

Effect of stump diameter thickness and nutrient management on shoot growth attributes of *Pterocarpus santalinus* Linn f

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Abstract: *Pterocarpus santalinus* (Red Sanders) is a rare and highly valued hardwood tree native to the Eastern Ghats of southern India. Its rich red heartwood is widely used in furniture, musical instruments and traditional medicine. Successful establishment of this species depends greatly on early seedling growth, which is influenced by factors such as stump diameter and nutrient availability. A study was conducted at the Gudagur Forest Nursery, Haveri District, to assess the effects of stump diameter thickness and nutrient management on seedling growth attributes of *Pterocarpus santalinus*. The experiment followed a factorial randomized block design with three main treatments and eight sub-treatments each replicated three times. Results indicated that stumps with a diameter greater than 5 mm significantly enhanced seedling performance. Among nutrient treatments, the combination of 0.5 g NPK per seedling along with 33 g poultry manure per seedling showed the most positive effect on plant height and collar diameter. The study concludes that selecting stumps larger than 5 mm and applying balanced nutrient doses can significantly improve the early growth and vigor of *P. santalinus* seedlings. These findings are important for nursery practices and plantation establishment, emphasizing the role of appropriate stump selection and nutrient management in promoting healthy and productive Red Sanders plantations.

Key words: Nutrient management, *Pterocarpus santalinus*, Seedling growth, Stump diameter

Introduction

India is home to a rich diversity of tree species and includes four of the world's major biodiversity hotspots: the Western Ghats, the Himalayan region, the Indo-Burma region (which includes the northeastern states) and the Nicobar Islands. The Western Ghats alone support 90 per cent of peninsular India's 600 rare or threatened plant species, with over 63 per cent of these being endemic to the region's low and mid-elevation evergreen forests. This includes endangered medicinal plants like *Pterocarpus santalinus* and *Pterocarpus marsupium*, both native to the Western Ghats and listed as threatened by the International Union for Conservation of Nature (IUCN) . *Pterocarpus santalinus* Linn., commonly known as red sander, belongs to the Fabaceae family. It is locally called "raktachandana" in Kannada and "lalchandan" in Hindi. This endangered and endemic tree is restricted to the southern parts of the Indian peninsula. A light-loving species, red sander thrives in dry, rocky and hilly terrain, occasionally occurring on the windward side of hills. It is prized for its dense, dark claret-red heartwood with wavy grain patterns and a red pigment known as santalin. The extremely hard, blood-red wood-sometimes streaked with light yellow-is in high demand internationally. It is typically found in tropical dry deciduous forests between 13°30' and 15°00' N latitude and 78°45' to 79°39' E longitude, particularly in the Arcot and Chengalpattu districts of Tamil Nadu, as well as in West Bengal, Kerala, Karnataka, Odisha, and the Chittoor district of Andhra Pradesh. It has also been reported in countries such as Taiwan, China, Sri Lanka and Pakistan (Thanuja, 2018). *P. santalinus* is a small to medium-sized deciduous tree known for its dark purple, bitter heartwood.

Its bark is blackish-brown, about 1-1.5 cm thick, with a pale-yellow inner blaze streaked with pink that exudes a thick, sticky red gum. The tree features drooping, hairless branches and trifoliate leaves measuring 10-18 cm in length, with a swollen base on the leaf stalk (rachis). The leaves are glossy, leathery, hairless, and clearly stalked. It produces fragrant, yellow, bisexual flowers approximately 2 cm long. The fruit is a flat, unequally rounded pod, around 5 × 4.5 cm in size, tapering into a short tip about 1 cm long. Each pod usually contains one, occasionally two, smooth, reddish-brown, kidney-shaped seeds, measuring about 1-1.5 cm in length (Arunakumara *et al.* 2011).

Material and methods

The present investigations entitled "Effect of stump diameter and nutrient Management on shoot growth attributes of *Pterocarpus santalinus* Linn. f." was conducted at Gudagur forest nursery, Gudagur village, Ranebennur Range, Haveri district during 2024 - 25. Experimental material consisted of freshly prepared six-month-old red sanders stumps which were prepared from six-month-old red sanders seedlings. The stumps of respective treatments were planted in slanting position in poly bags size of 8 x12 inch. Stumps planting was done by inserting the root portion inside the planting medium gently so that the root may not get damaged. After planting the stumps, same planting medium is used to cover the stumps. Seedlings were raised by providing suitable tending operation which involves regular weeding at regular intervals and cleaning. Different quantity of nutrients was measured as per the

treatment details by using electronic weighing balance and applied directly to the polybag as per the treatment details. The experiment included Main treatment - 03, Sub treatment - 08, Total treatments combination - 24 and replicated three times. The study utilized a Two Factorial Randomized Block Design. Each treatment group comprised of 10 stumps. A total of 720 stumps were selected for the experiment to study the effects of stump diameter thickness and different nutrient management on seedling growth attributes of *Pterocarpus santalinus*. The data collected for different shoot parameters includes Plant height (cm), Collar diameter (cm) was subjected to statistical analysis by using OP-STAT programme by adopting Factorial Randomized Block Design. The level of significance used in 'F' was P = 0.05.

