



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(7): 1644-1649
Received: 14-05-2026
Accepted: 18-06-2026

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Standardization of vegetative propagation techniques in *Ougeinia oojeinensis* Roxb. using growth regulators and rooting substrates

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i7u.6175>

Abstract

Ougeinia oojeinensis Roxb. is an ecologically and economically important multipurpose tree species; however, its natural regeneration and large-scale multiplication are limited due to inadequate propagation techniques. The present study was conducted during 2025–2026 at the Forest Nursery, College of Forestry, Sirsi, Karnataka, to standardize vegetative propagation techniques using different cutting types, rooting media and growth regulator treatments. The experiment was laid out in a three-factor Factorial Completely Randomized Design with two types of cuttings (branch and root sucker cuttings), three rooting media (perlite, vermiculite and cocopeat) and seven growth regulator treatments (control, IBA 1500, 3000 and 4500 ppm, and Coumarin 1000, 2000 and 3000 ppm). The parameters recorded included days for sprout initiation, sprouting percentage, days for root initiation and rooting percentage. Cutting type, rooting media and growth regulator treatments significantly influenced propagation success. Root sucker cuttings performed better than branch cuttings by recording earlier sprouting (16.70 days), higher sprouting (44.00%), earlier root initiation (37.05 days) and higher rooting (25.60%). Cocopeat enhanced sprouting, while perlite improved root initiation and rooting percentage. Among growth regulators, Coumarin 3000 ppm showed the best response, with maximum sprouting (65.00%) in root sucker cuttings planted in cocopeat and maximum rooting (39.20%) in root sucker cuttings planted in perlite. The study provides an effective vegetative propagation protocol for *Ougeinia oojeinensis*, which can support large-scale multiplication, conservation and restoration programmes of this valuable indigenous tree species.

Keywords: *Ougeinia oojeinensis*, vegetative propagation, root sucker cuttings, coumarin, rooting media, conservation

Introduction

Forests are among the most important natural resources, providing ecological, economic and social benefits through biodiversity conservation, carbon sequestration, soil protection, nutrient cycling and livelihood support. Tropical forests harbour several valuable indigenous tree species that contribute significantly to ecosystem stability and rural economies. Among the important indigenous timber species of tropical deciduous forests, *Ougeinia oojeinensis* Roxb. (Fabaceae) is a valuable multipurpose tree species distributed throughout different regions of the Indian subcontinent. Commonly known as Sandan, Tinsa or Kari Honne, it is a medium-sized deciduous tree with considerable ecological and economic importance (Kumar and Sane, 2003; Kew Science, 2026) ^[14, 12]. The species produces durable timber used for furniture, agricultural implements and construction purposes, while its leaves serve as fodder and different plant parts are traditionally used for medicinal purposes (Ambasta, 1986; Samyal *et al.*, 2013) ^[1, 20]. Being a leguminous tree, it contributes to soil fertility improvement through nitrogen fixation and nutrient cycling, making it suitable for agroforestry, restoration and plantation programmes (Nair, 1993) ^[18].

Despite its ecological and economic importance, natural regeneration and large-scale multiplication of *Ougeinia oojeinensis* are constrained by irregular seed production, limited seed availability and inadequate information on propagation techniques. Therefore, development of efficient propagation methods is essential for ensuring the availability of quality planting material for conservation and sustainable utilization. Vegetative propagation provides an effective

approach for rapid multiplication of superior planting material while maintaining desirable genetic traits. Successful rooting of stem cuttings depends on several factors, including cutting type, physiological condition of propagules, application of growth regulators and rooting substrate. Plant growth regulators, particularly auxins such as indole-3-butyric acid (IBA), indole-3-acetic acid (IAA) and naphthalene acetic acid (NAA), play a significant role in stimulating adventitious root formation and improving rooting efficiency. Among these, IBA is widely used in forestry nurseries due to its effectiveness in promoting root initiation and development (Hartmann *et al.*, 2011) ^[9]. The rooting substrate is another critical factor influencing vegetative propagation success, as it provides moisture retention, aeration and physical support required for root development. Different substrates such as sand, soil, cocopeat, vermiculite and their combinations influence rooting percentage, root quality and survival of propagated plants. Although propagation protocols have been developed for several forest tree species, information regarding the influence of growth regulators and rooting substrates on *Ougeinia oojeinensis* remains limited. The absence of standardized propagation techniques restricts large-scale multiplication and utilization of this valuable indigenous tree species. Therefore, the present study was undertaken to standardize vegetative propagation techniques in *Ougeinia oojeinensis* Roxb. using different growth regulator treatments and rooting substrates to develop an efficient protocol for mass multiplication and conservation of this ecologically and economically important species.

