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# Effect of months on softwood grafting in carambola (*Averrhoa carambola* l.)

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**Abstract**
Carambola is an important fruit of warm tropics and sub tropics region of world. In the Konkan region, carambola flowers and fruits thrice a year, making it a suitable boundary crop that can provide additional income to farmers, though its propagation poses some challenges. Earlier university studies focused on air layering and grafting; considering the crop's scope and demand, this experiment was undertaken The Experiment was laid out in randomize block design with eight treatments of I$^{st}$ and II$^{nd}$ fortnight of August to November month. September month especially grafting in I$^{st}$ Fortnight of September was found significantly superior for most of the parameters including sprouting (%) (80.00%) and subsequent growth parameters like Survival (%) (73.33%), rootstock girth (5.35 mm), graft union girth (7.18 mm) and scion girth (5.39 mm). The average optimum day temperature at 32.64°C, average monthly temperature at 24.17°C and average relative humidity I at 91 (%) and II at 58 (%) and reduction in the wind speed to 3.06 km/hr with increasing bright sunshine (7.47 hrs) during September to March month resulted in beneficial environmental factors that might boost the physiological and metabolic functions of the plant.

**Keywords:** Carambola; Softwood grafting; propagation studies; effect of months

## Introduction
Carambola (*Averrhoa carambola* L.), often known as the "star fruit" or "five finger" fruit, also important fruit of warm tropics and sub tropics region of world which belongs to Oxalidaceae family. In climatic region in Konkan region carambola is flowering and fruiting thrice so this crop can be used as boundary crop which may additionally provide income to the farmers. Traditionally, carambola plants have been propagated through seeds; however, seed propagation often results in high genetic variability among the progeny. Due to their heterozygous nature, seedlings are unlikely to have fruit that closely resembles that of the mother tree. (Sonawane *et al.*, 2012) [9]. As a result, seedling plants may vary significantly in terms of fruit size, shape, taste, yield and other characteristics. To overcome this issue and ensure uniformity and quality in commercial orchards, vegetative propagation methods such as air layering and softwood grafting have been adopted. Grafting enables the production of true-to-type plants that faithfully replicate the genetic and phenotypic characteristics of the elite mother plant. This technique not only ensures uniformity in fruit quality and maturity but also shortens the juvenile phase allowing for earlier fruiting compared to plants grown through seeds. Among various vegetative methods, softwood grafting is effective in carambola due to its relatively high success rate and ease of implementation. nowadays demand for carambola grafts is increasing day by day for which studies on propagation was done in which softwood grafting and air layering was practiced but now as per the changing climatic condition softwood grafting from August to September month was conducted with following objective
Effect of months on softwood grafting in carambola (*Averrhoa carambola* L.)

## Material and Methods
The experiment was conducted in 2024-2025, at nursery of Department of Fruit Science, College of Horticulture, Dapoli. The experiment was carried out in randomized block design with 8 treatments of I$^{st}$ and II$^{nd}$ fortnight of August to November month which were replicated

three times. Carambola seeds were collected from ripe fruits and sown in trays with a 2:1:2 mixture of soil, cocopeat and compost. After germination (20–25 days), seedlings were transplanted into polybags. Healthy seedlings (25–30 cm tall, 0.25–0.30 cm thick) were selected as rootstocks. Scion sticks were taken from 3–4-month-old shoots, defoliated and left on the tree for 8–12 days before use. Grafting involved inserting a wedge-shaped scion into a V-slit on the rootstock and tying it with a polythene strip. Grafts were kept in shade, watered every 3–4 days, and covered with polythene bags, which were removed after sprouting began. The observation was recorded till 180 days after grafting with 30 days interval. All the Sprouting percentage, Survival percentage and growth parameters (height, height from graft union, rootstock girth, graft union girth, scion girth).

