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ORIGINAL RESEARCH ARTICLE

# Multiplication performance of monkey jack by cleft grafting on single source seedling rootstock

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**ABSTRACT**

The present research work was undertaken to study the fate of cleft grafting of five potential monkey jack genotypes during 2020-2021 at the Germplasm Center, Patuakhali Science and Technology University, Bangladesh. Scions from five *in situ* conserved promising mother plants named as Dumki-Al-S1, Dumki-Al-S2, Dumki-Al-S3, Dumki-Al-S4 and Kalapara-Al-S5 were cleft grafted on seedling rootstock (Dumki-Al-R1) of single genotype. A pot experiment was set in two-factor (Scions and Days after grafting) RCBD with 10 replications. The time required to break bud varied significantly among the treatments and ranged from 14 to 20 days. Dumki-Al-S1 required the maximum time to bud break (20 days) followed by Dumki-Al-S3 (18 days). Dumki-Al-S2 took minimum time (14 days) for bud breaking. The maximum increased length of rootstock found in Dumki-Al-S2 which were 55.00, 55.70, 56.44 and 65.30 cm at 21, 42, 63 and 84 days after grafting (DAG), respectively, followed by Kalapara-Al-S5 (61.80, 54.80, 55.30, and 57.12 cm at 21, 42, 63 and 84 DAG, respectively). Kalapara-Al-S5 showed maximum diameter of rootstock (1.44, 1.70, 1.80 and 1.94 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S4 (1.08, 1.24, 1.34 and 1.42 cm at 21, 42, 63 and 84 DAG, respectively). The length and diameter of scion of Dumki-Al-S4 and Kalapara-Al-S5 were higher and statistically identical at 84 DAG. The maximum graft height was recorded in Kalapara-Al-S5 (70.60, 73.40, 76.00 and 77.10 cm at 21, 42, 63 and 84 DAG, which was statistically similar with Dumki-Al-S2. Kalapara-Al-S5, Dumki-Al-S3 and Dumki-Al-S4 showed maximum number of leaves per graft at 84 DAG. The maximum graft success of 40% was observed in both Dumki-Al-S1 and Dumki-Al-S3 at 84 DAG, whereas, other treatments had less than 20% graft success. Kalapara-Al-S5 and Dumki-Al-S2 showed significantly higher and identical number of sprouted shoots at 84 DAG. Dumki-Al-S1 showed the maximum lengths and diameters of shoot at 84 DAG. The overall performance of the stionic combinations indicated that Dumki-Al-S1 and Dumki-Al-S3 were found promising for further grafting trials with seedling rootstocks.



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## INTRODUCTION

Monkey jack (*Artocarpus lakoocha* Roxb), belonging to the family Moraceae is a valuable tropical tree native to India. Bangladesh has been blessed with numerous native fruits including monkey jack, which is very rich in micro nutrients and grown naturally by seed propagation (Bhattacherjee *et al*., 2019). It is assumed that monkey jack is derived from a place of Bangladesh and Assam

(Rahim *et al*., 2011). Monkey jack is a multipurpose tree of warm climate, a wide genetic variation of this fruit was observed in the coastal homesteads of Bangladesh (Sarker, 2016). Native fruits including monkey jack are known as fruit wealth to the coastal community, which are grown in the natural habitats, survive well without management and bear fruits at a limited scale; commonly known as minor fruits (Robbani, 2012). These fruits are highly nutritious but most of them are going to be extinct or endangered condition due to lack of proper care and management and planned multiplication.

Monkey jack is habitually propagated by seeds that induce heterogeneous progeny. True-to-type generation is obvious for propagating any chance seedling or elite germplasm. Selection of special seedling mother-tree can provide uniform, unique seedling rootstock for specific scion (Hartmann *et al*., 2009). In case of some minor fruit species, vegetative propagation through cleft grafting technique is developed and establishment of identified genotypes using the scions from their original sources on local rootstocks are undertaken. So, the problem therein can be minimized by vegetative propagation of minor fruit germplasm through cleft grafting or other suitable vegetative means. Ahmed (2008) mentioned that the highest graft success rate recorded when 'Kashmiri pear' was used as scion and this genotype differed significantly from all other genotypes. A number of researches have recognized cleft grafting as a fruitful method for fruit crops like carambola (Lederman and Berra, 2000), pummelo (Ledesma and Campbell, 2001), passion fruit (Sunyman and Fraser 1996), and Indian olive (Rahman, 2005). Aziz *et al.* (2013) observed that T-grafting in jamun gave maximum success (65.25%) followed by T-budding (24.75%) against minimum success (10.75%) in plants budded via cleft grafting. Regarding propagation in pomegranate, Goutam and Thapa (1994) observed that veneer grafting in April was most successful (67%), whip and cleft grafting in April, May and August and shield budding in August gave 33% success rates. Napier and Robbins (1989) reported that seed propagation of monkey jack increases its biodiversity but vegetative propagation is desirable for restoring the pleasing pomological traits of elite germplasm.