Materials and Methods

1. Experimental Site and Plant Material

The experiment entitled “Standardization of vegetative propagation techniques in *Ougeinia oojeinensis* Roxb.” was conducted during 2025–2026 at the Forest Nursery, College of Forestry, Sirsi, Karnataka. Healthy and mature *Ougeinia*

oojeinensis trees were selected as the source of vegetative propagules. Two types of cuttings, namely branch cuttings and root sucker cuttings, were collected during the active growing season. The cuttings of 10–15 cm length and approximately 0.5 cm diameter, containing 3–4 healthy buds, were collected during early morning hours and transported to the nursery under moist conditions to prevent desiccation.

2. Preparation and Treatment of Cuttings

The collected cuttings were prepared by removing leaves and trimming the basal and upper ends. The basal portions were treated with 1 per cent Bavistin solution to prevent fungal infection. After drying under shade, the cuttings were treated with different concentrations of growth regulators using the quick-dip method. Two growth regulators, viz., Indole-3-butyric acid (IBA) and Coumarin, were evaluated with the following treatments:

- 1. Control (without growth regulator)
- 2. IBA @ 1500, 3000 and 4500 ppm
- 3. Coumarin @ 1000, 2000 and 3000 ppm

The required concentrations were prepared using ethyl alcohol and distilled water, and the basal 2–3 cm portion of cuttings was dipped in respective solutions before planting.

3. Rooting Media and Experimental Design

Three rooting substrates, namely perlite, vermiculite and cocopeat, were evaluated for their influence on rooting performance. The experiment was laid out in a three-factor Factorial Completely Randomized Design (FCRD) with three replications. The factors included type of cutting (branch cutting and root sucker cutting), rooting media (perlite, vermiculite and cocopeat) and growth regulator treatments (seven levels), resulting in 42 treatment combinations and 126 experimental units (Table 1).

Table 1: Details of experiment

Factor	Treatment details	Levels
Factor A	Type of cuttings	A ₁ – Branch cuttingsA ₂ – Root sucker cuttings
Factor B	Rooting media	B ₁ – PerliteB ₂ – VermiculiteB ₃ – Cocopeat
Factor C	Growth regulator treatments	C ₁ – ControlC ₂ – IBA 1500 ppmC ₃ – IBA 3000 ppmC ₄ – IBA 4500 ppmC ₅ – Coumarin 1000 ppmC ₆ – Coumarin 2000 ppmC ₇ – Coumarin 3000 ppm
Experimental design	Factorial Completely Randomized Design (FCRD)	—
Number of factors	3	—
Treatment combinations	2 × 3 × 7	42
Replications	3	—
Total experimental units	42 × 3	126

4. Observations Recorded

Observations were recorded periodically to evaluate the rooting and sprouting performance of the cuttings. The following parameters were recorded:

• Shoot emergence (%)

The percentage of cuttings that produced at least one healthy shoot was calculated using the following formula:

Shoot emergence (%) = $\frac{\Sigma \text{ Number of cuttings sprouted}}{\text{Total number of cuttings planted}} \times 100$

• Rooting percentage (%)

The percentage of cuttings that successfully developed roots was calculated as:

Rooting (%) = $\frac{\Sigma \text{ Number of rooted cuttings}}{\text{Total number of cuttings planted}} \times 100$

• Number of days for sprout initiation

The number of days taken from planting to the appearance of the first visible sprout on each cutting was recorded. The mean number of days was calculated for each treatment.

• Number of days for root initiation

The number of days required from planting until the first visible root emergence was recorded for each treatment.

• Statistical Analysis

The recorded observations were subjected to analysis of variance

(ANOVA) appropriate for Factorial Completely Randomized Design as described by Gomez and Gomez (1984) [7]. The significance of treatment effects was tested at the 5 per cent probability level ($P \leq 0.05$), and treatment means were compared using the Critical Difference (CD) test wherever significant differences occurred. Statistical analysis was performed using OPSTAT software.