**Table 1:** Effect of month of grafting on sprouting (%) and survival (%) of carambola grafts

| Treatment details | Sprouting (%) at 30 DAG | Survival (%) at 180 DAG |
|---|---|---|
| $T_1$ | 32.22 | 28.89 |
| $T_2$ | 35.56 | 34.44 |
| $T_3$ | 80.00 | 73.33 |
| $T_4$ | 52.22 | 51.11 |
| $T_5$ | 18.89 | 17.78 |
| $T_6$ | 5.56 | 4.44 |
| $T_7$ | 25.56 | 24.44 |
| $T_8$ | 15.56 | 15.56 |
| *Average* | 33.19 | 31.25 |
| S.Em ± | 2.31 | 2.62 |
| CD 0.05% | 6.99 | 7.94 |
| Result | SIG | SIG |

## Result and Discussion

### Effect of month on softwood grafting on sprouting (%) and sprouting (%) of carambola grafts

The data related to sprouting (%) and survival (%) of carambola grafts was recorded at 30 DAG and 180 DAG respectively and presented in Table 1. The highest sprouting (80.00%) was recorded in $T_3$ (Grafting on I$^{st}$ fortnight of September) followed by $T_4$ (Grafting on II$^{nd}$ fortnight of September) (52.22%) and lowest (5.56%) sprouting was observed in $T_6$ (grafting in II$^{nd}$ Fortnight of October) treatment. These results were might be due to favourable climatic conditions in September months i.e. optimum day temperature (30.58$^{o}$C), average monthly temperature (26.04$^{o}$C), high relative humidity (92% and 79%), reduced wind speed (3.7 km/hr), and increased sunshine (4.61 hrs) which promoted early cambial alignment, quick callus development and growth initiation in carambola grafts, leading to a higher sprouting percentage. Similar results were found by Prasanth *et al*. (2007) [8] in mango where maximum sprouting (%) was observed in September month in softwood grafting.

The treatment maximum survival (%) (73.33) of grafts was recorded in Treatment $T_3$ (Grafting in I$^{st}$ Fortnight of September) which was followed by $T_4$ (Grafting in II$^{nd}$ Fortnight of September) (51.11). The minimum survival (%) (4.44) of grafts was noted in $T_6$ (Grafting in II$^{nd}$ Fortnight of October) treatment. Favourable climatic conditions during the growth period of grafts from September to march month, including an average optimum day temperature of 30.58$^{o}$C, monthly average of 26.04$^{o}$C, high relative humidity (92% and 79%), reduced wind speed (3.7 km/hr), and increased sunshine (4.61 hrs) which promoted effective scion-rootstock union. These conditions supported early cambial contact, quick callus formation and the onset of growth, leading to a higher graft survival rate. Similar results were found by Prasanth *et al*. (2007) [8], Karna *et al.* (2017) [5] and Kuree *et al.* (2024) [6] in mango where maximum survival (%) was found in September month for softwood grafting.

### Effect of month on softwood grafting on height (cm) and per cent increase in height of carambola grafts

The data related to height and per cent increase in height was recorded at 180 DAG and is presented in Table 2. The statistically highest percent increase in height (14.94%) of carambola grafts was found in $T_1$ treatment which was at par with $T_2$ (Grafting in II$^{nd}$ Fortnight of August) (14.58%), $T_6$ (Grafting in II$^{nd}$ Fortnight of October) (14.04%) and $T_3$ (Grafting in I$^{st}$ Fortnight of September) (13.31%). The lowest percent increase in height (11.09%) was noted in $T_5$ (Grafting in I$^{st}$ Fortnight of October) treatment. Grafting success, particularly graft height, is significantly influenced by climatic conditions. Grafting during late monsoon (August-September) and early winter (October-November) proved optimal. Consistent moisture in the air and media, a congenial temperature range of 24−26 ℃ and increasing light intensity during initial growth ($T_1$, $T_2$, $T_3$) facilitated better height development. Successful graft union enabled efficient nutrient and water transfer, promoting photosynthesis and subsequent growth. Similar results were found by Chander *et al*. (2016) [3] in jamun and Karna *et al.* (2017) [5] and Kuree *et al.* (2024) [6] in mango where maximum height was noted in September month for softwood grafting.

### Effect of month on softwood grafting on height from graft union (cm) and per cent increase in height from graft union of carambola grafts

The data related to height from graft union and per cent increase in height from graft union was recorded at 180 DAG is presented in Table 2. The highest percent increase in height from union of carambola graft (16.30%) was recorded in $T_1$ (Grafting in I$^{st}$ Fortnight of August) which was at par with $T_2$ (Grafting in II$^{nd}$ Fortnight of August) (16.18%) and $T_4$ (Grafting in II$^{nd}$ Fortnight of September) (13.54%) while the lowest percent increase in height from union of carambola graft (10.02%) was found in $T_5$ (Grafting in I$^{st}$ Fortnight of October) treatment. Successful cambium union facilitates the vital exchange of nutrients, water and food between rootstock and scion. The favourable climatic conditions during the growth period, as mentioned in section 3.2, likely enhanced photosynthate production, ultimately boosting scion growth and height. Similar results were found by Bhavya *et al.* (2018) [1] in karonda and Karna *et al.* (2017) [5] and Kuree *et al.* (2024) [6] in mango where maximum height was noted in September month for softwood grafting.

