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# Standardization of grafting of mango as affected by method, time and rootstocks age under Tripura condition

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ABSTRACT

The present study was carried out to standardize the epicotyl and softwood grafting techniques under Tripura condition considering the availability time of mango stones, suitable grafting time, appropriate rootstock age and grafting height. Epicotyl grafting was highly successful on 10 to 20 days old rootstocks during 1st June to 1st August with average graft success of 81.9%-85.1%. In the first year, softwood grafting can be done on 3 months (1st September) to 3½ months (15th September) old rootstocks at 8-10 cm height (79.5%-80.5% graft success). In the second year, softwood grafting is highly successful on 10 months (1st April) to 12 months (1st June) old rootstocks at 12-14 cm height (73.35-86.9% graft success), on 10 months (1st April) to 15 months (1st September) old rootstocks at 16-18 cm height (75.7%-91.3% graft success) and on 12 months (1st June) to 15 months (1st September) old rootstocks at 20-24 cm height (76.5%-88.3%). Further, during October to February is not suitable time for mango grafting as low temperature and low relative humidity prevails during this period under Tripura Condition.

## 1. Introduction

Mango (*Mangifera indica* L.) is one of the leading commercial fruit crops cultivated in tropical and subtropical agro-climatic zone. In India, mango production is 19687 thousand MT over an estimated area of 2263 thousand ha and productivity is 8.7 MT/ha (Anonymous 2017). Major mango producing states are Uttar Pradesh, Karnataka, Andhra Pradesh, Bihar, Telangana, Maharashtra and West Bengal. Apart from these states, commercial cultivation of superior mango varieties has been adopted in north eastern states like Tripura, Assam, Nagaland, Mizoram and Manipur. In Tripura, mango production is around 58.5 thousand MT over an area of 11.6 thousand ha and productivity is 5.0 MT/ha (Anonymous 2017). Popular traditional varieties are Himsagar, Langra, Fazli, Gulabkhans and Kishen Bhog, whereas, some new varieties have also become very much popular in the state namely Amrapali, Mallika, Arunima and Arunika. All these new varieties are semi dwarf in vigour, fruit quality is very good and recommended planting density varies from 278-400 plants/ha (Anonymous, 2017 and Bora *et al*., 2017). After introduction of var. Amrapali in Tripura in 1989, performance of this variety under medium density system (5-6.5 m spacing) has been found to be excellent. Area expansion under fruit crops has been one of the major priorities in the state under different developmental schemes. Accordingly, demand for quality planting material of fruit crops has increased many folds in the state, moreover, not only within Tripura but also from other north eastern states However, due to lack of standardized advanced propagation technology under the climatic condition of Tripura, large scale multiplication was a hurdle for production of quality planting materials. Consequently, large quantities of planting materials are being imported from other states. Epicotyl or stone grafting has been reported to be successful under hot and humid conditions in different parts of India and age of rootstock is very crucial (Singh and Srivastava, 1981; Padma and Reddy, 1997; Radha and Aravindakshan, 2000; Usare, 2016). Similarly, another widely adopted method for mango propagation is soft wood grafting (Ram and Pathak, 2006).

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Considering the climatic condition of Tripura which is Tropical to subtropical in nature, standardization of a propagation schedule using epicotyl as well as soft wood grafting techniques is very much essential so that propagation period may be extended which is affected by age of rootstock, time and height of grafting and more importantly grafting technique (Patel and Amin, 1981; Karna *et al*., 2017).

