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POMOLOGICAL TRAITS AND PROFITABILITY OF SELECTED VELVET APPLE GERMPLASM

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Abstract

The research was accomplished during February to August 2021 at Germplasm Center (GC) of Patuakhali Science and Technology University (PSTU) and farmers' homesteads in Patuakhali district to find out the different characteristics, fruit yield and profitability of four velvet apple germplasm. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Results manifested that there were significant variations among the germplasm, where local red germplasm exhibited the highest plant height (5.5 m), plant diameter (16.23 cm), number of main branches (12.8), length of the largest branch (3.9 m), plant canopy (8.80 m^2), leaf area (135.2 cm^2) but those traits were minimum in PSTU Bilati gab-2. PSTU Bilati gab-2 emerged floral bud for the longest duration (32.3 days). The measured length of inflorescence before first flowering varied from 5.03 – 6.60 cm where it required 24-28.3 days for development. A range of flowers per inflorescence (7.8 – 11) and duration of flowering (46.5 – 59.3 days) were observed in all the studied germplasm. The percentage of fruit set (18.3 – 30.8) per plant with individual fruit weight 126.70 to 202.43 g. The highest pulp weight (103.9 g) was obtained from PSTU Bilati gab-2 and the lowest (69.25 g) from local yellow germplasm. PSTU Bilati gab-2 was completely seedless. So, it contained the highest edible portion (81.92%). The highest fruit yield (3.5 t/ha) was recorded in PSTU Bilati gab-1 but maximum net profit (251160 Tk/ha) was obtained from PSTU Bilati gab-2 with the highest benefit cost ratio (BCR) of 3.81. Considering percent fruit set, percent edible portion, fruit yield and profitability, PSTU Bilati gab-2 was found to be the best among the four germplasm.

Keywords: Fruit yield, Germplasm, Profitability, PSTU Bilati gab, Velvet apple

Introduction

Velvet apple (*Diospyros discolor* Wild.) is an evergreen tree under the family Ebenaceae (Greuter, 2000), designated as cultivated exotic fruit in Bangladesh (Pasha *et al.*, 2019), which is originated from Philippines (Singh, 1998). Particularly it is native to low and middle altitude of Philippines which later introduced to Java, Malaysia, India and subsequently in all tropical area. It has several English names like 'Mabolo', 'Butter fruit', 'Camogan ebony', 'Velvet persimmon' but in Bangladesh it is termed as 'Gab' (Lim, 2012). It is commonly found in Assam, Bihar and southern part of India. In

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Malaya, it is known as 'buahmantega' or' buahsakhlat' or 'sagalat' and recently it has been reducing in number there. As an ornamental plant, it is seldom planted in India (Haque *et al.*, 2020). Though it has been growing for many decades in Bangladesh but widely grown in the district of Kustia, Jashore, Faridpur, Rajshahi, Barishal, Pirozpur, and Chattogram Hill Tracts region (Ahmed *et al.*, 2011).The plants of velvet apple thrive in a variety of soils and environments, from sea level to 750 meters (Hossain *et al.*, 2015) and they are dioecious, extensively branched, grow to heights of 7–32 m. They have a stout trunk of 50–80 cm diameter, dark brown to black bark with furrows having conical shape crowns. Shape of leaves are categorized as elliptical-oblong to oblong, 20–29 cm length and 6-11 cm width, with obtuse base and acuminate apex, dark green upper surface, glossy, glabrous and lower surface silvery, petiole up to 1.7 cm long and densely pubescent. Leaves at young stage are pinkish to pale green and silky hairy (Haque *et al.*, 2020 and Lim, 2012). The inflorescence of velvet apple is termed as axillary cymes, solitary or cluster where three to seven flowers arises from the leaf axile. Flower are unisexual, incomplete, regular, bracteate, hypogynus, 3-5 sepals, 4-5 petals, 3-5 stigmas with 4 multicarpellary superior ovary. The length of sepal varies between 0.8-1.3 cm and breath 0.8-1.2 cm where the area varies between 0.64 -1.56 cm^2. In case of petal, the length varies between 1.5-2.0 cm, breath 2.0 -2.6 cm and the area varies from 3.01-5.20 cm^2. On the other hand, stigma length varies from 0.3-0.6 cm (Fakir *et al.*, 2018).