### Effect of different month on rootstock girth (mm) of carambola graft

The data related to rootstock girth (mm) was recorded at 180 DAG is presented in Table 2. The maximum rootstock girth (5.35 mm) was recorded in $T_3$ (Grafting in I$^{st}$ Fortnight of September) treatment which was at par with $T_6$ (Grafting in II$^{nd}$ Fortnight of October) (5.28 mm), $T_5$ (Grafting in I$^{st}$ Fortnight of October) (5.25 mm) and $T_4$ (Grafting in II$^{nd}$ Fortnight of September) (5.24 mm). The minimum girth (4.88 mm) was found in $T_7$ (Grafting in I$^{st}$ Fortnight of November) treatment. Favourable environmental conditions from September to March significantly boosted carambola graft growth. An average optimal day temperature of 32.64℃, monthly average of 24.17

°C, high relative humidity (91% and 58%), reduced wind speed (3.06 km/hr) and increased bright sunshine (7.47 hrs) likely enhanced the plant's physiological and metabolic functions. This, combined with successful cambial layer union ensuring even metabolite distribution, led to increased girth in the rootstock, graft union, and scion. The rootstock's growing medium, a soil: cocopeat: compost (2:1:1) mix, provided sustained moisture, while moderate temperatures and regular application of the biostimulant (Balsarthi) encouraged vigorous cambial growth, leading to enhanced cell division and radial expansion. Similar results were found by Ghojage *et al*. (2009) [4] and Chander *et al*. (2016) [3] in jamun noted maximum girth in September month of softwood grafting.

**Effect of different month on graft union girth (mm) of carambola graft**

The data related to graft union girth (mm) was recorded at 180 DAG is presented in Table 2. the maximum graft union (7.18 mm) was recorded in $T_3$ (Grafting in I$^{st}$ Fortnight of September) treatment which was at par with $T_4$ (Grafting in II$^{nd}$ Fortnight of September) (7.03 mm), $T_6$ (Grafting in II$^{nd}$ Fortnight of October) (6.82 mm) and $T_5$ (Grafting in I$^{st}$ Fortnight of October) (6.67 mm). The minimum graft union girth (5.92 mm) was found in $T_8$ treatment. Increased girth at the graft union suggests robust wound healing and growth. Rapid callus tissue development likely formed a strong vascular connection, ensuring uninterrupted water, mineral, and assimilate translocation, thereby promoting radial growth and increased graft girth. Similar results were found by Ghojage *et al*. (2009) [4] and Chander *et al*. (2016) [3] in jamun noted maximum girth in September month of softwood grafting.

**Effect of different month on scion girth (mm) of carambola graft**

The data related to scion girth was recorded at 180 DAG is presented in Table 2. The maximum scion girth (5.39 mm) was recorded in $T_3$ (Grafting in I$^{st}$ Fortnight of September) treatment which was at par with $T_1$ (Grafting in I$^{st}$ Fortnight of August) (5.33 mm), $T_4$ (Grafting in II$^{nd}$ Fortnight of September) (5.29 mm), $T_6$ (Grafting in II$^{nd}$ Fortnight of October) (5.28 mm) and $T_5$ (Grafting in I$^{st}$ Fortnight of October) (5.27 mm). The minimum scion girth (5.09 mm) was found in $T_2$ (Grafting in II$^{nd}$ Fortnight of August) treatment. The $T_3$ treatment showed greater scion girth which may be likely due to increased leaf number and area during graft growth. Favourable climatic conditions led to successful cambium union and efficient metabolite transfer, boosting photosynthate production and subsequently scion girth. However, reduced relative humidity in October-November may have hindered growth. Similar results were found by Ghojage *et al*. (2009) [4] and Chander *et al*. (2016) [3] in jamun noted maximum girth in September month of softwood grafting.

