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EVALUATION OF GROWTH PERFORMANCE OF *SWIETENIA MACROPHYLLA* UNDER SOIL-LESS POTTING MIXTURE IN KONKAN REGION OF MAHARASHTRA, INDIA

S. V. Desai[1*], V. D. Tripathi[1], A. D. Rane[1], S. S. Narkhede[1], Pradyumna Prataprao Deshmukh[1] and M. M. Kulkarni[2]

[1]College of Forestry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

[2]College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

*Corresponding author E-mail: shubham.desai2011@gmail.com

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ABSTRACT

The increasing challenges of soil degradation, limited land availability, and soil-borne diseases have driven interest in alternative nursery practices such as soilless cultivation. This study evaluated the growth performance of *Swietenia macrophylla* (mahogany) seedlings under different soilless potting mixtures in the Konkan region of Maharashtra, India. Thirteen treatments, including various combinations of coco peat, vermicompost, leaf mould, and rice hulls, were assessed for their effects on germination, shoot and root growth, collar diameter, leaf number, and biomass. Results indicated significant differences among treatments, with the mixture of coco peat, vermicompost, leaf mould, and rice hulls in equal proportions (T_{12}) showing the highest performance across most growth parameters, including shoot length (53.36 cm), collar diameter (5.77 mm), number of leaves (32.07), and root length (20.60 cm). The synergistic effect of combining organic amendments enhanced nutrient availability, water retention, and aeration, thereby improving seedling vigour. This study underscores the potential of nutrient-rich soilless media, particularly T_{12}, as a sustainable alternative to conventional soil-based nursery practices for *Swietenia macrophylla* propagation in tropical regions.

***Keywords* :** *Swietenia macrophylla*, soilless potting mixture, vermicompost, nursery management

Introduction

Sudden and unexpected natural disasters, climate change, and soil fertility deterioration are only a few of the primary challenges to soil-based cultivation posed by growing urbanisation and industrialisation. Furthermore, plants growing in soil, face significant challenges such as inadequate drainage, soil compaction, erosion, the proliferation of soil-borne diseases (Divya and Sudini, 2013). In addition to these issues, soil cultivation necessitates a considerably larger area, many workers, more irrigation water, and other factors. Some contemporary scientific breakthroughs have established that plants and crops can be produced without soil and keep their nutritional and qualitative end product (Ram *et al.*, 2022). In the present scenario, soil-less potting mixture for nurseries is becoming an alternative to conventional soil-based potting mixture methods. This approach tackles major challenges affecting seedling production; including climate change, the decreasing amount of land, the availability of good soil for polythene filling and sufficient water for irrigation (Garg *et al.*, 2021). As a result, soil-less potting mixture is increasingly recognised as a practical technology, especially considering concerns regarding poor soil quality and the widespread occurrence of persistent soil-borne diseases (Hussain *et al.*, 2014).

Nursery potting media influence quality of seedlings produced there of (Baiyeri, 2005; Sahin *et al.*, 2005; Agbo and Omaliko, 2006). The quality of seedling obtained from a nursery influences re-establishment in the field (Baiyeri, 2006) and the eventual productivity of an orchard (Baiyeri and Ndubizu, 1994). Growing media whether organic or inorganic play a crucial role in supporting plant growth by providing a secure anchor for the root system (Ramachandran *et al*., 2025). In addition to anchorage, they serve as a source of essential nutrients vital for the metabolic processes, growth and overall development of plants. They not only offer stability to the plant's roots but also create air spaces for optimal respiration. Moreover, these media retain an adequate amount of available water crucial for sustaining plant growth. It reduces some of the problems like pests and diseases associated with the use of soil and reduced use of soil fumigants is equally possible (Salisu *et al*., 2017). Water and nutrient use efficiency are among many advantages of soilless medium due to a high cation exchange capacity and water holding capacity. Soil fumigant use equally reduced due to the reduction of soil-borne pests (Cantliffe *et al*., 2007). A good soilless media is said to possess some qualities such as low bulk density, light weight, friability, and slight acidity in addition to fungal free spores, weed seeds, insects (Meadn *et al*.,1998) and cost (Del and Gomez, 2009).

