ISSN: 1991-0037 (print), 2710-3285 (online)
SOUTH ASIAN JOURNAL OF AGRICULTURE
www.saja.edu.bd;https://www.banglajol.info/index.php/SAJA
Agrotechnology Discipline, Khulna University
www.ku.ac.bd

OPEN ACCESS

*South Asian J. Agric.*

Research Article Vol. 9, No. 1&2, 2022-'23: 1-10

Title: Growth Performance of Cleft Grafted Velvet Apple (*Diospyros discolor* Willd.)

Authors: Mahbub Robbani* and Chitta Ranjan Sarker

Germplasm Center, Department of Horticulture, Patuakhali Science and Technology University, Dumki, Patuakhali-8602, Bangladesh

*Corresponding Author: Mahbub Robbani Email: mrobbani@pstu.ac.bd

Article Info:

Received:
*November 14, 2021*
Accepted:
*June 11, 2022*

Keywords:
*Velvet apple, cleft graft, seedling rootstock*

## ABSTRACT

Velvet apple is usually propagated through seeds but seeded plants do not maintain its true-to-type quality. The present work was undertaken to study the fate of cleft grafting of five selected velvet apple genotypes during 2018 - 2019 at the Germplasm Center, Patuakhali Science and Technology University. The pot experiment was conducted in RCBD with two factors as scions and Days after Grafting (DAG) consisting of 10 replications of the scions. Scions from five promising mother plants were considered as treatments (Dumki-Dd-S1, Dumki-Dd-S2, Dumki-Dd-S3, Dumki-Dd-S4 and Mirzaganj-Dd-S5) and were cleft grafted on seedling rootstock of Dumki-Dd-R1.At 84 DAG, significant differences were observed among the scion treatments regarding the studied growth parameters. The days required to bud break varied significantly which ranged from 14 days (Dumki-Dd-S4) to 18 days (Mirzagonj-Dd-S5). The maximum length (54.30 cm) and diameter (2.00 cm) of rootstock were recorded in Mirzagonj-Dd-S5 at 84 DAG. However, maximum scion length (22.20 cm) and scion diameter (0.70 cm) were noted in Dumki-Dd-S1at 84DAG. The highest graft heights of Dumki-Dd-S2 (71.20 cm) and Mirzaganj-Dd-S5 (71.50 cm) were statistically similar at84 DAG. Graft success was highest in Mirzagonj-Dd-S5 (60.00%) followed by Dumki-Dd-S4 (40.00%) at 84 DAG. The maximum number of sprouted shoots (2.10) was counted in Dumki-Dd-S1, however, the highest length and diameter of sprouted shoot (7.1 cm and 0.66 cm, respectively) and maximum number of leaf (7.40 per graft) were found in Mirzaganj-Dd-S5during the study period. It could be concluded that, Mirzaganj-Dd-S5 and Dumki-Dd-R1showed the best stionic relationship for multiplication of velvet apple by cleft grafting.

DOI: https://doi.org/10.3329/saja.v9i1-2.69611

To cite this article: Robbani, M. and Sarker, C.R. 2022. Growth performance of cleft grafted velvet apple (*Diospyros discolor* Willd.), South Asian Journal of Agriculture, 9 (1 & 2): 1-10.

## INTRODUCTION

Velvet apple or Malabo (*Diospyros discolor* Willd.) is a dioecious evergreen tree of the family Ebenaceae (Greuter, 2000). Rural homesteads of the Southern area of Bangladesh have been blessed with numerous native fruits including velvet apple or bilati gab, which is very rich in micro-nutrients and grown naturally by seed multiplication (Bhattacherjee et al., 2019). It is grown spontaneously in the natural habitats, survives without any management practices but bear fruits at a limited scale; commonly known as minor ones (Robbani, 2012). Fruits are nutritious, wherein 100 g edible portion contains energy 113 kcal, 69.6g water, 26.6g carbohydrates, l.5g fiber, 0.1g fat, 1.4g protein and 0.8g minerals (Mondal, 2000). Among the minor fruit species available in the coastal homesteads of Patuakhali, velvet apple exhibited as one of the mostly planted homestead plant s(species diversity score 0.994) with top dominance rank (Sarker et al., 2015).

