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JAINTAPUR, SYLHET-3156

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Preface

The annual Research Report 2020-21 published with great pleasure on research and development activities of Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet. Citrus Research Station, Jaintapur Sylhet conducts different types of research activities on horticultural and spices crops. The aim of the research activities is to increase crop production to meet up local demand, provide nutrition and to ensure food security in the region along with other part of Bangladesh through the development of improved varieties and technologies.

Natural resources like Agricultural land, soil fertility, underground water are decreasing day by day. On the other hand, soil erosion, land degradation, urbanization are increasing rapidly and creates a challenge for researchers to meet the demand of ever increasing population to ensure food and nutritional security. Natural hazards including, drought, heavy rainfall, maximum day night length difference, disease and insect infestation, and extreme climatic condition decrease crop production.

Scientists of CRS conducts its research activities with the aim of solving problems associated with the crops of the region through development of high yielding varieties and technologies, increasing cropping intensity and productivity through proper utilization of soil, water and climatic condition. Till now CRS, Jaintapur has developed 7 varieties viz., BARI Komala-1, BARI Komala-3, BARI Malta-1, BARI Satkara-1, BARI Batabilebu-5, BARI Toikor-1 and BARI Golmorich-1. Scientists also work to disseminate BARI released varieties and technologies through adaptive trials and demonstrations in the farmer's field. CRS, Jaintapur also organize training, seminar and workshop to inform the latest varieties and technologies which are helpful for the farmers and ultimately increase socio-economic condition of the country.

The present report contains research achievements of CRS, Jaintapur during 2020-2021. This report can be helpful for researchers, extension personnel, NGOs, farmers and others who are involved in agricultural development.

I am grateful to the BARI authority for overall support in implementing the research programme. I express my sincere appreciation and thanks to all scientists of CRS, Jaintapur for their hard work in conducting research and reporting. I also thank the field and office staff for their sincere efforts in successfully completing the research and publishing the report.

Dr. Shah Md. Luthfur Rahman
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At a glance

Citrus Research Station, Jaintapur, Sylhet

Establishment

Jaintapur is a historically rich Upazila of Sylhet District. Anciently it is popular for citrus and spices crops. Due to its favorable climatic condition, a fruit orchard was established in 1960 to conduct research on different fruit crops especially citrus fruits to develop suitable varieties as well as to generate sustainable and profitable fruit production technologies. After the Liberation War, the fruit orchard was named as Citrus Research Station under the supervision of Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and expands its research activities with different fruits and spices crops. The land area of the research station is 118.64 acres of which 50 acres acquired in 1961 for establishment of Orange Orchard Scheme and the rest of 68.64 acres acquired in 1965 for strengthening the research activities.

Location and extent

The station is located at Jaintapur Upazila head quarter about 44 km from Sylhet District town at north-east direction. The area is under tropical region at $25^{0}8$ North latitude and $92^{0}8$ East longitude at about 22m elevation from the sea level under AEZ 22 and 29. The land type is hilly and there are many tillas (hillocks) within and around the farm. The khasia-Jaintia Hill of India is standing as a wall about two kilometer away from this station surrounding the north and east. The soil is stony containing abundant stones, boulders and small and big rocks underneath the soil surface.

Land area

Total area : 118.64 acres
Researchable area : 70 acres

Climate

Rainfall (yearly) : 6000 mm
Temperature (°c)
Maximum : 31.21
Minimum : 10.96
Average : 23.63

Scientific personnel

Designation		Existing manpower
Principal Scientific Officer	:	1
Scientific Officer	:	3

Scientific associates

Designation		Existing manpower
Scientific Assistants	:	4

Contents

HYBRIDIZATION IN CITRUS

S.M.L. RAHMAN, F. AHMED, M.S. ZAMAN AND M.H.M.B. BHUYAN

Abstract

A hybridization program was conducted in the flowering season of 2020-21 at Citrus Research Station (CRS), Jaintapur, Sylhet and Regional Agricultural Research Station (RARS), Akbarpur, Mouluvibazar. A total of 450 flowers were emasculated and pollinated. Seven hybrid fruits were obtained from different crosses. Two hybrid fruits from the cross of BARI Komala-1 x BARI Malta 1, 5 hybrid fruits from the cross of BARI Satkara-1 x BARI Batabilebu-3. These citrus fruits will be harvested at mature stage and seeds of the fruits were sowed in the soil for germination. After germination, seedlings of hybrid fruits will be transplanted in the main field and will be evaluated.

Introduction

Citrus fruits play an important role in the fruit world for its availability period and high market price. In Bangladesh, we have a good number of citrus species, which can certainly contribute to the nutritional improvement. It had been reported that from 1970 citrus fruits production increased from 23,513 MT to 165327 MT in 2019 at the average growing rate of 5.06%. We have already released 20 citrus varieties, of which some are now growing commercially and spread as a mega variety around the country. Although most of the varieties developed from chance seedlings, but they are less sweet, having slow growing tendencies and susceptible to major diseases or pests and possesses green fruit skin color. Recently there has been an increasing demand for quality citrus in local and international markets. To meet such demand it is urgently needed to produce quality fruits with high yielder, very sweet, quick growing habit and resistance to insect pest and diseases through hybridization. Keeping these points in mind an inter-specific hybridization program has been undertaken.

Materials and Methods

The experiment was conducted at Citrus Research Station (CRS), Jaintapur,Sylhet and Regional Agricultural Research Station (RARS), Akbarpur, Moulvibazar during February to March 2021 to develop new citrus hybrids having desirable characters like good quality fruits highly sweet in taste , quick growing tendency and having resistance to pest and diseases. The existing citrus germplasm of CRS, Jaintapur and RARS Akbarpur were used as parents. Cultural management and other practices were done as per schedule.

The cross combinations with specific objectives were as follows:

Cross Combinations (F ♀ * M♂)	Main objetives
BARI Komala-1 x BARI Malta-1	Transfer of sweetness
BARI Satkara-1 x BARI Batabilebu-3	Transfer of quick growing habit
BARI Satkara-1 x Ashkar Lebu	Transfer of quick growing habit with pest and disease resistance.

A brief description of five parents:

BARI Komala-1: It is a variety developed from chance seedling by selection method in 1996 with regular bearing habit. Harvesting period Nov-Dec with TSS (%) 10.2 having 300 to 400 fruits per tree at an average fruit weight 190-200g.

BARI Malta-1: It is a variety developed in 2004 by selecting exotic germplasm with regular bearing habit. Harvesting period Nov-Dec with TSS (%) 7.8 having 400 to 500 fruits per tree at an average fruit weight 160-200g.

BARI Satkara-1: It is a variety developed from chance seedling by selection method in 2004 with regular bearing habit. Harvesting period Sept-Nov with having 50 to 60 fruits per tree at an average fruit weight 300-325g.

BARI Batabilebu-3: It is a variety developed from chance seedling by selection method in with regular bearing habit. Harvesting period Sept-Oct with having fruits per tree at an average fruit wt. 300-325g. It has pinkish juice sac with TSS (%) 10, very juicy, less bitterness.

Ashkar Lebu: It is an extraordinary citrus fruit resistant to all types of disease and pests known as citron with non edible characteristics having profuse regular bearing habit more or less similar to satkara.

Techniques of Crossing

Crossing was carried out between two parents with prospective hermaphrodite flowers. Flowering start opening from 10 A.M in the morning and complete the anthesis generally in the 12 P.M. After emasculation female flowers were bagged with perforated polyethene bags to avoid unwanted pollen contamination. This perforated polyethylene bags were found superior for this purpose (Mukherjee et al. 1961; Singh and Thimmappain, 1982). All open flowers were removed from the respective branch after bagging.

Results and Discussion

A total of 450 flowers were emasculated and pollinated for the hybridization program. Combinations of parents along with relevant data were presented in the table-1.Total number of fruits retention at 20,40,60,80,100 and 110 days after pollination were 80, 50, 35, 15, 10 and 7 respectively.

Table 1. Number of flowers emasculated and pollinated in each cross combination

Cross Combination (F♂ ×M ♀)	Number of flowers emasculated	Number of flowers pollinated
BARI Komala-1 × BARI Malta-1	180	180
BARI Satkara-1 × BARI Batabilebu-3	150	150
BARI Satkara-1 × Ashkar Lebu	120	120
Total	450	450

Table 2. Number of fruit retention after 20,40,60,80,100 and 110 days intervals from each cross combination

Cross Combination (F♂ ×M ♀)	Fruits retention after 20 days intervals						No. of fruits obtained
	20 Days	40 Days	60 Days	80 Days	100 Days	110 Days	
BARI Komala-1× BARI Malta-1	25	20	13	6	4	2	2
BARI Satkara-1×BARI Batabilebu-3	40	25	20	9	6	5	5
BARI Satkara-1 × Ashkar Lebu	15	05	02	0	0	0	0
Total	80	50	35	15	10	7	7

Conclusion

Developed hybrid fruits will be harvested at proper mature stage and kept in the laboratory. After collecting seeds it will be sowed in the soil for germination in the hybrid seedling plot. After germination one year old hybrid seedlings will be transplanted in the main field and will be evaluated in the following season.

References

Mukherjee, S. K., P. K. Mojumdar and S. S. Chatterjee. 1961. An improved technique of mango hybridization, Indian J. Hort., 18:302.

Singh, H and Thimmappain. 1982. Effect of bagging materials on success of mango hybridization, Indian J. Hort., 39(1&2),pp 64-66.

PHYSIOMORPHOLOGICAL CHARACTERIZATION OF MANDARIN AND SWEET ORANGE IN THE HILLY AREA OF SYLHET REGION

M.H.M.B. BHUYAN, F. AHMED, J.C. SARKER AND S.M.L. RAHMAN

Abstract

An effort has been made for in situ characterization of BARI Komala-1 and BARI Malta-1. Wide variability was observed in different characters among the varieties/germplasm studied. Among the varieties/germplasm, BARI Malta-1 produced flowers in early February and fruit setting completed in early March but BARI Komala-1 produced flower 2 weeks later. There were differences among the harvesting time also. BARI Malta-1 can be harvested from late August but BARI komala-1 should not be harvested before mid-November.

Introduction

Citrus fruits play an important role in the fruit world for their availability period and high market value. In Bangladesh, we have a good number of citrus species, which can certainly contribute to the nutritional improvement of the people. Mandarin and sweet orange are very important among the citrus fruits of Bangladesh. Every year Bangladesh imports a good amount of mandarin and sweet orange from other countries. Bangladesh Agricultural Research Institute has already released three mandarin and two sweet orange varieties for farmer's cultivation. But to reduce the import of these fruits we have to increase the production as well as the number of good varieties. Morphophysiological characterization is one of the primary tools for developing hybrids from existing inbreed lines and/or varieties. Therefore, from the study the detailed characteristics of these varieties will be collected, which will further be used for breeding purpose to get desirable characters of interest. In these circumstances, characterization is a prime need for the mandarin and sweet orange germplasm. Hence the study has been undertaken.

Materials methods

In-situ morphological characterization of mandarin and sweet orange varieties/germplasm were conducted at the Citrus Research Station, BARI, Jaintapur, Sylhet during 2019-20. Mandarin variety BARI Komala-1 and sweet orange variety BARI Malta-1 was included in this study and was characterized. Characterization has been done following the descriptor published by IPGRI.

Descriptors State:

A. Plant descriptors:

1.	Rootstock	0 None 1 Sour orange 2 Trifoliate orange 3 Trifoliate hybrids 4 Rough lemon 5 Rangpur lime 6 Cleopatra mandarin 7 Citrus volkameriana 8 Sweet orange 9 Sweet lime
2.	Ratio trunk/rootstock diameter (Recorded at 20 cm above and under grafting line)	1 Smaller (<1) 2 Same (1) 3 Larger (>1)
3.	Scion trunk surface	1 Smooth 2 Grooved and ridged
4.	Tree shape	1 Ellipsoid 2 Spheroid 3 Obloid
5.	Tree growth habit	1 Erect 2 Spreading 3 Drooping
6.	Density of branches	3 Sparse 5 Medium 7 Dense
7.	Branch angle	3 Narrow 5 Medium 7 Wide
8.	Spine density on adult tree	0 Absent 3 Low 5 Medium 7 High
9.	Spine length on adult tree (Average of 10 spines at leaf axil)	1 ≤ 5 mm 2 6 - 15 mm 3 16 - 40 mm 4 >40 mm
10.	Spine shape	1 Curved 2 Straight
11.	Shoot tip colour	1 Green 2 Purple
12.	Shoot tip surface	1 Glabrous 2 Intermediate 3 Pubescent

B. Leaf Descriptors

1.	Vegetative life cycle	1 Evergreen 2 Deciduous 3 Semi-persistent
2.	Leaf division	1 Simple 2 Bifoliate 3 Trifoliate 4 Pentafoliate

3.	Intensity of green colour of leaf blade	1 Light 2 Medium (green) 3 Dark
4.	Leaf lamina attachment	1 Sessile (petiole absent) 2 Brevipetiolate (petiole shorter than leaf lamina) 3 Longipetiolate (petiole longer than or same length as leaf lamina)
5.	Length of petiole relative to length of leaf lamina	
6.	Leaf lamina length [mm]	Recorded from petiole base to lamina tip. Average of 10 fully developed leaves taken from three different adult trees
7.	Leaf lamina width [mm]	Recorded at the widest point. Average of 10 fully developed leaves taken from three different adult trees.
8.	Ratio	
9.	Leaf lamina length [mm]	Recorded from petiole base to lamina tip. Average of 10 fully developed leaves taken from three different adult trees.
10.	Leaf lamina width [mm]	Recorded at the widest point. Average of 10 fully developed leaves taken from three different adult trees.
11.	Ratio leaf lamina length/width	Calculated as a mean of 10 fully developed leaves taken from three different adult trees.
12.	Leaf thickness [mm]	Recorded at the thickest point. Average of 10 fully developed leaves taken from three different adult trees.
13.	Leaf lamina shape	1 Elliptic 2 Ovate 3 Obovate 4 Lanceolate 5 Orbicular 6 Obcordate
14.	Leaf lamina margin	1 Crenate 2 Dentate 3 Entire 4 Sinuate
15.	Leaf apex	1 Attenuate 2 Acuminate 3 Acute 4 Obtuse 5 Rounded 6 Emarginate
16.	Absence/presence of petiole wings	0 Absent 1 Present
17.	Petiole wing width	3 Narrow 5 Medium 7 Broad
18.	Petiole wing shape	1 Obcordate 2 Obdeltate 3 Obovate 4 Linear
19.	Junction between petiole and lamina	1 Fused 2 Articulate

C. Flower Descriptors

1.	Pedicel length [mm]	
2.	Calyx diameter	3 Small 5 Medium 7 Large
3.	Length of anthers relative to stigma	3 Shorter 5 Medium 7 Longer
4.	Flower type	1 Hermaphrodite 2 Male 3 Female
5.	Color of open flower	1 White 2 Light yellow 3 Yellow 4 Purple
6.	Color of anthers	1 White 2 Pale yellow 3 Yellow
7.	Number of petals per flower	
8.	Petal length [mm]	
9.	Petal width [mm]	
10.	Number of stamens	1 < 4 per petal 2 4 per petal 3 > 4 per petal
11.	Viable pollen	0 Pollen sterile 3 Sparse pollen (Imperial mandarin) 5 Normal pollen (Valencia orange) 7 Abundant pollen (Pummelo or W.I. Lime)
12.	Flowering month	1 January 2 February 3 March 4 April 5 May 6 June 7 July 8 August 9 September 10 October 11 November 12 December

D. Fruit Descriptors

1.	Fruiting season	1 Early 2 Midseason 3 Late
2.	Fruit weight	An average of 10 fruits was recorded

3.	Fruit diameter [mm]	
4.	Fruit length [mm]	
5.	Fruit shape	1 Spheroid 2 Ellipsoid 3 Pyriform 4 Oblique (asymmetric) 5 Obloid 6 Ovoid
6.	Shape of fruit base	1 Necked 2 Convex 3 Truncate 4 Concave 5 Concave collared 6 Collared with neck
7.	Shape of fruit apex	1 Mammiform 2 Acute 3 Rounded 4 Truncate 5 Depressed
8.	Fruit skin (epicarp) colour	1 Green 2 Green-yellow 3 Light yellow 4 Yellow 5 Dark yellow 6 Light orange 7 Orange 8 Dark orange 9 Pink-yellow 10 Pink-orange 11 Red 12 Red-orange
9.	Width of epicarp at equatorial area [mm]	
10.	Fruit surface texture	1 Smooth 2 Rough 3 Papillate 4 Pitted 5 Bumpy 6 Grooved
11.	Adherence of albedo (mesocarp) to pulp (endocarp)	3 Weak 5 Medium 7 Strong
12.	Nature of oil glands	1 Inconspicuous or very weakly conspicuous 2 Conspicuous 3 Strongly conspicuous
13.	Density of oil gland on fruit surface	3 Low (<40/cm2) 5 Intermediate (45–65/cm2) 7 High (>70/cm2)
14.	Oil gland size on fruit surface	3 Small (<0.8 mm) 7 Large (≥1.2 mm)
15.	Fruit rind (mesocarp) thickness [mm]	Measured in the equatorial area
16.	Albedo colour	1 Greenish 2 White 3 Yellow 4 Pink 5 Orange 6 Reddish
17.	Absence/presence of areola	0 Absent 1 Present
18.	Areola diameter [mm]	
19.	Fruit stylar end	1 Closed 2 Open 3 Persistent style
20.	Fruit attachment to stalk	3 Weak 5 Medium 7 Strong
21.	Segments	Average of well-developed segments observed on 30 fruits taken from three adult trees
22.	Number of segments per fruit	1 < 5, 2 5–9, 3 10–14, 4 15–18, 5 >18
23.	Adherence of segment walls to each other	3 Weak 5 Medium 7 Strong
24.	Segment shape uniformity	0 No 1 Yes
25.	Thickness of segment walls	3 Thin 5 Medium 7 Thick
26.	Fruit axis	1 Solid 2 Semi-hollow 3 Hollow
27.	Cross-section shape of axis	1 Round 2 Irregular
28.	Diameter of fruit axis [mm]	

E. Pulp Descriptors

1.	Pulp (flesh) colour	1 White 2 Green 3 Yellow 4 Orange 5 Pink 6 Light red 7 Orange–red 8 Red 9 Purple
2.	Pulp colour intensity	3 Light 7 Dark
3.	Pulp colour uniformity	0 No (streaked) 1 Yes
4.	Pulp firmness	3 Soft 5 Intermediate 7 Firm
5.	Pulp texture	1 Crispy 2 Fibrous 3 Fleshy
6.	Vesicle length	3 Short 5 Medium 7 Long
7.	Vesicle thickness	3 Thin 5 Medium 7 Thick
8.	Juice content in endocarp (Quantity related to total fruit weight)	3 Low 5 Medium 7 High

F. Seed Descriptors

1.	Average number of seeds per fruit (Observed only fully developed seeds)	0 None 1 1 – 4 2 5 – 9 3 10 – 19 4 20 – 50 5 > 50
2.	Seed shape	1 Fusiform 2 Clavate 3 Cuneiform 4 Ovoid 5 Semi-deltoid 6 Spheroid 7 Semi-spheroid
3.	Seed surface	1 Smooth 2 Wrinkled 3 Hairy
4.	Seed colour	1 White 2 Cream 3 Yellowish 4 Green 5 Brown
5.	Seed length (mm)	
6.	Seed width (mm)	
7.	Cotyledon colour	1 White 2 Light yellow–cream 3 Light green 4 White and green 5 Green (medium) 6 Dark green 7 Purple 8 Pinkish
8.	100 seed weight (g)	

Results and discussion

A wide variation was observed in different parameters studied. However the results have been presented in the following tables.

Table 1. Passport Descriptor

Name of Crop (English)	:	Mandarin	Sweet orange
Name of Crop (Bengali)	:	কমলা	মাল্টা
Scientific Name	:	*Citrus reticulata*	*Citrus sinensis*
Local Name	:	কমলা	মাল্টা
Collecting Institute	:	Bangladesh Agricultural Research Institute	Bangladesh Agricultural Research Institute
Country of Origin	:	Bangladesh	Bangladesh
Variety/Cultivar	:	BARI Komala-1	BARI Malta-1
Commercial value	:	High	High
Cultivation practices	:	Homestead and commercial orchard	Homestead and commercial orchard
Area coverage	:	N/A	N/A

Table 2. Plant Descriptors

Variety	Rootstock	Ratio trunk/rootstock diameter	Scion trunk surface	Tree shape	Tree growth habit	Density of branches	Branch angle
BARI Komala-1	Pummelo	Smaller	Smooth	Ellipsoid	Dense	Dense	Narrow
BARI Malta-1	Pummelo	Smaller	Smooth	Spheroid	Dropping	Medium	Wide

Table 2. Continued

Variety	Spine density	Spine length (mm)	Spine Shape	Shoot tip color	Parts of plant used	Frequency of use of the plant	Main cooking methods
BARI Komala-1	Low	≤5	Straight	Green	Fruit	Regular	N/A
BARI Malta-1	Low	≤5	Straight	Green	Fruit	Regular	N/A

Table 3. Leaf descriptors

Variety	Vegetative life cycle	Leaf division	Intensity of green color of leaf blade	Leaf lamina attachment	Leaf lamina length (mm)	Leaf lamina width (mm)
BARI Komala-1	Evergreen	Simple	Dark	Brevipetiolate	60	31
BARI Malta-1	Evergreen	Simple	Dark	Brevipetiolate	55	45

Table 3. Continued

Variety	Ratio leaf lamina length/width	Leaf lamina shape	Leaf lamina margin	Leaf apex	Absence/ presence of petiole wing	Petiole wing width	Junction between petiole and lamina
BARI Komala-1	1.93	Ovate	Dentate	Obtuse	Present	Narrow	Fused
BARI Malta-1	1.22	Ovate	Dentate	Obtuse	Present	Narrow	Fused

Table 4. Flower Descriptors

Variety	Pedicel length	Calyx diameter	Length of anthers relative to stigma	Flower type	Color of open flower	Color of anthers
BARI Komala-1	4 mm	Small	Medium	Hermaphrodite	White	Yellow
BARI Malta-1	7 mm	Medium	Longer	Hermaphrodite	White	Yellow

Table 4. Continued

Variety	No. of petals per flower	Petal length	Petal width	Number of stamens	Flowering month	Arrangement of flower
BARI Komala-1	5	13 mm	7 mm	> 4 per petal	February-March	Single & Inflorescence
BARI Malta-1	4	17 mm	9 mm	> 4 per petal	February	Single & Inflorescence

Table 4. Continued

Variety	Flower/Inflorescence position	Inflorescence type	No of flower bud per inflorescence	Stamina length	Separation of filament	Anther length
BARI Komala-1	Terminal & Axillary	Corymb	3-7	Medium	Partially separated	5 mm
BARI Malta-1	Terminal & Axillary	Corymb	5-8	Medium	Partially separated	8 mm

Table 4. Continued

Variety	Anther dehiscence	Style shape	Flowering regularity	Flowering abundance	Secondary flowering
BARI Komala-1	Good	Straight	Regular	Abundant	Absent
BARI Malta-1	Moderate	Straight	Regular	Abundant	Absent

Table 5. Fruit Descriptors

Variety	Bearing habit	Yield behavior	Fruiting season	Fruiting period	Fruit shape	Shape of fruit base
BARI Komala-1	Outside canopy	Regular	Mid	March-December	Spheroid	Concave collared
BARI Malta-1	Outside canopy	Regular	Mid	February-October	Obloid	Truncate

Table 5. Continued

Variety	Shape of fruit apex	Fruit weight (g)	Fruit diameter(mm)	Fruit length(mm)	Fruit Skin color	Fruit surface texture
BARI Komala-1	Truncate	118.5	58	54	Greenish Yellow	Smooth
BARI Malta-1	Truncate	135.0	65	65	Green	Rough

Table 5. Continued

Variety	Adherence of albedo to pulp	Fruit rind thickness (mm)	Albedo color	Fruit attachment to stalk	Number of segments per fruit	Adherence of segment walls to each other
BARI Komala-1	Medium	5	White	Strong	10-14	Week
BARI Malta-1	Strong	3.5	White	Strong	11-12	Strong

Table 5. Continued

Variety	Segment shape uniformity	Thickness of segment wall	Fruit axis
BARI Komala-1	Yes	Thin	Hollow
BARI Malta-1	Yes	Thin	Solid

Table 6. Pulp descriptors

Variety	Pulp color	Pulp color intensity	Pulp color uniformity	Pulp firmness	Fruit aroma
BARI Komala-1	White	Light	Yes	Soft	Strong
BARI Malta-1	White	Light	Yes	Soft	Strong

Table 6. Continued

Variety	Juice taste	Juice content in endocarp	Titratable acids content (%)	Total soluble solids content (% brix)	Ratio of total soluble solids to titratable acids
BARI Komala-1	Sour sweet	Medium	1.2	10.1	0.33
BARI Malta-1	Sweet	Medium	0.45	8.0	0.37

Table 7. Seed descriptors

Variety	Number of seeds per fruit	Seed surface	Seed color	Seed length (mm)
BARI Komala-1	10-19	Smooth	Cream	35
BARI Malta-1	7-14	Smooth	Cream	32

Table 7. Continued

Variety	Seed width (mm)	Seed shape (mm)	Cotyledon Color	100 seed weight (g)
BARI Komala-1	12	Clavate	Light green	16.66
BARI Malta-1	13	Clavate	White	18.75

Table 8. Biotic and abiotic stress susceptibility

Indicators	BARI Komala-1	BARI Malta-1
Major insect-pests	Black citrus aphid, Citrus leaf miner, Citrus psylla, Trunk borer	Green citrus aphid, Black citrus aphid, Brown citrus aphid, Citrus leaf miner, Citrus thrips, Citrus psylla, Trunk borer
Major diseases	Dieback, Gummosis, Lichen	Stem end rot, Anthracnose, Gummosis, Lichen

Conclusion

In this study, mandarin and sweet orange variety (BARI Komala-1 and BARI Malta-1, respectively) showed wide variation both in qualitative and quantitative characteristics. Therefore it can be concluded that these varieties/germplasm could further be used for varietal development programs. This is the first year of study. Next year more variety and germplasm will be included in the study.

