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Does a tree's ability to reproduce vegetatively vary with genotype?

Ashwath, M. N.[1]*, Santhoshkumar, A. V.[1], Hrideek, T.K.[2], Kunhamu, T. K.[1] and Shiran, K. [1]

[1]*Department of Forest Biology and Tree Improvement, College of Forestry, KAU, Thrissur, Kerala- 680656*
[2]*Department of Forest Genetics and Tree Breeding, KFRI, Peechi, Kerala, India*

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Abstract:
Teak (*Tectona grandis* L.f.) is the well-known tropical timber species to meet the demand of wood-based industries. Choosing superior parents and developing technologies for its vegetative propagation is essential for promising better growth and yield. Production of epicormic shoots on live detached branches under high humidity and temperature, is an excellent propagation option widely practiced in trees. The present study was designed to investigate the effect of genotype on the development of epicormic shoots from branch cuttings and its rooting behavior. Epicormic shoot and root production was observed to vary significantly among the genotypes studied. Initiation of bud burst started from the 5th day and continued till the 9th day of planting. The number of epicormic shoots produced too significantly varied among the genotypes. The maximum number of epicormic shoots was observed in genotypes Aravallikkavu,Topslip-6, Nellikutha-2, and Nellikutha-7, whereas Nedumkayam-1 produced one or no shoots. The average shoot diameter from different genotypes varied from 2.85 cm to 5.43 cm. Significant variation among the genotypes in rooting was observed. The highest rooting percentage of epicormic shoots was recorded in the Nellikutha-3 genotype (57.11 %) followed by Tholpatti 01 (47.89 %) and Mananthavadi 02 (39.11 %). The present study confirms the genotypic influence on vegetative propagation by varied shoot and root production potential.

Keywords: *Tectona grandis,* clonal propagation, Epicormic shoots, Rooting, Growth hormones, Genetic influence

Vegetative or clonal propagation of tree species proves highly advantageous in generating planting material with greater vigor and growth potential compared to plants originating from seeds. The selection of superior parent trees and the advancement of technologies for their vegetative propagation are crucial for introducing true-to-type materials into industrial and research domains. Teak (*Tectona grandis* L.f.), a prominent tropical timber species, has been widely introduced worldwide to meet the demands of wood-based industries. Traditionally, propagating teak through seeds to maximize yield poses challenges due to low germination rates, difficulties in flower induction, asynchrony in flowering among clones, and issues with pollination and fruit set (Florence and Mohanadas, 2011). Despite numerous attempts, there is limited knowledge on the macro-propagation of teak through epicormic shoot development (Husen, 2013; Guleria and Vashisht, 2014; Packialakshmi and Sudhagar, 2019).

In the case of woody perennials, juvenile propagules are typically produced through coppicing or girdling mature individuals, but these processes destroy the mother tree. An alternative approach involves inducing epicormic bud burst on branch cuttings, allowing the production of young shoots without harm to the mother tree (Thakur et al., 2021). The production of epicormic shoots on live detached

*Author for correspondences: Phone:, Email: ashumangalapare97@gmail.com

branches from trees, treated with plant growth regulators under high humidity and temperature, is a widely practiced and promising option in tree cultivation. However, the process of epicormic shoot production faces internal and external limitations, such as the quality of plant material and environmental conditions (Gordon et al., 2006). The shoot production on branch cuttings and subsequent rooting of shoot cuttings may be influenced by genotypes (Thakur et al., 2021; Pinon et al., 2021), posing significant challenge in standardizing protocols for the vegetative propagation of trees. Limited information is available about the genetic influence on epicormic shoot production and rooting potential among teak genotypes. Against this backdrop, the present study was designed to investigate the impact of genotype on the development of epicormic shoots from branch cuttings of teak and their rooting behavior.

The study was conducted at the Kerala Agricultural University, Kerala, India, from April 2022 to July 2022. The location experiences a warm, humid climate with an average annual rainfall of about 2100 to 2500 mm. The average temperature ranges from 24.4°C to 42.8°C with a relative humidity of 80% to 100%. A total of 22 plus tree accessions of 25-year-old age, assembled in the progeny trial at Livestock Research Station, Thiruvazhamkunnu, Palakkad District of Kerala, were selected for the study. Branch cuttings were obtained from the middle to lower portion of the crown from selected trees.

