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Effect of Application of Chitosan Soil Drenching on Growth and Vigour of Mango (*Mangifera indica* L.) Grafts Cv. Alphonso

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment on effect of application of chitosan on growth and vigour of mango grafts cv. Alphonso was conducted at Department of Fruit Science, College of Horticulture, Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2023-24. Seven treatments and 4 replications in Randomized Block Design viz., T_I Control – Soil + FYM (3:1), T_2 (Chitosan 0.5 %), T_3 (Chitosan 1.0 %), T_4 (Chitosan 1.5 %), T_5 (Chitosan 2.0 %), T_6 (Chitosan 2.5 %), T_7 (Chitosan 3.0 %) with the aim to investigate effect of chitosan drenching on growth, vigour and survival of mango grafts cv. Alphonso. The highest survival percentage (99.13 %), height of the grafts (38.10 cm), number of shoots per graft (2.06 nos.), number of leaves per graft (32.13 nos.) leaf area (694.31 cm ^{2}) were recorded in treatment T_5 i.e. Chitosan 2.0 %. The maximum stem girth (10.24 mm) found in treatment T_7 i.e Chitosan 3.0 %.

Keywords: Chitosan; mango; grafts; survival percentage; vigour; growth.

1. INTRODUCTION

Mango is the most important commercial fruit crop and popularly known as the "King of Tropical Fruits" and it is the “National Fruit of India” [1,2]. According to year 2024, in India 2.406 million ha area under cultivation of mango with 22.55 million MT production and 7.3 tonnes/ha productivity respectively [3]. In Maharashtra, the area under mango production is 4.85 lakh hectares with annual production is about 12.12 lakh metric tonnes and productivity is 2.5 tonnes/ha [4], while the area under mango in Konkan region is 1,00,000 ha. with production 50,000 MT and productivity is 3.12 tonnes/ha [5]. The mango fruit is a good source of beta-carotene a precursor of vitamin A and rich in vitamin C. Ripe mangoes are not only delicious but also nutritional value [6,7]. Mango farming requires loamy, alluvial, well-drained, aerated, and deep soils rich in organic matter with a pH range of 5.5 to 7.5. The ideal temperature for mango is 24 to 30 °C during the growing season, along with high humidity [8].

Since mango has been under cultivation in India since ancient times, numerous cultivars are known to exist in India. All have probably organized as superior-chance seedlings arising from natural crossing or gene mutation [8]. These superior plants were later maintained and perpetuated true to type through asexual propagation. Mango is commercially propagated by grafting. Dr. B.S.K.K.V. has standardized the stone grafting technique in mango. In the Konkan region, a large number of mango stone grafts are prepared annually. The quality of mango graft is of prime importance. Farmers need healthy and vigorous grafts. The Konkan belt is regarded as a key provider of highest-quality, disease-free planting material for all main mango cultivars like Alphonso, Kesar, Ratna, Sindhu, etc. There are currently around 250 fruit crop nurseries licensed in Konkan, generating 10 to 12 lakh sealable mango grafts every year [9].

Chitosan has gained popularity in recent years as an environmentally friendly approach to controlling diseases and importing vigor to the plant. It helps to improve the performance of nursery grafts. It functions as a plant growth promoter in various crops. As chitosan molecules are extremely hydrophilic, they reduce stress damage in plant cells by decreasing water content and accelerating several biological macromolecule activities. Among the most documented properties of chitosan is its effective antimicrobial activity against a wide range of microorganisms, including fungi, bacteria, viruses, and nematodes. Chitosan has multiple antibacterial modes of action. Repeated application of growth promotors is essential to enhance sprouting, survival and growth of rooted black pepper cuttings [10]. The Konkan region of Maharashtra experiences high humidity and heavy rainfall during the monsoon, which can create favorable conditions for fungal and bacterial infections of plants, especially nursery grafts. These environmental factors increase the risk of graft failure due to infections with the grafts. Climate change can disrupt traditional mango cultivation practices in the Konkan region by altering temperature patterns, rainfall distribution, and pest dynamics. Unpredictable weather conditions may affect graft survival rates and overall mango production [11].