The fruit is very tasty and attractive due to its beautiful reddish color (Haque *et al.*, 2020). The surface of the fruit is covered by brown or dull red powdery velvet structure. Although, ripe fruits are delicious, often served as dessert because of its sweet and melting pulp but, immature fruits are astringent. Owing to its sweet taste and aroma, people including children like it too much (Ahmed *et al.*, 2011). Despite being nutritious fruit, it is underutilized as human food because of its nauseous odor comparable to spoiled cheese or cat feces and the rind hair which is irritating to sensitive skin (Pobar, 2013). Fruits are nutritionally rich which contain (per 100 g of edible portion) calories 113 cal, water 69.6 g, carbohydrates 26.6 g, fibre 1.5 g, fat 0.1 g, protein 1.4 g, minerals 0.8 g, calcium 58 mg (Mondal, 2000). The moisture content of different velvet apple germplasm ranges from 77.5-82.5% where range of the approximate dry matter is 17.5-22.5% (Haque *et al.*, 2020). Apart from seed propagation, velvet apple can be propagated by grafting. Seedling plants are normally planted from 25 to 30 feet from each other (Hossain *et al.*, 2015). As a minor tropical fruit, velvet apple is not extensively cultivated, consumed and traded in Bangladesh because of being very limited both geographically and quantitatively, than those of major fruits (Saúco, 2013). Less emphasis on characterization and commercial cultivation as well as lack of proper documentation are the main problems of velvet apple production. Moreover, it is a high yielding plant with minimum investment. Considering the cost of production, the commercial cultivation of velvet apple will be more profitable. In 2015, Patuakhali Science and Technology University (PSTU) registered two varieties of velvet apple, where one having very few seeds namely "PSTU Bilati gab-1" and another was completely seedless variety namely "PSTU Bilati gab-2" but both of these were delicious comparing with local or wild germplasm. As grafted trees both of the germplasm become dwarfed height. Before commercial cultivation, a comparative pomological traits and profitability of the varieties needed to be checked.

Materials and Methods

Experimental materials and procedures

The research was conducted at Germplasm Centre, PSTU and different locations of Patuakhali district (located in between $21^0$48' and $22^0$36' north latitudes and in between $90^0$08' and $90^0$41' east longitudes) of Bangladesh during the year 2021. Four velvet apple germplasm, namely local red, local yellow, PSTU Bilati gab-1 and PSTU Bilati gab-2 were included in this study. The local germplasm were spontaneously grown farmers trees while PSTU varieties were grafted trees. However, the fruiting year-2 was commonly considered for selecting each of the germplasm. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Data were collected following the descriptor (reference) of Ebenaceae family and collected data were analyzed using JMP 14 computer program.

Plant characteristics

The height of plants, bole height, diameter and length of large branches were measured in meter (m), branching pattern and number of main branches were counted from the experimental sites. Considering the width of branches expansion as radius (r), the canopy was measured by this formula of, canopy = πr^2. The leaf area was measured by a leaf area meter (Mod: LAM-B).

Flower and fruit characteristics

Samples of flowers and fruits were collected from each location and carried them to postharvest laboratory of Department of Horticulture, PSTU. Data on flower and fruit characteristics were taken in the laboratory, in addition, data on flowering position, duration of bud emergence, days required for floral development, flowering duration, earliness of flowering, percent fruit set per plant and duration of fruit bearing were collected in the field condition.

Percent fruit set per plant

The numbers of fruit setting were counted from randomly selected 10 inflorescence of every plant and total number of flowers and total fruit sets were recorded. The percent fruit setting was measured according to the formula of Roy (1997), expressed as;

$$Percent\ fruit\ setting\ (\%) = \frac{total\ number\ of\ opened\ flower}{total\ numbrt\ of\ fruit\ beared} \times 100$$

Percent edible portion

It was determined by using this formula of Sharma (2004)-

$$Edible\ portion\ (\%) = \frac{Weight\ of\ the\ edible\ part}{weight\ of\ the\ whole\ fruit} \times 100$$

Determination of dry matter content (%)

Twenty grams (20 g) of fruit flesh was taken in an aluminum foil and kept in an electric oven at 80°C for 72 hours until the weight became constant. Thereafter, the percent moisture content of fruit was calculated using the following formula:

$$Percent\ moisture\ content = \frac{Initial\ weight\ (g) - Final\ weight\ (g)}{Initial\ weight\ (g)} \times 100$$

Percent dry matter content was calculated using the following formula: % dry matter = 100 - % moisture content.

