

Article

Flowering and fruiting behavior of velvet apple

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Abstract: The study was conducted at three upazilla of Patuakhali during the period from the 1st February, 2013 to the 31st July, 2013 to evaluate the flowering and fruiting behavior of velvet apple germplasm. Twelve velvet apple germplasm were selected from three locations (DD 01, DD 04, DD 06, and DD 09 from Dumki; DD 02, DD 05, DD 08 and DD 10 from Mirzaganj; DD 03, DD 07, DD 11 and DD 12 from Patuakhali sadar upazilla) by field survey. The age of plant varied from 10 to 25 years having satisfactory growth and good health. A lot of variations in different parameters were observed among the germplasm. Flowering season started from 22 February and continued up to 20 April. Percentage of fruit setting ranged from 65.15 % to 92.26 % in DD 07 and DD 01, respectively. Required time for fruit maturation ranged from 116 days (DD 01) to 129 days (DD 07). Single fruit weight varied from 198.10 g (DD 12) to 238.90 g (DD 01). The highest number of seeds (8) was found in DD 07 while DD 01 was seedless. The length and diameter of fruit ranged from 6.72 cm (DD 07) to 8.04 cm (DD 01) and 6.09 cm (DD 07) to 7.27 cm (DD 01), respectively. The maximum edible portion (87.33 %) was recorded in seedless germplasm DD 01, while it was the lowest (42.00 %) in DD 07.

Keywords: flowering behavior; fruiting behavior; velvet apple

1. Introduction

Velvet apple (*Diospyros discolor*) under the family Ebenaceae (Greuter, 2000) is an abounded and important minor tropical fruit. It is originated from Philippines (Singh, 1998). It widely found in Assam, Bihar and southern parts of India. In Bangladesh, this fruit is grown well in the districts of Kushtia, Jessore, Faridpur, Rajshahi, Barisal, Patuakhali, Pirozpur, and Chittagong Hill Tracts region (Ahmed *et al.*, 2011). It is a medium sized to large evergreen tree, grows well in a diversity of soil, from the sea level to the 2,400 feet above sea level. The leaves are oblong-acute usually 4 to 10 inches long, leathery, shiny green on upper surface, the blade is glossy green, smooth above and softly hairy below. Female flowers are white waxy have 4 petals and it is 1 cm in diameter when fully open. Fruits are fleshy, globose, up to 8-10 centimeters in diameter. It is one of the very tasty and beautiful fruits. The texture of the flesh is sandy. Utilization of this crop as a fruit is not very much in Bangladesh. Immature fruits are astringent, while ripe fruits are sweet smelling, delicious and are eaten as dessert fruit. The pulp is sweet and melting. The usual practice is to eat only the pulp. Almost all the people including children like it very much due to its sweet taste and aroma. It is generally used as table purpose fruits. Fruits are nutritionally rich which (per 100 g of edible portion) contain calories 113, 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). Different parts are used in different indications as traditional medicines which can be summarized as – bark is used for fevers; dysentery, diarrhea and itch skin ailments, decoction of bark for coughs (Das *et al.*, 2010).

Green fruits have medicinal value as the juice of immature fruit is used to cure ulcer and dysentery (Rashid *et al.*, 1987). Beside these, some commercially important chemicals are extracted from leaves, fruits and also from seeds, such as leaf extract yielded alkaloids, reducing sugar, gum, flavonoids and tannins. Tannins are also extracted from fruits and seeds (Lee *et al.*, 2003). It is of medium vigorous growth and makes a desirable ornamental shade tree (Wester, 2009). These plants are propagated by seed and grafts (Ahmed *et al.*, 2011), but usually propagated by seed. Seed trees are normally planted 25 to 30 feet from each other (Rahim *et al.*, 2011). Trees that were planted by seeds could take 6 or 7 years to give out fruit, but trees that were propagated by grafts or layering produce fruit within 3 or 4 years. It is a very productive tree. It grows about to a height of 10 to 12 meters (Wright, 1904). But there is no good and released distinct variety of velvet apple in Bangladesh. There are some germplasm, rarer than the red, with yellowish to light brown fruits, the flesh of which is cream colored and sweeter, and less astringent (Wester, 2009). The fruits are vary greatly in shape, color, hairiness and taste suggests that there is a great deal of genetic variation in the plant. Fruits produced in different or even in the same areas, different types of variation were observed. Some of the variations are genetic and some of them are environmental. Environmental variation could be manipulated but genetic variations are persistent (Ahmed *et al.*, 2011). Wide genetic variations of velvet apple germplasm were observed in the Patuakhali coastal region. Therefore, the present study was carried out to evaluate the flowering and fruiting behavior of velvet apple germplasm.