Branch cuttings (2-4 cm in diameter and 1.5 m in length) were collected, and cuttings were prepared by removing all the side branches and trimming them to 0.75 to 1.0 m in length. Branch cuttings were planted in soil media after treatment with carbendazim 2% (50 %WP) and maintained in a mist chamber. Each treatment (accession) was arranged using a CRD design and replicated thrice with four branch cuttings forming a replication. First shoot emergence, the total number of shoots produced, shoot length, shoot diameter, and the number of leaves produced were recorded. The epicormic shoots grown from the branch cuttings were excised at the three to four-pair leaf-stage and used for rooting study. The 2/3 parts of the leaves were carefully trimmed to prevent transpiration. The cut end of the excised shoots was treated with carbendazim 2% (50 %WP). The excised shoots were then treated in 6000 ppm IBA, prepared in talc (powder form), and planted in the root trainers filled with sterile vermiculite (Packialakshmi and Sudhagar, 2019; Ashwath et al., 2023). The root trainers were maintained in the mist chamber at 80% humidity and 30 to 35 °C temperature. After 40 days, rooted cuttings were removed and observed for rooting percentage.

Epicormic shoot and root production was observed to vary significantly among the genotypes studied (Table 1). The emergence of the first shoot was observed to be between the 5^{th} day and continued till the 9^{th} day. The accessions Nellikutha-1, Topslip-2, and Nedumkayam-2 started producing shoots earlier compared to other genotypes, whereas genotypes Tholpatti-2, Topslip-5, and Karulai began producing shoots on or after the 9^{th} day of planting. The number of epicormic shoots produced too significantly varied among the genotypes. The maximum number of epicormic shoots was observed in genotypes Aravallikkavu, Top slip-6, Nellikutha-2, and Nellikutha-7 (10.67, 8.33, 7.00, and 6.33, respectively). Nedumkayam-1 produced one or no shoots per branch cuttings, whereas Nedumkayam-2 had an average of 5 shoots. The average diameter of shoots produced from different genotypes varied from 2.85 cm to 5.43 cm. Genotype Nedumkayam-1 and Nellikutha-1 had the lowest shoot diameters of 2.85 and 3.66 cm, respectively, whereas genotypes Tholpatti-1, Karulai, and Nellikutha-4 recorded for highest shoot diameters of 5.36, 5.38 and 5.43 cm respectively. Shoot length varied from 10.65 cm (Cherupuzha) to 4.43 cm (Nellikutha-1). The shoot length significantly varied due to bud production and elongation variations, whereas the shoot diameter and number of leaves were on par in most

Table 1. Genotypic influence on epicormic shoot productionand rooting potential

Sl No.	Accession	FSE (days)	TSP	SD (mm)	SL (cm)	NOL	RP (%)
1	Cherupuzha	8.10 ± 2.19	2.50 ± 1.38 efgh	5.01 ± 0.98	10.65 ± 2.80 a	8.75 ± 1.50	32.91±8.96bc
2	Nedumkayam-1	5.75 ± 6.68	0.33 ± 0.52 h	2.85 ± 3.31	6.10 ± 8.14 bc	4.75 ± 4.62	32.91 ± 8.95bc
3	Nedumkayam-2	5.54 ±0.21	5.00 ± 2.28 cdef	5.27 ± 1.06	8.73 ± 2.13 ab	8.00 ± 1.41	36.23±4.26abc
4	Tholpatti-1	8.20 ± 0.59	4.33 ± 1.51 cdefg	5.36 ± 0.45	6.86 ± 2.78 abc	7.25 ± 1.71	47.90 ±4.08 ab
5	Tholpatti-2	9.35 ± 1.15	1.67 ± 1.21 gh	5.26 ± 0.49	6.78 ± 2.46 abc	8.75 ± 0.96	29.89 ±4.70bc
6	Tholpatti-3	7.70 ± 0.84	4.83 ± 2.32 cdefg	4.54 ± 0.83	8.77 ±1.99 ab	7.05 ± 0.74	36.23± 4.26abc
7	Top slip-2	5.35 ± 0.21	2.17 ± 0.75 efgh	4.51 ± 0.90	8.06 ± 1.91 abc	8.25 ± 0.50	28.84± 14.71bc
8	Top slip-5	8.95 ± 0.85	5.17 ± 2.56 bcde	4.94 ± 1.02	7.88 ± 2.57 abc	8.25 ± 0.50	25.83± 10.45bc
9	Top slip-6	5.90 ± 0.68	8.33 ± 2.94 ab	4.53 ± 0.56	6.59 ± 0.74 bc	9.20 ± 2.02	29.89±4.70bc
10	Top slip-10	8.32 ± 1.23	2.67 ± 1.63 efgh	5.23 ± 0.86	6.25 ± 1.56 bc	8.95 ± 0.85	25.83± 10.45bc
11	Nellikutha-1	5.13 ±3.43	1.83 ± 1.17 fgh	3.66 ± 2.45	4.43 ± 3.13 c	6.00 ± 4.04	28.84± 14.71bc
12	Nellikutha-2	8.28 ± 0.87	7.00 ± 2.09 bc	4.95 ± 0.73	6.77 ± 1.14 abc	6.50 ± 0.53	22.50± 5.75c
13	Nellikutha-3	7.85 ± 1.64	5.00 ± 2.28 cdef	5.29 ± 1.17	6.11 ±0.69 bc	8.60 ± 0.91	25.83± 10.45bc
14	Nellikutha-4	8.25 ± 0.64	3.17 ± 0.98 defgh	5.43 ± 0.73	8.40 ± 2.33 abc	7.85 ± 0.68	25.83± 10.45bc
15	Nellikutha-5	5.99 ± 0.96	2.50 ± 1.38 efgh	4.81 ± 0.43	7.92 ± 1.58 abc	8.25 ± 1.26	26.57± 0.00bc
16	Nellikutha-6	7.00 ± 0.99	4.50 ± 1.87 cdefg	4.44 ± 0.61	7.37 ± 2.28 abc	7.40 ± 0.23	57.11± 8.96a
17	Nellikutha-7	7.40 ± 0.23	6.33 ± 1.63 bcd	4.57 ± 0.60	6.38 ± 3.38 bc	8.35 ± 1.64	25.83± 10.45bc
18	Mananthavadi-1	7.21 ±0.72	3.17 ± 1.33 defgh	4.98 ± 0.89	6.05 ± 1.65 bc	6.80 ± 1.86	26.57 ± 0.00bc
19	Mananthavadi-2	5.63 ± 0.95	3.83 ± 2.14 cdefg	4.84 ± 0.87	6.85 ± 1.86 abc	7.25 ± 0.50	39.11± 8.34abc
20	Aravallikkavu	7.43 ± 1.25	10.67± 3.44 a	5.09 ± 0.78	7.67 ± 3.21 abc	7.50 ± 1.73	28.84 ± 14.71bc
21	Karulai	8.85 ± 1.01	4.00 ± 1.67 cdefg	5.38 ± 0.60	7.06 ± 2.74 abc	8.95 ± 1.40	29.89 ± 4.70bc
22	Thiruvazhamkunnu	6.95 ± 4.66	2.50 ± 2.11 efgh	4.04 ± 2.71	5.18 ±4.61 bc	7.20 ± 4.84	22.51± 5.75c
	MSE	4.95	8.06	1.64	8.05	4.63	20.40
	p-value (0.05)	NS	0.002	NS	0.049	NS	0.012