## 2. Materials and Methods

The present experiment was conducted at Tripura Centre, ICAR Research Complex for NEH Region, Lembucherra, during 2015-17. Climate of Tripura is tropical in nature with total annual rainfall 2400-3100 mm mainly as pre monsoon (mid-March-May), monsoon (June-August) and post monsoon (September-November). Temperature varies depending upon the season, 4-20$^0$ C in winter (December-January), 15-35$^0$ C in spring, rainy and autumn season (February-November). Relative humidity range is 65 (winter)-85% (summer and rainy season). Mango stones were collected from preselected wild mango trees in the month of May-August for epicotyl grafting. Properly cleaned and treated stones were sown in nursery bed comprising sand soil mixture (2:1) under net house at different days intervals, so that newly emerged seedlings can be taken at 5 days, 10 days, 20 days, 25 days and 30 days intervals after germination for epicotyl grafting at five dates (15 days interval) *i.e.* 1$^{st}$ June, 15$^{th}$ June, 1$^{st}$ July, 15$^{th}$ July and 1$^{st}$ August. In each date, 5, 10, 15, 20, 25 and 30 days old tender rootstocks with coppery leaf and shoots were uprooted for bench epicotyl grafting in net house. Greenish coppery coloured scions with coppery leaves and 3.0-4.0 mm thickness (3-3½ months old) were defoliated on the mother trees of var. Amrapali seven days before grafting operation. Tender seedlings rootstocks were headed back by giving a sharp transverse cut at 5-6 cm slanting cut on both sides at the base. Prepared scion was inserted into the wedge groove of the rootstock and tied height on epicotyl and a 3.0-3.5 cm longitudinal cut downward from the center of the transverse cut surface. Scions of 12 cm length were given a sharp 3.0-3.5 cm with polyethylene strip. After completion of grafting all the plants were planted in black polybags (25x 15 cm) comprising soil, sand and FYM (1:1:1) and kept in net shade house which was only covered with 75% shade net on top and kept open from all the sides. However, temperature ranged from 24-30$^0$C and RH 75-85%. For soft wood grafting stones were sown on 1$^{st}$ June in nursery bed and 10-15 days old seedlings were transferred to black polybags (25x15 cm) filled with soil, sand and FYM mixture (1:1:1). All the polyethylene bags were placed in 1 m wide x 10 cm depth trenches under shade nets structures. A strip of thick polyethylene sheet was places on the surface of the trench so that over grown roots cannot penetrate into the soil at the end of the season. Soft wood grafting was done in two stages, i) in the first year grafting using wedge method was done on current season growth of seedlings at three heights 8-10 cm, 12-14 cm and 16-18 cm at eight different time intervals (15 days interval) *i.e.* 1$^{st}$ August (on 2 months old rootstocks), 15$^{th}$ August (on 2½ months old rootstocks), 1$^{st}$ September (on 3 months old rootstocks), 15$^{th}$ September (on 3½ month old rootstocks), 1$^{st}$ October (on 4 months old rootstocks), 15$^{th}$ October (on 4½ month old rootstocks), 1$^{st}$ November (on 5 months old rootstocks) and 15$^{th}$ November (on 5½ month old rootstocks). ii) In the second stage, in the next season, softwood grafting using wedge method was done on seedlings raised from stones sown on 1$^{st}$ June of previous year. Grafting was done on 8-16 months old seedlings at three heights 12-14 cm, 16-18 cm and 20-22 cm at 16 different grafting time (15 days interval), *i.e*. 15$^{th}$ February (on 8½ months old seedlings), 1$^{st}$ March (on 9 months old seedlings), 15$^{th}$ March (on 9½ month old rootstocks), 1$^{st}$ April (on 10 month old rootstocks), 15$^{th}$ April (on 10½ months old rootstocks), 1$^{st}$ May (on 11 month old rootstocks), 15$^{th}$ May (on 11½ months old rootstocks), 1$^{st}$ June (on 12 months old rootstocks), 15$^{th}$ June (on 12½ months old rootstocks), 1$^{st}$ July (on 13 months old rootstocks), 15$^{th}$ July (on 13½ months old rootstocks), 1$^{st}$ August (on 14 months old rootstocks), 15$^{th}$ August (on 14½ months old rootstocks), 1$^{st}$ September (on 15 months old rootstocks), 15$^{th}$ September (on 15½ months old rootstocks) and 1$^{st}$ October (on 16 months old rootstocks). Observation was recorded on grafting success (%) after one month, grafting diameter at graft union and plant height after completion of one year of grafted plants. Plant height and shoot diameter was recorded with meter scale and vernier caliper, respectively. Twenty plants treatment was taken and experiment was laid out in factorial RBD with 3 replications. Two years data were pooled and analyzed using Minitab 18.

