orchards of local guava were found. Besides, almost every household possesses 1-2 plants of bullock's heart, custard apple, velvet apple, ber, local guava, golden apple, date palm, lime, lemon, bael, sapota, pummelo, wax apple, tamarind etc. The plants are poorly managed (Table 4).

Table 4. Status of lean season fruit crops in Barishal, Panchagarh, Rangamati and Gazipur region

Location	Fruit crop name	Cultivating method	No. of orchard	Plants per orchard	Plants per homstead
Barishal	Golden apple	Orchard	8	42	2
	Sweet orange	Orchard	5	120	1
	Guava (Local)	Orchard	3	56	3
	Velvet apple	Homestead			2
	Custard apple	Homestead			1
	Lemon	Homestead			2
	Sapota	Homestead			2
	Lime	Homestead			2
	Bullock's heart	Homestead			1
	Wax apple	Homestead			1
	Tamarind	Homestead			1
	Bael	Homestead			2
	Ber	Homestead			1
	Date palm (Local)	Homestead			2
Panchagarh	Burmese grape	Orchard	5	32	1
	Indian olive	Homestead			3
	Pummelo	Homestead			2
	Carambola	Homestead			2
	Bael	Homestead			2
	Wood apple	Homestead			2
	Ber	Homestead			1
	Custard apple	Homestead			2
	Bullock's heart	Homestead			2
	Jamun	Homestead			1
	Tamarind	Homestead			1
Rangamati	Sweet orange	Orchard	3	97	2
	Dragon fruit	Orchard	3	41	2
	Pineapple	Orchard	3	556	
	Pummelo	Orchard	1	50	2
	Mandarin	Orchard	1	100	2
	Cashew nut	Orchard	1	40	

Location	Fruit crop name	Cultivating method	No. of orchard	Plants per orchard	Plants per homstead
	Longan	Orchard	1	32	
	Sapota	Homestead			2
	Bael	Homestead			2
	Wood apple	Homestead			1
	Carambola	Homestead			3
	Custard apple	Homestead			3
	Velvet apple	Homestead			1
	Jamun	Homestead			2
	Aonla	Homestead			1
	Indian olive	Homestead			1
	Phalsa	Homestead			1
	Passion fruit	Homestead			1
	Indian dillenia	Homestead			1
Gazipur	Sweet orange	Orchard	3	70	2
	Burmese grape	Orchard	3	25	2
	Bullock's heart	Homestead			1
	Custard apple	Homestead			2
	Tamarind	Homestead			1
	Jamun	Homestead			2
	Bael	Homestead			1
	Wood apple	Homestead			2
	Indian dillenia	Homestead			1
	Longan	Homestead			3
	Sapota	Homestead			2
	Carambola	Homestead			1
	Lime	Homestead			3
	Lemon	Homestead			3
	Pummelo	Homestead			2

At Panchagarh region, among the 50 participants only 5 orchards of Burmese grape were noticed. Although Indian olive, aonla and pummelo are commercially sold from that region, orchards of those were not observed in the survey. Rather in each and every household, 2-3 plants of Indian olive, 1-2 plants of pummelo, carambola, bael, wood apple, ber, custard apple, bullock's heart, jamun, tamarind etc. were recorded. The growers did not manage their fruit crops well (Table 4).

At Rangamati region, 3 well planned orchards each of sweet orange, dragon fruit and pineapple, 1 each of pummelo, mandarin, cashewnut and longan were noticed. But farmers grow only 1 or 2 plants of sapota, bael, wood apple, carambola, custard apple, velvet apple, jamun, aonla, Indian olive, phalsa, passion fruit, Indian dillenia (chalta) etc. around their residence (Table 4).

At Gazipur location, 3 well managed orchards each of sweet orange (BARI Malta-1) and Burmese grape were observed. In the locality plants of custard apple, bullock's heart, tamarind, jamun, bael, wood apple, Indian dillenia, longan, sapota, carambola, lime, lemon, pummelo etc. were noticed (Table 4).



Figure 9. Lean season fruit orchard at different project locations of Bangladesh

Experiment No 2. Evaluation of custard apple germplasm at Joydebpur, Gazipur

The evaluated 12 custard apple germplasm are in vegetative stage. Hence, plant growth characters of those custard apple genotypes have been shown in Table 5. All the genotypes were erect in nature. In case of plant height, the highest plant height (3.20 m) was recorded in the genotype AS Joy-03 and the minimum height (2.0 m) was recorded in AS Joy-05. Base girth varied from 12.47 cm to 19.65 cm. Maximum base girth (19.65 cm) was found in the genotype AS Joy-07 while minimum base girth (12.47cm) was noted in AS Joy-10. The genotype AS Joy-07 had the highest (2.45 m) canopy spreading in East-West orientation while the genotypes AS Joy-05 exhibited the lowest (1.60 m) canopy spreading in East-West direction. In case of north-south direction, AS Joy-13 gave the highest (2.6 m) canopy spreading in north-south direction while the lowest (1.60 m) canopy spreading was recorded from the genotype AS Joy-02 (Table 5).

Table 5. Plant growth/vegetative characteristics of custard apple genotypes

Genotypes	Plant habit	Plant height (m)	Base girth (cm)	E-W canopy (m)	N-S canopy (m)
AS Joy-01	Erect	2.30	12.85	1.70	1.63
AS Joy-02	Erect	2.20	13.32	1.62	1.60
AS Joy-03	Erect	3.20	18.78	2.05	2.14
AS Joy-04	Erect	2.05	15.60	1.74	1.83
AS Joy-05	Erect	2.00	14.85	1.60	1.75
AS Joy-06	Erect	3.00	17.47	2.18	2.40
AS Joy-07	Erect	2.90	19.65	2.45	2.36
AS Joy-08	Erect	2.05	14.00	1.80	1.80
AS Joy-09	Erect	2.35	15.67	1.80	1.70
AS Joy-10	Erect	2.70	12.47	1.67	1.74
AS Joy-11	Erect	2.80	15.76	2.07	2.0
AS Joy-12	Erect	2.66	13.84	1.85	2.60
Mean	-	2.58	15.28	1.87	1.97
Range	-	2.0-3.20	12.47-19.65	1.60-2.45	1.6-2.6

For drawing a concrete result the experiment should be continued.



Figure 10. Custard apple genotypes at Pomology Division, HRC, Gazipur

Experiment No 3. Evaluation of bullock's heart germplasm at Joydebpur, Gazipur

A total of 8 bullock's heart germplasm were evaluated at Pomology Division, BARI, Gazipur. The performance results of bullock's heart are presented in Table 6. The maximum plant height (225 cm) was recorded in AR Joy-006 and AR Joy-008 germplasm. The base girth ranged between 11 cm to 22 cm. The highest base girth (22 cm) was found in AR Joy-006 germplasm and canopy ($250 \times 277 \text{ cm}^2$) was found in AR Joy-008 germplasm. Only one genotype (AR Joy-004) among eight genotypes produced fruits this year.

Table 6. Growth and yield contributing characters of bullock's heart genotypes

Genotypes	Plant height (cm)	Base girth (cm)	Canopy		No. of fruits/plant
			N-S (cm)	E-W (cm)	
AR Joy-001	155	13	190	196	-
AR Joy-002	120	11	140	160	-
AR Joy-003	209	15	210	214	-
AR Joy-004	164	12	104	114	2
AR Joy-005	143	15	146	137	-
AR Joy-006	225	22	266	260	-
AR Joy-007	205	17	230	230	-
AR Rai-008	225	19	250	277	-
Mean	180.8	15.5	192	198.5	
Range	120-225	11-22	104-266	114-277	

Most of the plants are at vegetative stage, so this experiment will be continued.



Figure 11. Bullock's heart genotypes at Pomology Division, HRC, BARI, Gazipur

Experiment No 4. Collection and evaluation of fig (*Ficus carica*) germplasm

Plant height and base girth varied from 72.3 cm to 98.1 cm and 4.60 cm to 5.62 cm, respectively. FC Joy-005 was noticed to obtain maximum plant height (98.10 cm) and FC Joy-007 exhibited minimum plant height. Number of main branch and number of fruits harvested per plant ranged from 3 to 6 and 4 to 12, respectively. Maximum number of fruits were harvested from the line FC Joy-001 following FC Joy-005. Whereas, minimum number of fruits were counted in FC Joy-007 (Table 7).

Table 7. Vegetative data of Fig germplasm at Joydebpur, Gazipur during 2020-2022

Accession No.	Number of Plants	Plant Height (cm)	Base Girth (cm)	Number of Main Branch	Number of fruits harvested
FC Joy-001	3	88.2	5.62	5	12
FC Joy-002	3	77.7	4.74	4	8
FC Joy-003	3	68.5	5.52	4	8
FC Joy-004	3	79.4	4.60	4	7
FC Joy-005	2	98.1	5.48	6	10
FC Joy-006	3	78.4	5.12	4	8
FC Joy-007	2	72.3	5.20	3	4
Mean	-	80.37	5.18	4.28	8.14
Range	-	72.3-98.1	4.60-5.62	3-6	4-12



Figure 12. Fig genotypes at Pomology Division, HRC, BARI, Gazipur

Experiment No 5. Standardization of propagation technique for avocado (*Persea Americana* L.)

Grafting success: The data revealed that highest mean success of grafting was recorded in cleft grafting (40.0%) which was higher than other methods viz. veneer grafting (13.3%), patch budding (12.5%) and T- budding (12.5%). Among the different months of grafting, the highest mean success was recorded in the month of June, July and September which was 32.5 per cent each. Among various combinations of methods and time of propagation, highest success (70%) was recorded in cleft grafting performed in the month of June, July September. This was closely followed by cleft grafting done in the month of March and August with 60 percent success. The success was lower (10%) in winter months in cleft grafting. Moderate success (up to 40 %) was recorded in cleft grafting during the months of April, May and October. In veneer grafting, highest success was only 20 percent in four summer months (June to September). T-budding and patch budding gave 20% success in the months of June, July and September whereas only 10% graft success was noted in the other months of the year (Table 8).

Table 8. Grafting success (%) in different methods of propagation practiced at different months of the year

Months	Propagation methods				Monthly mean
	Cleft grafting	Veneer grafting	Patch budding	T-budding	
January	10c	10	10	10	10.0
February	10c	10	10	10	10.0
March	60ab	10	10	10	22.5
April	30b	10	10	10	15.0
May	40b	10	10	10	17.5
June	70a	20	20	20	32.5
July	70a	20	20	20	32.5
August	60ab	20	10	10	25.0
September	70a	20	20	20	32.5
October	30b	10	10	10	15.0
November	20bc	10	10	10	12.5
December	10c	10	10	10	10.0
Mean	40.0	13.3	12.5	12.5	
Level of sig.	**	NS	NS	NS	
CV (%)	9.36	8.94	10.52	7.24	

Scion growth: As for as scion growth is concerned, it was the highest in the cleft grafting (7.97 cm) followed by veneer grafting (4.41 cm). Less growth was recorded on patch budding (2.97 cm) and T- budding (2.75 cm) after three months of grafting / budding. The mean scion growth in different months ranged from 5.9 cm to 10.3 cm, 2.8 cm to 5.6 cm, 2.0 cm to 3.9 cm and 2.1 cm to 2.9 cm in cleft grafting, veneer grafting, patch budding and T-budding, respectively but there was no significant difference among the scion length in different months. Among various combinations of propagation methods and months of propagation, highest scion growth (10.3 cm) was observed in cleft grafting performed in the month of September. This was followed by cleft grafting in the month of October with 9.4 cm scion growth (Table 9).

Table 9. Scion growth (cm) in different methods of propagation practiced at different months of the year

Months	Propagation methods				Monthly mean
	Cleft grafting	Veneer grafting	Patch budding	T-budding	
January	5.9	3.2	2.0	2.1	3.30
February	6.0	3.6	2.2	2.4	3.55
March	7.5	5.2	2.5	2.6	4.45
April	7.3	5.1	2.5	2.6	4.37
May	8.5	5.1	3.2	2.8	4.90
June	8.5	5.1	3.1	2.9	4.90
July	8.1	5.3	3.2	2.8	4.85
August	8.8	5.4	3.5	2.6	5.07
September	10.3	5.6	3.2	2.9	5.50
October	9.4	3.4	3.9	2.7	4.85
November	8.1	3.1	3.4	2.6	4.30
December	7.2	2.8	2.9	2.2	3.77
Mean	7.97	4.41	2.97	2.60	
Level of sig.	NS	NS	NS	NS	
CV (%)	9.85	7.28	7.54	8.36	

Percent transplantable grafts: The data revealed that highest transplantable grafts after one year were recorded in cleft grafting (30.8%) which was higher than other methods veneer grafting (7.5%), patch budding (3.3%) and T- budding (0.8%). Among various combinations of method and time of propagation, highest success (60%) was recorded in cleft grafting performed in the month of September. This was closely followed by cleft grafting in the month of March with 50 percent success. The numbers of transplantable grafts were very low or nil in veneer grafting, T- budding and patch budding in most of the months (Table 10).

Table 10. Percent transplantable grafts in different methods of propagation practiced at different months of the year

Months	Propagation methods			
	Cleft grafting	Veneer grafting	Patch budding	T-budding
January	10	0	0	0
February	10	0	0	0
March	50	10	10	0
April	30	0	10	0
May	30	10	0	0
June	40	10	0	0
July	40	20	10	10
August	40	10	10	0
September	60	10	0	0
October	30	10	0	0
November	20	10	0	0
December	10	0	0	0
Mean	30.8	7.5	3.3	0.8
Level of sig.	**	**	**	**
CV (%)	9.85	7.28	7.54	8.36



Figure 13. Successful cleft grafts of avocado

Experiment No 6. Effect of split application of fertilizer on manipulating harvest time, yield and quality of golden apple cv. BARI Amra-1

Effect of fertilizer doses on vegetative characters of golden apple

No significant influence due to fertilizer treatments was observed with respect to all vegetative characteristics (Table 11). Plant height, base girth, North-South canopy spread and East-west canopy spread ranged from 98.75 cm to 111.60 cm, 9.83 cm to 11.84 cm, 88.70 cm to 109.90 cm and 107.20 cm to 110.80 cm, respectively. In all the case, minimum value were recorded in plants treated with 100% of the recommended dose (FRG, 2018). While, plants treated with 200

% of the recommended fertilizer dose exhibited maximum vegetative growth except plant height which was observed higher in F₂ (150 % of the recommended dose) treatment (Table 11).

Table 11. Effect of fertilizer doses on plant height and base girth of golden apple

Treatment	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
F ₁	98.75	9.83	88.70	110.8
F ₂	111.60	11.27	108.2	107.2
F ₃	109.10	11.84	109.9	108.3
Level of significance	NS	NS	NS	NS
CV (%)	16.23	15.51	15.90	14.91

NS: Not significant, F₁: 100 % of the dose; F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

Effect of fertilizer application methods on vegetative characters of golden apple

There was no statistical variation among the treatments with respect to plant height and base girth upon fertilizer application frequencies but significant differences were noticed in North-South canopy spread and East-West canopy spread (Table 12). Plant height and base girth ranged from 89.11 cm to 118.00 cm and 9.44 cm to 11.93 cm, respectively. Here, plant height and base girth was recorded maximum at I₃ [Four splits of urea and MoP (September, November, March-April and May-June)] and I₂ [Three splits of urea and MoP (September, March-April and May-June)] treatment, respectively. The highest North-South and East-West canopy spread (113.7 cm and 110.9 cm, respectively) was observed in I₂. Three splits of urea and MoP (September, March-April and May-June)] treatment which had statistical similarity with I₁ and I₃ treatment. On the other hand, Plants where urea and MoP were applied at a time i.e., no split, showed minimum values in case of canopy growth.

Table 12. Effect of fertilizer application methods on plant height and base girth of golden apple

Methods of fertilizer application	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
I ₀	89.11	9.44	80.08b	79.00b
I ₁	110.78	11.07	109.1a	136.3a
I ₂	108.00	11.93	113.7a	110.9a
I ₃	118.00	11.49	106.3ab	109.0a
Level of significance	NS	NS	**	**
CV (%)	16.23	15.51	15.90	14.91

NS: Not significant ** Significant at 1 % level

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June), I₀: No split/whole urea and MoP at a time (September-October)

Combined effect of fertilizer doses and its application methods on vegetative characters of golden apple

Significant differences were observed in the combined effects of fertilizer doses and its application methods on all the vegetative parameters studied in the experiment (Table 13). Plant height and base girth ranged from 66.67 cm to 125.00 cm and 7.33 cm to 12.73 cm, respectively. Here, plant height and base girth increased with the increase of fertilizer dose and splitting of urea and MoP. Again, canopy spread (N-S and E-W) varied from 56.67 cm to 134.1 cm and 56.67 cm to 147.1 cm, respectively where maximum North-South canopy spread was recorded in plants treated with 200 % of the fertilizer dose per plant mentioned in the FRG, 2018

combined with urea and MoP were applied thrice (F₃I₂) and minimum canopy spread was noticed in plants where 100 % of the fertilizer dose per plant mentioned in the FRG, 2018 was applied and whole urea and MoP were used at a time during September-October (F₁I₀) (Table 13).

Table 13. Interaction effect of fertilizer doses and application methods on plant height and base girth of golden apple

Treatment	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
F ₁ I ₀	66.67 c	7.33 d	56.67 e	56.67 f
F ₁ I ₁	107.70 ab	9.40 bcd	106.0 abc	94.00 de
F ₁ I ₂	107.30 ab	11.60 abc	134.1 a	133.0 abc
F ₁ I ₃	113.30 ab	11.00 abc	64.67 de	117.0 a~d
F ₂ I ₀	85.00 bc	9.00 cd	118.9 ab	76.67 ef
F ₂ I ₁	116.30 a	12.63 a	116.3 ab	124.6 a~d
F ₂ I ₂	120.00 a	12.73 a	100.9 a~d	105.5 b~e
F ₂ I ₃	125.00 a	10.73 abc	72.92 cde	98.96 cde
F ₃ I ₀	115.70 a	12.00 ab	124.0 2a	103.7 b~e
F ₃ I ₁	108.30 ab	11.17 abc	86.67 b~e	136.7 ab
F ₃ I ₂	96.67 ab	11.47 abc	124.7 a	147.7 a
F ₃ I ₃	115.70 a	12.73 a	121.2 ab	111.0 a~e
Level of sig.	*	*	**	**
CV (%)	16.23	15.51	15.90	14.91

* Significant at 5% level ** Significant at 1% level

F₁: 100 % of the dose, F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June), I₀: Whole urea and MoP at a time (September-October)

Table 14. Effect of fertilizer doses on flower and fruit characters of golden apple

Treatment	Panicle/ plant	Fruit set/panicle	Fruits retained/panicle
F ₁	7.33	7.71	2.45
F ₂	8.00	9.42	3.44
F ₃	9.33	10.20	2.55
Level of significance	NS	NS	NS
CV (%)	21.43	17.58	18.07

NS: Not significant

F₁: 100 %, F₂: 150 % and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

Effect of fertilizer doses on flowering and fruit characters of golden apple

No statistical variation among the treatments was observed with respect to panicle per plant, fruit set per panicle and fruits retained per panicle (Table 14). Panicle per plant, fruit set per panicle and fruits retained per panicle varied from 7.33 to 9.33, 7.71 to 10.20 and 2.45 to 3.44, respectively. Panicle per plant and fruit set per panicle was found maximum in plants treated with 200 % of the dose per plant mentioned in the FRG, 2018 but maximum fruit retention noticed in plants treated with 150 % of the dose per plant mentioned in the FRG, 2018 (Table 14).

Effect of fertilizer application methods on flowering and fruit characters of golden apple

Among the reproductive parameters statistically significant difference was noted only in fruit set per panicle but rest of the parameters like panicle per plant and fruits retained per panicle were found statistically non-significant (Table 15). Panicle per plant and fruits retained per panicle ranged from 6.89 to 9.33 and 2.63 to 2.86, respectively. The highest fruit set per panicle was recorded in plants treated with basal dose of fertilizer plus four splits of urea and MoP (September, November, March-April and May-June) and the lowest fruit set per panicle was noticed in plants where whole urea and MoP were applied once (September-October) (Table 15).

Table 15. Effect of fertilizer application methods flower and fruit characters of golden apple

Treatment	Panicle /plant	Fruit set/ panicle	Fruits retained/ panicle
I ₀	6.89	7.16b	2.80
I ₁	9.33	9.76ab	2.63
I ₂	7.89	8.86ab	2.83
I ₃	8.78	10.67a	2.86
Level of significance	NS	*	NS
CV (%)	21.43	17.58	18.07

* Significant at 5 % level NS: Not significant

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June) and I₀: No split/whole urea and MoP at a time (September-October)

Combined effect of fertilizer doses and its application methods on flowering and fruit characters of golden apple

Statistical variations among the treatment results were noted with respect to panicle per plant, fruit set panicle and fruits retained per panicle (Table 16). The highest number of panicles per plant (10.00) and fruits set per panicle (11.53) were counted in plants received 200 % of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice (F₃I₁) and the lowest number of panicles per plant (4.00) and fruits per panicle was set (4.04) in plants where 100 % of the dose per plant mentioned in the FRG, 2018 was applied at a time (F₁I₀). Maximum fruits retention per panicle was counted (4.16) in F₂I₂ followed by F₂I₁ (3.43) and F₃I₃ (3.08) and minimum fruit retention was recorded in plants treated with 100 % of the recommended fertilizer dose combined with two splits of urea and MoP (September and April) (Table 16). Here, yield attributes responded affirmatively with the increase of fertilizer doses and splitting of urea and MoP.

Table 16. Interaction effect of fertilizer doses and application methods on flowering and fruiting characteristics of BARI Amra-1

Treatment	Panicle/ plant	Fruit set/panicle	Fruits retained/panicle
F ₁ I ₀	4.00 c	4.04 c	2.48 bc
F ₁ I ₁	9.67 a	8.17 ab	2.05 c
F ₁ I ₂	7.33 bc	8.70 ab	2.57 bc
F ₁ I ₃	8.33 ab	9.98 ab	2.77 b
F ₂ I ₀	7.67 bc	7.25 bc	2.77 b
F ₂ I ₁	8.33 ab	9.63 ab	3.43 ab
F ₂ I ₂	7.67 bc	9.65 ab	4.16 a
F ₂ I ₃	8.33 ab	11.19 a	3.43 ab
F ₃ I ₀	9.00 ab	10.18 ab	2.96 b
F ₃ I ₁	10.00 a	11.53 a	2.52 bc

Treatment	Panicle/ plant	Fruit set/panicle	Fruits retained/panicle
F ₃ I ₂	9.67 a	8.25 ab	2.75 b
F ₃ I ₃	9.67 a	10.80 ab	3.08 ab
Level of significance	*	**	**
CV (%)	21.43	17.58	18.07

* Significant at 5 % level ** Significant at 1 % level NS: Not significant
 F₁: 100 % of the dose, F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June) and I₀: No split/whole urea and MoP at a time (September-October)



Figure 14. Split fertilizer application in BARI Amra-1

Experiment No 7. Effect of split application of fertilizer on manipulating harvest time, yield and quality of golden apple cv. BARI Amra-2

Effect of fertilizer doses on vegetative characters of BARI Amra-2

No significant influence due to fertilizer treatments was observed with respect to all vegetative characteristics (Table 17). Plant height, base girth, North-South canopy spread and East-west canopy spread ranged from 340.8 cm to 350.0 cm, 42.75 cm to 43.92 cm, 343.3 cm to 351.7 cm and 382.5 cm to 412.1 cm, respectively. In all the case, minimum values were recorded in plants treated with 100 % of the recommended dose (FRG, 2018) (Table 17).

Table 17. Effect of fertilizer doses on plant height and base girth of BARI Amra-2

Fertilizer Dose	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
F ₁	340.8	42.75	343.3	382.5
F ₂	350.0	43.58	350.4	412.1
F ₃	342.9	43.92	351.7	400.4
Level of significance	NS	NS	NS	NS
CV (%)	10.13	8.96	12.28	17.06

NS: Not significant

F₁: 100 %, F₂: 150 % and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

Effect of fertilizer application methods on vegetative characters of BARI Amra-2

There was no statistical variation among the treatments with respect to plant height, base girth and canopy spread (N-S and E-W). Plant height, base girth and canopy spread in North-South and East-West directions varied from 335.6 cm to 355.6 cm, 40.78 cm to 44.89 cm, 341.1 cm to 361.1 cm and 385.0 cm to 421.1 cm, respectively (Table 18).

Table 18. Effect of fertilizer application methods on plant height and base girth of BARI Amra-2

Treatment	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
I ₀	355.6	44.33	341.1	385.0
I ₁	337.2	40.78	345.0	421.1
I ₂	350.0	44.89	361.1	400.0
I ₃	335.6	43.67	346.7	387.2
Level of significance	NS	NS	NS	NS
CV (%)	10.13	8.96	12.28	17.06

NS: Not significant

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June) and I₀: No split/whole urea and MoP at a time (September-October)

Combined effect of fertilizer doses and its application methods on vegetative characters of BARI Amra-2

No significant difference was observed in the combined effects of fertilizer doses and its application methods on plant height, base girth and canopy spread (N-S and E-W) (Table 19). Plant height, base girth, North-South canopy spread and East-West canopy spread ranged from 306.7 cm to 391.7 cm, 36.67 cm to 47.0 cm, 300.0 cm to 403.3 cm and 298.3 cm to 461.7 cm, respectively. In all the cases, lower values in vegetative parameters were obtained in plants applied with 100 % of the recommended fertilizer dose whole urea and MoP were used at a time during September-October (F₁I₀) (Table 19).

Table 19. Interaction effect of fertilizer doses and application methods on plant height and base girth of BARI Amra-2

Treatment	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
F ₁ I ₀	306.7	36.67	300.0	298.3
F ₁ I ₁	358.3	43.67	373.3	461.7
F ₁ I ₂	360.0	44.67	341.7	373.3
F ₁ I ₃	338.3	46.00	358.3	396.7
F ₂ I ₀	351.7	44.33	403.3	450.0
F ₂ I ₁	336.7	45.33	323.3	406.7
F ₂ I ₂	356.7	43.00	353.3	410.0
F ₂ I ₃	355.0	41.67	321.7	381.7
F ₃ I ₀	391.7	41.33	320.0	406.7
F ₃ I ₁	311.7	44.00	338.3	391.7

Treatment	Plant height (cm)	Base girth (cm)	Canopy spread N-S (cm)	Canopy spread E-W (cm)
F ₃ I ₂	350.0	47.00	388.3	420.0
F ₃ I ₃	318.3	43.33	360.0	383.3
Level of sig.	NS	NS	NS	NS
CV (%)	10.13	8.96	12.28	17.06

* Significant at 5 % level NS: Not significant

F₁: 100 % of the dose, F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

I₁: Two splits of urea and MoP (September and April), I₂: Three splits of urea and MoP (September, March-April and May-June), I₃: Four splits of urea and MoP (September, November, March-April and May-June) and I₀: No split/whole urea and MoP at a time (September-October)

Table 20. Effect of fertilizer doses on flower and fruit characters of BARI Amra-2

Treatment	Panicle/ plant	Fruit set/panicle	Fruits retained/panicle
F ₁	23.83	6.36	3.88
F ₂	22.58	5.72	3.58
F ₃	28.75	6.73	4.10
Level of significance	NS	NS	NS
CV (%)	19.17	16.46	17.19

** Significant 1 % level NS: Not significant

F₁: 100 %, F₂: 150 % and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

Effect of fertilizer doses on flowering and fruit characters of BARI Amra-2

No statistical variation among the treatments was observed with respect to panicle per plant, fruit set per panicle and fruits retained per panicle (Table 20). Panicle per plant and fruit set per panicle ranged from 22.58 to 28.75 and 5.72 to 6.73, respectively. Fruits retained per panicle varied from 3.58 to 4.10. In almost all the cases minimum values were noted in plants treated with 150 % of the fertilizer dose.

Table 21. Effect of fertilizer application methods on flower and fruit characters of BARI Amra-2

Methods of fertilizer application	Panicle/ plant	Fruit set/panicle	Fruits retained/panicle
I ₀	16.67 c	5.767	3.68 ab
I ₁	22.33 bc	6.656	3.75 ab
I ₂	30.44 ab	6.433	4.65 a
I ₃	30.78 a	6.211	3.34 b
Level of significance	**	NS	*
CV (%)	19.17	16.46	17.19

* Significant at 5 % level ** Significant at 1 % level NS: Not significant

I₁: Two splits of urea and MoP, I₂: Three splits of urea and MoP I₃: Four splits of urea and MoP and I₀: No split/whole urea and MoP at a time

Effect of fertilizer application methods on flowering and fruit characters of BARI Amra-2

Among the reproductive parameters studied so far statistically significant difference was noted panicle per plant and fruits retained per panicle but fruit set per panicle did not varied significantly (Table 21). Fruits retained per panicle (4.65) were counted the highest in plants where urea and MoP were applied thrice and minimum number of fruits was harvested from plants where urea and MoP applied at a time. Fruit set panicle varied from 5.77 to 6.66 where maximum number of fruits was set in plants where urea and MoP applied twice (Table 21).

Combined effect of fertilizer doses and its application methods on flowering and fruit characters of BARI Amra-2

Statistical variations among the treatment results were noted with respect to panicle per plant and fruits retained per panicle but fruit set panicle did not vary significantly (Table 22). The highest number of panicles per plant (65.17) and fruits retained per panicle (6.63) were counted in plants received 200 % of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied thrice (F₃I₂) and twice (F₃I₁), respectively. While, maximum number of fruits per plant and the heaviest fruit were noticed in F₃I₁ (387.0) and F₃I₂ (142.1 g), respectively. Again, F₃I₁ exhibited the highest fruit yield per plant (54.48 kg) and yield per hectare (8.50 t). On the other hand, the lowest number of panicles per plant (40.04) and fruit/plant (204.3) was recorded in plants treated with 100 % of the dose per plant mentioned in the FRG, 2018 combined with urea and MoP were splitted twice (F₁I₁) and the lowest number fruits per panicle (5.03) was noted in plants treated with 150 % of the dose per plant mentioned in the FRG, 2018 combined with urea and MoP were splitted twice a year (F₂I₁). Whereas, individual fruit weight, fruit yield per plant and yield per hectare were noted 97.0 g, 20.48 kg and 3.20 t, respectively in F₁I₀ (Table 22).

Table 22. Interaction effect of fertilizer doses and application methods on flower and fruit characters of BARI Amra-2

	Panicle	Fruit/panicle	Fruit/plant	WT (g)	Yield/plant (kg)	Yield/ha (t)
F ₁ I ₀	40.23fg	5.25cdef	211.0f	97.0g	20.48f	3.20f
F ₁ I ₁	40.04fg	5.10ef	204.3f	106.5ef	21.77f	3.40f
F ₁ I ₂	57.48b	5.11ef	294.0c	110.7de	32.53cd	5.07cd
F ₁ I ₃	63.86a	5.17def	330.0b	103.6f	34.19c	5.33c
F ₂ I ₀	39.46g	5.28cdef	208.3f	104.8f	21.89f	3.41f
F ₂ I ₁	55.46bc	5.03f	277.3d	112.7d	31.12d	4.86d
F ₂ I ₂	44.36ef	5.46cd	242.3e	128.4bc	31.09d	4.85d
F ₂ I ₃	47.51de	4.63g	217.0f	124.7c	27.05e	4.22e
F ₃ I ₀	43.86efg	5.41cde	235.7e	112.1d	26.39e	4.11e
F ₃ I ₁	50.93cd	6.63a	335.0b	132.1b	44.22b	6.90b
F ₃ I ₂	65.17a	5.94b	387.0a	140.7a	54.48a	8.50a
F ₃ I ₃	55.69b	5.56c	303.7c	142.1a	43.10b	6.73b
Level of significance	**	*	**	**	**	**
CV (%)	10.80	7.56	6.39	5.39	7.81	7.81

** Significant at 1 % level NS: Not significant

F₁: 100 % of the dose, F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018

I₁: Two splits of urea and MoP, I₂: Three splits of urea and MoP, I₃: Four splits of urea and MoP and I₀: No split/whole urea and MoP at a time

Cost and Return Analysis of BARI Amra-2

The expenses incurred and income generated in BARI Amra-2 cultivation is an important consideration with respect to the inputs applied for gross returns, net returns and benefit cost ratio. As maximum yield (8.50 t/ha) was recorded in treatment where 200% of the recommended fertilizer dose and urea and MoP were splitted for three times, non-material and overhead cost were recorded for the treatment and calculated (Table 23). The price of golden apple in wholesale market is assumed BDT 2800.00 per ton.

Table 23. Cost and return analysis in BDT (Tk.) of BARI Amra-2 production per hectare

Treatments	Gross return	Production cost	Net return	Benefit cost ratio (BCR)
Best treatment (F ₃ I ₂) - 200% of the recommended fertilizer dose and three times splitting of Urea and MoP	2,38,000	1,01,600	1,36,400	1.3558

Here, BDT 238000.00 was obtained as gross return and a production cost of BDT 101600.00 was expensed. Therefore, a net return of BDT 136400.00 was incurred. So, the BCR was found 1.3558 from cultivating BARI Amra-2.