Swietenia macrophylla, commonly known as Mahogany is a straight-grained, reddish-brown tropical hardwood species of the family Meliaceae. The species has been widely cultivated in Southeast Asia and the Pacific including India, Indonesia, Philippines and Sri Lanka. Mahogany grows normally taller than 30 m and attains a diameter of 150 cm at breast height. It grows in a wide range of soils and environmental conditions. Normally, mahogany requires deep, fertile, well-drained soils with a pH of 6.5-7.5 for its optimum growth and it requires a mean annual rainfall between 1000 and 2500 mm with a 4-month dry period for good growth. Mahogany can grow at an altitude of 0-1500 m above sea level, in areas with a mean annual temperature of 20-28°C (Krisnawati *et al*., 2011). Mahogany is a light demander, frost-tender, fire-hardy species. It avoids water logging and moderately coppice. The mahogany wood is used for manufacturing doors, windows, composite wood, boats, sports goods and musical instruments (Akhilraj *et al*., 2023). Its deep rooting nature, moderate fast growth, adaptability, outstanding wood qualities, better form higher sawn out turn and ability to withstand the stand management practices make it popular among tree farmers for adapting it in agroforestry. The present study was undertaken with the objective to standardize the soilless potting mixture combinations for the propagation of Mahogany (*Swietenia macrophylla*) in Konkan region of Maharashtra.

Material and Methods

Study Site

The experiment was conducted at Central Nursery, College of Forestry, Dapoli under Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Seed were collected from superior tree of *Swietenia macrophylla* (15-20 years old) from the campus of College of Forestry, Dapoli, Maharashtra (17°45'N, 73°12'E) in month of February 2024. The average minimum and maximum temperature are 17.1°C to 34.9 °C within an average annual precipitation of 3000-3500mm respectively (Fig. 1). The average relative humidity in the morning and evening was 89.4 and 66.6 % respectively.

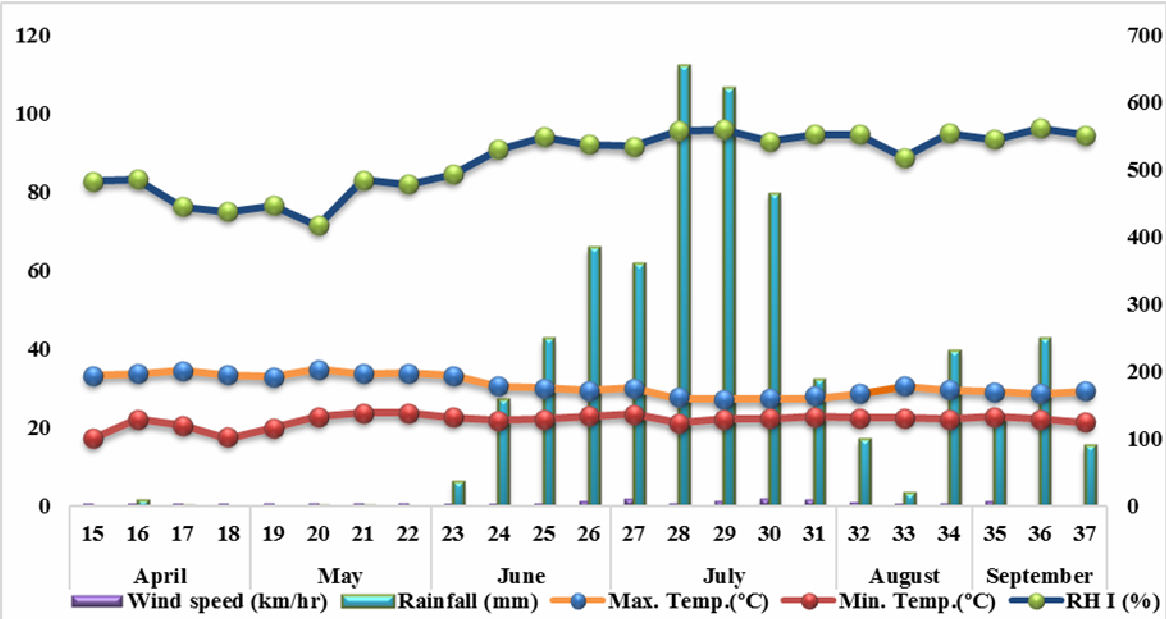

Fig. 1 : Meteorological data of experimental site during research study

Experimental details

The experiment comprises of thirteen treatments with different combinations practices. The thirteen treatments were T_1 [(Soil: Sand: FYM) (1:1:1)], T_2 [(Vermicompost)], T_3 [(Leaf mould)], T_4 [(Rice hulls)], T_5 [(Coco peat)], T_6 [(Coco peat: Vermicompost) (1:1)], T_7 [(Coco peat: Leaf mould) (1:1)], T_8 [(Coco peat: Rice hulls) (1:1)], T_9 [(Vermicompost: Leaf mould) (1:1)], T_{10} [(Rice hulls: Leaf mould) (1:1)], T_{11} [(Vermicompost: Rice hulls) (1:1)], T_{12} [(Coco peat: Vermicompost: Leaf mould: Rice hulls) (1:1:1:1)], T_{13} [(control) (soil)], with three replications. The experiment was laid out in complete randomized design. There were ten polythene bags in each replication having size of 8cm × 10cm. Moisture was maintained in the polybag from starting of the experiment. The seed germination was monitored daily. The seed germination was calculated using following formula:

Germination (%) = Number of germinated seeds / Number of Seeds sown × 100

At the end of the experiment, three seedlings per replication were selected, firstly polybags were removed after that it was watered thoroughly that growth media may get loose due to which roots can easily come out and later carefully uprooted without breaking roots for seedling growth studies.