References

IPGRI. 1999. Descriptors for Citrus. International Plant Genetic Resources Institute, Rome, Italy.

IN-SITU EVALUATION OF LOCAL MANDARIN LINES UNDER NORTH-EASTERN HILLY AREA OF BANGLADESH

J. C. SARKER, F. AHMED, M. H. M. B. BHUYAN AND S. M. L. RAHMAN

Abstract

The experiment was conducted to study the performance of mandarin germplasm in farmer's orchard and homestead at Jaintapur area of Sylhet during 2020-2021. BARI komala-1 used as a check. All the germplasm were found satisfactory considering growth parameters and yield as well as yield contributing characteristics. Among the germplasm maximum base girth (89.0 cm) was recorded in CR Jai 205 while minimum (46.6 cm) in BARI Komala-1. Plant height ranged from 3.25m to 6.70m in different germplasm with the tallest (6.70 m) in CR Jai-207 and the shortest (3.25 m) in BARI Komala-1. The highest canopy size (5.61×6.20 m) was found in CR Jai 207 while the lowest (2.12×2.42 m) in BARI Komala-1. The heaviest fruit (192.34 g) was found in CR Jai-203 while the lightest (156.38 g) in CR Jai-206. Maximum number of fruits per plant (622) was recorded in CR Jai-206 whereas minimum (310) in CR Jai-201. The highest yield per plant (98.43 kg) was found in CR Jai-203 whereas the lowest (54.54 kg) was in CR Jai-201. Maximum size of fruit (6.8×8.2 cm) was recorded in CR Jai-203 while minimum (6.1×6.5 cm) in CR Jai-206. Maximum edible portion was recorded in (72.69%) in CR Jai-203 while, the lowest (64.48%) in CR Jai-205. In case of total soluble solids (TSS) it was recorded the highest (13.6%) in CR Jai-203 and thelowest (10.3%) in CR Jai-201. Titratible acidity (TA) was also varied among the tested germplasm and the lowest TA (0.72%) was recorded in CR Jai-203 in contrast the highest (0.91%) in CR Jai-205.

Introduction

Citrus is one of the most important horticultural crops of Bangladesh. Further it is identified as one among four important agricultural commodities (rice, maize, potato and citrus). Among the citrus (sweet orange, lime & lemon and pummelo etc.) mandarin is predominantly produced in Bangladesh. Mandarins in Bangladesh are reported to be of two types: Sajek are cultivated in Chittagong hill tract and Khasi, which are cultivated in Jaintia Khasi hills of Bangladesh (Dorjee, 2006). However, there is no authentic history of citrus cultivation in Bangladesh (NPPC, 2007). Seed is the main mode of propagation of mandarin. So, variability is found among different genotypes. Due to climate and soil type, mutation and segregation is always happening. Most of the mandarins are local cultivars grown from either self raised or purchased from other farmers. Different genotype has significant characteristics, which are also needed to be characterized. Hence, in-situ evaluation of local mandarin germplasm has been the research priority. A wide range of variation exists in different farmer's field which in turn, can help to develop a suitable variety(s) by evaluating in-situ. Till now we have only three mandarin varieties but it is necessary to develop more varieties for commercial cultivation. Hence, this study has been undertaken.

Materials and Methods

Seven superior mandarin germplasm were selected on the basis of growth, yielding capacity & pest disease reaction at Jaintapur area during 2020-2021. Data on plant height, base girth, spreading, number of fruit per plant, yield per plant and pest & disease infestation were recorded. Mature fruits were collected from the plants on second week of November. Nine fruits from each plant were harvested randomly for collection ofdata on individual fruit weigh (g), fruit size (length and diameter at equatorial region), segments per fruit, seeds per fruit, seed weight per fruit, rind weight, percent juice content, total soluble solids (TSS), titratible acidity (TA). Total soluble solids (TSS) content was measured with the help of refractometer and corrected with temperature factor (Sherwood, 1928). Titratible acidity (TA) was measured by titrating 10 ml fresh juice with 1% NaOH (Hardy and Sanderson, 2010). All the recorded data on different parameters were statistically analyzed using MSTAT-C program and Duncan's Multiple Range Test was performed for mean separations and interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

The selected mandarin plants were in bearing stage and growth was found satisfactory. Data on plant height, base girth, plant spreading and growth condition presented in Table 1. Among the germplasm age of plant was ranged from 11 years to 15 years. A wide variation was observed in respect of vegetative growth under studied mandarin germplasm. Maximum base girth (89.0 cm) was recorded

in CR Jai-205 while minimum (46.6 cm) in BARI Komala-1. Plant height ranged from 3.25 m to 6.70 m in different germplasm with the tallest (6.70 m) in CR Jai-207 and the shortest (3.25 m) in BARI Komala-1. The highest canopy size (5.61×6.20 m) was found in CRJai-207, while the lowest (2.12×2.42 m) in BARI Komala-1. But regarding tree volume maximum value was obtained from CR Jai-202 (111.16 m^3), while minimum was observed in BARI Komala-1 (7.64 m^3). All the plants were in good growth condition.

Table 1. Plant age and growth characteristics of local mandarin germplasm

Germplasm	Plant age (Years)	Base girth (cm)	Plant height (m)	spreading (m)		Tree volume (m^3)	Growth Condition
				NS	EW		
BARI Kamala-1	13	46.6	3.25	2.12	2.12	7.64	Good
CRJai 201	11	86.3	6.30	3.72	3.72	45.63	Good
CR Jai 202	15	70.0	5.90	6.00	6.00	111.16	Good
CR Jai 203	13	60.9	4.88	5.23	5.23	69.86	Excellent
CR Jai 204	13	65.8	5.41	6.12	6.12	106.04	Good
CR Jai 205	11	89.0	6.20	5.81	5.81	109.53	Good
CR Jai 206	15	73.7	5.58	4.65	4.65	63.14	Good
CRJai 207	14	72.5	6.70	5.61	5.61	110.35	Excellent
Mean	13.13	70.6	5.53	4.91	4.9	77.92	-
SD	1.55	13.58	1.08	1.38	1.37	38.19	-
CV (%)	11.81	19.24	19.56	28.11	28.11	49.02	-

A wide variation was observed in respect yield and yield contributing characteristics of mandarin germplasm tested (Table 2). The heaviest fruit (192.34 g) was found in CR Jai-203 while the lightest (156.38 g) in CR Jai-206. Maximum number of fruits per plant (622) was recorded in CR Jai-206 whereas minimum (310) in CR Jai-201. The highest yield per plant (98.43 kg) was found in CR Jai-203 whereas the lowest (54.54 kg) was in CR Jai-201.

Table 2. Yield and yield contributing characteristics of mandarin germplasm

Accession No.	Individual fruit weight (g)	Fruits $plant^{-1}$ (no.)	Yield $plant^{-1}$ (kg)
BARI Kamala-1	165.56	368	62.67
CR Jai -201	175.35	310	54.54
CR Jai- 202	182.55	459	83.17
CR Jai- 203	192.34	515	98.43
CR Jai- 204	178.38	454	80.24
CR Jai- 205	188.36	487	91.45
CR Jai -206	156.38	622	92.57
CR Jai -207	170.66	512	85.67
Mean	176.20	465.88	81.09
SD	11.90	95.19	15.17
CV (%)	6.75	20.43	18.70

Variation was also found in respect of quantitative fruit characters (Table 3). Maximum fruit size (6.8×8.2 cm) was recorded in CR Jai-203 while minimum (6.1×6.5 cm) in CR Jai-206. The highest number of segments (13) was recorded in CR Jai-203 and CR Jai-204, while the lowest (11) in CR Jai-201. Fruit quality attributes were also varied among the tested germplasm. Maximum edible portion was observed in (72.69%) in CR Jai-203, while minimum (64.48%) in CR Jai-205. In case of total soluble solids (TSS) it was recorded the highest (13.6%) in CR Jai-203 and the lowest (10.3%) in CR Jai-201. Titratible acidity (TA) was also varied among the germplasm tested and the lowest TA (0.72%) was recorded in CR Jai-203 while the highest (0.91%) was in CR Jai-205.

Table 3. Quantitative characteristics of fruits of mandarin germplasm

Accession No.	Fruit Size (cm)		Segments fruit^{-1} (No.)	Edible portion (%)	TSS (%)	TA (%)
	Length	Diameter				
BARI Komala-1	6.2	6.8	12	68.45	11.6	0.82
CR Jai-201	6.8	7.8	11	67.23	10.3	0.83
CR Jai-202	6.9	6.6	12	69.35	12.5	0.81
CR Jai-203	6.8	8.2	13	72.69	13.6	0.72
CR Jai-204	6.7	7.8	13	70.42	12.6	0.76
CR Jai-205	6.5	7.7	12	64.48	12.8	0.91
CR Jai-206	6.1	6.5	12	67.54	11.4	0.84
CR Jai-207	6.3	7.5	12	70.32	12.3	0.82
Mean	6.54	7.36	12.13	68.81	12.14	0.81
SD	0.31	0.64	0.64	2.48	1.01	0.06
CV (%)	4.69	8.68	5.28	3.61	8.33	6.88

Table 3. Disease and insect pest infestation

Disease incidence	Insect pest infestation
Canker, Gummosis, Citrus Greening	Lemon butterfly, Leaf minor, mealy bug

Conclusion

The selected superior mandarin plants were found in good bearing stage and growth is satisfactory. Final conclusion will be made after 2-3 years of continuous in-situ evaluation.

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PERFORMANCE OF EXOTIC SWEET ORANGE GERMPLASM

J.C. SARKER, M.H.M.B. BHUYAN, F AHMED AND S.M.L. RAHMAN

Abstract

A study was conducted with four exotic sweet orange germplasm to evaluate their performance in Bangladesh at Citrus Research Station, Jaintapur, Sylhet during 2020 to 2021. BARI Malta-1 was used as check. Significant differences were recorded among the studied germplasm in terms of growth, yield and yield contributing characteristics. Maximum fruit weight (455 g) was recorded in CS Jai-051 while minimum (235 g) in BARI Malta-1. Fruit size also attained maximum (10.1×9.7 cm) in CS Jai-051. High juice content and the highest TSS (11 %) were recorded in CS Jai-003, while BARI Malta-1 attained the lowest TSS (9.7%). Edible portion was recorded maximum (79.12%) in CS Jai-051 which was followed by CS Jai 012 (77.37%), CS Jai-003 (75.87%) and BARI Malta-1 (73.83%). Fruit color at maturity of exotic sweet orange germplasm CS Jai-051, CS Jai-003, CS Jai-012, CS Jai-209 and BARI Malta-1were found pale green, bright yellow and greenish yellow respectively. Pulp colors of studied germplasm were found off white to orange, whereas BARI Malta-1was light yellow.

Introduction

Citrus fruits play an important role in the fruit world for its nutritive value, availability period and high market price. In Bangladesh, we have a good number of exotic citrus species, which can certainly contribute to the nutritional improvement. Sweet orange is one of the most important citrus fruits in Bangladesh. Bangladesh Agricultural Research Institute has released two sweet orange varieties named BARI Malta-1 and BARI Malta-2, Among them BARI Malta-1 is becoming popular to grower for commercial cultivation in Bangladesh and some plants are found scattered in homesteads also. Moreover, GO & NGOs already established a significant number of orchards of BARI Malta-1 across the country and these efforts are continuing. It produces tasty fruits having high nutritional value with immense economic importance. But every year we have to import a lot of sweet oranges

from different countries. Due to the thirst of growing demand day by day, we have to develop more improved varieties of sweet orange to fulfill the needs. Hence the study has been under taken.

Methods and Materials

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet (25.13562º N latitude, 92.13217º E longitude and 36m of elevation from mean sea level) during 2020 to 2021. Four exotic sweet orange germplasm viz. CS Jai-003, CS Jai-012, CS Jai-051and CS Jai-209 were used as the study material along with BARI Malta-1 as check. The germplasm were collected from different exotic sources and are of same ages (4 years), enjoying same management levels. Among the variety/germplasm BARI Malta-1 was grafted on pummelo. Based on rootstock trial CS Jai-003 was grafted on sweet orange; and CS Jai-012 was grafted on Karun Jamir (sour orange), while others were grafted on pummelo rootstocks. The plants were nourished with manures and fertilizers at a rate of cow dung 15 kg, N 169 g, P 79 g, K88 g, S18 g, B 1g and Zn 3.2 g. Fertilizers were used in two splits; one before rainy season at May and another after rainy season at September (Mandol *et al.,* 2014). Insecticides were used to reduce the infestation of leaf minor when new flushes immerged. Cupravit 50WP (Copper oxichloride + Mancozeb) with 7g L^{-1} of water were applied to control canker and other fungal disease. Bordeaux paste was used twice in a year to control lichen infestation. Bordeaux paste was applied first after rainy season and second before the rain starts. Light pruning was done where necessary. The experiment was laid down in a randomized complete block design with 3 replications (single plant per replication). Data were recorded on tree characters, vegetative life cycle, Leaf characters, fruiting season, yield, fruit quality characters (IPGRI, 1999). Scion trunk surface was observed according to citrus descriptor (IPGRI, 1999). All the collected data were further subjected to statistical analysis for interpretation of the results (Gomez and Gomez, 1984).

Result and Discussion

In respect of growth characteristics a significant variation was found among the germplasm. Plant height, base girth and canopy spread (NS-EW) ranged from 129 cm to 184 cm, 7.5 cm to 15.7 cm and (78×72 cm^2 to 98×115 cm^2) respectively (Table 1). Scion trunk surface was found smooth in all the germplasm. Tree shape was found ellipsoid in all the germplasm except CS Jai-051 which was found spheroid shape. All the germplasm exhibited upright growth habit except CS Jai-051, which was exhibited spreading growth habit. Among the germplasm BARI Malta-1, CS Jai-003 and CS Jai-012 were shown dense branching habit while CS Jai-051and CS Jai-209 were shown sparse. Shoot tip color was found green to purple and shoot tip surface was recorded glabrous in all the germplasm (Table 1).

Table 1. Growth characteristics of sweet orange germplasm

Variety/ Accession	Rootstock	Plant height (cm)	Base girth (cm)	Scion trunk surface	Canopy spread (cm)		Tree shape
					E-W	N-S	
BARI Malta-1	Pummelo	184	7.5	Grooved and ridged	78	72	Ellipsoid
CS Jai-003	Sweet orange	157	15.7	Grooved and ridged	91	103	Ellipsoid
CS Jai-012	Karun Jamir	135	9.3	Grooved and ridged	96	68	Ellipsoid
CS Jai-051	Pummelo	129	7.8	Grooved and ridged	92	118	Spheroid
CS Jai-209	Pummelo	171	7.9	Grooved and ridged	98	115	Ellipsoid
Mean	-	155.2	9.64	-	91.00	95.2	-
SD	-	23.32	3.45	-	7.81	23.72	-
CV%	-	15.03	35.87	-	8.58	24.91	-

Table 1. Continued

Variety/ Accession	Tree growth habit	Density of branches	Spine density	Shoot tip color	Shoot tip surface
BARI Malta-1	Upright	Dense	Absent	Green	Glabrous
CS Jai-003	Upright	Dense	Absent	Green	Glabrous
CS Jai-012	Upright	Dense	Absent	Green	Glabrous
CS Jai-051	Spreading	Sparse	Absent	purple	Glabrous
CS Jai-209	Upright	Sparse	Absent	purple	Glabrous
Mean	-	-	-	-	-
CV%	-	-	-	-	-
LSD	-	-	-	-	-

In case of leaf characteristics leaf type was found simple, vegetative life cycle was exhibited evergreen, color of leaf blade was shown dark green in all the germplasm. Length and width of leaf lamina ranged from 15 mm to 37 mm and 5 mm to 20 mm, respectively (Table 2). In case of leaf or leaflet shape, there was found much variation among the germplasm. Lanceolate and obovate shape was found in CS Jai-003 and CS Jai-051 respectively whereas CS Jai-012 attained ovate shape leaflets and rest two germplasm had elliptic leaflets. Leaf lamina margin was found entire in all the germplasm, except CS Jai-003 which was found dentate leaf margin. All the germplasm had the acuminate leaf apex. In case of presence of petiole wing was found narrow in all the germplasm except BARI Malta-1 and CS Jai-003 which were found absent (Table 2).

Table 2. Leaf characteristics of sweet orange germplasm

Variety/ Accession	Vegetative life cycle	Type of leaf	Leaf blade color	Leaf lamina length (mm)	Leaf lamina width (mm)
BARI Malta-1	Evergreen	Simple	Dark green	25	6
CS Jai-003	Evergreen	Simple	Dark green	19	5
CS Jai-012	Evergreen	Simple	Dark green	35	15
CS Jai-051	Evergreen	Simple	Dark green	37	20
CS Jai-209	Evergreen	Simple	Dark green	26	7
Mean				28.4	10.6
SD	-	-	-	7.46	6.58
CV%	-	-	-	26.30	62.07

Table 2. Continued

Variety/ Accession	Leaf/leaflet shape	Leaf lamina margin	Leaf apex	Petiole wing
BARI Malta-1	Elliptic	Entire	Acuminate	Absent
CS Jai-003	Lanceolate	Dentate	Acuminate	Absent
CS Jai-012	Ovate	Entire	Acuminate	Narrow
CS Jai-051	Obovate	Entire	Acuminate	Narrow
CS Jai-209	Elliptic	Entire	Acuminate	Narrow
Mean	-	-	-	-
SD	-	-	-	-
CV%	-	-	-	-

All the germplasm bore fruits in this season. All the exotic sweet orange lines were found late maturing (November -December) while BARI Malta-1 matured within October. The highest number of fruits was harvested from BARI Malta-1 (15) whereas lowest (8) from CS Jai-051. Maximum yield plant^{-1} (3.64 kg) was obtained in CS Jai-051 while minimum (3.00 kg) in CS Jai-003 (Table 3).

Table 3. Yield and yield contributing characters sweet orange germplasm

Variety/ Accession	Fruiting season		Fruits plant^{-1} (no.)	Yield plant^{-1} (kg)
	Start	End		
BARI Malta-1	February	October- December	15	3.53
CS Jai-003	February	November -December	12	3.00
CS Jai-012	February	November -December	13	2.54
CS Jai-051	February	November -December	8	3.64
CS Jai-209	February	November -December	9	1.31
Mean	-	-	11.4	2.8
SD	-	-	2.88	0.94
CV%	-	-	25.27	33.67

The heaviest fruit (455.0 g) was harvested from CS Jai-051, while the lightest (145.8 g) was from CS Jai-209. Fruit size attained maximum (10.1×9.7 cm) in CS Jai-051. Maximum TSS content (11.0%) was recorded in CS Jai-003 while BARI Malta-1 attained minimum TSS (9.7%). Edible portion was recorded maximum (79.12%) in CS Jai-051 which was followed by CS Jai-209 (77.37%), CS Jai-003 (75.87%) and BARI Malta-1 (73.83%) while minimum (64.74%) in CS Jai-012 (Table 4). The highest rind thickness (4.0 mm) was found in CS Jai-003 while the lowest (3.0 mm) in BARI Malta-1. Maximum number of segments was recorded in CS Jai-003 and CS Jai-051 (11) while rest of the line was exhibited similar number of segment fruit^{-1} (10). Maximum seeds fruit^{-1}

(35) was found in CS Jai-051 whereas CS Jai-003 produced fruits with no seed. Weight of 100 seed was recorded the highest (30.8 g) in BARI Malta-1 whereas it was the lowest (20.3 g) in CS Jai-051 (Table 4).