Figure 15. Split fertilizer application in BARI Amra-2

Experiment No 8. Effect of fertilizer application on yield and quality of sweet orange

Effect of fertilizer application on vegetative characters

No significant variation was observed on plant height, base girth and canopy spread (N-S & E-W) after application of fertilizers. Plant height, base girth, north-south canopy and east-west canopy dimension of the treated plants ranged from 282.21 cm to 323.33 cm, 27.20 cm to 30.67 cm, 212.23 cm to 372.16 cm and 214.62 cm to 324.35 cm, respectively. Plant height and base girth were noticed maximum in plants treated with 150 % of the recommended dose per plant (FRG' 2018). While, maximum canopy dimension was measured in plants treated with 175 % of the recommended dose per plant mentioned in the FRG' 2018 (Table 24).

Table 24. Growth and yield characteristics of sweet orange upon application of fertilizers

Treatment	Plant height (cm)	Base girth (cm)	Date of flowering	Canopy Dimensions (cm)	
				N-S	E-W
T ₀	282.21	27.20	Jan-Feb	212.23	214.62
T ₁	310.00	29.33	Jan-Feb	365.86	292.78
T ₂	280.00	29.00	Jan-Feb	272.46	312.25

Treatment	Plant height (cm)	Base girth (cm)	Date of flowering	Canopy Dimensions (cm)	
				N-S	E-W
T ₃	323.33	30.67	Jan-Feb	332.35	316.56
T ₄	308.33	30.67	Jan-Feb	372.16	324.35
CV (%)	8.41	7.20	-	8.57	10.24
Level of sig.	NS	NS	-	NS	NS

NS= Not significant * Significant 5 % level

Here, T₀: Control (Only Cowdung 30 kg/plant), T₁: 100 % of the recommended dose per plant (FRG, 2018), T₂: 125 % of the recommended dose, T₃: 150 % of the recommended dose, T₄: 175 % of the recommended dose

Table 25. Yield characteristics of sweet orange upon application of fertilizer

Treatment	Flower bud/plant	Fruit set/plant	Fruit retained/plant (30.06.2021)
T ₀	207.35	105.67c	48.00c
T ₁	224.24	142.40bc	58.24bc
T ₂	241.23	154.67bc	55.00bc
T ₃	225.74	166.00ab	66.33ab
T ₄	245.06	174.33a	87.00a
CV (%)	12.54	15.28	13.65
Level of sig.	NS	*	*

NS= Not significant * Significant 5 % level

Here, T₀: Control (Only Cowdung 30 kg/plant), T₁: 100 % of the recommended dose per plant (FRG, 2018), T₂: 125 % of the recommended dose, T₃: 150 % of the recommended dose, T₄: 175 % of the recommended dose

Effect on yield contributing characteristics

Statistically significant variation was observed in case of number of fruit set per plant and number of fruits retained per plant studied in the experiment (Table 25). The highest number of fruit set per plant was counted in plants treated with 175 % of the recommended dose per plant mentioned in the FRG' 2018 (174.33) which was statistically followed by T₃ (150 % of the recommended dose) treatment. Again, maximum number of fruits retained per plant was also noted in plants treated with 175 % of the recommended dose per plant mentioned in the FRG' 2018 (87.00) which was statistically followed by T₃ (150 % of the recommended dose) treatment. Minimum number of fruits set per plant and number of fruits retained per plant (105.67 and 48.00, respectively) were recorded in control plants (Table 25).

Therefore, nutrient must be provided for enhancing growth and yield of sweet orange. From this experiment, it was observed that applying 175 % of the recommended dose exhibited best results.



Figure 16. Fertilizer application in BARI Malta-1

Experiment No 9. Effect of time and level of pruning on growth, yield and quality of guava

Effect of pruning on vegetative characters

Statistically significant variation was noticed in terms of number of leaves at new shoot emerged after pruning. Maximum number of leaves at new shoot was counted 2251.3 in plants where pruning was practiced in mid-March with 30 cm tip removal (T₁L₃) followed by T₁L₂ (2181.7), T₁L₁ (2011.0 and T₂L₃ (2007.7). Minimum number of leaves at new shoot was noted in plants where no pruning was performed. Number of main branches per plant differed non-significantly.

Effect of pruning on number of fruits harvested

Pruning time and level of pruning exhibited significant influence on the number of fruits harvested from plants both in summer and winter (Table 26). In winter during the month of October-April maximum number of fruits (87.0/plant) were harvested from plants where pruning was done in mid-March with 30 cm tip removal (T₁L₃) followed by T₂L₃ (83.7/plant) T₁L₂ (81.0/plant) and T₃L₂ (76.7/plant). Again, in summer during May-September maximum number of fruits (78.3/plant) was harvested from plants where 30 cm tip was removed in mid-July (T₂L₃). Plants where no pruning was performed exhibited inferior results in terms of number of fruits harvested per plant (56.3 and 48.7 in winter and summer, respectively).

Table 26. Effect of pruning time and level of pruning on growth and yield of guava

Treatment	Main Branch	Leaves at new shoot	Fruits harvested/plant		Individual Fruit Weight (g)	Yield/plant (kg)	TSS (%)
			Winter (October-April)	Summer (May-September)			
T ₁ L ₀	3.7	1996.0bc	56.3e	48.7f	165.3d	17.37d	9.5
T ₁ L ₁	3.3	2011.0abc	69.0b~e	60.7de	206.3bc	26.76bc	9.4
T ₁ L ₂	3.0	2181.7ab	81.0abc	67.3bcd	227.7a	33.74a	9.6
T ₁ L ₃	3.7	2251.3a	87.0a	76.3ab	213.7abc	34.93a	9.4
T ₂ L ₀	3.7	2000.3bc	67.3cde	56.3ef	158.3d	19.83d	9.5
T ₂ L ₁	2.7	1986.3bc	64.3de	62.3de	203.3c	25.74c	9.5
T ₂ L ₂	2.7	1981.0bc	71.7a~e	68.0bcd	224.0ab	31.33ab	9.6
T ₂ L ₃	3.3	2007.7abc	83.7ab	78.3a	209.3abc	33.84a	9.4
T ₃ L ₀	3.0	1830.0c	63.3de	59.0de	155.7d	19.07d	9.2
T ₃ L ₁	3.7	1951.3bc	65.7cde	66.7cd	199.7c	26.49bc	9.4
T ₃ L ₂	3.3	1981.7bc	76.7a~d	72.3abc	224.0ab	33.40a	9.9
T ₃ L ₃	3.0	1985.7bc	74.0bcd	74.7abc	209.3abc	31.12ab	9.6
CV	30.3	7.17	13.12	8.6	5.92	11.16	4.19
Level of sig.	NS	**	**	**	**	**	NS

Where, T₁: mid-March, T₂: mid-July, T₃: mid-October

L₀: 0-cm tip removal, L₁: 10-cm tip removal, L₂: 20-cm tip removal, L₃: 30-cm tip removal

Effect of pruning on fruit yield and quality

Individual fruit weight and fruit yield per plant varied significantly due to pruning practice in guava but TSS content of fruits showed non-significant variation. Significantly heaviest fruit (227.7 g) was harvested from plants where pruning was applied in mid-March with 20 cm tip removal (T₁L₂) followed by T₂L₂ (209.3 g) and T₃L₂ (224.0 g). Lightest fruit (165.3 g) was obtained from plants where pruning was not performed. Maximum 34.93 kg fruit per plant was

recorded in plants where pruning was done in mid-March with 30 cm tip removal (T₁L₃) which was statistically similar with T₁L₂ (33.74 kg) T₂L₃ (33.84 kg) and T₃L₂ (33.40 kg). Whereas statistically minimum yield was calculated in control plants where no pruning was performed. TSS content of fruits was found non-significant but it ranged from 9.2 to 9.9 (Table 26).

Therefore, pruning time and level of pruning have significant role in improving fruit quality as well as increasing fruit yield of guava. From this experiment it was registered that pruning in March by removing 20-30 cm from the tip of the branch exhibited maximum yield with superior quality of fruits.



Figure 17. Pruning improved fruit quality in BARI Peyara-2

Experiment No 10. Effect of GA₃ on fruit quality of golden apple

Effect of GA₃ on fruit quality of golden apple

Gibberellic acid exhibited no statistical variation on fruit quality upon application on BARI Amra-2 when applied at pre-flowering, full bloom and fruit set stage of development. Individual fruit weight, seed weight and skin weight ranged from 78.0 to 83.3 g, 13.5 to 14.3 g and 11.5 to 12.2 g, respectively. Edible portion of the fruits obtained after application of GA₃ at different fruit developmental stages varied non-significantly from 61.5 to 68.2 %. Total soluble solids content ranged from 9.2 to 9.9 % (Table 27).

In BARI Amra-2, GA₃ exhibited no significant variation when applied at different developmental stages. Therefore, the experiment should be continued with modification of doses and application time.

Table 27. Effect of GA₃ on fruit quality of BARI Amra-2

Treatment	Fruit weight (g)	Seed weight (g)	Skin weight (g)	Edible portion (%)	TSS
S ₁ T ₀	83.3	14.1	11.9	68.2	9.3
S ₁ T ₁	78.3	14.1	12.0	62.2	9.4
S ₁ T ₂	81.7	13.9	11.9	66.4	9.6
S ₁ T ₃	79.0	14.1	12.2	62.8	9.4
S ₁ T ₄	80.0	14.1	12.1	64.0	9.7
S ₁ T ₅	78.3	14.0	11.8	62.5	9.2
S ₂ T ₀	81.7	13.8	11.7	66.7	9.5
S ₂ T ₁	79.0	13.8	11.7	63.6	9.7
S ₂ T ₂	79.3	14.1	11.9	63.4	9.3
S ₂ T ₃	81.0	14.0	11.7	65.8	9.2
S ₂ T ₄	78.3	14.3	12.2	61.6	9.7
S ₂ T ₅	81.7	13.5	11.5	67.3	9.7
S ₃ T ₀	78.0	13.7	12.1	62.1	9.7
S ₃ T ₁	81.0	13.9	11.7	65.8	9.6
S ₃ T ₂	78.3	13.7	11.7	63.0	9.4

Treatment	Fruit weight (g)	Seed weight (g)	Skin weight (g)	Edible portion (%)	TSS
S ₃ T ₃	77.3	13.9	11.7	61.5	9.2
S ₃ T ₄	81.7	14.3	12.2	65.6	9.4
S ₃ T ₅	79.0	13.7	11.7	63.6	9.9
CV	9.46	4.71	5.29	14.22	3.85
Level of sig.	NS	NS	NS	NS	NS

Where, S₁: pre-flowering stage, S₂: full bloom stage and S₃: fruit set stage

T₀: 0 mmol/L, T₁: 0.25 mmol/L, T₂: 0.50 mmol/L, T₃: 0.75 mmol/L, T₄: 1.00 mmol/L and T₅: 1.50 mmol/L



Figure 18. GA₃ application on fruit quality of golden apple

At the Breeder Seed Production Centre, Debiganj, Panchagarh

Experiment No 11. Collection and evaluation of bullock's heart (*Annona reticulata*) germplasm at BSPC, Debiganj, Panchagarh

Bullock's heart (*Annona reticulata*) germplasm at BSPC, Debiganj, Panchagarh exhibited distinguished result in terms of growth, yield and qualitative characters (Table 28 to Table 31). Among the vegetative parameters, mean plant height and canopy spread was higher in AR Deb-002 (440.3 cm and 447.0 cm; N-S and 406.7 cm; S-W, respectively) whereas base girth was noticed higher in AR Deb-001 (63.0 cm) (Table 28).

Table 28. Growth characteristics of bullock's heart germplasm at Debiganj during 2017- 2019

Germplasm	Plant height (cm)				Base girth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	395	422	455	424.0	52	59	78	63.0
AR Deb-002	402	432	487	440.3	47	54	64	55.0

Table 28. continued

Germplasm	Canopy Spread							
	N-S (cm)				E-W(cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	375	403	447	408.3	355	393	428	392.0
AR Deb-002	408	439	494	447.0	373	405	442	406.7

Both the bullock's heart germplasm exhibited regular bearing habit with similar flowering duration (early June to late September) but differed in harvest time (early March to mid May in AR Deb-001 and mid march to mid may in AR Deb-002) (Table 29).

Table 29. Flowering and fruiting behavior of bullock's heart germplasm at Debiganj during 2017- 2019

Germplasm	Flowering time			Harvesting duration			Bearing habit		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
AR Deb-001	Early July-Late Sept.	Early July-Late Sept.	Early July-Late Sept.	Early March-Mid May	Early March-Mid May	Early March-Mid May	Regular	Regular	Regular
AR Deb-002	Early July-Late Sept.	Early July-Late Sept.	Early July-Late Sept.	Mid March-Mid May	Mid March-Mid May	Mid March-Mid May	Regular	Regular	Regular

Yield and yield contributing characters also had some variation in the evaluated germplasm (Table 30 and Table 31). Though AR Deb-001 (322.3/plant) had lower number of fruits than that of AR Deb-002 (370.0/plant), individual fruit weight was distinguishably higher in AR Deb-001 (261.2 g) than that of AR Deb-002 (195.5 g). Therefore, yield per plant and yield per hectare was recorded higher in the germplasm AR Deb-001 (84.2 kg and 23.2 t, respectively) than AR Deb-002 (72.3 kg and 19.9 t, respectively).

Table 30. Quantitative fruit characteristics of bullock's heart germplasm at Debiganj during 2017- 2019

Germplasm	Fruit size							
	Length (cm)				Breadth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	8.4	8.3	8.3	8.3	7.5	7.3	7.3	7.4
AR Deb-002	7.4	7.3	7.3	7.3	7.2	7.1	7.0	7.1

Table 30. continued

Germplasm	Number of seeds/fruit				Seed weight/fruit			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	40.2	38.6	42.2	40.3	10.8	10.6	11.2	10.9
AR Deb-002	39.7	41.4	37.7	39.6	10.7	10.9	10.4	10.7

Table 30. continued

Germplasm	Number fruits/plant				Individual fruit weight (g)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	309	332	326	322.3	257.4	263.4	262.7	261.2
AR Deb-002	357	380	373	370.0	186.5	202.6	197.3	195.5

Table 30. continued

Germplasm	Yield per plant (kg)				Yield (t/ha)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	79.5	87.4	85.6	84.2	21.9	24.0	23.6	23.2
AR Deb-002	66.6	77.0	73.6	72.3	18.3	21.2	20.2	19.9

Table 31. Qualitative fruit characteristics of bullock's heart germplasm at Debiganj during 2017-2019

Germplasm	Edible portion (%)				Taste		
	2017	2018	2019	Mean	2017	2018	2019
AR Deb-001	72.0	71.5	71.8	71.8	Very good	Very good	Very good
AR Deb-002	70.3	71.2	70.4	70.6	Good	Good	Good

Table 31. continued

Germplasm	Flesh thickness (mm)				TSS (%)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
AR Deb-001	2.1	2.0	2.2	2.1	26.6	25.8	26.5	26.3
AR Deb-002	2.3	2.0	2.2	2.2	22.7	22.0	22.4	22.4

Table 31. continued

Germplasm	Fruit skin color			Flesh color		
	2017	2018	2019	2017	2018	2019
AR Deb-001	Reddish brown	Reddish brown	Reddish brown	Creamy white	Creamy white	Creamy white
AR Deb-002	Pale brown	Pale brown	Pale brown	Whitish	Whitish	Whitish

Bullock' heart fruit quality was also found to differ within the two germplasm. Edible portion and TSS conten was exhibited more in the fruits of AR Deb-001 (71.8 % and 26.3 %) than that of AR Deb-002 (70.6 % and 22.4 %). Taste of AR Deb-001 was also opined as very good by the evaluator for organolaptic test. Skin color of ripe fruit was seen as reddish brown in AR Deb-001 and pale brown in AR Deb-002 while, flesh color of AR Deb-001 was observed as creamy white and AR Deb-002 was noticed as whitish.

Hence, the germplasm AR Deb0-001 was noted as superior for wide cultivation in Bangladesh. Thereafter, with some proper official procedure the germplasm AR Deb-001 was released as a variety of bullock's heart named as BARI Ata-1 for cultivation in Bangladesh.



Figure 19. Bullock's heart germplasm at BSPC, Debiganj

Experiment No 12. Variability estimation among Bael (*Aegle marmelos*) germplasm in northern region of Bangladesh

Plant characters

Plant growth involves tree growth and tree habit. Plant height varied from each other. In case of base girth the germplasm AM Deb-3(0.72 m) was placed above the mean 0.67 cm (Table 32).

Table 32. Growth and tree characteristics of Bael germplasm

Genotype	Plant height (m)	Base girth (m)
AM Deb-001	6.23	0.63
AM Deb-002	6.35	0.64
AM Deb-003	6.23	0.72
AM Deb-005	6.13	0.67
Mean	6.24	0.67
SD	0.09	0.04
CV(%)	1.44	6.08

Yield components and yield

Yield and yield contributing characters of different germplasm showed numerical variation (Table 33). The accession AM Deb-001 exhibited the highest individual fruit weight 1.69 kg, but minimum fruit number (4.4). Number of fruit per plant (41.0) was recorded the highest in AM Deb-003. It was noticed that the individual fruit weight of AM Deb-002 (1.24 kg) was ranked second position but number of fruits per plant (19) and total fruit yield per plant (23.62 kg) was found maximum. It was observed that fruit shape of all the fruits was slightly compressed.

Table 33. Yield and yield attributes of Bael germplasm

Germplasm	Number of fruit/plant	Fruit weight (kg)	Yield/plant (kg)
AM Deb-001	4.4	1.69	6.73
AM Deb-002	19	1.24	23.62
AM Deb-003	41	0.56	23.12
AM Deb-005	35	0.64	22.34
Mean	24.85	1.03	18.95
SD	16.5	0.53	8.17
CV (%)	66.38	51.47	43.10

The percent of rind portion varied from 27.10 (AM Deb-005) to 17.90 (AM Deb-002), and the fiber weight varied from 41 g (AM Deb-003) to 10.2 g (AM Deb-005) (Table 33). Maximum seed weight (38.00 g) was recorded in the germplasm AM Deb-002 and minimum (19 g) seed weight was noted in AM Deb-003 (Table 3). The number of seeds per fruit in different germplasm ranged from 85.4 to 132.25. Percent edible index was noted maximum (78.86) in AM Deb-002 while it was minimum (65.61) in AM Deb-005.

Total Soluble Solids (TSS)

Total soluble solids (TSS) is an important factor for sweetness of a fruit. Maximum TSS (40.40⁰Brix) was found in AM Deb-005 and minimum TSS was measured in AM Deb-001 (28.4⁰Brix).

Table 34. Quantitative parameters of Bael germplasm

Germplasm	Seed no./fruit	Average wt. of seed (g)	Average wt. of fiber (g)	Rind portion (%)	Edible portion (%)	TSS (⁰ Brix)
AM Deb-1	97.8	24.80	40.8	19.55	75.48	28.4
AM Deb-2	132.25	38.00	29.5	17.90	78.46	35.5
AM Deb-3	117.5	19.00	41	20.74	72.00	34
AM Deb-5	85.4	28.40	10.2	27.10	65.61	40.4
Mean	108.24	27.55	30.375	21.32	72.89	34.6
SD	20.76	7.97	14.4841	4.02	5.53	4.94
CV(%)	15.23	28.52	62.54	19.99	3.32	14.3

Qualitative characters

Qualitative parameters like flavor, edible quality, grittiness, bitterness, sweetness and mucilage content of four bael germplasm are shown in Table 35. Excellent flavor and eating quality was noted in AM Deb-002 and AM Deb-005. Grittiness and bitterness was absent in all the germplasm. Sweetness varied from medium sweet to very sweet. Mucilage was present in AM Deb-003 and AM Deb-005 whereas AM Deb-001 and AM Deb-002 exhibited negligible amount of mucilage.

Table 35. Qualitative characters of Bael germplasm

Genotype	Flavor	Eating Quality	Grittiness	Bitterness	Sweetness	Mucilage
AM Deb-001	Good	Good	Absent	Absent	Medium sweet	Slight
AM Deb-002	Excellent	Excellent	Absent	Absent	Very sweet	Slight
AM Deb-003	Good	Good	Absent	Absent	Sweet	Present
AM Deb-005	Excellent	Excellent	Absent	Absent	Very sweet	Present

Considering the number of fruits per plant and different qualitative quality, the best performer was AM Deb-002 germplasm. Maximum yield along with acceptable individual fruit weight will help AM Deb-002 to serve the commercial and family purpose. The TSS content of 35.5 makes it suitable for the development of various products.



Figure 20. Bael germplasm at BSPC, Debiganj, Panchagarh

Experiment No 13. Evaluation of Carambola germplasm at BSPC, Debiganj

Growth characters

There were wide variations among the carambola genotypes with respect to growth characters. Among the germplasm, the highest plant height was noticed in AC Deb-006 (8.0 m), while the shortest plant was recorded 2.3 m, in AC Deb-009 and AC Deb-015 (Table 36). Base girth was noted the highest in AC Deb-014 (106 cm).

Table 36: Growth characters of Carambola germplasm

Accession number	Plant height (m)	Base girth(cm)
AC Deb-001	6.4	100
AC Deb-002	3.9	40
AC Deb-003	5.583	65
AC Deb-004	6.4	63
AC Deb-005	6.7	57
AC Deb-006	8	84
AC Deb-007	7.45	52
AC Deb-008	4.4	46
AC Deb-009	2.3	36
AC Deb-010	2.7	39
AC Deb-011	6.58	57
AC Deb-013	7.2	64
AC Deb-014	7.1	106
AC Deb-015	2.3	38
AC Deb-022	7.1	59
AC Deb-023	7.2	77
Mean	5.70	61.43
SD	2.01	21.25
CV(%)	35.38	34.59

Yield contributing characters

The fruit weight varied widely and ranged from 52.4 g to 128 g. The genotype AC Deb-014 exhibited maximum fruit weight (128 g) followed by AC Deb-007 (125.6 g). The fruit of AC Deb-014 (128 g) was 29.48% and 25.6% heavier than BARI Kamranga-1 (97 g) and BARI Kamranga-2 (100 g) (Azad *et al.*, 2020). On the other hand, minimum fruit weight (83.53 g) was recorded in the genotypes AC Deb-009. The mean value was 87.76 g (Table 37).

Fruit yield of different carambola genotypes ranged from 13.62 kg to 89.98 kg per plant with the average yield of 46.84 kg per plant. The genotype AC Deb-014 exhibited the highest yield (89.98 kg per plant) followed by AC Deb-007 (81.01 kg per plant) and the lowest yield was recorded in AC Deb-009 (13.62 kg per plant) (Table 37). Maximum number of fruits per tree was recorded in AC Deb-014 (703) followed by AC Deb-006 (666). The least number of fruits per tree (233) was recorded in AC Deb-015 (Table 37).

Table 37. Yield contributing characters of Carambola germplasm

Accession number	Number of fruits/plant	Individual fruit wt. (gm)	Yield/plant (kg)	TSS (°Brix)
AC Deb-001	676	79.9	54.01	5.5
AC Deb-002	413	65.6	27.09	5.6
AC Deb-003	511	57.6	29.43	4.4
AC Deb-004	570	80.4	45.83	6.6
AC Deb-005	513	74	37.96	5.5
AC Deb-006	666	116.8	77.79	6.5
AC Deb-007	645	125.6	81.01	6.5
AC Deb-008	363	71.6	25.99	5.2
AC Deb-009	260	52.4	13.62	5.5
AC Deb-010	250	67.6	16.90	3.5
AC Deb-011	576	100	57.60	7.5
AC Deb-013	550	106	58.30	8.5
AC Deb-014	703	128	89.98	7
AC Deb-015	233	67.2	15.66	5.5
AC Deb-022	516	108	55.73	5.5
AC Deb-023	603	103.6	62.47	6.5
Max.	703.00	128	89.98	8.5
Min.	233.00	52.4	13.62	3.5
Mean	503.00	87.76	46.84	5.95
SD	155.49	24.60	24.21	1.19
CV (%)	30.91	28.03	51.68	20.07

Total soluble solids (TSS)

The observed data of different genotypes showed significant variation for TSS. The observed value ranged from 3.5 °Brix in AC Deb-010 to 8.5 °Brix in AC Deb-013 with the mean value of 5.95 °Brix (Table 2). Azad *et. al.*, (2019) reported that TSS content in BARI Kamranga-1 and BARI Kamranga-2 was measured 7.5 °Brix and 8.0 °Brix, respectively which is lower than the TSS observed in AC Deb-013 (8.5 °Brix).



Figure 21. Carambola germplasm at BSPC, Debiganj, Panchagarh

So, based on the results obtained from the present investigation, it can be concluded that, selected carambola genotypes exhibited noticeable variation in the morphological and yield contributing characteristics. The genotypes AC Deb-014 gave maximum yield (89.94 kg) per

plant, AC Deb-013 exhibited the highest TSS (8.5 °Brix) and AC Deb-014 had the heaviest fruit (128 g). Considering fruit weight, fruit length, fruit diameter and yield per plant in a season AC Deb-014 was found promising.

Experiment No 14. Collection and evaluation of wood apple (*Feronia limonia*) germplasm at BSPC, Debiganj

The performances of wood apple germplasm at BSPC, BARI, Debiganj, Panchagarh are presented in Table 38 and Table 39.

Table 38. Plant growth and fruiting characteristics of wood apple germplasm at BSPC, Debiganj

Genotype	Plant Height (m)	Base girth (cm)	Number of fruits/plant	Date of harvest
FL Deb-001	3.70	39	32	November-January
FL Deb-002	5.26	42	41	November-January
FL Deb-003	6.00	52	0	
FL Deb-004	5.06	44	7	February-March
FL Deb-005	3.65	31	0	
FL Deb-006	2.90	35	0	
Mean	4.43	40.5	26.67	
SD	1.19	7.34	17.62	
CV%	26.78	18.13	66.07	

Maximum plant height (6 m) and base girth (52 cm) was found in FL Deb-003 germplasm. From the experiment it is revealed that there were two types of germplasm according to fruit harvest season; regular bearing season (November-January) and off-season (February-March). The germplasm FL Deb-001 and FL Deb-002 found seasonal, whereas FL Deb-004 was noticed to have off-season bearing habit. Flowering for all germplasm was similar which was occurred during 1st week of May 2020. Among the germplasm only three germplasm namely FL Deb-001, FL Deb-002 and FL Deb-004 provided 32, 41 and 7 fruits per plant, respectively. The remaining germplasm namely FL Deb-003, FL Deb-005 and FL Deb-006 did not bear any fruit.

Yield and yield contributing characters of elephant foot's apple germplasm were exhibited in Table 2. Maximum fresh fruit weight (295.67 g), ripe fruit weight (195.43 g) and pulp weight (140.5 g) were recorded in the germplasm FL Deb-002. Maximum yield per plant (12.12 kg) and edible portion (71.89 %) were also noticed in FL Deb-002 germplasm and it was very well in organoleptic test. The lowest rind weight (46.57 g), fiber weight (3.25 g) and rind thickness (3.67 mm) were measured in germplasm FL Deb-001. But the germplasm FL Deb-001 exhibited the highest TSS (16.00 %) compared to other germplasm.

Table 39. Yield and yield contributing characters of wood apple germplasm at BSPC, Debiganj

Genotype	Fresh fruit weight (g)	Ripe Fruit weight (g)	Pulp weight (g)	Rind weight (g)	Rind thickness (mm)
FL Deb-001	212.27	157.6	111.03	46.57	3.25
FL Deb-002	295.67	195.4	140.5	54.93	3.43
FL Deb-004	258.5	153.0	102.67	50.33	4.00
Mean	255.48	168.68	118.07	50.61	3.56
SD	41.78	23.28	19.87	4.19	0.39
CV%	16.35	13.80	16.83	8.27	10.99

Table 39. Cont'd.

Genotype	Fiber weight (g)	Number of seeds/fruit	Seed weight (g)	TSS (%)	Edible portion (%)	Yield/plant (kg)	Organoleptic test
FL Deb-001	3.67	214	18.33	16	70.45	6.79	Good
FL Deb-002	5.43	264.38	22.5	15.38	71.89	12.12	Very good
FL Deb-004	5	194.5	10	15	67.14	1.81	Good
Mean	4.7	224.29	16.94	15.46	69.83	6.91	
SD	0.92	36.06	6.36	0.50	2.44	5.16	
CV%	19.52	16.08	37.56	3.27	3.49	74.65	

Considering fresh fruit weight, ripe fruit weight, pulp weight, edible portion, organoleptic test and yield, the germplasm FL Deb-002 can be considered as promising line for regular season wood apple fruit. Considering the off season characteristics, the germplasm FL Deb-004 was found as suitable for cultivation in northern areas and might be released as wood apple variety in Bangladesh for commercial cultivation.



Figure 22. Wood apple germplasm at BSPC, Debiganj, Panchagarh

Experiment No 15. Collection and evaluation of peach fruit (*Prunus persica* L.) Germplasm

Maximum plant height (7.3 m) was recorded in PP Deb-001 germplasm. Maximum base girth (58 cm) was found in PP Deb-003 germplasm. Flowering for all germplasm occurred during Last week of January, 2021. The date of full bloom and date of fruit set of all peach fruit germplasm was 2nd week of February and last week of February, respectively. The fruits were harvested on 1st week of June, 2021.

Table 40. Plant growth and fruiting characteristics of peach fruit germplasm at BSPC, Debiganj

Genotypes	Plant height (m)	Base girth (cm)	Date of flowering	Date of full bloom	Date of Fruit set
PP Deb-001	7.3	43	Last week of January	2 nd week of February	Last week of February
PP Deb-002	6.8	47	Last week of January	2 nd week of February	Last week of February
PP Deb-003	6.75	58	Last week of January	2 nd week of February	Last week of February
Mean	6.95	49.33			

Maximum individual fruit weight (84 g), pulp weight (68.5 g), TSS (11.57%) and yield per plant (200 kg) were recorded in the germplasm PP Deb-001. But the germplasm PP Deb-003 produced the maximum edible portion (82.81%) which was almost similar to that of the germplasm PP Deb-001 (81.84). The lowest peel weight (7 g), fruit thickness (1.6 cm) and seed weight (4 g) were reported in germplasm PP Deb-003.

Table 41. Yield and yield contributing characteristics of peach fruit germplasm at BSPC, Debiganj

Genotypes	Fruit weight (g)	Pulp weight (g)	Harvest of fruit
PP Deb-001	84.0	68.75	1 st week of June
PP Deb-002	72.5	55	1 st week of June
PP Deb-003	64.0	53	1 st week of June
Mean	73.5	58.92	

Table 41. Cont'd.

Genotypes	Peel weight (g)	Fruit thickness (cm)	Seed weight (g)	TSS	Edible portion (%)	Yield/plant (kg)
PP Deb-001	8.25	1.60	7.00	11.57	81.84	200
PP Deb-002	7.00	1.75	5.00	11.00	75.86	65
PP Deb-003	7.00	1.60	4.00	10.67	82.81	25
Mean	7.42	1.65	5.33	11.08	80.17	96.67



Figure 23. Peach fruit germplasm at BSPC, Debiganj, Panchagarh

At the Hill Agriculture Research Station, Raikhali, Rangamati

Experiment No 16. Evaluation of bullock's heart germplasm at HARS, Raikhali, Rangamati

Fruit characteristics of four germplasm were presented in Table 42. Wide variation was observed among the germplasm respect to fruit characteristics. The weight of fruit varied from 120.5 g to 129.4 g. The highest fruit weight (129.4 g) was observed in AR Rai-001 followed by AR Rai-002 (122.6 g) and the lowest fruit weight was observed in AR Rai-004 (120.5 g). The highest (81.6 g) skin weight was measured from AR Rai-001 and the lowest skin weight was recorded from AR Rai-002 (49.0 g), seed weight was measured highest in AR Rai-002 (20 g) and lowest seed weight was measured in AR Rai-003 (16 g). Maximum (43.72%) edible portion was observed in AR Rai-002. The result showed the similarity with the Indian cultivars Balanagar, British guinea and Red sitaphal (Anon, 1987). TSS varied from 23.3 to 24.3 % but there was no significant difference in TSS % among the lines. The results showed the similarity with the result of Anon (1987). The fruit shape varied from heart shape to roundish.