Organoleptic evaluation

It was done at full ripe stage. A panel of 10 members were selected, they were instructed to score the difference of samples by allotting the number from 0 – 5 against the traits. The scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, 1 for poor and 0 for very poor.

Yield and profitability

The total approximate number of plant per hectare was estimated by the following formula-

$$Desired\ Plant\ Population\ (DPP) = \frac{10000\ m^2}{spacing\ (m^2)}$$

Using this formula, actual number of plants were counted per hectare area. The spacing of velvet apple was considered 6 m × 6 m. In case of PSTU Bilati gab-1 and PSTU Bilati gab-2, 9900 m^2 was allocated for plants population and rest 100 m^2 was allocated for graft production but for other two local varieties total unit of land was allocated. The average fruit yield per plant was calculated for every respective germplasm in kilogram (kg) and then the amounts were converted to per hectare area by the following formula -

$$Per\ hectare\ yield\ of\ velvet\ apple\ fruit\ (t) = \frac{DPP \times yield\ of\ fruit\ per\ plant\ in\ kilogram}{1000}$$

The profitability was measured by analyzing the benefit cost ratio (BCR), where the input cost in taka (Tk) was designated as- i. Labor cost-total number of labor in a year were counted. It was multiplied by the daily wage (600 Tk) per labor, ii. Manure and fertilizer cost, iii. Pesticide cost, iv. Irrigation cost v. Graft making cost and vi. Miscellaneous. As output/ income, the estimation was taken on two products (Fruits and Grafts) - 1. Fruits: In case of local variety, fruit was the only output for commercial cultivation of velvet apple, that's why there was no scope to get other income from it where the considered price of fruit of both local varieties, PSTU Bilati gab-1 and PTU Bilati gab-2 were 40 Tk, 50 Tk and 70 Tk, respectively. 2. Grafts: There is a good demand of PSTU Bilati gab-1 and PSTU Bilati gab-2 to the farmers and entrepreneur. Approximately 250 graft were established in a year which were distributed to the farmers and entrepreneurs @ 100 Tk and 120 Tk, respectively. Income from fruits was recorded by the formula, DPP × Average yield per plant (Kg) × Price of fruit per Kg (Tk)**.** So, Gross income = income from fruits + income from grafts. The net benefit estimated by subtracting the total cost (Tk) from gross income (Tk). So, the benefit cost ratio was obtained by using the following formula:

$$Benefit\ cost\ ratio = \frac{Gross\ income}{Total\ cost\ of\ production}$$

Results and Discussions

Plant characteristics

Plant characteristics varied significantly among the germplasm. The highest plant height (5.54 m), bole hight (1.67 m), diameter of plant (16.23 cm), number of main branches (12.75) (Table 1), length of largest branch (3.89 m), plant canopy (8.41 m^2), leaf area (135.24 cm^2) (Table 2) were observed in local red variety, while the local yellow variety had the similar results. On the other hand, PSTU Bilati gab-2 performed the least in most of the above mentioned traits indicating a highly dwarf plant growth characteristics. These variation among the germplasm might be due to the difference in spontaneously or seeded plant and graft plants. Grafting inhibits apical dominance of scion growth due to the variation in auxin cytokinin ratio (Wang *et al.*, 2017), which in return develop short height plant. Different branching pattern like horizontal, opposite, verticillate and irregular were found accordingly among the germplam. Similar observation was found in the study of Hossain *et al.*, 2015.

Table 1. Plant characteristics of different velvet apple germplasm

Germplasm	Plant height (m)	Bole height (m)	Diameter (cm)	Number of main branches
Local red	5.54 a	1.67 a	16.23 a	12.75 a
Local yellow	5.50a	1.53 a	14.78 ab	11.50 a
PSTU Bilati gab-1	3.33 b	0.58 b	13.10 b	5.25 b
PSTU Bilati gab-2	2.15 c	0.60 b	9.27 c	5.25 b
CV (%)	4.60	11.06	8.31	17.19

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT.