## 3. Results and Discussion

***Epicotyl grafting***

Epicotyl grafting interaction effect of grafting time and rootstock age (Table 1 and Figure 1) show that significantly maximum grafting success was achieved on 10, 15 and 20 days old seedling in comparison to 5, 25 and 30 day old seedlings when grafting was done at 15 days interval starting from 1$^{st}$ June to 15$^{th}$ August with grafting success range of 80.2% (1$^{st}$ July grafting time x 10 days old root stock) to 86.0% (1$^{st}$ June grafting time x 15 days old rootstock).

**Table 1.** Epicotyl grafting success and successive plant growth of mango var. Amrapali as affected by rootstock age and grafting time

| Rootstock Age(RA) | Graft Success (%) | | | | | | Plant Dia.(mm) | | | | | | Height (cm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grafting Time (GT) | | | | | | | | | | | | | | | | | |
| | 1st June | 15th June | 1st July | 15th July | 1st August | Mean | 1st June | 15th June | 1st July | 15th July | 1st August | Mean | 1st June | 15th June | 1st July | 15th July | 1st August | Mean |
| 5 days | 55.6 | 57.7 | 59.5 | 64.0 | 63.9 | 60.1 | 6.7 | 6.7 | 7.7 | 10.7 | 8.6 | 8.1 | 30.7 | 29.7 | 33.6 | 34.2 | 30.6 | 31.8 |
| 10 days | 84.2 | 80.8 | 80.2 | 84.1 | 85.4 | 82.9 | 9.8 | 10.2 | 10.2 | 10.2 | 10.8 | 10.2 | 35.2 | 36.6 | 35.2 | 35.5 | 31.4 | 34.8 |
| 15 days | 86.0 | 83.4 | 83.4 | 82.9 | 89.7 | 85.1 | 11.0 | 12.2 | 11.4 | 10.8 | 12.2 | 11.5 | 36.4 | 37.4 | 36.4 | 36.4 | 36.3 | 36.6 |
| 20 days | 81.5 | 83.2 | 80.5 | 81.5 | 82.6 | 81.9 | 11.4 | 11.4 | 10.8 | 13.1 | 12.7 | 11.9 | 37.5 | 36.4 | 38.5 | 37.4 | 35.8 | 37.1 |
| 25 days | 72.0 | 69.3 | 70.1 | 69.5 | 69.5 | 70.1 | 13.5 | 12.8 | 13.1 | 13.3 | 12.3 | 13.0 | 39.1 | 40.4 | 41.3 | 39.3 | 34.2 | 38.9 |
| 30 days | 35.3 | 41.4 | 30.4 | 32.4 | 30.2 | 33.9 | 13.6 | 13.2 | 12.9 | 13.5 | 13.2 | 13.3 | 34.8 | 29.2 | 40.8 | 38.5 | 34.6 | 35.6 |
| Mean | 69.1 | 69.3 | 67.4 | 69.1 | 70.2 | 69.0 | 11.0 | 11.1 | 11.0 | 11.9 | 11.7 | 11.3 | 35.6 | 35.0 | 37.6 | 36.9 | 33.8 | 35.8 |
| CD (0.05%) RA x GT | 4.7 | | | | | | 2.5 | | | | | | 3.6 | | | | | |
| CD (0.5%) GT | 1.9 | | | | | | 1.0 | | | | | | 1.5 | | | | | |
| CD (0.05%) RA | 2.1 | | | | | | 1.1 | | | | | | 1.6 | | | | | |