2. Materials and Methods

Data related to the flowering and fruiting behavior of velvet apple were collected from selected twelve velvet apple plant located at Patuakhali sadar, Mirzaganj and Dumki upazilla. Randomly one branch was selected in each direction (North, South, East and West) to collect field data from each plant. This chapter is outlined under the following major sub-headings:

2.1. Experimental design

The field experiment was conducted in randomized complete block design (RCBD) with four replications and the laboratory experiment was done in completely randomized design (CRD). Data were collected using standard procedure.

2.2. Plant characteristics

2.2.1. Tree age

The age of selected 12 germplasm was collected from tree owner. Although no recorded data were found but counted as possible as correctly.

2.2.2. Branching pattern

Branching pattern was determined by eye estimation comparing with the figure of descriptor. It was expressed in language as, opposite, verticillate, horizontal, and irregular (Sharma, 2004).

2.2.3. Leaf area measurement

Leaf area was measured at mature stage of leaf through the branch of selected germplasm. Forty eight leaves (1 leaf \times 4 branches \times 12 plants) were selected for leaf area measurement. These areas were measured using leaf area meter (Model-L1-3100C SR. NO. LAM 1832 LICOR, USA). Then the leaf area of selected leaves of a plant was calculated and recorded.

2.3. Flowering behavior

2.3.1. Days required for flower bud development

Days required for flower bud development was observed with randomly selected 48 buds (1 bud \times 4 branches \times 12 plants). The selected buds were tagged and their development was regularly observed from the initiation of flowering shoot up to the opening of flower. It was carried out from 22 February, 2013 to 21 March, 2013.

2.3.2. Duration of flowering season

Flowering season of velvet apple was considered to be the duration of first flower to last flower. The flowering season was recorded by regular visiting the selected plants. It was recorded from 22 February to 20 April.

2.3.3. Position of flower bud initiation

Detailed study in relation to position of flower bud initiation was carried out in the selected plants from flower bud initiation to last flowering date. The position of bud initiation was expressed as tip of branch or from the leaf axile.

2.3.4. Color of flower buds

The color of flower bud was determined by eye estimation. The observation was started from the initiation of flower bud till before opening the flower and it was expressed as light green or green in color.

2.3.5. Length of flower bud

Length of flower bud was measured just before flower opening. It was measured by using slide calipers in centimeter. Randomly selected 48 (1 × 4 × 12) buds were used to determine the length of flower bud.

2.3.6. Length of petal

Length of petals was measured by using slide calipers in centimeter and it was done when the flowers were completely open. Randomly selected 48 (1 × 4 × 12) completely opened flower were used to determine the length of petal.

2.3.7. Width of petal

Widths of petals were measured by using the slide calipers in centimeter and it was done when the flowers were completely open. Randomly selected 48 (1 × 4 × 12) completely opened flowers were used to determine the width of petal.

2.3.8. Arrangement of calyx and corolla

According to the botanical description the arrangement of calyx and corolla is known as aestivation. This arrangement was determined according to botanical description of flower and it was expressed as twisted and valvate respectively (Dutta, 1975).

2.4. Fruiting behavior**2.4.1. Percent fruit setting**

The total number of fruit setting was measured by counting the total number of flower and then total number of fruit (after fruit setting) by regular visiting the selected plants. The percent fruit setting was measured according to the formula of Roy (1997), expressed as;

$$\text{Percent fruit setting} = \frac{\text{Total number of fruit set}}{\text{Total number of flower}} \times 100$$

2.4.2. Percent fruit drop

The total number of fruit drop was measured by deducting the number of fruit remaining in the branch at harvesting time from the number of fruit setting in the branch. The percent fruit drop was measured according to the formula of Sharma (2004), expressed as;

$$\text{Percent fruit drop} = \frac{\text{Total number of fruit drop}}{\text{Total number of fruit set}} \times 100$$

2.4.3. Timerequired for fruit maturation (days)

The time required for maturation of immature fruit was considered as the time between the withering of the entire stigma on the female spike up to the harvest of the fruit. Withering of stigma was observed by a magnifying glass. For this purpose randomly 48 (1×4×12) fruits are selected from withering of stigma to fully matured time.

