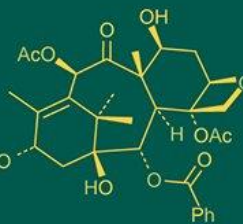
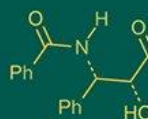


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Studies on stone grafting in commercial varieties of mango (*Mangifera indica* L.) under Raipur plains

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Abstract

An experiment was conducted at Precision Farming Development Centre, Department of Fruit Science, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during the year 2025-2026. The experiment was laid out in a Completely Randomized Design (CRD) with nine treatments and three repetitions. The results revealed that variety Langra (T_1) required the minimum number of days for sprouting (12.33 days) and also recorded the maximum shoot length of 3.20, 3.61, 4.16, 4.77, 5.38, and 6.13 cm at 30, 60, 90, 120, 150, and 180 DAG, respectively. Similarly, the highest number of leaves per graft (6.33, 7.73, 8.83, 9.06, 10.06 and 11.80) and the greatest graft diameter (6.30, 6.63, 7.03, 7.43, 7.66 and 8.26 mm) were recorded in Langra (T_1) at 30, 60, 90, 120, 150 and 180 DAG, respectively and this is statistically at par with followed by the treatment (T_7) variety Mallika. The maximum rootstock diameter (6.66 mm), graft success percentage (78.66 %), and survival percentage (70.00%) were also observed in the variety Langra (T_1) at 180 DAG. With respect to the biomass characteristics of grafted mango varieties, Langra (T_1) recorded the maximum tap root length (30.80 cm), secondary root length (20.10 cm), fresh shoot weight (16.83 g), dry shoot weight (9.79 g), fresh root weight (7.88 g) and dry root weight (4.92 g) at 180 DAG. In contrast, the variety Alphonso (T_6) exhibited the lowest values for most of the growth and biomass parameters evaluated during the study.

Keywords: Mango, stone grafting, propagation, scion, rootstock, graft success

Introduction

Mango (*Mangifera indica* L.) is also known as the king of fruits, one of the most important tropical fruits of India. It belongs to the family Anacardiaceae and its chromosome number is $2n = 40$. It was native to the Indo-Burma region (De Candolle, 1904) [5]. It was considered the premier and choicest fruit of India and undoubtedly one of the best fruits of the world. Mango was very well adapted to tropical and subtropical climates and thrived well in almost all regions from sea level to an altitude of 1500 metres. Mango can be grown successfully at temperatures between 24 °C and 27 °C. The tree was hardy in nature and could endure even temperatures as high as 48 °C. It grew successfully in low rainfall areas receiving as little as 25 cm and as much as 375 cm.

The unique flavour and nutritional value of the mango contribute to its popularity as a fruit. Vitamins A (540-1100 IU), B₆ (0.1 mg) and C (45.7 mg) are among the many vitamins and other nutrients such as fat (0.4 g), carbohydrates (28.1g), calcium (16.5 g) and Phosphorus (18.2 mg) that are said to be abundant in it. Malic, citric, and tartaric acids are additional ingredients that are present in a mango in small amounts. Mangoes have a good amount of fibre, which helps with many gastrointestinal conditions (Hassan *et al.*, 2022) [6]. Mango seed fat has been approved by the European Union as a substitute for cocoa butter and other nutraceuticals.

Mango production in India during 2024-25 is estimated to be 228.37 lakh metric tonnes, according to the second advance estimate shared by the Ministry of Agriculture and Farmers Welfare on July 22, 2025. In comparison, the production during 2023-24 was 223.98 LMT. The area for mango cultivation is estimated at 28.83 million hectares (based on the first advance estimates), a decrease from 29.08 million hectares in the previous year. The higher production is mainly due to better output of processable mango varieties, particularly in the southern states (Anonymous, 2025) [2]. In Chhattisgarh, the data reached an all-time high of 471.499 tons in 2025 and a record low of 271.470 tons in 2012 (Anonymous, 2024-25) [1].

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Grafting in fruit crops is a propagation technique where a scion (a shoot or bud from a desired variety) is joined to a rootstock selected for its vigour, disease resistance, or adaptability (Thamarsha *et al.*, 2024) ^[10]. However, successful grafting requires compatibility between scion and rootstock, and the union formation involves complex physiological, biochemical, and molecular changes (Warschefsky *et al.*, 2022) ^[11]. Grafting is commercially more beneficial than seedling propagation in mango (*Mangifera indica* L.) because it ensures true-to-type plants, uniform growth, and early fruit bearing. Grafted mango plants generally start producing fruits within 3-4 years, whereas seedling trees may take 7-10 years to bear fruit due to a long juvenile period.