Table 4. Quantitative and qualitative characteristics of fruits of sweet orange germplasm

Variety/ Accession	Fruit weight (g)	Fruit size (cm)		Pulp Weight (g)	Rind Weight (g)	Edible portion (%)	TSS (%)
		Length	Breadth				
BARI Malta-1	235.0	7.8	7.5	173.5	55.0	73.83	9.7
CS Jai-003	250.7	8.1	8.0	190.2	60.5	75.87	11.0
CS Jai-012	195.4	6.9	6.9	126.5	45.2	64.74	12.0
CS Jai-051	455.0	10.1	9.7	360.0	95.0	79.12	10.2
CS Jai-209	145.8	6.0	6.6	112.8	37.5	77.37	15.0
Mean	256.38	7.78	7.74	192.6	58.64	74.186	11.58
SD	118.20	1.54	1.22	98.91	22.17	5.63	2.10
CV (%)	46.10	19.73	15.78	51.35	37.81	7.59	18.14

Table 4. Continued

Variety/ Accession	Rind thickness (mm)	Segments fruit^{-1} (no.)	Seeds fruit^{-1} (no.)	Seed size (mm)		100 seed weight (g)
				Length	Breadth	
BARI Malta-1	3.3	10	12	10.5	6.9	30.8
CS Jai-003	4.0	11	Nil	-	-	-
CS Jai-012	3.5	10	7	9.4	4.3	26.4
CS Jai-051	3.0	11	35	12.4	3.9	20.3
CS Jai-209	3.8	10	9	10.0	3.0	23.6
Mean	3.52	10.4	15.75	10.57	4.52	25.275
SD	0.39	0.54	12.99	1.29	1.67	4.44
CV (%)	11.25	5.26	82.52	12.26	36.99	17.59

In case of fruit color, BARI Malta-1 was greenish yellow whereas CS Jai-051 was pale green, rest of the germplasm attained bright yellow fruits upon maturity. All the germplasm exhibited fruits having smooth surface. Pulp color was found light yellow in BARI Malta-1 while pulp color of other germplasm recorded off white except CS Jai-012, this germplasm produce fruits contained orange in pulp color. High juice content was recorded in all the exotic sweet orange line whereas medium in BARI Malta-1 (Table 5).

Table 5. Qualitative characteristics of fruits of sweet orange germplasm

Variety/ Accession	Fruit color at maturity	Surface texture of fruit	Color of pulp	Juice content in endocarp	Pest and disease reaction	Juice taste (According to evaluator)
BARI Malta-1	Greenish yellow	Smooth	Light yellow	Medium	Leaf minor	Very good
CS Jai-003	Bright yellow	Smooth	Off white	High	Lichen	Very good
CS Jai-012	Bright yellow	Smooth	Orange	High	Sooty mould	Pleasant
CS Jai-051	Pale Green	Smooth	Off white	High	Sooty mould	Very good
CS Jai-209	Bright yellow	Smooth	Orange	High	Sooty mould	Pleasant
Mean	-	-	-	-	-	-
SD	-	-	-	-	-	-
CV%	-	-	-	-	-	-

Conclusion

Among the germplasm, CS Jai-003 and CS Jai-051 are promising and can be released as new sweet orange (Malta) variety.

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COLLECTION AND EVALUATION OF LOCAL PUMMELO GERMPLASM

JC SARKER, F AHMED, MHMB BHUYAN AND SML RAHMAN

Abstract

Evaluation of local pummelo germplasm was conducted at Citrus Research Station, Jaintapur, Sylhet to study their performance. All the germplasm showed significant variation in respect of plant height, base girth and canopy spreading attributes. The highest plant height was recorded in CG Jai-061 (3.60 m) followed by CG Jai-054 (3.18 m) and the lowest in CG Jai-064 (1.28 m). Maximum base girth was also found from CG Jai-053 (21.00 cm) followed by CG Jai-062 (17.50 cm) and CG Jai-054 (17.00 cm). Canopy size was biggest in CG Jai-054 and smallest in CG Jai-055.

Introduction

Pummelo or shaddock (*Citrus maxima* (Burm.) Merr.) is a crispy citrus fruit which is a native to South and Southeast Asia (Morton, 1987). It is usually pale green to yellow at ripen stage, with sweet white or pink or red flesh and very thick rind. It is the largest citrus fruit, 15–25 centimeters (5.9-9.8 in) in diameter, and usually weighing 1-2 kilograms (2.2-4.4 lb). Pummelo is one of the most important citrus fruits in terms of availability and nutritional status. It contains vitamin C more than twice those of other citrus fruits. In case of table purpose use, it can easily substitute mandarin which is being imported by foreign currency. In our country, there exists a great variability of pummelo which is an opportunity to develop high quality and high yielding pummelo varieties. The study was therefore, undertaken to select promising line (s) to develop as variety.

Materials and Methods

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during 2020 to 2021. Scientists of CRS visited farmer's field and collected sixteen pummelo germplasm as scion. After taking these germplasm to CRS nursery these germplasm were managed systematically. Scions were grafted on pummelo rootstock. The graftages were then transplanted in the experimental plot by line planting method considering 3×3m spacing. Before planting, each pit was fertilized with 10 kg well rotten cow dung, 200g urea, 150 g TSP, 150 g of MoP and left for 15 days. The plants were planted on May'2020. Imidachloprid (Imitaf 0.24 mL L^{-1}) was applied to reduce leaf miner infestation when new leaf emerged. Weeding was done regularly so that weeds cannot retard the growth of the sapling. Mulching was done in the winter. Data were recorded on plant height, base girth canopy spreading and growth condition. All the data collected were processed and analyzed for interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

All the lines showed significant variation among plant height, base girth and canopy spreading. The highest plant height was recorded in CG Jai-061 (3.60 m) followed by CG Jai-054 (3.18 m) and the lowest in CG Jai-064 (1.28 m). Maximum base girth was also found from CG Jai-053 (21.00 cm) followed by CG Jai-062 (17.50 cm) and CG Jai-054 (17.00 cm). Canopy size was biggest in CG Jai-054 and smallest in CG Jai-055 (Table 1).

Table 1. Growth characteristics of pummelo germplasm

Lines	Plant height (m)	Base girth (cm)	Canopy Spreading (cm)		Growth condition
			E/W	N/S	
CG Jai-053	2.79	21.00	54.00	42.67	Good
CG Jai-054	3.18	17.00	56.00	41.67	Good
CG Jai-055	3.15	16.50	24.67	27.67	Good
CG Jai-061	3.60	15.00	43.00	50.00	Good
CG Jai-062	2.04	17.50	25.67	26.67	Good
CG Jai-063	2.40	15.25	45.23	24.29	Good
CG Jai-064	1.28	14.75	54.25	32.12	Good
Mean	2.63	16.71	43.26	35.01	-
LSD	0.791	2.16	13.27	9.78	-
CV (%)	30.06	12.93	30.68	27.94	-

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Conclusion
The plants are at vegetative stage and the growth is satisfactory. Final conclusion can be made after 3-5 years of fruit quality evaluation.

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INFLUENCE OF ROOTSTOCK ON THE GROWTH, YIELD, AND QUALITY OF SATKARA

M.H.M.B. BHUYAN, S.M.L. RAHMAN, J.C. SARKER AND F. AHMED

Abstract
The rootstock identification is a vital step towards developing a suitable propagation technique for any fruit. Three rootstock viz. Pummelo, Rangpur lime and Rough Lemon were selected for rootstock trial of satkara cv. BARI Satkara-1. Highest plant height (307.67.33 cm, base girth (26.93cm) and canopy spreading (319.00×312.33 cm) was found from Rough lemon rootstock. But maximum leaf and canopy size was found Rangpur lime rootstock (10.50×3.67 cm). Pummelo rootstock produced highest number of branches/plant. Among the yield contributing characters Rangpur lime was found superior regarding maximum number of fruits/plant (50.21), but fruit size (10.01×90.25 mm) and individual fruit weight (250.36 g) was highest in Pummelo root stock. But fruit yield was maximum in Rangpur lime rootstock (13.54 t/ha).

Introduction
Satkara (*Citrus macroptera*) commonly called; "wild orange" is a semi-wild species of citrus native to Melanesia (Hanlet, 2001). It is a high valued citrus crop for Sylhet region. Now–a-days it is exporting from our country to European market. Bangladesh Agricultural Research institute has released a variety named BARI Satkara-1. Farmers are generally propagating this fruit by seed. Usually the performance of citrus crops grown on its own root is not satisfactory and the plants can be infected by soil borne diseases. In case of seeded plant it may take 7-8 years to bear fruits. Although rootstocks are known to impart marked effects on the vigor, precocity, productivity, physico-chemical characteristics of fruits, longevity of trees, disease resistance, adaptability to climatic conditions, etc. Till now there is no recommended rootstock for satkara in Bangladesh. Hence, this experiment has been undertaken to select suitable rootstock(s) for satkara.

Materials and Methods
Seeds of three different types of rootstocks viz. Pummelo, Rough lemon, and Rangpur lime were directly sown in nursery beds for raising seedlings at Citrus Research Station (CRS), Jaintapur, Sylhet. Cleft grafting was made with the scion of BARI Satkara-1. The graftages were transplanted in line planting method considering 3×3m spacing. Before planting, fertilization was done with 10 kg well rotten cow dung, 200g urea, 150 g TSP, 150 g of MOP per plant and left for 15 days. Planting was done in July, 2012. The saplings were irrigated at an interval of 15 days from January to March. Imidachloprid (Imitaf @ 0.25mL L^{-1}) was applied to reduce leaf miner infestation when new leaf emerged. Weeding was done regularly so that weeds cannot retard the growth of the sapling. Mulching was done in the winter. Data were recorded on growth, yield contributing characters and yield.

Results and Discussion
Wide variations were found among the rootstocks in case of growth parameters (Table 10.1). Highest plant height (289.33 cm) and base girth (26.33cm) were found from Rough lemon rootstock while the lowest from pummelo rootstock. Canopy size was also biggest in case of rough lemon rootstock whereas rongpur lime rootstock produced a plant with small canopy. Leaf size was highest in rough lemon rootstock and the growth condition was also excellent but Pummelo rootstock produced a dense canopy highest many branches.

Table 1. Growth characteristics of BARI Satkara-1 as influenced by different rootstocks

Rootstocks	Plant height (cm)	Base girth (cm)	Spreading (cm)		Leaf size (cm)		Growth condition	Branching density
			EW	NS	Length	Breadth		
Pummelo	262.33	25.90	268.33	263.33	10.67	3.37	Good	Dense
Rangpur lime	279.33	26.90	273.00	272.33	10.50	3.67	Good	Medium
Rough Lemon	307.67	26.93	319.00	312.33	10.00	3.40	Excellent	Medium
Mean	283.11	26.57	286.77	282.66	10.39	3.48		
SD	22.90	0.58	28.00	26.08	0.348	0.16	-	-
CV(%)	8.09	2.20	9.76	9.22	3.35	4.74		

Pummelo rootstock produced highest number of branches/plant. Among the yield contributing characters Rangpur lime was found superior regarding maximum number of fruits/plant (50.21), but fruit size (10.01×90.25 mm) and individual fruit weight (250.36 g) was higher in Pummelo root stock. But Fruit yield was maximum in Rangpur lime rootstock (13.54 t/ha).

Table 2. Yield contributing characters and yield of BARI Satkara-1 as influenced by different rootstocks

Rootstocks	Flowering time	Fruits/plant (No.)	Fruit weight (g)	Fruit Size (mm)		Yield (t/ha)
				Length	Diameter	
Pummelo	Feb-Mar	35.45	250.36	70.01	90.25	9.76
Rongpur lime	Feb-Mar	50.21	245.32	68.12	87.15	13.54
Rough Lemon	Feb-Mar	32.12	245.56	68.35	88.45	8.67
Mean	-	39.26	247.08	68.82	88.61	10.65
SD	-	9.62	2.84	1.03	1.55	2.55
CV(%)	-	24.52	1.15	1.49	1.75	23.98

Dieback and canker was found in pummel rootstock, but we didn't find dieback on the other two rootstocks although canker was common. Leaf minor and citrus psylla was common in all the rootstocks.

Table 3. Diseases and insect reactions of BARI Satkara-1 as influenced by different rootstocks

Rootstocks	Diseases	Insects
Pummelo	Die back, Canker	Leaf minor, Psylla
Rongpur lime	Canker	Leaf minor, Psylla
Rough Lemon	Canker	Leaf minor, Psylla
Mean	-	-
SD	-	-
CV(%)	-	-

Conclusion

This is the second year of fruiting. Final conclusion will be made after another years of evaluation.

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MOTHER ORCHARD ESTABLISHMENT OF BARI RELEASED/POPULAR CITRUS FRUIT VARIETIES

M.H.M.B. BHUYAN, S.M.L. RAHMAN, F. AHMED AND J.C. SARKER

Introduction

Citrus fruits have immense importance in the local and foreign markets. In Bangladesh, we export sour pulp citrus fruits and import sweet ones. Bangladesh Agricultural research institute has already released twenty varieties of different citrus fruits. These varieties are very popular to farmers. But there are problems with authentic saplings for the farmers. Hence, this program was initiated to establish a good number of mother orchards of BARI released citrus varieties which would be a big source of scions for mass propagation.

Materials and Methods

Saplings of BARI Malta-1 were raised using Rangpur lime and pummelo as rootstock while Rough lemon and pummelo for BARI Komala-1. Air layered saplings were used for the plantation of Jara, seedless and Kolombo lemon. The graftages and layerages were transplanted in the mother orchard by line planting method considering $3\times3m^2$ spacing. Before planting, each pit was fertilized with 10 kg well rotten cow dung, 200g urea, 150g TSP, 150g MoP, and left for 15 days (Mandol *et al*., 2014). The plantation was done in March'2018. Imidacloprid (Imitaf 0.25mL/L) was applied to reduce leaf miner infestation when a new leaf emerged. Weeding was done regularly because of the rapid growth of weeds due to high rainfall in the region. Mulching was done in the winter.

Results and Discussion

The plants are in good growth condition and scion may be collected from one month after planting. The name of the varieties and the total number of Plants are shown in Table 1.

Table 1. List of varieties with the number of plants planted in mother orchard

SL. No.	Name of crops	Accession/variety	Number of saplings planted	Present status
1.	Mandarin	BARI Komala-1	60	
		BARI Komala-2	10	
		BARI Komala-3	50	
2.	Pummelo	BARI Batabilebu-1	20	
		BARI Batabilebu-2	10	
		BARI Batabilebu-3	50	
		BARI Batabilebu-4	5	
		BARI Batabilebu-5	150	
		BARI Batabilebu-6	5	
3.	Sweet orange	BARI Malta-1	150	
		BARI Malta-2	5	
4.	Citron/ Jara lemon	BARI Jara lebu-1	10	
		CM Jai-061	15	
		CM Jai-062	15	
5.	Lemon	BARI Lebu-1	5	
		BARI Lebu-2	5	
		BARI Lebu-3	5	
		BARI Lebu-4	5	
		BARI Lebu-5	20	
6.	Seedless lemon	CL Jai-012	174	
		CL Jai-001(Seedless)	65	
		Srimangle seedless	50	
		Rangpur seedless	50	
7.	Lime	BARI Kagzi lebu-1	10	
		CA Jai-001	45	
		CA Jai-002	20	

Conclusion

The plants are in good condition. The growth is satisfactory. Regular intercultural operations are going on. The orchard will serve as the source of true type citrus sapling in near future.

CLONAL SELECTION OF BANANA GERMPLASM CV. SABRI KOLA

J. C. SARKER, F. AHMED, M. H. M. B. BHUYAN AND S.M.L. RAHMAN

Abstract

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet during 2020-2021 with 4 sobri kola germplasm. A wide variation was observed regarding growth characteristics where MS Jai 021 was found superior with plant height, base girth, leaf size and growth condition followed by MS Jai-024. Maximum bunch weight was obtained from MS Jai-024 (10.5 kg) while minimum in MS Jai-021 (6.4 kg). Variation was also found in other characters. The highest hands weight (1.6 kg) and finger weight (95.5 g) was also found in MS Jai-024. Maximum yield was found in MS Jai-024 (47.84 t/ha) followed by MS Jai-022 (38.37 t/ha) while minimum (25.54 t/ha) in MS Jai 021. The highest TSS (25.5%) was recorded in MS Jai-024 while the lowest (18%) in MS Jai-022. Number of hands per bunch was found maximum in MS Jai-024 (13) but number of fingers per hand was higher in MS Jai-022 (18) compared to MS Jai-024 (14). Maximum finger size (12.8×3.5 cm) was recorded in MS Jai-024 while minimum (11.4×2.7 cm) in MS Jai-022. Edible portion was found highest (89%) in MS Jai-024.

Introduction

Bananas and plantains are the fourth most important food crop in the world after rice, maize and wheat (Picq 2000). Bananas are considered the most nutritional food source in the world and originate from south east Asia (Stover and Simmonds 1987, Jones 2000). Banana is an edible fruit produced by several kinds of large herbaceous flowering plants of the genus Musa. Sobri (Musa sp.) is one of the most popular commercial banana varieties in Bangladesh. A bunch of ripen banana attracts everyone irrespective of sexes and ages. But the shape, size, quality and yield differs widely in different areas. Sobri is successfully cultivated by farmers in different regions of Bangladesh. North eastern region of Bangladesh is blessed with different germplasm of Sobri banana which should be evaluated for getting best ones as variety. Therefore, the present study was undertaken.

Materials and Methods

The experiment was conducted at the Citrus Research Station, Jaintapur, Sylhet during 2020-2021 with 4 sobri banana germplasm. Suckers were collected from farmers' field and homesteads and planted at experimental plot with a spacing of 2×1.5 m in the month of February 2018. Each plant was fertilized with 10kg cow dung, 90g N, 30g P, and 50g K. Admire 2 mL L^{-1} was applied for reducing the infestation of banana stem weevil in April 2019. Data were recorded on plant height, base girth, spreading (east-west, north-south) and growth condition. Three germplasm fruited for the first time and was harvested for taking data on different fruit quality parameters.

Results and Discussion

The data on vegetative characteristics were shown in Table1. All the growth characters varied significantly among the germplasm tested. The highest plant height was found in MS Jai-021 (372.1 cm) followed by MS Jai-24 (352.2 cm) and the lowest in MS Jai-022 (240.3 cm). The highest base girth was found in MS Jai-021 (50.3 cm) followed by MS Jai-024 (45.7 cm). MS Jai-021 was also superior with leaf size and growth condition followed by MS Jai-024 (Table 1).

Table 1. Growth characteristics of sabri kola germplasm

Accessions	Plant height (cm)	Base girth (cm)	Leaf size (cm)			Growth condition
			Lamina length	Breadth	Petiole length	
MS Jai-021	372.1	50.3	136.7	57.33	35.31	Good
MS Jai-022	240.3	27.2	67.3	32.67	24.65	Good
MS Jai-023	253.6	37.4	97.6	42.43	33.35	Good
MS Jai-024	352. 2	45.7	134.3	57.32	31.33	Excellent
Mean	304.55	40.15	108.975	47.44	31.16	-
SD	67.22	10.15	33.05	12.09	4.63	-
CV (%)	22.07	25.28	30.32	25.49	14.87	-

Maximum bunch weight was obtained from MS Jai-024 (10.5 kg), while minimum in MS Jai-021 (6.4 kg). Variation was also found in other characters. The highest hands weight (1.6 kg) and finger weight (95.5 g) was also found in MS Jai-024. Maximum yield was found in MS Jai-024 (47.84 t ha^{-1}) followed by MS Jai-022 (38.37 t ha^{-1}) while minimum (25.54 t ha^{-1}) in MS Jai-021. The highest TSS (25.5%) was recorded in MS Jai-024 while the lowest (18%) in MS Jai-022 (Table 2).

Table 2. Quantitative fruit characters of three sabri kola germplasm

Accessions	Bunch weight (Kg)	Hands weight (Kg)	Finger weight (g)	Yield (t ha^{-1})	TSS (%)
MS Jai-021	6.4	1.5	79.4	25.54	24.3
MS Jai-022	6.8	1.4	87.6	38.37	18
MS Jai-024	10.5	1.6	95.5	47.84	25.5
Mean	7.9	1.5	87.5	37.25	22.6
SD	2.26	0.1	8.05	11.19	4.03
CV%	28.61	6.67	9.20	30.05	17.83

Number of hands per bunch was found maximum in MS Jai-024 (13), but number of fingers per hand was higher in MS Jai-022 (18) compared to MS Jai-024 (14). Maximum finger size (12.8×3.5 cm) was recorded in MS Jai-024, while minimum (11.4×2.7 cm) in MS Jai-022. Edible portion was highest (89%) in MS Jai-024 (Table 2).

Table 2. Continued

Accessions	Number of hands/bunch	Number of finger/hands	Finger size (cm)		Edible portion (%)
			Length	Diameter	
MS Jai-021	11	13	12.2	3.5	79
MS Jai-022	10	18	11.4	2.7	88
MS Jai-024	13	14	12.8	3.5	89
Mean	11.33	15.00	12.13	3.23	85.33
SD	1.53	2.65	0.70	0.46	5.51
CV(%)	13.49	17.64	5.78	14.28	6.45

The germplasm (MS Jai-021and MS Jai-022) were infected by Sikatoka disease, which was not observed in MS Jai-024. On the other hand banana stem weevil was observed in other germplasm except MS Jai-024 (Table 3).

Table 3. Disease and insect pest of three sabri kola germplasm

Accessions	Disease incidence	Insect pest infestation
MS Jai-021	Sikatoka	Banana stem weevil
MS Jai-022	Sikatoka	Banana stem weevil
MS Jai-024	Nil	Nil

Conclusion

This is the Third year study. Considering all the parameters MS Jai-024 may be further investigated for advanced yield trail (AYT).

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EVALUATION OF DRAGON FRUIT GERMPLASM

J.C. SARKER, M.H.M.B. BHUYAN, F. AHMED AND S.M.L. RAHMAN

Abstract

The study was conducted at Citrus Research Station (CRS), Jaintapur, Sylhet with three germplasm of dragon fruit viz., HC Joy-001, HU Jai-002 and HM Jai-003 during 2020-21. Number of side branches was found maximum (23) in HU Jai- 002 and minimum (16) in HM Jai-003. Flowering duration was recorded from 24 May to 28 May between the germplasm. Highest number of fruits was obtained from HU Joy-002 (24). HU Jai-002 produces largest fruit (398.3g) with maximum (84.56%) edible portion.

Introduction

The Dragon Fruit (also known as pitahaya or strawberry pear) is the fruit of several cactus species, especially of the genus *Hylocereus*. Dragon fruit or pitayacome in three types, all with leathery, slightly leafy skin: *Hylocereus costaricensis* (red fleshed pitaya) has red-skinned fruit with red flesh, *Hylocereus undatus* (white fleshed pitaya) has pink-skinned fruit with white flesh and *Hylocereus megalanthus* (white fleshed pitaya) has yellow-skinned fruit with white flesh. Its fruit is the most beautiful in the family Cactaceae with a bright red skin or yellow studded with green scales and white or red flesh with tiny edible black seeds. The flower is so beautiful that it is nicknamed as "Noble Woman" or "Queen of the Night". The juicy flesh of the fruit is delicious in taste. It is well established in Australia, China, Israel, Malaysia, Nicaragua, Taiwan and Vietnam. It has export potentiality, which fetches a higher price than even Durian, in south-east Asia. The agronomic practices are easy and less expensive; maintenance cost is low and aftercare is minimal due to fewer pest and disease attacks. The biggest advantage of this crop is that once planted, it will grow for about 20 years. More importantly, it is a fast return perennial fruit crop with production in the second year after planting and full production within five years. The crop dragon fruit is a species of dry tropical climates. The edible parts of raw dragon fruit consist of mostly water and carbohydrates, with some protein and fat content. It contains slight amounts of calcium, iron, phosphorus, and other nutrients. Thus the increase of production of dragon fruit may reduce the malnutrition problem of our country as well as can earn a lot of foreign currency. Thus, Dragon fruit is considered a fruit crop for the future (Gunasena and Pushpakumara, 2006; Gunasena *et al*., 2006). This fruit is being cultivated in the country for last five years by some large entrepreneurs. There is only one variety released from BARI with red flesh and these is scope to release white fleshed and more improved varieties. Hence the study was undertaken.