2.4.4. Fruit shape

Shape of the fruits was expressed in language as spheroid, ellipsoid and flatted–globose (Dutta, 1975). Randomly selected 48 (1×4×12) matured fruits were used to estimate the shape of fruits.

2.4.5. Weight of fruit

Fully matured 48 (1×4×12) fruits were gradually collected to find out the mean weight and other measurement of fruits. The weight was taken in gram with the help of a (DJ-220 A, Japan) balance sensitive to tengrams.

2.4.6. Length of fruit

Length of the fruits was measured from basal to polar by using slide calipers and a total of 48 (1 fruits × 4 branches ×12 plants) fully matured fruits were used to determine the length of fruits in centimeter.

2.4.7. Diameter of fruit

Diameter of the fruits was measured by using slide calipers and a total of 48 (1×4×12) fully matured fruits were used to determine the width of fruits in centimeters.

2.4.8. Number of seeds per fruit

Number of seeds per fruit was manually counted after the fruit ripe. Total numbers of 48 (1×4×12) fully ripe and soft fruits were used to calculate the number of seeds per fruit.

2.4.9. Rind weight

Fully ripe fruit was used to collect the rind (peel). Total numbers of 48 (1×4×12) fully ripe fruits were used to determine the rind weight. With the help of a sharp knife the rind was separated from the fruits and weight was taken in gram with the help of a (DJ-220 A, Japan) balance sensitive to ten (10) grams.

2.4.10. Seed weight

Fully ripe and soft fruit was used to collect the seeds. Seeds were separated from pulp and washed thoroughly with distilled water. Then the adjacent water was removed with the help of paper. After that the weight of seeds was taken in gram with the help of a balance sensitive to ten (10) g.

2.4.11. Weight of non-edible portion (rind + seed)

Seeds and rind is non-edible portion of velvet apple. Weights of seed and rind (peel) were taken separately with the help of a (DJ-220 A, Japan) balance sensitive to ten (10) grams. Weight of non-edible portion was counted with combined weight of seeds and rind.

2.4.12. Percentage of non-edible and edible portion

The percentage of non-edible (seed and rind) and edible (pulp) portion was measured by using the following formula of Sharma (2004), expressed as;

$$\text{Percent of non-edible portion} = \frac{\text{Weight of non-edible parts}}{\text{Weight of whole fruit}} \times 100$$

$$\text{Percent of edible portion} = \frac{\text{Weight of edible parts}}{\text{Weight of whole fruit}} \times 100$$

3. Results and Discussion**3.1. Plant characteristics****3.1.1. Age of tree**

The age of twelve germplasm under study was in the range of 10 to 25 years. The trees had satisfactory growth and good health (Table 1).

3.1.2. Branching pattern

The branching patterns of the germplasm were found to be different (Table 1). Opposite pattern was found in germplasm No. (DD 01, DD 03, and DD 07), verticillate in (DD 02 and DD 09), horizontal in (DD 04, DD 06, DD 011 and DD 12), and irregular in (DD 05, DD 08 and DD 10).

3.1.3. Leaf area measurement

Significant variation was observed among the studied germplasm in respect of area of leaves (Table 1). The largest size of leaf area was found in germplasm DD 01 (157.8 cm²) and followed by DD 10 (157.0 cm²) but it was found statistically identical and the smallest size was exhibited in germplasm DD 07 (150.0 cm²) followed by DD 08 (151.8 cm²), they showed statistically different values.

Table 1. Age of tree, branching pattern and leaf area of twelve velvet apple (*Diospyros discolor*) germplasm.

Acc. No.	Age of tree (years)	Branching pattern	Leaf Area (cm ²)
DD 01	14	Opposite	157.8 a
DD 02	10	Verticillate	155.6 c
DD 03	12	Opposite	153.4 e
DD 04	20	Horizontal	155.8 bc
DD 05	18	Irregular	153.0 ef
DD 06	15	Horizontal	153.6 de
DD 07	20	Opposite	150.0 g
DD 08	25	Irregular	151.8 f
DD 09	23	Verticillate	155.8 bc
DD 10	25	Irregular	157.0 ab
DD 11	24	Horizontal	154.7 cd
DD 12	21	Horizontal	152.9 ef
Level of significance			**
CV (%)			0.41

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Indicates significant at the 1% level of probability.