Propagation of mango by epicotyl or stone grafting, though tried relatively recently, had distinct advantages over other improved methods of propagation. In this method, the germinating mango stones from which epicotyls had just emerged and straightened to a height of 8-10 cm were used as rootstocks, as against one-year-old seedling stocks commonly used in veneer grafting and inarching, thus minimizing the cost of production of seedling rootstocks to a great extent. This new technique of mango propagation was tried earlier in West Bengal (Bhan *et al.*, 1969) ^[3] and other places in India (Majumdar and Rathore, 1970 ^[7]; Rajput and Haribabu, 1971) ^[9]. Stone or Epicotyl grafting of mango has drawn the attention of horticultural scientists and farmers during the last decade, as it has several advantages over other methods. There is a need to study the success of this method under different agroclimatic conditions in various commercially grown cultivars of mango.

Material and Methods

The present experiment was conducted during the year 2025-26 period in the month of August at the Precision Farming Development Centre (PFDC), Department of Fruit Science, College of Agriculture, IGKV, Raipur (C.G.). Nine different treatments viz., T₀- Dashehari, T₁- Langra, T₂- Totapuri, T₃- Bombay Green, T₄- Banganpalli, T₅- Amrapali, T₆- Alphonso, T₇- Mallika, T₈- Gaddemar of different varieties were tried in a Completely Randomized Design (CRD) with three replications.

Source of scion: The scion shoots used in the present investigation were collected from healthy, true-to-type mother plants maintained at the Government Horticulture Nursery at Paragaon (Arang), Chokara Nala and Mandir Hasaud, Raipur. Mature, disease-free and vigorous current-season shoots were selected as scion material to ensure better graft compatibility and higher success of grafting

Source of seedling rootstock: The seeds used for raising rootstock seedlings were collected from healthy and well-matured fruits of local deshi mango (*Mangifera indica* L.) trees available in the nearby areas of Raipur, Chhattisgarh. The stones were extracted from fully ripe fruits and thoroughly washed with clean water to remove adhering pulp. The freshly extracted stones were immediately sown in nursery beds under shade net to ensure better germination and uniform seedling growth.

Method of stone grafting: The epicotyl in the polythene bags was given a complete horizontal cut at 6 cm height so as to remove the upper portion. Then, a vertical cross-cut of 3 cm was given at the center. 8 cm-long scion sticks were used for grafting. A slanting cut to both sides of the scion

just below the terminal bud was given, thus forming a wedge and it was inserted in the vertical cut of the stock in such a way that both sides of scion-wedge contacted the sides of the vertical cut. The grafted portion was wrapped with a 1.5 cm wide and 45 cm long, 200-gauge transparent white polythene strip so as to prevent water from entering the grafted part.

Planting of grafts: Polybags 15 cm in length and 10 cm in diameter, 200-gauge in thickness, were used and filled to 2/3 of the volume with a potting mixture of soil + cocopeat + FYM (1:1:1). The grafts were planted in the bags and the potting mixture was again added to cover the roots and stone, leaving a one-centimetre margin of the bags for watering. Planting was adjusted so that the graft joint remained above the soil surface. The soil was gently pressed around the grafts, and the grafts were kept under a polytunnel.

Observations

Five grafts of each variety from each replication were tagged to record vegetative growth parameters, including days to sprouting, sprout length (cm), leaf count per graft, rootstock diameter (cm) and graft diameter (mm). Additionally, biomass parameters such as taproot length (cm), secondary root length (cm), shoot fresh weight (g), shoot dry weight (g), root fresh weight (g) and root dry weight (g) were recorded.

Percentage graft success (%)

The percent success of the graft was calculated with the help of the formula given below.

Number of grafts sprouted

Percent success of graft = ----- x100

Total number of grafts prepared

Survival percentage (%)

The percent survival of grafts of each treatment was calculated with the help of the formula given below and recorded as the survival percentage of grafts.

