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Standardization of age of rootstock and scion for softwood grafting in manila tamarind (*Pithecellobium dulce* L.)

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Abstract

The current research on ‘Standardization of age of rootstock and scion on softwood grafting in manila tamarind’ was conducted at the School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Coimbatore. This study evaluated the success of softwood grafting in manila tamarind using rootstocks and scions of different age ie., rootstocks of three different age viz. six (A₁), nine (A₂) and 12 (A₃) month old and scions of two different age, ie., 30 (S₁) and 60 (S₂) days old scions. The results indicated that the interaction effect of the age of rootstock and scion had a significant influence on the days taken for sprouting, length of sprout, number of leaves on grafted plants, diameter of rootstock and scion after grafting, number of sprouted grafts, graft success rate, graft survivability, chlorophyll index of the leaves and leaf proline content. The experimental results revealed nine-month-old rootstocks grafted with 60 days old scions (A₂S₂) as the best treatment recording the highest graft survivability (87.97%), graft union success (82.29%), number of sprouted grafts (52.78), number of leaves on grafted plant (104.80), length of sprout (29.44 cm), diameter of rootstock (5.18 mm) and scion (5.49 mm), leaf proline content (11.23 µg g⁻¹ FW) and least days taken for first sprouting (6.38 days). Hence, the treatment A₂S₂ can be suggested for successful commercial vegetative propagation of manila tamarind using softwood grafting.

Keywords: Manila tamarind, *Pithecellobium dulce*, softwood graft, graft survivability, graft success

Introduction

Manila tamarind (*Pithecellobium dulce* L.) belonging to the family Fabaceae and a native of South and Central America, is an underutilized fruit crop with greater potential for future use because of its high medicinal value, high productivity and suitability for wasteland cultivation (Keerthika *et al.*, 2020) [6]. It is also rich in vitamins, minerals, and bioactive compounds, contributing to their medicinal properties (Sivakumar *et al.* 2011) [13]. Kulkarni and Jamakhani (2018) [7] reported that manila tamarind fruits have anti-oxidant, anti-inflammatory, anti-diabetic, and anti-cancerous properties and other studies have shown that the fruit pulp of manila tamarind can be taken orally to stop blood flow in case of haemoptysis.

Despite its great potential as a dry land horticultural fruit crop, manila tamarind has historically been grown from seeds, which has led to a lengthy gestation period and a dearth of better cultivars (Orwa *et al.*, 2009) [8]. Given its nutritional and therapeutic benefits, currently there is a higher demand for its propagules. Vegetative propagation techniques like softwood grafting can be used to produce true-to-type propagules with a shorter juvenile stage and high-quality fruits, which is the need of the hour. Keerthika *et al.* (2020) [6] reported that softwood grafting in manila tamarind showed highest success rate of 97.33% compared to other propagation methods. Subbiah *et al.* (2024) [14] reported the highest survivability percentage in softwood grafts of manila tamarind when nine-month-old rootstocks were used. Hence the present study is formulated to standardize the age of rootstock and scion on success of softwood grafting in manila tamarind.

Materials and Methods

The current study on standardization of age of rootstock and scion on softwood grafting in manila tamarind was carried out during 2025-2026 at the Division of Horticulture, School of Agriculture Sciences, Karunya Institute of Technology and Sciences, Coimbatore. The experiment was laid out in a two-factorial randomized block design (RBD) with 60 replications per treatment combination. Softwood grafting was performed using six (A_1), nine (A_2) and 12-month-old (A_3) rootstocks. For the grafting purpose, scions of two physiological ages, 30 and 60 days old, were used. The treatment combinations in the study are mentioned below in Table 1.

Table 1: Treatment details

Treatment	Details
A_1S_1	Six-month-old rootstock grafted on 30 days old scion
A_1S_2	Six-month-old rootstock grafted on 60 days old scion
A_2S_1	Nine-month-old rootstock grafted on 30 days old scion
A_2S_2	Nine-month-old rootstock grafted on 60 days old scion
A_3S_1	12-month-old rootstock grafted on 30 days old scion
A_3S_2	12-month-old rootstock grafted on 60 days old scion

Manila tamarind rootstocks of variety PKM-1 were raised in polybags of thickness 5 x 7 inches. Scions of local variety were used to graft the rootstocks of different ages. The prepared grafts were covered from the top by polythene cap and this cap was retained on the graft till sprouting was observed on the graft. Various vegetative and biochemical parameters were assessed as observations. Days taken for first sprouting was assessed after grafting. Vegetative and biochemical characters such as number of sprouted plants, length of the sprout (cm), number of leaves, diameter of rootstock and scion (mm), graft survivability (%), chlorophyll index (SPAD), leaf proline content ($\mu\text{g g}^{-1}\text{FW}$) were assessed 90 days after grafting. Graft union success (%) was assessed 120 days after softwood grafting in manila tamarind. Chlorophyll index in the leaves was measured using chlorophyll SPAD meter SPAD-502 plus. Leaf proline content ($\mu\text{mol g}^{-1}$) was estimated through ninhydrin-based colorimetric assay (Bates *et al.*, 1973) [2].