3.2. Flower characteristics

3.2.1. Days required for floral bud development

The duration of floral bud development varied with germplasm to germplasm. A significant variation was observed for floral bud development (Table 2). Germplasm DD 07 was needed significantly higher time (26 days) to develop floral bud than germplasm DD 01 (21 days). The values of DD 01 and DD 07 were statistically different but the values of other germplasm were statistically identical with DD 07.

Table 2. Days required for floral bud development, duration of flowering, length of flower bud, length of petal and width of petal of twelve velvet apple germplasm.

Acc. No.	Days required for floral bud development	Duration of flowering (days)	Length of flower bud (cm)	Length of petal (cm)	Width of petal (cm)
DD 01	21.00b	58.00 a	1.55 a	1.30 a	0.60 a
DD 02	23.00ab	54.00 c	1.47 ab	1.27 a	0.47 b
DD 03	22.00ab	53.00 e	1.40 bc	1.25 ab	0.55 ab
DD 04	23.00ab	53.00 e	1.45 abc	1.25 ab	0.55 ab
DD 05	25.00ab	54.00 d	1.50 ab	1.13 b	0.52 ab
DD 06	22.00 ab	51.00 f	1.45 abc	1.27 a	0.52 ab
DD 07	26.00a	50.00 g	1.35 c	1.13 c	0.45 b
DD 08	24.00 ab	56.00 b	1.45 abc	1.27 a	0.49 b
DD 09	23.00 ab	52.00 f	1.45 abc	1.29 a	0.57 a
DD 10	24.00 ab	56.00 b	1.47 ab	1.27 a	0.55 ab
DD 11	22.00 ab	54.00 d	1.45 abc	1.13 b	0.52 ab
DD 12	22.00 ab	55.00 c	1.47 ab	1.28 a	0.57 a
Level of significance	*	**	**	**	*
CV (%)	8.18	0.27	3.56	2.83	6.79

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Indicates significant at the 1% level of probability

* Indicates significant at the 5% level of probability

3.2.2. Duration of flowering season (days)

Duration of flowering season is an important character in a good quality germplasm. Significant variation was exhibited among the studied germplasm in respect of duration of flowering season (Table 2). Duration of flowering season may depend on the genetic or environmental trait. The highest duration of flowering season (days) was found in germplasm DD 01 (58 days) followed by DD 08 (56 days) but the value of DD 08 was statistically identical with DD 10 (56 days) and the lowest duration of flowering season (days) was found in germplasm DD 07 (50 days) preceded by DD 06 (51 days) but the value of DD 06 was statistically similar with DD 09 (52 days).

3.2.3. Position of flower bud initiation

It was found from close observation and detailed study the maximum flower bud setting position was on the lateral side of the tip of branch from leaf axial.

3.2.4. Color of flower buds

It was found from close supervision and detailed study that, the flower buds were green in color.

3.2.5. Length of flower bud

Significant difference was observed among the studied germplasm in respect of length of flower bud (Table 2). Length of flower may predict the superiority or inferiority of a germplasm. The longest flower bud was produced by DD 01 (1.55 cm) but the value of DD 01 was statistically identical with all other germplasm except the value of DD 07 (1.35 cm) and DD 03 (1.40 cm), this two germplasm were exhibited the shortest flower bud, respectively.

3.2.6. Length of petal

Significant variation was observed among the selected germplasm in respect of length of petal (Table 2). The highest length was exhibited in DD 01 (1.30 cm) but the value of DD 01 was statistically identical with all other germplasm except the value of DD 07 (1.13 cm), DD 05 (1.13 cm) and DD 11 (1.14 cm). The lowest length was found in DD 07 (1.13 cm).

3.2.7. Width of petal

Significant variation was exhibited among the selected germplasm in respect of width of petal (Table 2). The highest width was found in DD 01 (0.60 cm) but it was statistically identical with all germplasm except DD 02 (0.47 cm), DD 07 (0.45 cm) and DD 08 (0.50 cm). The lowest width was exhibited in DD 07 (0.45 cm).