Table 42. Fruit characteristics of thirteen custard apple germplasm

Germplasm	Fruit length (cm)	Fruit breadth (cm)	Fruit circumference (cm)	No. of bulb/ fruit	No of seeds / fruit	Seed weight (g)	Fruit weight (g)	Skin weight/ fruit (g)
AR Rai-001	6.3	5.8	19.1 ^b	69.3 ^b	44.0	19	129.4	81.6 ^a
AR Rai-002	6.1	5.9	19.6 ^{ab}	56.0 ^c	41.0	20	122.6	49.0 ^b
AR Rai-003	6.2	5.4	20.1 ^a	74.3 ^a	42.3	16	122.0	78.0 ^a
AR Rai-004	6.3	5.9	19.6 ^{ab}	69.0 ^b	43.3	17	120.5	75.9 ^a
SE	0.16	0.41	0.30	1.83	1.25	1.13	10.78	3.57
CV (%)	3.8	8.6	1.87	3.34	3.60	10.91	10.68	6.14

Table 42. Continued

Germplasm	Fruit shape	Pulp color	Edible portion (%)	TSS (%)
AR Rai-001	Roundish	Creamy white	22.26	23.3
AR Rai-002	Roundish	White	43.72	23.3
AR Rai-003	Heart	White	22.95	24.3
AR Rai-004	Roundish	White	22.90	24.3
SE	-	-	-	0.47
CV (%)	-	-	-	2.42



Figure 24. Bullock's heart germplasm at HARS, Raikhali, Ramgamati

Experiment No 17. Evaluation of wood apple (*Feronia limonia*) in the hilly area of Rangamati

Maximum plant height (525 cm) and base girth (66 cm) was recorded in FL Rai-003. From the experiment it was revealed that there were two types of germplasm according to fruit harvest season, seasonal (December-January) and off-seasonal (February-May). The germplasm FL Rai-001 and FL Rai-002 were seasonal on the other hand FL Rai-003 and FL Rai-004 exhibited off-season bearing habit. The highest individual fruit weight (455 g) and lowest skin thickness (0.3 cm) was recorded in the germplasm FL Rai-003. Maximum yield per plant (90.1 kg) and edible portion (59.0 %) was also found in FL Rai-003 germplasm and it was also very well in organoleptic test.

The best germplasm was also evaluated for three consecutive years (2017-2019) with keeping BARI Kodbael-1 as check. The germplasm exhibited superiority over BARI Kodbael-1 in terms of all the growth characteristics, flowering and fruiting behavior and yield and yield contributing attributes (Table 45 to Table 48). Therefore, the germplasm FL Rai-003 has been released as BARI Kodbael-2.

Table 43. Growth and yield contributing characters of wood apple genotypes in the hilly area

Genotypes	Plant height (cm)	Base girth (cm)	Number of fruits/plant	Date of harvest
FL Rai-001	400	62	79	December-January
FL Rai-002	370	56	86	December-January
FL Rai-004	525	66	175	February-May
FL Rai-003	500	65	152	February-May
Mean	448.75	62.25	123	
SD	120.38	15.41	56.68	

Table 44. Yield and quality characters of wood apple genotypes in the hilly area

Genotypes	Ind. fruit wt. (g)	Skin thickness (cm)	Edible portion (%)	Yield/plant (kg)	Organoleptic test
FL Rai-001	404	0.4	53.0	31.9	Good
FL Rai-002	410	0.4	54.0	35.3	Good
FL Rai-003	455	0.3	59.0	90.1	Very good
FL Rai-004	450	0.4	58.9	68.4	Good
Mean	429.75	0.375	56.225	56.425	
SD	26.46	0.05	3.17	27.84	

Table 45. Growth characteristics of the wood apple germplasm at Raikhali during 2017- 2019

Genotype	Plant height (cm)				Base girth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
FL Rai-003	525	555	576	552	66	72	84	74
Check (BARI Kodbael-1)	530	564	592	562	64	75	88	76

Table 45. continued

Genotype	Canopy (cm)							
	N-S				E-W			
	2017	2018	2019	Mean	2017	2018	2019	Mean
FL Rai-003	645	660	695	667	585	600	630	605
Check (BARI Kodbael-1)	655	685	700	680	577	595	624	599

Table 46. Flowering and fruiting behavior of wood apple germplasm at Raikhali during 2017- 2019

Genotype	Flowering time			Harvesting time			Bearing habit		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
FL Rai-003	Mid Feb.- June	Mid Feb.- June	Mid Feb.- June	Feb. - May	Feb. - May	Feb. - May	Regu -lar	Regu -lar	Regu -lar
Check (BARI Kodbael-1)	April	April	April	Oct. - Nov.	Oct. - Nov.	Oct. - Nov.	Regu -lar	Regu -lar	Regu -lar

Table 47. Quantitative fruit characteristics of wood apple germplasm at Raikhali during 2017-2019

Genotype	Fruit size (cm)							
	Length				Breadth			
	2017	2018	2019	Mean	2017	2018	2019	Mean
FL Rai-003	8.6	8.5	8.6	8.6	8.7	8.8	8.9	8.8
Check (BARI Kodbael-1)	8.2	8.0	8.0	8.1	7.8	7.7	7.7	7.7

Table 47. continued

Genotype	Number fruit/plant				Individual Fruit weight (g)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
FL Rai-003	175	176	177	176.0	451	456	460	455.7
Check (BARI Kodbael-1)	155	168	175	166.0	344	350	348	347.3

Table 47. continued

Genotype	Yield per plant (kg)				Yield (t/ha)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
FL Rai-003	78.9	80.4	81.3	80.2	19.73	20.10	20.33	20.06
Check (BARI Kodbael-1)	53.3	58.8	60.9	57.7	13.33	14.70	14.43	14.15

Table 48. Qualitative fruit characteristics of wood apple germplasm at Raikhali during 2017-2019

Genotype	Fruit shape			Presence of seeds			
	2017	2018	2019	2017	2018	2019	Mean
FL Rai-003	Round	Round	Round	108	96	99	101
Check (BARI Kodbael-1)	Round	Round	Round	101	104	99	101

Table 48. continued

Genotype	Edible portion (%)				Taste		
	2017	2018	2019	Mean	2017	2018	2019
FL Rai-003	68	67	69	68	Very good	Very good	Very good
Check (BARI Kodbael-1)	67	69	68	68	Very good	Very good	Very good

Table 48. continued

Genotype	Flesh color			Fruit skin color		
	2017	2018	2019	2017	2018	2019
FL Rai-003	Dark brown	Dark brown	Dark brown	Woody brownish	Woody brownish	Woody brownish
Check (BARI Kodbael-1)	Dark brown	Dark brown	Dark brown	Woody brownish	Woody brownish	Woody brownish



Figure 25. Wood apple germplasm (FL Rai-003) released as BARI Kodbael-2

Experiment No 18. Evaluation and characterization of jamun germplasm at the hill valley of Rangamati district

Plant growth characteristics, flowering and fruiting behavior and quantitative and qualitative fruit characteristics of two previously screened jamun germplasm were described in Table 49, Table 50, Table 51 and Table 52.

Average plant height (cm), base girth (cm) and canopy spread (N-S and E-W in cm) were noted higher in SC Rai-008 (422.3 cm, 66.7 cm, 406.0 cm and 429.3 cm, respectively) (Table 49). Both the germplasm exhibited regular fruit bearing habit with similar flowering time (Early June- Mid July) and harvesting time (Mid June- Mid July) (Table 50).

Table 49. Growth characteristics of jamun germplasm at Raikhali during 2017- 2019

Genotypes	Plant height (cm)				Base girth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	395	417	455	422.3	52	59	89	66.7
Local (SC Rai-002)	310	373	407	363.3	47	54	73	58.0

Table 49. continued

Genotypes	Canopy Spread							
	N-S (cm)				E-W(cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	375	403	440	406.0	385	433	470	429.3
Local (SC Rai-002)	326	377	404	369.0	353	382	428	387.7

Table 50. Flowering and fruiting behavior of jamun germplasm at Raikhali during 2017- 2019

Genotypes	Flowering time			Harvesting duration			Bearing habit		
	2017	2018	2019	2017	2018	2019	2017	2018	2019
SC Rai-008	Early Feb-Mid March	Mid Feb-Mid March	Mid Feb-Mid March	Early June-Mid July	Mid June-Mid July	Mid June-Mid July	Regular	Regular	Regular
Local (SC Rai-002)	Early Feb-Mid March	Mid Feb-Late March	Mid Feb-Late March	Mid June-Mid July	Late June-Mid July	Late June-Mid July	Regular	Regular	Regular

The germplasm SC Rai-008 also had more number of fruits (4478/plant) with heavier fruits (9.6 g). Average length and breadth of fruit was recorded 2.9 cm and 2.4 cm, respectively. Comparatively higher fruit yield was recorded in SC Rai-008 (38.9/plant and 3.9 t/ha). Fruits of SC Rai-008 showed higher edible portion (83.8 %) with higher TSS content (14.3 %) (Table 51 and Table 52).

Table 51. Quantitative fruit characteristics of jamun germplasm at Raikhali during 2017- 2019

Genotypes	Fruit size							
	Length (cm)				Breadth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	3.1	2.7	2.8	2.9	2.6	2.3	2.3	2.4
Local (SC Rai-002)	2.8	2.8	2.6	2.7	2.6	2.1	2.1	2.3

Table 51. continued

Genotypes	Seed size							
	Length (cm)				Breadth (cm)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	1.8	1.6	1.6	1.7	1.06	1.02	1.01	1.03
Local (SC Rai-002)	1.7	1.5	1.7	1.6	1.06	1.02	1.02	1.03

Table 51. continued

Genotypes	Number fruits/plant				Individual Fruit weight (g)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	870	5893	6670	4478	11.8	8.1	8.8	9.6
Local (SC Rai-002)	871	2827	3600	2433	11.4	7.6	7.6	8.9

Table 51. continued

Genotypes	Yield per plant (kg)				Yield per hectare (t)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	10.2	47.7	58.7	38.9	1.0	4.8	5.9	3.9
Local (SC Rai-002)	9.9	21.5	47.3	26.2	1.0	2.2	4.7	2.6

Table 52. Qualitative fruit characteristics of jamun germplasm at Raikhali during 2017- 2019

Genotypes	Fruit shape			Individual seed weight (g)			
	2017	2018	2019	2017	2018	2019	Mean
SC Rai-008	Oblong	Oblong	Oblong	1.9	1.7	1.7	1.8
Local (SC Rai-002)	Oblong	Oblong	Oblong	1.9	1.3	1.3	1.5

Table 52. continued

Genotypes	Edible portion (%)				Taste		
	2017	2018	2019	Mean	2017	2018	2019
SC Rai-008	83.8	82.8	84.7	83.8	Very good	Very good	Very good
Local (SC Rai-002)	79.3	80.1	82.5	80.6	Good	Good	Good

Table 53. Flesh thickness and TSS (%) of jamun at Raikhali, Rangamati

Genotypes	Flesh thickness (mm)				TSS (%)			
	2017	2018	2019	Mean	2017	2018	2019	Mean
SC Rai-008	8.07	8.00	8.20	8.1	16.2	14.4	12.4	14.3
Local (SC Rai-002)	7.47	7.00	7.20	7.2	13.2	12.8	10.5	12.2

Table 54. Fruit skin color and fruit apex of jamun at Raikhali, Rangamati

Genotypes	Fruit skin color			Fruit apex		
	2017	2018	2019	2017	2018	2019
SC Rai-008	Black	Black	Black	Flat	Flat	Flat
Local (SC Rai-002)	Black	Black	Black	Flat	Flat	Flat



Figure 26. Jamun germplasm (SC Rai-008) released as BARI Jam-1

Experiment No 19. Study on propagation technique in bael with cleft grafting

Among different months when cleft grafting was performed, 70% graft success was recorded in the saplings where cleft grafting was conducted in the month of April. The success percentage of grafting was followed by the month of May and March. No successful grafting was recorded in the winter months (October to January). Maximum scion length after 3 months of grafting was noted where grafting was performed in the month of April (7.2 cm) followed by the month of March (6.3 cm). Scio length was decreased gradually in the later months with minimum length in the month of September (2.5 cm). Maximum transplantable grafts was obtained from the grafting that was performed in the month of April (60%) while no transplantable grafts was counted in the month of August to February.

Table 55. Performance of cleft grafts in bael at different months of the year

Months	Graft success (%)	Increase in scion length (cm)	Transplantable grafts (%)
January	0	-	0
February	10	2.6	0
March	40	6.3	20
April	70	7.2	60
May	60	5.4	30
June	20	5.6	20
July	20	5.8	10
August	20	4.2	0
September	10	2.5	0
October	0	-	0
November	0	-	0
December	0	-	0

Therefore, in bael grafting should be performed in the month of April when maximum success was obtained.



Figure 27. Bael sapling obtained through cleft grafting in April 2020

At the Regional Agricultural Research Station, Rahmatpur, Barishal

Experiment No 20. Evaluation of custard apple germplasm at RARS, Rahmatpur, Barishal

Data on plant height, base girth, canopy spreading and no. of branches are presented in Table 56. Plant height ranged from 3.27 to 6.20 m among the germplasm. The highest plant height (6.20 m) was recorded in AR Rah-006 and the lowest (3.27 m) plant height was noticed in AR Rah-003. Base girth was maximum (42.50 cm) in AR Rah-006 and minimum (30.00 cm) in AR Rah-005. The highest canopy spreading was observed in AR Rah-006 and the lowest canopy spreading was observed in AR Rah-005. The highest tree volume was observed in AR Rah-006 (59.30 m³) and the lowest tree volume was observed in AR Rah-005 (14.88 m³). Maximum number of branches (5.4) was observed in AR Rah-006 and minimum number of branches was observed in AR Rah-002 (3.3).

Table 56. Plant Characteristics of Bullock's heart germplasm

Germplasm	Plant height (m)	Base girth (cm)	Canopy spreading (m)		Tree volume (m ³)	Number of branches
			N-S	E-W		
AR Rah-001	4.56	34.20	3.90	4.08	37.99	3.7
AR Rah-002	3.93	32.30	3.50	3.43	24.69	3.3
AR Rah-003	3.27	30.50	3.75	3.30	21.26	3.5
AR Rah-004	5.30	40.00	3.95	4.25	46.63	4.0
AR Rah-005	3.50	30.00	3.30	2.40	14.88	4.0
AR Rah-006	6.20	42.50	4.20	4.35	59.30	5.4
Range	3.27-6.20	30.00-42.50	3.30-4.20	2.40-4.35	6.66-11.17	3.3-5.47
Mean	4.46	34.92	3.77	3.64	9.46	3.98



Figure 28. Custard apple germplasm at RARS, Rahmatpur, Barishal

Experiment No 21. Effect of vermicompost on growth, yield and quality of sweet orange

Effect of vermicompost on vegetative characters

No significant variation was observed on plant height, base girth and canopy spread (N-S & E-W) after application of vermicompost. Plant height, base girth, east -west canopy and north-south canopy dimension of the treated plants ranged from 285.00 cm to 313.00 cm, 29.00 cm to 30.67 cm, 290.33 cm to 325.00 cm and 273.33 cm to 325.00 cm, respectively. Among the vegetative characters plant height was recorded maximum in plants treated with 100 % of the recommended fertilizer dose and maximum base girth was noticed in plants treated with 100 % of the recommended fertilizer dose and 100 % of the recommended fertilizer dose plus 10 kg vermicompost simultaneously (Table 57).

Effect on yield contributing characteristics

Significant variation was observed in case of number of fruit set per plant and individual fruit weight studied in the experiment (Table 57). The highest number of fruit set per plant was counted in plants treated with 100 % of the recommended dose plus 30 kg vermicompost (104.00) which was statistically followed by T₃ (100 % of the recommended dose plus 20 kg vermicompost). Individual fruit weight was maximum in plants treated with 100 % of the recommended dose plus 30 kg vermicompost (147.67 g). The highest fruit yield and TSS were observed in plants treated with 100 % of the recommended dose plus 30 kg vermicompost (15.35 kg/plant) and (10.70 %) respectively. Minimum number of fruits set per plant and yield (97.33 and 13.32 kg/plant respectively) were recorded in plants treated with only 100 % of the recommended dose per plant where no vermicompost was added.

Table 57. Effect of vermicompost on growth and yield characteristics of sweet orange

Treatment	Plant age (yrs)	Plant height (cm)	Base girth (cm)	Canopy (E-W) cm	Canopy (N-S) cm
T ₁	3.0	313.00a	30.67	290.33b	291.67ab
T ₂	3.0	285.00c	30.67	292.33b	273.33ab
T ₃	3.0	290.00bc	29.00	325.00a	325.00a
T ₄	3.0	308.33ab	29.33	317.00a	317.00a
CV (%)	-	3.36	7.2	3.33	13.1
LSD	-	*	NS	*	*

Table 57. Cont'd

Treatment	No. of fruits/plant	Individual fruit wt.(g)	Fruit yield (kg/plant)	TSS (%)
T ₁	97.33 b	136.87 ab	13.32 b	8.83 ab
T ₂	99.33 ab	134.47 b	13.35 b	8.03 b
T ₃	103.33 a	136.33 b	14.09 ab	9.33 ab
T ₄	104.00 a	147.67 a	15.35 a	10.70 a
CV (%)	2.19	3.98	4.53	10.30
LSD	*	*	*	*

NS: Not significant * Significant 5 % level

Here, T₁: 100 % of the recommended dose per plant (FRG, 2018); T₂: 100 % of the recommended dose plus 10 kg vermicompost; T₃: 100 % of the recommended dose plus 20 kg vermicompost; T₄: 100 % of the recommended dose plus 30 kg vermicompost



Figure 29. Fruits of BARI malta-1 after vermicompost application

Component-II. Plant Pathology Division, BARI, Gazipur-1701

Experiment No 22. Survey and identification of major diseases of lean season fruit crops in Panchagarh, Hill Agricultural Research Station, Raikhali and Gazipur regions of the country

- At Breeder Seed Production Centre, BARI, Debiganj and Farmer home orchard at Panchagarh regions gummosis disease of bael, golden apple and wood apple were identified as the major disease. In this area, fruit rot/anthracnose disease caused by *Colletotrichum* sp. and gray leaf blight caused by *Pestalotia* sp. of Burmese grape and anthracnose disease caused by *Colletotrichum* sp. of bael were recorded as minor disease.
- In Barishal regions, gummosis disease of golden apple was identified as the major disease. In this area, leaf spot *Colletotrichum* sp. of golden apple and die back of Sapota were observed as minor diseases.
- At Fruit Research Farm, HRC, BARI and farmer home orchards at Gazipur sadar upazilla gummosis disease of bael and golden apple and fruit rot/anthracnose disease caused by *Colletotrichum* sp. of Burmese grape was identified as the major disease. In this area, gray leaf blight caused by *Pestalotia* sp. of Burmese grape and gummosis disease of wood apple were recorded as minor disease.
- In the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati gummosis disease of bael, golden apple and wood apple were recorded as the major disease and anthracnose disease caused by *Colletotrichum* sp. of bael was recorded as minor disease.

Experiment No 23. Screening of the chemical fungicides against fruit rot/ anthracnose disease of Burmese grape

Results of screening of the chemical fungicides against fruit rot/anthracnose disease of Burmese grape are presented in the Table. Results of the study revealed that foliar application of Tilt (Propiconazole) showed the lowest fruit rot disease incidence of 4.67% preceded by Autostin (Carbendazim) treatment where the fruit rot/anthracnose disease incidence was 6.67% (Table 58). Foliar application of Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) also gave significantly lower fruit rot/anthracnose disease incidence of 9.33% and 9.67%, respectively. The highest fruit rot/anthracnose disease incidence was 37.67% recorded from the control. The highest reduction of fruit rot/anthracnose disease incidence of 87.60% was recorded in foliar application of Tilt (Propiconazole) followed by Autostin (Carbendazim) treatment where the reduction of fruit rot/ anthracnose disease was 82.29% compared to control. Foliar application of Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) reduced fruit rot/anthracnose disease 75.23%, and 74.33%, respectively of lotkon compared to control (Table 58). Present findings are in agreement with the findings of Leroux and Gredt (1974), Pandey (1988), Oh and Kang (2002) and Everett *et al.* (2005) who found that Carbendazim (Derosal) gave better control of fruit rot/anthracnose disease caused by *C. gloeosporioides*.

Table 58. Effect of different fungicides on disease incidence of fruit rot/anthracnose disease of Burmese grape

Treatments	Fruit rot/anthracnose disease incidence (%)	Disease decreased over control (%)
T ₁ : Autostin (Carbendazim)	6.67 c (14.93)	82.29
T ₂ : Secure (Fenamidone + Mancozeb 600WG)	9.33 b (17.75)	75.23
T ₃ : Dithane M-45 (Mancozeb 80%)	9.67 b (18.10)	74.33
T ₄ : Tilt (Propiconazole)	4.67 d (12.47)	87.60
T ₅ : Control	37.67 a (37.85)	-
LSD (P=0.05)	1.845	-

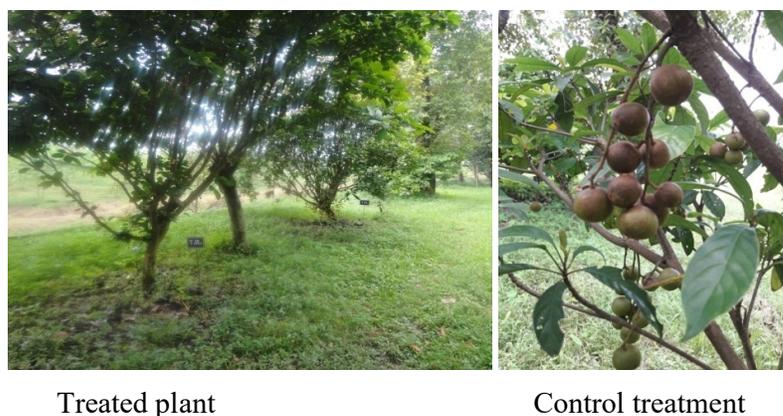


Figure 30. Effect of different fungicides on fruit rot/anthracnose of Burmese grape

Experiment No 24. Development of bio-rational based integrated disease management packages against gummosis disease of bael

The effectiveness of integration of Bordeaux paste with foliar spray of Bordeaux mixture/copper group fungicide and Coal tar with foliar spray of Bordeaux mixture/copper group of fungicide against gummosis disease of bael in two locations is presented in Table 59 and 60. It was found that all the treatments drastically reduced the gummosis disease of bael in both the locations over control. At BSPF, Debiganj, integration of Bordeaux paste with foliar spray of Bordeaux mixture/copper group of fungicide completely recovered 83.33% plants from the gummosis disease and rest of 16.67% plants partially recovered from the gummosis disease that means in the 16.67% plants there was secondary infection occurred in the infected areas. On the other hand integration of Coal tar with foliar application of Bordeaux mixture//copper group of fungicide completely recovered 83.33% plants from the disease and 16.67% plants were partially recovered from the disease (Table 59). At Hill Agricultural Research Station (HARS), Raikhali, integration of Bordeaux paste +foliar application of Bordeaux mixture/copper group of fungicide completely recovered 68.75% plants from the gummosis disease and the rest of 31.25% plants partially recovered from the disease where as integration of Coal tar +foliar application of Bordeaux mixture/copper group of fungicide completely and partially recovered 75.00% and 25.00% plants from the gummosis disease of bael (Table 60). In the present study, both the treatments i.e. integration of Bordeaux paste with foliar application of Bordeaux mixture/copper group of fungicide or integration of Coal tar with foliar application of Bordeaux

mixture/copper group of fungicide are the most promising treatment in controlling gummosis disease of bael. Similar findings have been reported by many other researchers who reported that Bordeaux paste and Coal tar effectively controlled stem bleeding of coconut (Brave, 1984; Rahman et al., 1989). Feichtenberger (1990) reported that gummosis disease of citrus (*Phytophthora* sp.) was controlled by using Bordeaux paste and Ridomyl gold as it is lower group of fungus.

Table 59. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture/copper group fungicide in reducing gummosis disease of bael at BSPC, Debiganj, Panchagarh

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Complete disease recover (%)	Partial disease recover (%)
T ₁	12	10	02	83.33	16.67
T ₂	12	10	02	83.33	16.67
T ₃	03	0	0	0	0

T₁: Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide

T₂: Coal tar +Foliar spray of Bordeaux mixture/copper fungicide

T₃: Control

Table 60. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture/copper group fungicide in reducing gummosis disease of bael at Hill Agricultural Research Station, Raikhali, Kaptai, Ranganati

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
T ₁	16	11	05	68.75	31.25
T ₂	16	12	04	75.00	25.00
T ₃	03	0	0	0	0

T₁: Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide

T₂: Coal tar +Foliar spray of Bordeaux mixture/copper fungicide

T₃: Control



Coal tar+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant completely recovered from disease



Bordeaux paste+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant completely recovered from disease

Figure 31. Bio-rational based integrated management of gummosis of bael

Experiment No 25. Development of bio-rational based integrated disease management packages against gummosis disease of golden apple

The effectiveness of integration of Bordeaux paste with foliar spray of Bordeaux mixture/copper group fungicide and Coal tar with foliar application of Bordeaux mixture/ copper group of fungicide in different locations is presented in Table 61, 62, 63 and 64. It was found that all the treatments drastically reduced the gummosis disease in both the locations over control. At HRC, BARI research field 100% plants were completely recovered from the gummosis disease by the integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicide and integration of Coal tar with foliar application of Bordeaux mixture/copper fungicide treatments (Table 61). At RARS, Rahmatpur, Barishal, integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicide and integration of Coal tar with foliar application of Bordeaux mixture/copper fungicide completely recovered 83.33% plants and partially recovered 16.67% plants from the gummosis disease of golden apple but at the Hill Agricultural Research Station (HARS), Raikhali, the above treatments completely recovered 66.67% plants and partially recovered 33.33% plants from the gummosis disease of golden apple (Table 62). At BSPC, Debiganj, integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicide completely recovered 75.00% plants and partially recovered 25.00% plants from the disease but integration of Coal tar with foliar application of Bordeaux mixture/copper fungicide completely recovered 100% plants from the disease (Table 63 and 64). In the present study, both the treatments i.e. integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicide or integration of Coal tar with foliar application of Bordeaux mixture/copper fungicide are the most promising treatments in controlling gummosis disease of golden apple. Similar findings have been reported by many other researchers who reported that Bordeaux paste and Coal tar effectively controlled stem bleeding of coconut (Brave, 1984; Rahman et al., 1989). Gummosis of citrus (*Phytophthora* sp.) was controlled by using Bordeaux paste and Ridomyl gold as it is lower group of fungus (Feichtenberger, 1990).

Table 61. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at Fruit Research Farm, HRC, BARI, Gazipur

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
T ₁	10	10	-	100	-
T ₂	10	10	-	100	-
T ₃	02	-	-	-	-

Table 62. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at RARS, Rahmatpur, Barishal

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
T ₁	6	5	01	83.33	16.67
T ₂	6	5	01	83.33	16.67
T ₃	02	-	-	-	-

T₁: Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide

T₂: Coal tar +Foliar spray of Bordeaux mixture/copper fungicide T₃: Control

Table 63. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at BSPC, Debiganj, Panchagarh

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
T ₁	04	03	01	75.00	25.00
T ₂	03	03	-	100	-
T ₃	01	-	-	-	-

T₁: Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide

T₂: Coal tar +Foliar spray of Bordeaux mixture/copper fungicide T₃: Control

Table 64. Effectiveness of Bordeaux paste, Coal tar and Bordeaux mixture in reducing gummosis disease of golden apple at the Hill Agricultural Research Station, Raikhali, Kaptai, Ranganati

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
T ₁	03	02	01	66.67	33.33
T ₂	03	02	01	66.67	33.33
T ₃	01	-	-	-	-

T₁: Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide

T₂: Coal tar +Foliar spray of Bordeaux mixture/copper fungicide T₃: Control



Bordeaux paste+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant completely recovered from disease

Coal tar+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant completely recovered

Figure 32. Bio-rational based integrated management of gummosis of golden apple

Experiment No 26. Field validation of integrated disease management packages against gummosis disease of bael

Results of the field validation trials showed that the developed technologies were effective against gummosis disease of bael in both the locations of Breeder Seed Production Center, BARI, Debiganj, Panchagarh and the Hill Agricultural Research Station, Raikhali, Kaptai,

Rangamati. At Breeder Seed Production Center, BARI, Debiganj, Panchagarh 100% plant were completely recovered from the gummosis disease by application of developed technologies. At Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati application of Coal tar +Foliar spray of Bordeaux mixture/copper fungicide, 100% plant were completely recovered from the gummosis disease where as application of Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide, 80% plants were completely recovered from the gummosis disease and 20% plants were partially recovered from the disease.

Table 65. Effectiveness of integrated gummosis disease management technologies of bael at BSPC, Debiganj, Panchagarh

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	Complete disease recover (%)
Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide	04	04	100
Coal tar +Foliar spray of Bordeaux mixture/copper fungicide	04	04	100

Table 66. Effectiveness of integrated gummosis disease management technologies of bael at Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati

Treatment	Total no. of plant treated	No. of plant (Completely recovered from disease)	No. of plant (Partially recovered from disease)	Completely disease recover (%)	Partially disease recover (%)
Bordeaux paste +Foliar spray of Bordeaux mixture/copper fungicide	05	04	01	80.00	20.00
Coal tar +Foliar spray of Bordeaux mixture/copper fungicide	05	05	00	100	0.00



Bordeaux paste+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant completely recovered from disease



Coal tar+ Foliar application of Bordeaux mixture/ copper fungicide treated bael plant completely recovered from disease



Bordeaux paste+ Foliar application of Bordeaux mixture/copper fungicide treated bael plant partially recovered from disease

Figure 33. Field validation of bio-rational based integrated management of gummosis of bael and golden apple

Component-III. Entomology Division, BARI, Gazipur-1701

Experiment No 27. Survey and monitoring of insect pests of lean season fruit crops in different locations of Bangladesh

The result of the survey has been presented in Table 67, 68, 69 and 70. It was observed that several insect pests attacked different crops during the study period at Barishal district in Bangladesh. Different insect pests were recorded in the lean season fruits crops (Golden apple/Amra, Ber, Wax apple and pomegranate etc). The insect pests name and status have been presented in the Table 67.

Table 67. Infestation of different insect pests of the lean season fruit crops at Barishal region of Bangladesh

Fruit tree type	Name of pests	Scientific name of pests	Status
Golden apple /Amra (<i>Spondias pinnata</i>)	Hog-plum beetle	<i>Podontia 14-punctata</i>	Major
Pomegranate (<i>Punica granatum</i>)	Fruit borer	<i>Deudorix isocrates</i> (Fab.)	Major
	Mealy bug	<i>Pseudococcus maritimus</i>	Minor
Wax apple (<i>Eugenia javanica</i> Lam)	Wax apple fruit flies	<i>Bactrocera dorsalis</i>	Major
Ber (<i>Ziziphus mauritiana</i>)	Ber fruit borer	<i>Meridarchis scyrodes</i>	Major
	Ber fruit fly	<i>Carpomyia vesuviana</i> Costa	Major
	Stone weevil	<i>Aubeus himalayanus</i> Voss	Minor

At BSPC, Panchagarh several lean season fruits were found to be attack by several insect pests during the study period at Panchagarh district in Bangladesh. Different insect pests were recorded in the lean season fruits crops (Golden apple/Amra,, Ber/jujube, custard apple, Bermese grape and pomegranate etc) (Table 68).



Figure 34. Infested lean season fruit tree in different region of Bangladesh during survey period

Table 68. Infestation of different insect pests of lean season fruit crops at Panchagarh district of Bangladesh.

Fruit tree name	Name of pests	Scientific name of pests	Status
Custard apple (<i>Annona squamosa</i>).	Pink Mealy bug	<i>Maconellicoccus hirsutu</i> (Green)	Major
	Oriental fruit fly	<i>Bactrocera dorsalis</i>	Minor
Golden apple /Amra (<i>Spondias pinnata</i>)	Hog-plum beetle	<i>Podontia 14-punctata</i>	Major
Bermese grape (Lotkon) (<i>Baccaurea sapida</i>)	Fruit borer	<i>Melalgus confertus</i>	Major
	Mealy bug	<i>Pseudococcus maritimus</i>	Minor

Fruit tree name	Name of pests	Scientific name of pests	Status
Ber (<i>Ziziphus mauritiana</i>)	Ber fruit borer	<i>Meridarchis scyrodes</i>	Major
	Ber fruit fly	<i>Carpomyia vesuviana</i> Costa	Major
	Stone weevil	<i>Aubeus himalayanus</i> Voss	Minor
Kodbel /wood apple	Fruit borer	<i>Deudorix isocrates</i>	Major

The result of the survey at Rangamati is presented in Table 69. The study was found to attack by several insect pests of different crops at Ranghamati district of Bangladesh. Different insect pests of the lean season fruits crops (Golden apple /Amra, ber, custard apple and wax apple etc) were recorded.

Table 69. Infestation of different insect pest of lean season fruits crop at Ranghamati district of Bangladesh

Fruit tree name	Name of pests	Scientific name of pests	Status
Custard apple (<i>Annona squamosa</i>).	Pink Mealy bug	<i>Maconellicoccus hirstus</i> (Green)	Major
	Oriental fruit fly	<i>Bactrocera dorsalis</i>	Minor
Golden apple /Amra (<i>Spondias pinnata</i>)	Hog-plum beetle	<i>Podontia 14-punctata</i>	Minor
Wax apple (<i>Eugenia javanica</i> Lam)	Wax apple fruit flies	<i>Bactrocera dorsalis</i>	Major
Ber (<i>Ziziphus mauritiana</i>)	Ber fruit borer	<i>Meridarchis scyrodes</i>	Major
	Ber fruit fly	<i>Carpomyia vesuviana</i> Costa	Major
	Stone weevil	<i>Aubeus himalayanus</i> Voss	Minor

The result of the survey performed at Gazipur have been presented in Table 70. The study was found to attack by several insect pests of different crops at Ranghamati district of Bangladesh. Different insect pests of the lean season fruits crops (Golden apple /Amra, ber/jujube, custard apple, Bermese grape, kodbel and wax apple etc) were recorded.