The number of grafts remained alive at 180 DAG

Percent survival = ----- x 100

Total number of successful grafts

Results and Discussion

Growth parameters

Days required for sprouting

Regarding the effect of different varieties on the days required for sprouting of stone grafting was noted that the treatment (T₁) variety Langra was found to take the fewest days to sprout (12.33), which was statistically at par with treatment (T₇) Mallika (13.33) and treatment (T₄) Banganpalli (13.66). Delay in the initiation of graft sprouting (15.66) was recorded in Alphonso, which was statistically on the same bar as Dashehari and Totapuri (14.66). A similar result was obtained by (Patel *et al.*, 2016) ^[8] in mango.

Percentage graft success (%)

The data revealed significant variation in the percentage of graft success of different mango varieties. The maximum graft success (78.66 %) was observed in Langra, followed by Mallika (76.66 %) and Amrapali (76.00 %). The minimum graft success (67.66 %) was observed in Alphonso, which is statistically at par with Totapuri (69.00 %) and Dashehari (70.33 %).

Survival percentage (%)

An appraisal of results about the survival percentage of grafted mango was significantly influenced by different mango varieties at 180 DAG. The data showed that the % varied from 53.00 to 70.00 %. The maximum survival percentage (70.00 %) was observed in T₁, i.e., Langra and it was statistically at par with T₇ (69.00 %) variety Mallika and Amrapali (67.00 %). The minimum survival percentage (53.00 %) was recorded in T₆, i.e., Alphonso and Totapuri (56.66 %), although the control Dashehari got (66.33 %).

Growth characteristics

At 30, 60, 90, 120, 150 and 180 DAG, the variety Langra recorded maximum sprout height (3.20 cm), (3.61 cm), (4.16 cm), (4.77 cm), (5.38 cm) and (6.13 cm) and maximum number of leaves (6.33), (7.73), (8.83), (9.06), (10.06) and (11.80), respectively. This was statistically at par with Mallika and the maximum rootstock diameter (6.66 mm) was found in treatment T₁ Langra. The increased

growth characteristics observed in certain mango varieties may be attributed to better graft compatibility and efficient vascular connection between stock and scion, which enhances the movement of water, nutrients and photosynthates to the developing buds. Higher availability of stored carbohydrates in the scion wood supports rapid cell division and elongation of sprouted shoots (Capelli *et al.*, 2021) [4].

Biomass study

The variety Langra, i.e., T₁, recorded maximum tap root length (30.80 cm), maximum length of the secondary root (20.10 cm), the maximum fresh weight of the shoot (16.83 g) and dry weight of the shoot (9.79 g), maximum fresh weight of root (7.88 g) and the treatment T₇ i.e., Mallika was observed maximum dry weight of root (4.92 g) at 180 days after grafting. Although the minimum biomass was recorded in T₆, i.e., Alphonso.

Table 1: Effect of stone grafting on the growth parameters of commercial varieties of mango

Notations	Treatment	Days required for sprouting	Percentage of graft success (%)	Diameter of rootstock (mm)	Survival Percentage (%)
T ₀	Dashehari	14.66 ^{ab}	70.33 ^{cde}	6.33ab	66.33b
T ₁	Langra	12.33 ^c	78.66 ^a	6.66a	70.00a
T ₂	Totapuri	14.66 ^{ab}	69.00 ^{de}	6.30ab	56.33e
T ₃	Bombay Green	14.33 ^{ab}	71.00 ^{cd}	6.20ab	60.66d
T ₄	Banganpalli	13.66 ^{bc}	75.33 ^b	6.30ab	63.66c
T ₅	Amrapali	14.33 ^{ab}	76.00 ^b	6.40ab	67.00b
T ₆	Alphonso	15.66 ^a	67.66 ^e	5.96b	53.00f
T ₇	Mallika	13.33 ^{bc}	76.66 ^{ab}	6.53ab	69.00a
T ₈	Gaddemar	15.00 ^{ab}	72.66 ^c	6.2ab	64.33c
SEm ±		0.83	1.97	0.12	1.22
CD at 5 %		1.59	5.85	0.36	3.64

Table 2: Effect of stone grafting on the growth parameters of commercial varieties of mango