Seed propagated plants become more vigorous but vegetative propagation induces dwarf traits that are useful for proper management and quality fruit production. There are numerous problems associated with the propagation of monkey jack, because tree population is decreasing due to poor seed viability, quick deterioration of seed viability, difficult to adventitious rooting and poor success in grafts. No suitable vegetative propagation technology has yet been developed for monkey jack. In a previous study, some potential sources of monkey jack scions have been selected and *in situ* conserved. For the sake of restoring the true-to-type qualities of the selected scions, the present research work was undertaken to study the performance of cleft grafting performance of selected monkey jack germplasm on seedling rootstock of single genotype.

## MATERIALS AND METHODS

The investigation was carried out at the Germplasm Center (GPC), PSTU during June, 2020 to November, 2021. 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.

### Rootstocks establishment

In the fruiting season (June –July) of 2018 about 100 seeds were collected from *in situ* conserved (22°27'01"NL and 90°18'41"EL) locally available 10 years old velvet apple rootstock mother plant (Dumki-Al-R1). Completely ripe fruits were considered for collection of seeds and raising of seedlings (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 saplings were then transferred to the experimental plots in open field condition. Proper care and management of the saplings were taken to maintain their optimum growth until grafting with scion.

**Plate 1.** *Seedling rootstock establishment from Dumki-Al-R1 mother plant of monkey jack.*

**Table 1.** Passport data of *in situ* conserved monkey jack scion and rootstock.

| Scion/Rootstock | Location of collection | GPS coordination | |
|---|---|---|---|
| | | Latitude (North) | Longitude (East) |
| *In situ* conserved scion source | | | |
| Dumki-Al-S1 | Lebukhali, Dumki | 22°28'23" | 90°24'11" |
| Dumki-Al-S2 | Sreerampur, Dumki | 22°28'22" | 90°22'51" |
| Dumki-Al-S3 | Sreerampur, Dumki | 22°27'47" | 90°22'59" |
| Dumki-Al-S4 | Jalisha, Dumki | 22°28'50" | 90°24'4" |
| Kalapara-Al-S5 | Kalapara Sadar, Patuakhali | 22°1'16" | 90°16'22" |
| *In situ* conserved seedling rootstock source | | | |
| Dumki-Al-R1 | Sreerampur, Dumki | 22°27'01" | 90°18'41" |

Here, Al = *Artocarpus lakoocha*; S= Scion and R=Rootstock.

### Scion mother plant selection

In a previous study, the Pomology Research Team of PSTU had recognized five promising velvet apple germplasm with desirable pomological traits. Healthy, vigorous, disease free 10 to 12 years old good bearing scion mother plants of 5 promising monkey jack germplasm were *in situ* conserved with GPS coordination from two upazilas of Patuakhali viz. Dumki and Kalapara (Table 1). The scion mother plants were named as Dumki-Al-S1, Dumki-Al-S2, Dumki-Al-S3, Dumki-Al-S4 and Mirzaganj-Al-S5.

### Rootstock preparation

Fifty healthy saplings of about one year old with uniform growth were selected for cleft grafting. At first, the main trunk of the rootstock was selected for grafting and the rest branches were removed with a pair of sharp secateurs. A round cut was given at a height of 15cm from the ground level of the rootstock to remove the upper portion and 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.

### Collection and preparation of scion

Well developed (10-12 months age), healthy, straight shoots of active growth of 15cm long 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 at the base of the scion were made smoothly by a sharp knife that gave the appearance of a peg. The basal end of the scion on both the sides opposite to each other was in to a gentle slope of 5cm long and the scions were prepared.

### Performing cleft grafting operation

The proximal end of the prepared scion was inserted in to 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. The grafted compound trees were kept under a shade net for one month followed by removal of net for allowing natural field condition.

