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Seed collection, extraction and germination performance of six multipurpose tree species under tropical conditions

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Abstract
The successful propagation of multipurpose tree species is essential for tropical reforestation, agroforestry, and ecological restoration initiatives. This study was conducted to evaluate seed collection, extraction methods, and germination performance of six important tropical tree species: *Mimusops elengi*, *Inga dulcis*, *Swietenia macrophylla*, *Acacia mangium*, *Acacia auriculiformis*, and *Caesalpinia decapetala*. Seeds were collected from mature fruits during the 2024 summer season and subjected to species-specific pre-sowing treatments such as soaking, scarification, and manual cleaning. The experiment followed a Completely Randomized Design (CRD) with three replications per species under controlled nursery conditions. Significant interspecific variation was recorded for all germination parameters. *Inga dulcis* showed the highest germination percentage (93%), germination energy (85%), germination value (6.8), and seedling vigour index (2790), indicating superior propagation potential. *Acacia mangium* and *Acacia auriculiformis* also performed well, showing rapid and uniform germination. In contrast, *Swietenia macrophylla* failed to germinate, while *Caesalpinia decapetala* showed very poor germination (1.6%), likely due to dormancy and recalcitrant seed behavior. Statistical analysis revealed significant differences ($p<0.05$) among treatments for all measured parameters, with CD (5%) values confirming meaningful distinctions. The results are in agreement with prior studies and underscore the need for species-specific seed handling strategies. The study concludes that *Inga dulcis*, *Acacia mangium*, and *A. auriculiformis* are highly suitable for large-scale nursery propagation, while further research is needed to enhance the germination success of *S. macrophylla* and *C. decapetala*. These findings offer practical insights for forestry managers, ecologists, and nursery practitioners involved in tropical tree conservation and restoration programs.

Keywords: Multipurpose tree species, seed collection, extraction, germination percentage, vigour, *Inga dulcis*, *Mimusops elengia*, reforestation

1. Introduction

Forests are vital ecosystems that provide a wide range of ecological, economic, and social benefits. In tropical regions, multipurpose tree species (MPTs) form an integral component of agroforestry systems, supplying timber, fuelwood, fodder, and medicinal products, while simultaneously enhancing soil fertility, conserving biodiversity, and regulating climate (Leakey, 2017; Nair, 2014) [7, 8]. Their successful propagation is crucial for reforestation, afforestation, and sustainable land management practices, particularly in regions facing extensive deforestation and land degradation (FAO, 2020; Jose, 2009) [2, 6].

Tropical forests are among the most biodiverse ecosystems on Earth, providing critical ecosystem services such as carbon sequestration, soil stabilization, hydrological regulation, and wildlife habitat (Roshetko *et al*., 2007) [12]. Within these ecosystems, MPTs contribute significantly to ecological balance and human well-being. By integrating agriculture and forestry, agroforestry systems that utilize MPTs can create more sustainable land-use strategies (Nair, 2014) [8]. However, large-scale cultivation of these species is often constrained by poor seed viability, dormancy, and germination challenges (Hong & Ellis, 1996; Sacandé *et al*., 2004) [5, 13]. Understanding species-specific seed biology including collection, extraction, and pre-sowing treatments is therefore essential to improving germination success and seedling establishment (Baskin & Baskin, 2014) [1].

Mimusops elengi (Spanish cherry or bullet wood), a medium-sized evergreen tree of the family Sapotaceae, is valued for its durable timber, fragrant flowers, and medicinal properties. Its seeds show intermediate storage behavior, with viability influenced by moisture content and storage conditions. Optimal seed collection occurs about two weeks before natural fruit drop, and germination can be enhanced by hot water soaking, cold treatment, or gibberellic acid application (Nikhil *et al*., 2024) [9]. *Inga dulcis*, a fast-growing leguminous tree, is widely used in agroforestry for its nitrogen-fixing ability, edible fruits, and shade provision, although its recalcitrant seeds characterized by high moisture content and desiccation sensitivity limit storage potential (Leakey, 2017) [7].