Materials and Methods

Three dragon fruit germplasm were supplied from different areas and abroad such as HC Joy-001were collected from BARI headquarter, Gazipur, HU Jai-002 were collected locallyas well as HM Jai-003 were collected from Thailand and planted at research field of Citrus Research Station, Jaintapur, Sylhet with a distance of 3×3 m^2 spacing in concrete pole. Each plant was fertilized with 20 kg cow dung, 200 g urea, 250 g of TSP, 150 g of MOP, 50 g of gypsum, 20 gm Zinc sulphate and 10 of boric acid (Mandol *et al.*, 2014). The plot was irrigated twice a month in dry period. Bavistin 50 wp was applied @ 2g/liter of water to prevent foot and stem rot. Data were recorded on spreading, side branches, and flowering and fruit characteristics.

Results and Discussion

The highest canopy spreading (311×228 cm) as well as number of side branches (23) were recorded in HU Jai-002 while the lowest (212×185 cm) in HM Jai-003 (Table 1).

Table 1. Growth characteristics of dragon fruit germplasm

Accessions	Spreading (cm)		Side branches/plant (no.)
	E-W	N-S	
HC Joy-001	283	241	19
HU Jai-002	311	228	23
HM Jai-003	212	185	16
Mean	268.67	218	19.33
SD	51.03	29.30	3.51
CV(%)	18.99	13.44	18.16

The earliest flowering was recorded in HC Joy-001 (04 May) followed by HU Jai-002(07 May) while HM Jai-003 flowered last (23 September). The highest number of fruits was recorded in HU Jai-002 (24) with the highest yield per plant (3.42 kg) while the lowest in HM Jai-003 (12 and 2.2kg respectively) (Table 2).

Table 2. Yield contributing characters and yield of dragon fruit germplasm

Accessions	Flowering date during 2020			Fruits/plant	Yield/plant (Kg)
	1st	2nd	3rd		
HC Joy-001	04 May	21 June	17 August	21	3.37
HU Jai-002	07 May	27 June	21 August	24	3.42
HM Jai-003	-	-	23 September	12	2.2
Mean	-	-	-	19	2.99
SD	-	-	-	6.24	0.69
CV(%)	-	-	-	32.86	23.03

The heaviest fruit (398.3g) was recorded in HU Jai-002 while the lightest was produced in HM Jai-003 (185.5g). The largest fruit (7.8×7.8 cm^2) was recorded in HU Jai-002 whereas the smallest (7.6×5.6 cm^2) in HM Jai-003. Maximum TSS (12.7%) was observed in HM Jai-003 while minimum (11.5%) in HC Joy-001. The highest edible portion (84.56%) was recorded in HM Jai-003 whereas the lowest (80.43%) was in HC Joy-001 (Table 3).

Table 3. Quantitative fruit characteristics of dragon fruit germplasm

Accessions	Individual fruit weight (g)	Fruit Size (cm)		Rind weight (g)	TSS (%)	Edible portion (%)	Fruit Color	
		Length	Diameter				Skin	Flesh
HC Joy-001	197.5	7.5	7.6	55	11.5	80.43	Red	Red
HU Jai-002	398.3	7.8	7.8	63	11.8	81.11	Red	White
HM Jai-003	185.5	7.6	5.6	56	12.7	84.56	Yellow	White
Mean	260.43	7.63	7.00	58.00	12.00	82.03	-	-
SD	119.54	0.15	1.21	4.35	0.62	2.21	-	-
CV (%)	45.90	2.00	17.37	7.51	5.20	2.69	-	-

Conclusion

HU Jai-002 found best regarding fruit weight, fruit size and yield but in consideration of edible portion (%), TSS (%) as well as extraordinary yellow-skinned white fleshed, HM Jai-003 was best. Further evaluation may be done for releasing it as a variety.

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EVALUATION OF BURMESE GRAPE GERMPLASM

M.H.M.B. BHUYAN, J.C. SARKER, F. AHMED AND S.M.L. RAHMAN

Abstract

The experiment was conducted at CRS, Jaintapur, Sylhet, from July 2019 to June 2020 with five Burmese grape germplasm. A wide variation was observed in the case of growth, yield contributing characters, yield, and fruit quality of the germplasm studied. The highest plant height, base girth, canopy spreading was found in BS Jai-005. BS Jai-002 takes 110 days to harvest is considered to be an early one. The number of fruit/cluster was higher in BS Jai-001 (30-35 fruits/cluster) with maximum cluster weight (365 g). The highest fruits/plant, yield/plant, and yield/ha were obtained in BS Jai-005. While BS Jai-001 was free from a disease whereas the others suffer from powdery mildew and sooty mold. Chapper beetle was common in the case of all the germplasm but BS Jai-001 and BS Jai-003 were free from fruit borer. Fruit size recorded highest in BS Jai-003 (3.4×3.4 cm) followed by BS Jai- 001 (3.3×3.1 cm). Flesh color and texture for all germplasm were off white and juicy respectively. Maximum edible portion (47.2%) and percent TSS (13.6%) were found inBS Jai-001.

Introduction

Burmese grape or Lotkon (*Baccaurea ramiflora* Lour.) belongs to the Family Euphorbiaceae is native to the Southeast Asian region and growing wild as well as under cultivation in Nepal, India, Myanmar, Bangladesh, South China, Indo-China, Thailand, the Andaman island, and Peninsular Malaysia. In Bangladesh, the species is grown in some pockets in Narsingdi, Manikgonj, Gazipur, Netrokona, Kishoregonj, and Sylhet. Lotkon is a commercially important fruit that is very popular with people of all ages in Bangladesh. Fruits contain 5.5 percent of protein, 178 mg vitamin C per 169 mg calcium, 137 mg potassium, 177 mg phosphorous, and 100 mg iron per 100g of fruit pulp (Kermasha *et al.*, 1987). The fruit has been consumed fresh. It is also reported from other parts of the world that fruits are used to make wine, and have been used as medicine to treat skin disease. Seeds contain 4.8 – 6 percent annatto dye. Annatto is used for coloring silk, cotton, and other textile materials for orange color (Abdullah *et al*., 2005). Lotkon is mainly available during the month of June-July and the price is slightly high during the time of 'Rathayatra' because of the profuse use of fruit by the local people for the ritual. Burmese grape prefers semi-shade conditions for their growth. So the crop can be grown under another fruit or forest crop, where no other fruit crop can be grown successfully, thus can be used for multistoried fruit garden. By growing this crop the farmers are now receiving a considerable amount of money to meet their family demand, moreover, apparently vacant space can be effectively utilized for fruit production which may help to meet their dietary supplement. But still, there is one recommended variety of Lotkon, which farmers can cultivate. Therefore, to reduce the demand for good varieties of lotkon this study was undertaken.

Materials and Methods

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet from July'2019 to July 2020. Five Lotkon germplasm was included in the study. These plants are 25 years or older and bear fruits regularly. At the beginning of the experiment, the plants were rejuvenated by pruning dead and diseased branches, freed them from parasitic plants, algae, and lichen. Therefore, the trunks were painted with Bordeaux paste to avoid fungal infection. The plants were fertilized with 30 kg cow dung, 1 kg urea, 1 kg TSP, 750 g MoP, 200 g gypsum, 50 g Zinc sulfate, and 20 g boric acid in two equal splits one in July and another after the rainy season in October. The plants were infested by chaper beetle twice in July and September hence two full cover spray of Cypermethrin (Cymcare 10 EC @ 1ml/L of water) was applied. Three-hand weeding was done throughout the rainy season to avoid loses of soil nutrients by weed and also to destroy the harbor of insect pests. Data were taken on growth, yield, and fruit characters. Fruit quality data were analyzed by the MSTAT-C computer program and DMRT was performed for interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

A wide variation was observed in the case of growth, yield, and fruit quality of the germplasm studied. The highest plant height was recorded in BS Jai-005 (9.0 m) while the lowest in BS Jai -002 (5.0 m). The base girth was also higher in BS Jai-005 (1.2 m). BS Jai-005 was also superior with a bigger canopy (15.0×12.0 m) but leaf size was bigger in BS Jai-001 (16.5×6.5 cm) with the long petiole (3.5 cm), while a small-sized leaf (8.5×4.5 cm) was found from BS Jai-004. Dense branches with good growth conditions were found from BS Jai-005, while medium dense branches with excellent growth conditions were found from BS Jai-001 but BS Jai-004 was in poor growth condition with sparse branching (Table 1).

Table 1. Growth Characters of different Burmese grape germplasm

Accession	Age of tree	Plant height (m)	Base girth (m)	Canopy spreading (m)		Leaf size (cm)			Branch density	Growth condition
				E/W	N/S	Lamina length	Lamina width	Petiole length		
BS Jai-001	31	7.5	1.0	8.5	9.0	16.5	6.5	3.5	Medium	Excellent
BS Jai-002	26	5.0	0.85	7.0	5.0	15.5	7.0	2.5	Sparse	Good
BS Jai-003	26	6.75	0.9	9.0	6.0	14.3	8.0	2.0	Sparse	Good
BS Jai-004	26	4.5	0.6	7.0	4.5	8.5	4.5	1.5	Sparse	Poor
BS Jai-005	41	9.0	1.2	15.0	12.0	13.0	6.0	2.5	Dense	Good
Mean	30	6.55	0.91	9.3	7.3	13.56	6.4	2.4	-	-
SD	6.51	1.84	0.21	3.30	3.15	3.11	1.29	0.74	-	-
CV%	21.73	28.09	24.07	35.58	43.21	22.98	20.22	30.90	-	-

BS Jai-002 takes 110 days to maturity is considered to be an early one that matures at the 4th week of June while BS Jai-003 needs 135 days to be matured. The other germplasm was of the midseason type and matures within 120-125 days and matures within the 2nd and 3rd week of July. All the germplasm fruited in the cluster but BS Jai-001 was unique with a long cluster of fruit with sufficient interspace between fruits that helps to avoid disease and insect infestation. The number of fruits cluster^{-1} was higher in BS Jai-001 (30-35) while the lowest fruits cluster^{-1} were found from BS Jai-004 (8-10). The weight of the fruit cluster was also higher in BS Jai-001 (365 g) (Table 2).

Table 2. Yield contributing characters of different Burmese grape germplasm

Accession	Days from flowering to harvesting	Time of harvest	Fruit clustering habit	Fruits cluster^{-1} (no.)	Weight of fruit cluster^{-1} (g)
BS Jai-001	125	1st week of July	Cluster	30-35	365
BS Jai-002	110	4th week of June	Cluster	15-20	330
BS Jai-003	135	3rd week of July	Cluster	18-25	270
BS Jai-004	125	2nd week of July	Cluster	8-10	72
BS Jai-005	120	3rd week of July	Cluster	25-30	350
Mean	123	-	-	-	277.4
LSD	9.08	-	-	-	120.36
CV%	7.38	-	-	-	43.39

The highest number of fruits/plant was obtained from BS Jai-005 (6000) while the lowest was found in BS Jai-004 (600). The maximum weight of fruit/plant (55.4 kg) and yield (56.8 t/ha) was obtained from BS Jai-005. No disease was observed in BS Jai-001 whereas the others suffer from powdery mildew and sooty mold. Chapper beetle was common in the case of all the germplasm but BS Jai-001 and BS Jai-003 were free from fruit borer (Table 3).

Table 3. Yield contributing characters, yield and disease, and insect reaction of different Burmese grape germplasm

Accession	Number of Fruit plant^{-1}	Weight of Fruit plant^{-1} (Kg)	Yield (t ha^{-1})	Disease	Insect
BS Jai-001	5200	49.5	52.0	Nil	Chapper beetle
BS Jai-002	1200	18.6	19.9	Powdery mildew, Sooty mold	Chapper beetle, fruit borer
BS Jai-003	1750	24.4	26.3	Powdery mildew, Sooty mold	Chapper beetle
BS Jai-004	600	5.2	6.1	Powdery mildew, Sooty mold	Chapper beetle, fruit borer
BS Jai-005	6000	55.4	56.8	Powdery mildew, Sooty mold	Chapper beetle, fruit borer
Mean	2950	30.62	32.22	-	-
LSD	2469.31	21.21	21.58	-	-
CV%	83.70	69.27	67.01	-	-

All the germplasm produces fruits of spheroid shape. Fruit size was higher in BS Jai-003 (3.43.4 cm) followed by BS Jai-001 (3.33.1 cm). The other germplasm also varied significantly in respect to fruit size. The ripe fruit was bright yellow in BS Jai-001 and BS Jai-002, whereas BS Jai-003 showed pinkish yellow color. BS Jai-004 and BS Jai-005 showed yellowish-green and pale yellow color respectively. The flesh color for all germplasm was off-white and the flesh texture was juicy (Table 4).

Table 4. Fruit characters of different Burmese grape germplasm

Accession	Fruit shape	Fruit size (cm)		Fruit color at ripening	Flesh color	Flesh texture
		length	width			
BS Jai-001	spheroid	3.3ab	3.1b	Yellow	Off white	Juicy
BS Jai-002	spheroid	3.1b	3.0b	Yellow	Off white	Juicy
BS Jai-003	spheroid	3.4a	3.4a	Pinkish Yellow	Off white	Juicy
BS Jai-004	spheroid	2.2c	2.7c	Yellowish green	Off white	Juicy
BS Jai-005	spheroid	3.1b	3.1b	Pale Yellow	Off white	Juicy
LSD	-	0.18	0.20	-	-	-
CV%	-	3.24	3.57	-	-	-

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Fruit weight ranged from 8.6 g to 14.6 g. The lowest fruit weight was found in BS Jai-004 (8.6 g). The other germplasm were statistically indifferent but the highest fruit weight was found from BS Jai-003 (15.2 g). Stone or seed weight was higher in BS Jai-002 (2.5 g) while maximum skin weight (6.7 g) was found from BS Jai-002. The edible portion is one of the most important features of any fruit. The maximum edible portion was found from BS Jai-001 (47.2%) while the minimum was from BS Jai-002 (36.7 g). The highest percent TSS was found from BS Jai- 001 (13.6%) while the lowest was found in BS Jai-003 (12.4%) (Table 5).

Table 5. Fruit, stone & rind weight, per cent edible portion and per cent TSS different Burmese grape germplasm

Accession	Fruit weight (g)	Weight of stone (g)	Weight of skin (g)	Edible portion (%)	TSS (%)
BS Jai-001	14.6a	1.9b	5.8bc	47.2a	13.6a
BS Jai-002	14.2a	2.5a	6.7a	36.7b	13.2a
BS Jai-003	15.2a	2.4ab	5.4c	47.1a	12.4b
BS Jai-004	8.6b	2.4ab	2.2d	46.5a	13.5a
BS Jai-005	14.2a	2.4ab	6.3ab	38.6b	13.4a
LSD	0.95	0.49	0.76	3.67	0.56
CV%	3.96	19.46	7.87	6.33	2.33

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by DMRT.

Conclusion

Considering all the parameters BS Jai-001 is the superior line among the germplasm tested followed by BS Jai-003. Percent TSS is also higher in BS Jai-001 and it was free from powdery mildew or sooty mold and also free from fruit borer infestation which gives this line superiority. Therefore, BS Jai-001 may further be released as a variety of lotkon.

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COLLECTION AND EVALUATION OF BAEL GERMPLASM

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Abstract

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet, during 2020-21. Four germplasm of Bael viz., AM Jai-001, AM Jai-002, AM Jai-003 and AM Jai-004 were evaluated under this study. A wide variation was observed in case of different characters of the germplasm tested. Among the germplasm the highest number of fruits (141) was recorded in AM Jai-001 with maximum TSS (39.4%). The heaviest fruit was found in AM Jai-002 (1250.6g) with large sized (13.5×12.5cm^2). Maximum edible portion (83.61%) was recorded in AM Jai-001 while minimum (59.13%) was in AM Jai-004.

Introduction

Bael (*Aegel 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 (Johnand Stevenson, 1979), therefore, Bangladesh is believed to be one of the primary centers of origin of this fruit (Neeraj and Johar 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.

Materials and Methods

The experiment was conducted at Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet, during 2020-21. Five germplasm were initially included in the study. But one dropped due to unsatisfactory growth and non bearing habit. The plants were of variable age range from 7-10 years. Each plant was fertilized with 20 kg cow dung, 375 g of N, 100 g of P and 200 g of K in two equal splits one before rainy season and another after rainy season (Mandol et al., 2014). Two full cover spray of carbendazim (Bavistin 50WP @ 2 g/L of water) was applied before spring in the month of February. As bael requires a pronounced dry season to give flowers and fruits therefore no irrigation was applied in winter. Weeding was done in rainy season before applying fertilizer. Data on number of fruits/plant, branching density, yield and fruit quality parameters were taken. The recorded data on different parameters were statistically analyzed (Gomez and Gomez, 1984).

Results and Discussion

In difference quantitative fruit characteristics there were found significance differences among the germplasm studied (Table 1). The heaviest (1250.6 g) fruit was obtained in AM Jai-002 while the lightest (572.7g) was found in AM Jai-001. The biggest fruit (13.5×12.5 cm) was obtained in AM Jai-002 followed by AM Jai-001 (12.1×11.5 cm) while the smallest (10.3×9.5 cm) in AM Jai-003. Maximum TSS (39.4%) was recorded in AM Jai-001, whereas minimum (31.3%) in AM Jai-004. Number of fruits per plant was recorded the highest (141) in AM Jai-001 while the lowest (68) was in AM Jai-003. In case of rind thickness, maximum (0.35 cm) was recorded in AM Jai-004 whereas minimum (0.26 cm) in AM Jai-003.

Table 1. Quantitative fruit characteristics of bael germplasm

Accessions	Fruit weight (g)	Fruit size (cm)		TSS (%)	Fruits/plant	Rind thickness (cm)
		Length	Diameter			
AM Jai-001	572.7	12.1	11.5	39.4	141	0.31
AM Jai-002	1250.6	13.5	12.5	34.4	69	0.32
AM Jai-003	670.8	10.3	9.5	32.6	68	0.26
AM Jai-004	740.5	10.5	11.7	31.3	89	0.35
Mean	808.65	11.6	11.3	34.425	91.75	0.31
SD	302.56	1.50	1.27	3.55	34.22	0.037
CV(%)	37.41	12.94	11.28	10.31	37.30	12.06

The highest weight of pulp (959.2 g) was recorded in AM Jai-002 whereas the lowest (474.5g) in AM Jai-001. Maximum weight of fiber (38.5g) was recorded in AM Jai-004 whereas minimum (34.7g) in AM Jai-003. Number of seed per fruits was recorded maximum (65) in AM Jai-001 and minimum (54) in AM Jai-004. Maximum edible portion (83.61%) was recorded in AM Jai-001 followed by AM Jai-002 (76.91 %) while minimum (59.13%) in AM Jai-004. Total yield/plant was recorded (80.97 kg) maximum in AM Jai-002 while minimum (44.74 kg) in AM Jai-003 (Table 2).

Table 2. Quantitative fruit characteristics of bael germplasm

Accessions	Wt. of Pulp (g)	Wt. of fiber (g)	Wt. of seed (g)	Seeds fruit^{-1} (no.)	Edible portion (%)	Yield/plant (kg)
AM Jai-001	474.5	35.4	45	65	83.61	76.37
AM Jai-002	959.2	36.2	60	55	76.91	80.97
AM Jai-003	480.4	34.7	41	58	71.73	44.74
AM Jai-004	486.5	38.5	40	54	59.13	63.27
Mean	600.15	36.2	46.5	58	72.845	66.33
SD	239.41	1.65	9.25	4.96	10.35	16.23
CV(%)	39.892	4.56	19.90	8.56	14.21	24.47

Conclusion

From the above study it was found that AM Jai-001 was the best in terms of TSS (%), number of fruits/plant and edible portion with no bitterness. It may be released as new variety.

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COLLECTION AND EVALUATION OF MINOR FRUITS GERMPLASM

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Abstract

The experiment was conducted at Citrus Research Station, BARI, Jaintapur, Sylhet during the period from December 2020 to April 2021 to find out superior lines suitable for the acidic soil of the northeastern region of Bangladesh. False mangosteen recorded plant height 120cm, spreading E-W (42cm), N-S (28cm), and base girth (0.8cm).Monkey jack recorded plant height (112cm), spreading E-W (55cm), N-S (47cm) and base girth (1.0cm). Jamun recorded plant height (120cm), spreading E-W (40cm), N-S (45cm) and base girth (1.0cm).These three germplasm are relatively fast-growing than other minor fruits germplasm. On the other hand, wood apple is relatively slow-growing than all the fruits germplasm. Wood apple attains the lowest plant height (48cm), lowest base girth (0.3 cm) as well as lowest spreading E-W (15cm), N-S (18cm).

Introduction

Bangladesh is blessed with a great diversity of fruits and, in 2017, was placed sixth in world rankings for tropical fresh fruit production (FAOSTAT, 2019). There are about 70 various kinds of fruits growing in Bangladesh (Hossain et al. 2011). In today's world, food must be wholesome and safe for human consumption. Fruits are an integral part of food needed to meet the mineral requirements of the human body and to strengthen immunity against various biotic and abiotic stresses. For proper health, per capita requirement of fruits is 115 g. On average, fruits have been contributing to about 4% of human nutrition (APCAEM, 2007). A significant quantity of tropical fruits is underexploited generally recognized as indigenous or minor fruits. Usually, these fruits are found in home yards; year on year, these fruit trees are being destroyed. Minor fruit occupies 3.01 of the area and 8.38% of production compared to the total fruit production of Bangladesh (BBS, 2011). The country spent about Tk. 8,000–10,000 million for import of fruits from other countries (Hossain and Uddin, 2005), therefore, increasing production of these indigenous fruits are time demanding for mitigating nutrient deficiency as well as reducing import. Most of the rural houses possess a home garden. It is reported that the planting intensity has increased at least 4-folds in 65% of households during the last few years. But, 34 plant species are already under severe threat of extinction from Bangladesh (Gain 2002). The loss of such species has serious implications on rural life and not only deprives people of essential nutrients but also medicinal attributes and employment opportunities (Rahman, 2003). In the country, the landholding pattern in hill tracts reveals that nearly 90% of the farmers are small and marginal; hence, the minor fruits are ideal for cultivation as they need low input requirement, less production cost comprising higher nutritive value, and high yield. Apart from nutritive value, most people are familiar with the medicinal properties of locally grown minor fruits. It emphasizes exploiting the versatile use of these tremendous resources, in combating the challenges of nutritional security as well as exploiting medicinal attributes adding income generation for the better livelihood of the tribal and rural people. Keeping this view in mind, the collection was emphasized to conserve these resources from getting extinct as well as finding out suitable varieties for the northeastern region of Bangladesh.