Table 70. Infestation of different insect pest of lean season fruits crop at Gazipur district of Bangladesh

Fruit tree name	Name of pests	Scientific name of pests	Status
Custard apple (<i>Annona squamosa</i>).	Pink Mealy bug	<i>Maconellicoccus hirstus</i>	Major
	Oriental fruit fly	<i>Bactrocera dorsalis</i>	Minor
Golden apple /Amra (<i>Spondias pinnata</i>)	Hog-plum beetle	<i>Podontia 14-punctata</i>	Major
Bermese grape (Lotkon) (<i>Baccaurea sapida</i>)	Fruit borer	<i>Melalgus confertus</i>	Major
	Mealy bug	<i>Pseudococcus maritimus</i>	Minor
Pomegranate (<i>Punica granatum</i>)	Fruit borer	<i>Deudorix isocrates</i> (Fab.)	Major
	Mealy bug	<i>Pseudococcus maritimus</i>	Minor
Wax apple (<i>Eugenia javanica</i> Lam)	Wax apple fruit flies	<i>Bactrocera dorsalis</i>	Major
Ber	Ber fruit borer	<i>Meridarchis scyrodes</i>	Major

Fruit tree name	Name of pests	Scientific name of pests	Status
(<i>Ziziphus mauritiana</i>)	Ber fruit fly	<i>Carpomyia vesuviana</i> Costa	Major
	Stone weevil	<i>Aubeus himalayanus</i> Voss	Minor
Kodbel	Fruit borer	<i>Deudorix isocrates</i>	Major

Experiment No 28. Management approaches against fruit borer (*Deudorix Isocrates*) attacking wood apple

The result of the present study (Table 71) at Gazipur region indicated that the lowest number of fruit infestation was 4.6 % obtained from the treatment (T₃) Sanitation + Spraying of Spinosad (Success 2.5SC) @ 1.2 ml/l of water and the highest number of fruit infestation was 18.7 % from the (T₆) untreated control plot. Significantly the lowest of number fruit infestation was 6.90 % in T₅ (insecticide with doses) which was statistically similar with T₃ (4.6%) (Table). The highest number of fruits infestation over control (75.4%) were observed in the same treatment(T₃) than those of others treatments.



Borer infested fruit in experimental field



Seriously infested fruit by larvae



Pupae of *Deudorix isocrates*



Adult of *Deudorix isocrates*

Figure 35. Fruit borer management in wood apple

Table 71. Efficacy of different treatments on the infestation (%) by fruit borer, *Deudorix isocrates* attacking wood apple at Gazipur

Treatment	Total number of fruits	Fruit infestation (%)	Reduction over control (%)
T ₁ : Sanitation+ Polythene bagging	156.0 b	12.6 b	32.6
T ₂ : Sanitation+ Minto plus (Bt+Spinosad)	164.0 a	10.0 c	46.5
T ₃ : Sanitation+Spinosad (Success 2.5 SC)	148.0 c	4.6 d	75.4
T ₄ : Sanitation + Azadirachtin (Fytomax 3 EC)	156.3 b	12.0 b	35.8
T ₅ : Emamectin benzoate (Proclaim 5SG)	130.0 d	6.9 d	63.1
T ₆ : Untreated Control	146.0 c	18.7 a	-
CV (%)	12.36	6.93	

Note: Means having same letter(s) in a column are not significantly different at P> 0.05 followed by LSD

The result of the present study (Table 72) at Panchagarh region indicated that the lowest number of fruit infestation was 3.9 % obtained from the treatment (T₃) Sanitation+Spraying of Spinosad (Success 2.5SC) @ 1.2 ml/l of water and the highest number of fruit infestation was 21.5 % from the T₆ untreated control. Significantly the lowest fruit infestation was (5.10 %) T₅ which was statistically similar with T₃ (Table 72). On the other hand, the highest number of fruits infestation over control observed 81.8% in the same treatment than those of other treatments.

Table 72. Efficacy of different treatments on the infestation (%) by fruit borer, *Deudorix isocrates* attacking wood apple at Debigonj, Panchagarh.

Treatment	Total number of fruits	Fruit infestation (%)	Reduction over control (%)
T ₁ : Sanitation+ Polythene bagging	60.0 a	14.8 b	31.1
T ₂ : Sanitation+ Minto plus (Bt+Spinosad)	52.0 b	12.3 bc	57.2
T ₃ : Sanitation+Spinosad (Success 2.5 SC)	45.0 c	3.9 d	81.8
T ₄ : Sanitation + Azadirachtin	49.3 c	13.0 ab	39.5
T ₅ : Emamectin benzoate (Proclaim 5SG	65.0 a	5.1 d	76.27
T ₆ : Untreated Control	39.0 d	21.5 a	-
CV (%)	11.45	7.13	

Note: Means having same letter(s) in a column are not significantly different at $P > 0.05$ followed by LSD.

Experiment No 29. Development of management approach against hog plum beetle, *Podontia 14-punctata*

At HRC, BARI, Gazipur

The highest larval and adult population reduction (86.90% and 82.01%) over control was observed in T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) treated plants (Table 73).



Hog plum beetle infested leaf in field

Seriously infested fruit tree an experimental field

Pupae of hog plum beetle

Figure 36. Bio-rational management of hog plum beetle

Table 73. Efficacy of different pest management packages in controlling hog-plum beetle, *Podontia 14-punctata* under field condition at HRC, Gazipur

Treatment	No. of larvae/m ² quard	No. of larvae/m ² quard	No. of adult/m ² quard	No. of adult/m ² quard	Reduction of larvae over control (%)	Reduction of adult over control (%)
	Before treatment	After treatment	Before treatment	After treatment		
T ₁	12.56 a	6.46 b	9.45 a	7.66 b	63.2118	43.75
T ₂	10.25 a	2.30 d	10.14 a	2.45 d	86.9021	82.01
T ₃	11.35 a	4.31 bc	9.43 a	4.25 c	75.4556	68.80
T ₄	13.44 a	8.13 b	10.44 a	6.37 b	53.7016	53.23
T ₅	11.19 a	17.56 a	8.31 a	13.62 a	-	-

All means followed by same letters at each column were not significantly different by Turkey test ($P < 0.05$).

(Note: T₁: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape T₂:

Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) T₃: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval T₄: Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 2.0 ml/litre of water; and T₅: Untreated Control)

The percentage of leaflet and fruit infestation were also significantly reduced by 84.85% and 79.86% when golden apple plants were offered with T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water). The result indicated that Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5%) is environment friendly pest management package against *P. 14-punctata* (Table 73).

Table 74. Efficacy of different pest management packages on shoot and fruit infestation by hog-plum beetle, *Podontia 14-punctata* under field condition at HRC, Gazipur

Treatment	Leaf infestation (%)	Fruit infestation (%)	Reduction of leaf infestation over control (%)	Reduction of fruit infestation over control (%)
T ₁	10.98 b	9.45 b	51.79	46.85
T ₂	3.45 d	3.58 d	84.85	79.86
T ₃	6.56 c	6.56 bc	71.20	63.10
T ₄	8.55 bc	8.55 b	62.46	51.91
T ₅	22.78 a	17.78 a	-	-

All means followed by same letters at each column were not significantly different by Tukey test ($P < 0.05$).

(Note: T₁: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) T₃: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval T₄: Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @2.0 ml/litre of water; and T₅: Untreated Control)

At RARS, BARI, Rahmatpur, Barishal

The highest larval and adult population reduction, 82.58% and 78.50% over control was observed in the plants treated with (T₂) Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5%) @ 1.5 ml/L of water.

The percentage of leaflet and fruit infestation was also significantly reduced, 88.40% and 81.74% when golden apple plants were treated with (T₂) Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water). Therefore, it is evident that sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5%) is the sustainable and environment friendly pest management package against *P. 14-punctata*.

Table 75. Efficacy of different pest management packages in controlling hog-plum beetle, *Podontia 14-punctata* under field condition at Rahmatpur, Barishal

Treat ment	No. of larvae/m ² quard	No. of larvae/m ² quard	No. of adult/m ² quard	No. of adult/m ² quard	Reduction of larvae over control (%)	Reduction of adult over control (%)
	Before treatment	After treatment	Before treatment	After treatment		
T ₁	13.55 a	7.58 b	11.52 a	8.59 b	60.83	44.87
T ₂	11.35 a	3.37 d	12.45 a	3.35 d	82.58	78.50
T ₃	12.36 a	5.38 bc	10.34 a	5.58 c	72.20	64.18
T ₄	14.34 a	9.35 b	11.33 a	7.34 b	51.68	52.89
T ₅	12.33 a	19.35 a	10.32 a	15.58 a	-	-

All means followed by same letters at each column were not significantly different by Tukey test ($P < 0.05$).

(Note: T₁: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) T₃: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval T₄: Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @ 2.0 ml/litre of water; and T₅: Untreated Control)

Table 76. Efficacy of different pest management packages on shoot and fruit infestation by hog-plum beetle, *Podontia 14-punctata* under field condition at Rahmatpur, Barishal

Treatments	Leaf infestation (%)	Fruit infestation (%)	Reduction of leaf infestation over control (%)	Reduction of fruit infestation over control (%)
T ₁	9.56 b	8.56 b	53.21	44.95
T ₂	2.37 d	2.84 d	88.40	81.74
T ₃	5.38 c	5.16 bc	73.67	66.82
T ₄	7.35 bc	7.39 b	64.02	52.48
T ₅	20.43 a	15.55 a	-	-

All means followed by same letters at each column were not significantly different by Tukey test ($P < 0.05$).

(Note: T₁: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape T₂: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) T₃: Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval T₄: Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @2.0 ml/litre of water; and T₅: Untreated Control)

12. Research highlight (title, background, objectives, methodology, key findings, and key words):

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

At Pomology Division, HRC, BARI, Joydebpur

Experiment No 1.

Title

Survey on production and management of lean season fruit crops in Bangladesh

Background

About 70 types of fruit species are grown in Bangladesh. But not all the fruits are cultivated all over the country. Again, more than 54% of the total fruits produced in Bangladesh become available during May-August. The country faces scarcity of fruits in rest of the year. In this scarce period some fruits like custard apple, bullock's heart, tamarind, sapota, bael, wood apple etc. are the main fruits. Besides this, availability of fruits is different in different area. Therefore, a benchmark study or survey was essential prior to commencing the basic activities of the sub-project.

Objectives

- i) To know lean season fruit production status in Gazipur, Barishal, Panchagarh and Rangamati
- ii) To formulate research programs based on the survey output

Methodology

Baseline survey is an important task in conducting any research work. Under the present research project a base line survey was planned and executed in four project locations; Barishal, Panchagarh, Rangamati and Gazipur. For conducting survey a questionnaire was prepared. At each location production and management related information of lean season fruit crops were collected from 50 participants. Thus as many as 200 fruit growers were interviewed. The participants were selected randomly from 5 upazilas each of Barishal, Panchagarh, Rangamati and Gazipur districts with the help of Upazila Agriculture Officer (UAO). The collected information was compiled and reported.

Key Findings

- A total of 40 well established orchards of golden apple (BARI Amra-2), sweet orange (BARI Malta-1), guava (Local & Thai), Burmese grape, dragon fruit (BARI Dragonfruit-1), pine apple (Honey Queen, Joldubi), pummelo, mandarin, cashewnut and longan were noted.
- Besides these orchards 1-2 plants of local fruits were found in every house hold.

- Different lean season fruit crops namely bullock's heart, custard apple, Indian olive, aonla, carambola, bael, wood apple, sapota, wax apple, tamarind, jamun, Indian dillenia etc. were observed in the surveyed locations.

Key Words

Baseline survey, Production, Lean season fruit, Barishal, Panchagarh, Rangamati and Gazipur

Experiment No 2.

Title

Evaluation of custard apple germplasm at Joydebpur, Gazipur

Background

Custard apple (*Annona squamosa*) is a minor fruit of Bangladesh. The fruit is rich in vitamins, minerals (calcium, copper, magnesium) and high nutritive value. The fruit has a demand to the consumers but this fruit is on the verge of extinction due to their non-commercial use. Moreover, the available genetic variability within the fruit species has not yet been collected, properly evaluated and systematically conserved. Therefore, it is essential to identify superior genotypes, collection and planting in the research field for critical evaluation in order to test their potentiality and release for commercial cultivation as well as strengthen the base of the fruit industry of the country. With this view in mind, this experiment has been undertaken.

Objectives

- i) To release as variety of custard apple
- ii) To conserve genetic material for breeding purpose

Methodology

As many as 12 genotypes were included in this experiment. Saplings of custard apple were collected from farmers' homestead of different locations of Bangladesh and planted in the fruit research farm of Pomology Division, HRC, BARI, Gazipur during March 2019. The plants were 3 years old at the beginning of the sub-project. As harvesting was not started, data were recorded on plant growth characters.

Key Findings

- Plants are in good vegetative stage.
- Plant height and base girth of the germplasm ranged from 2.0 to 3.20 m and 12.47 to 19.65 cm, respectively.
- Canopy dimensions varied from 1.60 to 2.45 m (E-W) and 1.60 to 2.60 m (N-S), respectively.

Key Words

Custard apple, Evaluation, Vegetative characteristics

Experiment No 3.

Title

Evaluation of bullock's heart germplasm at Joydebpur, Gazipur

Background

The Bullock's heart (*Annona reticulata*) is a tasty fruit as well as nutritious. It is widely distributed in tropical and subtropical regions. Bullock's heart received its name due to its resemblance to a bull's heart. It is also known as 'ata' or 'ataphal' in Bangladesh. It is botanically classified as *Annona reticulata* and belongs to the Annonaceae family. In India it is widely cultivated and naturalized as a fruit consuming plant and deciduous tree. It is distributed in Bengal, Burma and Southern regions of India. It is native to tropical regions of America, particularly in West Indies and South America (Acevedo-Rodriguez and Strong, 2012). The plant is cultivated in Bangladesh and Pakistan. Bullock's heart contains ample vitamin C, a nutrient that boosts the immune system, keeps skin healthy and assists with repairing wounds and cuts. The fruit also contains a good source of potassium, which helps the body to regulate its electrolyte balance, enhances muscle growth, and improves the body's ability to process waste. The immature fruits, seeds and roots are considered medicinal value both in Aurvedic and Yunani systems of medicine (Kirtikar and Basu, 1933). There is wide genetic diversity of bullock's heart in Bangladesh. But attempt was not taken to study the variability for selection of improved germplasm and release varieties for farmers.

Objectives

- i) To release as variety of custard apple
- ii) To conserve genetic material for breeding purpose

Methodology

As many as 8 genotypes were included in this experiment. Saplings of bullock's heart were collected from farmers' homestead of different locations of Bangladesh. The collected germplasm were planted during March 2019 in the fruit research farm of Pomology Division, HRC, BARI, Gazipur. The plants are 3 years old at the end of the sub-project. As harvesting was not started, data were recorded on plant growth characters.

Key Findings

- Plants are in good vegetative stage.
- Plant height and base girth of the germplasm ranged from 120 to 225 cm and 11 to 22 cm, respectively.
- Canopy dimensions varied from 104 to 266 cm (N-S) and 114 to 277 cm (E-W), respectively.

Key Words

Bullock's heart, Evaluation, Vegetative characteristics

Experiment No 4.

Title

Collection and evaluation of fig (*Ficus carica*) germplasm

Background

Fig (Teen) is a highly nutritious exotic fruit. The fruits are a good source of minerals and bioactive compounds. They are considered healthy fruits because they are a rich source of minerals (iron, calcium, potassium), amino acids (aspartic acid, glutamine) fiber and carotenoids such as lycopene, cryptoxanthin and β -carotene. Fresh figs provide a large amount of antioxidants, polyphenols and flavonoids (catechin, epicatechin). In addition, figs are free of fats and cholesterol and are a good source of sugars (fructose, glucose), organic acids and volatile compounds that enhance the flavour of the fruit (Deunas *et al.*, 2008; Hssaini *et al.*, 2019). Besides these, dried figs have sweet and chewy taste. The fruits are relished as dried fruit due to characteristic detectable flavour. Daily consumption of figs can provide almost 20 per cent of the recommended dietary fibre per serving. It also helps to regulate blood pressure and blood cholesterol due to the presence of potassium, omega-6 and omega-3 fatty acids (Satnar *et al.*, 2011). It is a popular juicy fruit that is widely and commercially cultivated in the middle-east and east Asia. It has become the cash crop of those countries. Though the climatic condition of Bangladesh is different from middle-east but some mass media have noted some reports of Arabian and Turkish fig (Teen) in some places of the country. Again, Bangladesh agricultural Research Institute has not undertaken any research on fig and released any variety of fig yet. Hence, this program is undertaken to collect, evaluate, characterize and release a superior variety of fig in Bangladesh.

Objectives

- i) To find out the superior germplasm of fig
- ii) To identify suitable germplasm for higher yield and quality
- iii) To release as variety

Methodology

A total of 19 plants of 7 fig germplasm were collected and planted in fruit research farm in November 2019. Fruiting was started from 7 months after planting. Data on plant height, base girth, number of main branch and number of fruits harvested were collected and analyzed.

Key Findings

- Plant height and base girth of the germplasm ranged from 72.30 to 98.10 cm and 4.60 to 5.62 cm, respectively.
- Maximum 12 fruits were harvested from germplasm FC Joy-001.

Key Words

Fig, Evaluation, Vegetative characteristics, Fruits, Variety

Experiment No 5.

Title

Standardization of propagation technique for avocado (*Persea Americana* Mill.)

Background

Avocado (*Persea americana* Mill) is a native of tropical America specifically from Mexico and Central America. It is one of the most nutritive fruits and contains higher protein (up to 4%), fat (up to 30%) and low sugars (< 1.0 %). The cultivation of avocado is now gaining popularity by virtue of its nutritional properties and increasing health awareness. Due to cross-pollination, there is great variability in the seedlings produced from seeds, it is impossible to obtain genetically uniform plant as required for plantation of commercial orchards. These seedlings plants take long time to start bearing and fruit quality is unreliable (Whiley *et al.*, 2002). Vegetative propagation of superior clones of avocado by budding or grafting is essential to avoid these problem. Grafting/budding is also beneficial in utilization of rootstocks with *Phytophthora* and salinity tolerance for elite line and varieties (Castro *et al.*, 2009). Thus, there is a need to standardize the time and method of propagation in avocado under the tropical humid conditions of Bangladesh so that the vegetatively propagated plants may be provided to the growers to get better yield and quality in future.

Objectives

- i) To find out suitable grafting method for propagating avocado
- ii) To search out appropriate month for avocado propagation

Methodology

The experiment was conducted at the Research Field of Pomology Division, HRC, BARI, Gazipur during 2018-2019. The climate is humid tropical with moderate temperature. Four method of propagation namely T₁: cleft grafting, T₂: veneer grafting, T₃: patch budding and T₄: T - budding were tried in all twelve months of the year starting from January to December with three replications and 10 plants were maintained each replication. For raising rootstocks, large sized fruits from vigorous trees were collected and the seedlings were raised in the potting medium of 1:1:1 (soil: sand: Farmyard Manure) for rootstock purpose. Four to six months old vigorous seedlings were used as rootstock for grafting/budding. The shoots of current season's growth of three to four months age from elite trees were used as scion material. The leaves from the scion shoots were removed 3 days prior to grafting. The grafting/budding was done on 15th of every month. The survival and growth of scion was recorded after 3 months of budding/grafting. The number of transplantable grafts/budlings was recorded after one year of budding/grafting. The data were analyzed using standard statistical procedures as described by Gomez and Gomez (1984).

Key Findings

- Among various combinations of methods and time of propagation, highest success (70%) was recorded in cleft grafting performed in the month of June, July September. In veneer grafting, highest success was only 20 percent in four summer months (June to September). T-budding and patch budding gave 20% success in the months of June, July

and September whereas only 10% graft success was noted in the other months of the year.

- Among various combinations of propagation methods and months of propagation, highest scion growth (10.3 cm) was observed in cleft grafting performed in the month of September.
- Among various combinations of method and time of propagation, highest success (60%) was recorded in cleft grafting performed in the month of September. The numbers of transplantable grafts were very low or nil in veneer grafting, T- budding and patch budding in most of the months.

Key Words

Avocado, grafting, budding, graft success, scion growth, transplantable graft

Experiment No 6.

Title

Effect of split application of fertilizer on manipulating harvest time, yield and quality of golden apple cv. BARI Amra-1

Background

In Bangladesh, more than 54 % fruits are available during mid-May to mid-August and people get fairly adequate quantities of fruits during the four summer months. But golden apple var. BARI Amra-1 bears fruits all the year round and BARI Amra-2 is harvested till mid-September (Azad *et al.*, 2020). Thus during the lean season golden apple can be a source of nutrient security as an acute shortage of native fruits prevails at that period. Golden apple are considered to have good nutritional quality; the fruit has a pleasant aroma and a juicy pulp, as well as a distinctive bittersweet flavor (Silva *et al.*, 2007). Although BARI Amra-1 possesses the habit of year round fruit bearing characters, but due to nutrient deficiency and inadequate cultural practices, irregular flowering, low fruit set and low fruit retention leading to low yield and poor quality fruits are common problems in production. Brar *et al.* (2015) declared that the fruit yield and quality of rainy season crop significantly improved with higher doses of split application of inorganic fertilizers.

Objectives

- i) To find out suitable fertilizer dose for profitable growth and yield of golden apple
- ii) To search out appropriate split/instalments of fertilizer application
- iii) To evaluate to quality of fruits produced after fertilizer application

Methodology

The experiment was performed at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2018 to June 2021. BARI Amra-1 was used in this study as variety. The experiment was laid out in Randomized Complete Block Design (Factorial) with 3 replications. Here, single plant was considered as an experimental unit which was replicated for three times. The fertilizer doses i. e., F₁: 100 % of the

dose (N: 100 g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018 in combination with four application methods were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and urea and MoP were applied in splits as per treatments. Urea and MoP were splitted I₁: twice (September and April), I₂: thrice (September, March-April and May-June) and I₃: four times (September, November, March-April and May-June) and the other application method was I₀: the application of whole urea and MoP at a time (September-October). Weeding was done before each of the fertilizer application and light irrigation was applied immediately after fertilizer application for better uptake of nutrient by the plants. Insecticide (Cypermethrin @ 2 ml per litre) was sprayed once after fruit set and fungicide (Carbendazim @ 2 g per litre) was also applied once after a five day long rain in May 2021. The data on the following parameters like plant height, base girth, canopy spread (N-S & E-W), final canopy spread (N-S and E-W), panicle per plant, fruit set per panicle, fruits retained per panicle were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Key Findings

- Among the collected data superiority in number of fruits retained per panicle (3.44) was recorded from plants treated with 150 % of the dose per plant mentioned in the FRG, 2018.
- Control plants always exhibited minimum number of fruits per panicle.
- The highest number of panicles per plant (10.00) and fruits retained per panicle (11.53) were counted in plants received 200 % of the fertilizer dose per plant mentioned in the FRG, 2018 in combination with urea and MoP were applied twice and
- The lowest number of panicles per plant (4.00) and fruits retained per panicle was recorded (4.04) in plants where 100 % of the dose per plant mentioned in the FRG, 2018 was applied at a time.

Key Words

BRAI Amra-1, Fertilizer, Split application, Growth, Yield, Quality

Experiment No 7.

Title

Effect of split application of fertilizer on manipulating harvest time, yield and quality of golden apple cv. BARI Amra-2

Background

In Bangladesh, more than 54% fruits are available during mid-May to mid-August and people get fairly adequate quantities of fruits during the four summer months. But BARI Golden Apple-2 harvested is harvested till mid-September (Azad *et al.*, 2020). Thus during the lean season

golden apple can be a source of nutrient security as an acute shortage of native fruits prevails at that period. Hog plums are considered to have good nutritional quality; the fruit has a pleasant aroma and a juicy pulp, as well as a distinctive bittersweet flavor (Silva et al., 2007). BARI Amra-2 bears flowers in March-April and subsequently fruit is harvested during June-July. Rarely, it bears fruits in the winter. But fertilizer management may help in bearing flowers as well as fruits in the off-season. The golden apple trees grow best in fertile, well-drained soils but can thrive satisfactorily in a variety of poorer soils if they are given adequate nutrition (Crane and Wasielewski, 2019). Brar *et al.* (2015) declared that the fruit yield and quality of rainy season crop significantly improved with higher doses of split application of inorganic fertilizers.

Objectives

- i) To find out suitable fertilizer dose for profitable growth and yield of golden apple
- ii) To search out appropriate split/installments of fertilizer application
- iii) To evaluate to quality of fruits produced after fertilizer application

Methodology

The experiment was performed at the Fruit Farm of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during September 2018 to June 2021. BARI Amra-2 is used in this study as variety. The experiment was laid out in a Randomized Complete Block Design (Factorial) with 3 replications. Here, single plant was treated with individual treatment which was replicated for three times. The fertilizer doses i. e., F₁: 100 % of the dose (N: 100 g, P: 50 g, K: 90 g, S: 15 g, B: 1.5 g and Cowdung: 15 kg); F₂: 150 % of the dose and F₃: 200 % of the dose per plant mentioned in the FRG, 2018 in combination with four application methods were used as treatments of the experiment. All the fertilizers except urea and MoP were applied during final land preparation as basal dose and the rest of urea and MoP are being applied in splits as per treatments. Urea and MoP were splitted I₁: twice (September and April), I₂: thrice (September, March-April and May-June) and I₃: four times (September, November, March-April and May-June) and the other application method was I₀: the application of whole urea and MoP at a time (September-October). Weeding was done before each of the fertilizer application and light irrigation was applied immediately after fertilizer application for better uptake of nutrient by the plants. Insecticide (Cypermethrin @ 2 ml per litre) was sprayed once after fruit set and fungicide (Carbendazim @ 2 g per litre) was also applied once after a five day long rain in May 2021. The data on the following parameters like plant height, base girth, canopy spread (N-S & E-W), final canopy spread (N-S and E-W), panicle per plant, fruit set per panicle, fruits retained per panicle were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Key Findings

- Superiority in number of fruit retention was recorded from plants treated with 200 % of the dose per plant mentioned in the FRG, 2018.
- The highest number of panicles per plant (65.17) and fruits retained per panicle (6.63) were counted in plants received 200 % of the fertilizer dose per plant mentioned in the

FRG, 2018 in combination with urea and MoP were applied thrice (F₃I₂) and twice (F₃I₁), respectively.

- While, maximum number of fruits per plant and the heaviest fruit were noticed in F₃I₁ (387.0) and F₃I₂ (142.1 g), respectively.
- Again, F₃I₁ exhibited the highest fruit yield per plant (54.48 kg) and yield per hectare (8.50 t).

Key Words

BARI Amra-2, Fertilizer, Split application, Growth, Yield, Quality

Experiment No 8.

Title

Effect of fertilizer application on yield and quality of sweet orange

Background

In Bangladesh where the monsoon climate has relatively high annual mean temperature and large annual mean rainfall, favors the mineralization of soil organic matter and minerals, and thus increases the risk of nutrients leaching, which has become one of the predominant degradation processes of soil fertility (Diacono and Montemurro, 2010). Sweet orange var. BARI Malta-1 is one of the most important members among citrus fruits grown in the country. It is the heaviest bearer than any other citrus fruit. It is very much liked by all sorts of people due to its excellent taste, dietary values, rich in vitamin-C, large amount of juice and melting juice vesicles. Best fertilization strategies to increase yields and quality of these two crops are of great significance to economical growth. Citrus is perennial and evergreen plant with many flowers and requires a large amount of nutrients. Applying proper compound fertilizers has been shown to enhance the growth, increase yield and improve quality of citrus (Yu, 2000; Wen and Cai, 2001). Hence, the present experiment was undertaken with the mentioned objectives.

Objectives

- i) To find out suitable fertilizer dose for profitable growth and yield of sweet orange
- ii) To evaluate to quality of fruits produced after fertilizer application

Methodology

The experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to March 2022 and onward to find out a suitable fertilizer dose with respect to growth, yield and fruit quality of sweet orange. BARI Malta-1 was used in the study as variety. The experiment was laid out in Randomized Complete Block Design with 4 replications. Four different levels of fertilizer i.e., T₁: 100 % of the dose (N: 179 g, P: 79 g, K: 88 g, S: 18 g, Zn: 32 g, B: 1.0 g and cowdung: 15 kg); T₂: 125 % of the dose; T₃: 150% of the dose and T₄: 175% of the dose per plant mentioned in the FRG, 2018 were used as treatments of the experiment. In control plants only 30 kg cowdung was used in two equal splits; one in October and the other in May. Fertilizers like cowdung, P, S, Zn and B

were applied as basal dose on October just after fruit harvest and urea and Mop were applied in three splits, October, March and May. The data on the following parameters like plant height, base girth, number of fruits set per plant, fruits retained per plant were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Key Findings

- The highest number of fruit set per plant was counted in plants treated with 175 % of the recommended dose per plant mentioned in the FRG' 2018 (174.33).
- Again, maximum number of fruits retained per plant was also noted in plants treated with 175 % of the recommended dose per plant mentioned in the FRG' 2018 (87.00) which was statistically followed by 150 % of the recommended dose.
- Minimum number of fruits set per plant and number of fruits retained per plant (105.67 and 48.00, respectively) were recorded in control plants

Key Words

BARI Malta-1, Fertilizer, Growth, Yield, Quality

Experiment No 9.

Title

Effect of time and level of pruning on growth, yield, and quality of guava

Background

BARI Peyara-2 is a widely accepted and cultivated guava variety throughout the country. It is a variety of profuse bearing with the yield potentiality of about 25-30 t/ha. It has year round production characteristics. But due to heavy bearing in regular season (June to August) and lack of new shoots during the month of September to April, it fails to bear optimum level of fruits in the lean period when there is a huge demand of fruits throughout the country. Sahar and Abdel-Hameed (2014) mentioned that pruning is required to stimulate the growth of productive shoots and eliminate unproductive shoots or shoots that point inward, facilitate the plants' maintenance and form tree canopies (young plants). Again, severity of insect-pest attack is much in the monsoon but low in the dry period. Fruit quality is also better in fruits obtained in the dry period. Therefore, the present investigation was undertaken with the following objectives.

Objectives

- i) To find out suitable time and level of pruning for increase the availability of guava in lean period
- ii) To increase the guava production round the year
- iii) To manage a suitable plant structure for easy intercultural operations

Methodology

The experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to July 2021 and onward to find out a suitable pruning time and level of pruning with respect to sustainable growth, yield and fruit quality of guava. BARI Peyara-2 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design with 3 replications. Three different pruning times i.e., Mid-March, mid-July and mid-October and four pruning levels (tip removal) viz., 0-cm, 10-cm, 20-cm and 30-cm were used as treatments of the experiment. Regular fertilization, irrigation and weeding were done as and when necessary. Insects and diseases were controlled by applying biological and chemical pesticides and fungicides. The data on the following parameters like number of main branch, number of leaves at new shoot, number of fruits harvested in summer (May-September) and winter (October-April), individual fruit weight, fruit yield per plant and TSS content of fruits were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Key Findings

- Maximum number of leaves at new shoot was counted 2251.3 at plants where pruning was practiced in mid-March with 30 cm tip removal. Minimum number of leaves at new shoot was noted at plants where no pruning was performed.
- In winter during the month of October-April maximum number of fruits (87.0/plant) was harvested from plants where pruning was done in mid-March with 30 cm tip removal.
- Again, in summer during May-September maximum number of fruits (78.3/plant) was harvested from plants where 30 cm tip was removed in mid-July.
- Maximum 34.93 kg fruit per plant was recorded in plants where pruning was done in mid-March with 30 cm tip removal.
- Therefore, it was registered that pruning in March by removing 20-30 cm from the tip of the branch exhibited maximum yield with superior quality of fruits.

Key Words

BARI Peyara-2, Pruning, New shoots, Yield, Quality

Experiment No 10.

Title

Effect of GA₃ on fruit quality of golden apple

Background

Sustainable fruit production with good quality and high biological value is the resultant of the plants response to the balanced nutrient availability. And the nutrient uptake by plants largely depends upon the plants' physiological activities. Again, the plants' physiological functions and

processes are regulated by phytohormones or plant growth regulators. plant growth regulators have profound impact on strawberry production as it determines the physiological and biochemical metabolic processes responsible for plant growth and fruit production. The growth regulating chemicals are also becoming important in the golden apple for the modification of their vegetative growth, flowering, and fruiting affecting total yield and also quality (Vishal *et al.*, 2016; Palei *et al.*, 2016). Several researchers addressed that Gibberellic acid (as GA₃) at 25 to 150 ppm markedly improved the quality fruit yield in many fruit crops (Kumar *et al.*, 2012, Asadi *et al.*, 2013, Saima *et al.*, 2014, Nuruzzaman *et al.*, 2015). Therefore, the experiment was taken with the following objectives.

