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# Standardization of grafting time and height on success of softwood grafting in mango (*Mangifera indica* L.)

**Ajay Kumar Karna, DK Varu, Puja Archana Panda and Debashish Hota**

**Abstract**
The experiment was conducted at Sakkarbaug, Fruit research station, Department of horticulture, college of Agriculture, Junagadh Agricultural University, Junagadh during June 2015 to February 2016. The treatments comprised of six grafting times and three grafting height. The experiment was laid out in a Completely Randomized Design with factorial concept and three replications. Interaction effect was observed significant in majority of parameter except carbohydrate content, phenol content, days to shoot emergence, success percentage, survival percentage, length of taproot and girth of taproot. Significantly maximum shoot length and plant height were reported at 15th September grafting with 60 cm grafting height ($T_3H_3$). However, it was at par with treatment combination of 30th August with 60 cm ($T_2H_3$). While, maximum stock girth and leaves were recorded in 30th August with 60 cm ($T_2H_3$) followed by $T_3H_3$. Likewise, maximum scion girth was noted in treatment combination of 30th August with 40 cm ($T_2H_2$). Similarly, poor result in plant height, number of leaves and scion girth were reported in 30th October with 20 cm ($T_6H_1$). Whereas, lowest shoot length was noted in 15th October with 20 cm ($T_5H_1$) and lowest stock girth was also reported in 30th October with 40 cm ($T_6H_2$).

**Keywords:** mango, grafting time, height, growth parameter

## Introduction
The Mango (*Mangifera indica* L.) is belongs to family anacardiaceae originated in South East Asia. The mango is one of the most common and important fruit crop cultivated all over India. It is also called the king of fruits and known as national fruit of India. The fruit can be grown in Indian sub continents for well over 4000 years (De Candolle, 1984) and has been favorites for king and commencer. India is the major producer of mango in the world with an area of 25.15 lakh hector and annual production is 184.31 lakh MT. In Gujarat total area under mango cultivation is about 1.42 lakh hector and production about 11.25 lakh MT (Anon., 2014). Mostly, mangoes are vegetative propagated by inarching, veneer grafting, epicotyl grafting, softwood grafting etc. Among different method softwood grafting has distinct advantages over other methods of propagation which is an efficient, economics; rapid method and grafts can be ready within a year. So, softwood grafting gives an excellence response in initial success with least possibility of mortality, better and uniform orchard establishment (Ram and Pathak, 2006). Best grafting time was obtained during high humidity and moderate temperature usually from August to October. Grafting height also play a most important role as from which height the grafting operation can be done for maximum success and its subsequent growth. Hence, considering the above facts, it is highly essential to standardize the grafting time and height on success of softwood grafting in mango.

## Materials and Methods
The present investigation was carried out at Sakkarbaug, Fruit Research Station, Department of Horticulture, Junagadh Agricultural University, Junagadh during 2015-16. It was laid out in completely Randomized Design (FCRD) with Factorial concept having three repetitions. Eighteen treatment combinations involve two factors among these first factor contains six levels of grafting at 15th August ($T_1$), 30th August ($T_2$), 15th September ($T_3$), 30th September ($T_4$), 15th October ($T_5$) and 30th October ($T_6$). Second factor contains three level of grafting height viz. 20cm ($H_1$), 40cm ($H_2$) and 60cm ($H_3$) on the rootstock. For experiment purpose ten grafts were prepared in each treatment. For rootstock purpose the stone are removed from the pulp and they were immediately planted on the polythene bags of 12 inch x 10 inch and 300 gauge thicknesses containing potting mixture of soil and F.Y.M. in the ratio of 2:1. The stones were sown in the 1st June 2015 and the seedlings were ready for grafting on particular date as per programme from 15th August to 30th October 2015.

The mature healthy, terminal, vigorous and 3-4 month old shoots were selected for scion and leaves were defoliated 7-10 days before for grafting. The tree scion shoots were collected from mother trees in the morning time on the day of grafting. Immediately after separation of the scions from the mother tree, they were wrapped in moist cloth and carried in polythene covers to the site of grafting. Grafting was performed on the same day of separation. Five representative plants from each treatment were selected and observed for different growth characters, viz. carbohydrate and phenol content of scion, days to shoot emergence, success and survival percentage, shoot length of scion, number of leaves, scion girth, stock girth, root length and root girth. The observation was recorded two month after grafting operation at intervals of 30 days until 120 days after grafting. The data were analyzed as per method suggested by Panse and Sukhatme (1985) [14].