### Data collection

**Number of days required to bud break:** The bud break of the graft was observed critically every day and the time required to bud break from the date of 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:

**Number of leaves per graft at different DAG:** It was noted at 21 days interval starting from 21 days and continued up to 84 DAG.

**Length of the rootstock at different DAG:** The increase in the length (in cm) of the rootstock per successful graft was noted from the base up to the graft joint at 21 days interval starting from 21 days and continue up to 84 DAG.

**Diameter of the rootstocks at different DAG:** Measured (in cm) with a slide caliper at 21 days interval starting from 21 days and continue up to 84 DAG.

**Length of the scion at different DAG:** Measured (in cm) from the middle portion of the graft joint up to the tip of the plant at 21 days interval starting from 21 and continue up to 84 DAG.

**Diameter of scion at different DAG:** Diameter of scion was noted (in cm) with slide calipers just above the joint portion at 21 days interval stating from 21 up to 84 DAG.

**Length of the sprouted shoot at different DAG:** Shoot length was measured (in cm) from the middle portion of the shoot at 21 days interval starting from 21 days and was continue up to 84 DAG.

**Diameter of the sprouted shoot at different DAG:** Shoot diameter was noted (in cm) with slide calipers just above the joint portion at 21 days interval stating from 21 up to 84 DAG.

**Increased graft height at different DAG:** It was measured (in cm) with a measuring scale from base to top of the graft at 21 days interval starting from 21 up to 84 DAG.

### Statistical analyses

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

## RESULTS AND DISCUSSION

There are a number of vital problems linked with regeneration and propagation of monkey jack. Its population is decreasing gradually due to poor seed viability and extensive exploitation for food, timber and other uses. Seeds, once extracted from fruit, quickly loose viability within a few days or sometimes even in a week. Seed propagation of monkey jack is desirable in terms of increasing biodiversity but seeds carry inherent traits resulting in failure to maintain true-to-type genotypes. Additionally, sexual propagation faces many unpredictable problems related to germination and prolong juvenile phase. Vegetative propagation such as rooting of hardwood or softwood stem cuttings had not been successful in monkey jack (Napier and Robbins, 1989).

### Number of days required to bud break

It was revealed from the data that the time required for bud breaking varied significantly among the grafts and ranged from 14 to 20 days. Dumki-Al-S1 required the maximum time (20 days) to bud break followed by Dumki-Al-S3 (18 days). Dumki-Al -S2 took minimum time (14 days) for bud breaking. The earlier bud break in Dumki-Al-S2 might be due physiological uniqueness in the synthesis and translocation of auxin to the graft union portion for callus formation and differentiation of parenchymatous tissue as well as the cambium and vascular bundle.

### Length of rootstock of at different DAG

There was significant variation among the treatments in regard to increased length of rootstock (Table 2). The maximum increased lengths (55.00, 55.70, 56.44 and 65.30 cm at 21, 42, 63 and 84 DAG, respectively) of rootstock were observed when grafted with Dumki-Al-S2 scion, followed by Kalapara-Al-S5 (61.80, 54.80, 55.30, and 57.12 cm at 21, 42, 63 and 84 DAG, respectively). On the other hand, the minimum length of rootstock was found in Dumki-Al-S4 (48.80, 49.50, 50.20 and 50.80 cm at 21, 42, 63 and 84 DAG, respectively). The maximum length of rootstock with the scions Dumki-Al-S2 and Kalapara-Al-S5 were statistically alike and the minimum length of rootstock with the scions Dumki -Al-1 and Dumki-Al-S4 were statistically alike.

### Diameter of rootstock at different DAG

It was revealed from the results that diameter of rootstock varied significantly among the treatments (Table 3). Graft combination with Kalapara-Al-S5 showed maximum diameter (1.44, 1.70, 1.80 and 1.94 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S4 (1.08, 1.24, 1.34 and 1.42 cm at 21, 42, 63 and 84 DAG, respectively). The minimum diameter of rootstock was found with Dumki-Al-S2 (1.12, 1.12, 1.20 and 1.26 cm at 21, 42, 63 and 84 DAG, respectively).