Materials and Methods

The experiment was conducted at Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during the period from May 2020 to April 2021. There are 10 types of minor fruit of different ages collected from different parts of Bangladesh. After collection, these plants were raised in the nursery and cared for proper establishment in this high rainfall area. In the nursery, these plants were evaluated by recording data of plant height, plant spreading, base girth etc. These plants will be planted in the fruit orchard of Citrus Research Station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet in this rainy season of June to August 2021 to know the performance and adaptability of these fruit plants.

Results and Discussion

Data in the Table 1 showed that false mangosteen recorded plant height 120cm, spreading E-W (42cm), N-S (28cm), and base girth (0.8cm).Monkey jack recorded plant height (112cm), spreading E-W (55cm), N-S (47cm) and base girth (1.0cm). Jamun recorded plant height (120cm), spreading E-W (40cm), N-S (45cm) and base girth (1.0cm).These three germplasm are relatively fast-growing than other minor fruits germplasm. On the other hand, wood apple is growing than all the fruits germplasm. Wood apple attains the lowest plant height (48cm), lowest spreading E-W (15cm), N-S (18cm), and lowest base girth (0.3 cm).

Table1. Growth characteristics minor fruits at nursery

Serial No.	English name	Average Plant height (cm)	Average Spreading		Average Base girth (cm)
			E-W	N-S	
1.	Hogplum	91	70	58	3.16
2.	Ber	93	87	65	1.5
3.	False mangosteen	120	42	28	0.8
4.	Monkey jack	112	55	47	1.0
5.	Jamun	120	40	45	1.0
6.	Wood apple	48	15	18	0.3
7.	Pomegranate	300	40	80	2
8.	Black berry	85	30	34	0.4
9.	Avocado	55	32	33	0.5
10.	Flacourtia	205	115	155	3.3

Conclusion

Considering the parameters it can be concluded that false mangosteen, Monkey jack, and Jamun are fast-growing than other minor fruits in nursery condition. On the other hand, wood apple is slow growing compared to all other fruits. These plants will be planted in the fruit orchard of Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet in this rainy season to know the performance and suitability of these fruit in this region.

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EVALUATION OF CINNAMON GERMPLASM

F. AHMED, M.H.M.B. BHUYAN, J.C. SARKER AND S.M.L. RAHMAN

Abstract

The experiment was conducted at spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet during the period from May 2020 to May 2021 to identify the best germplasm of cinnamon.Three cinnamon germplasm viz. CC Jai-001, CC Jai-002, and CC Jai-003 were evaluated. There were no significant variations among the germplasm tested except quill thickness. Almost all the qualitative parameters found maximum in CC Jai-002 and the minimum in CC Jai-003. The maximum quill fresh and thickness and weight were recorded in CC Jai-002 while minimum in CC Jai-003. The germplasm CC Jai-002 performed best among the treatments under study.

Introduction

Cinnamon (*Cinnamomum cassia* (L.) J.Presl) is a spice obtained from the inner bark of several tree species from the genus Cinnamomum. Cinnamon is used mainly as an aromatic condiment and flavoring additive in a wide variety of cuisines, sweet and savory dishes, breakfast cereals, snack foods, tea, and traditional foods. The aroma and flavor of cinnamon derive from its essential oil and principal component, cinnamaldehyde, as well as numerous other constituents, including eugenol. In Bangladesh, cinnamon is not very common. Some farmers are growing this spice crop on the homesteads, and don't know the processing of the bark. Therefore, quality also varied in the market. In the context of commercial agriculture, variability should be identified for the farmers, consumers, and researchers. Bangladesh Agricultural Research Institute has already released a variety of cinnamon for commercial cultivation. But still, there is an opportunity to release new varieties for farmers' uses.

Moreover, location-specific variety for problem soils and extreme climatic regions should also be selected and released. Yet, it is high time to release a variety through systematic research for the northeastern

part as this region is famous for growing spices crops. The Spices Research Sub-station, under Citrus Research Station, BARI, Jaintapur, is long maintaining three cinnamon germplasm collected locally, and their performance is quite impressive in this extreme climatic zone. Hence, this germplasm should be characterized and evaluated for releasing them as variety and keeping this view in mind; this experiment was undertaken.

Materials and Methods

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during the period from May 2020 to April 2021. There was 3 types of cinnamon germplasm having almost the same ages in this station. These 3 types of germplasm were planted maintaining at least a 3 m distance between plants. Each plant was fertilized with 150 g N, 75 g P_2 O_5 and 150 g K_2 O per plant in two equal splits during the first week of September and in March. Weeding and other inter-cultural operations were done when necessary and before applying fertilizer. Data on plant height, plant spreading, base girth were collected and analyzed by MSTAT-C program for interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

There was no significant variation among the cinnamon germplasm under study except fresh quil thickness (Table 1). The maximum plant height (843.49 cm) was recorded in CC Jai-002while the shortest plant (812.90 cm) was recorded in CC Jai-003. Plants spreading in both directions were maximum with CC Jai-002but lowest with CC Jai-003.Stem base girth was found maximum (16 cm) with CC Jai-002 while lowest (15.33 cm) was from CC Jai-003.

Table 1. Growth characteristics of Cinnamon germplasm

Treatment	Plant height (m)	Base girth (cm)	Spreading	
			E-W (m)	N-S (m)
CC jai-001	8.43	15.67	5.40	6.68
CC jai-002	8.63	16.00	5.40	6.68
CC jai-003	8.12	15.33	5.39	6.65
CV (%)	9.33	6.89	1.07	1.24
LSD (0.05)	7.49 ^{ns}	3.14 ^{ns}	16.89 ^{ns}	25.15 ^{ns}

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test.

Only fresh quill thickness had significant variation among the treatments. The maximum fresh quill thickness (0.14 mm) was recorded with CC Jai-002. On the other hand, the minimum fresh quill thickness was found at CC Jai-003. Quill fresh weight found maximum (16.62 mm) at CC Jai-002 but lowest (13.16 mm) at CC Jai-003. The maximum fresh quill dry thickness and dry weight was found from CC Jai-002 (0.11 mm and 10.92 g respectively, Table 2).

Table 2. Qualitative growth characteristics of Cinnamon form 15 cm long piece of branch

Treatment	Fresh Quill thickness (mm)	Fresh Quill weight (g)	Dry Quill thickness (mm)	Dry Quill weight (g)
CC Jai-001	0.13 ab	15.61	0.1 b	9.33 b
CC Jai-002	0.14 a	17.62	0.11a	10.92 a
CC Jai-003	0.10 b	13.16	0.09 c	7.76 c
CV (%)	10.11	13.12	9.1	7.82
LSD (0.05)	0.37 ^{ns}	5.91 ^{ns}	0.09	1.56

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test.

Conclusion

The maximum fresh and dry quil thickness as well as fresh and dry weight was found with CC Jai-002, which determines the best germplasm. Therefore, CC Jai-002 can be a good source of cinnamon. This is first year observation. The experiment will be repeated in the next year for more confirmation.

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EVALUATION OF BAY LEAF GERMPLASM

M.H.M.B. BHUYAN, J.C. SARKER, F. AHMED AND S.M.L. RAHMAN

Abstract

The study was conducted at spices research sub-station, BARI, Jaintapur, Sylhet during July, 2020 to May, 2021. Three bay leaf germplasm were selected for the study. A wide variability was observed in different parameters such as pungency and size of leaf, yield, pest and diseases infestation among the germplasm studied. TM Jai-001 was superior with biggest leaf followed by TM Jai-003. Among the accessions TM Jai-001 also gave the highest yield but leaf aroma was highest in TM Jai-003.

Introduction

Bay leaf (*Cinnamomumtamala*(Buch.-Ham.) T.Nees&C.H.Eberm.), is an important spice crop in Bangladesh and also known as tejpata is a tree within the Lauraceae family which is native to Bangladesh, India, Nepal, Bhutan, and China. It can grow up to 20 m (66 ft) tall. It has aromatic leaves which are used for culinary and medicinal purposes. It is thought to have been one of the major sources of the medicinal plant leaves known in classic and medieval times as malabathrum. Bay leaves were used for flavoring by the ancient Greeks. It is a fixture in the cooking of many European cuisines (particularly those of the Mediterranean), as well as in the Americas. They are used in soups, stews, meat, seafood, vegetable dishes, and sauces. The leaves also flavor many classic French dishes. The leaves are most often used whole and removed before serving. They can be abrasive in the digestive tract. Thai cuisine employs bay leaf in a few Arab-influenced dishes, notably massaman curry. Spices Research Center under Bangladesh Agricultural Research Institute has already released 26 modern varieties of 12 different spices but still there is no variety of Bay leaves. As Bangladesh is a center of origin of bay leaf there are different unselected strains available throughout different regions of Bangladesh. Therefore, an effort has been taken to select a superior bay leaf germplasm as variety.

Materials and Methods

The experiment was carried out at spices research sub-station, BARI, Jaintapur, Sylhet from July, 2020 to May, 2021 with three germplasm of bay leaf as treatment. The plants were of about same age. At the beginning of the experiment the plants were rejuvenated by pruning of dead and diseased branches, freed them from parasitic plants, algae and lichen. The plants were fertilized with 10 kg cow dung, 500 g urea, 250 g TSP, 250 g MoP and 100 g gypsum in two equal splits one in the month of January (after harvest) and another at the beginning of rainy season in the month of May. The plants were infested by termite during November to February hence two full cover spray of Darsban @ 2mL L^{-1} of water was applied in the trunk. Omite @ 2mL L^{-1} of water and Bavistin @ 1g L^{-1} was applied in the plants for protecting the leaves from gall mites twice in the growing period when new leaves emerged. Data were taken on yield and yield contributing characters and analyzed by MSTAT-C program for interpretation of results (Gomez and Gomez, 1984).

Results and Discussion

Variation was observed in case of yield contributing characters and yield of the germplasm studied (table-1). Leaf size was bigger in CT Jai-001 (18×4.2 cm) while small sized leaf (14.5×4.5 cm) was found from CT Jai- 003. Leaf thickness was also high with CT Jai-001. Dense leaf was found from CT Jai-001 with 3.5 cm long internode while the distance of leaf in other germplasm was higher than CT Jai-001. The highest leaf yield (12 kg/plant) was also found from CT Jai-001 but in case of pungency CT Jai-002 was best with strong aroma. Termite and mite was found in every germplasm which was removed by chemicals. Leaf spot and tip blight was found in every plant and cured by applying fungicide.

Table 1. Yield contributing characters and yield of different Bay leaf germplasm

Parameters		CT Jai-001	CT Jai-002	CT Jai-003
Leaf (cm)	Length	18	14.7	14.5
	Breadth	4.2	5.3	4.5
Leaf thickness (mm)	Fresh	0.3	0.2	0.25
	Dry	0.2	0.15	0.2
Length of inter-node (cm)		3.5	4.5	4
Leaf yield/Plant (kg)		12	10	10.5
Fresh and dry weight ratio		1.7:1	1.9:1	2:1
Moisture		41.78	47.12	50.11
Pungency		Moderately strong	Very strong	Strong
Pest		Termite, Mite	Termite, Mite	Termite, Mite
Diseases		Tip blight, Leaf spot	Tip blight, Leaf spot	Tip blight, Leaf spot

Conclusion

This is the first year study. The experiment will be continued for further confirmation and for selection of one germplasm to be proposed for releasing a variety for commercial cultivation.

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COLLECTION AND EVALUATION OF INDIGENOUS SPICES CROP UNDER SYLHET REGION

J.C. SARKER, F. AHMED, M.H.M.B. BHUYAN AND S.M.L. RAHMAN

Abstract

The study was conducted at Citrus research Station (CRS), Jaintapur, Sylhet. Eleven different indigenous spices crop were collected from different location of Sylhet region. These germplasm were kept in controlled condition in net house for evaluation.

Introduction

Many of the crop cultivars and in some cases, many species already extinct due to climatic change as well as anthropogenic activities. Geographically Sylhet region is surrounded by hills from all three sides. Its burgeoning economy has contributed to the regional attractions of landscapes filled with fragrant citrus, pineapple, agar, rubber, tea as well as spice crops like black pepper, Naga chili, betel leaf and bay leaf plantations. The region has a high rainfall in monsoon with a highly acidic pH of the soil. Therefore, every year a number of germplasm are lost forever. Hence this question arises on collection, documentation and conservation of the spices germplasm. On the other hand, BARI has

released black pepper variety BARI Golmorich-1 which is suitable for cultivation in acidic soil and suitable for hilly ecosystem of Sylhet. After establishment of Spices Research Sub-station, Jaintapur, Sylhet, a systematic efforts have been made periodically to collect indigenous germplasm of spices and its wild relatives. Germplasm conservatories have been established for black pepper, chuijhal (*piper chaba*), bay leaf, Naga chili, pepper, capsicum, plum (Alubukhara), allspice etc. representing the available variability. Therefore, with the thirst of more improved variety different germplasm were collected from different locations of the region and planted at CRS, Jaintapur. These germplasm will further characterized by CRS scientists for enriching gene pool and to evaluate their performance and further thirst of releasing new variety for commercial use in farmer's level. Hence the study has been under taken.

Materials methods

Collection of germplasm was done followed by survey. Farmer's homestead and field were visited from August, 2019 to April, 2021 and the germplasm were collected as seed, scion and cuttings. After collection the germplasm were taken to the CRS nursery. The germplasm were marked systematically after giving an accession number. Moreover, a germplasm collection sheet was documented and kept for future. The germplasm were grafted on different available rootstock or cuttings were planted in nursery beds. These germplasm were conserved under net house condition. Evaluation of these germplasm will be done.

Results and discussion

A lot of variability was found among the germplasm collected. The lists of the collected germplasm were presented in the Table 1.

Table 1. Spices crop germplasm collected locally

Species	Bengali/ Local Name	Scientific name	Accession number	Collecting source	Number of sapling collected
Black pepper	গোলমরিচ	*Piper nigram*	PN Jai-151	Local	10
Chui jhal	চুইঝাল	*piper chaba*	PC Jai-001	Local	05
Allspice	সর্বমসলা	*Pimenta dioica*	PD Jai-001	Local	06
Plum	আলুবোখারা	*Prunus domestica*	PD Jai-001	Local	03
Cinnamon	দারুচিনি	*Cinnamomum cassia*	CZ Jai-001	Local	04
Cubeb	কাবাবচিনি	*Piper cubeba*	PC Jai-001	Local	05
Bay leaf	তেজপাতা	*Cinnamomum tamala*	CT Jai-001	Local	100
Naga chili	নাগামরিচ	*Capsicum chinense*	CC Jai-001	Local	20
Clove	লবঙ্গ	*Syzygiumaromaticum*	SA Jai-001	Local	05
Nutmeg	জায়ফল	*Myristica fragrans*	MF Jai-001	Local	05
Curry leaf	কারিপাতা	*Murraya koenigii*	MK Jai-001	Local	05

Conclusion

All the germplasm are in good growth condition. These germplasm will be characterized and evaluated in the next season.

COLLECTION, CONSERVATION, AND CHARACTERIZATION OF SMALL AND LARGE CARDAMOM GERMPLASM

J.C. SARKER, F. AHMED, M.H.M.B. BHUYAN AND S.M.L. RAHMAN

Abstract

Twenty one germplasm of cardamom (*Amomum subulatum* Roxb.) were collected from spices Research Center (SRC), Bogra, and planted at Citrus Research Station (CRS), Jaintapur, Sylhet in November 2020. The highest plant height was recorded in AS Jai-006 (67.5 cm), which was followed by AS Jai-58 (58.3 cm) while AS Jai-004 (35.2 cm) showed the lowest height. The maximum number of tillers/clump was found in AS Jai-006 (6.3) while the minimum was in AS Jai-004 (3.2). AS Jai-005 produced the highest (25.8 cm) number of leaves per plant while the lowest (9.8) number of leaves/plant produced in AS Jai-004.

Introduction

Cardamom is a valuable spice that is obtained from the seeds of a perennial plant (*Elettaria cardamomum*). Cardamom originates from the coastal area of India. It is now grown in Guatemala, Tanzania, Sri Lanka, El Salvador, Vietnam, Laos and Cambodia. India is the main exporter of dried cardamom. Cardamom is known as the "Queen of Spices". It is one of the most highly priced and exotic spices in the world. It is a perennial tropical herb plant belonging to the ginger family (Zingibaraceae) and grows from a thick rootstalk up to around 6-10 feet. It is indigenously grown in the evergreen forests of the Western Ghats in South India. There are two main types of cardamom: Small green cardamom (*Eletteria cardamomum*) and large red/black cardamom (*Amomum subulatum* Roxb). Large cardamom is known as Alaichiin in Nepal, Badi Alaichiin in India and Alachi in Bangladesh and renounced as black cardamom, black gold, and queen of spices. It is evergreen, perennial, herbaceous plant grown in north facing hill slope (Shrestha *et al.*, 2018). Cardamom is among the world's oldest spices, and is the third most expensive spice following saffron and vanilla (Tangjang and Sharma, 2018). It is the most important cash as well as spice crop of Himalayan region including Nepal, India (Sikkim and Darjeeling hills), and Bhutan (Sharma *et al.*, 2000). It is a climate sensitive crop as it strictly requires cool, moist soil, humid under shaded area (Yadav *et al.*, 2015). This spice is being cultivated in the country for last few years by some large entrepreneurs. But the potentiality of this fruit is not yet defined properly. Keeping this view in mind this experiment was undertaken.

Materials and Methods

Twenty one saplings of six cardamom germplasm were supplied from Spices Research Center, BARI, Bogura and planted at CRS, Jaintapur, Sylhet on November, 2020. The saplings were planted at a distance of 3×3 m. Each plant was fertilized with 20 kg cow dung, 200 g urea, 250 g of TSP, 150 g of MOP, 50 g of gymsum, 20 gm Zinc sulphate and 10 g of boric acid (Mandol *et al*., 2014). The plot was irrigated twice a month in dry period. Bavistin 50wp was applied @ 2g L^{-1} of water to prevent foot and stem rot. Passport data of the germplasm was recorded for the plant height, productive tillers $clump^{-1}$.

Results and Discussion

The highest plant height was recorded in AS Jai-006 (67.5 cm), which was followed by AS Jai-58 (58.3 cm) while AS Jai-004 (35.2cm) showed the lowest height. The maximum number of tillers $clump^{-1}$ was found in AS Jai-005 (6.3) while the minimum was in AS Jai-004 (3.2). AS Jai-005 produced the highest (25.8 cm) number of leaves per plant while the lowest (9.8) number of leaves $plant^{-1}$ produced in AS Jai-004 (Table 1).

Table 1: Growth characteristics of large cardamom

Accessions	Plant height (cm)	Tillers $clump^{-1}$ (no.)	Leaves $plant^{-1}$ (no.)	Growth condition
AS Jai-001	47.5	4.6	13.4	Good
AS Jai-002	40.7	4.1	11.3	Good
AS Jai-003	47.9	5.3	14.2	Good
AS Jai-004	35.2	3.2	9.8	Good
AS Jai-005	58.3	6.3	25.8	Good
AS Jai-006	67.5	5.6	18.4	Excellent

Conclusion

All the plants are now in vegetative stage. Flowering and fruit setting will be expected to start in the next year. That's why the final evaluation and conclusion can be made after this period.

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EFFECT OF SPACING ON THE YIELD OF NAGA CHILI

M.H.M.B. BHUYAN, F. AHMED, J.C. SARKER AND S.M.L. RAHMAN

Abstract

The experiment was conducted during December 2020 to April 2021 at Spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet to determine the effect of spacing on chili production under acidic soil of north eastern region of Bangladesh. The experiment was laid out in randomized complete block design with three replications. Six different levels of spacing were used as treatments viz. T_1 (50×60 cm), T_2 (60×70 cm), T_3 (70×60 cm), T_4 (80×60 cm), T_5 (90×75 cm) and T_6 (100×60 cm). There were significant variations among the treatments. Among the treatments maximum stem diameter (1.83 cm), heaviest fruit weight (5.36 g), and highest yield (12.53 t ha^{-1}) were recorded at T_6. On the other hand, treatment T_1 recorded the least amount of yield contributing characters and lowest yield (6.67 t ha^{-1}). Therefore, the results obtained from the study suggested that 100×60 cm spacing has a great effect for increasing yield of Naga chili and its yield attributes, and can be recommended for farmers' use in the north eastern region of Bangladesh.

Introduction

Naga Chili (*Capsicum chinense* Jacq.) is a woody perennial semi-shrub belonging to the Solanaceae family which is found mostly in the region of North East India. It is considered a spice crop among the people of North East India and northeast parts of Bangladesh. It is abundantly grown in these parts of the region due to its suitable environmental condition. The Naga Chili is known for its pungency, color, and taste. It is a rich source of Vitamin-C and Capsaicin. The people of Bangladesh and North East India especially Khasias, Manipuris, Nagas, and Assamese prefer pungent hot cuisine in their traditional food. So, Naga Chili has a local, traditional and economic importance. It is an interspecies hybrid, mostly *Capsicum chinense* with some *Capsicum frutescens* genes.

Proper spacing is one of the main factors for enhancing the crop morphological and quality attributes leading to more production and productivity. Spacing had a significant effect on the growth and yield of chili. The number of branches $plant^{-1}$, the number of fruits $plant^{-1}$, and yield $plant^{-1}$ were increased with the increasing of plant spacing but plant height and number of leaves significantly increase with the decreasing plant spacing (Sharma and Kumar, 2017). Therefore, proper research on its spacing to increase yield, as well as quality attributes, is necessary. Moreover, the proper spacing of Naga chili is not yet well documented. Keeping this view in mind the present study was undertaken.

Materials and Methods

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during the period from December 2020 to May 2021. The experimental site belongs to AEZ 22 characterized by extremely acidic (pH 4.5-4.8) in nature and heavy rainfall during Kharif season. The experiment was laid out in Randomized Complete Block Design with three replications. The experiment consists of six different levels of spacing used as treatments viz. T_1= 50×60 cm, T_2=60×60 cm, T_3 = 70×60 cm, T_4 = 80×60 cm, T_5 = 90×60 cm, T_6 = 100×60 cm. A promising local line of Naga chili was used as the experimental material. The experimental field was prepared by ploughing and laddering. The entire experimental field was divided into three blocks and each block contains six units' plots. There were 18 individual plots. The treatments were randomly set in each plot. The unit plots were 2.1m×1m in size having a 0.5 m drain between the blocks and plots. There were total 108 numbers of plants. Fifty days old seedlings were planted in the main field maintaining the above-mentioned spacing. After final land preparation dolomite lime (2 t ha^{-1}) was applied to each plot and left for fifteen days for mixing in the soil. A full dose of Cow dung, TSP, Zn, and B was applied at final land preparation. Urea and MoP were applied in two equal splits. The rest of the fertilizers were applied in two splits; half as basal dose during final land preparation and another half as a top dressing after 40 days of transplanting. The plots were covered with blue-colored net for the partial shed as well as to control insect pests and to control cross-pollination. Irrigation, weeding, and other inter-cultural operations were done regularly. Bamboo sticks were used to support the individual plants. Harvesting green chilies started in the first week of April (after 120 days of transplanting) and continued up to May. Acaricide was applied to control mite infestation. Growth characteristics yield and yield contributing characters, the incidence of disease, insect pest data were recorded. Collected data were analyzed by Statistix 10 software for the interpretation of the results.