**Result and Discussion**

The variation was found significant and maximum carbohydrate content (12.78%) was noted in grafting at 30th August ($T_2$) but was found at par with 15th September ($T_3$). Similarly, lowest carbohydrate content (11.52%) in scion was recorded in 30th October ($T_6$). The Carbohydrate content of scion was increasing from 15th August to 30th August, but then it decreased drastically as grafting time increased. It may be due to immaturity stage of shoot and if shoot age is increased, the carbohydrate content is decreased due to its maturity. The poor success is that the decrease in carbohydrates was partially responsible for the decrease in graft take, but at that time some other substances was low in supply and was the limiting factor at that time for graft success. This observation agreed with the finding of Rodrigues *et al.* (1960) [21] in avocados. Similar trend of carbohydrate content was noted in phenol content. Lowest phenol content (1.23 %) was obtained in 15th September ($T_3$) followed by 30th August ($T_2$). Whereas, highest phenol content (2.99 %) was noted in 15th October ($T_5$). With grafting time the phenol content decreased constantly to a certain level and was observed minimum in 15th September grafting but after onwards the phenol content increased. The lowest phenol content may be due to maturity of scion shoots. However, it increased as it becomes over mature. This fact was in accordance with the findings of Baskaran *et al.* (2008) [3] in jackfruit.

However, grafting height and its interaction were found non-significant on carbohydrate and phenol content of scion at the time of softwood grafting.

The data revealed that least time taken for shoot emergence (12.07 days) was recorded at 30th August ($T_2$) which was at par with 15th September ($T_3$). Likewise, maximum time taken to shoot emergence (15.40 days) was noted in 30th October ($T_6$). The early sprouting may be due to higher meristamatic activity and also because of the optimal weather condition prevailing during that period. This fact was in accordance with the findings of Sharma and Tiwari (1995) [22] and Prasanth *et al.* (2007) [19] in mango. It may also be due to abundant supply of carbohydrate and defoliation which initiates bud activation and they are in a position to sprout early. Similar results were also obtained by Zimmerman (1958) [26] and Purbiati *et al.* (1991) in mango. However, grafting height and interaction effect was found non-significant. The effect of grafting time was found significantly superior and higher shoot length (14.99 cm) was recorded in grafting at 15th September ($T_3$) followed by 30th August ($T_2$) during 120 days after grafting, respectively. Similarly, lowest shoot length (9.85cm) was registered in 30th October ($T_6$). The result may be due to favorable climactic parameters during monsoon helped in faster growths which act positively on the rootstock and scion shoot, which might had happened due to the longer time available for growth in meristamatic cells coupled with better physiological process like photosynthesis and lower respiration. This result is similar with Mandal *et al.* (2011) [10] in mango. Variation in different grafting height was also found significant and maximum shoot length (13.61 cm) was observed in 60 cm grafting height ($H_3$) during 120 DAG, respectively. Likewise, minimum shoot lengths (11.91cm) were recorded in 20 cm grafting height ($H_1$) at DAG, respectively. It might be optimum numbers of leaves are retained on rootstock which causes more production of synthesized food material by the leaves. These photosynthates must have helped in the cambial activity for healing of the graft union. The roots also nourish properly and the strong root system might have absorbed more nutrients from the soils thereby increasing the shoot length of scion on the grafted plants. Higher shoot length (16.27 cm) was registered with grafting at 60 cm height in 15th September ($T_3H_3$) respectively during 120 DAG. However, they were found at par with grafting at 30th August with 60 cm height ($T_2H_3$) during 120 DAG, respectively. Whereas, lowest shoot length (9.37 cm) were noted in treatment combination $T_5H_1$ during 120 DAG.