Results and Discussion

Effect of age of rootstock and scion on number of days taken for sprouting

The results revealed that age of rootstock and scion had a significant effect on days taken for first sprouting in softwood grafts of manila tamarind (Table 2). The minimum time required for bud sprouting (6.38 days) was observed when softwood grafting was carried out in manila tamarind using nine-month-old rootstocks with 60 days old scions (A_2S_2), which was followed by the treatment, nine-month-old rootstocks with 30 days old scions (A_2S_1) that sprouted in 8.46 days. The maximum time required for bud sprouting (14.99 days) was observed in softwood grafts of manila tamarind when grafting was carried out using 12-month-old rootstocks with 60 days old scions (A_3S_2) which was on par with 12-month-old rootstocks grafted with 30 days old scions (A_3S_1) in 13.92 days. Similar results were reported by Prasanth *et al.* (2007) [9] in mango grafts, where earlier sprouting within 24.50 days was observed in nine-month-old rootstocks due to enhanced cambial activity and physiological efficiency.

Effect of age of rootstock and scion on number of sprouted grafts

It was observed that age of rootstock and scion had a significant

effect on the number of grafts sprouted in manila tamarind (Table 2). The highest number of sprouted grafts (52.78) were observed in softwood grafts of manila tamarind when grafting was carried out using nine-month-old rootstocks with 60 days old scions (A_2S_2) which was followed by the treatment in which grafting was done using nine-month-old rootstocks grafted with 30 days old scions (A_2S_1) with 47.38 sprouted grafts. The lowest number of sprouting (36.97) was observed in softwood grafts of manila tamarind when six-month-old rootstocks were grafted with 30 days old scions (A_1S_1). A study from Reddy *et al.* (2019) [10] observed that graft sprouting was significantly higher in combinations involving physiologically mature rootstocks and scions, due to enhanced cambial activity and efficient translocation of metabolites.

Effect of age of rootstock and scion on length of the sprout

The results indicated that age of rootstock and scion had a significant effect on the sprout length in softwood grafting of manila tamarind (Table 2). The highest sprout length (29.44 cm) was recorded in softwood grafts of manila tamarind when nine-month-old rootstocks were grafted with 60 days old scions (A_2S_2) which was followed by 12-month-old rootstock grafted with 60 days old scion (A_3S_2) with sprout length of 25.32 cm. The lowest sprout length (12.54 cm) was recorded in softwood grafts of manila tamarind when six-month-old rootstock was grafted with 30 days old scion (A_1S_1) which was followed by six-month-old rootstock grafted with 60 days old scion (A_1S_2) with sprout length of 16.24 cm. Study from Hartmann and Kester (2011) [5] reported that shoot growth after grafting, including sprout length, is strongly influenced by the physiological maturity and vigour of both rootstock and scion, as these factors determine cambial activity and successful vascular connection.

Effect of age of rootstock and scion on number of leaves present on the grafted plant

It was observed that age of rootstock and scion had a significant effect on the number of leaves present on the grafted plant taken 90 days after grafting in softwood grafts of manila tamarind (Table 2). The maximum number of leaves (104.80) were present in manila tamarind grafts when 12-month-old rootstocks were grafted with 30 days old scions (A_3S_2) which was followed by nine-month-old rootstocks grafted with 30 days old scions (A_2S_2) with a mean value of 84.60. The minimum number of leaves (43.60) were observed in softwood grafts of manila tamarind when six-month-old rootstocks were grafted with 30 days old scions (A_1S_1) which was followed by six-month-old rootstocks grafted with 60 days old scions (A_1S_2) with mean value of 54.30. These findings are in agreement with Singh *et al.* (2014) [12], which observed enhanced vegetative growth and maximum leaf production in softwood graft of mango, when 12 months old rootstocks were grafted with three months old scions, attributing to improved physiological efficiency and higher assimilate translocation.