Velvet apple is usually propagated through seeds but seeded plants do not maintain its true-to-type quality. Napier and Robbins (1989) reported that seed propagation of velvet apple increases biodiversity but vegetative propagation is essential for true-to-type of elite germplasm. Selection of special seedling mother-tree can provide uniform, special seedling rootstock for specific scion (Hartmann et al., 2009). In Bangladesh, the cultivation of velvet apple is in a hurdle due to lack of proper investigation, suitable variety, proper care and management (Sarker, 2016). A very few research works have been performed on the grafting of velvet apple (Rahim et al., 2011). Success of grafting depends on the scion as reported by Ahmed (2008) who recorded the highest graft success rate in pear when 'Kashmiri pear' was used as scion.

Cleft grafting is a suitable method for fruit crops as carambola (Campbell, 1981; Lederman and Bezerra, 2000), pummelo (Ledesma and Campbell, 2001), passion fruit (Sunyman and Fraser, 1996), and Indian olive (Rahman, 2005). However, Aziz et al. (2013) observed that T-grafting in jamun gave maximum success (65.25%) followed by T-budding (24.75%) against minimum success from cleft grafting (10.75%). On the contrary, Coronel and Sotto (2001) got higher rate of success from cleft grafting (85%) in pummelo while they used mature green scions and one year old rootstocks. Goutam and Thapa (1994) found that veneer grafting is most successful (67%) than shield budding (33%) in pomegranate.

There are numerous problems associated with the propagation of velvet apple, such as the recalcitrant seeds deteriorate viability very quickly, difficult to adventitious rooting and poor success in grafts (Rahim et al., 2011). No suitable grafting technology has yet been developed for velvet apple. With a view to restoring the true-to-type nature, precocity in fruiting, uniform and dwarf growth of selected velvet apple scions, an attempt was made to study the performance of cleft grafting on seedling rootstock of single genotype.

## MATERIAL AND METHODS

The investigation was carried out at the Germplasm Center (GPC), PSTU during June, 2018 to November, 2019. The two-factor (Scions and Days after Grafting) pot experiment was conducted in a Randomized Complete Block Design with 10 replications. Hence, five types of scions were considered as treatments with one type of rootstock and 10 replications for the scions, altogether required 50 earthen tubs.

### *Establishment and preparation of rootstock*

In the fruiting season (July –August) of 2018 about 100 seeds were collected from an *in situ* conserved (22°27'01"NL and 90°18'41"EL) locally available 10 years old velvet apple rootstock mother plant (Dumki-Dd-R1). This plant showed vigorous growth and annual bearing nature with 6-8 seeds per fruit. Due to excessive seeds, the flesh content was

minimum. This single source of seedling rootstock was considered for maintaining homogeneity of its performance. Completely ripe fruits were considered for collection of seeds (Plate 1). Before drying, the collected seeds were allowed to germinate and grow in the rooting media (1:1 soil and cowdung) crammed in small polybag. The polybags were kept in a lathhouse and intermittent irrigation was done as and when needed. At seedling stage, a total number of 50 (10 for each treatment) healthy saplings of about one year old and uniform size were selected and transferred to the earthen tubs kept in a glasshouse for further growth and development. After establishment, the saplings were kept for a week under partial shade for acclimatization.

The branches except the main trunk of the tub grown saplings were removed and a horizontal cut was given in the main trunk at a height of 15cm from the ground level of the rootstock to remove the upper portion. Then a 5 cm vertical cut was given through the middle portion of the first cut and the stocks were prepared with a cleft shape.

### *Selection of mother plant for scion collection*

The Germplasm Research Team of PSTU has recognized five promising velvet apple germplasm (named as Dumki-Dd-S1, Dumki-Dd-S2, Dumki-Dd-S3, Dumki-Dd-S4 and Mirzaganj-Dd-S5) with desirable pomological traits. The fruits of the scion mother plants showed some elite characteristics, such as, velvet-like skin, attractive color, big size, uniform shape and very few seeds (0-3). Healthy, vigorous, disease free 10 to 12 years old good bearing scion mother plants of five promising germplasm were *in situ* conserved in two upazilas viz. Dumki and Mirzaganj (Table 1).

### *Scion preparation*

Well developed (10-12 months age), healthy, straight shoots of active growth of 15cm long (3-5 nodes) having nearly the same thickness of the rootstocks were detached from the selected scion mother plants with a pair of sharp secateurs. The selected scions were collected on the same day of grafting. All the leaf blades were trimmed-off leaving their petioles intact with the dormant buds, immediately wrapped with a water soaked piece of cloth and kept in perforated polyethylene bags to minimize desiccation. Then two opposite long sloping wedge cuts (5cm) were made at the proximal end of the scion smoothly by a sharp knife that gave the appearance of a peg.