Results and Discussion

1. Days for Initiation of Sprouting

The days required for sprouting initiation were significantly influenced by cutting type, rooting media and growth regulator treatments (Table 2). Root sucker cuttings showed earlier sprouting (16.70 days) compared with branch cuttings (20.30 days). Among rooting media, cocopeat recorded the minimum days for sprouting in both root sucker (15.70 days) and branch cuttings (19.00 days). Growth regulator application significantly reduced sprouting duration, with Coumarin 3000 ppm recording the earliest sprouting. The minimum duration (12.00 days) was observed in root sucker cuttings planted in cocopeat and treated with Coumarin 3000 ppm ($A_1B_3C_6$), whereas untreated branch cuttings in perlite required the maximum period (25.00 days). The $A \times B$ and $A \times C$ interactions were significant, while $B \times C$ and $A \times B \times C$ interactions were non-significant.

The earlier sprouting in root sucker cuttings may be attributed to their juvenile nature, higher physiological activity and greater reserve food materials. Similar findings were reported by Amri *et al.* (2010) [2] in *Dalbergia melanoxylon*. Kumar (1995) [15] and Hareesh (2001) [8] also observed reduced sprouting duration in *Ougeinia oojeinensis* following growth regulator application. Similar stimulatory effects of growth regulators have been reported in *Aesculus indica* (Majeed *et al.*, 2009) [17], *Dalbergia sissoo* (Singh *et al.*, 2012) [21] and *Toona ciliata* (Thakur *et al.*, 2018) [22]. The favourable response of cocopeat may be related to its balanced moisture retention and aeration, as reported by Nazir (2020) [19] and Garg and Kumar (2025) [4].

2. Sprouting Percentage (%)

Sprouting percentage differed significantly with cutting type, rooting media and growth regulator treatments (Table 2). Root sucker cuttings recorded higher sprouting (44.00%) compared with branch cuttings (24.97%). Cocopeat resulted in maximum sprouting in both root sucker (48.60%) and branch cuttings (34.10%). Among growth regulator treatments, Coumarin 3000 ppm recorded the highest sprouting percentage, with the maximum value of 65.00% observed in root sucker cuttings planted in cocopeat ($A_1B_3C_6$). The lowest sprouting (8.80%) was recorded in untreated branch cuttings planted in perlite ($A_2B_1C_7$). The $A \times B$, $A \times C$ and $B \times C$ interactions were significant, whereas $A \times B \times C$ was non-significant.

Higher sprouting in root sucker cuttings may be associated with their juvenile physiological status and greater regenerative ability. Similar observations were reported by Liu *et al.* (2022) [16] in *Robinia pseudoacacia*. The superior performance of cocopeat could be due to its favourable moisture availability and aeration, which promote bud emergence. Similar responses were observed in *Ulmus villosa* (Nazir, 2020) [19], *Casuarina* clones (Garg and Kumar, 2025) [4] and *Ficus carica* (Gharate *et al.*, 2021) [6]. The positive response of growth regulators agrees with earlier reports in *Ougeinia oojeinensis* (Kumar, 1995; Hareesh, 2001) [15, 8] and other woody species such as *Pongamia pinnata* (Kala *et al.*, 2018)

[11] and *Acacia catechu* (Thakur *et al.*, 2018) [22].

3. Days for Initiation of Rooting

Root initiation was significantly affected by cutting type, rooting media and growth regulator treatments (Table 3). Root sucker cuttings-initiated roots earlier (37.05 days) than branch cuttings (39.71 days). Perlite recorded the earliest root initiation in both root sucker (34.86 days) and branch cuttings (37.71 days). Coumarin 3000 ppm significantly accelerated rooting, with the earliest root initiation (27.00 days) recorded in root sucker cuttings grown in perlite ($A_1B_1C_6$), while untreated branch cuttings required 50.00 days. The $A \times C$ and $B \times C$ interactions were significant, whereas $A \times B$ and $A \times B \times C$ interactions were non-significant.

The better rooting response of root sucker cuttings may be due to their juvenile characteristics and higher regenerative potential. Similar findings were reported by Amri *et al.* (2010) [2]. The superior performance of perlite may be attributed to its high porosity and aeration, which favour root differentiation. Similar effects of well-aerated media were reported by Gehlot *et al.* (2014) [5] in *Azadirachta indica* and Topaçoğlu *et al.* (2016) [23] in *Ficus benjamina*. The beneficial effect of growth regulators on early rooting has also been reported in *Ougeinia oojeinensis* (Kumar, 1995) [15], *Pongamia pinnata* (Kala *et al.*, 2018) [11] and *Terminalia arjuna* (Babu *et al.*, 2018) [3].