Shoot length was measured from leading shoot tip to collar region of the seedling. Root length of tap root was recorded by placing it horizontally on the ground. Collar diameter of the seedling was measured using Digital Vernier calliper. Number of leaves calculated per plant. Fresh and dry root weight along with fresh and dry shoot weight were calculated electronic balance.

Sturdiness equation calculated using following formula:

Sturdiness=Plant height (cm)/Collar diameter (mm)

Statistical analysis

Conclusions were drawn by tabulating the different parameters and ‘F’ test yielded significant results. Statistical analysis of data obtained during the investigation was carried out by using the OPSTAT Statistical package (CCS HAU, Hisar).

Results and Discussion

The data given in Table 1 shows effect of different potting mixtures on germination and growth attributes of mahogany seeds. The germination percentage was maximum in T_2 (93.33%) and T_5 (90.00%) whereas, T_7 showed the minimum germination percentage (43.33%). Collar diameter was recorded significantly highest in T_{12} (5.77mm) which was at par with T_2 (5.46 mm), T_9 (4.33 mm), T_5 (4.32 mm), T_3 (4.24 mm), and T_{10} (4.13 mm), respectively. Shoot length was also significantly highest in T_{12} (53.36 cm) which was at par with T_5 (47.74 cm), T_3 (43.75 cm), and T_2 (41.47 cm). Significantly highest number of leaves per plant was recorded in T_{12} (32.07), which was on par with T_2 (31.83).

Root length was recorded significantly highest in T_{12} (20.60 cm), which was at par with T_6 (20.13 cm), T_8 (18.90 cm), T_5 (18.03 cm), T_4 (17.47 cm), and T_1 (17.20 cm). The fresh shoot weight was observed significantly highest in T_{12} (64.33 g), which was at par with T_9 (63.33 g), T_{11} (57.00 g), T_6 (56.67 g), T_{10} (52.33 g), T_2 (51.67 g), and T_3 (51.00 g). The dry shoot weight was observed highest in T_{12} (16.00 g), which was at par with T_2 (15.67 g), T_6 (13.00 g), T_9 (12.67 g), T_3 (12.67 g), T_4 (12.33 g), T_7 (11.67 g), and T_{11} (11.67 g). The significantly highest fresh root weight was observed in T_{12} (43.67 g), however, the minimum fresh root weight was found in T_4 (17.0 g). The dry root weight was observed significantly highest in T_{12} (14 g), which was at par with T_7 (12.00 g), T_5 (12.00 g), T_{11} (11.33 g), and T_6 (10.33 g). From the observation it is apparent that among the thirteen treatments, T_{12} was found significantly superior treatment as compared to other.

The growth of *Swietenia macrophylla* seedlings varied significantly across different soilless potting mixtures in terms of germination, shoot length, collar diameter, leaf number, and root length, underscoring the importance of nutrient-rich media for optimal development. A mixture of (coco peat: vermicompost: leafmould: ricehulls) (1:1:1:1) synergistically improved these growth attributes. Each component offers unique benefits: coco peat enhances aeration and water retention due to its porosity and moisture-holding capacity, crucial for early seedling establishment (Abad *et al*., 2002); vermicompost provides essential nutrients (nitrogen, phosphorus, potassium) and increases rhizosphere microbial activity, promoting root development and plant vigour (Kale and Bano, 1992); leaf mould, rich in organic matter, improves soil texture and provides slow-release nutrients for sustained growth (Singh *et al*., 2020); and rice hulls improve drainage and prevent waterlogging, supporting root health (Goyal *et al*., 2009). This combination enhances nutrient cycling, water holding capacity, and root aeration (Patil *et al*., 2020). Vermicompost contributes to shoot elongation by providing a steady nutrient supply and maintaining soil aeration and moisture retention (Aremu *et al*., 2019), and its nutrient availability boosts chlorophyll synthesis and photosynthesis, increasing leaf production (Kumar *et al*., 2020). Similar synergistic effects of these organic amendments have been observed in other forestry species: *Tectona grandis* showed improved growth parameters due to enhanced soil fertility, water retention, and microbial activity (Zhou *et al*., 2012); *Gmelina arborea* benefited from rice hulls in potting mixes, leading to better root length and overall seedling health through improved drainage and root aeration (Anitha and Rao, 2015); *Eucalyptus grandis* exhibited increased nitrogen uptake, chlorophyll content, photosynthesis, and biomass production with vermicompost and coco peat (Pires *et al*., 2014); and *Casuarina equisetifolia* displayed enhanced stem girth and survival rates in substrates containing leaf mould and rice hulls, demonstrating the role of these amendments in preventing waterlogging and improving nutrient cycling (Sharma and Sharma, 2016). Such organic amendment combinations also mimic natural forest floor conditions, crucial for seedling establishment in degraded lands, with *Dalbergia sissoo* showing improved root: shoot ratios, important for drought tolerance, in substrates enriched with coco peat and vermicompost (Bhattacharyya *et al*., 2019). The study demonstrates that nutrient-rich soilless potting mixtures, particularly those incorporating vermicompost, significantly enhance the growth and development of *Swietenia macrophylla*. The treatment T_{12} – coco peat + vermicompost + leaf mould + rice hulls emerged as the best-performing substrate, highlighting the potential of integrating vermicompost with other organic amendments for nursery management.