Objectives

- i) To find out suitable dose of GA₃ for quality improvement of golden apple
- ii) To evaluate the quality and seed size of golden apple

Methodology

The experiment was conducted at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, BARI, Gazipur during June 2020 to July 2021 and onward to find out an appropriate dose of GA₃ and fruit development stages when the influence of the growth regulator was the most with respect to fruit quality of golden apple. BARI Amra-2 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design with 3 replications. Three different fruit development stages i.e., pre-flowering stage, full bloom stage and fruit set stage and five different concentrations GA₃ viz., 0.25 mmol/L, 0.50 mmol/L, 0.75 mmol/L, 1.00 mmol/L and 1.50 mmol/L along with control (only distilled water or 0 mmolL⁻¹) were used as treatments of the experiment. Regular fertilization, irrigation and weeding were done as and when necessary. Insects and diseases were controlled by applying biological and chemical pesticides and fungicides. The data on the following parameters like individual fruit weight, seed weight, skin weight, edible portion and TSS content of fruits were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical package programme MSTAT-C. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance.

Key Findings

- Individual fruit weight, seed weight and skin weight ranged from 78.0 to 83.3 g, 13.5 to 14.3 g and 11.5 to 12.2 g, respectively.
- Edible portion of the fruits varied non-significantly from 61.5 to 68.2 %.
- GA₃ exhibited no significant variation when applied at different developmental stages.
- This experiment should be continued with modification in concentration and application time.

Key Words

BARI Amra-2, GA₃, Fruit weight, Edible portion, Quality

At the Breeder Seed Production Centre, Debiganj, Panchagarh

Experiment No 11.

Title

Collection and evaluation of bullock's heart (*Annona reticulata*) germplasm at BSPC, Debiganj, Panchagarh

Background

The Bullock's heart (*Annona reticulata*) is a tasty fruit as well as nutritious. It is widely distributed in tropical and subtropical regions. Bullock's heart received its name due to its resemblance to a bull's heart. It is also known as 'ata' or 'ataphal' in Bangladesh. It is botanically classified as *Annona reticulata* and belongs to the Annonaceae family. In India it is widely cultivated and naturalized as a fruit consuming plant and deciduous tree. It is distributed in Bengal, Burma and Southern regions of India. It is native to tropical regions of America, particularly in West Indies and South America. The plant is cultivated in Bangladesh and Pakistan. Bullock's heart contains ample vitamin C, a nutrient that boosts the immune system, keeps skin healthy and assists with repairing wounds and cuts. The fruit also contains a good source of potassium, which helps the body to regulate its electrolyte balance, enhances muscle growth, and improves the body's ability to process waste. The immature fruits, seeds and roots are considered medicinal value both in Aurvedic and Yunani systems of medicine (Kirtikar and Basu, 1933). There is wide genetic diversity of bullock's heart in Bangladesh. But attempt was not taken to study the variability for selection of improved germplasm and release varieties for farmers.

Objectives

- i) To release as variety of custard apple
- ii) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Horticulture Research Farm, BSPC, Debiganj, Panchagarh during 2017-2020. Two bullock's heart fruit germplasm viz. AR Deb-001 and AR Deb-002 were evaluated. Manures and fertilizers were applied @ 20kg Cowdung, 435g Urea, 286g TSP, 200g MOP and 100g Gypsum per plant per annum in three equal installment. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas quantitative and qualitative fruit parameters were recorded by different laboratory instruments. Pulp, peel and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer. The data were analyzed statistically.

Key Findings

- Both the bullock's heart germplasm exhibited regular bearing habit with similar flowering duration (early June to late September) but differed in harvest time (early March to mid May in AR Deb-001 and mid march to mid may in AR Deb-002).

- AR Deb-002 had higher number of fruits 370.0/plant but heavier and bigger fruit was recorded in AR Deb-001 (261.2 g).
- Yield per plant and yield per hectare was recorded higher in the germplasm AR Deb-001 (84.2 kg and 23.2 t, respectively) than AR Deb-002 (72.3 kg and 19.9 t, respectively).
- Edible portion and TSS content was exhibited more in the fruits of AR Deb-001 (71.8 % and 26.3 %) than that of AR Deb-002 (70.6 % and 22.4 %).
- The germplasm AR Deb-001 has been released as a variety of bullock's heart named as BARI Ata-1 for cultivation in Bangladesh.

Key Words

Bullock's heart, Evaluation, Yield, Quality

Experiment No 12.

Title

Variability estimation among Bael (*Aegle marmelos*) germplasm in northern region of Bangladesh

Background

Bael (*Aegle marmelos*) is the only member of the monotypic genus *Aegle* (Sharma *et al.*, 2007; Baliga *et al.*, 2011). It is a mid-sized, slender, aromatic, armed, gum-bearing tree having a leaf with three leaflets. Bael occurs in dry forests on hills and plains of northern, central and southern India, southern Nepal, Sri Lanka, Myanmar, Bangladesh, Vietnam, Laos, Cambodia and Thailand (Jauhari *et al.*, 1969). It is cultivated throughout India, as well as in Sri Lanka, but in Bangladesh its commercial cultivation is limited or nil. It has a reputation in India for being able to grow in places that other trees cannot. It grows in a wide range of soil conditions (pH range 5-10), tolerant to water logging and has an unusually wide temperature tolerance (from -7°C to 48°C). Therefore, this fruit can be a key to bring in the problem soils of Bangladesh under cultivation like north western and south eastern part where the pH level of soil is low. Bael is an indigenous fruit of Indian subcontinent and it is commonly known as Bengal quince (John and Stevenson, 1979), therefore, Bangladesh is believed to be one of the primary centers of origin of this fruit (Neeraj *et al.*, 2017) having a wide range of genetic variability, which may be used for varietal development. Keeping this view in mind the present study was undertaken.

Objectives

- iii) To release as variety of bael
- iv) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Horticulture Research Farm, BSPC, Debiganj, Panchagarh during 2018-2021. There were 49 plants of 7 different germplasm in the farm. Four germplasm was selected as treatment during the experiment viz., AM Deb-001, AM Deb-002, AM Deb-003, and AM Deb-005. The treatment (germplasm) was replicated thrice considering each plant as

one replication following RCB Design. Planting distance was maintained as 5×5 m in both ways. Data on plant height, fruit length, fruit diameter, individual fruit weight, seed weight, rind weight and pulp weight were recorded. The qualitative data were noted on the basis of organoleptic test with a panel of 10 persons.

Key Findings

- The accession AM Deb-001 exhibited the highest individual fruit weight 1.69 kg, but minimum fruit number (4.4). Number of fruit per plant (41.0) was recorded the highest in AM Deb-003.
- Percent edible index was noted maximum (78.86) in AM Deb-002 while it was minimum (65.61) in AM Deb-005.
- Maximum TSS (40.40⁰Brix) was found in AM Deb-005 and minimum TSS was measured in AM Deb-001 (28.4⁰Brix).

Key Words

Bullock's heart, Evaluation, Yield, Quality

Experiment No 13.

Title

Evaluation of Carambola germplasm at BSPC, Debiganj, Panchagarh

Background

Carambola is one of the important minor fruits in Bangladesh. The fruit becomes available during the month of August-October and February to March. The fruit has important nutrient value along with vitamin C. In Bangladesh there exists a lot of variation in growth and fruiting habit in carambola. So, collection, evaluation and characterization of carambola are essential. Therefore, the present study was undertaken with the following objectives.

Objectives

- v) To release as variety of carambola
- vi) To conserve genetic material for breeding purpose

Methodology

The study was conducted at the BSPC, BARI, Debiganj, Panchagarh. A total of 23 accessions of *Averrhoa sp.* was collected throughout Bangladesh and introduced from other countries. Among them 16 accessions were used for this study and data on nine traits were recorded during January to March 2021. Different traits of fruit quality were characterized by mean difference. Fertilization and intercultural operations were done as per requirement.

Key Findings

- Among the germplasm, the highest plant height was noticed in AC Deb-006 (8.0 m), while the shortest plant was recorded 2.3 m, in AC Deb-009 and AC Deb-015.

- The fruit weight varied significantly and ranged from 52.4 g to 128 g. The genotype AC Deb-014 exhibited maximum fruit weight (128 g) followed by AC Deb-007 (125.6 g).
- Maximum number of fruits per tree was recorded in AC Deb-014 (703), followed by AC Deb-006 (666). The least number of fruits per tree of (233) was recorded in AC Deb-015.

Key Words

Carambola, Evaluation, Yield, quality

Experiment No 14.

Title

Collection and evaluation of wood apple (*Feronia limonia*) germplasm at BSPC, Debiganj

Background

Wood Apple (*Feronia limonia*) belongs to the family Rutaceae. It is also called as monkey fruit, curd fruit and kadbhel. The plant is native of India and Sri Lanka and grows throughout South India. The tree is subtropical and it prefers dry climatic conditions during flowering and fruit setting. It is one of the very hardy trees and found growing all over the semi-arid and arid regions. Troup (1921) described wood apple as a small to moderate sized, deciduous, glabrous tree with thorny branches, growing to a height of 10 m and 0.6 to 1.6 m in girth. The importance of elephant foot's apple fruit is used for curative properties, which make the tree one of the useful medicinal plants of India (Kirtikar and Basu, 1933). The different parts of plant (leaf, stem, bark, fruit and seed) were being used for curing various diseases (Joshi *et al.*, 2011 and Sharma *et al.*, 2012). The fruits contain a myriad of phytochemicals such as polyphenols, phytosterols, saponins, tannins, coumarins, triterpenoids, vitamins, amino acids, tyramine derivatives, etc. (Dar *et al.*, 2013). The diverse pharmacological properties of the fruit includes anti-diabetic (Gupta *et al.*, 2009), anti-ulcerative (Mishra *et al.*, 2009), hepatoprotective (Jain *et al.*, 2011), wound healing (Ilango and Chitra, 2010), anti-tumour (Saima *et et al.*, 2000), anti-132 microbial activity (Senthilkumar and Venkatesalu, 2013). It has high medicinal value, astringent properties and has beneficial effect on cardiovascular system. The ripe fruit pulp makes excellent chutney and it is also consumed as fresh along with sugar. Though its nutritional economic importance has been widely recognized, this fruit can be exploited for regular cultivation in dry areas. Providing support by processing industry as it makes excellent chutney, can be used as adjunct in jelly and made into squash. There is only one recommended variety in Bangladesh which is grown seasonally named BARI Kodbael 1.

Keeping above points in view and perspective of climate change; an attempt was made to identify suitable elephant foot's apple germplasm for developing a year-round off season kadbhel variety for Bangladesh.

Objectives

- i) To release as variety of off-season wood apple
- ii) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Horticulture Research Farm, BSPC, BARI, Debiganj, Panchagarh during 2019-2021. Six woodapple germplasm viz. FL Deb-001, FL Deb-002, FL Deb-003, FL Deb-004, FL Deb-005 and FL Deb-006 were evaluated. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g M_oP and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer. The recorded data on different parameters were statistically analyzed by using MS excel 2013.

Key Findings

- Among these germplasm only two germplasm namely FL Deb-001, FL Deb-002 produced fruits and the remaining germplasm namely FL Deb-003, FL Deb-004, FL Deb-005, FL Deb-006 did not produce any fruit.
- The highest number of fruits (75) was obtained from the germplasm FL Deb- 002.
- The highest fruit weight (223.83 g), fruit length (7.3 cm), fruit diameter (7.23 cm), pulp weight (155.67 g), TSS (15.83 %) and yield per plant (14.55 kg) were recorded in the germplasm FL Deb-001 than that of the germplasm FL Deb-002.
- The highest edible portion 82.04% and the lowest rind weight (36.14 g), fiber weight (4.29 g), rind thickness (0.21 mm) and seed weight (14.71 g) were found in the germplasm FL Deb-002.

Key Words

Wood apple, Evaluation, Yield, Quality

Experiment No 15.

Title

Collection and evaluation of peach fruit (*Prunus persica* L.) germplasm

Background

Peach (*Prunus persica* L. Batsch) is an important stone fruit, cultivated throughout warm temperate and sub-tropical region of the world (Singh *et al.*, 2003). It is a small deciduous tree growing up to 15 feet tall with spreading crown. It produces delicious fruits, peaches and nectarines (Faust and Timon, 2010). It belongs to the genus *Prunus* and is a member of the family Rosaceae. Flower bud of peach is solitary, without leaves and always in lateral rather than terminal position (Westwood, 1988). China is one of the earliest and important country of origin of cultivated plants in the world, where many fruits plant species such as peach, Asian pear, apricot, plum, jujube, chestnut and filbert have been originated. Some of the peach varieties ripen before rains when no other fresh fruits are available in the market. Fruits are consumed raw, canned or dehydrated. The quality of peach fruit is determined by several

internal and external factors. External factors such as shape, mass and color can be measured easily using different techniques, but internal attributes such as firmness, sugar and acid content and the absence or presence of internal defects are more difficult to assess. Peaches are a popular summer fruit and there has been an increasing interest in their nutritional value (Wolfe et al., 2008). Peaches are a tasty treat with modest calories (~70 kcal), a good source of potassium, vitamins A and C, low sodium and no saturated fat. The seed can contain high levels of hydrogen cyanide. In small quantities, hydrogen cyanide has been shown to stimulate respiration and improve digestion, it is also claimed to be of benefit in the treatment of cancer. In excess, however, it can cause respiratory failure and even death.

Hence, the present study was attempted for characterization and evaluation of peach fruit germplasm and it can be released as a variety for cultivation all over the country.

Objectives

- i) To release as variety of peach fruit
- ii) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Horticulture Research Farm, BSPC, BARI, Debiganj, Panchagarh during 2018-2021. Five peach fruit germplasm viz. PP Deb-001, PP Deb-002, PP Deb-003, PP Deb-004 and PP Deb-005 were included in evaluation. Intercultural operations were done as and when necessary. All trees of the germplasm were of 5-7 years age and PP Deb-005 germplasm was 3 years old. Observations were recorded on plant height, base girth, canopy spread, days of flowering, days of full bloom (at 80% flowers open), days to fruit set and harvest of fruit (tree-ripe stage), fruit length and diameter, fruit weight, pulp weight, peel weight, fruit thickness, total soluble solids (TSS), seed per fruit, seed weight, edible portion (%) and yield per plant status. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit by slide calipers. Pulp, skin and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer. The recorded data on different parameters were statistically analyzed by MS excel 2013.

Key Findings

- The highest individual fruit weight (98 g), fruit length (6.36 cm), fruit diameter (5.58 cm), pulp weight (84.8 g), edible portion (86.53 %) were found in PP Deb-004.
- The highest total soluble solids (TSS) which (11.6%) was recorded in the germplasm PP Deb-005 and maximum yield per plant (180 kg) was observed in the germplasm PP Deb-001.
- The lowest peel weight (6.4 g) and seed weight (2.8 g) were reported in the germplasm PP Deb-002.

Key Words

Wood apple, Evaluation, Yield, Quality

At the Hill Agriculture Research Station, Raikhali, Rangamati

Experiment No 16.

Title

Evaluation of bullock's heart germplasm at HARS, Raikhali, Rangamati

Background

The Bullock's heart (*Annona reticulata*) is a tasty fruit as well as nutritious. It is widely distributed in tropical and subtropical regions. Bullock's heart received its name due to its resemblance to a bull's heart. It is also known as 'ata' or 'ataphal' in Bangladesh. It is native to tropical regions of America, particularly in West Indies and South America (Acevedo-Rodriguez and Strong, 2012). The plant is cultivated in Bangladesh and Pakistan. Bullock's heart contains ample vitamin C, a nutrient that boosts the immune system, keeps skin healthy and assists with repairing wounds and cuts. The fruit also contains a good source of potassium, which helps the body to regulate its electrolyte balance, enhances muscle growth, and improves the body's ability to process waste. The immature fruits, seeds and roots are considered medicinal value both in Aurvedic and Yunani systems of medicine (Kirtikar and Basu, 1933). There is wide genetic diversity of bullock's heart in Bangladesh. But attempt was not taken to study the variability for selection of improved germplasm and release varieties for farmers.

Objectives

- i) To release as variety of bullock's heart
- ii) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Hill Agriculture Research Station, Raikhali, Rangamati during 2018-2021. Four bullock's heart fruit germplasm viz. AR Rai-001, AR Rai-002, AR Rai-003 and AR Rai-004 was evaluated. Manures and fertilizers were applied @ 20 kg Cowdung, 435 g Urea, 286 g TSP, 200 g MoP and 100 g Gypsum per plant per annum in three equal installments. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, peel and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer. The recorded data on different parameters were statistically analyzed by MS excel 2013.

Key Findings

- The highest fruit weight (129.4 g) was observed in AR Rai-001 followed by AR Rai-002 (122.6 g) and the lowest fruit weight was observed in AR Rai-004 (120.5 g).
- Maximum (43.72%) edible portion was observed in AR Rai-002.
- TSS varied from 23.3 to 24.3 % but there was no significant difference in TSS % among the lines.

Key Words

Bullock's heart, Evaluation, Yield, Quality

Experiment No 17.

Title

Evaluation of wood apple (*Feronia limonia*) in the hilly area of Rangamati

Background

Wood Apple (*Feronia limonia*) belongs to the family Rutaceae. It is also called as monkey fruit, curd fruit and kadbhel. The plant is native of India and Sri Lanka and grows throughout South India. The tree is subtropical and it prefers dry climatic conditions during flowering and fruit setting. It is one of the very hardy trees and found growing all over the semi-arid and arid regions. Troup (1921) described wood apple as a small to moderate sized, deciduous, glabrous tree with thorny branches, growing to a height of 10 m and 0.6 to 1.6 m in girth. The importance of elephant foot's apple fruit is used for curative properties, which make the tree one of the useful medicinal plants of India (Kirtikar and Basu, 1933). The different parts of plant (leaf, stem, bark, fruit and seed) were being used for curing various diseases (Joshi *et al.*, 2011 and Sharma *et al.*, 2012). The fruits contain a myriad of phytochemicals such as polyphenols, phytosterols, saponins, tannins, coumarins, triterpenoids, vitamins, amino acids, tyramine derivatives, etc. (Dar *et al.*, 2013). The diverse pharmacological properties of the fruit includes anti-diabetic (Gupta *et al.*, 2009), anti-ulcerative (Mishra *et al.*, 2009), hepatoprotective (Jain *et al.*, 2011), wound healing (Ilango and Chitra, 2010), anti-tumour (Saima *et et al.*, 2000), anti-132 microbial activity (Senthilkumar and Venkatesalu, 2013). It has high medicinal value, astringent properties and has beneficial effect on cardiovascular system. The ripe fruit pulp makes excellent chutney and it is also consumed as fresh along with sugar. Though its nutritional economic importance has been widely recognized, this fruit can be exploited for regular cultivation in dry areas. Providing support by processing industry as it makes excellent chutney, can be used as adjunct in jelly and made into squash. There is only one recommended variety in Bangladesh which is grown seasonally named BARI Kodbael 1.

Keeping above points in view and perspective of climate change; an attempt was made to identify suitable elephant foot's apple germplasm for developing a year-round off season kadbhel variety for Bangladesh.

Objectives

- i) To release as variety of wood apple
- ii) To conserve genetic material for breeding purpose

Methodology

The experiment was conducted at the Research Farm, HARS, Raikhali, Rangamati during 2017-2020. Four wood apple germplasm viz. FL Rai-001, FL Rai-002, FL Rai-003 and FL Rai-004 were evaluated. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g MoP and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight

basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer.

Key Findings

- The highest individual fruit weight (455 g) and the lowest skin thickness (0.3 cm) was recorded in the germplasm FL Rai-003.
- Maximum yield per plant (90.1 kg) and edible portion (59.0 %) was also found in FL Rai-003 germplasm and it was also very well in organoleptic test.
- The germplasm FL Rai-003 has been released as BARI Kodbael-2 variety for off-season cultivation in Bangladesh.

Key Words

Wood apple, Evaluation, Yield, Quality, Organoleptic taste

Experiment No 18.

Title

Evaluation and characterization of jamun germplasm at the hill valley of Rangamati district

Background

The black plum or Indian black berry, commonly known as jamun (*Syzygium cumini*) is an important minor fruit with commercial value. It is originated in Indian or the East Indies (Singh, 1969). It possesses considerable nutritive value. It is a good source of iron, apart from the usual contents, e.g., minerals, sugars, protein and others (Bose *et al.*, 2001). The tasty and pleasant flavored jamun fruit is mostly used for dessert purpose and it is very much liked by the people. It has sub-acid spicy flavor. In Bangladesh, there is no named or standard cultivar of jamun under cultivation. Due to the lack of variety, it is losing area under cultivation in Bangladesh. There is a lot of superior germplasm of jamun available in Chittagong Hill Tracts. If a germplasm is released as a variety, obviously the production of jamun will be increased, which will in turn help in mitigating the nutritional requirement of the people.

Methodology

During 2012 a total of 9 jamun germplasm were collected from different parents of hill districts and planted in the research field of HARS, Raikhali, Rangamati. After 5 years of consecutive evaluation and characterization, 2 were selected for further close supervision. The screened 2 germplasm were Sc Rai-002 and SC Rai-008. The two germplasm were then evaluated for 3 years (2017-2020) for releasing as variety. Manures and fertilizers were applied @15 kg Cowdung, 370 g Urea, 357 g TSP, 350 g M₀P and 200 g Gypsum per plant per annum in three equal installments during February, May and October. Intercultural operations were done as and when necessary. Plant growth, yield and yield contributing characters were recorded and tabulated. The fruit shape was recorded visually whereas fruit size was recorded by measuring length and diameters of fruit. Pulp, rind and seed were separated, weighed and calculated in percent on fresh weight basis. The Total soluble solid (TSS) of fruit pulp was determined with the help of hand refractometer.

Key Findings

- Average plant height (cm), base girth (cm) and canopy spread (N-S and E-W in cm) were noted higher in SC Rai-008 (422.3 cm, 66.7 cm, 406.0 cm and 429.3 cm, respectively).
- Both the germplasm exhibited regular fruit bearing habit with similar flowering time (Early June- Mid July) and harvesting time (Mid June- Mid July).
- The germplasm SC Rai-008 also had more number of fruits (4478/plant) with heavier fruits (9.6 g).
- Comparatively higher fruit yield was recorded in SC Rai-008 (38.9/plant and 3.9 t/ha).
- Fruits of SC Rai-008 showed higher edible portion (83.8 %) with higher TSS content (14.3 %).
- The germplasm SC Rai-008 has been release as BARI Jam-1 for cultivation in Bangladesh.

Key Words

Jamun, Evaluation, Yield, Quality, Organoleptic taste, Variety release

Experiment No 19.

Title

Study on propagation technique in bael with cleft grafting

Background

Bael is one of the important minor fruit crops in Bangladesh. It has high nutritive value. It is cultivated throughout India, as well as in Sri Lanka, but in Bangladesh its commercial cultivation is limited or nil. It has a reputation in India for being able to grow in places that other trees cannot. It grows in a wide range of soil conditions (pH range 5-10), tolerant to water logging and has an unusually wide temperature tolerance (from -7°C to 48°C). But propagation to develop true to mother type plants is a challenge. Therefore, the experiment was under taken to find out suitable time for cleft grafting in jamun.

Objectives

- i) To find out suitable month for cleft grafting of jamun

Methodology

An experiment on vegetative propagation techniques through cleft grafting was performed at HARS, Raikhali, Rangamati during 2019-2021. Grafting was performed in all the twelve months of the year starting from January to December with three replications and 10 plants were maintained each replication. Ten to twelve months old healthy seedlings were used as rootstock for grafting. The shoots of current season's growth of three to four months age from elite trees were used as scion material. The grafting was done on the 1st week of every month. The survival and growth of scion was recorded after 3 months of grafting. The number of transplantable grafts was recorded after one year of grafting. The data were analyzed using standard statistical procedures as described by Gomez and Gomez (1984).

Key Findings

- Among different months when cleft grafting was performed, 70% graft success was recorded in the saplings where cleft grafting was conducted in the month of April.
- Maximum scion length after 3 months of grafting was noted where grafting was performed in the month of April (7.2 cm) followed by the month of March (6.3 cm).
- Maximum transplantable grafts was obtained from the grafting that was performed in the month of April (60%) while no transplantable grafts was counted in the month of August to February.

Key Words

Jamun, cleft grafting, graft success, scion length, transplantable grafts

At the Regional Agricultural Research Station, Rahmatpur, Barishal

Experiment No 20.

Title

Evaluation of custard apple germplasm at RARS, Rahmatpur, Barishal

Background

Custard apple (*Annona squamosa*) is a minor fruit of Bangladesh. The fruit is rich in vitamins, minerals (calcium, copper, magnesium) and high nutritive value. The fruit has a demand to the consumers but this fruit is on the verge of extinction due to their non-commercial use. Moreover, the available genetic variability within the fruit species has not yet been collected, properly evaluated and systematically conserved. Therefore, it is essential to identify superior genotypes, collection and planting in the research field for critical evaluation in order to test their potentiality and release for commercial cultivation as well as strengthen the base of the fruit industry of the country. With this view in mind, this experiment was undertaken.

Objectives

- ii) To release as variety of custard apple
- iii) To conserve genetic material for breeding purpose

Methodology

As many as 06 genotypes were included in this experiment. Saplings of custard apple were collected from farmers' homestead of different locations of Bangladesh and planted in the fruit research farm of RARS, Rahmatpur, Barishal. The plants were 3 years old at the beginning of the sub-project. As harvesting was not started, data were recorded on plant growth characters.

Key Findings

- The highest plant height (6.20 m) was recorded in AR Rah-006 and the lowest (3.27 m) plant height was noticed in AR Rah-003.

- The highest canopy spreading was observed in AR Rah-006 and the lowest canopy spreading was observed in AR Rah-005.
- The highest tree volume was observed in AR Rah-006 (59.30 m³) and the lowest tree volume was observed in AR Rah-005 (14.88 m³).
- Maximum number of branches (5.4) was observed in AR Rah-006 and minimum number of branches was observed in AR Rah-002 (3.3).

Key Words

Custard apple, Evaluation, Growth characteristics

Experiment No 21.

Title

Effect of vermicompost on growth, yield and quality of sweet orange

Background

Sweet orange (*Citrus sinensis* L.) is a nutritious and popular citrus fruit crops of the world, occupied third position among the sub-tropical fruits. It has a great nutritional role in our daily food requirements, being a rich source of vitamin C. In our climatic condition, Malta can easily be grown under the ago-economic edaphic condition of Bangladesh. The popularity and demand of Malta is increasing day by day but farmers do not use balance fertilizer for its cultivation, which cause serious nutritional disorders. However, it has a scope to ensure the yield and quality of BARI Malta-1 checking the deficiency of nutrients. Under such situation, integrated plant nutrient system (IPNS) has assumed a great importance and has vital significance for the maintenance of soil productivity. With the above point of view, the present study was carried out to determine the effect of vermicompost application alone or combined with recommended fertilizer dose on plant growth, yield and quality of sweet orange.

Objectives

- i) To know the efficacy of vermicompost on yield of sweet orange
- ii) To evaluate the quality of sweet orange

Methodology

The experiment was conducted at Regional Agricultural Research Station, Rahmatpur, Barishal during March 2019 to February 2022. BARI Malta-1 was used in the study as variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The fertilizer doses i. e., T₁: 100 % of the recommended fertilizer dose; T₂: 100 % of the recommended fertilizer dose plus 10 kg vermicompost, T₃: 100 % of the recommended fertilizer dose plus 20 kg vermicompost and T₄: 100 % of the recommended fertilizer dose plus 30 kg vermicompost were used as treatments of the experiment. All fertilizer doses of cowdung, P, S, Zn, B was applied as basal dose and urea and MoP and vermicompost was applied in three splits, March, May and October (just after harvest of fruits). The data on the following parameters like plant height, base girth, canopy spread, number of fruits per plant, individual fruit weight, yield and TSS were recorded. The collected data were tabulated and statistically analyzed with appropriate design of experiment (Gomez and Gomez, 1984) adopting a statistical

package programme R. The treatment means were separated by Least Significant Difference (LSD) test at 5 % level of significance

Key Findings

- The highest number of fruits per plant was counted in plants treated with 100 % of the recommended dose plus 30 kg vermicompost (104.00) which was statistically followed by 100 % of the recommended dose plus 20 kg vermicompost (103.33).
- The highest fruit yield and TSS in plants treated with 100 % of the recommended dose plus 30 kg vermicompost were observed to be 15.35 kg/plant and 10.70 %, respectively.
- Minimum number of fruits per plant and fruit yield (97.33 and 13.32 kg/plant, respectively) was recorded in plants treated with only 100 % of the recommended dose per plant where no vermicompost was added.

Key Words

Vermicompost, Sweet orange, Yield, Quality

Component II. Plant Pathology Division, BARI, Gazipur-1701

Experiment No 22.

Title

Survey and identification of major diseases of lean season fruit crops in the RARS, Basishal, Breeder Seed Production Centre, BARI, Debiganj, Panchagarh; Hill Agriculture Research Station (HARS), Raikhali and Gazipur regions of the country

Background

In Bangladesh more than 60% fruits are available only four months (during mid-May to mid-August) and less than 40% during the rest eight months. On the other hand the average yield and quality of fruits especially in the lean season fruits in Bangladesh is lower than other developed countries. Disease play major role to reduce yield and quality of fruits in Bangladesh (Meah & Khan 1987). The detail information about present status of diseases of lean season fruit crops is not available. So, the study has been undertaken to reveal the incidence, severity and pathogens associated with major diseases of lean season fruits in Bangladesh.

Objectives

- i) To know the status of disease of lean season fruits
- ii) To identify the pathogens associated with the disease

Methodology

The survey were conducted at three upazila namely Barishal Sadar, Uzirpur and Nesarabad and RARS, BARI, Rahmatpur farm of Barisal district; Three upazila namely Sadar, Debiganj and Boda of Panchagarh; Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and in Gazipur district only Gazipur sadar upazilla and BARI head office Fruit Research Farm, BARI,

Gazipur, Bangladesh. Farmers home orchards of each location, fruit orchards at BARI head office, RARS, BARI, Rahmatpur, Barishal, Breeder Seed Production Centre of BARI, Debiganj, Panchagarh and Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati were also surveyed and noted the percent disease and representing disease samples along with the soil brought to Plant Pathology Laboratory for the identification of the causal pathogen. Pieces of the diseased tissues were sterilized by 10% chlorox for 2-3 minutes, followed by several rinses with sterile distilled water and placed on Potato dextrose agar (PDA). After a day single spore was collected using sterilized glass needle under a dissecting microscope and transferred to Petri plates containing PDA media and incubate at 25±5°C up to 12 days. After incubation the appearance of the colonies and the vegetative and reproductive structures of fungus were examined under stereo as well as compound microscope.

Key Findings

- In all the locations, gummosis disease of golden apple, bael and wood apple were the major problems in all the regions in Bangladesh.
- In Gazipur and Panchagarh regions, fruit rot/anthracnose disease caused by *Colletotrichum* sp. and gray leaf blight caused by *Pestalotia* sp. of lotkon were observed.
- In Barishal regions, leaf spot *Colletotrichum* sp. of golden apple and die back of Sapota were observed as minor diseases.
- In the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and Breeder Seed Production Farm, BARI, Debiganj, Panchagarh regions anthracnose disease caused by *Colletotrichum* sp. of bael was recorded as minor disease.

Key Words

Lean season, Survey, Disease, Fruits

Experiment No 23.

Title

Screening of the chemical fungicides against fruit rot/anthracnose disease of Burmese grape

Background

Burmese grape (*Baccaurea ramiflora*), Family Phyllanthaceae is an important tropical and subtropical, evergreen, slow growing, dioeciously fruit tree. It is one of the most popular and commercially important minor fruits of Bangladesh. In Bangladesh it is mainly grown in the regions of Tangail, Mymensingh, Gazipur, Dhaka, Narshinghi, Sylhet, Chittagong hill tracts and more or less in other parts of the country. The fruit was reported to possess antiviral and antioxidant and the stem bark of the plant was reported to have diuretic activity (Hasan *et al.*, 2009). The health benefits of Burmese grape are significant. It contains twice as much potassium as bananas. However, there are some diseases generally that affect the lotkon such as Anthracnose (*Colletotrichum* spp.), Leaf blight, Bacterial leaf spot, Black rot (*Guignardia bidwellii*), Scab (*Venturia inaequalis*), Mould rot (*Botrytis cinerea*), Foot rot (*Cylindrocarpon* sp.) and so on. In Bangladesh detail information about the management of these diseases especially Anthracnose disease is not available.