**Table 2.** Length of rootstock of monkey jack at different DAG.

| Graft/Treatment | Rootstock length (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 46.10 d | 48.80 c | 49.60 c | 51.00 c |
| Dumki-Al-S2 | 55.00 b | 55.70 b | 56.44 b | 65.30 b |
| Dumki-Al-S3 | 54.60 b | 62.80 b | 64.00 b | 56.00 b |
| Dumki-Al-S4 | 48.80 c | 49.50 c | 50.20 c | 50.80 c |
| Kalapara-Al-S5 | 61.80 a | 54.80 a | 55.30 a | 57.12 a |
| LSD (0.05) | 1.60 | 2.17 | 2.01 | 1.76 |
| Level of significance | * | * | * | * |
| CV (%) | 2.23 | 2.97 | 2.72 | 2.35 |

Means in a column with the same letter(s) do not differ significantly; * = Significant at the 5% level of probability.

**Table 3.** Diameter of rootstock of monkey jack at different DAG.

| Graft/Treatment | Rootstock diameter (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 0.74 c | 1.04 c | 1.22 bc | 1.28 bc |
| Dumki-Al-S2 | 1.12 b | 1.12 bc | 1.20 c | 1.26 c |
| Dumki-Al-S3 | 1.12 b | 1.16 bc | 1.22 bc | 1.26 c |
| Dumki-Al-S4 | 1.08 b | 1.24 b | 1.34 b | 1.42 b |
| Kalapara-Al-S5 | 1.44 a | 1.70 a | 1.80 a | 1.94 a |
| LSD (0.05) | 0.17 | 0.14 | 0.13 | 0.15 |
| Level of significance | * | * | * | * |
| CV (%) | 11.68 | 8.42 | 7.05 | 7.60 |

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

**Table 4.** Length of scion of monkey jack at different DAG.

| Graft/Treatment | Scion length (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki–Al-S1 | 11.90 c | 12.20 b | 13.60 d | 13.80 d |
| Dumki–Al-S2 | 13.20 b | 13.20 b | 15.80 c | 17.20 c |
| Dumki–Al-S3 | 13.20 b | 15.60 a | 18.50 b | 18.60 bc |
| Dumki–Al-S4 | 13.00 b | 15.60 a | 20.10 a | 20.80 ab |
| Kalapara–Al-S5 | 14.30 a | 16.00 a | 21.00 a | 21.60 a |
| LSD (0.05) | 0.86 | 1.04 | 1.10 | 2.87 |
| Level of significance | * | * | * | * |
| CV (%) | 4.88 | 5.35 | 4.62 | 11.62 |

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

**Table 5.** Diameter of scion of monkey jack at different DAG.

| Graft/Treatment | Scion diameter (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 0.44 c | 0.54 c | 0.60 b | 0.62 c |
| Dumki -Al-S2 | 0.48 bc | 0.58 bc | 0.68 ab | 0.72 b |
| Dumki-Al-S3 | 0.48 bc | 0.58 bc | 0.68 ab | 0.72 b |
| Dumki-Al-S4 | 0.50 b | 0.60 b | 0.72 a | 0.78 ab |
| Kalapara-Al-S5 | 0.60 a | 0.66 a | 0.76 a | 0.86 a |
| LSD (0.05) | 0.06 | 0.06 | 0.09 | 0.09 |
| Level of significance | * | * | * | * |
| CV (%) | 9.49 | 7.74 | 10.63 | 10.02 |

Means in a column followed by the same letter(s) do not differ significantly by DMRT; * = Significant at the 5% level of probability.

**Table 6.** Graft height of monkey jack at different DAG.

| Graft/Treatment | Graft height (cm) at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 58.80 c | 60.40 d | 66.00 d | 67.40 c |
| Dumki-Al-S2 | 65.20 b | 68.00 b | 70.60 b | 76.20 a |
| Dumki-Al-S3 | 65.70 b | 65.96 c | 67.30 cd | 68.50 c |
| Dumki-Al-S4 | 65.40 b | 66.10 bc | 68.70 bc | 71.00 b |
| Kalapara-Al-S5 | 70.60 a | 73.40 a | 76.00 a | 77.10 a |
| LSD (0.05) | 2.76 | 1.97 | 1.97 | 1.24 |
| Level of significance | * | * | * | * |
| CV (%) | 3.15 | 2.20 | 2.10 | 2.19 |

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

### Length of scion at different DAG

There were significant variations among the treatments in regards to length of scion (Table 4). The maximum length of scion was recorded in Kalapara-Al-S5 (14.30, 16.00, 20.00 and 21.60 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S4 (13.00, 15.60, 20.10 and 20.80 cm at 21, 42, 63 and 84 DAG, respectively). The minimum length of scion was recorded in Dumki-Al-S1 (11.90, 12.20, 13.60 and 13.80 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S2 (13.20, 13.20, 15.80 and 17.20 cm at 21, 42, 63 and 84 DAG, respectively). The length of scion of Dumki-Al-S4 and Kalapara-Al-S5 were statistically alike at 84 DAG.