This study demonstrated significant effects of varying soilless potting mixtures on *Swietenia macrophylla* seedling biomass. The synergistic contribution of vermicompost and organic amendments in improving nutrient availability, water retention, and aeration, thus promoting robust shoot development. Vermicompost, recognized for its rich nutrient content and microbial activity, has been shown to enhance plant growth and biomass accumulation (Ansari and Ismail, 2012). Root biomass is directly affected by nutrient availability and soil aeration, both of which are improved by incorporating organic amendments such as rice hulls and leaf mould. These materials enhance the substrate's physical structure, allowing for improved root penetration and nutrient uptake (Patil *et al*., 2020). The results align with findings from previous studies demonstrating the positive effects of integrating organic amendments into soilless media on plant biomass (Hossain *et al*., 2021). The study highlights that, a combination of vermicompost with other organic components can significantly enhance the biomass of *Swietenia macrophylla*, making it a sustainable alternative for nursery practices.

Table 1: Effect of different potting mixtures on germination and growth attributes of Mahogany seeds

Treatment	Germination (%)	Collar diameter (mm)	Shoot length (cm)	Number of leaves	Root length (cm)	Fresh shoot weight (g)	Dry shoot weight (g)	Fresh root weight (g)	Dry root weight (g)
T_1	70.00	2.97	25.79	17.96	17.20	34.00	11.33	26.00	7.00
T_2	93.33	5.46	41.47	31.83	13.20	51.67	15.67	31.67	9.33
T_3	86.67	4.24	43.75	20.63	15.60	51.00	12.67	25.33	7.67
T_4	70.00	3.27	25.34	16.60	17.47	52.33	12.33	17.00	8.67
T_5	90.00	4.32	47.74	22.23	18.03	32.67	5.00	26.67	12.00
T_6	63.33	3.98	32.03	12.47	20.13	56.67	13.00	31.67	10.33
T_7	43.33	3.55	33.66	13.13	16.40	46.00	11.67	24.67	12.00
T_8	60.00	2.77	27.66	13.37	18.90	54.00	11.00	27.00	9.00
T_9	83.33	4.33	35.44	22.07	15.70	63.33	12.67	25.00	9.67
T_{10}	73.33	4.13	36.26	17.97	15.30	52.33	10.33	27.33	8.67
T_{11}	63.33	3.21	26.01	14.97	13.00	57.00	11.67	30.00	11.33
T_{12}	70.00	5.77	53.36	32.07	20.60	64.33	16.00	43.67	14.00
T_{13}	56.67	2.44	17.09	10.77	14.67	23.00	7.33	22.00	6.33
SE(m)	11.510	0.56	5.00	2.88	1.38	4.62	1.56	3.90	1.31
C.D. (5%)	NS	1.64	14.62	8.42	4.03	13.51	4.56	11.42	3.85

Conclusion

The findings of this research demonstrate that soilless potting mixtures significantly influence the growth and development of *Swietenia macrophylla* seedlings. Among the tested treatments, the combination of coco peat, vermicompost, leaf mould, and rice hulls (1:1:1:1) (T_{12}) emerged as the most effective substrate, enhancing germination, shoot and root growth, collar diameter, and biomass accumulation. The integration of organic amendments improved nutrient supply, water retention, and aeration, fostering robust seedling establishment. This study highlights the potential of using enriched soilless media as an efficient, sustainable strategy for mahogany nursery production, offering a viable solution to soil-related constraints such as poor fertility, disease incidence, and limited availability of quality soil.

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