The variation in respect to success and survival percentage of softwood grafting (table 2) reported that effect of various factor was found significant. Highest success percentage (80 %) and survival percentage (71.11 %) were reported in grafting on 15th September ($T_3$) whereas, minimum success percentage (23.33 %) and survival percentage (20.11 %) was noted in 30th October ($T_6$). The maximum success and survival percentage may be due to presence of enough carbohydrate and other food material in the scion and rootstock and the accumulated food material is mobilized for new growth which in turns high meristamatic activity in scion. It may also be due to abundance humidity in atmosphere during 15th August to 15th September resulted in more callusing at graft union as compared to 30th October ($T_6$), when humidity is very low in atmosphere. This result was supported by Tayde *et al.* (1988), Pereira *et al.* (2004) [18] and Mandal *et al.* (2012) [11] in mango; Bharad *et al.* (1999) [2] in tamarind and Giri and Lenka (2008) [7] in wood apple.

Result was also found significant and maximum success (59.44 %) and survival percentage (49.44 %) was recorded in 60 cm ($H_3$). Success on more grafting height might be due to higher cambial activity of softwood in the rootstock as compared to hardwood in 20 cm height ($H_1$). These results are in accordance with Patil *et al.* (1991) [16], Gandhoke (1993) [6] and Kumar *et al.* (2006) [9] in mango, Pathak and Srivastava (1973) [17] in apple, Sharma and Chauhan (1981) [23] in walnut. The data on interaction effect of grafting time and height on success and survival percentage was found non-significant.

The result was also found significant and maximum numbers of leaves (14.85) was noted in grafting time 15th September ($T_3$) during 120 DAG, respectively. Whereas, minimum number of leaves recorded in 30th October ($T_6$). It may be due to the quick and strong union formation and better nutrient uptake might have caused for better plant growth and more number of leaves per plant. These findings are in line with the results of Patel and Amin (1981) [15] in mango; Chovatia and Singh (2000) in Jamun and Palande *et al.* (2004) [13] in Tamarind. The results indicated that the leaves numbers

(12.77) were recorded at 60 cm height ($H_3$) during 120 DAG, respectively. The highest number of leaves might be due to photosynthetic accumulation in newly grafted plants which in turns increased the number of nodes and absorption of nodes and absorption of nutrients by leaf primordial. The result was supported by Mandal *et al*. (2012) [11] in mango and Synman and Fraser (1988) [24] in passion fruit. But at 120 DAG, highest number of leaves (16.47) was recorded in 30th August and 60 cm height ($T_2H_3$) but was found at par with $T_3H_3$ (16.28). Likewise, minimum numbers of leaves (8.36) was observed in 30th October with 60 cm heights ($T_6H_1$) at 120 DAG, respectively.

A perusal of data presented in Table 3 indicated that difference in grafting time significantly influenced. The maximum plant height (56.61cm) was registered during 15th September ($T_3$) at 120 DAG, respectively. However, they were found at par with treatment 30th August ($T_2$) at 120 DAG. This might be due to favorable climatic condition and optimum numbers of leaves on shoot which accumulate more food thereby increase the plant height. Ample differences were found in plant height of the graft due to assortment of different grafting height. The maximum plant height (75.23 cm) was observed at 60 cm ($H_3$) during 120 DAG. Maximum plant height was due to different grafting height on the rootstock. The graft heights were influenced by the interface effect of grafting time and height on the rootstock. Interaction effects of grafting time and height was also found significant during 120 days after grafting and highest plant height (79.09 cm) were recorded in treatment combination 15th September with 60 cm height ($T_3H_3$) which was statistically at par with treatments $T_2H_3$ (78.48 cm). Conversely, minimum plant height (30.12 cm) was observed in 30th October with 20 cm height ($T_6H_1$) in 30th October with 20 cm height ($T_6H_1$) during 120 days after grafting, respectively.

Highest increment of scion girth (8.81 mm) was noted in 15th September ($T_2$) recorded during 120 DAG as compared to other grafting times. This might be due to the suitable temperature and relative humidity prevailing during this period in nursery condition which was responsible for increment of scion girth. Result was also found significant on height and maximum scion girth (8.58 mm) was recorded in 40 cm ($H_2$) at 120 DAG, respectively as compared to other grafting height. The above findings may happened due to the longer time available for growth in meristamatic cells coupled with better physiological processes along with better graft union due to better contact of cambium layers of the stock and scion causes increase in scion growth. These results are in accordance with Kelaskar *et al.* (1993) [8] and Mandal *et al.* (2012) [11] in mango. Moreover, maximum scion girth (9.56 mm) was recorded in 30th August grafting with 40 cm height ($T_2H_2$). The treatment combination 30th October with 20 cm height ($T_6H_1$) showed minimum scion girth (6.15 mm) during 120 days after grafting, respectively.