Notations	Treatment	Shoot length (cm)						Number of leaves per graft						Graft Diameter (mm)					
		30 DAG	60 DAG	90 DAG	120 DAG	150 DAG	180 DAG	30 DAG	60 DAG	90 DAG	120 DAG	150 DAG	180 DAG	30 DAG	60 DAG	90 DAG	120 DAG	150 DAG	180 DAG
T ₀	Dashehari	2.78	3.36	3.68	4.44	4.97	5.62	4.66	6.20	7.33	8.46	8.70	10.16	6.00	6.33	6.63	7.16	7.36	7.65
T ₁	Langra	3.20	3.61	4.13	4.77	5.38	6.13	6.33	7.73	8.83	9.06	10.06	11.80	6.30	6.63	7.03	7.43	7.66	8.26
T ₂	Totapuri	2.66	3.11	3.82	4.44	4.98	5.72	4.66	6.30	7.33	8.33	8.56	10.26	6.00	6.20	6.60	7.00	7.30	7.46
T ₃	Bombay Green	2.45	3.20	3.87	4.48	5.01	5.69	4.66	6.26	7.4b	8.53	8.6	10.26	6.10	6.53	6.93	7.20	7.50	7.63
T ₄	Banganpalli	2.63	3.38	3.91	4.54	5.10	6.05	5.00	6.70	7.83	8.56	9.10	10.86	6.10	6.20	6.60	7.00	7.30	7.46
T ₅	Amrapali	2.87	3.29	3.81	4.42	4.97	5.64	5.33	6.93	7.96	9.00	9.26	11.00	6.00	6.23	6.64	7.03	7.33	7.63
T ₆	Alphonso	2.45	3.13	3.76	4.36	4.90	5.59	4.33	5.86	7.00	8.33	8.56	9.83	5.80	6.06	6.46	6.86	7.16	7.33
T ₇	Mallika	3.00	3.55	4.16	4.74	5.28	6.06	5.66	7.43	8.56	8.60	9.86	11.63	6.10	6.33	6.73	7.13	7.43	8.03
T ₈	Gaddemar	2.71	3.46	4.09	4.71	5.27	5.83	4.33	5.86	6.93	8.47	8.23	9.90	6.20	6.40	6.80	7.33	7.63	7.8
SEm ±		0.21	0.42	0.14	0.14	0.15	0.16	0.41	0.43	0.44	0.17	0.44	0.45	0.11	0.09	0.09	0.09	0.09	0.18
CD at 5 %		0.07	0.14	0.42	0.43	0.45	0.48	1.24	1.28	1.32	0.52	1.33	1.37	0.34	0.29	0.29	0.29	0.29	0.54

Table 3: Effect of stone grafting on the biomass study of commercial varieties of mango

Notations	Treatment	Length of tap root (cm)	Length of secondary root (cm)	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
T ₀	Dashehari	20.40ef	15.60d	13.47cd	7.07bcd	6.73ab	3.72ab
T ₁	Langra	30.80a	20.10a	16.83a	9.79a	7.80a	4.06ab
T ₂	Totapuri	20.10fg	14.21e	12.45de	6.19cde	6.39ab	3.12b
T ₃	Bombay Green	22.40d	14.91de	12.98d	6.17cde	7.06ab	3.07b
T ₄	Banganpalli	21.60de	18.60bc	13.09d	7.14bcd	6.90ab	3.50ab
T ₅	Amrapali	24.60c	19.50ab	14.58bc	7.64bc	7.26ab	3.76ab
T ₆	Alphonso	17.50h	13.90e	11.19ef	5.108e	6.05b	2.77b
T ₇	Mallika	28.40b	17.40c	15.78ab	8.48ab	7.88a	4.92a
T ₈	Gaddemar	18.90gh	15.80d	10.55f	5.74de	6.82ab	2.98b
SEm ±		0.57	0.58	0.57	0.61	0.62	0.58
CD at 5 %		1.71	1.72	1.71	1.81	1.84	1.70

Conclusion

Based on the findings of the present investigation, it can be concluded that mango variety significantly influenced the growth and biomass attributes of epicotyl grafts. Among the tested varieties, Langra (T₁) consistently recorded the best performance for growth parameters, including minimum days to sprouting, highest graft success, sprout height, number of leaves, graft diameter and rootstock diameter. Likewise, Langra (T₁) exhibited superior performance for biomass parameters, namely tap root length, secondary root length, fresh and dry shoot weight, fresh and dry root weight, and survival percentage. Mallika (T₇) ranked second for most growth and biomass traits, while Banganpalli (T₄) also performed well for several biomass parameters. Therefore, Langra (T₁) is recommended as the most suitable variety for epicotyl grafting under the agro-climatic conditions of the Raipur plain.

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