Swietenia macrophylla (big-leaf mahogany) is a highly valued timber species native to Central and South America and currently listed as endangered due to overexploitation. Its recalcitrant seeds lose viability quickly and show strong sensitivity to temperature, with optimal germination reported near 37 °C (Grogan & Barreto, 2005) [3]. In contrast, *Acacia mangium*, native to Australia and Southeast Asia, is a fast-growing leguminous tree widely cultivated for timber, pulpwood, and land rehabilitation. It’s hard-coated seeds require scarification or hot water immersion to break dormancy, and germination rates often exceed 75% under favorable conditions (Harwood, 1998) [4].

Similarly, *Acacia auriculiformis*, another versatile leguminous species native to Australia, Papua New Guinea, and Indonesia, is valued for fuelwood, timber, and land reclamation. Pre-sowing treatments such as boiling water immersion significantly improve its germination performance (Orwa *et al*.,2009) [10]. Finally, *Caesalpinia decapetala* (Mysore thorn), a thorny shrub or small tree used for live fencing, erosion control, and tannin production, has a hard seed coat that necessitates scarification or hot water treatments. However, germination remains low, and further research is needed to optimize its propagation (Parrotta, 2000) [11].

2. material and methods

2.1 Study Location and Duration

The study was conducted at the nursery site near College of Forestry, Orissa University of Agriculture and Technology, Bhubaneswar, located in a tropical region, during the summer and monsoon months of 2024 (May to July). Germination trials were performed under nursery conditions with partial shade, regular watering, and open-air ventilation.

2.2 Experimental Design

A Completely Randomized Design (CRD) was adopted for the experiment. Each tree species was considered as a treatment, and seeds were sown in three replications per species. Each replication consisted of 20–30 seeds, depending on seed availability and viability, maintaining a uniform sowing depth and spacing.

Design	CRD (Completely Randomized Design)
No. of Treatments	6 tree species
Replications	3
Total No. of Experimental Units	18 (6 species × 3 replicates)
Observation Duration	Up to 30 days post-sowing

2.3 Plant Material Used: The following six multipurpose tropical tree species were selected for study:

Sl.No.	Botanical Name	Common Name	Family
1.	*Mimusops elengi*	Spanish Cherry, Baula, Bakula	Sapotaceae
2.	*Inga dulcis*	Jungle Jalebi, Manila tamarind, Seema kayan	Fabaceae
3.	*Swietenia macrophylla*	Mahogany	Meliaceae
4.	*Acacia mangium*	Black wattle, Hickory wattle	Fabaceae
5.	*Acacia auriculiformis*	Ear leaf Acacia, Sunajhari, Ear pod wattle	Fabaceae
6.	*Caesalpinia decapetala*	Mysore thorn, Cat’s claw	Fabaceae

2.4 Seed Collection and Extraction

Seeds were collected either from ripe fruits on trees or from freshly fallen mature pods/fruits on the ground. Each species was handled separately to avoid mixing. The extraction and cleaning process varied by species.

Sl. No.	Species	Seed Extraction Method
1.	*Mimusops elengi*	Fruits peeled, soaked, then macerated manually; seeds washed and air-dried.
2.	*Inga dulcis*	Pods opened manually; pulp removed by hand; seeds washed and dried.
3.	*Swietenia macrophylla*	Wings clipped; seeds soaked in water
4.	*Acacia mangium*	Orange funicles removed; seeds soaked in hot water (24-36 hr) or cold-hot treatment
5.	*Acacia auriculiformis*	Similar to *A. mangium* treatment
6.	*Caesalpinia decapetala*	Seeds soaked in water (12-24 hr)

2.5 Seed Pre-Sowing treatments

Pre-sowing treatments were applied to overcome dormancy and enhance germination. These included:

- Soaking in water (Room temperature or Hot water)
- Manual scarification (For hard-coated seeds)
- Mechanical cleaning of seed coat/funicle

2.6 Sowing Procedure

- Seeds were sown in poly bags filled with a standard soil mixture (Loamy soil: FYM: Sand) in 2:1:1 ratio
- Sowing depth was kept uniform (1-1.5 cm)
- Seeds were watered daily and partial shade was maintained using a green net.
- Observations were taken daily for 30 days post-sowing.