It was observed from the data presented in table 4 that the grafting time was significantly influenced on stock girth. Significantly maximum stock (9.25 mm) was recorded in 15th September ($T_3$) followed by 30th August ($T_2$). This might be due to the suitable temperature and relative humidity prevailing during this period in nursery condition which was responsible for increment of stock girth. Highest stock girth of grafts (9.33 mm) was recorded when grafted on 60 cm height on rootstock ($H_3$) and the minimum girth (8.55 mm) was recorded at 20 cm height on rootstock. The increase in stock girth at higher grafting height may be due to the increase in leaf number and leaf area resulting into more synthesis of photosynthates. It is in conformity with the observations of Nalage *et al.* (2010) [12] in mango.

Data revealed that a highest stock girth (9.83 mm) was recorded under treatment combinations of 30th August with 60 cm height ($T_2H_3$) during 120 DAG, respectively. However, it was found at par 15th September at 60 cm grafting height ($T_3H_3$). The lowest stock girth (8.26 mm) was observed under treatment combination of 30th October with 40 cm height ($T_6H_1$) during 120 DAG. The increase in stock girth may be due combine effect of favorable climactic condition and maximum number of leaves both on stock and scion which synthesized more food both in stock and scion.

Variation in length of taproot in different grafting time showed significant effect and maximum tap root length (28.30 cm) was observed in 30th August ($T_2$) but which was at par with $T_3$ and $T_6$. Minimum taproot length (27.15 cm) was noted in 15th august ($T_1$). The data pertaining to root length was found significant and maximum root length (28.82 cm) was noted when grafting was performed at 60 cm on the rootstock. At higher grafting height, more synthesized food materials are produced by the leaves, so that the root nourished properly, thereby increasing the length of taproot of graft. The data pertaining to interaction effect of grafting time and height on length of taproot are found non-significant. The effect of grafting time was found significantly superior on girth of tap root. Highest girth of tap root (8.24 mm) was measured in 15th September ($T_3$). Similarly, lowest tap root girth (7.27 mm) was observed in 30th September ($T_6$). This may be due to higher favorable climactic condition. The result obtained as influence of grafting height was found significant on girth of tap root. The highest tap root girth (8.23 mm) was recorded in the treatment 60 cm ($H_3$) followed by $H_2$. Lowest girth (7.43 mm) was observed in 20 cm ($H_1$). The data on interaction effect of grafting time and height on girth of tap root was found non-significant.

## Conclusion

In the light of the results obtained from the present investigation it is concluded that better performance in majority of parameter like success percentage, shoot length, plant height, number of leaves, scion girth and stock girth, Survival percentage as well as root girth and length were observed in grafting on 15th September ($T_3$) and grafting height at 60 cm ($H_3$) individually as well as grafting on 15th September with grafting height at 60 cm ($T_3H_3$). Hence, it is recommended to prepare the mango graft under soft wood grafting technique on 15th September with grafting height at 60 cm.

**Table 1:** Effect of grafting time and height on carbohydrate and phenol content of scion (%)

| S. No | Treatment | Carbohydrate content of scion (%) | | | | Phenol content of scion (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 12.46 | 12.46 | 12.46 | 12.46 | 1.83 | 1.83 | 183 | 1.83 |
| ($T_2$) | 30th August | 12.78 | 12.78 | 12.78 | 12.78 | 1.48 | 1.48 | 1.48 | 1.48 |
| ($T_3$) | 15th September | 12.67 | 12.67 | 12.67 | 12.67 | 1.23 | 1.23 | 1.23 | 1.23 |
| ($T_4$) | 30th September | 12.15 | 12.15 | 12.15 | 12.15 | 2.45 | 2.45 | 2.45 | 2.45 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ($T_5$) | 15th October | 11.95 | 11.95 | 11.95 | 11.95 | 2.99 | 2.99 | 2.99 | 2.99 |
| ($T_6$) | 30th October | 11.52 | 11.52 | 11.52 | 11.52 | 2.85 | 2.85 | 2.85 | 2.85 |
| Mean | | 12.25 | 12.25 | 12.25 | | 2.14 | 2.14 | 2.14 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 0.038 | 0.019 | 0.115 | | 0.014 | 0.007 | 0.043 | |
| C.D. (P=0.05) | | 0.011 | NS | NS | | 0.04 | NS | NS | |
| C.V. % | | 4.80 | | | | 6.59 | | | |