Effect of age of rootstock and scion on diameter of rootstock and scion

It was found from the current study that the age of rootstock and scion had a significant influence on the diameter of rootstock and scion in softwood grafts of manila tamarind (Table 2). The highest rootstock diameter (5.18 mm) was observed in manila tamarind grafts when nine-month-old rootstock were grafted with 60 days old scion (A_2S_2) which was followed by 12-month-old rootstock grafted with 60 days old scion (A_3S_2) recording

diameter of 4.87 mm. The lowest rootstock diameter (3.33 mm) was observed in softwood grafts of manila tamarind when grafting was taken place using six-month-old rootstocks with 30 days old scions (A₁S₁) followed by six-month-old rootstock grafted with 60 days old scion (A₁S₂) with the diameter of 3.74 mm.

The highest scion diameter (5.49 mm) was observed when grafting was carried out using nine-month-old rootstock with 60 days old scion (A₂S₂) which was followed by 12-month-old rootstock grafted with 60 days old scion (A₃S₂) with the diameter of 5.02 mm. The lowest scion diameter (3.72 mm) was recorded in softwood grafts of manila tamarind when six-month-old rootstock was grafted with 60 days old scion (A₁S₂) which was followed by six-month-old rootstock grafted with 30 days old scion (A₁S₁) with the diameter of 3.89 mm. These observations are backed by the study done by Hartmann and Kester (2011) [5], who reported that the increase in stem diameter of rootstock and scion following grafting is primarily attributed to active cambial growth and effective vascular connection, both of which are influenced by the physiological maturity of the stock and scion.

Effect of age of rootstock and scion on chlorophyll index of leaves

From the results of the present study, it was observed that age of rootstock and scion had a significant effect on the chlorophyll index of manila tamarind grafts (Table 2). The highest chlorophyll index (66.31 SPAD) was recorded in softwood grafts of manila tamarind when 12-month-old rootstocks were grafted with 60 days old scions (A₃S₂) which was followed by nine-month-old rootstock grafted with 60 days old scion (A₂S₂) with chlorophyll index of 54.91 SPAD. The lowest chlorophyll index (33.11 SPAD) was recorded in softwood grafts of manila tamarind when six-month-old rootstocks were grafted with 30 days old scions (A₁S₁) followed by nine-month-old rootstocks grafted with 30 days old scions (A₂S₁) with chlorophyll index of 36.11 SPAD. Aloni *et al.* (2010) [11] reported that successful graft union formation enhances the transport of water, nutrients, and photosynthates, resulting in increased chlorophyll content and improved leaf physiological parameters.

Effect of age of rootstock and scion on leaf proline content

From the results of the current study, it was observed that age of rootstock and scion had a significant effect on the leaf proline content in manila tamarind softwood grafts (Table 2). The lowest proline content (11.23 µg g⁻¹ FW) was recorded in softwood grafts of manila tamarind when grafting was carried out using nine-month-old rootstock with 60 days old scion (A₂S₂) which was followed by six-month-old rootstock grafted with 60 days old scion (A₁S₂) with the leaf proline content of 15.87 µg g⁻¹ FW. The highest leaf proline content (27.84 µg g⁻¹ FW) was recorded in 12-month-old rootstocks grafted with 60 days old scions (A₃S₂) which was followed by 12-month-old

rootstock grafted with 30 days old scion (A₃S₁) with leaf proline content of 24.27 µg g⁻¹ FW. A study from Ghosh *et al.* (2017) [4] reported higher proline content in fruit crops under stressed graft conditions, whereas successful graft unions showed reduced proline levels due to recovery from stress.

Effect of age of rootstock and scion on graft survivability

It was observed that age of rootstock and scion had a significant effect of on the graft survivability in softwood grafting of manila tamarind (Figure 1). The highest graft survivability (87.97%) was observed in softwood grafts of manila tamarind when nine-month-old rootstocks were grafted with 60 days old scions (A₂S₂) which was followed by nine-month-old rootstocks grafted with 30 days old scions (A₂S₁) with graft survivability of 78.98%. The lowest graft survivability (61.75%) was recorded in softwood grafts of manila tamarind when six-month-old rootstocks were grafted with 30 days old scions (A₁S₁) which was followed by 12 months old rootstocks grafted with 60 days old scions (A₃S₂) with graft survivability of 67.67%. These findings are similar to the study conducted by Prasanth *et al.* (2007) [9] in mango, who reported highest graft survivability (82.50%) when nine months old rootstocks were grafted with four months old scions, attributing this to better cambial activity and compatibility. These findings are also in accordance with the study conducted by Das *et al.* (2019) [3], who reported highest graft survivability (85%) in softwood grafts of mango when eight-month-old rootstocks were used for grafting attributing to enhanced cambial activity and better graft union formation.

