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# Standardization of grafting month and growing conditions on softwood grafting in mango (*Mangifera indica*) cv. Kesar

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## Abstract
An investigation on "Standardization of grafting month and growing conditions on softwood grafting in mango (*Mangifera indica*) cv. Kesar" was carried out at Department of Fruit Science, Kittur Rani Channama College of Horticulture, Arabhavi, Karnataka during the year 2023-24. The treatments comprised of three levels of growing conditions (C) viz., $C_1$ = Partial shade, $C_2$ = Shade house condition, $C_3$ = Naturally ventilated polyhouse (NVP) and five levels of different grafting months (M) *viz*., $M_1$ = September, $M_2$ = October, $M_3$ = November, $M_4$ = December, $M_5$ = January. The experiment was laid out in Completely Randomized Design (CRD) with Factorial concept comprising fifteen treatment combinations with three replications. The results revealed that among the different treatment combinations grafting done in September under polyhouse conditions required minimum days for first sprouting (15.42). Whereas, $C_3M_1$ (15$^{th}$ September and Polyhouse condition) recorded the maximum number of sprouts per graft (5.41), sprout length (7.42 cm), number of leaves (20.20), graft height (47.12 cm), graft vigour index I (694.82 cm) and graft vigour index II (4513.34 cm) at 120 days after grafting respectively. While, maximum graft success percentage (93.33%) was recorded at 90 days after grafting and maximum graft survival percentage (89.17% and 85.83%) was recorded at 120 and 180 days after grafting respectively.


**Keywords:** Month, growing conditions, softwood grafting, *Mangifera indica*, growth parameter, success percentage, survival percentage

## 1. Introduction
Mango (*Mangifera indica* L.) is one of the most important and oldest fruit crops cultivated in India for at least 4000 years ago. It belongs to the family Anacardiaceae, which originated in the Indo-Burma region. The fruit plays a major socio-economic role in India and is named as the National fruit of India. It is also known as the "King of Fruits" due to its appealing appearance as well as its taste, attractive aroma and engaging flavor. (De Candolle, 1885) [3]. India is considered as the largest mango producer in the world and leader in mango production with 2.34 million hectares of area, 20.9 million tons of production and 9 Mt per ha productivity. In Karnataka, mango is cultivated in 148.38 thousand hectares, producing 1462.25 thousand metric tons (India Stat, 2023) [5]. In ancient time mango was mostly propagated by stones. The stone propagated plants have long juvenile phase and poor fruit quality. Hence, it needs to be propagated vegetatively to produce true to type planting materials. Since growing area is increasing and quality planting material is required to meet the demand of the farmers. Propagation by the asexual method is generally followed for successful propagation. It is less expensive, and one of the most rapid techniques to produce high quantity and quality planting material in less time, and area. The 'Gir Kesar' mango, also called Kesar is known for its bright orange coloured pulp, excellent keeping quality, good shelf life, export oriented and suitable for processing. Hence farmers are interested to grow Kesar but the vigorous plants are not available (Karna *et al*., 2018) [6]. However, success of grafting depends upon grafting time and environmental conditions. Hence, the study was taken to know the suitable month and growing conditions for softwood grafting in Mango cv. Kesar.

## 2. Material and Methods

The experiment was carried out during the year 2023-24 at the Department of Fruit Science, Kittur Rani Channama College of Horticulture, Arabhavi, Karnataka. It is situated at an elevation of 612 m above the mean sea level at 16 º15' North latitude and 74º 45' East longitude. Arabhavi lies in Zone-3, Region- 2 of agro climatic zones of Karnataka. The treatments comprised of three levels of growing conditions (C) viz., $C_1$ = Partial shade, $C_2$ = Shade house condition, $C_3$ = Naturally ventilated polyhouse (NVP) and five levels of different Grafting months (M) *viz*., $M_1$ = September, $M_2$ = October, $M_3$ = November, $M_4$ = December, $M_5$ = January. The grafting operations are carried out at second fortnight interval in the above-mentioned months. The experiment was laid out in Completely Randomized Design (CRD) with Factorial concept comprising fifteen treatment combinations with three replications. Total 450 healthy mango compatible rootstocks were used for this experiment *i.e.*, 30 plants per treatment.