**Table 2.** Grafting success and plant growth of Softwood grafted mango var. Amrapali on 3-6 months old root stocks as affected by grafting time and height

| Grafting Time (GT) | Rootstock Age (months) | Grafting Success (%) | | | | Graft union dia. (mm) | | | | Plant height (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grafting Height(GH) | | | | | | | | | | | |
| | | 8-10 mm | 12-14 mm | 16-18 mm | Mean | 8-10 mm | 12-14 mm | 16-18 mm | Mean | 8-10 mm | 12-14 mm | 16-18 mm | Mean |
| 1st August | 2 | 45.0 | 15.7 | 13.7 | 24.8 | 5.8 | 5.2 | 5 | 5.3 | 73.6 | 60.6 | 60.4 | 64.9 |
| 15th August | 2½ | 70.2 | 54.2 | 15.1 | 48.5 | 6.1 | 5.6 | 5.1 | 5.6 | 73.3 | 65.4 | 64.3 | 67.7 |
| 1st September | 3 | 80.5 | 68.1 | 35.4 | 70.1 | 6.4 | 6 | 5.3 | 5.9 | 73.6 | 68.5 | 61.5 | 67.9 |
| 15th September | 3½ | 79.5 | 60.6 | 33.5 | 69.3 | 6.9 | 6.2 | 5.3 | 6.1 | 74.5 | 70.4 | 54.6 | 66.5 |
| 1st October | 4 | 64.7 | 51.6 | 36.5 | 54.3 | 7 | 6.5 | 5.5 | 6.3 | 56.7 | 65.7 | 49.6 | 57.3 |
| 15th October | 4½ | 26.0 | 25.4 | 16.4 | 22.6 | 7.2 | 6.8 | 5.6 | 6.5 | 56.2 | 59.1 | 45.4 | 53.6 |
| 1st November | 5 | 10.4 | 10.1 | 15.2 | 11.9 | 7.1 | 6.7 | 5.6 | 6.5 | 55.6 | 57.4 | 42.6 | 51.9 |
| 15th November | 5½ | 2.5 | 6.3 | 8.5 | 5.8 | 7.4 | 6.9 | 5.9 | 6.7 | 48.7 | 50.6 | 44.6 | 48.0 |
| Mean | | 51.6 | 41.9 | 21.8 | 38.4 | 6.7 | 6.2 | 5.4 | 6.1 | 64.0 | 62.2 | 52.9 | 59.7 |
| CD (0.05%) GTxGH | | 4.2 | | | | 0.6 | | | | 2.1 | | | |
| CD (0.05%) GT | | 2.4 | | | | 0.3 | | | | 1.2 | | | |
| CD (0.05% GH | | 1.5 | | | | 0.2 | | | | 0.8 | | | |

Epicotyl grafting performed on rootstocks taken at 25 days after sprouting resulted 69.3% (15th June grafting time) to 72.0% (1st June grafting time). As the rootstock age increased epicotyl graft success rate decreased which can be assessed from the overall low grafting success on 30 days old rootstocks irrespective of grafting time, which was in the range of 30.4-35.3% only. Whereas, 5 day old rootstocks resulted in 55.6-64.0% success under Tripura condition, which may be due to scion thickness mismatching and callusing failure with very tender and thin epicotyl of 5 day old rootstocks. Better graft success of epicotyl grafting on very tender coppery rootstock epicotyl of 10 to 20 days old rootstocks with tender greenish coppery scion sticks may be due to appropriate scion thickness, proper cambial layer overlapping of both rootstock epicotyl and scion sticks, and ultimately accelerated cambial and hormonal activities at the graft union facilitated timely callusing and proper graft union formation. Moreover, during this period from 1st June to 1st August RH (75-85%) and temperature (27-33$^0$ C) were also favourable for better graft union formation and successive plant growth. In case of average diameter of grafting union after one year of growth, it ranged from 10.8 mm (10 days old rootstock) to 12.7 mm (20 days old rootstock). Plant height after one year was in the range of 34.8 cm (10 days old rootstock) to 37.1 cm (20 days old rootstocks). Reduced growth rate and thicker union diameter of epicotyl grafted plants in comparison to softwood grafting (Table 1, 2 and 3) may be due to restricted longitudinal cell expansion and tissue growth and more transverse cell division and growth at epicotyl portion of rootstock. Agrawal (2007) and Singh *et al.*, (2014) also reported that better epicotyl graft success and comparatively higher graft union diameter was achieved on 7-16 days old rootstocks and minimum success was recorded on 35 day old rootstocks. Under Tripura condition 1st June to 1st August was the suitable time for epicotyl grafting because local mango epicotyl of different fruit maturity groups are available during this period. Moreover, after 1st August rootstocks and scion wood become over mature for epicotyl grafting and August is the transition phage for shift of epicotyl stage to soft wood stage. Prasant *et al.*, (2006) and Usare (2016) also reported that July-August is the suitable time for epicotyl grafting.