**Table 2:** Effect of grafting time and height on days to shoot emergence and shoot length of scion at 120 day after grafting (DAG)

| S. No | Treatment | Days to shoot emergence | | | | Shoot length (cm) at 120 DAG | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 12.37 | 12.16 | 12.69 | 12.41 | 13.54 | 14.80 | 15.36 | 14.56 |
| ($T_2$) | 30th August | 12.24 | 11.63 | 12.34 | 12.07 | 13.84 | 14.60 | 16.21 | 14.88 |
| ($T_3$) | 15th September | 12.32 | 11.91 | 12.20 | 12.14 | 13.77 | 14.94 | 16.27 | 14.99 |
| ($T_4$) | 30th September | 13.93 | 13.96 | 14.08 | 13.99 | 11.54 | 11.80 | 12.76 | 12.03 |
| ($T_5$) | 15th October | 14.65 | 14.94 | 14.87 | 14.82 | 9.37 | 10.47 | 10.93 | 10.25 |
| ($T_6$) | 30th October | 15.25 | 15.30 | 15.66 | 15.40 | 9.42 | 9.96 | 10.18 | 9.85 |
| Mean | | 13.46 | 13.32 | 13.64 | | 11.91 | 12.76 | 13.61 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 0.051 | 0.025 | 0.15 | | 0.012 | 0.006 | 0.036 | |
| C.D. (P=0.05) | | 0.14 | NS | NS | | 0.03 | 0.02 | 0.10 | |
| C.V. % | | 5.05 | | | | 2.58 | | | |

**Table 3:** Effect of grafting time and height on success and survival percentage of mango grafts (%) at 120 DAG

| S. No | Treatment | Success percentage (%) | | | | Survival percentage (%) at 120 DAG | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 73.33 | 73.33 | 76.66 | 74.44 | 60.00 | 63.33 | 70.00 | 63.33 |
| ($T_2$) | 30th August | 73.33 | 76.33 | 83.33 | 77.77 | 63.33 | 70.00 | 73.33 | 68.88 |
| ($T_3$) | 15th September | 73.33 | 76.33 | 90.00 | 80.00 | 66.66 | 70.00 | 76.66 | 71.11 |
| ($T_4$) | 30th September | 33.33 | 36.66 | 46.66 | 38.88 | 26.66 | 23.33 | 33.33 | 27.77 |
| ($T_5$) | 15th October | 23.33 | 20.00 | 33.33 | 25.55 | 16.66 | 20.00 | 23.33 | 21.11 |
| ($T_6$) | 30th October | 20.00 | 23.33 | 26.66 | 23.33 | 16.66 | 20.00 | 20.00 | 20.00 |
| Mean | | 49.44 | 51.11 | 59.44 | | 42.22 | 43.88 | 49.44 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 3.703 | 1.851 | 11.11 | | 4.69 | 2.34 | 14.81 | |
| C.D. (P=0.05) | | 10.69 | 5.34 | NS | | 13.54 | 6.77 | NS | |
| C.V. % | | 10.82 | | | | 14.63 | | | |