### 2.1 Selection of rootstocks

The healthy stones of mango were selected and sown in polythene bags of 15 cm × 25 cm size with potting mixture containing 2:1:1 potting mixture of soil, sand and FYM. Vigorously growing 6-12 months old, 30-40 cm tall and up to 1 cm wide at a point about 20-30 cm above ground level were selected and then used for grafting. The compatible mango rootstocks were taken from Horticultural Research and Extension Centre (HREC), Hidkal dam, Badakundri, Belagavi.

### 2.2 Selection of scion and collection

The 9-10 years old bearing tree is selected for scion collection. The tree is highly regular, high yielding type with good fruit quality. The mother plant is located in Department of Fruit Science, KRCCH, Arabhavi. Fully matured current season shoots were selected as scion on the mother tree. Removal of all leaves from selected scions with the help of a secateur and leaving only petioles of the leaves attached to the scions of shoots on the mother tree, which forces the buds to swell. Defoliation of scion on mother tree was done 8-10 days prior to grafting. The scions of (10-15 cm) were collected from the current season growth of mother plant during morning (8.00 - 9.00 AM) on the day of grafting. Immediately after the separation of the scions from mother trees, they were wrapped in moist cloth and carried in polythene cover to the site of grafting. Soon. after, these scions were dipped in solution of 0.1 per cent carbendazim to make the scion material free from fungal infection.

### 2.3 Method of grafting

For softwood grafting, healthy, disease-free rootstocks selected for grafting were decapitated with a sharp knife at 15-20 cm from the ground level. Care was taken while selecting the scion material to match the girth of the stock. Split the softwood of stock vertically in the form of a cleft to a length of 4-5 cm downward with a sharp knife. The cleft looked like a fork or the letter 'V'. The scion was prepared by giving a cut into gently sloping wedge of about 5 cm to the morphological base of the scion. The wedge-shaped scion thus prepared was inserted into the 'V' shaped slit of the stock and tied with a polythene strip tightly. Then, the grafts were covered with small polythene cap to avoid desiccation of the scion and to create humidity condition. Grafts were watered regularly with the required quantity of water and weeding in the poly bags were also done regularly.

Five grafts were selected from each treatment and observations such as days taken for first sprouting (Days), number of sprouts per graft, sprout length, number of leaves, graft height and graft vigour index were recorded at 120 days after grafting while, graft success percentage was recorded at 90 days after grafting and graft survival percentage was recorded at 120 and 180 days after grafting respectively. Various characters under study were statistically analysed by using analysis of variance technique for Completely Randomized Design (CRD) with Factorial concept as described by Panse and Sukhatme (1985) [11]. Graft vigour index, graft success and survival percentage were calculated by using the following formula.

Graft vigour index I = Mean sprout length × Graft percentage

Graft vigour index II = Mean graft height × Graft percentage

$$\text{Graft success percentage} = \frac{\text{No. of grafts success at the end of the experiment}}{\text{No. of grafts used for treatment}} \times 100$$

$$\text{Graft survival percentage} = \frac{\text{No. of grafts remained alive at the end of the experiment}}{\text{No. of successful grafts}} \times 100$$

## 3. Results and Discussion

### 3.1 Days taken for first sprouting

With respect to grafting months, significantly least number of days (17.72) taken for sprouting was resulted in $M_1$-15$^{th}$ September, while the more number of days (22.53) for sprouting was reported in $M_4$-15$^{th}$ December. Among the different conditions, significantly least number of days (15.90) taken to sprouting was registered under the $C_3$-polyhouse condition, whereas more number of days (24.14) for sprouting was achieved in the $C_1$-partial shade condition. Among different treatment combinations, significantly less number of days (15.42) required for sprouting was reported in $C_3M_1$ (15$^{th}$ September and Polyhouse condition) presented in Table 1. However, the more number of days (27.80) required for sprouting was attained in treatment $C_1M_4$ (15$^{th}$ December and partial shade condition). This was mainly because the stock and scion cells interlocked and produced parenchymatous cells, establishing intimate contact in the cambial region under optimum weather conditions such as higher temperature and humidity during this month inside the polyhouse, leading to improved and early sprouting. This was also recorded by Syamal *et al.* (2012) [16] in Guava.