***Softwood grafting in the first year***

Data of softwood grafting performed (Table 2 & Figure 2) on the seedlings in the first year of growth starting from 1st August (on 2 months old seedlings) at 15 days intervals upto 15th November (on 5½ months old seedlings) showed that significantly maximum graft success 80.5% at 8-10 cm height was recorded on 1st September grafted plants and this was on par with the graft success achieved from 15th September grafted plants (79.5%). Significantly higher graft success in the month of September at 8-10 cm is due to development of appropriate thickness and softwood maturity which matched with the thickness of the scion sticks and prevailing favourable micro climate facilitated proper callusing and better graft union formation. On the contrary, low graft success in August (1st and 15th) may be due to transition phage of rootstocks from epicotyl stage to softwood stage as well as mismatching of the scion thickness of var. Amrapali with rootstock shoot and improper callusing at graft union. Thickness and age of rootstock is very much critical for softwood grafting. In the present study, it is also evident that on 2 months old rootstocks (1st August grafting) only 45.0%, 15.7% and 13.7% graft success was recorded at 8-10 mm, 12-14 mm and 16-18 mm height, respectively. Accordingly, average graft union diameter was also less 5.4 mm at 16-18 cm height, whereas, it was 6.7 cm and 6.2 cm at 8-10 cm and 12-14 cm height, respectively. However, as the rootstock age increased union diameter was also increased. Average plant height after one year was comparatively higher in case of plants grafted on 1st August (64.9 cm) to 15th September (66.5 cm), whereas, success of grafting preformed during 1st October to 15th November was significantly less. In late season grafting during 15th October to 15th November, low grafting success was due to unfavourable weather conditions due to onset of winter under Tripura conditions resulting into improper graft union formation, scion wood sprouting failure and restricted successive growth still early February. The results indicate that under Tripura conditions, wedge grafting may be performed during 1st September to 15th September on 3-3½ months old seedlings at lower grafting height 8-10 cm, but October to February in the first year is not suitable for softwood grafting due to low winter temperature and low relative humidity. Reddy and Melanta (1988) and Singh and Suryanarayan (1996) also reported that softwood grafting is possible on rootstock age from one month to six months with varying success rate depending upon the agro-climatic conditions.

***Softwood grafting in the second year***

In the second year, wedge grafting was performed on the rootstocks sown on 1st June in previous year and grafting started from 15th February when seedlings attained 8½ month age. Successive grafting operation was done at 15 days intervals upto 1st October (on 16 month old rootstocks) on rootstocks of different age. Data (Table 3 & Figure. 3) reveal that grafting from 15th April (10½ months old rootstocks) to 15th May (11½ months old rootstocks) resulted in 84.8% to 86.9% graft success at 12-14 cm height, whereas, before and after this critical period grafting success was low at this particular height.

**Table 3.** Grafting success and plant growth of Softwood grafted mango var. Amrapali on 10-16 months old root stocks as affected by grafting time and height