Results and Discussion

Results showed that there is no significant difference among the treatments (Table 1). Plant height varied from 106.67 cm to 126.67 cm. The tallest plant (126.67 cm) was recorded at both T_3 and T_5 while the shortest plant (106.67 cm) was recorded at T_6. The effect of treatments on plant spreading was insignificant. Plants spread maximum at T_6 but minimum at T_1. The number of primary branches remained the same in all of the treatments. Stem diameter differed significantly with the treatments. Maximum stem diameter (1.83 cm) was found at T_6 while the lowest at T_1 (1.27 cm).

Table1. Effect of spacing on growth characteristics of Naga chili

Treatment	Plant height (cm)	Spreading		Primary branches (no)	Stem diameter (cm)
		E-W (cm)	N-S (cm)		
T_1	120.33	94.33	103.33	2.00	1.27
T_2	126.67	110.00	120.00	2.00	1.46
T_3	116.67	106.67	113.33	2.00	1.53
T_4	120.00	123.33	111.67	2.00	1.60
T_5	126.67	138.33	108.33	2.33	1.57
T_6	106.67	113.33	120.00	2.00	1.83
CV (%)	15.62	23.02	19.92	11.47	19.59
LSD (0.05)	52.853 ^{ns}	74.522 ^{ns}	63.606 ^{ns}	0.6673 ^{ns}	0.8567 ^{ns}

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1= 50×60 cm, T_2=60×60 cm, T_3 = 70×60 cm, T_4 = 80×60 cm, T_5 = 90×60 cm, T_6 = 100×60 cm

Results on fruit and yield contributing characteristics were found significant. Fruits $plant^{-1}$ varied from 98 to 156. The maximum number of fruits $plant^{-1}$ (156.33) was recorded at T_4. On the other hand, the lowest number of fruits $plants^{-1}$ (98.00) was recorded at T_1. Both fruit length and breadth were statistically similar among all the treatments. Single fruit weight was maximum at Treatments T_6 (5.12 g) but minimum fruit weight (3.75 g) was noticed at T_1. The maximum yield $plant^{-1}$ (763.88 g) was obtained at T_6 but the lowest yield (406.92 g) was obtained at T_1. Moreover, T_6 produced maximum yield (12.53 t ha^{-1}) while T_1 produced the lowest (6.67 t ha^{-1}) (Table 2).

Table 2. Effect of spacing on yield contributing characteristics of Naga chili

Treatment	Fruit length (cm)	Fruit breadth (cm)	Fruits plant^{-1} (no)	Fruit weight (g)	Yield (g plant^{-1})	Yield (t ha^{-1})
T_1	4.60	2.47	98.00 c	4.15 c	406.92 d	6.67 d
T_2	4.47	2.17	132.33 b	4.65 b	615.05 bc	10.09 bc
T_3	5.07	2.10	142.67 ab	4.93 ab	702.64 ab	11.52 ab
T_4	5.17	2.13	156.33 a	3.75 c	586.82 c	9.62 c
T_5	5.00	2.13	144.67 ab	3.98 c	575.64 c	9.44 c
T_6	4.90	2.23	149.33 ab	5.12 a	763.88 a	12.53 a
CV (%)	9.00	12.76	4.80	3.32	5.87	5.87
LSD (0.05)	1.2395 ^{ns}	0.7969 ^{ns}	18.663	0.4167	101.10	1.6578

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1= 50×60 cm, T_2=60×60 cm, T_3 = 70×60 cm, T_4 = 80×60 cm, T_5 = 90×60 cm, T_6 = 100×60 cm

Cultivation of Naga chili with varied spacing showed varied monetary return (Table 3). The highest gross return, gross margin, and BCR were recorded from T_6 (1.87) followed by T_3 (1.63). On the other hand, the lowest gross return, gross margin, and BCR were recorded from T_1 (0.53) (Table 3).

Table 3. Cost-benefit analysis of Naga chili production under different plant spacing

Treatment	Gross return	Total cost	Gross margin	BCR
T_1	1000500	692205	308295	0.45
T_2	1513500	666560	846940	1.27
T_3	1728000	666560	1061440	1.59
T_4	1443000	640920	802080	1.25
T_5	1416000	640920	775080	1.21
T_6	1879500	640920	1238580	1.93

Price of Naga chili 150 BDT Kg^{-1}; T_1= 50×60 cm, T_2=60×60 cm, T_3 = 70×60 cm, T_4 = 80×60 cm, T_5 = 90×60 cm, T_6 = 100×60 cm

Conclusion

Considering all the parameters, it can be concluded that spacing has a significant effect on Naga chili. The study revealed that 100× 60 cm spacing performs best considering yield, fruit quality, and BCR. This is the first-year study and should be repeated next year for further confirmation.

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STANDARDIZATION OF SINGLE NODE CUTTINGFOR QUICK MULTIPLICATION OF BLACK PEPPER

M.H.M.B. BHUYAN, S.M.L. RAHMAN, F. AHMED AND J.C. SARKER

Abstract

The experiment was conducted at spices Research Sub-station, Citrus Research Station, BARI, Jaintapur, Sylhet from July 2020 to October 2020 under lath house condition. There were three treatments viz. (a) single-node cuttings, (b) double-node cuttings, (c) triple-node cuttings. Previously standardized potting media (Cocopeat + vermicompost 1:1) was used for planting the cuttings. Commercial rooting hormone cutting aid was used before planting the cuttings. There were variations among the treatments regarding days taken to first sprouting,

number of shoots per cuttings, number of leaves per cuttings, length and diameter of shoots. Among the treatments, maximum success and survivability were obtained from both single and double node cuttings respectively, while the lowest success and survivability found in triple node cutting. Maximum number of shoots per cuttings, number of leaves per shoot, and shoot length were found in triple node cuttings while maximum shoot diameter (0.35 cm) was found in double node cuttings. The result revealed that both single and double node cuttings can be occupied for rapid multiplication of black pepper under nursery conditions.

Introduction

Black pepper (*Piper nigrum* L.), King of Spices, (Piperaceae) is a perennial vine grown for its berries extensively used as spices and in medicine. India is one of the major producers, consumers, and exporters of black pepper in the world. Black pepper is a climbing evergreen plant and grows to a height of 10 m or more. The climbing vines on supporting trees have been classified into five distinct types of stem portion based on the growth habits, morphological characters, and biological functions, as orthotropic, plagiotropic, geotropic, runners, and main stem. Cultivated pepper grown from cuttings produces initially one main climbing stem, but others rapidly appear and branch profusely, and mature vines have a bushy, columnar shape.

Cuttings are the simplest and cheapest method of propagation, but pepper can be grown from seed, graftages, marcottages, or plantlets grown from single-node cuttings (Gigi *et al.* 1993). Plant raised by vegetative propagation required skilled and specialized treatment, cloning allows large numbers to be raised from a selected parent (Singh and Singh 2005). After several years of research Bangladesh Agricultural Research Institute has recommended a black pepper variety JaintiaGolmorich/BARI Golmorich-1 for farmers' cultivation. As a result, an increased number of farmers are now producing black pepper on the homestead and/or commercially. Still, Bangladesh spent 12 million BDT for importing black pepper. Therefore, there is a prospect of Black pepper cultivation for reducing the import of this spice.

Mainly runner shoots at the base of selected high-yielding vine are the main propagating material for black pepper. Runners are separated from the parent vine in February –March, cut into lengths of three to four nodes, and planted in nurseries, or directly into the field. In Bangladesh, Bangladesh Agricultural Research Institute is the main source of cutting for farmers and supplies rooted pepper cuttings to growers at a subsidized price. But as the demand increasing there is a lack of runners for producing rooted cuttings for farmers. Therefore, the present study was designed to standardize the rapid multiplication of black pepper from a minimum amount of parent materials.

Materials and Methods

The experiment was conducted at spices Research Sub-station, Citrus Research Station, BARI, Jaintapur, Sylhet from July 2020 to October 2020 under lath house condition. There were three treatments viz. (a) single-node cuttings, (b) double node cuttings, (c) triple node cuttings. In every cutting one entire leaf was kept to facilitate photosynthesis and rapid growth. Previously standardized potting media (Cocopeat + vermicompost 1:1) was used for planting the cuttings. Commercial rooting hormone cutting aid was used before planting the cuttings. After planting the pot was kept under the shed in the nursery lath house and irrigated regularly.

Results and Discussion

There were variations among the treatments regarding days taken to first sprouting, number of shoots per cuttings, number of leaves per cuttings, length and diameter of shoots (Table 1). Among the treatments, the lowest days for first sprouting were observed from double node cuttings (21.30), whereas the maximum was taken by the triple node cutting (22.56). Maximum success and survivability were obtained from both Single and double node cuttings respectively (60 and 60% respectively), while the lowest success and survivability was from triple node cutting (40%). The maximum number of shoots per cuttings was found from triple node cuttings (1.90) whereas the lowest was from single-node cuttings (1.83). Similarly the number of leaves per shoot (7.04) and shoot length (21.11 cm) was highest in the case of triple node cuttings, while maximum shoot diameter (0.35 cm) was found from double node cuttings (Table 2).

Table 1. Effect of number of nodes on days to sprout, success and survivability of black pepper cuttings

Treatments	Days took to first sprouting	Success (%)	Survivability (%)
Single node cutting	22.05	60	60
Double node cutting	21.30	60	60
Triple node cutting	22.56	40	40
SD	0.63	11.54	11.54

Table 2. Effect of number of nodes on number of shoots per cuttings, number of nodes per cuttings, length, and diameter of shoots of black pepper cuttings

Treatments	No. of shoots/cutting	No. of leaves/shoots	Length of shoots (cm)	Diameter of Shoots (cm)
Single node cutting	1.83	5.74	15.06	0.30
Double node cutting	1.85	6.80	20.91	0.35
Triple node cutting	1.90	7.04	21.11	0.34
SD	0.036	0.69	3.43	0.026

Conclusion

Considering the above result it can be concluded that both single and double node cuttings can be occupied for rapid multiplication of black pepper under nursery conditions. The experiment should be repeated for the confirmation of the results.

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EFFECT OF DIFFERENT POTTING MEDIA ON THE SUCCESS AND SURVIVABILITY OF BLACK PEPPER CUTTING IN NURSERY

F. AHMED, M.H.M.B. BHUYAN, J.C. SARKER AND S.M.L. RAHMAN

Abstract

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute, Jaintiapur, Sylhet during the period from April 2021 to July 2021 to select suitable potting media for quality planting materials production. Nine treatments, viz. T_1= Soil , T_2= Coco dust, T_3= Soil + Coco dust (1:1), T_4= Soil + Vermicompost soil (1:1), T_5= Soil + FYM (1:1), T_6= Coco dust + Vermicompost (1:1), T_7= Coco dust + FYM (1:1) , T_8= Soil + Coco dust + Vermicompost (1:1:1), T_9= Soil + Coco dust + FYM (1:1:1) were tested with three replications. The study revealed that, among the different growth media Coco dust + Vermicompost (1:1) helped in early sprouting, maximum cutting success and survivality, maximum number of newly emerged leaves, maximum number of primary roots/ cutting. Maximum root and shoot length, root and shoot fresh and dry weight found promising in media consisting Coco dust + Vermicompost (1:1). Hence the study proved that, the cuttings grown in the media of Coco dust + Vermicompost (1:1) were proven best for propagating of Black pepper cuttings.

Introduction

Black pepper *(Piper nigrum* L.), of the family Piperaceae, is a perennial export oriented cash crop. It is also known as "King of Spices" and "Gold of Spices". Today it commands the leading position among the spices in world trade. The crop has great economic importance in Bangladesh and some other countries *viz.,* Thailand, Indonesia, Malaysia and Brazil. Now a day's, pre-rooted cuttings from runner shoots are used in commercial level. When hanging shoots are used as planting materials, they take a longer time to establish due to lack of roots at the nodes

(Singh and Singh, 1996).It may also be due to the variation of growing media and cutting from different positions of vines. Production of pre-rooted cutting in light polyethylene bags is the surest way of producing quality planting material throughout India. Application of media has been found to enhance root proliferation. Farmers use the cutting directly in the soil without proper media and facing many problems for slow growth. So the experiment was taken to find out proper media for better growth and success of black pepper cuttings in nursery.

Materials and Methods

The experiment was conducted at Jaintapur, Sylhetconducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhetduring the period from April 2021 to July 2021.The cuttings of black pepper var. BARI Golmorich-1 were used in this experiment. The experiment consists of nine treatments. Viz. T_1 = Soil, T_2 = Coco dust, T_3 = Soil+Cocodust (1:1), T_4 = Soil+Vermicompost soil (1:1), T_5 = Soil+FYM (1:1), T_6 = Cocodust+Vermicompost (1:1), T_7 = Cocodust+FYM (1:1), T_8 = Soil+Cocodust+Vermicompost (1:1:1), T_9 = Soil+Cocodust+FYM (1:1:1). Three nodded cuttings of runners from BARI Golmorich-1 were planted in 7" x 6" poly bags in nursery. Each bag contains only one cutting. The number of replications was three and each replication contains six bags. Days to first sprout, Percent success, Percent survivality, no of leaves/cutting,No of primary roots/cutting, Length of root and shoot (cm), Fresh and dry weight of root and shoot (g) were observed. The data obtained was analyzed by Statix 10 software for interpretation of the results.

Result and Discussion

There were significant differences regarding duration for sprouting, percent success and survivality of the black pepper cuttings grown on different potting media for two consecutive years 2020 and 2021. In the year 2020, the earliest sprouting (17 days), maximum success (100 %) and maximum survivality (94.33%) was observed in Coco dust+Vermicompost (1:1). Similarly, in 2021 earliest sprouting (19 days), maximum success (86.67%) and maximum survivality (89%) was observed in Coco dust+Vermicompost (1:1),which was statistically similar with Cocodust+FYM (1:1). On the Other hand, potting media containing Soil only took longer time to sprout with lowest success and survivality in both the years (Table 1). This might be due to the presence of growth promoting substances in vermicompost which helped in better utilization of stored carbohydrates, nitrogen and other factors. These results are in confirmity with Gavrilov (2010) who reported that vermicompost could be a definitive source of plant growth regulators produced by interactions between microorganisms and earthworms and significantly enhance plant growth.

Table 1. Effect of different potting media on days to first sprout, percent success and percent survivality of black pepper cuttings 75 days after planting in two consecutive years 2020 and 2021

Treatments	Days to first sprout			Success (%)			Survivality (%)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1	24.0a	28.0a	26.0a	80.33cd	33.33e	56.83d	67.33c	44.67d	56.00e
T_2	20.7b	26.0a-c	23.3b	91.67 ab	53.33cd	72.50bc	82.33b	75.33bc	78.83bc
T_3	20.0bc	26.0a-c	23.0b	85.00bc	46.67c-e	65.83b-d	77.67b	69.00c	73.33cd
T_4	20.0bc	27.0ab	23.5b	91.33ab	46.67c-e	69.00bc	78.67b	69.00c	73.83cd
T_5	21.7ab	27.0ab	24.3ab	89.67b	40.33de	65.00cd	93.67a	69.00c	81.33b
T_6	17.0c	19.0d	18.0c	100.0a	86.67a	93.33a	94.33a	89.00a	91.67a
T_7	21.0ab	24.0c	22.5b	80.00cd	73.33ab	76.67b	59.33d	82.33ab	70.83d
T_8	22.0ab	25.0bc	23.5b	73.33d	60.00bc	66.67b-d	42.00e	75.33bc	58.67e
T_9	22.3ab	25.0bc	23.7b	73.00d	60.00bc	66.50b-d	64.67cd	75.33bc	70.00d
CV (%)	5.27	3.96	2.89	3.59	11.91	5.64	3.54	5.26	2.77
LSD (0.05)	3.16	2.86	1.90	8.72	18.9	11.3	7.42	10.8	5.76

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1 = Soil, T_2 = Coco dust, T_3 = Soil+Cocodust (1:1), T_4 = Soil+Vermicompost soil (1:1), T_5 = Soil+FYM (1:1), T_6 = Cocodust+Vermicompost (1:1), T_7 = Cocodust+FYM (1:1), T_8 = Soil+Cocodust+Vermicompost (1:1:1), T_9 = Soil+Cocodust+FYM (1:1:1).

In 2020, the maximum number of primary roots/cutting (15.67), longest root (24.00 cm), highest fresh (12.9 g) and dry (2.72 g) weight of root were found from the cuttings grown on Coco dust + Vermicompost (1:1). Similarly, in 2021 the same potting media (Coco dust + Vermicompost (1:1)) produced the maximum number of newly emerged leaves (4.67), maximum number of primary roots/cutting (16), maximum root (19 cm) and shoot (39 cm) length (Table 2). The physicochemical properties of vermicompost consisting media like optimum water retention capacity and near neutral pH. It is also a source of plant growth regulators, which have probably been resulted in highest rooting percentage. These results are similar with Haissing and Davis (1984) who reported that vermicompost is peat-like with high porosity, aeration, drainage, and water holding capacity. Vermicompost comprising media attributed to the excellent structure, porosity and nutrients in available form such as nitrate nitrogen and soluble phosphorus for excellent rooting. Coir dust has a low particle density indicating its high specific surface, which contributes to the high adsorption of water and ions. Coir dust has a high water holding capacity. Increased root length might be attributed to the better texture and porosity of coir dust which probably facilitated easy penetration of roots and also being a well drained media it promoted better root characters.

Table 2. Effect of different potting media on number of newly emerged leaves/cutting, number of primary roots/cutting, root and shoot length of black pepper cuttings 75 days after planting in two consecutive years 2020 and 2021

Treatments	Newly emerged leaves/cutting (No.)			Primary roots/cutting (No.)			Root length (cm)			Shoot length (cm)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1	1.7bc	2.0d	1.8c	4.3d	4.3e	4.3d	9.0cd	4.3e	6.7e	20.7e	26.0g	23.3d
T_2	2.3bc	3.0c	2.6bc	8b-d	11.7b	9.8b	12.0bc	7.3d	9.7cd	26.7cd	34.0bc	30.3b
T_3	2.7bc	3.0c	2.8bc	11.0b	6.7cd	8.8bc	15.3b	7.7d	11.5bc	31.7b	32.0cd	31.8b
T_4	3.0a-c	3.0c	3.0 b	9.0bc	5.0de	7.0c	11.7bc	4.7e	8.2de	30.3bc	35.0b	32.7b
T_5	3.3ab	3.0c	3.2b	11.0b	5.7de	8.3bc	13.0bc	7.7d	10.3b-d	31.3b	29.0ef	30.2b
T_6	4.7a	4.7a	4.7a	15.7a	16.0a	15.8a	24.0a	19.0a	21.5a	37.0a	39.0a	38.0a
T_7	2.3bc	4.0ab	3.2b	8.3bc	11.7b	10.0b	11.0c	11.3c	11.2bc	25.7d	27.0fg	26.3c
T_8	1.3c	3.3bc	2.3bc	6.0cd	8.0c	7.0c	10.0cd	15.0b	12.5b	23.7de	30.0de	26.8c
T_9	1.3 c	3.3bc	2.3bc	4.3 d	10.7b	7.5c	6.0d	12.7c	9.3cd	22.7de	38.0a	30.3b
CV (%)	25.34	10.23	12.46	16.08	8.42	8.67	11.26	6.96	6.82	5.05	3.10	3.03
LSD (0.05)	1.82	0.95	1.02	3.96	2.13	2.16	4.00	1.98	2.18	4.00	2.86	2.59

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1 = Soil, T_2 = Coco dust, T_3 = Soil+Cocodust (1:1), T_4 = Soil+Vermicompost soil (1:1), T_5 = Soil+FYM (1:1), T_6 = Cocodust+Vermicompost (1:1), T_7 = Cocodust+FYM (1:1), T_8 = Soil+Cocodust+Vermicompost (1:1:1), T_9 = Soil+Cocodust+FYM (1:1:1).

There was a significant difference among the treatments regarding root and shoot fresh and dry weight in both the experimental years, where cuttings grown on cocodust+vermicompost (1:1) produced highest root fresh (1.05 g) and dry (0.07 g) weight. In a similar way this potting media (cocodust+vermicompost (1:1)) contributed in producing maximum shoot fresh (12.9 g) and dry (2.72 g) weight in black pepper cuttings. On the other hand, in 2021 cocodust+vermicompost (1:1) also showedmaximum fresh (1.14 g and 17.99 g) and dry weight (0.43 g and 4.34 g) of roots and shoots respectively. The fresh and dry weight of roots reflects the root parameters recorded. The treatments with better root parameters have higher fresh and dry weights, while treatments with lower root parameters had shown lower fresh and dry weights (Table 3).

Table 3. Effect of different potting media on root fresh and dry weight, and shoot fresh and dry weight of black pepper cuttings 75 days after planting in two consecutive years 2020 and 2021

Treatments	Root fresh weight (g)			Root dry weight (g)			Shoot Fresh weight (g)			Shoot Dry weight (g)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1	0.08e	0.19f	0.13g	0.01d	0.09f	0.05fg	3.95 e	10.25f	7.10d	1.04e	1.97e	1.51e
T_2	0.33c	0.84b	0.58b	0.02cd	0.33b	0.18b	7.33c	15.14bc	11.24b	1.61c	4.88a	3.24ab
T_3	0.43b	0.25ef	0.34ef	0.03bc	0.09 f	0.06ef	8.63b	13.15cd	10.89b	1.98b	4.21b	3.10b
T_4	0.50b	0.09g	0.29f	0.04b	0.03g	0.04g	8.40b	15.44b	11.92b	2.01b	3.37cd	2.69c
T_5	0.51b	0.30e	0.40de	0.04b	0.11f	0.08de	8.25bc	10.91ef	9.578c	1.89 b	2.98d	2.43c
T_6	1.05a	1.14a	1.10a	0.07a	0.43a	0.25a	12.9a	17.99a	15.45a	2.72a	4.34ab	3.53a
T_7	0.32c	0.71c	0.52c	0.02cd	0.29c	0.16b	5.67d	10.76ef	8.21d	1.36d	2.41e	1.88d
T_8	0.22d	0.66c	0.44d	0.01d	0.25d	0.13c	3.99e	12.34 de	8.16d	0.92e	3.17d	2.05d
T_9	0.13de	0.48d	0.30f	0.01d	0.18e	0.10d	4.53e	16.91ab	10.72bc	1.08e	3.86bc	2.47c
CV (%)	8.87	6.08	5.09	19.25	5.93	6.19	4.92	5.24	4.11	5.03	5.50	4.46
LSD (0.05)	0.10	0.08	0.06	0.016	0.034	0.020	0.99	2.04	1.21	0.23	0.54	0.32

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1 = Soil, T_2 = Coco dust, T_3 = Soil+Cocodust (1:1), T_4 = Soil+Vermicompost soil (1:1), T_5 = Soil+FYM (1:1), T_6 =, T_7 = Cocodust+FYM (1:1), T_8 = Soil+Cocodust+Vermicompost (1:1:1), T_9 = Soil+Cocodust+FYM (1:1:1).