**Table 2:** Effect of month of grafting on growth parameters of carambola grafts

| Treatment details | Height (cm) and per cent increase in height | Height from graft union (cm) and per cent increase in height from graft union | Rootstock girth (mm) | Graft union girth (mm) | Scion girth (mm) |
|---|---|---|---|---|---|
| $T_1$ | 65.11 (14.94) | 48.50 (16.30) | 5.01 | 6.34 | 5.33 |
| $T_2$ | 68.99 (14.58) | 53.95 (16.18) | 5.16 | 6.46 | 5.09 |
| $T_3$ | 73.33 (13.31) | 60.59 (12.85) | 5.35 | 7.18 | 5.39 |
| $T_4$ | 71.78 (11.94) | 54.00 (13.54) | 5.24 | 7.03 | 5.29 |
| $T_5$ | 69.53 (11.09) | 50.85 (10.02) | 5.25 | 6.67 | 5.27 |
| $T_6$ | 69.33 (14.04) | 44.58 (13.05) | 5.28 | 6.82 | 5.28 |
| $T_7$ | 67.65 (11.36) | 42.68 (11.19) | 4.88 | 6.12 | 5.03 |
| $T_8$ | 66.51 (11.37) | 46.06(13.30) | 4.95 | 5.92 | 5.06 |
| Average | 69.03 (12.83) | 50.15 (13.32) | 5.14 | 6.57 | 5.22 |
| S.Em ± | 0.87 | 0.97 | 0.09 | 0.18 | 0.08 |
| CD 0.05% | 2.63 | 2.94 | 0.29 | 0.55 | 0.23 |
| Result | SIG | SIG | SIG | SIG | SIG |

Treatment details
T1: Grafting in Ist Fortnight of August. T2: Grafting in IInd Fortnight of August.
T3: Grafting in Ist Fortnight of September. T4: Grafting in IInd Fortnight of September.
T5: Grafting in Ist Fortnight of October. T6: Grafting in IInd Fortnight of October.
T7: Grafting in Ist Fortnight of November. T8: Grafting in IInd Fortnight of November.

**Table 3:** Average of climatic parameters during grafting to 180 days after grafting of carambola grafts

| Period | Tmax | Tmin | Average temp. | RH-I | RH-II | Wind speed | Rain | RD | BSS | Epan |
|---|---|---|---|---|---|---|---|---|---|---|
| | (°C) | (°C) | | (%) | (%) | (Kmph) | (mm) | day | (hrs.) | (mm) |
| $T_1$ | 31.39 | 17.84 | 24.61 | 92.27 | 67.19 | 3.77 | 50.61 | 2.15 | 5.59 | 3.16 |
| $T_2$ | 31.84 | 17.07 | 24.45 | 91.90 | 63.83 | 3.35 | 39.97 | 1.63 | 6.31 | 3.25 |
| $T_3$ | 32.53 | 15.82 | 24.18 | 91.28 | 58.63 | 3.08 | 17.82 | 0.92 | 7.34 | 3.40 |
| $T_4$ | 32.76 | 15.58 | 24.17 | 91.08 | 57.38 | 3.06 | 14.26 | 0.72 | 7.62 | 3.46 |
| $T_5$ | 33.16 | 15.16 | 24.16 | 90.36 | 55.31 | 3.16 | 6.08 | 0.42 | 8.15 | 3.55 |
| $T_6$ | 33.21 | 14.90 | 24.06 | 90.22 | 54.37 | 3.17 | 5.36 | 0.36 | 8.30 | 3.56 |
| $T_7$ | 33.27 | 14.83 | 24.05 | 88.72 | 53.56 | 3.44 | 0.25 | 0.00 | 8.89 | 3.70 |
| $T_8$ | 33.26 | 15.04 | 24.15 | 88.30 | 53.89 | 3.53 | 0.41 | 0.04 | 8.90 | 3.74 |

**Source:** Department of Agronomy, Dr. B. S. K. K.V. Dapoli

**Conclusion**

From the present investigation, considering the higher ranking of treatment in various parameter under study, it can be concluded that grafting in September month especially in I$^{st}$ fortnight resulted the superior efficacy in enhancing the plant growth parameters i.e. sprouting (%), rootstock girth, graft union girth, scion girth, survival (%). Climatic conditions during grafting and further growth plays an important role in success and

growth of the graft.

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