### Diameter of scion at different DAG

The diameter of the scion varied significantly among the treatments (Table 5). The data procured on diameter of rootstock at different days were subjected to statistically analysis. Kalapara-Al-S5 showed maximum diameter (0.60, 0.66, 0.76 and 0.86 cm at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S4 (0.50, 0.60, 0.72 and 0.78 cm at 21, 42, 63 and 84 DAG, respectively). The minimum diameter of scion was found in Dumki-Al-S1 (0.44, 0.54, 0.60 and 0.62 cm at 21, 42, 63 and 84 DAG, respectively). The diameter of scion of Dumki-Al-S4 and Kalapara-Al-S5 were statistically alike at 84 DAG.

### Graft height

The graft height of rootstock varied significantly among the treatments (Table 6). The data regarding graft height of rootstocks were analyzed statistically. The maximum graft height was recorded in Kalapara-Al-S5 (70.60, 73.40, 76.00 and 77.10 cm at 21, 42, 63 and 84 DAG, followed by Dumki-Al-S2 (65.20, 68.00, 70.60 and 76.20 cm at 21, 42, 63 and 84 DAG, respectively). The minimum graft height was found in Dumki-Al-S1 58.80, 60.40, 66.00 and 67.40 cm at 21, 42, 63 and 84 DAG, respectively). The graft height of Dumki-Al-S2 and Kalapara-Al-S5 were statistically alike and the Dumki-Al-S1 and Dumk-Al-S3 were statistically alike at 84 DAG.

**Table 7.** Number of leaves of monkey jack graft at different DAG.

| Graft/Treatment | Number of leaves per graft at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 2.00 b | 3.00 c | 4.00 c | 4.40 c |
| Dumki-Al-S2 | 2.10 b | 4.00 b | 5.00 b | 5.80 b |
| Dumki-Al-S3 | 2.80 a | 4.00 b | 5.10 b | 6.10 ab |
| Dumki-Al-S4 | 2.90 a | 4.10 b | 5.80 ab | 6.80 a |
| Kalapara-Al-S5 | 3.00 a | 5.00 a | 6.00 a | 7.00 a |
| LSD (0.05) | 0.33 | 0.56 | 0.80 | 0.92 |
| Level of significance | * | * | * | * |
| CV (%) | 9.47 | 10.33 | 11.58 | 11.42 |

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

**Table 8.** Number of sprouted shoots of monkey jack graft at different DAG.

| Graft/Treatment | Number of sprouted shoots per graft at different DAG | | | |
|---|---|---|---|---|
| | 21 | 42 | 63 | 84 |
| Dumki-Al-S1 | 1.00 | 2.00 | 3.00 a | 3.20 a |
| Dumki-Al-S2 | 1.00 | 2.00 | 2.00 bc | 2.40 b |
| Dumki-Al-S3 | 1.00 | 1.00 | 2.20 b | 3.00 a |
| Dumki-Al-S4 | 1.00 | 1.00 | 1.60 c | 2.00 c |
| Kalapara-Al-S5 | 1.00 | 1.00 | 1.00 d | 2.00 c |
| LSD (0.05) | - | - | 0.40 | 0.29 |
| Level of significance | NS | NS | * | * |
| CV (%) | - | - | 15.31 | 8.65 |

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

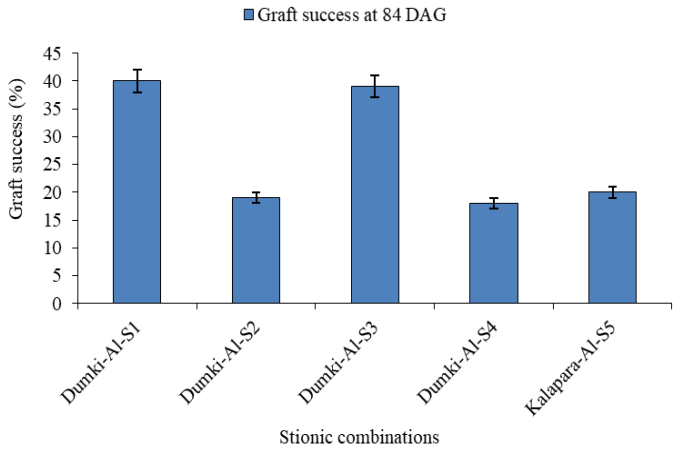


**Figure 1.** *Graft success (%) at 84 DAG of five stionic combinations of monkey jack. Vertical bars indicate standard error (n=10).*