Conclusion

Considering all the parameters, treatments T_6 = Coco dust + Vermicompost (1:1) performed best and acts as a good supporting media for black pepper cuttings preparation at nursery. The experiment is continuing to collect more data parameters for surety of the result.

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EFFECT OF DIFFERENT LIVING AND NON-LIVING STANDARDS ON THE ESTABLISHMENT, GROWTH AND YIELD OF BLACK PEPPER CV. BARI GOLMORICH-1

J.C. SARKER, F. AHMED, M.H.M.B. BHUYAN AND S.M.L. RAHMAN

Abstract

An experiment was conducted to study different living and non-living standards on the establishment, growth and yield of black pepper var. BARI Golmorich-1 at Spices Research Sub-station, BARI, Jaintapur, Sylhet from September' 2018 to May' 2019. The experiment consists of three different living and non-living standards as treatment viz. T_1= Reinforced concrete posts, T_2=Bhadi tree (*Lanneacoromandelica* (Houtt.) Merr.) and T_3=Mandar tree (*Erythrinavariegata*L.). The experiment was conducted in Randomized Complete Block Design with four replications. The vines in Bhadi tree exhibited superior performance with respect to average height of vine (470.6 cm), average number of branches/vine (56.52), number of spikes per vine (163.5) and yield(1.3 kg/plant).

Introduction

Black pepper (*Piper nigrum* L.) is an important and widely used spice in the world. India is the major producer and exporter of this crop. Due to the huge requirement of planting material (vine) in Bangladesh, traditional methods including runner shoot multiplication; serpentine method and bamboo multiplication technique are being used for

the large scale production of planting materials (Ravindran, 2000). Black pepper vines require a support for its growth & development and yield. These supports are called standards. Ideal supports play an important role in successful establishment of black pepper vines. Since the black pepper vine is productive for 15 years and more selection of standards assumes great significance. The standards used for trailing black pepper vines are of two types normally living and non-living. The non-living standards include reinforced concrete posts, granite pillars and teak poles. Such non living standards are more commonly used in Malaysia, Brazil and Indonesia (George *et al*., 2005). In Malaysia an parts of Indonesia, the preferred support material is the wooden pole of the Beliam tree (*Eusideroxylonzwageri*, Lauraceac) otherwise called Borneo iron wood which is a high density, heavy, construction timber resistant to white ants. The use of reinforced concrete posts at closer spacing (2×1m) accommodated 5000 plants per hectare and recorded higher yields (Reddy *et al*., 1991). Cultivation of black pepper *(Piper nigrum* L.*)* is restricted in the Sylhet region and Cht. Hill tracts of Bangladesh, so the present study has been undertaken to find out suitable standards on the establishment, growth and yield of black pepper cv. BARI Golmorich-1.

Materials and Methods

The experiment was conducted at Spices Research Sub-station, Bangladesh Agricultural Research Institute, Jaintapur, Sylhet. Semi-hardwood cuttings of black pepper (cv. BARI Golmorich-1) were prepared in August 2016 and kept for rooting and served as base material for planting on different standards (treatments). The experiment consists of three treatments viz. T_1=Reinforced concrete cement (RCC) posts, T_2=Bhadi tree (*Lanneacoromandelica* (Houtt.) Merr) and T_3=Mandar tree **(***Erythrinavariegata*L.). The experiment was conducted in a randomized complete block design and each treatment was replicated thrice. The standard plants Bhadi and Mandar was planted in August 2016 and allowed to grow up to 5 feet height. In the next year (August 2017) the rooted cuttings of black pepper was planted 20 cm apart from the base of the standards. For planting the cutting a trench of 45cm×30cm was dug around the standards and filled with a mixture of cow dung, soil and sand (1:1:1). The planted cuttings were irrigated regularly. No major disease and insects were observed during the experimental period. Data on growth parameters namely, vine height, number of branches/vine, canopy spreading and yield/plant were recorded (Table 1). Data collected on different parameters were analyzed by MSTAT-C program and means were separated following DMRT for further interpretation.

Results and Discussion

The mean height of vines varied from 240.5 cm in T_3 treatment to 470.6 cm in T_2 treatment. Similarly, the number of branches vine^{-1} also varied significantly from 22.67 to 56.52 in the treatments. The maximum number of spikes vine^{-1} was found in T_2 treatment followed by T_1, whereas minimum was found from T_3. Growth condition in T_2 (Bhadi tree standard) was superior over the other standards (Table 1).

Table 1. Growth and yield performance of black pepper on different standards

Treatment	Height of vine (cm)	Branches vine^{-1}(No.)	Spikes vine^{-1}(No.)	Yield (kg plant^{-1})
T_1	350.4	34.45	133.4	0.5
T_2	470.6	56.52	163.5	1.3
T_3	240.5	22.67	77.8	0.3
CV (%)	16.67	26.88	15.66	0.8
LSD (0.05)	73.75	7.11	9.42	4.22

T_1= Reinforced concrete posts, T_2=Bhadi tree (*Lanneagrandis* D.), T_3=Mandar tree (*Erythrina indica*).

Conclusion

In terms of the growth and yield attributes of black pepper from the present experiment, it can be concluded that Bhadi (*Lanneacoromandelica* (Houtt.) Merr.)tree is the best live standard for Black pepper.

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EFFECT OF ORGANIC FERTILIZER FOR SAFE NAGA CHILI PRODUCTION

M.H.M.B. BHUYAN, F. AHMED, J.C. SARKER AND S.M.L. RAHMAN

Abstract

An increase in the application of inorganic fertilizers in the agricultural field deteriorated the soil quality. As a result, organic farming is now popular as it is eco-friendly. Organic fertilizers from plant and animal origin release vital nutrients to the plant for its development. The experiment was conducted at spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet during the period from December 2020 to April 2021 to check the significance and importance of organic manures for Naga chili cultivation. Therefore, this work examines the effect of cow dung, vermicompost, poultry manure, and mustard oil cake on the growth and yield characteristics of Naga chili. After investigation, it was found that the application of cow dung compost recorded maximum fruit length (4.57cm), fruit breath (2.20cm), fruit weight (4.29g), fruits plant^{-1} (44.33), and ultimately fruits yield (2.55 t ha^{-1}) than no usage (0.51 t ha^{-1}).

Introduction

Organic agriculture is the production method supportive of the environment. The application of inorganic fertilizer is a common practice, but using composts derived from various green wastes in agriculture is tardily coming back. Compost contains variable amounts of N, P, and K and it is a valuable source of plant nutrients. Inorganic fertilizers are expensive and sometimes it is not available in the market. On the other hand, organic manure is easily available to the farmers and its cost is low compared to that of inorganic fertilizers. Most often this new type of technology (organic agriculture) is defined as a system for maintenance of the natural fertility of the soil, biological diversity of the species, and the ecological balance of the environment. Naga chili is a cultivated Solanaceous crop. It is mainly used for its pungency. India is the largest producer and consumer of Naga chili among the other major producer of the world. However, the Naga chili, which received the attention of the world scientific community due to its extremely high pungency and unique aroma. It has been acknowledged as the hottest chili in the Guinness Book of World Records (2006). Producing safe fruit and vegetable is a burning issue nowadays. On the other hand, Naga Chili is not only popular among Bangladesh people, but some foreigners also like this chili for its aroma and pungency. As a result, a considerable amount of Naga chili is exported every year. Therefore, safe production technology as well as conserving soil health is important. Keeping this view in mind the present study was undertaken

Materials and Methods

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during the period from December 2020 to April 2021. The experimental site belongs to AEZ 22 characterized by extremely acidic (pH 4.5-4.8) in nature and heavy rainfall during Kharif season. The experiment was laid out in Randomized Complete Block Design with three replications. The experiment consists of five different types of organic manure used as treatments viz. T_1 = Native nutrients, T_2 = Poultry manure (5 t ha^{-1}), T_3 = Vermicompost (3 t ha^{-1}), T_4 = Mustard oil cake (4 t ha^{-1}), T_5 = Cow dung compost (15 t ha^{-1}), T_6 = Farmers practice.

A local line of Naga chili was used as the experimental material. The experimental field was prepared by ploughing and laddering. The entire experimental field was divided into three blocks and each block contains six units' plots. There were 18 individual plots. The treatments were randomly set in each plot. A unit plot was 2.1×1m in size having a 0.5 m drain between the blocks and plots. Each plot contains 6 individual plants and there were total 108 numbers of plants. 50 days old seedlings were planted in the main field maintaining 70×50 cm spacing. Organic fertilizers were applied after final land preparation. The whole field including each plot was covered with a blue-colored net to control insect pests to keep the plants free of artificial pollination. Irrigation, Weeding, and other inter-cultural operation were done when necessary. Bamboo branches were used to support the individual plants. Green chili harvesting starts in the first week of April and continues up to June. Acaricide was applied to control mite infestation. Growth characteristics yield and yield contributing characters, the incidence of disease, Insect pest data were recorded. The experimental data were analyzed by Statistix 10 software.

Results and Discussion

Plant height differed significantly among the treatments. Plant height ranged from 66 cm to77 cm. longest plant (77.33 cm) was recorded in T_4 while the shortest plant (66.33 cm) was recorded in both T_1 and T_5. Plant spreading in both directions was found significant. Plants spread maximum in T_1 but lowest in T_5. The number of secondary

branches was maximum (3.0) in T_2 and T_6 but lowest (2.00) in T_1.Stem diameter was statistically similar to the treatments. Maximum stem diameter (1.43 cm) was found in T_1 while the lowest (1.20 cm) was in T_3, T_4, and T_5. Results showed significant variation between fruit, yield, and yield contributing characteristics. Fruits plants^{-1} varied from 21 to 44. Profuse bearing (44.33 number plants^{-1}) was noticed in T_5. On the other hand; T_1 bears the least number (21.33 number plants^{-1}). Both fruit length and breadth were found maximum in T_3. Individual fruit weight was maximum (4.29 g) was noted in T_5 but thinnest fruit (4.20 g) in T_1. The maximum yield plant^{-1} (832.30 g) was obtained in T_6 but the lowest yield (1.77 g) was obtained in T_1. So T_5 produced maximum yield (2.55 t ha^{-1}) while T_1 produced the lowest yield (0.51 t ha^{-1}). Results revealed that treatment T_5 produced maximum yield (2.55 t ha^{-1}) in the case of cow dung compost application on Naga chili, which influences the plant to maximize yield.

Table 1. Effect of Organic Manure on growth characteristics of Naga chili at first harvest

Treatments	Plant height (cm)	Spreading		Stem diameter (cm)
		E-W (cm)	N-S (cm)	
T_1	66.33 c	76.00 a	92.00 a	1.433
T_2	75.68 ab	74.33 a	73.68 b	1.23
T_3	72.33 b	63.00 b	70.33 bc	1.20
T_4	77.33 a	65.68 b	54.33 d	1.200
T_5	66.68 c	60.00 b	63.33 cd	1.20
T_6	66.75 c	75.23 a	59.43 cd	1.25
CV (%)	2.27	3.89	5.06	19.22
LSD (0.05)	4.5837	7.4320	10.081	0.6781 ^{ns}

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1 = Native nutrients, T_2 = Poultry manure (5 t ha^{-1}), T_3 = Vermicompost (3 t ha^{-1}), T_4 = Mustard oil cake (4 t ha^{-1}), T_5 = Cow dung compost (15 t ha^{-1}), T_6 = Farmers practice.

Table 2. Effect of Organic Manure on yield contributing characteristics of Naga chili

Treatments	Fruit length (cm)	Fruit breadth (cm)	Fruits/plant (no)	Fruit weight (g)	Yield (g plant^{-1})	Yield (t ha^{-1})
T_1	3.07 c	1.33 b	21.33 c	1.77 d	37.95 d	0.51 d
T_2	4.03 ab	1.50 b	22.33 c	2.99 c	66.88 cd	0.90 cd
T_3	4.67 a	1.90 ab	36.33 ab	4.13 b	150.18 b	2.01 b
T_4	3.63 bc	1.47 b	28.33 bc	3.12 c	88.38 c	1.19 c
T_5	4.57 a	2.20 a	44.33 a	4.29 a	190.38 a	2.55 a
T_6	4.51 a	2.21 a	36.54 ab	3.21 c	151.2 b	2.00 b
CV (%)	6.58	13.79	11.27	1.68	11.09	11.09
LSD (0.05)	0.7396	0.6523	9.6929	0.1543	33.346	0.4474

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1 = Native nutrients, T_2 = Poultry manure (5 t ha^{-1}), T_3 = Vermicompost (3 t ha^{-1}), T_4 = Mustard oil cake (4 t ha^{-1}), T_5 = Cow dung compost (15 t ha^{-1}), T_6 = Farmers practice.

Conclusion

Considering all the parameters it can be concluded that cow dung compost has a significant effect on Naga chili and it increases its yield up to 127% compared to farmers practice. The study revealed that cow dung compost (15 t/ha) performs best. The study should be repeated in next year for further confirmation.

Acknowledgement

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EFFECT OF LIME ON THE GROWTH AND YIELD OF NAGA CHILI

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Abstract

The experiment was conducted at spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet during the period from January 2020 to June 2020 and December 2020 to April 2021 to determine the effect of lime for Naga chili production under acidic soil of north eastern region of Bangladesh. The experiment was laid out in randomized complete block design with three replications. Six different levels of lime were used as treatments viz.0, 0.5, 1.0, 1.5, 2.0 and 2.5 t/ha. Among the treatments, number of primary branches, stem diameter, fruit length, fruit breath, fruit weight, fruits plant $^{-1}$, fruit weight and ultimately yield found maximum at T_6 in both the years of 2020 and 2021. On the other hand, treatment T_1 recorded least amount of yield contributing characteristics and lowest yield in two years. Therefore, the results obtained from the study suggested that application of 2.5 t ha $^{-1}$ lime has great effect on Naga chili increasing the yield attributes and can be recommended for farmers use in north eastern region of Bangladesh.

Introduction

Naga chili popularly known as Naga morich is the hottest chili in the world. Naga chili is cultivated due to its extraordinary pungency level. The cultivation of Naga chili in our country is relatively lower than other countries. Most of the agricultural soils of Sylhet region are acidic in nature with pH value of ≥4.9 (Hossain and Sattar, 2002). Dolomite lime is Ca and Mg containing inorganic mineral increases the pH of acidic soil and improves water penetration. It also improves the uptake of major plants nutrients growing on acid soil. Soil with extreme low pH may need liming for having a good yield. On the other hand, too much addition of lime can decrease the availability of micronutrients, especially Fe, Mn, Zn and Cu sufficiently to cause deficiencies of those plant nutrients (Haynes, 1982). Also, over dose of lime application makes insoluble form of phosphate combined with Ca and Mg (Westermann, 1992; Murphy and Sims, 2012). Moreover, a judicious application of lime and fertilizer may help to overcome this problem in acid soils. Determination of an accurate lime requirement for an acid soil is important to bring soil pH in suitable range for facilitating nutrient availability to plants and thereby encourage proper growth and yield of crops. So the present investigation was undertaken to find out influence of lime on growth and yield of Naga chili.

Materials and Methods

The experiment was conducted at Spices Research Sub-station, Citrus research station, Bangladesh Agricultural Research Institute (BARI), Jaintapur, Sylhet during the period from January 2020 to June 2020 andDecember 2020 to April 2021. The experimental site belongs to AEZ 22 characterized by extremely acidic (pH 4.5-4.8) in nature and heavy rainfall during Kharif season. The experiment was laid out in Randomized Complete Block Design with three replications. The experiment consists of six different levels of lime used as treatments viz. T_1=0 t ha $^{-1}$, T_2= 0.5 t ha $^{-1}$, T_3= 1.0 t ha $^{-1}$, T_4= 1.5 t ha $^{-1}$, T_5= 2.0 t ha $^{-1}$, T_6 = 2.5 t ha $^{-1}$ respectively. A local line of Naga chili was used in this experiment. The experimental field was prepared by ploughing and laddering. The entire experimental field was divided into three blocks and each block contains six unit plots. Totally there were 18 individual plots. The treatments were randomly set in each plot. The unit plots were 2.1×1m in size having 0.5 m drain between the blocks and plots. Each plot contains 6 individual plants and there were total 108 numbers of plants. 50 days old seedlings were planted in the main field maintaining 70×50 cm spacing. After final land preparation dolomite lime was applied according to the treatments in each plot and left for seven days for mixing in the soil. Other fertilizers were also applied as per requirements. Full dose of Cow dung, TSP, were applied at final land preparation. Urea and MoP were applied in two equal splits; half at basal dose and another half are at top dressed. The whole field including each plot was covered with blue colored net to control insect pest to keep the plants free of artificial pollination. Irrigation, Weeding and other inter cultural operation were done when necessary. Bamboo branches were used to support the individual plants. Green chili harvesting starts at first week of April and continues up to June. Acaricide was applied to control mite infestation. Growth characteristics yield and yield contributing characters, incidence of disease, Insect pest data was recorded. The experimental data was analyzed at Statistix 10 software.

Results and Discussion

Results showed that there were no significant differences among the treatments regarding plant height, East-West and North-South spreading of Naga chili grown applying different doses of lime in to consecutive years 2020 and 2021. In the year 2020, treatment T_6 recorded maximum plant height (100 cm). But in 2021 treatment T_5 recorded maximum plant height (160 cm) which was statistically similar with other treatments. Plants Spreading was statistically similar in both directions during 2020 and 2021 (Table 1).

Table1. Effect of lime on growth characteristics of Naga chili during 2020 and 2021

Treatments	Plant height (cm)			Spreading					
				E-W			N-S		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1	95.67b	136.67a	116.17a	74.6c	117.33a	96.00a	89.33a	110.00a	99.67a
T_2	94.67b	157.67a	126.17a	78.0bc	113.33a	95.67a	92.67a	126.67a	109.67 a
T_3	97.67ab	143.33a	120.50a	82.67ab	110.00a	96.33a	94.67a	115.00a	104.83 a
T_4	96.33ab	141.67a	119.00a	84.00a	113.33a	98.67a	93.33a	115.33a	104.33 a
T_5	97.67ab	160.00a	128.83a	87.00a	110.00a	98.50a	100.67a	110.00a	105.33 a
T_6	100.00a	136.67a	118.33a	86.67a	115.00a	100.83a	98.33 a	128.33a	113.33 a
CV (%)	1.38	10.71	6.15	2.17	13.92	8.45	4.81	14.31	7.65
LSD (0.05)	3.79	44.27	21.14	5.04	44.60	23.36	12.90	47.63	22.99

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1=0 t ha^{-1}, T_2= 0.5 t ha^{-1}, T_3= 1.0 t ha^{-1}, T_4= 1.5 t ha^{-1}, T_5= 2.0 t ha^{-1}, T_6= 2.5 t ha^{-1}.

Insignificant variations were recorded among the treatments regarding number of primary branches and fruit length (cm) on different doses of lime in both the years. In both the years 2020 and 2021 treatment T_6 produced maximum number of primary branches (2.7 and 3.0, respectively). On the other hand in both years treatments T_1 recorded lowest number of primary branches. Stem diameter differed significantly with the treatments in both the years. In 2020, maximum stem diameter (5.57 cm) was found from T_5 but treatment T_6 produced maximum stem diameter (1.70 cm) in 2021. Again treatment T_1 produced the thinnest stem in both the years. Maximum fruits plant^{-1} (210.67) were found from T_5 in 2020 and 155.33 number of fruits were recorded from T_6 in 2021. Contrary T_1 yielded lowest number of fruits plant^{-1} in both years (Table 2).

Table 2. Effect of lime on yield contributing characteristics of Naga chili during 2020 and 2021

Treatment	Primary branches (no.)			Stem diameter (cm)			Fruits plant^{-1}		
	2020	2021	Mean	2020	2021	Mean	2020	2021	mean
T_1	2.0a	2.0a	2.0a	1.80c	1.30c	3.05c	119.0c	75.67e	97.33 d
T_2	2.3a	3.0a	2.7a	1.03bc	1.43bc	3.23bc	132.67c	96.33 d	114.50 c
T_3	2.3a	2.3a	2.3a	1.27a-c	1.63ab	3.45ab	157.67b	120.67c	139.17 b
T_4	2.3a	2.7a	2.5a	1.33ab	1.87a	3.60a	201.33a	135.00b	168.17 a
T_5	2.0a	2.3a	2.1a	1.57a	1.43bc	3.50ab	210.67a	148.00a	179.33 a
T_6	2.7a	3.0a	2.8a	1.43ab	1.70ab	3.57a	204.33a	155.33	179.83 a
CV (%)	19.08	22.21	13.62	3.55	6.58	3.19	4.99	3.33	3.67
LSD (0.05)	1.23	1.61	0.93	0.53	0.29	0.31	24.144	11.477	15.211

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1=0 t ha^{-1}, T_2= 0.5 t ha^{-1}, T_3= 1.0 t ha^{-1}, T_4= 1.5 t ha^{-1}, T_5= 2.0 t ha^{-1}, T_6= 2.5 t ha^{-1}.

But significant variation on fruit length among the treatments was recorded. In 2020 longest fruit (6.40 cm) was found from T_6, while the shortest (5.80 cm) was from T_1.But in 2021, there were no significant variation among the treatments regarding fruit length, where T_6 produced the longest fruit (6.10 cm) and T_1 produced the shortest (95.17 cm). On the other hand, maximum fruit breath was recorded at T_2 (2.60 cm), which was statistically similar with T_4 and T_6 in 2020. But in 2021 all the treatments produced statistically similar fruit breadth. Fruit weight also differed significantly among the treatments in both the year where treatment T_6 produced the heaviest fruit 5.37 g and 5.36 g in 2020 and 2021, respectively. On the other hand treatment T_1 recorded with the lightest fruit 3.63 g and 4.20 g in 2020 and 2021, respectively (Table 3).

Table 3. Effect of lime on yield contributing characteristics of Naga chili during 2020 and 2021

Treatment	Fruit length (cm)			Fruit breadth (cm)			Fruit weight (g)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
T_1	5.80b	5.17 a	5.48 a	1.97d	1.60a	1.78 b	3.63 c	4.20c	3.97d
T_2	6.43a	5.07 a	5.75 a	2.60 a	1.97a	2.28 a	4.47 b	4.77 b	4.62bc
T_3	6.17ab	5.37 a	5.77 a	2.17bd	2.03a	2.10 ab	4.70 b	5.11ab	4.90b
T_4	6.37a	5.50 a	5.93 a	2.43ab	1.90a	2.17 ab	4.57 b	4.24 c	4.41c
T_5	6.07ab	6.10 a	6.08 a	2.10cd	2.07a	2.08 ab	4.83 b	4.9 ab	4.90b
T_6	6.40a	6.10 a	6.25 a	2.37ac	2.27a	2.32 a	5.37 a	5.36 a	5.36a
CV (%)	3.08	11.01	4.91	4.23	15.48	6.62	3.85	3.38	2.66
LSD (0.05)	0.54	1.73	0.82	0.27	0.86	0.40	0.50	0.46	0.35

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1=0 t ha^{-1}, T_2= 0.5 t ha^{-1}, T_3= 1.0 t ha^{-1}, T_4= 1.5 t ha^{-1}, T_5= 2.0 t ha^{-1}, T_6 = 2.5 t ha^{-1}.