4. Rooting Percentage (%)

Rooting percentage showed significant variation due to cutting type, rooting media and growth regulator treatments (Table 3). Root sucker cuttings recorded higher rooting (25.60%) than branch cuttings (21.60%). Perlite recorded the highest rooting percentage in both root sucker (28.80%) and branch cuttings (24.20%). The application of growth regulators significantly improved rooting compared with untreated cuttings. The highest rooting percentage (39.20%) was recorded in root sucker cuttings planted in perlite and treated with Coumarin 3000 ppm ($A_1B_1C_6$), whereas the lowest rooting (7.80%) was observed in untreated branch cuttings planted in cocopeat. The $A \times C$ and $B \times C$ interactions were significant, while $A \times B$ and $A \times B \times C$ interactions were non-significant.

The higher rooting ability of root sucker cuttings may be attributed to their juvenile status, active cambial tissues and favourable endogenous hormonal conditions. Similar findings were reported by Amri *et al.* (2010) [2] and Liu *et al.* (2022) [16]. The effectiveness of perlite as a rooting medium is supported by its favourable aeration and drainage properties, which enhance adventitious root formation (Gehlot *et al.*, 2014; Topaçoğlu *et al.*, 2016) [5, 23]. Although reports on Coumarin application in forest species are limited, the present study demonstrated its potential in improving rooting efficiency. Similar improvements through growth regulator application have been reported in *Ougeinia oojeinensis* (Kumar, 1995) [15], *Pongamia pinnata* (Kala *et al.*, 2018) [11], *Aesculus indica* (Majeed *et al.*, 2009) [17] and *Pinus caribaea* (Henrique *et al.*, 2006) [10].

Overall, root sucker cuttings showed superior propagation performance compared with branch cuttings. Cocopeat enhanced sprouting, while perlite promoted rooting. Among growth regulators, Coumarin 3000 ppm was the most effective treatment, indicating its potential for standardizing vegetative propagation techniques in *Ougeinia oojeinensis* Roxb.

Table 2: Effect of cutting type, potting media and rooting hormones on days to sprout initiation and sprouting percentage in *Ougeinia oojeinensis*

Factor A	Factor B	Factor C	Days for initiation of sprouting		Sprouting%	
A ₁ (Root suckers)	B ₁ perlite	C ₁	20.00		31.50	
		C ₂	18.00		39.00	
		C ₃	15.00		47.00	
		C ₄	17.00		42.00	
		C ₅	16.00		45.50	
		C ₆	14.00		52.00	
		C ₇	24.00		18.50	
	Mean (B ₁)		17.70		39.40	
	B ₂ vermiculite	C ₁	19.00		35.00	
		C ₂	17.00		44.00	
		C ₃	14.00		52.50	
		C ₄	16.00		47.50	
		C ₅	15.00		50.50	
		C ₆	13.00		58.00	
		C ₇	23.00		20.50	
	Mean (B ₂)		16.70		44.00	
	B ₃ cocopeat	C ₁	18.00		39.00	
		C ₂	16.00		48.00	
		C ₃	13.00		57.00	
		C ₄	15.00		52.50	
		C ₅	14.00		55.50	
		C ₆	12.00		65.00	
		C ₇	22.00		23.00	
	Mean (B ₃)		15.70		48.60	
Mean (A ₁)			16.70		44.00	
A ₂ (Branch cuttings)	B ₁ perlite	C ₁	23.00		15.00	
		C ₂	22.00		19.30	
		C ₃	20.00		23.00	
		C ₄	21.00		20.50	
		C ₅	20.00		22.30	
		C ₆	19.00		26.00	
		C ₇	25.00		8.80	
	Mean (B ₁)		21.40		19.27	
	B ₂ vermiculite	C ₁	22.00		17.30	
		C ₂	21.00		21.30	
		C ₃	19.00		25.30	
		C ₄	20.00		23.00	
		C ₅	19.00		24.80	
		C ₆	18.00		29.30	
		C ₇	24.70		9.80	
	Mean (B ₂)		20.50		21.54	
	B ₃ cocopeat	C ₁	21.00		26.00	
		C ₂	19.00		34.50	
		C ₃	17.00		41.00	
		C ₄	18.00		36.50	
		C ₅	17.00		40.00	
		C ₆	16.00		46.50	
		C ₇	24.70		14.00	
	Mean (B ₃)		19.00		34.10	
Mean (A ₂)			20.30		24.97	
	Source		CD @ 5%	SEm ±	CD @ 5%	SEm ±
	Factor A		0.34	0.12	1.67	0.59
	Factor B		0.42	0.15	2.05	0.73
	Factor C		0.64	0.23	3.13	1.11
	A × B		0.60	0.21	2.89	1.03
	A × C		0.91	0.32	4.42	1.57
	B × C		NS	0.40	5.41	1.93
	A × B × C		NS	0.56	NS	2.72