### *Performing cleft grafting operation*

The proximal end of the prepared scion was inserted into the cleft of rootstock by opening the splits slightly. Then both were brought into close contact and secured firmly with a polyethylene strip and was covered with a polyethylene cap to reduce transpiration. In total, 50 grafts were prepared in July 2019. The grafted compound trees were kept under a shade net for one month followed by removal of net and data collection.

## Data collection

### *Number of days required to bud break*

The bud break of the scion was observed critically every day and the time required to bud break from the date of grafting operation was noted.

### *Percent success in the grafting*

The number of successful grafts in each treatment was counted at every 21 days interval up to 84 DAG. The results were expressed in percentage and calculated using the formula:

$$\%\ \text{success of the grafting} = \frac{\text{Number of successful graft}}{\text{Number of grafting operations}} \times 100$$

### *Number of leaves per graft*

It was counted from21 DAG at an interval of 21 days and continued up to 84 DAG.

### *Length and diameter of the rootstock, scion and sprouted shoot*

The length (cm) of the rootstock in successful grafting was noted from the base up to the graft joint at 21 days interval starting from 21 DAG and continued up to 84 DAG.

Data on diameter (cm) of the rootstock was recorded simultaneously by using a slide calipers. Similarly, in case of scion, data on the length (cm, measured from the middle portion of the graft joint up to the tip of the plant) and diameter (cm, at just above the joint portion) were also recorded. Data on length (cm) and diameter (cm) of the sprouted shoots were also recorded in the same way.

### *Statistical analyses*

The collected data on various parameters were compiled and tabulated in the proper form for analyses. The analysis of variance (ANOVA) was done with the MSTAT-C computer package program (Russel, 1986). The mean for all treatments was calculated and analysis of variances was performed using the 'F' test. Finally, the means of the parameters were separated by DMRT (Gomez and Gomez, 1984).

## RESULTS AND DISCUSSION

### *Days required for bud break*

The days required to break bud did not vary significantly among the scions which ranged from 11.82 to 14.10 days (Table 2). However, graft combination with Mirzagonj-Dd-S5 required the maximum days (14.10) to break bud. On the other hand, the graft combination with Dumki-Dd-S1 needed minimum days (11.8) to break bud. Ledesma and Campbell (2001) reported 24 days to bud break in cleft grafted pumello which was more than the findings from current study. This variation may be due to genotype, time of the grafting, conditions of the scion and rootstock etc.

### *Length of rootstock at different DAG*

There was significant variation among the scions regarding the increase in the length of the rootstock (Table 2). The maximum increase in rootstock lengths (1.05-fold increase from 21 to84 DAG) was observed when grafted with Mirzagonj-Dd-S5 scion. On the contrary, the minimum length of rootstock on 84 DAG (48.50 cm) was recorded when grafted with Dumki-Dd-1 scion. At the same time (84 DAG) the lengths of the rootstocks with Dumki-Dd-S2 and Dumki-Dd-S3scions were statistically alike.

### *Diameter of rootstocks at different DAG*

It varied significantly among the graft combinations at 63 and 84 DAG (Table 3).The stionic combination with Mirzaganj-Dd-S5 showed the maximum diameter (1.06, 1.12, 1.60 and 2.00 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Dd-S4 (1.26, 1.44, 1.56 and 1.62 cm at 21, 42, 63 and 84 DAG, respectively).The minimum diameters (1.10, 1.12, 1.22 and 1.26 cm at 21, 42, 63 and 84 DAG, respectively) were found when rootstock was grafted with Dumki-Dd-S3 scion.