Result and discussion

Plant height (cm)

The differences in plant height among different stump thickness were significant as indicated by Table 1 and Fig 1 where D3 having size more than 0.5 mm stump diameter thickness maintained the highest growth with heights of 27.33 cm. The minimum heights were observed in D1 having size less than 3 mm diameter thickness 18.47 cm. Application of different nutrients also showed significant effects on the growth attributes of *Pterocarpus santalinus*. T6 (0.5 g of NPK / Seedlings + Poultry manure @ 33 g/ seedlings) showed maximum heights of 26.07 cm, significantly higher than other treatments, while T1 (Control 2:1:1 Soil: Sand: FYM) remaining the lowest 15.64 cm and the differences were statistically significant. The study investigated the interaction effects of stump diameter and application of different nutrients on plant height. D3 T6 (More than 5mm stump diameter thickness+ 0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings) exhibited the maximum height (31.26 cm) followed by D3 T3 (More than 5mm stump diameter thickness1.0 g of NPK / seedlings) with seedling height(29.98 cm) while D1 T1 (Less than 3 mm diameter thickness + Control 2:1:1 Soil: Sand: FYM) had the minimum (15.3 cm), with significant differences.

Collar diameter (mm)

The diameter class D3 having size more than 5 mm stump diameter thickness showing the highest collar diameter

Treatment details

Treatments	Description
Main factor treatments: 3	
D1	Less than 3 mm stump diameter thickness
D2	3 mm - 5 mm stump diameter thickness
D3	More than 5 mm stump diameter thickness
Sub factor treatments: 8	
T ₁	Control (2:1:1) Soil: Sand: FYM
T ₂	T ₁ + 0.5 g of NPK / seedlings
T ₃	T ₁ + 1.0 g of NPK / seedlings
T ₄	T ₁ + 1.5 g of NPK/ seedlings
T ₅	T ₁ + vermicompost (20 g) + VAM (10 g)
T ₆	T ₁ + 0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings
T ₇	T ₁ + 0.5 g of NPK / seedlings + PSB (10 g)
T ₈	T ₁ + 0.5 g of NPK / seedlings + Azospirillum @ 5 g/seedlings

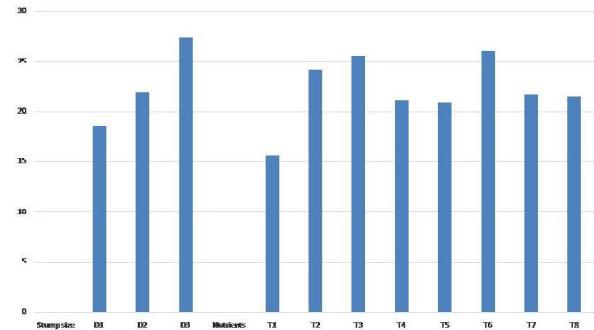


Fig1. Influence of stump diameter thickness and nutrient management on Plant height (cm) of *Pterocarpus santalinus* seedlings.

(7.04 mm) followed by D2 having size 3 mm- 5 mm stump diameter thickness (5.13 mm) and D1 having size less than 3 mm stump diameter thickness was the lowest (3.26 mm). Study evaluates the effects of different nutrients management on collar diameter of the seedlings. T6 (0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings) continued to have the highest collar diameter (6.61 mm) and T1- Control (2:1:1) Soil: Sand: FYM was the lowest (3.15 mm). in interaction effect of collar diameter D1 T1 (Less than 3 mm Stump diameter thickness + Control (2:1:1) Soil : Sand : FYM) exhibited the minimum collar diameter of 2.42 mm, whereas D3 T6 (More than 5mm stump diameter thickness+ 0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings) showed the maximum diameter of 5.23 mm followed by followed by D3 T3 (More than 5mm stump diameter thickness1.0 g of NPK / seedlings) had the collar diameter of 5.08 mm.