3.2.8. Arrangement of calyx and corolla (petal)

From detailed study it was found that the arrangement of calyx of velvet apple known as coiled or twisted (Alternate arranged first on one side and then on the other at different levels or points) and the arrangement of corolla was known as velvet (An arrangement of the flower in which the petals meet at their edge to edge without overlapping).

3.3. Fruit characteristics

3.3.1. Percent fruit setting

The percentage of fruit setting under natural pollination showed a wide range of significant variation (Table 3). The highest percentage of fruit setting was found in germplasm DD 01 (92.26 %) followed by DD 04 (86.60 %) but the value of DD 04 was statistically identical with the value of DD 10 (85.56 %). While the lowest percentage of fruit setting was found in germplasm DD 07 (65.15 %) followed by DD 08 (70.17 %). The value of DD 08 was statistically identical with the value of DD 06 (71.04 %) and DD 11 (70.85 %). Percent fruit setting may depend on the genetic or environmental factors such as availability of water and light.

Table 3. Percent fruit setting, percent fruit drop, time required for fruit maturation (days) and weight of fruit of twelve velvet apple germplasm.

Acc. No.	Percent fruit setting (%)	Percent fruit drop (%)	Time required for fruit maturation (days)	Weight of fruit (g)
DD 01	92.26 a	20.56 d	116.50 e	238.90 a
DD 02	82.12 c	23.82 c	120.90 d	232.20 b
DD 03	74.43 d	31.31 b	123.30 bc	228.50 c
DD 04	86.60 b	35.89 a	121.00 d	223.40 d
DD 05	74.43 d	22.65 cd	124.00 bc	218.70 e
DD 06	71.04 e	23.13 cd	122.30 cd	211.30 f
DD 07	65.15 f	36.17 a	129.30 a	199.30 h
DD 08	70.17 e	29.28 b	124.80 b	221.40 de
DD 09	82.57 c	23.82 c	125.30 b	200.70 h
DD 10	85.56 b	28.93 b	122.50 cd	230.00 bc
DD 11	70.85 e	34.85 a	124.00 bc	206.80 g
DD 12	81.29 c	23.34 cd	120.00 d	198.10 h
Level of significance	**	**	**	**
CV (%)	1.74	5.31	0.82	0.72

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Indicates significant at the 1% level of probability.

3.3.2. Percent fruit drop

A wide range of significant variation was observed among the selected germplasm in respect of fruit drop percentage (Table 3). It was found that; fruit drop percentages were low in south branches. The highest fruit drop percentage was exhibited in germplasm DD 07 (36.17 %) followed by DD 04 (35.89 %) but the value of DD 07 and DD 04 was statistically identical with the value of DD 11 (34.85 %). The lowest percentage of fruit drop was found in DD 01 (20.56 %) followed by DD 05 (22.65 %) but these values were statistically similar with DD 06 (23.13 %) and DD 12 (23.34 %).

3.3.3. Time required for fruit maturation (days)

It is the most important character for a fruit crop. A wide range of significant variation was observed among the selected germplasm in respect of time required for fruit maturation (days). Time required for fruit maturation may depend on the genetic characteristics of plant or availability of water and essential nutrients. The highest time required for fruit maturation was recorded in the germplasm DD 07 (129.30 days) followed by DD 09 (125.30 days) but the value of DD 09 was statistically identical with the value of DD 03, DD 05, DD 08 and DD 11 (Table 3). While the lowest time was recorded in the germplasm DD 01 (116.50 days).

3.3.4. Fruit shape

Fruit shape of different germplasm was classified into different categories such as spheroid, flatted–globose and ellipsoid. Most of the fruits (DD 02, DD 03, DD 04, DD 06, DD 07, DD 09 and DD 12) were spheroid in shape while flatted–globose in DD 01, DD 05 and DD 11 and ellipsoid shape was found in DD 08 and DD 10.

3.3.5. Weight of fruit

As evident the fruit weight was found markedly significant different among the twelve (12) germplasm studied (Table 3). The highest fruit weight was recorded in germplasm DD 01 (238.9 g) followed by DD 02 (232.2 g) but the value of DD 02 was statistically identical with the value of DD 10 (230.0 g). While the lowest fruit weight was recorded in germplasm DD 12 (198.1 g) and this value was statistically identical with DD 07 (199.3 g) and DD 09 (200.7 g). These results were similar with Ahmed *et al.* (2011), who reported that the highest fruit weight (283 g) followed by that of (185.8 g) and the lowest weight was (118 g).