**Table 1.Passport data of selected *in situ* conserved velvet apple scion and rootstock**

| Scion/Rootstock | Scientific name | Family | Location | Latitude (N) | Longitude (E) |
|---|---|---|---|---|---|
| *In situ* conserved scion source | | | | | |
| Dumki-Dd-S1 | *Diospyros discolor* | Ebenaceae | Basbunia | 22º27′02″ | 90º18′41″ |
| Dumki-Dd-S2 | *D. discolor* | Ebenaceae | Basbunia | 22º27′02″ | 90º18′41″ |
| Dumki-Dd-S3 | *D. discolor* | Ebenaceae | Kartickpasha | 22º26′54″ | 90º20′25″ |
| Dumki-Dd-S4 | *D. discolor* | Ebenaceae | Moukaran | 22º26′56″ | 90º20′27″ |
| Mirzagonj-Dd-S5 | *D. discolor* | Ebenaceae | Mirzagonj | 22º22′30″ | 90º14′25″ |
| *In situ* conserved seedling rootstock source | | | | | |
| Dumki-Dd-R1 | *D. discolor* | Ebenaceae | Dumki | 22º27′01″ | 90º18′41″ |

Here, Dd= *Diospyros discolor*; S= Scion and R= Rootstock

**Table 2. Length of rootstock of velvet apple at different DAG and days required to bud break**

| Scion/rootstock | Length (cm) of the rootstock at different DAG | | | | Days required to bud break |
|---|---|---|---|---|---|
| | 21 | 42 | 63 | 84 | |
| Dumki-Dd-S1 | 45.70 | 47.20 | 47.80 e | 48.50 d | 11.82 |
| Dumki-Dd-S2 | 50.60 | 51.50 | 52.50 c | 53.00 b | 12.42 |
| Dumki-Dd-S3 | 50.60 | 50.80 | 53.30 b | 53.90 b | 12.50 |
| Dumki-Dd-S4 | 48.80 | 49.50 | 50.20 d | 50.80 c | 14.00 |
| Mirzaganj-Dd-S5 | 51.60 | 52.40 | 53.60 a | 54.30 a | 14.10 |
| LSD (0.05) | - | - | 1.08 | 2.06 | - |
| Level of significance | NS | NS | * | * | NS |
| CV (%) | - | - | 1.12 | 2.11 | - |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS =Non Significant

### *Length of scions at different DAG*

There was significant difference among the scions in respect of length at 63 and 84 DAG (Table 4). At 84 DAG, the highest lengths of scion were recorded in Dumki-Dd-S1 (22.20 cm) and Dumki-Dd-S2 (20.00 cm), respectively. At the same time, the minimum lengths were recorded in Dumki-Dd-S3 (15.90 cm), Dumki-Dd-S4 (16.80 cm) and Mirzaganj-Dd-S5 (17.20 cm), respectively. In a compound tree, both scion and rootstock influence each other. Webster (2003) mentioned that seedling rootstocks of *Pyrus* spp. impose slight but inconsistent scion growth control.

### *Diameter of scion at different DAG*

It varied significantly among the treatments from 42 DAG and continued up to 84 DAG (Table 5). The maximum diameter of scion was recorded in Dumki-Dd-S1 (0.56, 0.64, 0.70 and 0.70 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Dd-S4 (0.50, 0.62, 0.72 and 0.74 cm at 21, 42, 63 and 84 DAG, respectively). The minimum diameter of the scion was in Dumki-Dd-S3 (0.48, 0.50, 0.54 and 0.60 cm at 21, 42, 63 and 84 DAG, respectively). At 84 DAG, all treatments varied significantly in this regard, wherein the highest diameter (0.78 cm) was noted in Mirzaganj-Dd-S5. Westwood and Roberts (1970) mentioned that trunk cross sectional area or diameter is an excellent indicator of scion growth. In general, all the graft combinations in this study have shown steady scion growth. In a study with pear rootstock, Robbani et al. (2006) stated that weak growing stocks require small reserves of carbohydrates and extract fewer minerals from soils.

### *Graft height*

It varied significantly among the treatments at 63 and 84 DAG (Table 6 and Plate 2). The maximum graft height was gained in Dumki-Dd-S2 (63.00, 66.28, 69.70, and 71.20 cm at 21, 42, 63 and 84 DAG, respectively) followed by Mirzaganj-Dd-S5 (62.20, 65.60, 69.26 and 71.50 cm at 21, 42, 63 and 84 DAG, respectively). However, at 84 DAG, both Dumki-Dd-S2 and Mirzaganj-Dd-S5 exhibited the highest but statistically similar graft heights (71.20 cm and 71.50 cm, respectively). The potentials in term of accumulation of materials like metabolites and carbohydrates could possibly be responsible for differences in graft height. The growth of a grafted plant also depends on the stock-scion relationship, which is responsible for uptake or restrict nutrients from soil and transport of photoassimilates to the other parts of plant (Hartmann et al., 2009).