Table 2. Plant characteristics of different velvet apple germplasm

Germplasm	Length of the largest branch (m)	Branching pattern	Plant canopy (m^2)	Leaf area (cm^2)
Local red	3.89 a	Horizontal	8.41 a	135.24 a
Local yellow	2.68 b	Opposite	7.08 b	134.33 a
PSTU Bilati gab-1	2.56 bc	Verticillate	8.80 a	116.49 ab
PSTU Bilati gab-2	2.16 c	Irregular	7.10 b	104.32 b
CV (%)	7.00		9.12	8.71

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT.

Flower and fruit characteristics

The flower traits of velvet apple germplasm were observed meticulously where terminal flowering was observed in both local germplasm and both axile and terminal flowering were found in PSTU Bilati gab-1 and PSTU Bilati gab-2. In addition, local red germplasm produced bud of light green color, local yellow variety of olive green and

both PSTU Bilati gab-1 and PSTU Bilati gab-2 of green flower bud. Wallnöfer (2001) reported that ebenaceae developed bud in the axile of leaves. Maximum duration of floral bud emergence (32.25 days) was observed in PSTU Bilati gab-2 while it was minimum (22 days) in local red germplasm. PSTU Bilati gab-1 produced the largest inflorescence (6.60 cm) but the longest flower (2.70 cm) was produced in local red germplasm where PSTU Bilati gab-2 formed the smallest flower (2.23 cm). The widest diameter (1.11 cm) of flower was recorded in PSTU Bilati gab-1 but the narrowest (0.99 cm) was found in PSTU Bilati gab-2. The longest sepal (1.45 cm) and the longest petal (2.35 cm) were observed in local red germplasm while PSTU Bilati gab-2 gave the smallest value in both cases (1.25 cm and 1.88 cm, respectively) (Table 3).

Table 3. Flowering behavior of different velvet apple germplasm

Germplasm	Duration of bud emergence (Days)	No. of flower per inflorescence	Length of inflorescence (cm)	Days required for development	Length of flower (cm)	Diameter of flower (cm)
Local red	22.00 b	9.75	5.03 c	28.25 a	2.70 a	1.00 b
Local yellow	23.75 b	8.25	6.05 b	26.00 b	2.58 a	1.04 ab
PSTU Bilati gab-1	25.00 b	7.75	6.60 a	29.75 a	2.48 ab	1.11 a
PSTU Bilati gab-2	32.25 a	11.00	5.88 b	24.00 c	2.23 b	0.99 b
CV (%)	16.45		2.55	3.27	8.96	3.89

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT.

Table 4. Flowering behavior of different velvet apple germplasm

Germplasm	Length of sepal (cm)	Length of petal (cm)	Width of sepal (cm)	Width of petal (cm)	Duration of flowering	Earliness of flowering
Local red	1.45 a	2.35 a	1.13	0.64 b	46.50 c	0.00 c
Local yellow	1.25 b	1.89 b	1.13	0.66 b	51.00 b	4.25 b
PSTU Bilati gab-1	1.33 ab	2.15 ab	1.20	0.75 a	57.50 a	5.75 b
PSTU Bilati gab-2	1.25 b	1.88 b	1.33	0.61 b	59.25 a	10.75 a
CV (%)	6.17	6.76		3.72	2.75	20.88

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT

On the other hand, width of petal was statistically identical which ranged from 1.13 – 1.33 cm but PSTU Bilati gab-1 formed the widest petal (0.75 cm) whereas the narrowest (0.61 cm) found in PSTU Bilati gab-2. Fakir *et al*. (2018) mentioned that the length and breadth of sepal were 1.04±0.037 cm and 1.03±0.031 cm, respectively, and the length and breadth of petal were 1.78±0.035 cm and 2.32±0.041 cm, respectively. PSTU Bilati gab-1 required the longest time (29.75 days) for flower development but PSTU Bilati gab-2 needed the least time (24 days). The highest number of flowers

(11.00) were produced in PSTU Bilati gab-2 having statistical no difference with others. Similarly, PSTU Bilati gab-2 had been produced the longest duration of flowering (59.25 days) and performed earliness of flowering (10.75 days) while local red germplasm showed the poorest performance both of those traits (Table 4). These results were supported by the findings of Hossain *et al.* (2015) where they reported 21-26 days required for floral bud development and had been flowered for 50-58 days. The spheroid, ellipsoid, elongated and elliptical shaped fruits were observed in our studied germplasm. The skin color of fruits were differentiated as deep red, yellow, reddish brown and brown. Both the local red germplasm and PSTU Bilati gab-2 consisted of creamy white flesh color where local yellow variety and PSTU Bilati gab-1 exhibited yellowish and white color, respectively (Table 5 and Fig. 1). The research finding had similarity with those traits reported by Haque *et al.*, 2020.