Objective

To know the efficacy of different chemical fungicides against the Anthracnose disease

Methodology

The experiment was conducted at Fruit Research Field of Horticulture Research Center, BARI, Gazipur during 2020-21. The design was RCB having 3 replications. Each plant considered as a treatment. The experiment was conducted under natural infection condition in an established orchard. The five treatments were T₁= Autostin (Carbendazim) @1g/L, T₂= Secure (Fenamidone+Mancozeb 600WG) @ 2g/L water, T₃= Dithane M-45 (Mancozeb (80%) @ 2g/L water, T₄= Tilt (Propiconazole) @ 0.5ml/L water, T₅= Control. Three sprays were done at an interval of 10-12 days while the first one was applied just at the first appearance of the disease symptom. Data were recorded on incidence of fruit rot disease of lotkon. Collected data were analyzed statistically following LSD.

Key Findings

- Chemical fungicide, Tilt (Propiconazole) and Autostin (Carbendazim) performed the best for reduction of fruit rot/anthracnose disease incidence of of Burmese grape
- Application of Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) also gave significantly reduction of fruit rot/anthracnose disease of Burmese grape

Key word

Burmese grape, Fruit rot/anthracnose disease, Chemical Fungicide

Experiment No 24.

Title

Development of bio-rational based integrated management packages against gummosis disease of bael

Background

Bael *Aegle marmelos* is one of the edible fruit native to India and parts of Bangladesh, Pakistan, Sri Lanka and Southeast Asia east to Java. This fruits are grown throughout the country and can be cultivated along both peninsulas of the country. Bael has excellent health benefits along with some religious use. Most of the people grow as side crop by planting on borders or mostly cultivated in the homestead areas . The plants can survive in dry regions with minimum water requirement. Bael being a hardy crop, there is no many serious insect pest and diseases as of now. But bacterial shot hole, fruit canker and gummosis are the serious diseases. Fruit cracking is the physiological disorder in some genotypes of Bael which occurs just before ripening. In Bangladesh gummosis disease is on the most serious disease all over the country. At present research report about the management of gummosis disease of bael are not available in Bangladesh. Therefore, the present study has been taken to develop integrated management technology of gummosis disease of bael.

Methodology

For the development of bio-rational based integrated management packages against gummosis of bael the experiments were conducted at the Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh and Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati. There were 3 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide, T₂:

Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide and T₃: Control. The treatments were added three times viz. 1st application was done during February-March 2020, 2nd application was done during May-June 2020 and 3rd application was done during September-October 2020. Data were collected on the reduction of disease severity after 3rd time application of treatments.

Key Findings

Integration of:

- Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide
- Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide Bordeaux paste with foliar application of Bordeaux mixture/ or integration of Coal tar with foliar application of Bordeaux mixture are the effective for the management of gummosis disease of bael.

Key word

Bael, Gummosis disease, Bordeaux paste/mixture, Coal tar, Copper Fungicide

Experiment No 25.

Title

Development of bio-rational based integrated disease management packages against gummosis disease of golden apple

Background

In Bangladesh, more than 60% fruits are available during mid-May to mid-August and people get fairly adequate quantities of fruits during the four summer months. Golden apple is one of the most popular and market demanding minor fruits in Bangladesh. It is a minor fruit in Bangladesh but at present the demand of this fruit increasing day by day. Diseases of golden apple are one of the constraints for cultivation. Among them gummosis disease is the major one. At present research report about the management of gummosis disease of golden apple are not available in Bangladesh.

Objective

To develop an integrated management technology against gummosis disease of golden apple

Methodology

For the development of bio-rational based integrated management packages against gummosis of golden apple the experiments were conducted at the Fruits Research Farm, HRC, BARI, Gazipur; RARS, Rahmatpur, Barisal; Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati and Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh. There were 3 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide, T₂: Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide and T₃: Control. The treatments were added three time viz. 1st application was done during February-March 2020, 2nd application was done

during May-June 2020 and 3rd application was done during September-October 2020. Data were collected on the reduction of disease severity after 3rd time application of treatments.

Key Findings

Integration of:

- Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/Copper Fungicide
- Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide Bordeaux paste with foliar application of Bordeaux mixture/ or integration of Coal tar with foliar application of Bordeaux mixture were the effective for the management of gummosis disease of golden apple.

Key word

Golden apple, Gummosis disease, Bordeaux paste/mixture, Coal tar, Copper Fungicide

Experiment No 26.

Title

Field validation of integrated disease management packages against gummosis disease of bael

Background

Bael *Aegle marmelos* is one of the edible fruit native to India and parts of Bangladesh, Pakistan, Sri Lanka and Southeast Asia east to Java. This fruits are grown throughout the country and can be cultivated along both peninsulas of the country. Bael has excellent health benefits along with some religious use. Most of the people grow as side crop by planting on borders or mostly cultivated in the homestead areas. The plants can survive in dry regions with minimum water requirement. Bael being a hardy crop, there is no many serious insect pest and diseases as of now. But bacterial shot hole, fruit canker and gummosis are the serious diseases. Fruit cracking is the physiological disorder in some genotypes of Bael which occurs just before ripening. In Bangladesh gummosis disease is on the most serious disease all over the country. At present research report about the management of gummosis disease of bael are not available in Bangladesh.

Objective

To validate the integrated developed technologies against gummosis disease of bael

Methodology

For the field validation of integrated disease management packages against gummosis of bael the experiments were conducted at the Breeder Seed Production Centre (BSPC), BARI, Debiganj, Panchagarh and Hill Agriculture Research Station, Raikhali, Kaptai, Rangamati. There were 2 treatments viz. T₁: Scoping disease infected area with small portion of healthy area and covering with Bordeaux paste + Foliar spray of Bordeaux mixture/copper group of fungicide and T₂: Scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/copper group of fungicide. The treatments were added three time viz. 1st application was done during February-March 2021, 2nd application was done during May-June 2021 and 3rd application was done during August-September 2021. Data were collected on the reduction of gummosis disease severity after 3rd time application of treatments.

Key findings

- The integrated developed technologies against gummosis disease of bael were effective in both the location
- Integration of scoping disease infected area with small portion of healthy area and covering with Coal tar + Foliar spray of Bordeaux mixture/Copper Fungicide, 100% plants were completely recovered from the gummosis disease
- Integration of scoping disease infected area with small portion of healthy area and covering with Bordeaux paste with foliar application of Bordeaux mixture/Copper Fungicide, 80% plants were completely recovered from the gummosis disease

Key word

- Bael, Gummosis disease, Bordeaux paste/mixture, Coal tar, Copper Fungicide

Component III. Entomology Division, BARI, Gazipur-1701

Experiment No 27.

Title

Survey and monitoring of insect pests of lean season fruit crops

Background

Minor edible fruits are the genetic resource of a country, playing a vital role as food, nutrition and medicine. Bangladesh having both tropical and sub-tropical climatic condition possesses a large number of species that produce minor edible fruits. The present study represents 255 species of minor edible fruit yielding plants of Bangladesh.

Many factors are responsible for low yield of fruit crops. Among them, pests are considered as the major factors. Insect pests play an important role in reducing the marketable yields. Farmers use only chemical pesticides indiscriminately even mixture of two or three chemicals at very high frequency and dose to save mango crop (Rahman and Rahman, 1988; Kabir, 2003), which have several limitations including ineffectiveness, killing of pollinators, parasitoids and predators, resulting resurgence of other pest populations, develop resistant insect biotypes and excessive residues in marketable fruits (Debach and Rosen, 1991; Pedigo, 1999; Irshad and Gilani, 1990). The detail information about present status of major insects of lean season fruit crops is not available. So, this study has been undertaken to reveal the incidence, severity of major insects of lean season fruits in Bangladesh. Insect pests play a key role in reducing the yield and quality of fruits with other factors. But the information on major insect pests of lean season fruit crops is scanty in Bangladesh. Keeping this view in mind, this experiment has been designed. In this regards a survey program have been started to know the present status of insect pests of lean season fruits. From June 2018 to May 2020 a survey was done in the Barisal, Panchagarh, Ranghamati and Gazipur districts.

Objective

- ✓ To document pest status and its' severity

Methodology

An extensive field survey has been conducted in different localities of 4 districts of Bangladesh namely, Barishal, Panchghor, Ranghamati and Gazipur, from 2019 to 2020. In the farmer's field, lean season fruits crops (Bael, Custard apple, Ber/jujube, golden apple, Burmese grape, Strawberry, tamarind etc) were visually checked to count all insects pests populations to identify of the insects noted to the notebook. Surveys were done several times during the cropping season.

Key findings

- ✓ From this survey it was observed that hog-plum beetle, trunk borer of hog-plum fruit borer Kodbel /Elephants foot apple fruit borer, pomegranate fruit borer, custard apple pink mealy bug, Jujube/ ber fruit borer is the major pests in the all locations of Bangladesh.
- ✓ Therefore, the insect pests that were recorded as important pests needs researches and development intervention works.

- ✓ Moreover, regular monitoring strategy has to be designed since; one minor pest at a time became major pest on other time

Key word

Lean season fruit, insects pests, major insects, minor insects

Experiment No 28.

Title

Management approaches against fruit borer, *Deudorix isocrates* attacking wood apple

Background

The wood apple, *Feronia limonia* (Linn.) is a minor fruit crop in Bangladesh. The plants are hardy with deep penetrating root system, which makes them survive in harsh soil and climatic condition. Recently serious attack of fruit borer *Deudorix isocrates* has been recorded in different parts of our country, causing significant fruit damage. The caterpillar of this pest bores into young fruits and feeds on internal contents (pulp and seeds) resulting fruit rotting and dropping. So, it is necessary to develop an environment friendly management packages against this devastating pest, which would ultimately increase the productivity of wood apple in our country.

Objectives

To find out an effective and suitable management approach(es) against fruit borer, *Deudorix isocrates*.

Methodology

The experiments were conducted to the, fruit borer infestation management approach against fruit borer, *Deudorix isocrates* attacking wood apple at experimental Horticulture Fruit Research Station, BARI, Gazipur and Breeder Seed Production Centre, Debigonj, Panchgarh during 2020-21 to Fruit borer, *Deudorix isocrates* attacking wood apple. The experiment was laid out in RCBD design with three replications to development of management approach against fruit borer, *Deudorix isocrates* attacking wood apple. Five treatment packages for fruit borer, *Deudorix isocrates* including untreated control were undertaken, such as T₁= Sanitation+ Polythene bagging when the fruits are up to 5 cm, T₂= Sanitation + Bio-pesticide Minto plus (Bt+Spinosad) @ 1g/ litre of water, T₃= Sanitation +Spraying of Spinosad (Success 2.5SC), @ 1.2 ml/L of water, T₄= Sanitation +Spraying of Azadirachtin (Fytomax 3 EC) @ 1.0 ml/litre of water, T₅= Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water, T₆= Untreated Control. The experiment data were observed before treatments, 15, 30 and 45 days after application of treatments. Total number of fruit, healthy and infested fruit in whole tree was also recorded *in situ* for visible fruit infestation of wood apple. The fruit infestation was calculated on the weight based of total number of fruits and infested fruits in the different treatments and the per cent of fruit infestation was worked out. The data were analyzed by R software. The fruit infestation was subjected to arcsine transformation before the analysis of variance (ANOVA) and means were separed by turkey's multiple range tests.

Key Findings

- ✓ Spraying of bio-pesticide Spinosad (Tracer 45 SC, @ 0.4 ml/L of water or Success 2.5SC, @ 1.2 ml/L of water at 07-10 days interval.
- ✓ Usually, 3-4 sprays are required to obtain good results
- ✓ It would contribute substantially reducing 75-82% fruit infestation over control.

Key Words

Wood apple, bio-rational, fruit borer, *deudorix isocrates*

Experiment No 29.

Title

Development of management approach against hog plum beetle, *Podontia 14-punctata*

Background

Hog-plum (*Spondias cytherea*) is known as “Amra” has been considered as major fruit for its availability in Bangladesh especially in Barishal region. It is one of the popular fruit in all over Bangladesh and Barishal is famous for golden apple. The production of golden apple is greatly hampered by the infestation of several insect pests, among them hog-plum beetle or fourteen spotted leaf beetle, *Podontia 14-punctata* L. (Chrysomelidae: Coleoptera) is an important pest. So, it is necessary to develop an environment friendly bio-rational based management approach against this devastating pest which ultimately increases the productivity of golden apple in our country. By applying this bio-rational based management package pesticide free safe fruit can be produced which helps to ensure food security in our country.

Objectives

To find out an effective and suitable management approach(es) against hog plum beetle, *Podontia 14-punctata*

Methodology

The experiment was conducted at the hog-plum orchard of Fruit Research Farm, BARI, Gazipur and Regional Agricultural Research Station (RARS), BARI, Rahmatpur, Barishal, during 2019 to 2020 in a randomized complete block design (RCBD) with 5 treatments and 3 replications. A total of 15 trees of around 5-7 years old were used for this study. One hog-plum tree was considered as one treatment replication. Plant to plant distance was 15 ft × 15 ft. The treatments were assigned as follows : T₁= Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + trunk banding with packaging tape T₂= Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + spraying of Matrine (Biotrin 0.5% @ 1.5 ml/L of water) T₃= Sanitation (removal of infested leaves with egg mass and larvae) + soil drenching with microbial pesticide, *Metarhizium anisopliae* + Spraying of Emamectin benzoate (Proclaim 5SG) @ 1.0 g/litre of water after first incidence of insect at 7 days interval T₄= Farmers practice: spraying with Nitro 505EC (Chlorpyrifos + Cypermethrin) @2.0 ml/litre of water; and T₅= Untreated Control. Sanitation was done twice in a week. Each spray was done by manually driven foot pump sprayer as a full cover spray for the hog-plum tree. The leaves,

branches and the main trunk of each tree were sprayed with spray mixture through the outlet of the nozzle. Application was made in such a way that the spray pressure would not knock down the pest from the tree. The pre treatment data were recorded on the number of 1st, 2nd, 3rd and 4th instars larvae and adults. One square meter (1 m²) quadrat was placed in the central position of the east side canopy structure. The number of adults and larvae was counted from inside each quadrat under different treatments at one day before the first spray and 1 week after each spray. The number of healthy and infested leaves was counted from inside each quadrat under different treatments at one day before the first spray and one week after each spray.

Key Findings

- ✓ Spraying of bio-pesticide Matrine (Biotrin 0.5) 1 ml/liter of water of whole tree at 07-10 days interval.
- ✓ Usually, 3-4 sprays are required to obtain good results.
- ✓ It would contribute substantially in reducing hog plum beetle, *Podontia 14-punctata* attack in hog plum infestation.

Key Words

Hog- Plum, bio-rational, hog plum beetle, *podontia 14-punctata*

B. Implementation Status

1. Procurement (Component wise):

Component-I: Pomology Division, HRC, BARI, Gazipur-1701

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	06 (six)	5739500.00	06 (six)*	5739500.00	**
(c) Other capital items					

* The list of laboratory and field equipments and chemicals procured under the sub-project and their photographs are given in Annex-2.

** Note:

- Laboratory apparatus and chemicals were procured as research items.
- Laboratory equipments, lab facilities (rack building, electricity work, etc.) and bush cutter were procured as capital entity.

Component-II: Plant Pathology Division, HRC, BARI, Gazipur-1701

N/A

Component-II: Entomology Division, HRC, BARI, Gazipur-1701

N/A

2. Establishment/renovation facilities:

N/A

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 participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	100	20	120	01 (one) day	Four (04) trainings have been conducted.
(b) Workshop	78	22	100	01 (one) day	Two (02) workshops (inception and conclusion) have been organized.

** Photographs of the training and workshop arranged under the sub-project are given in Annex-3.

C. Financial and physical progress (Combined & Component wise)

Combined Financial and physical progress

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	5158843	4385634	4357590	28044	99.36	
b. Field research/lab expenses and supplies	6087992	5820970	5795687	25283	99.57	
c. Operating expenses	1012780	855271	810750.6	44520.4	94.79	
d. Vehicle hire and fuel, oil & maintenance	714484	694891	647484	47407	93.18	
e. Training/workshop/seminar etc.	608400	608400	608400	0	100.00	
f. Publications and printing	400000	10000	10000	0	100.00	
g. Miscellaneous	278001	253945	230640	23305	90.82	
h. Capital expenses	5739500	5739500	5739500	0	100.00	
Total	20000000	18368611	18200051.60	168559.40	99.08	

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

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	4372543	3713630	3698930	14700	99.60	
b. Field research/lab expenses and supplies	5199877	5015567	4953617	61950	98.76	
c. Operating expenses	706500	595474	572134.6	23339.4	96.08	
d. Vehicle hire and fuel, oil & maintenance	472184	472184	439184	33000	93.01	
e. Training/workshop/seminar etc.	608400	608400	608400	0	100	
f. Publications and printing	400000	10000	10000	0	100	
g. Miscellaneous	249776	230276	210276	20000	91.31	
h. Capital expenses	5739500	5739500	5739500	0	100	
Total	17748780	16385031	16232041.60	152989.40	99.07	

Component-II. Plant Pathology Division, BARI, Gazipur-1701

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	428160	357560	357560	0	100	
b. Field research/lab expenses and supplies	510940	474246	472640	1606	99.66	
c. Operating expenses	143845	117180	116180	1000	99.15	
d. Vehicle hire and fuel, oil & maintenance	114500	110500	110500	0	100	
e. Training/workshop/ seminar etc.	0	-	0	0	0	
f. Publications and printing	0	-	0	0	0	
g. Miscellaneous	13675	10894	10814	80	99.27	
h. Capital expenses	0	-	0	0	0	
Total	1211120	1070380	1067694	2686	99.75	

Component-III. Entomology Division, BARI, Gazipur-1701

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	358140	314444	301100	13344	96.76	
b. Field research/lab expenses and supplies	377175	331157	369430	-38273	111.56	
c. Operating expenses	162435	142617	122436	20181	85.85	
d. Vehicle hire and fuel, oil & maintenance	127800	112207	97800	14407	87.16	
e. Training/workshop/ seminar etc.	0	0	0	0	0	
f. Publications and printing	0	0	0	0	0	
g. Miscellaneous	14550	12775	9550	3225	74.76	
h. Capital expenses	0	0	0	0	0	
Total	1040100	913200	900316	12884	98.58	

D. Achievement of Sub-project by objectives (Tangible form): Technology generated/developed

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

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) Development of lean season (September-April), high yielding and good quality fruit varieties and management technologies	a) Collection, characterization and evaluation of lean season fruit germplasm b) Evaluation and characterization of existing lean season fruit germplasm c) <i>In-situ</i> and <i>ex-situ</i> evaluation	a) Three (03) lean season fruit varieties have been developed 1. BARI Jam-1 2. BARI Ata-1 3. BARI Kodbael-2 b) Two (02) fertilizer management packages on golden apple have been developed	a) Cultivation and year round production of fruit will be increased b) People will get adequate fruits in the lean period c) Nutrition security will be ensured
ii) Collection, characterization, evaluation, conservation and utilization of lean season fruit germplasm	Lean season fruit germplasm were collected from Chittagong Hill Tracts, North-Western and Southern part of the country	A total of 80 fruit germplasm have been collected and planted at the four project locations	New lean season fruit varieties will be developed
iii) Standardization of propagation and other management techniques for major and minor fruit crops	a) Vegetative propagation techniques for difficult to propagate fruit crops and lean season crops have been standardized b) Different propagation techniques namely cleft grafting, air layering, budding etc. have been practiced	a) Cleft grafting in avocado has been standardized. b) April (before new leaf emergence) has been proved the best time for bael propagation	a) Developed propagation techniques and methods will help growers in multiplying fruit plants true to type b) Area of fruit cultivation as well as production will be increased
iv) Knowledge development through training	a) Arranging training for the fruit growers and stakeholders on lean	a) Four (04) farmers/stakeholder training have been	a) Fruit growers/ stakeholders gained

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
	<p>season fruit crops</p> <p>b) Organizing workshop on technical and technological progress for the extension personnel or root level workers</p>	<p>arranged; each at Gazipur, Barishal, Rangamati and Panchagarh</p> <p>b) Two (02) workshops (inception and completion) have been organized</p>	<p>knowledge on lean season fruit production and management practices</p> <p>b) DAE personnel have become familiar with the varieties and technologies developed under the sub-project</p>
v) Upliftment of income as well as livelihood of the people	<p>a) Dissemination of lean season fruit crops</p> <p>b) Cultivation of developed lean season fruit varieties by the people</p> <p>c) Transferring technologies and knowledge regarding production and management of lean season fruits</p>	<p>a) More fruits will be produced in the lean period</p> <p>b) Profit might be earned by selling the fruits</p>	<p>a) Availability of fruits will be increased</p> <p>b) Nutritional security will be ensured</p> <p>c) Livelihood of people will be improved</p>

Component-II. Plant Pathology Division, BARI, Gazipur-1701

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)
Identification of important diseases and their incidence and severity of predominant lean season fruit crops	<p>Survey and identification of major diseases of lean season fruit crops in Bangladesh</p> <p>➤ During June 2018 to December 2019 a</p>	<p>⇒ Gummosis disease of golden apple, wood apple and wood apple were the major problems in the all surveyed regions</p> <p>⇒ In Gazipur and</p>	Farmers became aware about the disease of lean season fruit crops

	survey was done in Barishal, Panchagarh, the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and Gazipur regions	Panchagarh regions, fruit rot/anthracnose disease caused by <i>Colletotrichum</i> sp. and gray leaf blight caused by <i>Pestalotia</i> sp. of lotkon were observed ⇒ In Barishal region, leaf spot caused by <i>Colletotrichum</i> sp. of golden apple and die back of Sapota were observed as minor disease ⇒ In the Hill Agricultural Research Station, Raikhali and Breeder Seed Production Farm, BARI, Debiganj, Panchagarh regions anthracnose disease caused by <i>Colletotrichum</i> sp. of wood apple was recorded as minor diseases	
Determination of protective measures taken by the growers against major diseases of lean season fruits	Screening of the chemical fungicides against fruit rot/anthracnose disease of lotkon	<ul style="list-style-type: none"> ➤ Foliar application of Tilt (Propiconazole) @ 0.5 ml/l water and Autostin (Carbendazim) 2 g/l water three times at 10-12 days interval reduced 82.29-87.60% fruit rot/anthracnose disease of lotkon compared to control ➤ Foliar application of Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) reduced 75.23%, and 74.33%, respectively fruit rot/anthracnose disease of lotkon than control 	The selected chemical fungicides may contribute for the management of fruit rot/anthracnose disease of lotkon which would be helpful for farmers inspiring their economic income
Development of suitable disease management packages against major diseases of lean season fruit	For the development of bio-rational based integrated disease management packages against gummosis disease of bael two	The following technologies have been developed <ul style="list-style-type: none"> ➤ Integration of Bordeaux paste with foliar application of Bordeaux mixture/copper 	The technology generated from this study would help the farmer for the management of

crops	experiments were conducted at BSPF, Debiganj, Panchagar and the Hill Agricultural Research Station (HARS), Raikhali with three different treatments	fungicides and ➤ Integration of Coal tar with foliar application of Bordeaux mixture/copper fungicides drastically reduced gummosis disease of bael	gummosis disease of bael and reduced the use of chemical fungicides
	Bio-rational based integrated disease management packages against gummosis disease of golden apple	The following technologies have been developed ➤ Integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicides and ➤ Integration of Coal tar with foliar application of Bordeaux mixture/copper fungicides drastically reduced gummosis disease of golden apple	The technology generated from this study would benefit the farmers for bio-rational based management of gummosis disease of golden apple and reducing the use of chemical fungicides
Validation and dissemination of developed technologies	For field validation of integrated disease management packages against gummosis of bael and golden apple: The field validation trials have conducted on bael and golden apple at Breeder Seed Production Center, BARI, Debiganj, Panchagarh and Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati	Results of the field validation trials showed that the developed technologies were effective against gummosis disease of bael and golden apple in both the locations of Breeder Seed Production Center, BARI, Debiganj, Panchagarh and Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati	

Component-III. Entomology Division, BARI, Gazipur-1701

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)
Documentation of pest status and its' severity of lean season fruit crops	Survey and monitoring of insect pests of lean season fruit crops in the Major Fruit growing areas in Bangladesh	From the survey it was observed that hog plum beetle, trunk borer of hog-plum fruit borer wood apple fruit borer, pomegranate fruit borer,	Farmers became aware about the insect pests of lean season fruit crops in

		custard apple pink mealy bug, Jujube/ ber fruit borer were major pests at all the locations of Bangladesh	Bangladesh
Development of an effective and suitable management approach(es) against major pests of important lean season fruit crops	Management approaches against fruit borer, <i>Deudorix isocrates</i> attacking wood apple were conducted at HRC, Fruit Research Station, BARI, Gazipur and BSPC, Debigonj, Panchgarh	The following technologies have been developed; Spraying of bio-pesticide Spinosad (Tracer 45 SC, @ 0.4 ml/L of water or Success 2.5SC, @ 1.2 ml/L of water at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results	The technology would contribute substantially reducing 75-82% fruit infestation over control. As a result, pesticide free safe fruit can be produced with higher productivity of wood apple in our country
	Development of bio-rational based management approach against hog plum beetle, <i>Podontia 14-punctata</i> was performed at HRC, Fruit Research Station, BARI, Gazipur and RARS, Barishal.	The following technologies have been developed: Spraying of bio-pesticide Matrine (Biotrin 0.5) 1 ml/liter of water of whole tree at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results	The technology would contribute substantially in reducing hog plum beetle attack in golden apple infestation
Validation and dissemination of developed insect management technologies	For field validation and dissemination of developed insect management packages against fruit borer, <i>Deudorix isocrates</i> attacking wood apple were conducted at HRC, Fruit Research Station, BARI, Gazipur and BSPC, Debigonj, Panchgarh	Results of the field validation trials showed that the developed technologies were effective against fruit borer of wood apple in both the locations of HRC, Fruit Research Station, BARI, Gazipur and BSPC, Debigonj, Panchgarh	This would certainly help in increasing fruit production of wood apple

E: Information/knowledge generated/policy generated

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

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)
i) Development of lean season (September-April), high yielding and good quality fruit varieties and management technologies	a) Collection, characterization and evaluation of lean season fruit germplasm b) Evaluation and characterization of existing lean season fruit germplasm	a) Three (03) lean season fruit varieties and two (02) management technologies have been developed b) Farmers and DAE personnel got familiar with the varieties and technologies	a) Cultivation and year round fruit production will be increased b) Nutrition security will be ensured
ii) Collection, characterization, evaluation, conservation and utilization of lean season fruit germplasm	Lean season fruit germplasm were collected from Chittagong Hill Tracts, North-Western and Southern part of the country	a) New lean season fruit varieties with nutritional benefit will be developed b) Growers and entrepreneurs will cultivate the new varieties	a) Varieties will provide nutrition to the people b) Biodiversity will be increased
iii) Standardization of propagation and other management techniques for major and minor fruit crops	a) Vegetative propagation techniques for difficult to propagate fruit crop and lean season crop has been standardized b) Different propagation techniques namely cleft grafting, air layering, budding etc. have been practiced	a) Cleft grafting in avocado has been standardized b) April (before new leaf emergence) has been proved the best time for bael propagation	a) Developed propagation techniques and methods will help growers in multiplying fruit plants true to type b) Area of fruit cultivation as well as production will be increased
iv) Knowledge development through training	a) Arranging training for the fruit growers and stakeholders on lean season fruit crops	a) Four (04) farmers/stakeholder training have been arranged; each at	a) Fruit growers/ stakeholders gained knowledge on

	b) Organizing workshop on technical and technological progress for the extension personnel or root level workers	Gazipur, Barishal, Rangamati and Panchagarh b) Two (02) workshops (inception and completion) have been organized	lean season fruit production and management practices b) DAE personnel have become familiar with the varieties and technologies developed
v) Upliftment of income as well as livelihood of the people	a) Dissemination of lean season fruit crops b) Cultivation of developed lean season fruit varieties by the people c) Transferring technologies and knowledge regarding production and management of lean season fruits	a) More fruits will be produced in the lean period b) Profit might be earned by selling the fruits	a) Availability of fruits will be increased b) Nutritional security will be ensured c) Livelihood of people will be improved

Component-II. Plant Pathology Division, BARI, Gazipur-1701

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)
Identification of important diseases and their incidence and severity of predominant lean season fruit crops	Survey and identification of major diseases of lean season fruit crops in Bangladesh ➤ During June 2018 to December 2019 a survey was done in Barishal, Panchagarh, the Hill Agricultural Research Station, Raikhali, Kaptai, Rangamati and Gazipur regions	⇒ Gummosis disease of golden apple, wood apple and wood apple were the major problems in the all surveyed regions ⇒ In Gazipur and Panchagarh regions, fruit rot/anthracnose disease caused by <i>Colletotrichum</i> sp. and gray leaf blight caused by <i>Pestalotia</i> sp. of lotkon were observed ⇒ In Barishal region, leaf spot caused by <i>Colletotrichum</i> sp. of golden apple and die	Farmers became aware about the disease of lean season fruit crops

		<p>back of Sapota were observed as minor disease</p> <p>⇒ In the Hill Agricultural Research Station, Raikhali and Breeder Seed Production Farm, BARI, Debiganj, Panchagarh regions anthracnose disease caused by <i>Colletotrichum</i> sp. of wood apple was recorded as minor diseases</p>	
Determination of protective measures taken by the growers against major diseases of lean season fruits	Screening of the chemical fungicides against fruit rot/anthracnose disease of lotkon	<ul style="list-style-type: none"> ➤ Foliar application of Tilt (Propiconazole) @ 0.5 ml/l water and Autostin (Carbendazim) 2 g/l water three times at 10-12 days interval reduced 82.29-87.60% fruit rot/anthracnose disease of lotkon compared to control ➤ Foliar application of Secure (Fenamidone + Mancozeb 600WG) and Dithane M-45 (Mancozeb 80%) reduced 75.23%, and 74.33%, respectively fruit rot/anthracnose disease of lotkon than control 	The selected chemical fungicides may contribute for the management of fruit rot/anthracnose disease of lotkon which would be helpful for farmers inspiring their economic income
Development of suitable disease management packages against major diseases of lean season fruit crops	For the development of bio-rational based integrated disease management packages against gummosis disease of bael two experiments were conducted at BSPF, Debiganj, Panchagar and the Hill Agricultural Research Station (HARS), Raikhali with three different treatments	<p>The following technologies have been developed</p> <ul style="list-style-type: none"> ➤ Integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicides and ➤ Integration of Coal tar with foliar application of Bordeaux mixture/copper fungicides drastically reduced gummosis disease of bael 	The technology generated from this study would help the farmer for the management of gummosis disease of bael and reduced the use of chemical fungicides
	Bio-rational based integrated disease	The following technologies have been developed	The technology generated from

	management packages against gummosis disease of golden apple	<ul style="list-style-type: none"> ➤ Integration of Bordeaux paste with foliar application of Bordeaux mixture/copper fungicides and ➤ Integration of Coal tar with foliar application of Bordeaux mixture/copper fungicides drastically reduced gummosis disease of golden apple 	this study would benefit the farmers for bio-rational based management of gummosis disease of golden apple and reducing the use of chemical fungicides
--	--	---	--

Component-III. Entomology Division, BARI, Gazipur-1701

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)
Documentation of pest status and its' severity of lean season fruit crops	Survey and monitoring of insect pests of lean season fruit crops in the Major Fruit growing areas in Bangladesh	From the survey it was observed that hog plum beetle, trunk borer of hog-plum fruit borer wood apple fruit borer, pomegranate fruit borer, custard apple pink mealy bug, Jujube/ ber fruit borer are major pests at all the locations of Bangladesh	Farmers became aware about the insect pests of lean season fruit crops in Bangladesh
Development of an effective and suitable management approach(es) against major pests of important lean season fruit crops	Management approaches against fruit borer, <i>Deudorix isocrates</i> attacking wood apple were conducted at HRC, Fruit Research Station, BARI, Gazipur and BSPC, Debigonj, Panchgarh	The following technologies have been developed; Spraying of bio-pesticide Spinosad (Tracer 45 SC, @ 0.4 ml/L of water or Success 2.5SC, @ 1.2 ml/L of water at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results	The technology would contribute substantially reducing 75-82% fruit infestation over control. As a result, pesticide free safe fruit can be produced with higher productivity of wood apple in our country
	Development of bio-rational based management approach	The following technologies have been developed: Spraying of	The technology would

	against hog plum beetle, <i>Podontia 14-punctata</i> was performed at HRC, Fruit Research Station, BARI, Gazipur and RARS, Barishal.	bio-pesticide Matrine (Biotrin 0.5) 1 ml/liter of water of whole tree at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results	contribute substantially in reducing hog plum beetle attack in golden apple
--	--	---	---

F. Materials Development/Publication made under the Sub-project

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

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.	05	-	One booklet and 4 leaflets are being prepared.
Journal publication	03	-	Three research articles are being processed.
Video clip/TV program		-	
News Paper/Popular Article	01	-	Popular article on importance of lean season fruit is under process.
Other publications, if any	-	01	An advertisement paper regarding the sub-project has been published.