Table 3: Variation in days to root initiation and rooting percentage of *Ougeinia oojeinensis* under different cutting types, potting media and rooting hormone treatments

Factor A	Factor B	Factor C	Days for initiation of rooting		Rooting%	
A ₁ (Root suckers)	B ₁ perlite	C ₁	38.00		22.00	
		C ₂	35.00		28.10	
		C ₃	31.00		34.60	
		C ₄	33.00		31.10	
		C ₅	32.00		32.60	
		C ₆	27.00		39.20	
		C ₇	48.00		14.00	
	Mean (B ₁)		34.86		28.80	
	B ₂ vermiculite	C ₁	40.00		19.50	
		C ₂	37.00		24.80	
		C ₃	33.00		31.20	
		C ₄	35.00		27.30	
		C ₅	34.00		28.70	
		C ₆	30.00		34.30	
		C ₇	49.00		12.10	
	Mean (B ₂)		36.86		25.40	
	B ₃ cocopeat	C ₁	42.00		17.50	
		C ₂	39.00		22.00	
		C ₃	36.00		28.40	
		C ₄	38.00		24.30	
		C ₅	37.00		25.40	
		C ₆	34.00		30.60	
		C ₇	50.00		10.00	
	Mean (B ₃)		39.43		22.60	
Mean (A ₁)			37.05		25.60	
A ₂ (Branch cuttings)	B ₁ perlite	C ₁	41.00		18.60	
		C ₂	38.00		24.00	
		C ₃	34.00		29.30	
		C ₄	36.00		25.90	
		C ₅	35.00		27.60	
		C ₆	31.00		33.00	
		C ₇	49.00		10.80	
	Mean (B ₁)		37.71		24.20	
	B ₂ vermiculite	C ₁	43.00		16.20	
		C ₂	40.00		21.60	
		C ₃	36.00		26.60	
		C ₄	38.00		23.00	
		C ₅	37.00		24.80	
		C ₆	33.00		30.10	
		C ₇	50.00		9.20	
	Mean (B ₂)		39.57		21.60	
	B ₃ cocopeat	C ₁	45.00		14.00	
		C ₂	42.00		19.00	
		C ₃	39.00		23.40	
		C ₄	41.00		20.10	
		C ₅	40.00		21.90	
		C ₆	36.00		26.10	
		C ₇	50.00		7.80	
	Mean (B ₃)		41.86		18.90	
Mean (A ₂)			39.71		21.60	
	Source	CD @ 5%	SEm ±	CD @ 5%	SEm ±	
	Factor A	0.35	0.13	0.30	0.11	
	Factor B	0.43	0.15	0.36	0.13	
	Factor C	0.66	0.24	0.56	0.20	
	A × B	NS	0.22	0.52	0.18	
	A × C	0.94	0.33	0.79	0.28	
	B × C	1.15	0.41	0.96	0.34	
	A × B × C	NS	0.58	NS	0.48	

Conclusion

The present study successfully standardized vegetative propagation techniques for *Ougeinia oojeinensis* Roxb. using different cutting types, rooting media and growth regulator treatments. The results revealed that root sucker cuttings

exhibited better propagation performance than branch cuttings, with higher sprouting and rooting ability and reduced time for shoot and root initiation. Among the rooting media, cocopeat was more effective for enhancing sprouting, whereas perlite provided a favourable environment for early root initiation and higher

rooting percentage. Growth regulator application significantly improved propagation success compared with untreated cuttings, with Coumarin 3000 ppm showing the best response across most parameters. The combination of root sucker cuttings with cocopeat and Coumarin 3000 ppm resulted in maximum sprouting, while root sucker cuttings with perlite and Coumarin 3000 ppm recorded superior rooting performance. The developed propagation protocol can be effectively utilized for large-scale multiplication, conservation and restoration programmes of this ecologically and economically important indigenous tree species.

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