Table 5. Fruit characteristics of different velvet apple germplasm

Germplasm	Shape	Skin color	Flesh color
Local red	Spheroid	Deep red	Creamy white
Local yellow	Ellipsoid	Yellow	Yellowish
PSTU Bilati gab-1	Elongated	Reddish brown	White
PSTU Bilati gab-2	Elliptical	Brown	Creamy white

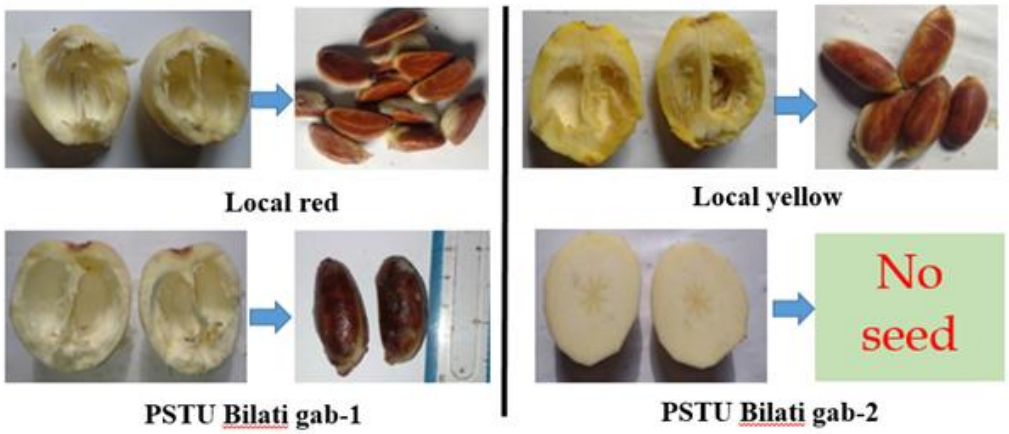


Fig. 1. Pulp and seed of different velvet apple germplasm

The highest fruit set (30.81%), number of fruits per branch (30), the longest fruit (9.78 cm) and the widest fruit (7.04 cm) were found in PSTU Bilati gab-1. Similarly, the highest weight of fruit, the highest weight of peel and the highest weight of pulp were also recorded in PSTU Bilati gab-1 to be 202.43 g, 31.25 g and 145.73 g, respectively but the lowest values were recorded randomly among the germplasm (Table 6).

Table 6. Fruit characteristics of different velvet apple germplasm

Germplasm	Fruit set per plant (%)	No. of fruits per branch	Length of fruit (cm)	Width of fruit (cm)	Weight of fruit (g)	Weight of peel (g)	Weight of pulp (g)
Local red	22.43 b	28.00	8.35 ab	6.26 b	152.58 b	27.83 a	81.04 c
Local yellow	20.63 b	27.50	8.01 b	6.03 b	129.78 b	21.98 b	69.25 c
PSTU Bilati gab-1	27.25 a	30.00	9.78 a	7.04 a	202.43 a	31.25 a	145.73 a
PSTU Bilati gab-2	26.45 a	29.75	5.83 c	6.48 ab	126.70 b	21.83 b	103.85 b
CV (%)	6.47		8.29	4.28	9.01	6.19	8.30

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT

Local red germplasm gave the highest number of seed and maximum weight of seed were 6.49 and 41.68 g, respectively where local yellow germplasm gave statistically similar results of both traits. In addition, the longest (4.95 cm) and the widest (2.20 cm) seeds were obtained from PSTU Bilati gab-1 while local yellow variety gave the smallest (3.89 cm) and the narrowest (1.66 cm) seed (Table 7 and Fig. 1). Hasan *et al.* (2014) mentioned that the length and diameter of velvet apple fruits follow a double sigmoid pattern to attain 9.08 cm and 7.62 cm, respectively whereas flesh weight follows a sigmoid pattern and attained 165 g whose were agreed with our results. As PSTU Bilati gab-2 was seed less, so, the values of all seed traits were designated as null whose indicated it as a superior variety. The superiority of PSTU Bilati gab-2 was also found due to the highest edible portion (81.92%) and dry matter (18.53%).