Component-II. Plant Pathology Division, BARI, Gazipur-1701

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.	01	-	-
Journal publication	-	-	-
Video clip/TV program	-	-	-
News Paper/Popular Article	-	-	-
Other publications, if any	-	-	-

Component-III. Entomology Division, BARI, Gazipur-1701

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.	01	-	-
Journal publication	-	-	-
Video clip/TV program	-	-	-
News Paper/ Popular Article	-	-	-
Other publications, if any	-	-	-

G. Description of generated Technology/knowledge/policy:

- i. Technology Fact Sheet (title, introduction, description, suitable location/ecosystem, benefits, name and contact address of author)**

Component-I. Pomology Division, Horticulture Research Centre, BARI, Gazipur

Technology Factsheet- 1

1. **Title:** BARI Jam-1: A high yielding later variety of Jamun

2. **Introduction:** Jamun (*Syzygium cumini*) is an important minor fruit crop in Bangladesh with commercial value. It is a good source of iron, apart from the usual contents, e.g., minerals, sugars, protein and others (Bose *et al.*, 2001). It is supposed to be originated in India or the East Indies



Figure 37. BARI Jam-1

(Singh, 1969) but it is sporadically found in the homestead all over the country. In Bangladesh, there was no standard or registered cultivar of jamun under commercial cultivation. Due to the lack of variety, it is losing area under cultivation day by day. But its importance in nutrient security can't be ignored. Hence, the only registered jamun variety of Bangladesh, BARI Jam-1, was released from the Hill Agricultural Research Station, BARI, Raikhali, Rangamati under the sub-project. Nine superior jamun germplasm was collected from farmers' field and planted in the research farm in 2013. After 6 years of perfect evaluation, the most promising germplasm with respect to yield and quality was released as the variety BARI Jam-1. Hopefully the production of jamun will be increased, which will in turn help in economic development as well as mitigate the nutritional requirement of the people.

3. Description of the Technology

- a) Regular bearer and high yielding variety
 - b) Fruits are bigger and individual fruit weight is 9.8g
 - c) Very sweet (TSS:14.3%) and edible portion is more than 83%
 - d) Harvesting period is late June to late July
 - e) Fruit yield (6 years) is 58.7 kg/plant and number of fruit per plant is 6670
4. **Suitable Location/Ecosystem:** Jamun is a tropical and sub-tropical fruit crop. The fruit tree requires deep loam and well-drained soil for its optimum growth and good fruiting. Though it can be grown in all types of soils, but very heavy or light sandy soils should be avoided. It can be cultivated in all Agro Ecological Zones (AEZs) of the country.
5. **Benefit of the Technology:** BARI Jam-1 is the first and only registered jamun variety in Bangladesh. One of the main characteristics of the variety is fruits are bigger in size and very pleasant in taste (TSS 12.4%). It has got excellent fruit quality with high (83%) edible portion. The tasty and pleasant flavored fruit is mostly used for dessert purpose and it is very much popular to the people of all age. It is also an excellent source of iron and anti-oxidants. So, the cultivation of the variety will surely increase the availability of nutrient rich local fruits. Besides, the fruit has a good market value, which will improve the socio-economic condition of the farmer as well as more farmers will be encouraged to grow jamun.
6. **Name and Address of the Researcher (including mobile and e-mail)**
- i. **Mohidul Islam**, Mobile- 01821815800; Email- mail2repon@yahoo.com.

Technology Factsheet- 2

1. **Title:** BARI Ata-1; A high yielding variety of Bullock's heart

2. **Introduction:** Bullock's heart (*Annona reticulata*), belonging to the family Annonaceae, is a delicious fruit which is native to Mexico, Central America and South America. Hoque (1985) reported that every 100 g of edible fruit of bullock's heart contain 90 kcal energy, 15.7 g carbohydrate, 3.1 g dietary fibre, 1.4 g protein, 10 mg calcium, 67 g carotene etc. Besides, it has some medicinal values too. The most important character of the fruit is its' availability in the lean period (March to May) when very few native fruits are found in the markets of Bangladesh. It is grown scatteredly and sporadically everywhere in Bangladesh but due to the lack of registered variety, it is losing area under cultivation. Four bullock's heart germplasm were collected from the farmer's orchard of Panchagarh in 2012 by the scientists of Breeder Seed Production Centre, Debiganj, Panchagarh and planted in the Fruit Research Farm. After 8 years of perfect evaluation, the most promising germplasm was released by the Bangladesh Agricultural Research Institute as the first registered bullock's heart variety in Bangladesh.



Figure 38. BARI Ata-1

3. Description of the Technology

1. Regular bearer and high yielding variety
2. Fruits are comparatively bigger (fruit weight: 261g)
3. Edible portion is 72% and very sweet in taste (TSS 26%)
4. Harvesting period is early March to mid May
5. Fruit yield (8 years) 84 kg/plant and number of fruits per plant is 322

4. Suitable Location/Ecosystem: Bullock's heart is mainly a tropical fruit crop. But the crop is spread upto calm weathered sub-tropical region. It requires sandy-loam and well-drained soil for its optimum growth and good fruiting. It can be grown in all Agro Ecological Zones (AEZs) of Bangladesh. But heavy soil with poor drainage, sub-soil hard pan or high water table is to be avoided.

5. Benefit of the Technology: BARI Ata-1 is the only registered bullock's heart variety in Bangladesh. The fruits are comparatively bigger in size and very sweet in taste (TSS 26%) along with higher edible portion (72%). One of the main characteristics of the variety is its availability in the lean period (March to May), when very few fruits are present in the market. It is also an excellent source of carotene and vitamin B. So, the cultivation of the variety will surely increase the availability of nutrient rich local fruits in the lean period. Besides, the fruit has a good market value, which will improve the socio-economic condition of the farmer as well as more farmers will be encouraged to grow bullock's heart.

6. Name and Address of the Researcher (including mobile and e-mail)

- a) **Srijan Chandra Das**, Mobile- 01722257525; Email- srijandas.pstu@gmail.com

Technology Factsheet- 3

1. **Title:** BARI Kodbael-2; A high yielding off-season variety of Wood apple
2. **Introduction:** Wood apple (*Feronia limonia*), a member of Rutaceae family, is one of the important minor fruit crops which becomes available beyond the normal fruiting season generally cultivated in both peninsulas. The fruit is available during October-November. Bangladesh Agricultural Research Institute has released one superior wood apple variety for commercial cultivation. But more varieties with promising characters are required for increasing more land under the cultivation of the fruit. As an indigenous fruit huge variability of wood apple exists in Bangladesh. Four promising wood apple germplasm was collected from the farmer's orchard of Rangamati in 2009 by the scientists of HARS, Rangamati and planted in the research field. After 10 years of perfect evaluation, one was found promising among the collected four wood apple germplasm and BARI Kodbael-1. Fruits of this germplasm were bigger in size and average individual fruit weight was 455 g and its harvesting period is February to May when very few fruits are available in Bangladesh. So, BARI Kodbael-2 was released as an off season wood apple variety in Bangladesh.



Figure 39. BARI Kodbael-2

3. Description of the Technology

- Regular bearer and high yielding variety
- Availability of fruits in the off season (February to May), which is an unique character
- Fruits are bigger in size, average individual fruit weight is 455 g
- Average fruit yield per plant (10 years) is 80 kg and average number of fruit is 176
- Harvesting period is February to May when very few fruits are available in the country

4. **Suitable Location/Ecosystem:** Wood apple is a tropical fruit crop and can withstand dry weather. The fruit tree requires deep loam and well-drained soil for its optimum growth and good fruiting. Though it can be grown in all types of soils, but very heavy or light sandy soils should be avoided. Besides it also grows well in slightly saline soils. It can be cultivated in all Agro Ecological Zones (AEZs) of Bangladesh.

5. **Benefit of the Technology:** The main feature of BARI Kodbael-2 is that it is an off-season variety of wood apple. It usually blooms from February to March and ripens from October to December. But this new variety flowers from mid-April to July and ripe fruits can be collected from February to May when the availability of fruits in the country is very low. The size of the fruit is also very large and delicious to eat. The fruit remains quite fresh for a long time after collection. Besides, the market price of the fruit is also higher in the off-season which will contribute to the socio-economic development of the farmer and will motivate the farmer to cultivate the nutritious fruits.

6. Name and Address of the Researcher (including mobile and e-mail)

- a) **Mohidul Islam**, Mobile- 01821815800; Email- mail2repon@yahoo.com.

Technology Factsheet- 4

1. **Title:** Standardization of vegetative propagation in avocado

2. **Introduction:** Avocado is one of the important exotic fruits has been growing in Bangladesh for recent past. It is an ancient fruit, originated mainly from Central America and Mexico. The tree was commonly referred to as the “testicle tree” because of the shape of the avocado and the way they hung from the tree. It is also known as: Alligator Pear, Butter fruit, Makhanphal (Hindi), Kulu naspati, Vennai Pazham (Tamil), Alpukat (Marathi), Magar Nashpati (Urdu), Benne Hannu (Kannada), Venna Pandu (Telegu). Popenoe (1935) considered the avocado as “God’s greatest gift to humanity”. Today, this fruit is highly regarded as an important fruit for food and nutrition. Avocados are rich in important human nutrients and antioxidants for good health. The avocado fat consists predominantly of monounsaturated oleic acid, which has been found to reduce harmful LDL cholesterol while maintaining beneficial HDL-cholesterol, performing better than the usual low-fat diet. In addition, the avocado has various uses as a natural cosmetic, with advantages in rapid skin penetration, and as a superior natural sunscreen. However, remarkable development of this fruit has been recorded in every continent. Unfortunately, this fruit has not yet been popularized in Asia, most likely due to unawareness of its merits/qualities. Indeed, real starvation and malnutrition are very common in a number of Asian countries. In a country such as Bangladesh, this situation is even worse. Growing of avocados could be helpful in

averting this condition, whose product has a relatively high food, nutrition and market value. Yet, cultivation of avocado in Bangladesh is somewhat problematic. Therefore, there is immense need to encourage, develop and implement an appropriate production technology especially standardization of vegetative propagation method of avocado in Bangladesh.

3. Description of Technology

Salient Features

- i) Grafting in avocado is easily attainable, environmentally friendly and profitable.
- ii) Cleft grafting is the best method of avocado organ reproduction.
- iii) The success rate of quality pen production in this method is about 80 percent.
- iv) June-August is the best time to make pens.

How to Use the Technology

- i) In June-August one year old avocado rootstock should be cleft grafted with six month old suitable scion.
- ii) The entire scion including the graft zone should be covered with a polythene cap so that it does not dry out.
- iii) Then the grafts should be kept in a darkish environment for 7 days.
- iv) The grafts are successfully attached in 30 days after being taken out of the dark environment.
- v) Above 80% of the avocado graftings produced in this way are successful and are suitable for planting in the field in one year.

4. Suitable Location/Ecosystem: Avocado vegetative propagation by cleft grafting can be used in all Agro Ecological Zones (AEZs) of Bangladesh. One thing must be noted that the rootstock and scion must be at same physiological maturity and compatible with each other.

5. Benefit of Technology: The standardization of cleft grafting methods for avocado propagation will accelerate the production of quality avocado saplings. The only recognized variety of avocado in Bangladesh is BARI Avocado-1. It contains 20.2% of linoleic acid/Omega-6 (unsaturated fatty acids) which are beneficial fats for human body. It also contains other important vitamins and minerals. However, due to the lack of ideal breeding methods, its maternal qualities are not intact, so it has not been possible to propagate the improved BARI Avocado-1 and establish new gardens. Using the invented cleft grafting method, it will be possible to make maternal avocado pens. As a result, the establishment of new orchards in the country will increase the production of BARI Avocado-1 which will play an important role in providing nutritional security to the people.

6. Name and Address of the Researcher (including mobile and e-mail)

- a) **Dr. Babul Chandra Sraker**, Mobile- 01716009319; Email- bsarker_64@yahoo.com



Figure 40. Vegetative propagation in Avocado

Technology Factsheet- 5

1. **Title:** Increased yield and quality of BARI Amra-1 (short, year round) through fertilizer management
2. **Introduction:** In Bangladesh, more than 54% fruits are available during mid-May to mid-August and people get fairly adequate quantities of fruits during the four summer months. But golden apple var. BARI Amra-1 bears fruits all the year round and BARI Golden Apple-2 harvested till mid-September (Azad *et al.*, 2019). Thus during the lean season golden apple can be a source of nutrient security as an acute shortage of native fruits prevails at that period. Hog plums are considered to have good nutritional quality; the fruit has a pleasant aroma and a juicy pulp, as well as a distinctive bittersweet flavor (Silva *et al.*, 2007). Although BARI Amra-1 possesses the habit of year round fruit bearing characters, but due to nutrient deficiency and inadequate cultural practices, irregular flowering, low fruit set and low fruit retention leading to low yield and poor quality fruits are common problems in production. Brar *et al.*, (2015) declared that the fruit yield and quality of rainy season crop significantly improved with higher doses of split application of inorganic fertilizers.
3. **Description of the Technology**

Salient Features

 - i) The technology is feasible, environmentally friendly and profitable.
 - ii) Applying 200 % (two times higher) of the approved level of fertilizer for BARI Amra-1 as per FRG'2018 (BARC).
 - iii) Average fruit weight and average yield increased by 12.60% (62.2 g) and 18.40% (30.24 kg per plant), respectively after using the technology compared to the yield of BARI Amra-1 (age: 6 years) obtained in the general management mentioned in FRG' 2018.

- iv) Using this technology, the potential net profit of the farmers is Tk. 1,20,000.00 per hectare and in this case BCR is 1.35.
- v) According to the characteristics of BARI Amra-1, it is possible to ensure balanced fruit collection throughout the year. However, comparatively more fruits are collected during August-October and February-April.

Methods of Using the Technology

Fertilizer dose: Fertilizer should be applied according to the age of the tree.

Plant age (Year)	Cowdung (kg)	Urea (g)	TSP (g)	MoP (g)	Gypsum (g)	Boron (g)
1-2	10	220	300	200	100	10
3-4	14	325	400	300	160	20
5-7	20	450	500	400	220	40
8-10	24	550	600	500	280	60
> 10	30	660	700	600	350	80

Application Method:

- i) All TSP, gypsum and boron fertilizers should be applied in September.
- ii) Cowdung should be applied in two installments i.e. half in September and the other half in March-April.
- iii) Urea and MoP fertilizers should be applied in four installments i.e. one-fourth in September, November, March-April and May-June.
- iv) Fertilizer should be applied at least 50-100 cm away from the base around the tree where the shade falls at noon except.
- v) Irrigation should be done immediately after application of fertilizer.

Other Special Cares

- i) The base of the tree should always be kept free from weeds.
 - ii) After every harvest, dried, dead, diseased and weak stalks/twigs of the tree should be cut off and the cut part should be covered with bordeaux paste (100 g CuSO₄, 100 g lime and 1 liter water) or copper fungicide.
 - iii) In the dry season i.e., from December to April watering should be done at two-week intervals. Mulching should be used if necessary.
 - iv) If diseases and insects are found in the tree, it should be treated.
4. **Suitable Location/Ecosystem:** The fertilizer management technology is suitable for the areas where BARI Amra-1 is cultivated.
5. **Benefit of Technology:** Golden apple is one of the major unconventional and vitamin-C rich fruits in Bangladesh. Through the application of developed fertilizer management technology, both the fruit size and yield of BARI Amra-1 variety, which bears fruit all the year round, has increased. The yield of eight year old BARI Amra-1 becomes 16.92 tons per hectare, 30.24 kg per tree, number of fruits 490 and average weight of each fruit is 82.20 g. Again, in fertilizer management fruits can be collected 5-6 times a year and availability is abundant in August-October and February-April. In addition, the

fruit is popular to younger to older because of its sour-sweet taste. Therefore, the availability and production of more nutritious BARI Amra-1 will be increased in the off-season through the use of developed fertilizer management technology. As the market price of this off-season fruit is also satisfactory, the farmers will be interested in using this technology which will motivate them to cultivate the fruit.

6. Name and Address of the Researcher (including mobile and e-mail)

a) **Dr. Babul Chandra Sraker**, Mobile- 01716009319; Email- bsarker_64@yahoo.com



Figure 41. Fertilizer management in BARI Amra-1

Technology Factsheet- 6

1. **Title:** Ecofriendly fertilizer management package for BARI Amra-2
2. **Introduction:** In Bangladesh, more than 54% fruits are available during mid-May to mid-August and people get fairly adequate quantities of fruits during the four summer months. But BARI Golden Apple-2 harvested is harvested till mid-September (Azad *et al.*, 2019). Thus during the lean season golden apple can be a source of nutrient security as an acute shortage of native fruits prevails at that period. Hog plums are considered to have good nutritional quality; the fruit has a pleasant aroma and a juicy pulp, as well as a distinctive bittersweet flavor (Silva *et al.*, 2007). BARI Amra-2 bears flowers in March-April and subsequently fruit is harvested during June-July. Rarely, it bears fruits in the winter. But fertilizer management may help in bearing flowers as well as fruits in the off-season. The golden apple trees grow best in fertile, well-drained soils but can thrive satisfactorily in a variety of poorer soils if they are given adequate nutrition (Crane and Wasielewski, 2019). Brar *et al.*, (2015) declared that the fruit yield and quality of rainy season crop significantly improved with higher doses of split application of inorganic fertilizers.

3. Description of the Technology

Salient Features

- i) The technology is feasible, environmentally friendly and profitable.
- ii) Applying 200 % (two times higher) of the approved level of fertilizer for BARI Amra-2 as per FRG'2018 (BARC).
- iii) Average fruit weight and average yield increased by 50% (142.1 g) and 10.40% (54.48 kg per plant), respectively after using the technology compared to the yield of BARI Amra-2 (age: 8 years) obtained in the general management mentioned in FRG' 2018.
- iv) Using this technology, the potential net profit of the farmers is Tk. 1,36,400.00 per hectare and in this case BCR is 1.3558.
- v) Fruits can be harvested during August to October.

Methods of Using the Technology

Fertilizer dose: Fertilizer should be applied according to the age of the tree.

Plant age (Year)	Cowdung (kg)	Urea (g)	TSP (g)	MoP (g)	Gypsum (g)	Boron (g)
1-2	20	300	400	300	150	20
3-4	24	450	600	450	240	40
5-7	30	650	750	600	320	80
8-10	40	800	900	750	400	120
> 10	50	1000	1000	900	500	150

Application Method:

- i) All TSP, gypsum and boron fertilizers should be applied in September.
- ii) Cowdung should be applied in two installments i.e. half in September and the other half in March-April.
- iii) Urea and MoP fertilizers should be applied in three installments i.e. one-third in September, March and June.
- iv) Fertilizer should be applied at least 1 m away from the base around the tree where the shade falls at noon except.
- v) Irrigation should be done immediately after application of fertilizer.

Other Special Cares

- i) The base of the tree should always be kept free from weeds.
 - ii) After every harvest, dried, dead, diseased and weak stalks/twigs of the tree should be cut off and the cut part should be covered with bordeaux paste (100 g CuSO₄, 100 g lime and 1 liter water) or copper fungicide.
 - iii) In the dry season i.e., from December to April watering should be done at two-week intervals. Mulching should be used if necessary.
 - iv) If diseases and insects are found in the tree, it should be treated.
4. **Suitable Location/Ecosystem:** The fertilizer management technology is suitable for the areas where BARI Amra-1 is cultivated.

5. Benefit of Technology: BARI Amra-2 is available in August-October when there are no seasonal fruits in the country. The fruit is rich in Vitamin-C and other vitamins and mineral salts and thus the fruit helps in boosting the body's immune system and helps in body building. By applying the developed fertilizer management technology, both the fruit size and yield of BARI Amra-2 variety are increased. Eight year old BARI Amra-2 yields 5 tons per hectare, 54.53 kg per tree, 245 fruits per tree and average weight of each fruit is 100.20 g. In addition, the fruit is popular to younger to older because of its sour-sweet taste. Therefore, through the use of invented fertilizer management technology, the availability of more nutritious BARI Amra-2 will be increased in the off-season. As the market price of this off-seasonal fruit is also satisfactory, the farmers will be interested in using this technology which will play a role in their socio-economic development.

6. Name and Address of the Researcher (including mobile and e-mail)

a) **Dr. Babul Chandra Sraker**, Mobile- 01716009319; Email- bsarker_64@yahoo.com



Figure 42. Fertilizer management in BARI Amra-2

Component-II. Plant Pathology Division, BARI, Gazipur-1701

Technology Factsheet- 1

1. **Title:** Integrated Management of Gummosis disease of bael
2. **Introduction:** Bael *Aegle marmelos* is one of the edible fruits native to India and parts of Bangladesh, Pakistan, Sri Lanka and Southeast Asia east to Java. These fruits are grown throughout India and can be cultivated along both peninsulas of the country. These plants can survive in dry regions with minimum water requirement. Bael being a hardy crop, there is no many serious insect pest and diseases as of now. But bacterial shot hole, fruit canker and gummosis are the serious diseases. Fruit cracking is the physiological disorder in some genotypes of bael which occurs just before ripening.

3. Description of Technology

- Keep clean the bael orchard
- Use recommended doses of fertilizer and irrigation
- Scooping the disease infected areas with some healthy areas using Chisel and then covering the scooping area with Bordeaux paste (prepared by 1:1:10, CuSO₄: Lime: Water) or Coal tar.
- Spray the whole plant with Bordeaux mixture (prepared by 1:1:50, CuSO₄: Lime: Water) or copper fungicide three times at 10-12 days interval

4. **Suitable Location/Ecosystem:** Panchagarh, Dinajpur, Mymeningh, Gazipur, Hilly areas such as Rangamati, Khagrachari, Bandarban and other bael growing areas in Bangladesh

5. **Benefit of Technology:** Use of chemical pesticide will be reduced. Gummosis disease would be controlled about 80 to 90% and bael production will be increased.

6. Name and Address of the Researcher (including mobile and e-mail)

Dr. Md. Iqbal Faruk, Principal Scientific Officer, Plant Pathology Division, BARI, Gazipur;
Mobile: +8801732587563, +8801963533118 and E-mail: mifaruk2012@yahoo.com;
mifaruk2013@gmail.com



Disease plant



Scooping+ Bordeaux paste plant



Coal tar+ Bordeaux mixture treated plant of wood apple at Debigonj



Bordeaux paste + Bordeaux mixture treated plant of wood apple at Debigonj

Figure 43. Integrated Management of Gummosis disease of bael

Technology Factsheet- 2

1. **Title:** Integrated Management of Gummosis disease of Golden apple
2. **Introduction:** Golden apple, *Spondias dulcis* is one of the most popular and market demanding minor fruits in Bangladesh. *S. dulcis*, also known as yellow mombin or hog plum or golden apple is a species of tree and flowering plant in the family Anacardiaceae. It is native to the tropical Americas, including the West Indies. The tree was introduced by the Portuguese in South Asia in the beginning of the 17th century. It has been naturalized in parts of Africa, India, Nepal, Bangladesh, Sri Lanka, The Bahamas, Indonesia, and other Caribbean islands. It is rarely cultivated except in parts of the Brazilian Northeast. Several insect and diseases are one of the major constraints for golden apple cultivation in Bangladesh. Among the diseases gummosis disease is the major one.

3. Description of Technology

- Keep clean the golden apple orchard
- Use recommended doses of fertilizer and irrigation
- Scooping the disease infected areas some healthy areas using Chisel and then covering the scooping area with Bordeaux paste (prepared by 1:1:10, CuSO₄: Lime: Water) or coaltar.

- Spray the whole plant with Bordeaux mixture (prepared by 1:1:50, CuSO₄: Lime: Water) three times at 10-12 days interval

4. Suitable Area/Location

Barishal, Panchagarh, Dinajpur, Mymeningh, Gazipur, Hilly areas such as Rangamati, Khagrachari, Bandarban and other golden apple growing areas in Bangladesh.

5. Benefit of Technology

Use of chemical pesticide will be reduced. Gummosis disease would be controlled about 80 to 90% and golden apple production will be increased.

6. Name and Address of the Researcher (including mobile and e-mail)

Dr. Md. Iqbal Faruk, Principal Scientific Officer, Plant Pathology Division, BARI, Gazipur;
Mobile: +8801732587563, +8801963533118 and E-mail: mifaruk2012@yahoo.com;
mifaruk2013@gmail.com



Figure 44. Integrated Management of Gummosis disease of Golden apple

Component-III. Entomology Division, BARI, Gazipur-1701

Technology Factsheet- 1

1. Title of the Technology

Management of fruit borer, *Deudorix isocrates* attacking wood apple/kodbael

2. Introduction

The wood apple, *Feronia limonia* (Linn.) is a minor fruit crop in Bangladesh. The plants are hardy with deep penetrating root system, which makes them survive in harsh soil and climatic condition. Recently serious attack of fruit borer *Deudorix isocrates* has been recorded in different parts of our country, causing significant fruit damage. The caterpillar of this pest bores into young fruits and feeds on internal contents (pulp and seeds) resulting fruit rotting and dropping. So, it is necessary to develop an environment friendly management packages against this devastating pest, which would ultimately increase the productivity of wood apple in our country.

3. Description of Technology

Fruit borer, *Deudorix isocrates* attacking wood apple can be successfully managed by the following bio-rational based management package, recently developed by Entomology Division, BARI under its PIU-BARC, NATP-Phase II funded, Lean season fruit sub project. The salient features of this management package are as follows:

Sanitation: Severely infested wood apple fruits should be collected from the tree and burned.

Use of Bio-pesticide: Spraying of bio-pesticide Spinosad (Tracer 45 SC, @ 0.4 ml/L of water or Success 2.5SC, @ 1.2 ml/L of water at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results.

4. Suitable Area/Location

All over Bangladesh (Including Barishal, Panchgarh, Raikhali and Gazipur).

5. Benefit of Technology

The technology would contribute substantially reducing 75-82% fruit infestation over control. As a result pesticide free safe fruit can be produced with higher productivity of wood apple in our country.

6. Name and Address of the Researcher (including mobile and e-mail)

Dr. Md. Kafil Uddin, Senior Scientific Officer, Entomology Division, BARI, Gazipur;
Mobile: +8801552-334879 and E-mail: mkafil77@yahoo.com



Borer infested fruit in experimental field



Seriously infested fruit by larvae



Pupae of *Deudorix isocrates*



Adult of *Deudorix isocrates*

Figure 45. Fruit borer management in wood apple

Technology Factsheet- 1

1. Title of the Technology

Development of bio-rational based management approach against hog plum beetle, *Podontia 14-punctata*

2. Introduction

Hog-plum (*Spondias cytherea*) is known as “Amra” has been considered as major fruit for its availability in Bangladesh especially in Barishal region. It is one of the popular fruit in all over Bangladesh and Barishal is famous for golden apple. The production of golden apple is greatly hampered by the infestation of several insect pests, among them hog-plum beetle or fourteen spotted leaf beetle, *Podontia 14-punctata* L. (Chrysomelidae: Coleoptera) is an important pest. So, it is necessary to develop an environment friendly bio-rational based management approach against this devastating pest which ultimately increases the productivity of golden apple in our country. By applying this bio-rational based management package pesticide free safe fruit can be produced which helps to ensure food security in our country.

3. Description of Technology

Hog plum beetle, *Podontia 14-punctata* attack in hog plum can be successfully managed by the bio-rational based management package, recently developed under this sub project. The salient features of this bio-rational based management package are as follows:

Sanitation: Severely infested golden apple leaves (leaves including egg mass and larvae) should be cut, removed and burned.

Use of Bio-pesticide: Spraying of bio-pesticide Matrine (Biotrin 0.5) 1 ml/liter of water of whole tree at 07-10 days interval. Usually, 3-4 sprays are required to obtain good results..

4. Suitable Area/Location

All over Bangladesh (Including Barishal, Panchgarh, Raikhali and Gazipur).

5. Benefit of Technology

The technology would contribute substantially in reducing hog plum beetle, *Podontia 14-punctata* attack in hog plum infestation. As a result pesticide free safe fruit can be produced which helps to ensure food security in our country.

6. Name and Address of the Researcher (including mobile and e-mail)

Dr. Md. Kafil Uddin, Senior Scientific Officer, Entomology Division, BARI, Gazipur;
Mobile: +8801552-334879 and E-mail: mkafil77@yahoo.com



Hog plum beetle infested leaf in field



Seriously infested fruit tree an experimental field



Pupae of hog plum beetle

Figure 46. Bio-rational management of hog plum beetle

ii. Effectiveness in Policy Support (if applicable)

- Under the sub-project, three lean season fruit varieties have been released. This will definitely lead to the increased fruit production as well as availability in the off-season. As a result food and nutrient security will be ensured which is one of the goals of SDGs as well as national plan.
- Two management practices in golden apple and one propagation method in avocado have been developed. Fruit production in golden apple will be ameliorated. Farmers will be able to produce more fruits and earn money from their produce. Again, standard vegetative propagation method will help in multiplying quality saplings. This will help in increasing cultivation area of avocado, a highly nutritive and beneficial fruit. Thus the sub-project output will help in poverty alleviation.
- The fruit growers and young generation will be encouraged in establishing off-season fruit orchard and their livelihood will be uplifted.
- The overall vegetation cover of the country will be increased which will add more oxygen to the nature. Thus indirectly the sub-project output has positive environmental impact.

H. Technology/Knowledge generation/Policy Support (as applied)

i. Immediate impact on generated technology (commodity & non-commodity)

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

- Under the sub-project, three lean season fruit varieties (BARI Jam-1, BARI Ata-1 and BARI Kodbael-2), two fertilizer management packages and one vegetative propagation method have been developed.
- The farmers got acquainted with the developed lean season fruit varieties and their nutrient values, availability period and management technologies.
- BARI Ata-1 is available during March-May and BARI Kodbael-2 is harvested during February-April when there is scarcity of fruits in Bangladesh. Farmers are taking saplings of the new varieties and establishing new fruit orchards.
- Due to the use of fertilizer management technology individual fruit size (weight in 'g') and fruit yield (kg per plant) of BARI Amra-1 and BARI Amra-2 have been increased by 12.60% (62.2 g/fruit) and 21.26% (100.02 g/fruit) and 18.40% (30.24 kg per plant) and 10.40% (54.53 kg per plant), respectively. The prepared saplings using the standard developed propagation technique become suitable for planting in the field in one year.
- Employment opportunities for both male and female also created by the sub-project. One scientific officer, two scientific assistants, five labors and one accountant were appointed contractually for smooth running of the sub-project activities.

Component-II. Plant Pathology Division, BARI, Gazipur-1701

- The generated technologies will be immediately helping the farmers for the management of gummosis disease of bael and wood apple.

Component-III. Entomology Division, BARI, Gazipur-1701

- The generated both the technologies would contribute substantially reducing fruit borer of wood apple and hog plum beetle, *Podontia 14-punctata* attack in golden apple infestation. As a result pesticide free safe fruit can be produced with higher productivity of wood apple and golden apple in our country.

ii. Generation of new knowledge that help in developing more technology in future

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

- During the sub-project tenure about 80 germplasm of different lean season fruits have been collected and planted in the four project locations. New fruit varieties with improved nutrition and quality will be developed.
- The collected germplasm will be served as a source of breeding materials in the future. Thus new hybrid varieties can be developed.
- Through morphological and molecular characterization, the genetic makeup of the germplasm can be known that will open a new window for research in the future.
- Several management and propagation related researches are being conducted under the sub-project. New technologies will be evolved from those researches.

Component-II. Plant Pathology Division, BARI, Gazipur-1701

- The generated new information on the fruit rot/anthracnose disease management of lotkon will be helping to develop technology for the management of fruit rot/anthracnose disease of lotkon.

Component-III. Entomology Division, BARI, Gazipur-1701

- The generated both of the new technologies information on the fruit borer of wood apple and hog plum beetle, *Podontia 14-punctata* attack in golden apple infestation will be helping owing to develop the technology for the management of wood apple and hog plum beetle.

iii. Technology transferred that help increased agricultural productivity and farmers' income

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

- Fertilizer management technology in golden apple potentially increased the fruit yield by 10-15%. More income will be incurred from this extra yield.
- Farmers are motivated to establish new fruit orchard and use sub-project generated technologies for securing higher yield and thereby upgrading their livelihood.
- Modern production and management technologies on lean season fruit production have been disseminated by training and field visit. The growers and entrepreneurs

gathered information on fruit production. Saplings of fruit crops have been supplied to them. They will establish new fruit orchard.

- Year round and off-season availability of fruits will be increased.

Component-II. Plant Pathology Division, BARI, Gazipur-1701

- The generated technology on “integrated management of gummosis disease and management of bael” has been selected for demonstration at the farmers field that will help to ameliorate the productivity of bael.

Component-III. Entomology Division, BARI, Gazipur-1701

- The generated technology of Management of fruit borer, *Deudorix isocrates* attacking wood apple/ Kathbel has been selected for demonstration in the farmers field that will help to contribute reducing fruit infestation. As a result pesticide free safe fruit can be produced with higher productivity of wood apple in our country and farmers income as well as livelihood would be uplifted.

iv. Policy Support

- Under the sub-project, three lean season fruit varieties have been released. This will definitely lead to the increased fruit production as well as availability in the off-season. As a result food and nutritional security will be ensured which is one of the goals of SDGs as well as national plan.
- Two management practices in golden apple and one propagation method in avocado have been developed. Increased fruit production in golden apple will be possible. As a result, farmers will produce more fruits and earn money from their produce. Again, vegetative propagation method will help in multiplying quality saplings. This will contribute in increasing cultivation area of avocado, a highly nutritive and beneficial fruit. Thus the sub-project output will assist in poverty alleviation.
- The fruit growers and young generation will be encouraged in establishing off-season fruit orchard and their livelihood will be uplifted.