FSE: First Shoot Emerged; *TSP:* Total Shoots Produced; *SD:* Shoot Diameter; *SL:* Shoot length; *NOL:* Number of Leaves; *RP:* Rooting percentage

treatments. A similar reduction in shoot production after treating the cutting with sucrose and auxin was observed in *I. paraguariensis* (Wendling et al. 2013). There was no significant variation among the genotypes for number of the leaves produced among the genotypes. Nedumkayam-1 produced the lowest number of leaves (4.75) while maximum leaves were observed in Topslip-6 (9.20). The potential of epicormic shoot production on the trees could be influenced by species genetics, light availability, hormonal dynamics, physiological and other stress factors (Burrows et al., 2008). This ability of trees to produce shoots is one fact that affects the facet of clonal propagation. These considerable genetic variations may be attributed to the physiological state and adaptation to the growing environment of the parent tree too.

The ability of auxins to encourage adventitious roots from vegetative propagules is well known. Both exogenous and endogenous auxins influence the rooting capacity and quantity of roots generated in cuttings. Significant variation among the genotypes in rooting was observed. The highest rooting percentage was recorded in Nellikutha-6 genotype (57.11 %) followed by Tholpatti 01 (47.90 %) and Mananthavadi 02 (39.11 %). The lowest rooting percentage (22.50 %) was observed in Nellikutha-2 and Thiruvazhamkunnu genotypes (22.51%). IBA at its highest concentration (6000 ppm) was better than the lower concentrations. Rooting parameters such as root length, diameter, and rooting percentage increased with increasing IBA concentration compared to other auxins. The effect of exogenous application of IBA has been reported to increase the rooting in teak (Badilla et al., 2016; Packialakshmi and Sudhagar 2020; Ashwath et al., 2023) and other tree species (Pinon et al., 2021; Olaniyi et al., 2021; Mohapatra et al., 2021). Studies have shown that plant genotype influences the induction of adventitious roots; hence the tendency for vegetative propagation may be used as a selection criterion in plus tree selection. It's conceivable that the physiological conditions and endogenous hormone levels contribute to part of the heterogeneity in the rooting response. The decline in rooting capacity may also be attributed to the tissue's poor auxin sensitivity or the build-up of secondary metabolites, which results in oxidation, causing the inactivation of phytohormones and enzymes, inhibiting the ability of tissues to regenerate.

The present study confirms the genotypic influence on vegetative propagation by altering cuttings' shoot and root production potential. Sprouting and rooting capacity have to be considered key factors when choosing plus trees for large-scale multiplication in teak. Research on the indigenous levels of plant hormones, the physiology of bud dormancy release, and anatomical and ontogenetic studies are essential to understanding the genotypic influence on vegetative propagation.

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