| Grafting Time (GT) | Rootstock age (Month) | Grafting Success (%) | | | | Graft union dia. (mm) | | | | Plant height (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grafting Height (GH) | | | | | | | | | | | |
| | | 12-14 mm | 16-18 mm | 20-22 mm | Mean | 12-14 mm | 16-18 mm | 20-22 mm | Mean | 12-14 mm | 16-18 mm | 20-22 mm | Mean |
| 15th February | 8½ | 40.4 | 34.2 | 15.1 | 29.9 | 5.9 | 5.8 | 4.3 | 5.4 | 89.7 | 90.5 | 76.4 | 85.5 |
| 1st March | 9 | 45.1 | 45.4 | 15.3 | 35.3 | 6.3 | 6.0 | 5.0 | 5.8 | 91.7 | 90.9 | 70.4 | 84.3 |
| 15th March | 9½ | 64.2 | 60.6 | 35.7 | 53.5 | 6.7 | 6.3 | 5.2 | 6.1 | 90.4 | 88.4 | 78.6 | 85.8 |
| 1st April | 10 | 78.2 | 75.7 | 57.0 | 70.3 | 6.9 | 7.2 | 5.2 | 6.4 | 90.4 | 93.6 | 78.5 | 87.5 |
| 15th April | 10½ | 86.5 | 84.5 | 65.2 | 78.7 | 7.1 | 7.2 | 5.5 | 6.6 | 87.6 | 95.4 | 76.6 | 86.5 |
| 1st May | 11 | 84.8 | 86.7 | 65.8 | 79.1 | 7.3 | 7.5 | 5.6 | 6.8 | 89.5 | 95.7 | 77.7 | 87.6 |
| 15th May | 11½ | 86.9 | 84.6 | 65.8 | 79.1 | 7.3 | 7.6 | 5.4 | 6.8 | 86.2 | 93.4 | 75.4 | 85.0 |
| 1st June | 12 | 73.3 | 90.3 | 76.5 | 80.0 | 7.6 | 7.7 | 5.8 | 7.0 | 85.6 | 87.4 | 73.6 | 82.2 |
| 15th June | 12½ | 74.8 | 91.3 | 78.3 | 81.5 | 7.9 | 7.6 | 5.6 | 7.0 | 84.1 | 84.6 | 74.6 | 81.1 |
| 1st July | 13 | 60.5 | 90.3 | 86.6 | 79.1 | 8.2 | 8.4 | 5.5 | 7.4 | 84.9 | 82.6 | 74.1 | 80.5 |
| 15th July | 13½ | 55.4 | 90.1 | 85.3 | 76.9 | 8.5 | 8.3 | 5.4 | 7.4 | 47.0 | 82.7 | 74.6 | 68.1 |
| 1st August | 14 | 34.7 | 91.1 | 88.3 | 71.4 | 8.3 | 8.4 | 6.2 | 7.6 | 47.5 | 76.3 | 72.5 | 65.5 |
| 15th August | 14½ | 42.5 | 89.1 | 86.4 | 72.7 | 8.2 | 8.6 | 6.7 | 7.8 | 36.5 | 65.4 | 69.1 | 57.0 |
| 1st September | 15 | 15.3 | 85.6 | 83.7 | 61.5 | 8.6 | 7.8 | 6.4 | 7.6 | 36.2 | 66.4 | 69.3 | 57.3 |
| 15th September | 15½ | 15.3 | 54.7 | 60.3 | 43.4 | 8.5 | 7.6 | 6.7 | 7.6 | 34.3 | 63.2 | 60.4 | 52.7 |
| 1st October | 16 | 8.0 | 45.9 | 47.3 | 33.7 | 8.5 | 7.3 | 6.6 | 7.5 | 34.7 | 64.6 | 59.4 | 52.9 |
| Mean | | 54.1 | 75.0 | 63.3 | 64.1 | 7.6 | 7.5 | 5.7 | 6.9 | 69.8 | 82.6 | 72.6 | 75.0 |
| CD (0.05%) GTxGH | | 3.7 | | | | 0.6 | | | | 3.2 | | | |
| CD (0.05%) GT | | 2.2 | | | | 0.4 | | | | 1.9 | | | |
| CD (0.05%) GH | | 0.9 | | | | 0.2 | | | | 0.8 | | | |