### *Percent success in grafting*

There was significant variation among the treatments regarding success in grafting (Figure 1). The maximum graft success was in Mirzagonj-Dd-S5 (60.00%) followed by Dumki-Dd-S4 (40.00%) at 84 DAG. The treatments Dumki-Dd-S1, Dumki-Dd-S2 and Dumki Dd-S3 performed poor in respect of graft success. Although an intra-species

grafting was performed, the overall graft success was not up to the mark. Moreover, no graft incompatibility symptoms like abnormal swelling or secondary growth of both scion and rootstock was observed. Rootstock age could be a factor for this lower success of grafting, as only one year old rootstock was used in this study.

### *Number of sprouted shoots per graft*

The number of sprouted shoot per graft varied significantly except 21 DAG (Table 7). At 84 DAG, Dumki-Dd-S1 showed the maximum number of sprouted shoots (2.10) followed by Dumki-Dd-S2 (2.00) and Mirzagonj-Dd-5 (2.00). Growth variability among the treatments might have influenced the production of sprouted shoots.

### *Number of leaves per graft*

It varied significantly among the treatments at 63 and 84 DAG (Table 8). Number of leaves per graft was counted in Mirzaganj-Dd-S5 (1.80, 5.40, 6.60 and 7.40 at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Dd-S3 (2.00, 4.00, 5.60 and 7.00 at 21, 42, 63 and 84 DAG, respectively). The minimum number of leaf was in Dumki-Dd-S1 (1.40, 2.60, 3.20 and 4.00 at 21, 42, 63 and 84 DAG, respectively). Remarkable variability in morphological markers among the scions would have induced the variation in the number of leaves per grafts.

### *Length of sprouted shoots*

There was significant variation among the treatments regarding the length of the sprouted shoot except at 21 DAG (Table 9). At 84 DAG, the length of the sprouted shoots of Dumki-Dd-S3 (5.60 cm), Dumki-Dd-S4 (6.00 cm) and Mirzaganj-Dd-S5 (7.10 cm) was maximum but statistically alike. The minimum lengths of the sprouted shoots were in Dumki-Dd-S1 (0.80, 1.56, 1.76 and1.76 cm at 21, 42, 63 and 84 DAG, respectively). Shoot growth variability in *Pyrus* seedling rootstock was also reported by Azarenko et al. (2002) who found minimum growth in scions of *Pyrus calleryana* and vigorous in *Pyrus betulaefolia* seedling rootstocks.

**Table 3.Diameter of rootstock of velvet apple at different DAG**

| Scion/rootstock | Rootstock diameter (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Dd-S1 | 1.10 | 1.26 | 1.36 c | 1.40 d |
| Dumki-Dd-S2 | 1.20 | 1.26 | 1.34 d | 1.44 c |
| Dumki-Dd-S3 | 1.10 | 1.12 | 1.22 e | 1.26 e |
| Dumki-Dd-S4 | 1.26 | 1.44 | 1.56 b | 1.62 b |
| Mirzaganj-Dd-S5 | 1.06 | 1.12 | 1.60 a | 2.00 a |
| LSD (0.05) | - | - | 0.06 | 0.85 |
| Level of significance | NS | NS | * | * |
| CV (%) | - | - | 2.037 | 29.10 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 4. Length of scions of velvet apple germplasm at different DAG**

| Scion/rootstock | Length (cm) of the scion at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Dd-S1 | 13.10 | 15.50 | 21.40 a | 22.20 a |
| Dumki-Dd-S2 | 12.40 | 14.80 | 17.90 b | 20.00 a |
| Dumki-Dd-S3 | 12.90 | 12.20 | 14.60 c | 15.90 b |
| Dumki-Dd-S4 | 12.20 | 14.00 | 16.20 bc | 16.80 b |
| Mirzaganj-Dd-S5 | 13.00 | 13.40 | 16.20 bc | 17.20 b |
| LSD (0.0. 5) | - | - | 2.11 | 2.21 |
| Level of significance | NS | NS | * | * |
| CV (%) | - | - | 9.16 | 8.97 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 5. Diameter of scion of velvet apple germplasm at different DAG**