### 3.2 Effect of different grafting months

The perusal of data showed the significant effect of grafting months on growth parameters (Table 1). Significantly maximum number of sprouts per graft (4.77), sprout length

(6.91 cm) and number of leaves (17.76) were noted in $M_1$-15th September whereas, the minimum number of sprouts per graft (3.96), sprout length (5.58 cm) and number of leaves (13.22) were found in $M_4$-15th December at 120 days after grafting. The increase in growth parameters may be attributed to the high rate of photosynthesis and the increased storage of carbohydrates, which helps in fast and strong formation of graft union, encourages more cell activity which allows for better nutrient uptake and can readily serve as a food reserve for new growth. It was also seen with Chander *et al.* (2016) [2] in Jamun and Nanditha *et al.* (2017) [10] in Guava.

The significant effect of grafting months on graft height and graft vigour index is presented in Table 2. Significantly maximum graft height (45.62 cm), graft vigour index I (580.36) and graft vigour index II (3905.51) were reported in $M_1$-15th September while, minimum graft height (40.10 cm), graft vigour index I (355.80) and graft vigour index II (2666.34) were achieved in $M_4$-15th December at 120 days after grafting. Higher graft height was the result of the primary growth being accelerated by the photosynthetic food generated in leaves. These findings were also seen in Bhavya *et al.* (2018) [1] in Karonda and Karna *et al.* (2018) [6] in Mango.

The significant effect of grafting months on graft success and graft survival percentage is presented in Table 3. Significantly The maximum graft success (83.33%) was found in $M_1$-15th September, while minimum graft success (63.33%) was achieved in $M_4$-15th December at 90 days after grafting. The maximum graft survival (87.81%) was noted in $M_1$-15th September, while while minimum graft survival (83.39%) was recorded in $M_4$-15th December at 120 days after grafting and maximum graft survival (84.08%) was reported in $M_1$-15th September while minimum graft survival (78.19%) was registered in $M_4$-15th December at 180 days after grafting. The high success rate in grafting is due to the alignment of optimal maximum and minimum temperatures with minimal variation, along with elevated humidity levels. These favourable conditions stimulated significant cambial activity in both the stock and scion, leading to the convergence of their cambium layers, there by promoting callus formation and initiating subsequent growth. These were also seen in Tripathi and Karunakaran (2020) [19] in avocado. Higher graft survivability is due to hospitable climatic circumstances that predominated throughout these months encouraged greater cellular activities through fast vascular linkage, increasing graft survivability. Similar findings were also seen by Parmar *et al*. (2019) [12] in Mulberry.

### 3.3 Effect of different growing conditions

Different growing conditions had significant effect on growth parameters (Table 1). Significantly maximum number of sprouts per graft (5.04), sprout length (6.63 cm) and number of leaves (16.39) were recorded in $C_3$-Polyhouse condition while, minimum number of sprouts per graft (3.64), sprout length (5.72 cm) and number of leaves (13.59) was found in $C_1$-partial shade condition at 120 days after grafting. The increase in growth attributes is due to controlled humidity and temperature may be to the reason for this. The growth of more sprouts, which results in increased meristematic activity and improved graft healing, may be the other factor. The higher leaf count per graft in a polyhouse environment is likely due to optimal temperature, light and ample water availability, which accelerate photosynthesis and the production of photosynthates, promoting sprout growth and development. These were observed by Mulla *et al.* (2011) [8] in Jamun, Sivudu *et al.* (2014) [14] in Mango and Mir and Kumar (2011) [7] in Walnut.

The significant effect of different growing conditions on graft height and graft vigour index is presented in Table 2. Significantly maximum graft height (44.74 cm), graft vigour index I (573.58) and graft vigour index II (3950.00) were obtained in $C_3$- polyhouse condition while, minimum graft height (41.97 cm), graft vigour index I (337.90) and graft vigour index II (2533.52) were achieved in $C_1$-partial shade condition at 120 days after grafting. The increase in graft height and graft vigor index is due to increased vegetative growth observed in grafted plants within a polyhouse environment is likely attributed to the favourable growing conditions present in such controlled settings, where enhanced $CO_2$ assimilation is facilitated, in contrast to plants grown in partial shade conditions. This was also seen in the findings of (Chander *et al*., 2016) [2] in Jamun and Yadav *et al.* (2019) [18] in Mango.