3.3.6. Length of fruit

A wide range of significant variation was observed among the selected germplasm in respect of fruit length. The highest fruit length was obtained from germplasm DD 01 (8.04 cm) followed by DD 02 (7.92 cm) but the value of DD 01 and DD 02 was statistically identical with the value of DD 03 and DD 10. While the lowest fruit length was found in DD 07 (6.73 cm) followed by DD 06 (6.93 cm) but these values were statistically

similar with DD 11 (Table 4). Same findings were found by Ahmed *et al.* (2011), who reported that the maximum length of fruits 7.7 cm while the lowest was recorded 6.63 cm and average length was recorded 7.08 cm.

3.3.7. Diameter of fruit

A wide range of significant variation was observed among the selected germplasm in respect of fruit diameter. The highest fruit diameter was obtained from germplasm DD 01 (7.27 cm), this value was statistically identical with DD 02 (7.15 cm) and DD 10 (7.15 cm). While the lowest fruit diameter was exhibited in DD 07 (6.09 cm); DD 06 (6.12 cm) also statistically identical with the value of DD 07 (Table 4). It may be decide based on this study that; comparatively good quality fruit bear on the south branches of the plant. Similar findings were found by Ahmed *et al.* (2011), who reported that the maximum fruit diameter was 8.30 cm and minimum was 5.73 cm. Average diameter was recorded 6.61 cm.

3.3.8. Number of seeds/fruit

A wide range of significant variation was observed among the selected germplasm in respect of number of seeds per fruit (Table 4). It was found that, there were no seeds in the germplasm DD 01 (seedless). The causes of absence of seed in DD 01 may be environmental, such as; due to natural mutation or may be genetical, such as; abnormal gamet formation due to polyploidy. These results were agreed with Yonemori *et al.* (2000), they were reported that, seedless may occur due to parthenocarpy. But several numbers of seeds were found in other germplasm. The lowest number of seeds were found in DD 10 (5 seeds) and highest number of seeds in DD 07 (08 seeds).

3.3.9. Rind weight

A wide range of significant variation was observed among the selected germplasm in respect of rind weight (Table 4). Highest rind weight was exhibited in DD 07 (30.27 g), this value was statistically identical with DD 01 (29.28 g), while the lowest rind weight was recorded in germplasm DD 11 (24.16 g) followed by DD 02 (25.46 g). DD 02 was statistically identical with DD 03, DD 04, DD 08 and DD 12.

3.3.10. Seed weight

As evident the seeds weight was found markedly significant different among the twelve germplasm studied (Table 4). The highest seeds weight was recorded in germplasm DD 07 (86.29 g) followed by DD 05 (80.28 g) and it was statistically identical with DD 06 and DD 09. While the lowest seeds weight was recorded in germplasm DD 01 (0.00 g) due to seedless germplasm followed by DD 02 (60.48 g) but DD 02 was statistically identical with DD 08 and DD 10.

Table 4. Length of fruit, diameter of fruit, number of seeds/fruit, rind weight and seed weight of twelve velvet apple germplasm.

Acc. No.	Length of fruit (cm)	Diameter of fruit (cm)	No. of Seeds/fruit	Rind weight (g)	Seed weight (g)
DD 01	8.04 a	7.27 a	0.00 f	29.28 a	0.00 g
DD 02	7.92 ab	7.10 a	5.25 de	25.46 e	60.48 f
DD 03	7.79 abc	6.87 b	6.00 c	25.71 de	71.60 e
DD 04	7.66 bcd	6.69 bc	6.00 c	25.68 de	73.43 d
DD 05	7.50 d	6.51 cd	6.75 b	27.85 b	80.28 b
DD 06	6.92 ef	6.12 e	6.75 b	26.97 bc	78.85 bc
DD 07	6.72 f	6.09 e	7.75 a	30.27 a	86.29 a
DD 08	7.15 e	6.35 d	5.75 cd	25.66 de	61.44 f
DD 09	7.72 bcd	6.84 b	7.00 b	26.67 cd	79.08 bc
DD 10	7.91 ab	7.14 a	5.00 e	26.95 bc	61.19 f
DD 11	6.94 ef	6.87 b	6.00 c	24.16 f	70.49 e
DD 12	7.55 cd	6.50 cd	6.00 b	26.39 cde	78.31 c
Level of significance	**	**	**	**	**
CV (%)	1.68	1.60	5.79	1.91	1.31

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Indicates significant at the 1% level of probability.