2. MATERIALS AND METHODOLOGY

The field trial was conducted at nursery No. 10, College of Horticulture, Dapoli, Dr. Balasaheb

Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2023-24. It is located between 17^0 45" North longitude and 73^0 12" East longitude. The experiment was laid out in Randomized Block Design (RBD) with seven treatments replicated fourth times. T_I Control – Soil + FYM (3:1), T_2 Chitosan 0.5 %, T_3 Chitosan 1.0 %, T_4 Chitosan. 1.5 %, T_5 Chitosan 2.0 %, T_6 2.5 %, T_7 3.0 %, The (30 /treatment/replication). Drenching of chitosan were applied at monthly interval while first drenching was given at first week August and subsequent drenching done at monthly interval up to 3 months. For control (T_1) grafts without treatment. Graft height was measured by scale in centimeters. The final calculations were made using an average of five grafts. Total number of leaves per grafts were counted from the five selected observational grafts. The leaf area was measured by the area of triangle. After computing mean, it was recorded as total leaf area in square centimetre. The observations on number of shoots per grafts counted from selected five observational grafts and average number of shoots were recorded. The stem girth was measured by using digital vernier calliper mean of randomly selected five observational grafts were drawn. It was recorded as average girth of grafts in mm. At the end of the experiment (270 days after application), the number of alive grafts were used to calculate the survival percentage of the grafts. The number of grafts survived per treatment per replication were counted at 270 days after application and recorded in percentage. The data were statistically analyzed by the method suggested by Panse and Sukhatme 1995.

3. RESULTS AND DISCUSSION

The result showed significant increase in graft height, number of leaves per graft and leaf area of mango grafts at 270 days after application (Table 1). The maximum graft height found in chitosan 2.0 % (T_5- 38.10 cm) and it was closely followed by chitosan 2.5 % (T_6- 35.59 cm). The lowest height of grafts (30.34 cm) recorded in treatment chitosan 1.0 % (T_3). This might be due to the chitosan promotes growth of the plant which enhance the plant height. Besides, the chitosan carries 5 acetyl groups which activates plant immune system results in generation of reactive oxygen system that enhance the key enzyme activities of nitrogen metabolism which increases hormones like auxins and gibberellins. Physiological activities produce new shoots and leaves which triggered the process of photosynthesis resulted in accumulation of energy. Hence, the hormonal activities boost growth of grafts by cell elongation and cell enlargement.

Similar findings were observed by El-Mniawy et al. [12] in strawberry (Fragaria x ananassa) and Irawati et al. [13] in kemiri sunan [*Reutealis trisperma* (Blanco) Airy Shaw].

Table 1. Effect of chitosan drenching on graft height, number of leaves per graft and leaf area of mango grafts at 270 days after application

Treatments	Graft height (cm)	Number of leaves per graft	Leaf area (cm2)
T_I- Control (soil + FYM)	31.74	28.33	460.64
T_2- Chitosan 0.5 %	31.29	28.96	460.85
T_3- Chitosan 1.0 %	30.34	27.28	450.25
T_4- Chitosan 1.5 %	33.83	28.05	525.99
T_5- Chitosan 2.0 %	38.10	32.13	694.31
T_6- Chitosan 2.5 %	35.59	31.61	633.32
T_7- Chitosan 3.0 %	34.62	30.74	614.49
Mean	33.64	32.51	548.63
Range	30.38-38.10	27.28-32.13	450.25-694.31
S. Em. ±	0.91	0.17	1.23
CD at 5 %	2.69	0.51	3.65
Result	SIG	SIG	SIG

Table 2. Effect of drenching mango grafts with different concentrations of chitosan on survival percentage, number of shoots and stem girth

Treatments	Number of shoots	Stem girth	Survival (%)
T_I- Control (soil + FYM)	1.68	9.29	79.50 (63.07) *
T_2- Chitosan 0.5 %	1.72	9.26	94.25 (76.12)
T_3- Chitosan 1.0 %	1.70	8.33	93.17 (74.84)
T_4- Chitosan 1.5 %	1.79	9.02	95.08 (77.18)
T_5- Chitosan 2.0 %	2.06	9.69	99.13 (84.63)
T_6- Chitosan 2.5 %	1.99	10.18	97.92 (81.70)
T_7- Chitosan 3.0 %	1.97	10.24	96.17 (78.70)
Mean	1.84	9.43	99.52
Range	1.68-2.06	8.33-10.24	79.50-99.13
S. Em. ± CD	0.05	0.19	0.74
at 5 %	0.16	0.56	2.19
Result	SIG	SIG	SIG

The highest number of leaves were recorded in chitosan treatment 2.0 % (T_5- 32.13) which was significantly superior over rest of the treatments which was followed by chitosan treatment 2.5 % (T_6- 31.61). The lower number of leaves were recorded in treatment chitosan 1.0 % (T_3- 27.28) This might be due to the proper equilibrium of nutrients and moisture resulted in faster growth and physiological activities which produces new shoots. New growth started by the forces for cell division and cell elongation which was favoured by auxins and IAA pathways that increases photosynthesis and accumulation of carbohydrates. Hence, these effects indicate the increase in number of leaves.