**Table 4:** Effect of grafting time and height on number of leaves and plant height at 120 DAG

| S. No | Treatment | Number of leaves at 120 DAG | | | | Plant height at 120 DAG | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 12.54 | 14.06 | 15.48 | 14.03 | 34.72 | 32.88 | 77.53 | 55.72 |
| ($T_2$) | 30th August | 12.98 | 14.47 | 16.47 | 14.54 | 34.82 | 55.86 | 78.48 | 56.38 |
| ($T_3$) | 15th September | 13.33 | 14.93 | 16.28 | 14.85 | 34.82 | 55.93 | 79.09 | 56.61 |
| ($T_4$) | 30th September | 9.41 | 9.73 | 10.09 | 9.74 | 33.97 | 52.76 | 73.38 | 53.37 |
| ($T_5$) | 15th October | 8.42 | 8.91 | 9.62 | 8.98 | 30.41 | 51.33 | 71.73 | 51.16 |
| ($T_6$) | 30th October | 8.36 | 8.65 | 8.98 | 8.66 | 30.12 | 50.70 | 71.18 | 50.67 |
| Mean | | 10.84 | 11.79 | 12.77 | | 33.07 | 53.66 | 75.23 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 0.026 | 0.013 | 0.078 | | 0.145 | 0.072 | 0.43 | |
| C.D. (P=0.05) | | 0.07 | 0.03 | 0.22 | | 0.42 | 0.21 | 1.26 | |
| C.V. % | | 3.44 | | | | 2.12 | | | |

**Table 5:** Effect of grafting time and height on scion and stock girth (mm) at 120 DAG

| S. No | Treatment | Scion girth (mm) at 120 DAG | | | | Stock girth (mm) at 120 DAG | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 7.87 | 9.49 | 8.46 | 8.61 | 8.54 | 9.16 | 9.73 | 9.14 |
| ($T_2$) | 30th August | 8.12 | 9.56 | 8.69 | 8.79 | 8.73 | 9.19 | 9.83 | 9.25 |
| ($T_3$) | 15th September | 8.32 | 9.51 | 8.62 | 8.81 | 8.80 | 9.15 | 9.80 | 9.25 |
| ($T_4$) | 30th September | 7.28 | 8.35 | 7.57 | 7.73 | 8.40 | 8.62 | 8.96 | 8.66 |
| ($T_5$) | 15th October | 6.81 | 7.34 | 6.97 | 7.04 | 8.45 | 8.53 | 8.87 | 8.62 |
| ($T_6$) | 30th October | 6.15 | 7.21 | 6.89 | 6.75 | 8.39 | 8.26 | 8.83 | 8.49 |
| Mean | | 7.42 | 8.58 | 7.86 | | 8.55 | 8.82 | 9.33 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 0.007 | 0.003 | 0.02 | | 0.005 | 0.002 | 0.015 | |
| C.D. (P=0.05) | | 0.02 | 0.01 | 0.06 | | 0.01 | 0.007 | 0.04 | |
| C.V. % | | 3.17 | | | | 2.40 | | | |

**Table 6:** Effect of grafting time and height on length (cm) and girth of taproot (mm)

| S. No | Treatment | Length of taproot (cm) | | | | Girth of taproot (mm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean | 20 cm ($H_1$) | 40 cm ($H_2$) | 60 cm ($H_3$) | Mean |
| ($T_1$) | 15th August | 26.44 | 27.17 | 27.86 | 27.15 | 6.98 | 7.57 | 8.58 | 7.71 |
| ($T_2$) | 30th August | 26.74 | 28.44 | 29.89 | 28.36 | 7.57 | 7.93 | 8.71 | 8.07 |
| ($T_3$) | 15th September | 27.04 | 28.49 | 29.37 | 28.30 | 7.70 | 8.39 | 8.64 | 8.24 |
| ($T_4$) | 30th September | 27.58 | 28.14 | 28.58 | 28.10 | 7.53 | 7.69 | 8.14 | 7.79 |
| ($T_5$) | 15th October | 27.15 | 27.93 | 28.51 | 27.86 | 7.63 | 7.70 | 7.96 | 7.76 |
| ($T_6$) | 30th October | 27.79 | 28.34 | 28.75 | 28.29 | 7.20 | 7.25 | 7.36 | 7.27 |
| Mean | | 27.12 | 28.08 | 28.82 | | 7.43 | 7.75 | 8.23 | |
| Source | | Time | Height | T x H | | Time | Height | T x H | |
| S.Em.± | | 0.056 | 0.028 | 0.08 | | 0.027 | 0.013 | 0.08 | |
| C.D. (P=0.05) | | 0.16 | 0.04 | NS | | 0.08 | 0.03 | NS | |
| C.V. % | | 2.54 | | | | 6.37 | | | |

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