Table 1. Effect of stump diameter and nutrients management on shoot growth attributes of *Pterocarpus santalinus* seedlings

Treatments	Plant height (cm)	Collar diameter (mm)
Stump diameter		
D ₁ - less than 3 mm	18.47	3.26
D ₂ - 3-5 mm	21.84	5.13
D ₃ - more than 5 mm	27.33	7.04
S.Em(±)	0.09	0.02
C.D @ 5%	0.25	0.07
Nutrients management		
T ₁ - Control (2:1:1) Soil: Sand: FYM	15.64	3.15
T ₂ - 0.5 g N: P: K	24.10	5.42
T ₃ - 1 g N: P: K	25.49	5.87
T ₄ - 1.5 g N: P: K	21.08	4.87
T ₅ - vermicompost (20g) + VAM (10g)	20.87	5.21
T ₆ - 0.5 g of NPK / seedlings + Poultry manure @ 33 g/seedling	26.07	6.61
T ₇ - 0.5 g of NPK / seedling + PSB (10 g)	21.65	4.92
T ₈ - 0.5 g of NPK / seedling +Azospirillum @ 5 g/seedling	21.47	5.11
S.Em(±)	0.14	0.01
C.D @ 5%	0.42	0.05
Interaction (T x I)		
S.Em(±)	0.25	0.25
C.D @ 5%	0.72	0.72

Effect of stump diameter thickness and nutrient

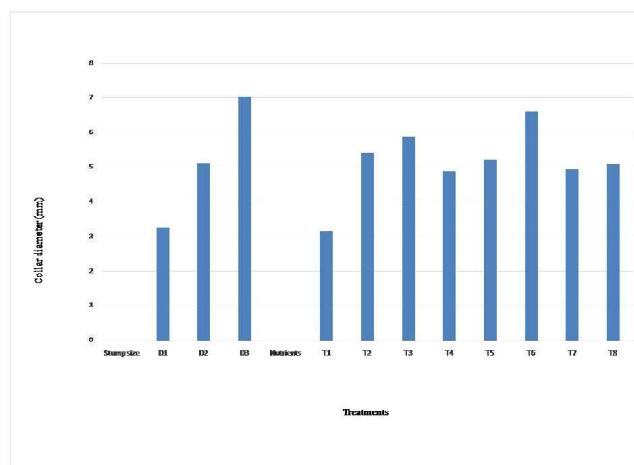


Fig 2. Influence of stump diameter thickness and nutrient management on collar diameter(mm) of *Pterocarpus santalinus* seedlings.

The thicker stump diameter possessing more reserved carbohydrates might be the reason for the better growth of seedling as compared to thinner ones. The increase in plant height with bigger stumps may be attributed to presence of higher carbohydrate reserves in the bigger stumps, which gave initial boost to the seedling height growth. These findings are in conformity with Chethan and Rathod (2024) in Teak and Tiwari (1995) in *Dalbergia latifolia* and Mohan and Chaturvedi (1990) in *Acacia nilotica* and *Albizia lebbeck* who found that the stumps of bigger diameter thickness enhanced the height growth of seedlings. Because of greater allocation of photosynthesis into stem, there was significant increase in collar diameter due to bigger stumps diameter thickness. The findings of this study are similar to those obtained by Wilson (1987) in *Gmelina arborea* and Latif *et al.* (1986) in *Tectona grandis*.

grandis seedlings, who observed that increase in collar diameter of seedlings due to bigger stumps of size 1.0-2.0 cm diameter. The significant higher plant height, collar diameter, in Treatment T₆, which combined a balanced dose of 0.5 g NPK and poultry manure (33/ g) per seedling, The synergistic effect of inorganic and organic sources provided both immediate and slow-release nutrients, maintaining consistent nutrient availability throughout seedling development. Poultry manure likely contributed to improved soil structure, microbial activity, and water-holding capacity, enhancing nutrient uptake efficiency. These findings align with previous studies. Mahantappa and Shivanna (2010) reported that in *Pterocarpus santalinus*, the application of 33 g of poultry manure per seedling resulted in the highest seedling height of 42.50 cm. Similarly, Humnessa *et al.* (2022) observed that poultry manure application led to a 30.70% increase in height growth compared to the control in *Albizia gummifera*. Patel (2022) also reported that in *Pterocarpus santalinus*.

Conclusion

Larger stump diameter thickness having size more than 5 mm (D3) consistently resulted in taller plants at later growth stages. Nutrient treatment T6 consisting of 0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings showed the highest plant heights. The combination of D3 with T6 resulted in the tallest plants. D3 having size more than 5 mm consistently had the largest collar diameter. T6 consisting of 0.5 g of NPK / Seedlings + Poultry manure @ 33 g/seedlings again had the maximum collar diameter, with D3 T6 showing the best results. These results provide valuable insights for reforestation projects, especially in selecting the right stump size and nutrient management strategies to ensure successful plant establishment and growth.

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