The significant effect of growing conditions on graft success and graft survival percentage is presented in Table 3. Significantly, the maximum graft success (86.00%) was attained in the $C_3$- polyhouse condition, while minimum graft success (58.70%) was attained in $C_1$- partial shade condition at 90 days after grafting. The maximum graft survival (88.27%) was seen in the $C_3$- polyhouse condition, while minimum graft survival (84.42%) was showed in the $C_1$-partial shade condition at 120 days after grafting and significantly maximum graft survival (84.55%) was achieved in the $C_3$- polyhouse condition and minimum graft survival (77.08%) was observed in the $C_1$-partial shade condition at 180 days after grafting. A longer duration of favorable conditions (25-32 °C, 45%-75% RH) within the polyhouse that prevent the desiccation of the scion's active tissue and formed a better union of grafted scion and stocks, resulting in better graft success and survival. The variations in the relative humidity and temperature that predominate during partial shade conditions may be the cause of lower success. Similar kind of findings were recorded by Nagargoje *et al.* (2016) [9] in Sapota.

### 3.4 Interaction effect of different grafting months and growing conditions

Different grafting months and growing conditions had a significant effect on growth parameters (Table 1). Significantly maximum number of sprouts per graft (5.41), sprout length (7.42 cm) and number of leaves (20.20) were noted in $C_3M_1$ (15th September and Polyhouse) whereas, the minimum number of sprouts per graft (3.20), sprout length (5.30 cm) and number of leaves (11.93) were found in $C_1M_4$ (15th December and partial condition) at 120 days after grafting. Here, increase in growth parameters is due to environmental factors, such as the optimal temperature and relative humidity present in the polyhouse, in contrast to the shade house and partial shade conditions. These were observed by Mulla *et al.* (2011) [8] in Jamun and Mir and Kumar (2011) [7] in Walnut.

The significant effect of different grafting months and growing conditions on graft height and graft vigor index is presented in Table 2. Significantly maximum graft height (47.12 cm), graft vigour index I (694.82) and graft vigour index II (4513.34) were obtained in $C_3M_1$ (15th September and Polyhouse) while, minimum graft height (39.43 cm), graft vigour index I (247.43) and graft vigour index II (1883.00) were attained in $C_1M_4$ (15th December and partial shade condition) at 120 days after grafting. This result might be ascribed to its ability to build up more of the photosynthates and its subsequent partitioning thereby resulting into development of greater framework of grafted plant. The vigour of grafts which is presented in the above discussion can be also attributed to the better compatibility of the scion-stock combination. Both of these values would be generally high where there is a high degree of graft compatibility. This was also seen in the findings of (Chander *et al*., 2016) [2] in Jamun, Reshma (2019) [13] in Mango and Thokchom *et al*. (2019) [17] in Nagpur mandarin.

The significant effect of growing conditions on graft success and graft survival percentage is presented in Table 3. Significantly, the maximum graft success (93.33%) was obtained in $C_3M_1$ (15th September and Polyhouse), while minimum graft success (46.70%) was noticed in $C_1M_4$ (15th December and Partial shade condition) at 90 days after grafting. The maximum graft survival (89.17%) was resulted in $C_3M_1$ (15th September and Polyhouse), while minimum graft survival (78.33%) was found in $C_1M_4$ (15th December and partial shade condition) at 120 days after grafting. Whereas, maximum graft survival (85.83%) was attained in $C_3M_1$ (15th September and Polyhouse), while minimum graft survival (71.67%) was obtained in $C_1M_4$ (15th December and partial shade condition) at 180 days after grafting. Here, the increase in the graft success and survivability is due to healthy graft union requires the creation of callus tissue, which is strongly influenced by temperature and humidity. The parenchyma cells of callus tissues have thin walls and are delicate, they are easily harmed in open field circumstances due to desiccation, which is brought on by low relative humidity and direct sunshine. This was also seen in Sulkhe (2014) [15] in Jackfruit and Gotur *et al*. (2017) [4] in Guava.