| Scion/rootstock | Scion diameter (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumk-Dd-S1 | 0.56 | 0.64 a | 0.70 a | 0.70 d |
| Dumki-Dd-S2 | 0.4 | 0.58 b | 0.70 a | 0.72 c |
| Dumki-Dd-S3 | 0.48 | 0.50 c | 0.54 b | 0.60 e |
| Dumki-Dd-S4 | 0.50 | 0.62 ab | 0.72 a | 0.74 b |
| Mirzaganj-Dd-S5 | 0.44 | 0.62 ab | 0.70 a | 0.78 a |
| LSD (0.05) | - | 0.06 | 0.08 | 0.09 |
| Level of significance | NS | * | * | * |
| CV (%) | - | 7.26 | 9.23 | 10.57 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 6. Graft height of velvet apple germplasm at different DAG**

| Scion/rootstock | Graft height (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Dd-S1 | 59.20 | 62.00 | 67.00 c | 68.20 b |
| Dumki-Dd-S2 | 63.00 | 66.28 | 69.70 a | 71.20 a |
| Dumki-Dd-S3 | 65.30 | 65.96 | 67.10 c | 67.50 c |
| Dumki-Dd-S4 | 61.00 | 63.30 | 66.50 d | 67.60 c |
| Mirzaganj-Dd-S5 | 62.20 | 65.60 | 69.26 b | 71.50 a |
| LSD (0.05) | - | - | 1.65 | 0.80 |
| Level of significance | NS | NS | * | * |
| CV (%) | - | - | 1.32 | 0.61 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 7. Number of sprouted shoots per graft of velvet apple germplasm at different DAG**

| Scion/rootstock | Number of sprouted shoots per graft at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki–Dd-S1 | 1.00 | 1.80 b | 2.00 a | 2.10 a |
| Dumki-Dd-S2 | 1.00 | 2.00 a | 2.00 a | 2.00 b |
| Dumki-Dd-S3 | 1.00 | 1.20 d | 1.40 c | 1.40 c |
| Dumki-Dd-S4 | 1.00 | 1.20 d | 1.40 c | 1.40 c |
| Mirzaganj-Dd-S5 | 1.00 | 1.60 c | 1.80 b | 2.00 b |
| LSD (0.05) | - | 0.84 | 0.82 | 0.83 |
| Level of significance | NS | * | * | * |
| CV (%) | - | 28.67 | 25.45 | 24.74 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 8. Number of leaves per graft of selected velvet apple germplasm at different DAG**

| Scion/rootstock | Number of leaves per graft at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Dd-S1 | 1.40 | 2.60 | 3.20 e | 4.00 d |
| Dumki-Dd-S2 | 2.20 | 4.00 | 5.00 c | 6.00 c |
| Dumki-Dd-S3 | 2.00 | 4.00 | 5.60 b | 7.00 b |
| Dumki-Dd-S4 | 1.40 | 4.00 | 4.80 d | 6.00 c |
| Mirzaganj-Dd-S5 | 1.80 | 5.40 | 6.60 a | 7.40 a |
| LSD (0.05) | - | - | 0.42 | 1.24 |
| Level of significance | NS | NS | * | * |
| CV (%) | - | - | 4.46 | 10.83 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

**Table 9. Length of sprouted shoots and diameter of the sprouted shoots of velvet apple germplasm at different DAG**

| Scion/rootstock | Diameter of sprouted shoot (cm) at different DAG | | | | Length of sprouted shoot (cm) at different DAG | | | |
|---|---|---|---|---|---|---|---|---|
| | 21 | 42 | 63 | 84 | 21 | 42 | 63 | 84 |
| Dumki-Dd-S1 | 0.18 | 0.26 c | 0.36 b | 0.42 b | 0.80 | 1.56c | 1.76 c | 1.76 c |
| Dumki-Dd-S2 | 0.22 | 0.30 bc | 0.38 b | 0.48 b | 1.00 | 2.20b | 3.40 bc | 4.70 b |
| Dumki -Dd-S3 | 0.20 | 0.26 c | 0.38 b | 0.50 b | 0.98 | 1.40c | 3.50 bc | 5.60 ab |
| Dumki-Dd-S4 | 0.22 | 0.34 ab | 0.50 a | 0.60 a | 1.40 | 3.40a | 4.60 ab | 6.00 ab |
| Mirzaganj-Dd-S5 | 0.22 | 0.38 a | 0.56 a | 0.66 a | 0.84 | 1.90bc | 6.20 a | 7.10 a |
| LSD (0.05) | - | 0.06 | 0.09 | 0.08 | - | 2.40 | 2.31 | 2.10 |
| Level of sig. | NS | * | * | * | NS | * | * | * |
| CV (%) | - | 16.55 | 15.64 | 11.67 | - | 25.37 | 24.11 | 34.42 |