Yield plant^{-1} also differed significantly in both the years. Among the treatments T_6 produced maximum yield/plant (1096 g and 832 g) in 2020 and 2021, respectively; whereas lowest yield plant^{-1} was recorded from T_1 in both the years. Significant variation was also found among the treatments regarding per hectare yield of Naga chili grown using different doses of lime during two consecutive years 2020 and 2021 (Table 4). In 2020, yield ranges from 9.55 t ha^{-1} to 24.27 t ha^{-1} where T_6 produced the maximum yield (24.27 t ha^{-1}), and T_1 produced the lowest (9.55 t ha^{-1}). Although compared to 2020 in 2021 lower yield was obtained from all the treatments where per ha yield ranged from 4.26 t ha^{-1} to 11.17 tha^{-1} but T_6 produced the maximum yield (11.17 t ha^{-1}).

Table 4. Effect of lime on yield of Naga chili during 2020 and 2021

Treatment	Yield (g plant^{-1})			Yield (t ha^{-1})		
	2020	2021	Mean	2020	2021	Mean
T_1	431.4d	317.39e	964.35 a	9.55 d	4.26 e	6.90 d
T_2	590.9c	461.20d	878.03 a	13.08 c	6.19 d	9.63 c
T_3	741.6	616.37c	746.44 b	16.41 c	8.27 c	12.34 b
T_4	919.7b	573.17c	678.99 b	20.36 b	7.69 c	14.02 b
T_5	1019.7ab	736.39b	526.05 c	22.57 ab	9.88 b	16.22 a
T_6	1096.4 a	832.30a	374.40 d	24.27 a	11.17 a	17.71 a
CV (%)	6.82	5.68	5.23	6.82	5.68	5.53
LSD (0.05)	154.38	94.79	102.81	3.42	1.27	2.00

In a column means followed by common letters are not significantly different from each other at 5 % level of probability by Tukey's HSD test. T_1=0 t ha^{-1}, T_2= 0.5 t ha^{-1}, T_3= 1.0 t ha^{-1}, T_4= 1.5 t ha^{-1}, T_5= 2.0 t ha^{-1}, T_6 = 2.5 t ha^{-1}.

Cost benefit analysis

Cultivation of Naga chili with lime showed higher monetary return than no usage. The highest gross return, gross margin and BCR was recorded from T_6=2.5 t ha^{-1} followed by T_5=2.0 t ha^{-1}. On the other hand the lowest gross return, gross margin and BCR was recorded from T_1=0 t ha^{-1} in both the years 2020 and 2021.

Table 5. Cost-benefit analysis of Naga chili production under different doses of lime in two consecutive years 2020 and 2021

Treatment	Gross return	Gross return	Total cost	Total cost	Gross margin	Gross margin	BCR	BCR
	2020	2021	2020	2021	2020	2021	2020	2021
T_1	1432350	639000	906000	396000	526350	243000	0.58	0.61
T_2	1961850	928500	916000	406000	1045850	522500	1.14	1.28
T_3	2462250	1240500	926000	416000	1536250	824500	1.65	1.98
T_4	3053550	1153500	936000	426000	2117550	727500	2.26	1.70
T_5	3385350	1482000	646000	436000	2739350	1046000	4.24	2.39
T_6	3640200	1675500	656000	446000	2984200	1229500	4.55	2.75

Price of Naga chili 150 BDT Kg^{-1}, T_1=0 t ha^{-1}, T_2= 0.5 t ha^{-1}, T_3= 1.0 t ha^{-1}, T_4= 1.5 t ha^{-1}, T_5= 2.0 t ha^{-1}, T_6 = 2.5 t ha^{-1}.

Conclusion

Considering all the parameters it can be concluded that lime has significant effect on Naga chili and it increases its yield up to 262% than no use. The study revealed that (2.5 t ha^{-1}) lime performs best at Spices Research Sub-Station, Citrus Research Station, BARI, Jaintapur, Sylhet. The study should be repeated in next year for final confirmation.

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CONSERVATION OF GERPLASM IN FIELD GENE BANK

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Abstract

A total of 631 germplasm including of 37 crops both indigenous and exotic germplasm is maintaining at the field gene bank of Plant Genetic Resources Centre (PGRC), Citrus Research Station, Bangladesh Agricultural Research Institute, Jaintapur. The fruit germplasm are sweet orange, mango, mandarin, litchi, guava, jackfruit, jujube, aonla, bilimbi, bullocks heart etc. The spices crops are black pepper, bay leaf etc. The exotic germplasm are pear, coffee etc. The intercultural practices were done as and when necessary. The field gene bank has been maintained since 2007 and continued for the following years.

Introduction

Field gene bank is used to store and conserve the plant genetic resources of major crop plants and their crop wild relatives. This is a method of planting plants for the conservation of genes in field condition. For this purpose, an ecosystem is created in different environment as an *ex-situ* conservation. Through this method, one can compare the differences among plants of different species and can study them in detail. It needs more land, adequate soil, weather, etc. Germplasm of important crops are conserved through this method. Field gene bank belongs to *ex-situ* method where genetic variation is maintained away from its original location and samples of a species, subspecies or variety are transferred and conserved as living collections; e.g. cocoa, coconut, oil palm, rubber and many tropical fruits like mango, mangosteen, jackfruit, durian and rambutan. Seeds of some recalcitrant species can only be stored without desiccation for a few days, weeks or months. Even the technology for *in-vitro* conservation of recalcitrant seeds is still being problem with the long regeneration cycle for perennial species (Hawkes, 1982). Some crops are sexually sterile and are dependent on vegetative propagation for survival; examples are yam, taro, cultivated banana, potato, sweet potato, cassava, pineapple and sugarcane. Therefore, the existing germplasm of vegetatively propagated crops are being maintained in field gene bank.

Materials and Methods

The Field Gene Bank of Plant Genetic Resources Centre, CRS, Jaintapur, Sylhet has been established with an aim to conserve vegetatively propagated and recalcitrant seeded plant germplasm. The plants were earthen up after rainy season. Fertilizer was applied by two installments per year following fertilizer recommendation guide (Azad*et al*., 2019) covering before and after rainy season. The plants were watered and weeded as and when necessary. There was no pest and disease infestation during the period. Yam, turmeric, zinger etc. germplasm were harvested in this year and these germplasm have been maintaining at field level. The other germplasm were maintained accordingly.

Results and Discussion

Intercultural operations are regular activities in a field gene bank. These activities have been done in different times of this year for different crops (Table 1 & 2). A total of 631 indigenous and exotic germplasm are conserved at field gene bank.

Table 1. Intercultural operations in field gene bank

Date	Crop name	Intercultural operation
16/06/2020 to 20/07/2020 and 20/12/2020 to 17/01/2021	Coconut, sweet orange, Mandarin, Guava, Jackfruit, Lemon, Wax jambu, Coffee plant, pummelo, Mango, Litchi etc	Weeding
10/12/2020 to 19/12/2020 and 10/03/2020 to 20/03/2020		Spading and application of fertilizer
06/01/2020	Sweet orange	BARI Malta-1 Seedling transferred to the field
12/04/2020	Sweet orange	Spading and application of fertilizer
17/04/2020	Wax jambu	Weeding
18/04/2020	Pear	Weeding
11/05/ 2020	Olive	Weeding
06/06/ 2020	Olive, Rose apple, Coffee plant, Toikor, Jackfruit, Black pepper, Pommelo, Black pepper	Fertilizer application and watering
05/ 07/ 2020	Jackfruit, Black pepper, Pommelo	Weeding
23/01/2021 to 07/03/2021	All germplasm in the field	Weeding
02/04/2021 to 11/04/2021	All citrus germplasm	Weeding

Table 2. List of germplasm maintaining in the field gene bank at PGRC upto June -2021

English name	Scientific name	Acc.	Germ.	English name	Scientific name	Acc.	Germ.
Fruit	**Fruit**						
Olive	*Olea europaea*	195		Burmese grape	*Baccaurea ramiflora*	4	
Bilimbi	*Averrhoa bilimbi*	5		Mandarin	*Citrus reticulata*	57	
Black berry	*Syzygium cumini*	53		Cocunut	*Cocos nucifera*	2	
Cowa	*Garcinia indica*	9		**Sub-Total (A)**		**589**	
Custard apple	*Annona squamosa*	1					
Date palm	*Phoenix sylvestris*	1					
Dillenia	*Dillenia indica*	2		**Spices & Medicinal**			
Elephant's foot apple	*Feronia limonia*	2		Bohera	*Terminalia belerica*	1	
Guava	*Psidium guajava*	36		Chebulic	*Terminalia bellirica*	2	
Hog plum	*Spondias mangifera*	1		Betel leaf	*Piper betle*		
Jackfruit	*Artocarpus heterophyllus*	64		Black pepper	*Piper nigram*	6	
Jujube	*Zizyphus mauritiana*	5		Muhua	*Madhuca longifolia*		
Lemon	*Citrus limon*	1		**Sub-Total (B)**		**9**	
Lime	*Citrus aurantifolia*	2					
Litchi	*Litchi chinensis*	23		**Beverage**			

English name	Scientific name	Acc.	Germ.	English name	Scientific name	Acc.	Germ.
Mango	*Mangifera indica*	2		Coffee	*Coffea robusta*	20	
Monkey jack	*Artocarpus lactuca*	2		**Sub-Total (C)**		**20**	
Orange	*Citrus sinensis*	92					
Pear	*Pyrus communis*	1		**Wild tree**			
Pummelo	*Citrus grandis*	5		Blackboard Tree	*Alstonia scholaris*	3	
Rose apple	*Syzygium jambos*	4		Lebbek Tree	*Albizia lebbeck*	10	
Sapota	*Achras zapota*	4		**Sub-Total (D)**		**13**	
Star goose berry	*Phyllanthus distichus*	4		**Total (A+B+C+D+E)**		**631**	
Sweet lime	*Citrus limon*	1					
Wax jambu	*Eugenia javanica*	3					
Carambola	*Averrhoa carambola*	10					

Conclusion

A total of 631 germplasm including of 37 crops both indigenous and exotic germplasm in the field gene bank.up to June 2021. The field gene bank acts as a reliable source of indigenous and exotic germplasm.

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Technology Transfer

Table 1: Sapling production and distribution of fruits and Spices at CRS, Jaintapur during 2020-21

Name of fruit/Spices crop	Name of variety	Production	Distribution
Mandarin	BARI Kamala-1	1300	1250
Malta	BARI Malta-1	1200	1100
Pummelo	BARI Batabilebu-3	300	250
	BARI Batabilebu-5	500	400
Satkara	BARI Satkara-1	200	200
Guava	Kazi Peyera	100	100
	BARI Peyera 2	500	450
Litchi	BARI Litchu-2	100	100
	BARI Litchi-3	1000	1000
Lemon	Seedless	500	500
	Kolombo lebu	500	500
	Jara	250	250
	Lime	100	80
	Others	200	160
Rootstocks	Pummelo	10000	12400 Used for grafting and planting for mother orchard
	Rough Lemon	500	
	Malta	500	
	Karun Jamir	200	
	Rongpur lime	100	
	Cleopatra mandarin	500	
	CS Jai-001	200	
	CA Jai-010 (Hybrid)	200	
	China Mandarin	50	
	Kalamanshi	50	
	Others	100	
Jackfruit	Local	1400	1000
Jamun	Local	50	50
Lotkon	Local	300	50
Bel	Local	150	100
Betel nut	Local	3000	2500
Black pepper	BARI Golmorich-1	3000	2700
Total =		**27050**	**25140**

Table 2: Dissemination of BARI released varieties & technologiesat CRS, Jaintapur during 2020-21

A. Training organized by CRS, Jaintapur, Sylhet

Sl. No.	Type	Participants	Number of participants
Horticulture			
1.	Farmers' Training	Farmer	40
2.	Field Day	Farmer	100
Spices			
1.	Farmers' Training	Farmer	30
2.	Field Day	Farmer	70

B. Motivational tour held at CRS, Jaintapur, Sylhet

Sl. no.	Type	Participating Organization	Number of participants
1.	Motivational Tour	Ministry of Agriculture	150

Table 3: Demonstration Plot established in farmers field under Safe Fruits and Vegetables Production and Promotion of their exports scheme

Sl. no.	Crop	Variety	Number of Demonstration plots
1.	Lemon	BARI Lebu-5	15
2.	Lemon	Seedless lemon	30
3.	Citron	Bari Jara Lebu-1	20
4.	Guava	BARI Peyera-2	20
5.	Bottle gourd	BARI Lau-4	18
6.	Hyacinth bean	BARI Seam-6	15
		BARI Seam-9	1
		BARI Seam-10	1
7.	Brinjal	BARI Begun-10	20
8.	Chili	Naga chili	2
		BARI Chili-2	2
9.	Onion	BARI Piaz-5	5

Table 4: Seeds and seedlings distribution under Safe Fruits and Vegetables Production and Promotion of their exports scheme

Sl. no.	Crop	Variety	Amount (no./kg)
1.	Lemon	BARI Lebu-5	500
2.	Lemon	Seedless lemon	3000
3.	Citron	Bari Jara Lebu-1	2000
4.	Guava	BARI Peyera-2	2000
5.	Bottle gourd	BARI Lau-4	2 kg
6.	Hyacinth bean	BARI Seam-6	8 kg
		BARI Seam-9	250 gm
		BARI Seam-10	250 gm
7.	Brinjal	BARI Begun-10	300 gm
8.	Chili	Naga chili	5000
		BARI Chili-2	50 gm
9.	Onion	BARI Piaz-5	5 kg

MAINTENANCE OF BARI RELEASEDFRUITS AND SPICES VARIETIES 2020-2021

Sl.No.	Name of fruits	Name of variety	Number of plants	Total number of plants
1.	Komala	BARI Komala-1	300	370
		BARI Komala-2	10	
		BARI Komala-3	60	
2.	Malta	BARI Malta-1	100	102
		BARI Malta-2	2	
3.	Satkara	BARI Satkara-1	150	150
4.	Pummelo	BARI Batabilebu-1	10	175
		BARI Batabilebu-2	5	
		BARI Batabilebu-3	50	
		BARI Batabilebu-4	5	
		BARI Batabilebu-5	100	
		BARI Batabilebu-6	5	
5.	Lemon	BARI lebu-1	5	220
		BARI lebu-2	5	
		BARI lebu-3	5	
		BARI lebu-4	5	
		BARI lebu-5	200	
6.	Taikor	BARI Taikor-1	200	200
7.	Black pepper	BARI Golmorich-1	200	200
8.	Mango	BARI Aam-1	15	103
		BARI Aam-2	10	
		BARI Aam-3	20	
		BARI Aam-4	15	
		BARI Aam-5	05	
		BARI Aam-6	05	
		BARI Aam-7	05	
		BARI Aam-8	05	
		BARI Aam-9	05	
		BARI Aam-10	05	
		BARI Aam-11	10	
		BARI Aam-12	03	
9.	Jackfruit	BARI Kanthal-1	10	20
		BARI Kanthal-2	10	
10	Litchi	BARI Lichu-1	05	450
		BARI Lichu-2	145	
		BARI Lichu-3	300	
11.	Guava	BARI Peyara-1	30	555
		BARI Peyara-2	500	
		BARI Peyara-3	20	
		BARI Peyara-4	05	
12.	Banana	BARI Kola-1	25	37
		BARI Kola-2	02	
		BARI Kola-3	05	
		BARI Kola-4	05	
13.	Ber	BARI Kul-1	15	30
		BARI Kul-2	15	
14.	Sapota	BARI Safeda-1	05	10
		BARI Safeda-2	05	
15.	Wax Jambo	BARI Jamrul-1	05	05
		BARI Jamrul-3	02	02
16.	Golden apple	BARI Amra-1	15	15
17.	Coconut	BARI Narikel-1	30	60
		BARI Narikel-2	30	
18.	Karambola	BARI Kamranga-1	20	20

19.	Anola	BARI Aamloki-1	02	02
20.	Longon	BARI Ashfol-1	05	10
		BARI Ashfol-2	05	
21.	Carambola	BARI Kamranga-1	20	20
			Total	2756

MAINTENANCE OF DIFFERENT FRUITS AND SPICES GERMPLSM 2020-2021

Sl. No.	Name of crop	Name of germplasm/varieties	Number of plants	Total number of plants
1.	Mandarin	Local komala	300	640
		Bhutan Komala	20	
		Indian Komala	20	
		Others (From seed)	300	
2.	Malta	Washington navel	20	92
		Variegated malta	10	
		Valencia Orange	10	
		Decibre	50	
		Thai Malta	2	
3.	Lemon	Karun Zamir	11	608
		Ashkar	12	
		Kata lebu	17	
		Guljara	87	
		Adazamir	54	
		Jara labu	120	
		Pati lebu	12	
		Shashni	15	
		Kagaji Lebu	200	
		Seedless lebu	80	
4.	Sweet orange	Sweet orange	10	
5.	Root stock	Trifoliate Orange	03	138
		Rough lemon	100	
		Tryor citrange	03	
		Rangpur lime	02	
		Cleopatra mandarin	25	
		Kalamonsi	03	
		Citrumelo	02	
6.	Pummelo	Local	100	100
7.	Mango	Langra	10	30
		Mollica	10	
		Komala sinduri	10	
8.	Jackfruit	Local	500	505
		Graftage	05	
9.	Litchi	Mongol bari	100	150
		Local	50	
10.	Banana	Sobri (Local)	20	20
11.	Guava	Sayedi Peyara	02	305
		Poly peyera	03	
		Local	300	
12.	Velvet Apple	Local	15	15
13.	Lukluki	Local	21	21
14.	Rose Apple	Local	26	26
15.	Cowa	Local	56	56
16.	Bel	Local	97	97
17.	Star goose berry	Local	02	02

18.	Lotkon	Local	100	105
		advanced line	05	
19.	Strawberry	Local	20	20
20.	Plum	Local	06	06
21.	Palm	Local	250	250
22.	Indian Dilenia (Chalta)	Local	36	36
23.	Indian Olive	Local	455	455
24.	Jamun	Local	19	19
25.	Rambutan	Local	3	3
26.	Bilimbi	Local	03	03
27.	Ber	Local	23	23
28.	Sapota	Local	35	35
29.	Bullock's heart	Local	25	25
30.	Wax jambu	Local	49	49
31.	Wood apple	Local	20	20
32.	Golden apple	Local	05	05
33.	Khirni	Local	02	02
34.	Aonla	Local	04	04
35.	Betel Nut	Local	6000	6000
36.	Pear	Local	02	02
37.	Longan (Ashfal)	Local	09	09
38.	Monkey Jack	Local	08	08
39.	Tamarind	Local	01	01
40.	Star Apple	Local	01	01
41.	Cassia	Local	03	03
42.	Bay Leaf	Local	385	385
43.	Chapalish	Local	01	01
44.	Neem	Local	05	05
45.	Arjun	Local	05	05
46.	Wood Apple	Local	05	05
47.	Agar	Local	250	250
48.	Eucalyptus	Local	05	05
49.	Horitoki	Local	05	05
50.	Bohera	Local	04	04
51.	Debdaru (weeping)	Local	08	110
52.	Dragon fruit	Exotic	50	50
53.	Dayfal	Local	01	01
54.	Bakul	Local	15	15
55.	Coconut	Local	25	25
56.	Black pepper	Local	05	05
57.	Cinnamon	Local	8	8
58.	Cardamom	Local	13	13
59.	All spices	Local	2	2
60.	Cubeb	Local	38	38
61.	Betel leaf	Local	9	9
62.	Chui jhal	Local	6	6
63.	Clove	Local	05	05
64.	Nutmeg	Local	05	05
65.	Curry leaf	Local	05	05
66.	Naga chili		20 (5lines)	20
			Total	**9531**

Appendix I. Meteorological information

Monthly average maximum and minimum temperature and total rainfall during the period from July 2020 to June 2021 at CRS, BARI, Jaintapur, Sylhet

Month	Fortnight	Temperature (°C)			Rainfall (cm)	Rainy days (No.)	RH (%)	Avg. Sun shine hours
		Max.	Min.	Avg.				
July 2020	1st	29.10	24.06	26.09	616.20	14	91	5.6
	2nd	30.90	25.54	27.71	331.80	8	84	6
August 2020	1st	29.39	24.15	26.19	389.02	11	90	6.2
	2nd	31.21	25.65	27.81	293.60	9	84	6.6
September 2020	1st	29.20	23.57	25.90	276.66	10	83	6.8
	2nd	31.00	25.03	27.50	313.20	12	89	7.2
October 2020	1st	30.66	22.90	26.46	117.66	5	80	8.9
	2nd	27.74	20.71	23.94	104.34	5	80	8
November 2020	1st	28.56	17.64	22.99	16.43	2	73	9.5
	2nd	25.84	15.96	20.81	14.57	0	72	8.6
December 2020	1st	25.83	13.75	19.64	7.41	1	70	8.2
	2nd	23.37	12.45	17.77	6.89	0	68	8.1
January 2021	1st	22.89	10.96	16.78	6.36	0	68	8.5
	2nd	24.31	11.64	17.82	5.64	2	74	8.96
February 2021	1st	25.41	13.10	19.11	27.03	1	65	9
	2nd	26.99	13.91	20.29	23.97	2	69	9.5
March 2021	1st	27.94	16.59	22.21	108.12	3	66	8.6
	2nd	29.66	17.61	23.59	95.88	5	70	9.3
April 2021	1st	28.42	20.18	23.96	311.64	8	78	7.3
	2nd	30.18	21.42	25.44	276.36	8	84	7.2
May 2021	1st	28.91	22.21	25.12	406.51	9	83	6.7
	2nd	30.69	23.59	26.68	360.49	11	89	7.1
June 2021	1st	29.00	23.77	25.90	507.74	10	20	5.5
	2nd	30.80	25.24	27.50	450.26	11	22	5.9
Average		**28.25**	**19.65**	**23.63**	**211.15**	**6.13**	**73**	**7.64**

Appendix II. Scientists and scientific assistants at CRS Jaintapurduring 2020-21

A. Scientists

Sl. No.	Name	Designation	Discipline	Remarks
01.	Dr. Shah Md. Luthfur Rahman	PSO	Horticulture	In-charge
02.	Dr. M. H. M. Borhannuddin Bhuyan	SO	Soil Science	
03.	Jhutan Ch. Sarker	SO	Soil Science	
04.	Faisal Ahmed	SO	Agronomy	Farm super

B. Scientific Assistants

Sl. No.	Name	Designation	Posting
01.	Md. Yeakub	Scientific Assistant	Nursery
02.	Abaid ullah	Scientific Assistant	PGRC
03.	Md. Salahuddin Prodhania	Scientific Assistant	Farm Division
04	Kaysar Hamid	Scientific Assistant	Horticulture
04.	Shahadat Hossain	Scientific Assistant	Spices