**Table 1:** Effect of grafting months, growing conditions and their interactions on growth parameters at 120 days after grafting

| C<br>M | 120 DAG | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days taken for first sprouting (Days) | | | | Number of sprouts per graft | | | | Sprout length (cm) | | | | Number of leaves | | | |
| | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean |
| $M_1$ | 20.40 | 17.38 | 15.42 | 17.72 | 4.00 | 4.88 | 5.41 | 4.77 | 6.15 | 7.14 | 7.42 | 6.91 | 16.16 | 16.93 | 20.20 | 17.76 |
| $M_2$ | 22.20 | 18.07 | 15.56 | 18.60 | 3.80 | 4.62 | 5.14 | 4.51 | 5.81 | 6.58 | 7.11 | 6.50 | 14.33 | 16.87 | 17.73 | 16.31 |
| $M_3$ | 24.60 | 18.67 | 15.64 | 19.63 | 3.65 | 4.37 | 5.00 | 4.34 | 5.72 | 6.33 | 6.58 | 6.21 | 13.47 | 15.73 | 16.67 | 15.29 |
| $M_4$ | 27.80 | 23.28 | 16.51 | 22.53 | 3.20 | 4.00 | 4.73 | 3.96 | 5.30 | 5.63 | 5.80 | 5.58 | 11.93 | 14.73 | 13.00 | 13.22 |
| $M_5$ | 25.80 | 19.65 | 16.38 | 20.62 | 3.60 | 4.12 | 4.93 | 4.22 | 5.61 | 6.21 | 6.28 | 6.01 | 12.07 | 15.92 | 14.33 | 14.11 |
| Mean | 24.14 | 19.41 | 15.90 | | 3.64 | 4.40 | 5.04 | | 5.72 | 6.38 | 6.63 | | 13.59 | 16.04 | 16.39 | |
| | C | M | C×M | | C | M | C×M | | C | M | C×M | | C | M | C×M | |
| S. Em± | 0.12 | 0.15 | 0.26 | | 0.05 | 0.06 | 0.10 | | 0.06 | 0.07 | 0.13 | | 0.13 | 0.17 | 0.29 | |
| CD @ 5% | 0.34 | 0.44 | 0.76 | | 0.13 | 0.17 | 0.30 | | 0.17 | 0.21 | 0.37 | | 0.38 | 0.49 | 0.84 | |

**Note:** DAG- Days after grafting, C-Growing condition, M- Grafting months, $C_1$- Partial shade condition, $C_2$- Shade house condition, $C_3$- Polyhouse condition, $M_1$- 15th September, $M_2$- 15th October, $M_3$- 15th November, $M_4$-15th December, $M_5$- 15th January

**Table 2:** Effect of grafting months, growing conditions and their interactions on graft height and graft vigor index at 120 days after grafting

| C<br>M | 120 DAG | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Graft height (cm) | | | | Graft vigor index -I (cm) | | | | Graft vigor index -II (cm) | | | |
| | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean |
| $M_1$ | 43.94 | 45.80 | 47.12 | 45.62 | 451.24 | 595.00 | 694.82 | 580.36 | 3297.45 | 3905.72 | 4513.34 | 3905.51 |
| $M_2$ | 43.05 | 44.70 | 46.41 | 44.72 | 367.82 | 526.40 | 639.48 | 511.23 | 2790.12 | 3659.44 | 4274.36 | 3574.64 |
| $M_3$ | 42.10 | 42.83 | 44.13 | 43.02 | 324.00 | 485.61 | 570.56 | 460.05 | 2441.33 | 3360.25 | 3913.84 | 3238.47 |
| $M_4$ | 39.43 | 40.67 | 42.59 | 40.10 | 247.43 | 375.56 | 444.41 | 355.80 | 1883.00 | 2774.60 | 3341.42 | 2666.34 |
| $M_5$ | 41.33 | 41.83 | 43.47 | 42.21 | 300.00 | 434.98 | 518.61 | 417.54 | 2255.70 | 2996.42 | 3707.03 | 2986.38 |
| Mean | 41.97 | 43.17 | 44.74 | | 337.90 | 483.51 | 573.58 | | 2533.52 | 3339.29 | 3950.00 | |
| | C | M | C×M | | C | M | C×M | | C | M | C×M | |
| S. Em± | 0.24 | 0.31 | 0.54 | | 4.23 | 5.46 | 9.46 | | 12.93 | 16.69 | 28.90 | |
| CD @ 5% | 0.70 | 0.90 | 1.56 | | 12.22 | 15.77 | 27.32 | | 37.33 | 48.20 | 83.48 | |