Table 7. Fruit characteristics of different velvet apple germplasm

Germplasm	No. of seeds	Weight of seed (g)	Length of seed (cm)	width of seed (cm)	Edible portion (%)	Dry matter (%)	Duration of fruit bearing (days)
Local red	6.04 a	41.68 a	4.30 b	1.97 b	53.45 c	16.05 c	139.25 c
Local yellow	5.55 a	36.95 ab	3.89 c	1.66 c	53.21 c	16.52 b	132.25 d
PSTU Bilati gab-1	2.05 b	23.60 b	4.95 a	2.20 a	61.95 b	16.73 b	175.75 a
PSTU Bilati gab-2	0.00 c	0.00 c	0.00 d	0.00 d	81.92 a	18.53 a	158.50 b
CV (%)	16.22	31.25	4.86	6.53	4.88	1.04	11.66

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT

On the other hand, PSTU Bilati gab-1 had been bearing fruits for maximum duration (175.75 days) whereas local yellow variety bears minimum time (132.25 days) (Table 7). Hossain *et al.*, (2015) supported our findings where they reported that one germplasm formed the highest number of seeds (7.14) where another germplasm was seedless. In addition, the highest rind weight (30.27 g), seed weight (86.29 g), non-edible portion (58%) as well as edible portion (87.33%) were found among the germplasm.

Organoleptic evaluation of fruit

PSTU Bilati gab-2 scored the highest result in organoleptic test in respect to all the parameter noted here (i.e., sweetness, aroma, texture, juiciness, fibreness, peeling quality and eye appeal) where other germplasm varied randomly. But the evaluated germplasm were only identical in pulp color (Table 8).

Table 8. Organoleptic evaluation of different velvet apple germplasm

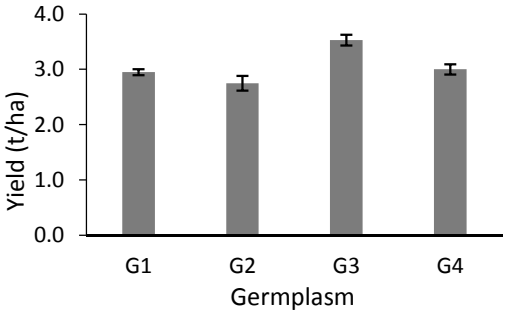
Germplasm	Pulp color	Sweetness	Aroma	Texture	Juiciness	Fibreness	Peeling quality	Eye appeal
Local red	3.55	3.68 b	2.30 ab	2.57 b	2.90 b	3.00 b	2.70 b	3.20 a
Local yellow	3.13	2.90 c	2.07 b	2.60 b	2.90 b	2. 78 c	2.25 c	2.63 b
PSTU Bilati gab-1	3.33	3.17 c	1.95 b	2.87 ab	3.30 a	3.10 b	2.49 bc	3.46 a
PSTU Bilati gab-2	3.15	4.10 a	2.67 a	3.12 a	3.63 a	3.36 a	3.03 a	3.57 a
CV (%)		5.55	8.38	5.97	4.87	2.89	5.30	7.82

In a column, the means bearing similar letter (s) do not differ significantly at 0.05 level by DMRT.

Fruit yield and profitability

The highest fruit yield (3.5 t/ha) was recorded in PSTU Bilati gab-1 followed by PSTU Bilati gab-2 (3.0 t/ha) and local red germplasm (2.95 t/ha) but the least fruit yield (2.8 t/ha) was found in local yellow (Fig. 1). Similar trend of fruit yield was recorded by Ahmed *et al.* (2011) where they reported the fruit yield per plant (at the age of 8 years) to be 7.53 kg which indicated the fruit yield of 2.1 t/ha.

The maximum cost of production (109480 Tk/ha) was estimated from PSTU Bilati gab-1 while the minimum (112320 Tk/ha) from local red germplasm (Fig. 2). The highest gross income (360200 Tk) and net benefit (251160 Tk) achieved from PSTU Bilati gab-2 where those were the lowest in local yellow germplasm (230300 Tk and 124030 Tk, respectively) (Fig. 3 and Fig. 4). PSTU Bilati gab-2 drawn significantly the highest BCR (3.31) whereas it was least (2.17) in local yellow germplasm (Fig. 5). Marri *et al*. (2013) extracted similar profitability in their study on minor fruits in Sindh province of Pakisthan during 2010. They reported that minor fruits cultivation was very profitable but government affiliation would be preferable for promoting and assisting growers and processors of minor fruits.