At 16-18 cm height graft success was in the range of 84.5% to 91.3% when grafting was done from 15th April (10½ months old rootstocks) to 1st September (15th months old rootstocks). However, during 1st June (90.3%) to 1st August (91.1%) graft success was above 90% at 16-18 cm height. More than 85% grafting success was also recorded at 20-22 cm height only during 1st July (86.6%) to 1st September (85.6%) which indicates that as the age of rootstock increased suitability for grafting also increased at higher level. During February to March climatic conditions are not suitable for better graft union formation due to receding winter season; moreover, scions are also not physiologically ready enough for grafting due to flowering season. As the season progressed there was faster rate of rootstock growth during April to September. At the later growth stage from July to September, base shoot of the rootstocks (below 12-14 cm height) passed the softwood stage due to expansion and hardening of the tissues and became unfit for grafting. Whereas, upper part of the rootstock shoot attained softwood stage during this period which facilitated better grafting success at grafting height 16-18 cm and 20-22 cm height. Graft union diameter after one year of grafting was higher at 12-14 grafting height, followed by 16-18 cm and lowest at 20-22 cm height. Average growth of the grafted plants was significantly higher at 16-18 cm grafting height, followed by 20-24 cm. Over maturity of the rootstocks and unfavourable micro climatic conditions for proper union formation and successive plant growth after September months may be the reason for low grafting success and lesser plant growth of the grafts done on 1st October. Better softwood grafting during June-September on different age rootstocks has also been reported under different tropical-subtropical agro-climatic conditions in India (Singh and Srivastava. 1980; Gunjate *et al*., 1989; Singh and Suryanarayana, 1996).