### Number of leaves per graft

The number of leaves per graft varied significantly among the treatments (Table 7). Kalapara-Al-S5 showed maximum number of leaves per graft 3.00, 5.00, 6.00 and 7.00 at 21, 42, 63 and 84 DAG, respectively followed by Dumki-Al-S4 (2.90, 4.10, 5.80 and 6.80 at 21, 42, 63 and 84 DAG, respectively). Dumki-Al-S1 showed minimum leaves 2.00, 3.00, 4.00 and 4.40 at 21, 42, 63 and 84 DAG, respectively.

### Percent success in grafting

There was significant variation among the treatments in respect to percent graft success (Figure 1). Dumki-Al-S1 and Dumki-Al-S3 showed maximum (40.00) percentage of success at 84 DAG. The minimum percentage (20.00) of success was recorded in Dumki-Al-2, Dumki-Al-S4 and Kalapara-Al-5. The higher success in Dumki-Al-S1 and Dumki-Al-S3 might be due to balanced C: N ratio in scions, which helped towards maximum graft union process. Graft success is variable and mostly depends on botanical distance, several physiological factors and also compatibility between the stock and scion. Rahman (2005) found that cleft grafting success of carambola and Indian olive had maximum graft success of 97.77% and 93.33% at 120 DAG, respectively. On the other hand, Aziz *et al.* (2013) reported that T-grafting in jamun gave maximum success (65.25%) followed by minimum (10.75%) in cleft grafting. Our result is partially consistent with these findings. Although, a number of researches have recognized cleft grafting as a fruitful method for fruit crops like carambola (Lederman and Berra, 2000), pummelo (Ledesma and Campbell, 2001), passion fruit (Suyman and Fraser, 1996) and Indian olive (Rahman, 2005), in our research with monkey jack the result is very unsatisfactory. These variable results might be due to stionic incapability, which might hinder in the synthesis and translocation of auxin to the union portion for callus formation and differentiation of parenchymatous tissue as well as the cambium and vascular bundle creation. Other reasons might be due to improper grafting, time of operation and environmental factors.

### Number of sprouted shoot per graft

The number of sprouted shoots per graft varied significantly among the treatments (Table 8). Kalapara-Al-S5 showed maximum number of sprouted shoot (1.00, 2.00, 3.00 and 3.20 at 21, 42, 63 and 84 DAG, respectively) followed by Dumki-Al-S2 (1.00, 1.00, 2.20 and 3.00 cm at 21, 42, 63 and 84 DAG, respectively) Dumki-Al-S3 showed minimum number of sprouted shoot (1.00, 1.00, 1.60 and 2.00 at 21, 42, 63 and 84 DAG, respectively).

**Table 9.** Length and diameter of sprouted shoot of monkey jack graft at different DAG.

| Graft/Treatment | Dimension of the sprouted shoots of monkey jack at different DAG | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 21 | | 42 | | 63 | | 84 | |
| | Length (cm) | Diameter (cm) | Length (cm) | Diameter (cm) | Length (cm) | Diameter (cm) | Length (cm) | Diameter (cm) |
| Dumki-Al-S1 | 1.44 a | 0.22 | 2.54 a | 0.48 a | 4.22 a | 0.62 a | 4.68 a | 0.74 a |
| Dumki-Al-S2 | 1.00 c | 0.20 | 1.52 c | 0.30 c | 2.52 c | 0.42 b | 2.76 e | 0.48 c |
| Dumki-Al-S3 | 1.14 b | 0.20 | 2.06 b | 0.24 d | 3.54 b | 0.40 b | 3.82 c | 0.58 b |
| Dumki-Al-S4 | 1.38 a | 0.22 | 2.48 a | 0.42 b | 3.60 b | 0.56 a | 4.10 b | 0.58 b |
| Kalapara-Al-S5 | 1.00 c | 0.22 | 2.00 b | 0.30 c | 2.70 c | 0.40 b | 3.52 d | 0.52bc |
| LSD (0.05) | 0.13 | - | 0.13 | 0.04 | 0.35 | 0.08 | 0.25 | 0.08 |
| Level of sig. | * | NS | * | * | * | * | * | * |
| CV (%) | 8.43 | - | 4.83 | 9.53 | 7.84 | 13.18 | 4.95 | 10.90 |