Legend

G1= Local red

G2= Local yellow

G3= PSTU Bilati gab-1

G4= PSTU Bilati gab-2

Fig. 2. Yield of four velvet apple germplasm in t/ha. Vertical bars represent standard error.

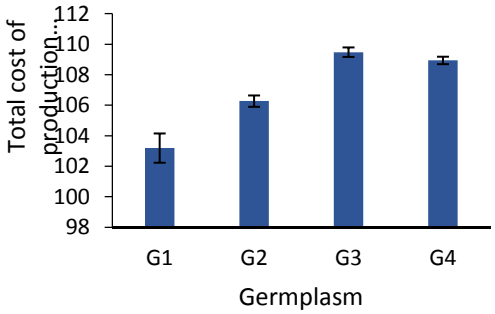


Fig. 3. Total cost of production per hectare area in Taka of four studied germplasm. Vertical bars represent standard error.

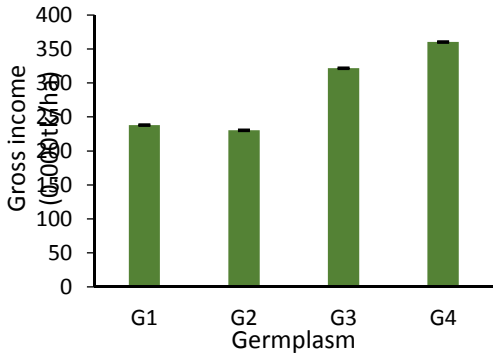


Fig. 4. Gross return in taka per hectare of four studied velvet apple germplasm. Vertical bars represent standard error.

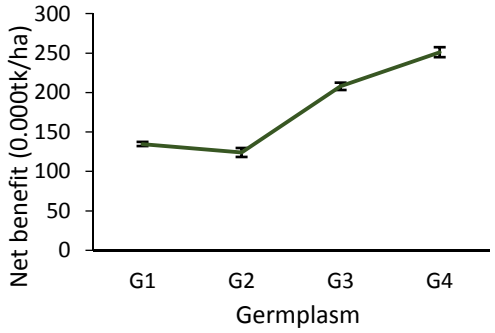


Fig. 5. Net obtained benefit (taka) of four studied germplasm estimated per hectare area. Vertical bars represent standard error.

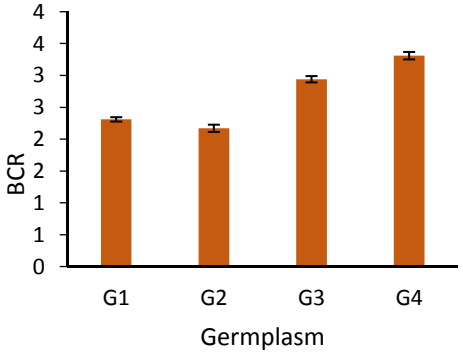


Fig. 6. Benefit cost ratio of four studied germplasm. Vertical bars represent standard error**.**

Conclusion

The findings of this study clearly expressed that the local red germplasm was the best in all parameters of plant characteristics, flower and fruit characteristics as well as yield and profitability. Due to grafting PSTU Bilati gab-2 was induced to be dwarf. During flowering PSTU Bilati gab-2 showed the best performances in forms of duration of flower bud emergence, duration of flowering and earliness of flowering followed by PSTU Bilati gab-1, local yellow germplasm and local red germplasm . PSTU Bilati gab-1 grabbed the superior position in respect to our studied fruit characteristics. Though, PSTU Bilati gab-1 yielded the highest amount of fruits (3.5 t/ha) but ultimate the highest profitability was estimated with PSTU Bilati gab-2. So, overall calculation revealed that PSTU Bilati gab-2 was the best over others. Therefore, PSTU Bilati gab-2 will be recommended for commercial orchard establishment in the southern belt of Bangladesh.

Conflicts of interest

The authors declare no conflicts of interest regarding publication of this paper.

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