3.3.11. Weight of non-edible portion (Rind + Seed)

It is the most important character for a fruit crop. A wide range of significant variation was observed among the selected germplasm in respect of weight of non-edible portion (Table 5). The maximum weight of non-edible portion was found in germplasm DD 07 (115.60 g) followed by DD 05 (108.10 g) while the minimum weight was noted in DD 01 (30.27 g) followed by DD 02 (85.94 g). DD 02 was statistically identical with DD 08 and DD 10.

3.3.12. Percentage of non-edible and edible portion

There were highly significant differences found in percentage of non-edible portion (Table 5). The highest percentage of non-edible portion was found in the germplasm DD 07 (58.00 %) followed by DD 12 (52.87 %). DD 12 was statistically identical with DD 09. The lowest percentage were found in DD 01 (12.67 %) followed by DD 02 (37.01 %). The percentage of edible portion showed a wide range of significant variation (Table 5). It can be suggested based on this study; that the fruits bearing on the south branch become comparatively larger than other branch's fruit, it may be due to sufficient light is available in south direction that helps to accumulate the photosynthate in the fruit easily. The highest percentage of edible portion was found in the germplasm DD 01 (87.33 %) followed by DD 02 (62.99 %) while the lowest percentage was observed in germplasm DD 07 (42.00 %) followed by DD 12 (47.13 %) but DD 12 was statistically identical with DD 09. Similar findings were found by Ahmed *et al.* (2011), who reported that the highest percentage of edible portion was (68.30 %) and lowest edible portion was (47.60 %) while the average value was obtained (53.44 %).

Table 5. Weight of non-edible portion (rind + seed), percent of non-edible portion and percent of edible portion of twelve velvet apple germplasm.

Acc. No.	Weight of non-edible portion (Rind + Seed) (g)	Percent of non-edible portion (%)	Percent of edible portion (%)
DD 01	30.27 g	12.67 i	87.33 a
DD 02	85.94 f	37.01 h	62.99 b
DD 03	97.31 d	42.58 f	57.42 d
DD 04	99.12 d	44.36 e	55.64 e
DD 05	108.10 b	49.44 c	50.56 g
DD 06	105.80 c	50.08 c	49.92 g
DD 07	115.60 a	58.00 a	42.00 i
DD 08	87.10 f	39.34 g	60.66 c
DD 09	105.70 c	52.70 b	47.30 h
DD 10	88.14 f	38.33 g	61.67 c
DD 11	94.65 e	45.77 d	54.23 f
DD 12	104.70 c	52.87 b	47.13 h
Level of significance	**	**	**
CV (%)	1.20	1.38	1.07

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Indicates significant at the 1% level of probability.

4. Conclusions

Flowering behavior were studied from 22 February to 20 April, including different floral criteria. Fruit characteristics were studied before and after fruit harvest at well facilities Horticulture laboratory. The objectives of this research work were to study about floral bud development, flowering behavior, fruit setting and maturation of fruits and to find out the germplasm, that may be recommended for the selection as variety. The age of the plant was determined from the information supplied by the owner and eye estimation. Branching pattern was determined by eye estimation and expressed as botanical language. Leaf area was measured at mature stage of leaf by using leaf area meter. Flowering behavior such as days required for floral bud development, duration of flowering season, position of flower bud initiation, color of flower buds, length of flower bud, length of petal, width of petal, arrangement of calyx and corolla and number of stigma were studied. Fruiting behavior such as fruit drop percentage, percent fruit setting, time required for fruit maturation, fruit shape, weight of fruit, length of fruit, diameter of fruit, number of seeds per fruit, rind weight, seed weight, weight of non-edible portion (rind + seed), percentage of non-edible portion and percentage of edible portion were studied. The results on plant characteristics of velvet apple showed that the highest age of germplasm was

25 years in DD 08 and lowest age 10 years in DD 02 with highest leaf area in DD 01 (157.8 cm²) and the lowest was in DD 07 (150.0 cm²).

Conflict of interest

None to declare.

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