Effect of age of rootstock and scion on graft union success

The results indicated that the age of rootstock and scion had a significant effect on graft union success in softwood graft of manila tamarind (Figure 1). The highest graft union success (82.29%) was recorded in softwood grafts of manila tamarind when nine-month-old rootstocks were grafted with 60 days old scion (A₂S₂) which was followed by 12-month-old rootstocks grafted with 30 days old scions (A₃S₁) with graft union success of 71.12%. The lowest graft union success (51.20%) was recorded in softwood grafts of manila tamarind when six-month-old rootstocks were grafted with 30 day-old-rootstocks (A₁S₁) which was followed by six-month-old rootstocks grafted with 60 days old scions (A₁S₂) with graft union success of 61.27%. The results are supported by the study conducted by Roshan *et al.* (2013) [11] in aonla, which observed improved graft union success (79%) when grafting was carried out using 7-9 months old rootstock, owing to enhanced vascular connection and nutrient translocation. The results are also supported by the study conducted by Tanuja (2015) [15] in sapota, which observed highest graft union success of 84% when grafting was carried out using two-month-old scions.

Table 2: Effect of age of rootstock and scion on vegetative, physiological and biochemical parameters

Treatments	Vegetative Parameters						Physiological Parameters	Biochemical Parameters
	Diameter on rootstock (mm)	Diameter of scion (mm)	Days taken for sprouting	Number of sprouted plants	Length of sprout (cm)	Number of leaves	Leaf chlorophyll index (SPAD value)	Leaf proline content (µg g ⁻¹ FW)
Age of rootstock								
A ₁	3.54	3.97	11.50	40.95	14.72	73.23	36.01	17.22
A ₂	4.62	4.93	7.42	50.08	24.66	77.95	45.50	15.94
A ₃	4.46	4.96	14.45	42.07	23.85	89.00	57.05	26.05
SE(d)	0.08	0.04	0.37	0.50	0.40	0.51	0.41	0.71
CD (5%)	0.18	0.10	0.82	1.11	0.89	1.14	0.90	1.58

Age of scion								
S ₁	4.01	4.36	11.01	42.56	18.26	73.23	39.04	21.16
S ₂	4.59	4.88	11.23	46.16	23.89	70.70	53.36	18.31
SE(d)	0.06	0.03	0.30	0.40	0.32	0.417	0.33	0.41
CD (5%)	0.15	0.08	0.21	0.90	0.72	0.929	0.73	1.29
Interaction (A x S)								
A ₁ S ₁	3.33	3.82	10.67	36.97	12.54	43.60	33.11	18.57
A ₁ S ₂	3.74	4.13	12.34	45.11	16.91	54.30	38.94	15.87
A ₂ S ₁	4.06	4.37	8.46	47.38	19.88	71.30	36.11	20.65
A ₂ S ₂	5.18	5.49	6.38	52.78	29.44	84.60	54.91	11.23
A ₃ S ₁	4.65	4.91	13.92	43.53	22.38	104.80	47.83	24.27
A ₃ S ₂	4.87	5.02	14.99	40.61	25.32	73.20	66.31	27.84
SE (d)	0.11	0.07	0.37	0.70	0.56	0.72	0.57	0.71
CD (5%)	0.26	0.15	1.16	1.57	1.25	1.61	1.27	2.23

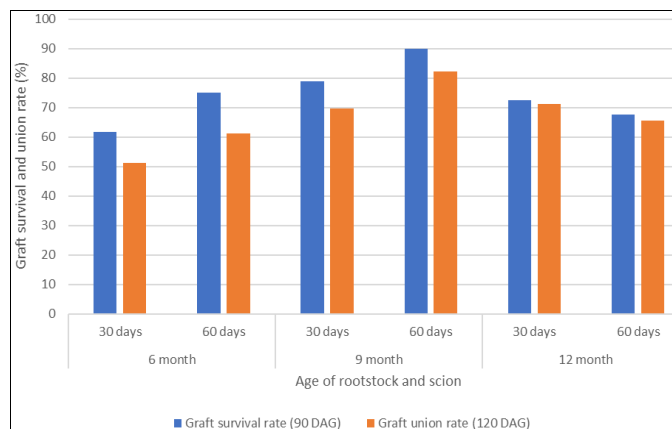


Fig 1: Effect of age of rootstock and scion on graft survival and union rate (%)

Conclusion

The current study found that the age of rootstock (6, 9 & 12 months old) and scion (30 & 60 days old) had a significant effect on softwood grafting in manila tamarind. Among all the treatment combinations, nine-months old rootstocks grafted with 60 days old scions (A₂S₂) recorded the lowest days taken for sprouting (6.38 days), highest sprouted grafts (53.66), highest graft survivability (87.97%), and highest graft union success (82.29%). Therefore, the treatment A₂S₂ can be considered the best among all other treatment combinations and can be suggested for successful commercial vegetative propagation of manila tamarind using softwood grafting.

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