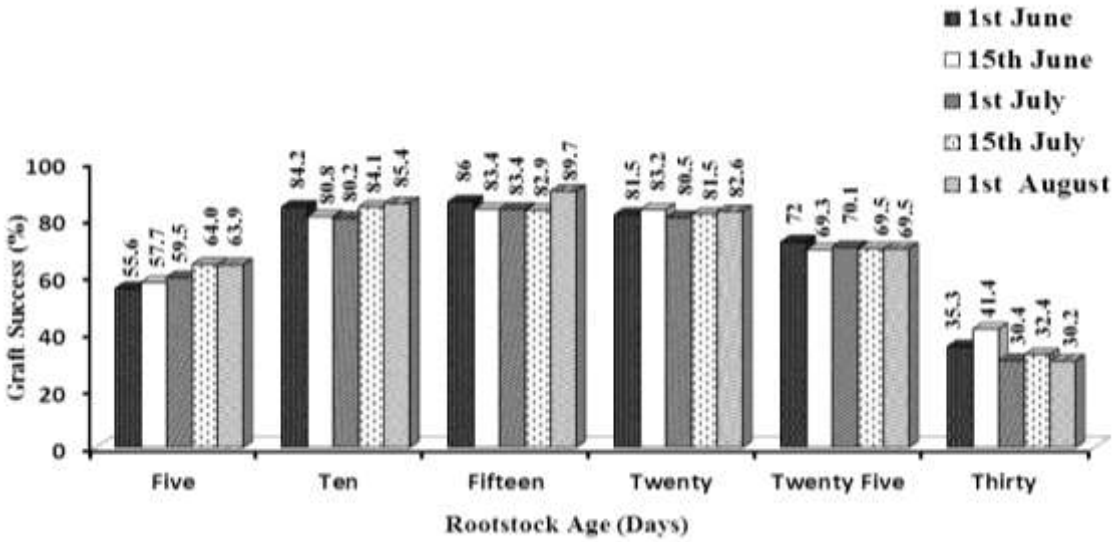


**Figure 1.** Mango epicotyl grafting success (%) as affected by grafting time and rootstock age.

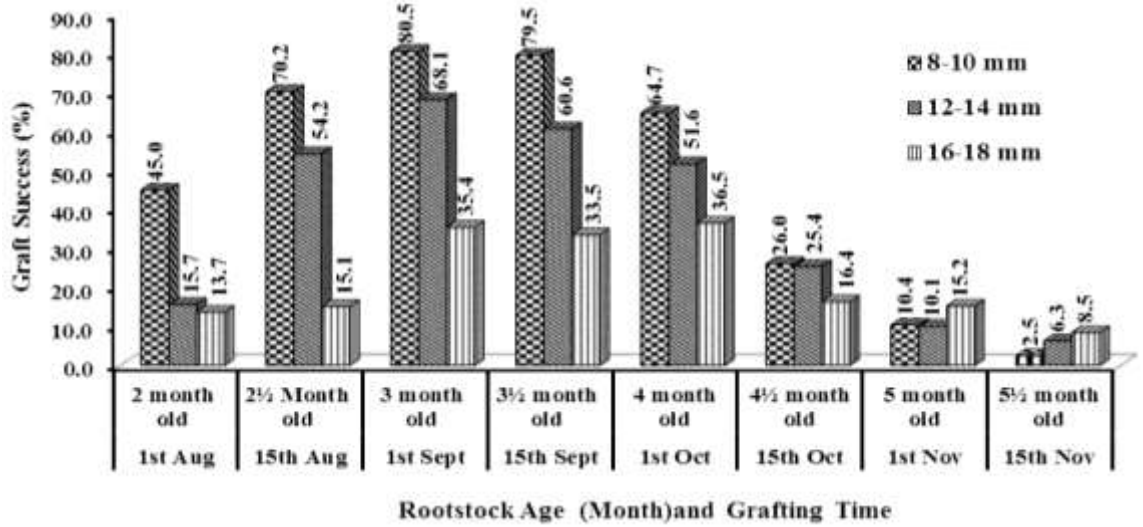


**Figure 2.** Mango softwood grafting success (%) on 2-5½ months old rootstocks as affected by grafting time and height.

Success of epicotyl and softwood grafting is dependent on time of stone availability, rootstock growth rate and grafting height, physiological maturity of scion wood and its thickness, and more importantly prevailing agro-climatic conditions. Therefore, under Tripura climatic conditions as mentioned in materials and methods and in areas with similar climatic conditions, epicotyl grafting should be done on 10 to 20 days old rootstocks during 1st June to 1st August when epicotyl of different maturity groups are available. Softwood grafting can be done on 3 months (1st September) to 3½ months (15th September) old rootstocks at 8-10 cm height and again on the grownup rootstocks softwood grafting is highly successful on 10 months (1st April) to 12 months (1st June) old rootstocks at 12-14 cm height, on 10 months (1st April) to 15 months (1st September) old rootstocks at 16-18 cm height and on 12 months (1st June) to 15 months (1st September) old rootstocks at 20-24 cm height.

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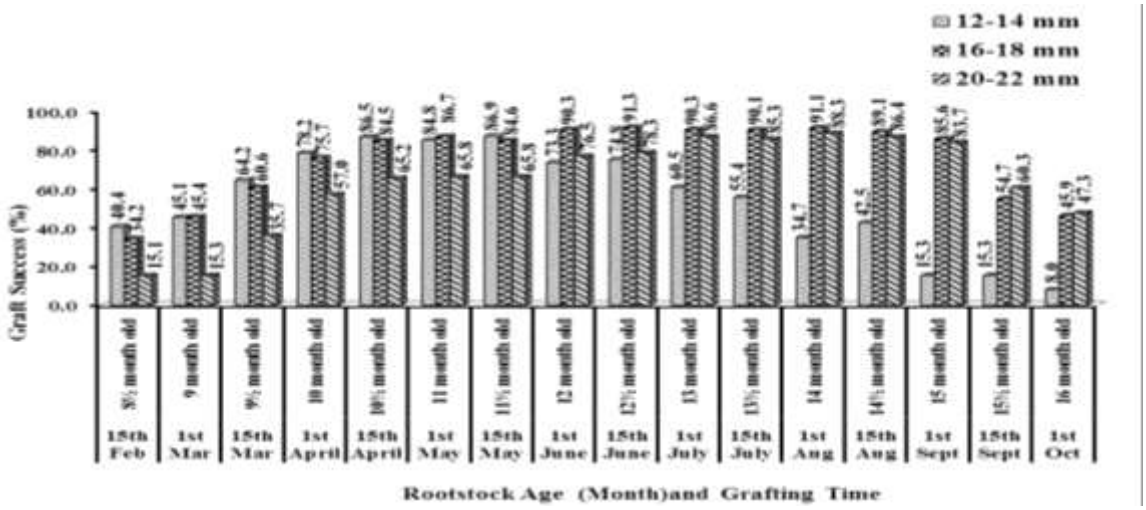


**Figure 3.** Mango softwood grafting success on 8½-16 months old rootstocks as affected by grafting time and height