Means in a column with the same letter(s) do not differ significantly by DMRT, * = Significant at the 5% level of probability, NS = Non Significant

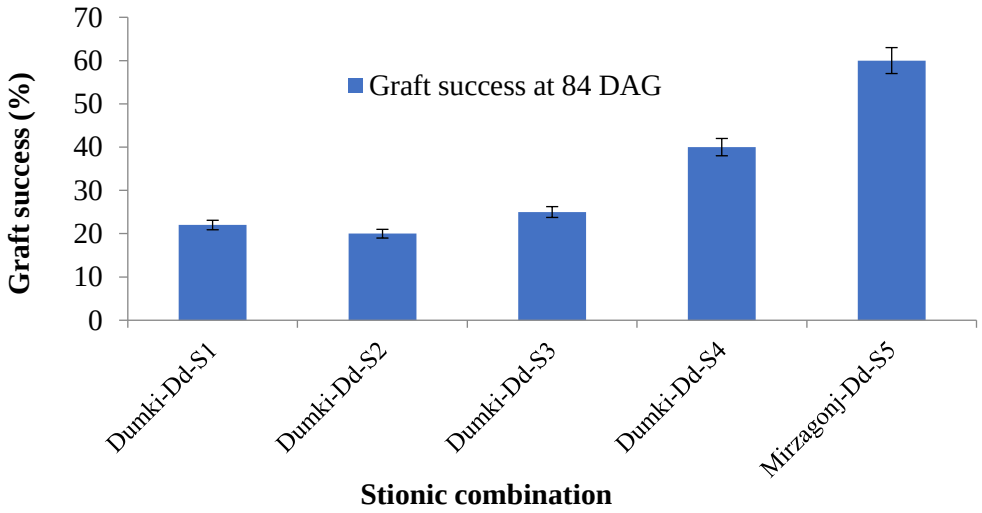


**Figure 1. Cleft graft success of five stionic combinations of velvet apple. Vertical bars indicate mean ± standard error (n=10).**

**Plate 1. Seedling rootstock establishment from Dumki-Dd-R-1 mother plant of velvet apple**


**Plate 2. Sprouted scions of velvet apple germplasm after cleft grafting**

### *Diameter of sprouted shoots*

The diameter of the sprouted shoots varied significantly among the treatments except at 21 DAG (Table 9). The diameter of the sprouted shoots of Dumki-Dd-S4 and Mirzaganj-Dd-S5 was highest and statistically alike. The minimum diameters of sprouted shoots were recorded from Dumki-Dd-S1 (0.18, 0.26, 0.36 and 0.42 cm at 21, 42, 63 and 84 DAG, respectively).Cleft grafting has been recognized as a useful method for multiplication of fruit crops like carambola (Campbell, 1981; Lederman and Bezerra 2000), pummelo (Ledesma and Campbell, 2001), passion fruit (Sunyman and Fraser, 1996) and Indian olive (Rahman, 2005), but in this experiment we found a very poor performance in general. These inconsistent results might be due to stionic incapability, which may hinder the synthesis and translocation of auxin to the union portion for callus formation and differentiation of parenchymatous tissue as well as the formation of cambium and vascular bundles (Azarenko et al., 2002). Some other reasons might be due to improper grafting, time of operation, age of rootstock, post grafting management and environmental factors.

## CONCLUSION

Vegetative propagation by cleft grafting of five types of velvet apple germplasm was investigated. There were significant variations among the stionic combinations of the germplasm when cleft grafting method was performed. The scions of Dumki-Dd-S4 and Mirzaganj-Dd-S5 enacted well in most of the studied parameters when cleft grafted on Dumki-Dd-R1 seedling rootstock genotype. However, the overall performance indicators suggest the best stionic relationship between Mirzaganj-Dd-S5 and Dumki-Dd-R1 for multiplication of velvet apple by cleft grafting. Further researches including more rootstock genotypes, grafting season and graft environment might explore the possibilities of developing the best stionic combinations of velvet apple with higher rate of success by cleft grafting.

## REFERENCES

Ahmed, M. 2008. Biodiversity in Pear (*Pyrus communis*L.): Characterization and conservation of germplasm from Azad Jamun and Kashpur. Ph.D. thesis, Department of Horticulture, University College of Agriculture, Bahauddin Zakaria University, Multan.