I. Information regarding Desk and Field Monitoring

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.):

Year	No of meeting	Name and address	Remarks/activities
2018	01	1. Dr. Madan Gopal Saha, CSO, Pomology Division, BARI, Gazipur 2. Dr. Manaranjan Dhar, CSO, Pomology Division, BARI,	- Formulating program and setting up research experiments - Addressing future plan of activities for the sub-

		Gazipur 3. Dr. Babul Chandra Sarker, PSO, Pomology Division, BARI, Gazipur	project - Preparing circular for recruiting staff - Arranging inception workshop
2019	02	1. Dr. Madan Gopal Saha, Director, Support & Service Wing, BARI, Gazipur 2. Dr. Manaranjan Dhar, CSO, Pomology Division, BARI, Gazipur 3. Dr. Babul Chandra Sarker, CSO, Pomology Division, BARI, Gazipur	- Research progress - Recruiting contractual staff - Formulating procurement plan
2020	04	1. Dr. Babul Chandra Sarker, CSO, Pomology Division, BARI, Gazipur 2. Dr. Md. Iqbal Faruk, PSO, Plant Pathology Division, BARI, Gazipur 3. Dr. Md. Kafil Uddin, SSO, Entomology Division, BARI, Gazipur 4. Joydeb Gomasta, SO, Pomology Division, BARI, Gazipur	- Research progress - Report writing - Formulating procurement plan - Purchasing procurements - Preparing and setting new research programs
2021	04	1. Dr. Babul Chandra Sarker, CSO, Pomology Division, BARI, Gazipur 2. Dr. Md. Iqbal Faruk, PSO, Plant Pathology Division, BARI, Gazipur 3. Dr. Md. Kafil Uddin, SSO, Entomology Division, BARI, Gazipur 4. Joydeb Gomasta, SO, Pomology Division, BARI, Gazipur	- Research progress - Report writing - Formulating procurement plan - Purchasing procurements - Preparing and setting new research programs

ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output):

A) Monitoring by sub-project personnel

Year	No. of visit	Name and address	Remarks/activities
2018	02 (RARS, Barishal & HARS, Raikhali, Rangamati)	1. Dr. Madan Gopal Saha, CSO, Pomology Division, BARI, Gazipur 2. Dr. Manaranjan Dhar, CSO, Pomology Division, BARI, Gazipur 3. Dr. Babul Chandra Sarker, PSO, Pomology Division, BARI, Gazipur	- Knowledge sharing about the sub-project - Formulating program and setting up research experiments - Addressing future plan of activities for the sub- project
2020	02 (RARS, Barishal & BSPC, Debiganj, Panchagarh)	1. Dr. Babul Chandra Sarker, CSO, Pomology Division, BARI, Gazipur 2. Joydeb Gomasta, SO, Pomology Division, BARI, Gazipur	- Visiting fields and research progress - Collecting germplasm - Sharing knowledge on production and management of lean season fruits
2021	03 (RARS, Barishal; HARS, Raikhali, Rangamati & BSPC, Debiganj, Panchagarh)	1. Dr. Babul Chandra Sarker, CSO, Pomology Division, BARI, Gazipur 2. Joydeb Gomasta, SO, Pomology Division, BARI, Gazipur	- Visiting fields and research progress - Collecting germplasm - Sharing knowledge on production and management of lean season fruits - Attending training

B) Monitoring by NATP personnel

Year	No. of visit	Name and address	Remarks
2019	01 (BSPC, Debiganj)	Members of NATP-2, PIU-BARC	- Appreciated
2020	01 (Pomology Division, BARI, Gazipur)	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Md. Ashequr Rahman, Assistant Manager (Accounts), PIU- BARC, NATP-2. 3. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2. 4. Md. Hasan Mahmud, Capacity Development Associate, PIU- BARC, NATP-2.	<ul style="list-style-type: none"> • Insect management trial should be started immediately • Validation trial on disease management need to be initiated as soon as possible • Economic analysis should be done in fertilizer, irrigation, insect and disease management trial

			<ul style="list-style-type: none"> • Leaflets on the generated technologies need to be published • Arranging training on production technologies of related lean season fruit crops
2021	01 (Pomology Division, BARI, Gazipur)	<ol style="list-style-type: none"> 1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2 2. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2 	<ul style="list-style-type: none"> • The sub-project completion report (PCR) need to be submitted within revised time schedule • Scientists must be included as per approved project proposal • Leaflets on the generated technologies need to be published

Component-II. Plant Pathology Division, BARI, Gazipur-1701

i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.)

Quarterly, half yearly and annual reports have been submitted. Meeting on progress of project activities were conducted in every month

ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output)

Year 2020

Sub-project Title & ID	:	Development of lean season fruit varieties and management packages (ID: 013) (Component-2, Plant Pathology Division, BARI, Gazipur)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	18 January 2021
Visiting Place	:	BARI, Gazipur
Team Member (s) & address	:	<ol style="list-style-type: none"> 1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Md. Ashequr Rahman, Assistant Manager (Accounts), PIU-BARC, NATP-2. 3. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2. 4. Md. Hasan Mahmud, Capacity Development Associate, PIU-BARC, NATP-2.

Year 2021

Sub-project Title & ID	:	Development of lean season fruit varieties and management packages (ID: 013) (Component-2, Plant Pathology Division, BARI, Gazipur)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	26 September 2021

Visiting Place	:	BARI, Gazipur
Team Member (s) & address	:	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2.

SI #	Recommendation	Progress of Implementation
1.	The sub-project completion report (PCR) need to be submitted within revised schedule time	It will be done within scheduled time

Component-III. Entomology Division, BARI, Gazipur-1701

i. Desk Monitoring:

Quarterly, half yearly and annual reports have been submitted. Meeting on progress of project activities were conducted in every month.

ii. Field Monitoring:

Year 2020

Sub-project Title & ID	:	Development of lean season fruit varieties and management packages (ID: 013) (Component-3, Entomology Division, BARI, Gazipur)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	18 January 2021
Visiting Place	:	BARI, Gazipur
Team Member (s) & address	:	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Md. Ashequr Rahman, Assistant Manager (Accounts), PIU- BARC, NATP-2. 3. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2 4. Md. Hasan Mahmud, Capacity Development Associate, PIU- BARC, NATP-2.

SI #	Recommendation	Progress of Implementation
1.	Bio-rational based insecticides need to be used	Bio-rational based insecticides are being used
2.	Management approaches of new insects and diseases should be developed	It will be done
3.	Economic analysis should be done	An economic analysis will be done
4.	Leaflets on the generated technologies need to be published	It will be done

Year 2021

Sub-project Title & ID	:	Development of lean season fruit varieties and management packages (ID: 013) (Component-3, Entomology Division, BARI, Gazipur)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	26 September 2021
Visiting Place	:	BARI, Gazipur

Team Member (s) & address	:	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2.
---------------------------	---	---

SI #	Recommendation	Progress of Implementation
1.	The sub-project completion report (PCR) need to be submitted within revised time schedule	It will be done in scheduled time

iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities:

Weather data of the sub-project duration (2018-2021) are not gathered yet. Data collection and processing are being performed. Data will be submitted in the next review.

J. Sub-project auditing (covers all types of audit performed)

Component-I. Pomology Division, HRC, BARI, Gazipur-1701

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD 2019	No objection	17,86,424.00	1 st year audit	
FAPAD 2020	No objection	26,79,419.00	2 nd year audit	
FAPAD 2021	No objection	26,79,419.00	3 rd year audit	
Company Audit 2020	No objection	1,05,55,440.00	2 nd year audit	
Company Audit 2020	No objection	1,05,55,440.00	3 rd year audit	

Component-II. Plant Pathology Division, BARI, Gazipur-1701

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD 2019	No objection	1,22,215.00	1 st year audit	
FAPAD 2020	No objection	5,15,609.00	2 nd year audit	
FAPAD 2021	No objection	4,29,870.00	3 rd year audit	

Component-III. Entomology Division, BARI, Gazipur-1701

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAPAD 2019	No objection	1,77,585.00	1 st year audit	
FAPAD 2020	No objection	5,69,842.50	2 nd year audit	
FAPAD 2021	No objection	4,06,662.50	3 rd year audit	

K. Lessons Learned

- i) Very few farmers had knowledge regarding the lean season fruit crops and they did not have to show their interest on growing the lean season which needs to be upgraded.
- ii) The villagers of the surveyed regions were not much aware of the health and nutritional benefits in the locally grown minor fruits in Bangladesh.
- iii) The farmers had no awareness of diseases and insect-pests management of the lean season fruit crops. Therefore, they must be trained on the topics.
- iv) The farmers never followed the modern production technology of fruit crops except some commercial fruits.
- v) Almost no minor/lean season fruit orchard have been developed in the country except few golden apple, Burmese grape, Dragon fruit orchards in the project areas.
- vi) Modern fruit varieties and appropriate modern management packages might improve fruit production and availability period.
- vii) Numerous underutilized off-season fruit crops have been observed but researches were undertaken with few of them. More and more lean season/minor fruits can be brought under research to improve their quality.
- viii) Different insect pests of lean season fruit crops especially fruit borer, beetle, trunk borer and mealy bug are the major problems in Bangladesh which should be properly addressed.

L. Challenges (if any)

- i) Promotion of fruit production in lean season through technological intervention
- ii) Collection of indigenous highly adapted local Landraces of lean season fruits with highly desired characteristics available in the remotest corner of the country including hilly and coastal areas and their storage and conservation for a considerable period of time is graet challenge
- iii) Heavy rain during the crop management season impedes fruit production.
- iv) Growers sometimes find it difficult to manage fruit crops rather than others. They do not know proper management technologies.
- v) Ensuring availability of good quality propagules true to type of promising lean season fruit varieties
- vi) Inadequate training facility for farmers, scientific staff and scientific personnel on lean season fruit production technologies

M. Suggestions for future planning (if any)

- i) Further researches must be explored on collection, conservation, characterization, evaluation and utilization of more and more minor fruit crops from every corner of the country.
- ii) Fruit growers and consumers need to be made aware and motivated on growing and consuming highly nutritious and healthy locally grown minor fruits.
- iii) Research on propagation techniques, cultural management, diseases and insects-pests management on lean season fruit crops should be strengthened.
- iv) Fruit exhibition should be arranged at remotest corner of the country on regular basis.
- v) Organizing more training programmes for farmers on production and management technologies of lean season fruit crops are suggested.
- vi) Vegetatively propagated saplings of lean season fruits need to be made available to the fruit growers in an extensive amount for establishing new orchard.
- vii) Along with training motivational tours and visit can be arranged for farmers to build awareness and encouraging the farmers.
- viii) In terms of research project handling, funding should be reasonable, in time and long term.
- ix) Marketing channel needs to develop for ensuring maximum price of farmers' product.
- x) As fruit is a permanent long term investment. Project for long time is suggested for getting the actual outcome.
- xi) National policies and regulations need to be developed and implemented in order to improve fruit sector by supplying of safe and nutritious lean season fruit.
- xii) Strengthening research on lean season fruit crops through adequate funding for the development of variety and pest management technologies in Bangladesh is strongly suggested.

N. References (in alphabetical order)

- Acevedo-Rodríguez, P. and M. T. Strong. 2012. Catalogue of the Seed Plants of the West Indies. Smithsonian Contributions to Botany, 98:1192 pp. Washington DC, USA: Smithsonian Institution.
- Anonymous. 2014. BARI Annual Report, BARI, Joydebpur, Gazipur.
- Asadi Z., M. Jafarpour, A. R. Golparvar and A. Mohammadkhani. 2013. Effect of GA₃ application on fruit yield, flowering and vegetative characteristics on early yield of strawberry cv. Gaviota. International Journal of Agriculture and Crop Sciences, 5-15/1716-1718.
- Azad A. K., M. Miruddin, M. A. Wohab, M. H. R. Sheikh and B. L. Nag. 2020. *Edited. KRISHI PROJUKTI HATBOI (Handbook on Agro-Technology)*, 9th edition, Bangladesh Agricultural Research Institute, Gazipur-1701, Bangladesh.
- Baliga, M. S., H. P. Bhat, M. M. Pereira, N. Mathias and P. Venkatesh. 2010. Radioprotective effects of *Aegle marmelos* (L.) Correa (Bael): a concise review. *J Altern Complement Med.*, 16(10): 1109-1116.

- Bangladesh Bureau of Statistics (BBS). 2020. Year Book of Agricultural Statistics 2020. Statistics and Information Division, Ministry of Planning. Government Republic of Bangladesh. pp203.
- Brar, J. S., H. S. Dhaliwal and M. S. Gill. 2015. Split application of inorganic fertilizers for rainy and winter season crops in guava cv. L-49. *Indian Journal of Horticulture*, 72(4), 466-471.
- Brave, S. G. 1984. All about Coconut Palm. Santishaha Publishers, Bombay, India. 100-110 pp.
- Castro, V.M., E. R. Iturrieta and O.C. Fassio , 2009. Rootstock effect on the tolerance of avocado plants cv. Hass to NaCl stress. *Chilean Journal of Agricultural Research*, 69(3):316-324.
- Crane, J. H. and J. Wasielewski. 2019. *Revised* (Original: April 1994). Spondias Growing in the Florida Home Landscape. Department of Horticultural Sciences, UF/IFAS Extension, University of Florida, USA.
- Dar, A. I., G. Masar, V. Jadhaw, S. K. Bansal and R. C. Saxena. 2013. Isolation and structural elucidation of the novel flavones glycoside from *Feronia limonia* L. *Journal of Pharmacy Research*, 7: 697–704.
- Diacono, M. and F. Montemurro. 2010. Long-term effects of organic amendments on soil fertility. A review. *Agronomy for Sustainable Development*, Springer Verlag/EDP Sciences/INRA, 30(2). Doi: 10.1051/agro/2009040ff. fahal-00886539
- Duenas, M.; J.J. Perez-Alonso, C. Santos-Buelga and T. Escribano-Bailon. 2008. Anthocyanin composition in fig (*Ficus carica* L.). *J. Food Compo. Anal.*, 21, 107–115.
- Everett, K. R., S. G. Owen and J. G. M. Cutting. 2005. Testing efficacy of fungicides against postharvest pathogens of avocado (*Persea americana* cv. Hass). *New Zealand Plant Protection* 58: 89-95.
- Faust, M. and B. Timon. 2010. Origin and dissemination of peach. *Hort. Rev.* N. Y. 17: 331-379.
- Feichtenberger, E. 1990. Control of *Phytophthora* gummosis of citrus with systemic fungicides in Brazil. *EPPO Bulletin*, 20(1):139-148.
- FRG'2018. Fertilizer Recommendation Guide (eds). Bangladesh Agricultural Research Council (BARC), Farmgate, Dhaka.
- Gomez, K. A. and A. A. Gomez. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, Inc., New York. pp. 67-215.
- Gupta, R., S. Johri and A. M. Saxena. 2009. Effect of ethanolic extract of *Feronia elephantum* Correa fruits on blood glucose levels in normal and streptozotocin- induced diabetic rats. *Natural Product Radiance*, 8: 32–6.
- Hssaini, L.; J. Charafi, H. Hanine, S. Ennahli, A. Mekaoui, A. Mamouni and R. Razouk. 2019. Comparative analysis and physiobiochemical screening of an ex-situ fig (*Ficus carica* L.) collection. *Hortic. Environ. Biotechnol.*, 60, 671–683.
- Ilango, K. and V. Chitra. 2010. Wound healing and anti-oxidant activities of the fruit pulp of *Limonia acidissima* Linn. (Rutaceae) in rats. *Tropical Journal of Pharmaceutical Research*, 2010; 9:223-30.
- Jain, M., R. Kapadia, R. N. Jadeja, M. C. Thounaojam, R. V. Devkar and S. H. Mishra. 2011. Cytotoxicity evaluation and hepatoprotective potential of bioassay guided fractions from *Feronia limonia* L. leaf. *Asian Pacific Journal of Tropical Biomedicine*, 1(6): 443–7.

- Jauhari, O. S., R. D. Singh and R. K. Awasthi. 1969. Survey of some important varieties of bael (*Aegle marmelos* Correa.). *Punjab Hort J.*, 9:48-53.
- John, L. and V. Stevenson. 1979. The complete book of fruit. Angus and Robertson Publishers Sydney.
- Joshi, R. K., V. M. Badakar, S. D. Kholkute and N. Khatib. 2011. Chemical composition and antimicrobial activity of the essential oil of the leaves of *Feronia elephantum* (Rutaceae) from northwest Karnataka. *Natural Product Communications*, 6(1):141-3.
- Kirtikar, K.R. and B. D. Basu. 1933. Indian Medicinal Plants. 2nd Edn., Lalit Mohan Basu, Allahabad, India, pp: 179-180
- Kumar, R., N. Sharma, M. Jamwal, R. M. Sharma, D. B. Singh, and A. M. Parmar. 2012. Production and economic studies of PBRs treated strawberry (*Fragaria x ananassa* Duch.) cv. Sweet Charlie. *American-Eurasian Journal of Agriculture and Environmental Science*, 12(12) p1.
- Leroux, P. and M. Gredt. 1974. Study of the systemic activity of Benomyl, Carbendazim, Thiophanate methyl and Thiophamine, used as seed dressings for various herbaceous plant species. *Phytiatrie Phytopharmacie* 23: 51-68.
- Mishra, A., S. Arora, R. Gupta, R. K. Manvi Punia and A. K. Sharma. 2009. Effect of *Feronia elephantum* (Correa) fruit pulp extract on indomethacin-induced gastric ulcer in albino rats. *Tropical Journal of Pharmaceutical Research*, 8: 509–14.
- Neeraj, V. Bisht and V. Johar. 2017. Bael (*Aegle marmelos*) Extraordinary Species of India: A Review. *Int. J. Curr. Microbiol. App. Sci.*, 6(3), 1870-1887.
- Nuruzzaman, M., M. S. Islam, S. Shilpi, H. Mehraj and A. F. M. Jamal Uddin. 2015. Plant growth regulators to improve the growth and berry of strawberry. *Int. J. Sustain. Crop Prod.* 10(1), 33-39.
- Oh, J. H. and N. W. Kang. 2002. Efficacy of Fluazinam and Iprodione+Propineb in the suppression of *Diaporthe phaseolorum*, *Colletotrichum truncatum* and *Cercospora kikuchii*, the causal agents of seed decay in soybean. *Plant Pathol J* 18 (4): 216-220.
- Palei, S., A. K. Das, A. K. Sahoo, A. K. Dash and S. Swain. 2016. Influence of plant growth regulators on strawberry *Fragaria x ananassa* Cv. Chandler) under Odisha conditions. *International journal of Recent Scientific Research*, 7(4); 9945-9948.
- Pasha M. K. and S. B. Uddin 2019. Minor edible fruits of Bangladesh. *Bangladesh J. Plant Taxon.* 26(2): 299–313.
- Sadhu, M. K. and S. K. Ghosh. 1976. *Indian Agric.*, 20: 297-301
- Sahar, A. F. and A. A. Abdel-Hameed. 2014. Effect of pruning on yield and fruit quality of guava trees,” *IOSR Journal of Agriculture and Veterinary Science*, 7(12):41–44.
- Saima, Y., A. K. Das, K. K. Sarkar, A. K. Sen and P. Sur. 2000. A antitumor pectic polysaccharide from *Feronia limonia*. *International Journal of Biology and Macromolecule*, 27: 333-335.
- Saima, Z., A. Sharma, I. Umar and V. K. Wali. 2014. Effect of plant bio- regulator on vegetative growth, yield and quality of strawberry cv. Chandler. *Academic journals*, 9(22): 1694-1699.
- Sarker, B. C. and M. A. Rahim. 2010a. Effect of split application of fertilizer on harvesting time, yield and quality of mango. *J. Bangladesh Soc. Agric. Sci. Technol.* 7 (3&4): 109-114.

- Sarker, B. C. and M. A. Rahim. 2010b. Effect of irrigation frequency on harvesting time, yield and quality of mango. *J. Bangladesh Soc. Agric. Sci. Technol.* 7 (3&4): 11-16.
- Senthilkumar, A., and V. Venkatesalu. 2013. Chemical constituents, *in-vitro* antioxidant and antimicrobial activities of essential oil from the fruit pulp of wood apple. *Industrial Crops and Products*, 46: 66–72.
- Sharma, B., S. K. Satapathi and P. Roy. 2007. Hypoglycemic and hypolipidemic effect of *Aegle marmelos* (L.) leaf extract on streptozotocin induced diabetic mice. *Int. J. Pharmacol.*, 3: 444-452.
- Sharma, P., S. L. Bodhankar and P. A. Thakurdesai. 2012. Protective effect of aqueous extract of *Feronia elephantum* Correa leaves on thioacetamide induced liver necrosis in diabetic rats. *Asian Pacific Journal of Tropical Biomedicine*, 2(9):691-695.
- Silva, Y. C., M.E.R.M.C. Mata, M.E.M. Duarte, A.S.R.R.M. Cavalcanti, C.C.A. Oliveira and M.A. Guedes. 2007. Sensory analysis pulp and hog plum juice obtained by rehydration of cajá powder. *J. Agro-Industrial Prod. Camp. Gd.* 9(1):1-6.
- Singh, S., S. K. Singh, S. Srivastava, P. Singh, M. Trivedi, , P. Shanker, R. K. Dixit and R. S. Rana. 2003. Experimental evaluation of diuretic activity of *Prunas persica* in rats. *International Journal of Pharma and Bio Sciences*, 3, 98–102.
- Slatnar, A., U. Klancar, F. Stampar and R. Veberic. 2011. Effect of drying of figs (*Ficus carica* L.) on the contents of sugars, organic acids and phenolic compounds. *J. Agric. Food Chem.*, 59, 11696–11702.
- Subhadrabandhu, S and P. Tongumpai, 1990. Offseason production of some economic fruit in Thailand. Dept. Hort., Faculty of Agriculture, Kasetsart University, Thailand. p. 84
- Vishal, V. C., D. Thippesha, K. Chethana, B. M. Maheshgowda, B. G. Veeresha and A. K. Basavraj. 2016. Effect of Various Growth Regulators on Vegetative parameters of strawberry (*Fragaria x ananassa* Duch.) Cv. Sujatha Research Journal Chemical and Environmental Sciences, 4 (4): 68-71.
- Westwood, M. N., 1988. Temperate Zone Pomology. Freeman, San Francisco, pp. 428.
- Whiley, A.W., B. Schaffer, B. and B.N. Wolstenholme, 2002. *The Avocado: Botany, Production and Uses*. CABI publishing UK.
- Wolfe, K. L., X. Kang, X. He, M. Dong, Q. Zhang and R. H. Liu. 2008. Cellular antioxidant activity of common fruits. *J. Agric. Food Chem.*, 56: 8418-8426.
- Yu, L. D. 2000. Fertilization techniques on citrus. *Beijing Fruits Sci* 23 (4): 16-18.

Signature of the Coordinator
Date

Seal

Counter signature of the Head of the
organization/authorized representative
Date

Seal

Appendices

Appendix 1. The questionnaire of the survey on lean season fruit production in Bangladesh

PIU-BARC, NATP-2
Bangladesh Agricultural Research Council (BARC), Dhaka

Development of lean season fruit varieties and management packages

অমৌসুমী ফলের জাত ও উৎপাদন প্রযুক্তি উদ্ভাবন

অপ্রচলিত ও অমৌসুমী ফল চাষ সম্পর্কিত জরীপ

সাক্ষাৎকার গ্রহণের তারিখ :

কৃষকের নাম : পিতার নাম :

গ্রাম : ইউনিয়ন : উপজেলা : জেলা :

১। কৃষকের তথ্যঃ

পুরুষ /মহিলা

বয়সঃ বৎসর

শিক্ষাগত যোগ্যতাঃ ৫ম শ্রেণী পর্যন্ত/৮ম শ্রেণী পর্যন্ত/এসএসসি পাশ/এইচএসসি পাশ/স্নাতক/মাস্টার্স/লেখাপড়া করেন
নাই।.....

২। খামারের অভিজ্ঞতাঃ

(ক) কৃষি কাজে বৎসর

(খ) প্রধান ফল চাষে.....বৎসর

(গ) অপ্রচলিত ফল চাষে বৎসর

(ঘ) অমৌসুমী ফল চাষে বৎসর

৩। মোট আবাদী জমি হেক্টর

(ক) ফল চাষে মোট জমির পরিমাণ হেক্টর

(খ) প্রধান ফল চাষে মোট জমির পরিমাণ হেক্টর

(গ) অপ্রচলিত ও অমৌসুমী ফল চাষে জমির পরিমাণ..... হেক্টর

(ঘ) মোট অপ্রচলিত ও অমৌসুমী ফল গাছের সংখ্যা টি

৪। যে সকল অপ্রচলিত ও অমৌসুমী ফল চাষ করেন (জাতের নাম ও সংখ্যাসহ)

.....
.....

৫। সারাবছর ফলের প্রাপ্যতা বৃদ্ধির জন্য অমৌসুমী ফল কিভাবে ভূমিকা রাখবে? কিছু গুরুত্বপূর্ণ ও সুস্বাদু ফলের নাম বলুন।

.....
.....

৬। অপ্রচলিত ও অমৌসুমী ফল ফসল উত্তোলনের/ফল সংগ্রহের সময়কাল

ফল ফসলের নাম	ফল উত্তোলন শুরু (মাস)	ফল উত্তোলন শেষ (মাস)

- ৭। (ক) অমৌসুমী ফলের উন্নত জাতের অভাব আছে বলে আপনি মনে করেন কিনা?
 (খ) উন্নত জাত চাষ করলে ফলন বৃদ্ধি পাবে বলে মনে করেন কিনা?

- ৮। অপ্রচলিত ও অমৌসুমী ফলের নতুন বাগান তৈরীর জন্য বংশবিস্তার কিভাবে করেন?
 (ক) বীজ রোপণ/ (খ) বীজের চারা রোপণ/ (গ) কলম তৈরী করে রোপণ/ (ঘ) বাজার থেকে চারা ক্রয় করে রোপণ/
 (ঙ) নার্সারী থেকে চারা ক্রয় করে রোপণ/ (চ) গবেষণা প্রতিষ্ঠান থেকে প্রাপ্ত/ (জ) অন্যান্য.....
- ৯। আপনি যেসকল চারা রোপণ করেন তার গুণগতমান সম্পর্কে আপনি কতটা নিশ্চিত?
 (ক) সাধারণ মানের/ (খ) ভালো মানের/ (গ) উত্তম মানের/ (ঘ) গুণগতমানসম্পন্ন/ (ঙ) অন্যান্য.....
- ১০। অপ্রচলিত ও অমৌসুমী চাষে যে সকল সমস্যা মনে করেনঃ
 (ক) পোকা মাকড়ের আক্রমণ (হপার পোকা/ফলের মাছি পোকা/মিলি বাগ/পাতা কাটা উইভিল/নাট উইভিল/ফল ছিদ্রকারী উইভিল পোকা/ফল ছিদ্রকারী পোকা/পাতার গল/বা অন্যান্য)
 (খ) রোগ-বালাই এর প্রাদুর্ভাব (এ্যানথ্রাকনোজ বা ফোঙ্কা রোগ/পাউডারী মিলডিউ/ফলের আগা পচা/ডাই ব্যাক বা আগা মরা/ক্যান্কার/সুটি মোল্ড/ক্ষ্যাব বা দাদ রোগ বা অন্যান্য)
 (গ) ফুল ও ফল ঝরে পড়া/ (ঘ) পানি সেচের অভাব/ (ঙ) সার প্রয়োগ/(চ) অন্যান্য
- ১১। গাছ প্রতি কি পরিমাণ এবং কোন ধরনের সার বিগত মৌসুমে আপনি আপনার বাগানে প্রয়োগ করেছিলেন? উল্লেখ করুন।
 (ক)
 (খ)
 (গ)
- ১২। বিগত মৌসুমে আপনি কতবার এবং কোন পদ্ধতিতে আপনার অপ্রচলিত ও অমৌসুমী ফলের বাগানে/গাছে পানি সেচ দিয়েছিলেন? উল্লেখ করুন।

- ১৩। বেশী ফলন পাবার জন্য কোন ধরনের ব্যবস্থাপনা সবচেয়ে বেশী কার্যকরী বলে আপনি মনে করেন? উল্লেখ করুন।

- ১৪। ফলের বেশী ফলন পাবার জন্য আপনি কার বা কোন প্রতিষ্ঠানের পরামর্শ নিয়ে থাকেন?
 প্রতিবেশীর/সম্প্রসারণ কর্মী/বিজ্ঞানী/এনজিও কর্মীর/পেস্টিসাইড ডিলার/রেডিও/টেলিভিশন /অন্যান্য
- ১৫। আপনি কি কোন কৃষক সংগঠনের সদস্য? হ্যাঁ/না
 হ্যাঁ হলে, সংগঠনের নাম উল্লেখ করুন
- ১৬। আপনি কি ফল চাষে উন্নত উৎপাদন প্রযুক্তির উপর প্রশিক্ষণ পেয়েছেন? হ্যাঁ হলে, প্রশিক্ষণের বিষয়

 এবং আয়োজনকারী প্রতিষ্ঠানের নাম.....।

সাক্ষাৎকার গ্রহণকারীর স্বাক্ষরঃ

সাক্ষাৎকার গ্রহণকারীর নাম ও পদবীঃ

Appendix 2a. List of Laboratory and Field Equipments Purchased

A) List of capital items already have been purchased as per approved project proposal

i) Furniture

SI #	Facilities description	Unit	Qty
	Furniture	-	-
1.	Lab facilities (Rack building, electricity work etc)		

ii) Equipment, Tools, etc.

a) Laboratory Equipments

SI #	Facilities description	Unit	Qty
1.	Autoclave, 65L	-	1
2.	Gel Electrophoresis a) Horizontal and b) vertical with accessories	-	1 1
3.	Deep fridge (-20 degree Celsius), 253 L	-	1
4.	Distilled water plant, 4 L/Hr	-	1
5.	Drying oven, 60 L	-	1
6.	Electric Balance, 220 g, 0.1 mg	-	1
7.	Fume hoods	-	1
8.	Gel documentation system	-	1
9.	Spectrophotometer, Nano	-	1
10.	Hi speed refrigerated Centrifuge, 5000 rpm, 15/10 mL	-	1
11.	Hot plate magnetic stirrers	-	1
12.	Liquid Nitrogen containers, 35L	-	1
13.	Micro centrifuge, 15000 rpm, 1.5/2.0 ml	-	1
14.	PCR Machine	-	1
15.	pH meter	-	1
16.	Refrigerator	-	1
17.	Shaker	-	1
18.	Vortex mixture	-	1
19.	Water Bath	-	1
20.	Water De-ioniser Plant	-	1

b) Field equipments

SI #	Facilities description	Unit	Qty
1.	Bush cutter	Nos	2

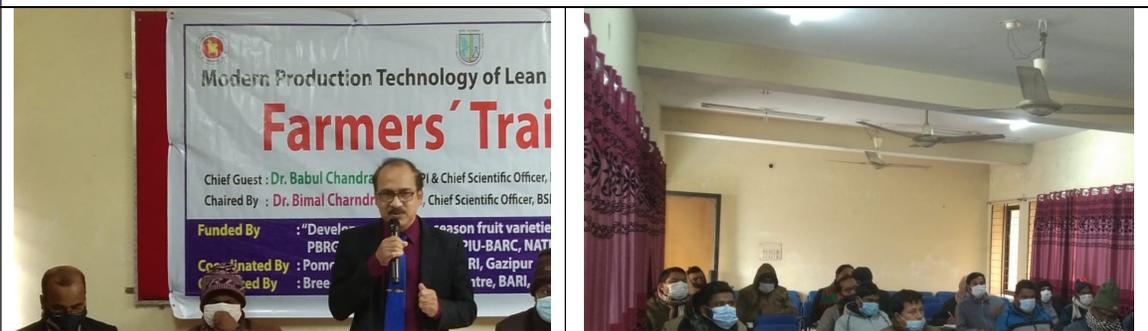
Appendix 2b. Photographs of Laboratory Equipments and Glasswares Purchased under PBRG-013 sub-project



Appendix-3. Photographs of different trainings and workshops arranged under the PBRG-013 sub-project



Training at RARS, Rahmatpur, Barishal



Training at BSPC, Debiganj, Panchagarh



Training at Pomology Division, HRC, BARI, Gazipur



Training at HARS, Raikhali, Rangamati

BACK PAGE



Integrated Fertilizer Management in BARI Amra-1



Integrated Fertilizer Management in BARI Amra-2



Successful cleft grafting in Avocado



Promising Bullock's heart germplasm



BARI Jamun-1



BARI Ata-1



Gummosis management of bael and golden apple