The present results are accordance with findings of Hussein and Radwan [14] in mango (*Mangifera indica* L.) and EI-Miniawy et al. [12] in strawberry (*Fragaria x ananassa*).

Among all treatments, drenching chitosan 2.0 % recorded maximum total leaf area (T_5- 694.31 cm^2) which was statistically meritorious over all the treatments. It was followed by chitosan treatment 2.5 % (T_6- 633.32 cm^2). The minimum total leaf area was recorded in chitosan treatment 1.0 % (T_3- 450.25 cm^2). This results owing to the growth is attributed by various hormonal activities and changes with the nitrogen metabolism in grafts which enhances nitrogen content in leaf that increases photosynthetically active leaves. However, photosynthetically active leaves produced more quantity of enzymes which accelerate cell division and expansion of leaf.

The similar findings were reported by Hussein and Radwan [14] in mango (*Mangifera indica* L.) and Nithin et al. [15] in strawberry (*Fragaria x ananassa*).

The highest number of shoots per grafts was found in chitosan % (T_5- 2.06) and it was followed by chitosan 2.5 % (T_6- 1.99) and chitosan 3.0 % (T_7- 1.97). The lowest number of shoots per graft (1.68) recorded in control-soil + FYM (3:1) treatment (T_1) This might be due to the enhancement impact of chitosan on number of shoots may be due to carbon sources in the polymer stimulating the growth of beneficial microbes in the soil. The microbial growth accelerated the transferring processes of organic matter into inorganic forms and facilitating the root system of plants to absorb more nutrients from the soil and stimulating plant growth. Moreover, chitosan may also be attributed to the promoting effects on nutrient uptake and nutritional status; nitrogen, potassium and phosphorous especially result in higher graft growth which enhance the shoot growth in graft.

The present findings were similar to the research findings recorded by Mondal et al. [16] in okra (*Abelmoschus esculentus* L.), Farouk and Amany [17] in cowpea (*Vigna unguiculata*) and Irawati et al. [13] in kemiri sunan [*Reutealis trisperma* (Blanco) Airy Shaw].

The maximum stem girth was recorded in chitosan treatment 3.0 % (T_7- 10.24 mm) which was at par with chitosan treatments (T_6- 10.18 mm and T_5- 9.69 mm). the lowest stem girth was found in treatment chitosan 1.0 % (T_3- 8.33 mm). this might be due to the chitosan mineralized organic nutrients into inorganic form which was efficiently taken through root by absorption. It helped in cell division and cell elongation that time this phloem tissues enlarges their size for translocate the flow of nutrients, sugars and carbohydrates from root to shoot and vice versa.

Similar results were reported by Edirimanna et al. [18] in jackfruit (*Artocarpus heterophyllus* L.) and Irawati et al. [13] in kemiri sunun [*Reutealis trisperma* (Blanco) Airy Shaw] [19].

Drenching various concentrations of chitosan showed significant effect on survival percentage of mango grafts cv. Aphonso. Result from the present investigation revealed that the highest survival was observed in treatment chitosan 2.0 % (T_5- 99.13 %) which was statistically superior over all the treatments. It was followed by treatment chitosan 2.5 % (T_6- 97.92 %). The lowest survival percentage (79.50 %) was recorded in T_1, which was significantly lower than all the other treatments. This might be due to, the chitosan has antibacterial, antifungal property and wound healing capacity which made strong graft union by graft healing ultimately the highest survival percentage. The overall performance in relation to growth parameters of shoot were significantly better in treatment T5 i.e. drenching chitosan 2.0 % which ultimately increased survival percentage [20].

Similar results expressed by Edirimanna et al. [18] in jackfruit (*Artocarpus heterophyllus* L.).

4. CONCLUSION

Among different treatments, drenching chitosan 2.0 % (T_5) at monthly interval was recorded the maximum height of grafts, number of leaves per graft leaf area, number of shoots per graft and survival percentage and for stem girth chitosan 3.0 % (T_7) was recorded highest. Thus, on the basis of results revealed from above investigation, it can be concluded that treatment T_5 (chitosan 2.0 %) gave excellent results for better growth performance of grafts in mango over rest of treatments in this study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors here by declare that No generative AI technologies such as large language models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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