Azarenko, A.N., Mielke, E., Sugar, D., Eady, F., Lay, B., Tehrani, G., Gaus, A. and Rom, C.2002. Final evaluation of the NC140 national pear rootstock trial. Acta Horticulture, 596: 319-323.

Aziz M., Abbas, M.M., Javed, M.A., Ahmad, S., and Sharif, N. 2013. Studies on softwood grafting techniques in jamun, *Euginea jambolana*. Journal of Agricultural Research, 52(2): 32-35.

Bhattacherjee, T.N., Robbani, M., Ali, M., Mursheed, N. and Mehedi, M.N.H. 2019.Biodiversity of indigenous jujube germplasm available in Dumki Upazila. Asian Journal of Plant Science and Research, 9(1):22-31.

Campbell, T.P. 1981.Cultivation of *Litchi chinensis* Sonn in Australia. Queensland Fruit Veg. News 52:156-17.

Coronel, R.F. and Sotto R.C. 2001.Fruit characterization and propagation of pummelo in Los Banos. Philippine Agricultural Scientist, 48:114-115.Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. 2nd ed. John Willey and Sons. New York. p.64.

Goutam, S.R. and Thapa, M.P.1994. Preliminary observation on plant propagation methods of pomegranate. PAC Working paper, Paphriba Agricultural Centre.24: 19.

Greuter,W. 2000.International Code of Botanical Nomenclature. Regnum Veg., p. 138.

Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, R.L. 2009. Plant Propagation-Principles and Practices (7th Edition). Published by Asoke K. Ghosh, PHI Learning Private Limited, New Delhi-110001.

Lederman, I.E., and Bezerra, J.E.F. 2000. Effect of grafting method and rootstock age on propagation of carambola. Revistabrasileira de Fruit culture, 21: 262-265.[Cited from Hort. Abst.Vol. 70(3), 2086, 2003].

Ledesma, N., and Campbell, R.Z. 2001. Review of cultivars and propagation of pummelo in Southern Florida. Proceedings of International Society of Tropical Horticulture, pp.12-14.

Mondal, M.F. 2000. Production and Storage of Fruits (in Bengali). Mrs. Afia Mondal, BAU Campus, Mymensingh.

Napier, I. and Robbins, M. 1989. Forest Seeds and Nursery Practice in Nepal. pp. 94-95.

Rahim M.A., Alam, M.S., Alam, A.K.M.A. and Hossain, M.M.A. 2011.Underutilized Fruits in Bangladesh, Bangladesh Agricultural University, Mymensingh, Bangladesh, Biodiversity International, Malaysia, and Rural Development Administration (RDA), Korea. pp. 105-108.

Rahman, M.M. 2005.A study on the performance of different methods of vegetative propagation of minor fruits, M. S. Thesis, Department of Horticulture, Bangladesh Agricultural University, Mymensingh.

Robbani, M. 2012. Collection, conservation and characterization of minor fruit germplasm available in Patuakhali coast of Bangladesh. UGC research report, Department of Horticulture, PSTU. pp. 2-8.

Robbani, M., Banno, K. Yamaguchi, K. Fujisawa, N. Liu J. Y. and Kakegawa, M. 2006. Selection of dwarfing pear rootstock clones from *Pyrus betulaefolia* and *P. calleryana* seedlings. Journal of the Japan Society for Horticultural Science, 75 (1):1-10.

Russel, D.F. 1986. MSTAT-C Package Program. Crop and Soil Science, Department of Michigan State University, USA.

Sarker, C.R. 2016. Conservation and characterization of minor fruit germplasm available in Patuakhali coast of Bangladesh. PhD thesis, Department of Horticulture. Patuakhali Science and Technology University.

Sarker, C.R., Robbani, M., Rahim, M.A. and Iqbal, T.M.T. 2015.Fruit diversity in the coastal homesteads of Bangladesh. Journal of Crop and Weed, 11: 95-105.

Sunyman, C. and Fraser, C. 1996. Propagation of passion fruits. Information Bulletin, Citrus and Sub-tropical Fruit Research Institute, California 185, pp. 4-5.

Webster, A.D. 2003. Breeding and selection of apple and pear rootstocks. Acta Horticulture, 622: 499-512.

Westwood, M. N. and Roberts, A. N.1970. The relationship between trunk cross-sectional area and weight of apple trees. J. Amer. Soc. Hort. Sci. 95, 28-30.