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 sprouted shoot

There was significant variation among the treatments in regard to length of sprouted shoot (Table 9). The maximum length of shoot was recorded in Dumki-Al-S1 (1.44, 2.54, 4.22 and 4.68 cm at 21, 42, 63 and 84 DAG, respectively followed by Dumki-Al -S3 (1.14, 2.06, 3.54 and 3.82 cm at 21, 42, 63 and 84 DAG, respectively). Dumki-Al-S2 showed the minimum length of shoot 1.00, 1.52, 12.52 and 2.76 cm at 21, 42, 63 and 84 DAG, respectively). The length of sprouted shoot of Dumki-Al-S1 was statistically different from another germplasm.

### Diameter of sprouted shoot

The diameter of sprouted shoot varied notably among the treatments (Table 9). Dumki-Al-S1 showed the maximum diameters (0.22, 0.48, 0.62 and 0.74.00 cm at 21, 42, 63 and 84 DAG, respectively followed by Dumki-Al-4 (0.20, 0.24, 0.40 and 0.58 cm at 21, 42, 63 and 84 DAG, respectively). Dumki-Al-S2 showed the minimum diameters (0.20, 0.30, 0.42 and 0.48 cm at 21, 42, 63 and 84 DAG, respectively. The diameters of Dumki-Al-S1 were statistically differed from another germplasm. The growth parameters i.e., percent success, days to bud break in grafting, number of leaves per graft, increased length of rootstock and diameter of rootstock, length of scion, diameter of scion, graft height, number of sprouted shoots, length of sprouted shoot and diameter of sprouted shoots were related with each other and influenced by supply of nutrients from soil, climatic conditions, genotypes and also stock-scion relationship. The response of the genotypes varied significantly for the growth parameters. The germplasm Dumki-Al-S2 gave the maximum numbers of shoots and Kalapara-Al-S5 had the highest number of leaves per plant compared to other genotypes. More number of leaves was due to a greater number of shoots that ultimately affected the length and thickness of the shoots. As far as the length of the sprouted shoot concerned, significant variation among genotypes was observed. The maximum shoot length was in Kalapara -Al-S5 and it had a greater number of leaves. The potential 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 photo-assimilates to the other parts of plant (Hartmann *et al.*, 2009). In general, all the graft combinations in this study had 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. The native monkey jack germplasm was used as the rootstocks for grafting which were considered as hardy enough for growing at the coastal edaphic condition. Significant differences were observed among the graft combinations for the growth parameters. The grafts differed for time taken to sprouting after grafting of scions. The scions of Dumki-Al-S1 took the longest periods to sprout while Dumki-Al-S2 sprouted earlier. Here, the potential in terms of accumulation of materials like metabolites and carbohydrates could possibly be responsible for variation in sprouting time. The germplasm Dumki-Al-S3 and Dumki-Al-S1 expressed significantly better success on native saplings compared to other genotypes.

## Conclusion

Reproduction of underutilized fruits like monkey jack is much unplanned and generally depends on naturally occurring seeds. Now a day's people are interested to restore, cultivate and consume this fruit. In some cases, natural seed propagation induces to grow "chance seedling" with desirable pomological traits that could be maintained true-to-type by vegetative multiplication only. Accordingly, this research work was undertaken to study the performance of cleft grafting of five potential monkey jack genotypes during 2018-2019 at the Germplasm Center, Patuakhali Science and Technology University. All the five selected scion mother plants were *in situ* conserved in a previous study of this research team. Scions from five promising mother plants were cleft grafted on seedling rootstock (Dumki-Al-R1) of single genotype. Although, significant variations among the treatments (Stions) were observed, the overall performance of the stionic combinations of monkey jack was not satisfactory because of poor graft success in general. However, stionic combinations with Dumki-Al-S1 and Dumki-Al-S3 were found promising for further grafting trials with other seedling rootstocks.

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