**Note:** DAG- Days after grafting, C-Growing condition, M- Grafting months, $C_1$- Partial shade condition, $C_2$- Shade house condition, $C_3$- Polyhouse condition, $M_1$- 15th September, $M_2$- 15th October, $M_3$- 15th November, $M_4$-15th December, $M_5$- 15th January

**Table 3:** Effect of grafting months, growing conditions and their interactions on graft success (%) at 90 days after grafting, graft survival (%) of mango grafts at 120 and 180 days after grafting

| C / M | Graft success (%) 90 DAG | | | | Graft survival (%) 120 DAG | | | | Graft survival (%) 180 DAG | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean | $C_1$ | $C_2$ | $C_3$ | Mean |
| $M_1$ | 73.34 (59.01) | 83.34 (66.14) | 93.33 (80.65) | 83.33 * (68.60) | 86.31 (68.29) | 87.96 (69.70) | 89.17 (70.80) | 87.81 (69.59) | 82.14 (65.19) | 84.26 (66.82) | 85.83 (68.09) | 84.08 (66.70) * |
| $M_2$ | 63.33 (52.77) | 80.00 (63.43) | 90.00 (71.56) | 77.78 (62.59) | 84.13 (65.08) | 87.50 (68.79) | 88.89 (70.52) | 86.84 (68.77) | 79.37 (63.16) | 83.33 (66.19) | 85.19 (67.64) | 82.63 (65.67) |
| $M_3$ | 56.67 * (48.84) | 76.67 (61.22) | 86.67 (68.85) | 73.33 (59.64) | 82.22 * (65.08) | 86.90 (68.79) | 88.43 (70.08) | 85.85 (67.98) | 76.67 (61.36) | 82.74 * (65.69) | 84.72 (67.23) | 81.38 (64.76) |
| $M_4$ | 46.70 (43.07) | 66.67 (54.78) | 76.67 (61.22) | 63.33 (53.02) | 78.33 (62.29) | 84.92 (68.15) | 86.90 (68.79) | 83.39 (66.07) | 71.67 (58.06) | 80.16 (63.79) | 82.74 (65.69) | 78.19 (62.51) |
| $M_5$ | 53.34 (46.92) | 70.00 (56.99) | 83.33 (66.14) | 68.90 (56.68) | 81.11 (66.25) | 85.52 (68.65) | 87.96 (69.70) | 84.86 (67.20) | 75.56 (60.53) | 81.35 (64.56) | 84.26 (66.82) | 80.39 (63.97) |
| Mean | 58.70 (50.12) | 75.33 (60.51) | 86.00 (69.98) | | 82.42 (65.28) | 86.56 (68.51) | 88.27 (69.98) | | 77.08 (61.66) | 82.37 (65.41) | 84.55 (67.09) | |
| | C | M | C×M | | C | M | C×M | | C | M | C×M | |
| S. Em± | 0.15 | 0.19 | 0.33 | | 0.37 | 0.48 | 0.83 | | 1.80 | 2.33 | 4.03 | |
| CD @ 5% | 0.43 | 0.56 | 0.96 | | 1.07 | 1.39 | 2.40 | | 5.21 | 6.73 | 11.65 | |

**Note:** DAG- Days after grafting, C-Growing condition, M- Grafting months, $C_1$- Partial shade condition, $C_2$- Shade house condition, $C_3$- Polyhouse condition, $M_1$- 15th September, $M_2$- 15th October, $M_3$- 15th November, $M_4$-15th December, $M_5$- 15th January
*Figures in parenthesis are arcsine transformed values and are significant (P = 0.05) by DMRT.

## 4. Conclusion

From the present study, it can be concluded that among the different grafting months, grafting in the month of September resulted in maximum graft success, vegetative growth such as number of sprouts, sprout length, number of leaves etc. due to the active sap flow is noticed which resulted in good graft union. Among the different growing conditions, polyhouse condition showed best outcomes for graft parameters, due to prevailing microclimate inside it, resulted in better graft union. Among the interaction, grafting in the month of September under polyhouse condition resulted in increase in the growth attributes, vigor of the grafts and maximum graft survivability.

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