2.7 Observation Recorded

The following parameters were recorded:

- Germination Percentage (%)

$$Germination\ Percentage = \frac{Number\ of\ seeds\ germinated}{Total\ number\ of\ seeds\ sown} \times 100$$

Germination Energy: Rate of early germination-number of seeds germinated by day 7-10

$$\text{Mean Daily Germination (\%)} = \frac{\text{Cumulative germination\%}}{\text{Total Number of Days}}$$

$$\text{Peak Value (PV)} = \frac{\text{Total germination percentage}}{\text{Number of days required to reach Peak Germination}}$$

Germination Value (GV): Combined measure of rate and completeness of germination GV = Mean Daily Germination × Peak Value

Seedling Vigour Index (SVI)

$$SVI = \frac{Germination\ \%}{Mean\ seedling\ length\ (cm)}$$

2.8 Statistical Design

Data was statistically analyzed using Analysis of Variance (ANOVA) under CRD. Standard Error (SE) and Critical Difference (CD) at 5% level were calculated using Microsoft excel.

3. Results and Discussion

- **Germination Percentage:** Significant variation in germination percentage was observed among the six studied species (Table 1). *Inga dulcis* exhibited the highest germination percentage (93%), followed closely by *Acacia mangium* (90.7%) and *Acacia auriculiformis* (77%). These results align with previous findings highlighting the rapid and uniform germination of leguminous species under suitable pre-sowing treatments (Harwood, 1998; Orwa *et al*., 2009) [4, 10]. High germination in *Inga dulcis* further supports its potential as a multipurpose agroforestry species due to its rapid establishment and adaptability (Leakey, 2017) [7]. In contrast, *Mimusops elengi* showed moderate germination (52.5%), while *Swietenia macrophylla* failed to germinate under nursery conditions. Similarly, *Caesalpinia decapetala* recorded only 1.6% germination, reflecting strong seed dormancy and possible recalcitrant seed behavior. Earlier studies have also reported low germination in *Swietenia* due to rapid loss of viability (Grogan & Barreto, 2005) [3], while poor germination in *C. decapetala* has been linked to its thick seed coat (Parrotta, 2000) [11].

Table 1: Germination and Seedling Vigour of Six Multipurpose Tree Species

Species	Germination %	Germination Energy (%)	Germination Value	Seedling Vigour Index (SVI)
Mimusops elengi	52.5	40.0	3.5	1050
Inga dulcis	93.0	85.0	6.8	2790
Swietenia macrophylla	0.0	0.0	0.0	0
Acacia mangium	90.7	75.0	5.2	1980
Acacia auriculiformis	77.0	68.0	4.5	1575
Caesalpinia decapetala	1.6	1.0	0.2	30
SE (±)	2.5	2.0	0.3	120
CD (5%)	5.0	4.0	0.6	245

- **Germination Energy:** The rate of early germination, expressed as germination energy, followed a similar pattern. *Inga dulcis* recorded the highest value (85%), indicating rapid and uniform germination. *Acacia mangium* (75%) and *Acacia auriculiformis* (68%) also performed well. Such high early germination in Acacia species is consistent with previous studies demonstrating the effectiveness of hot water or scarification treatments in breaking seed dormancy (Harwood, 1998) [4]. In contrast, *Mimusops elengi* showed moderate germination energy (40%), while *Swietenia macrophylla* and *Caesalpinia decapetala* recorded negligible values.
- **Germination Value:** The germination value, which combines both speed and completeness of germination, was highest in *Inga dulcis* (6.8), followed by *Acacia mangium* (5.2) and *Acacia auriculiformis* (4.5). These results highlight the superior propagation potential of these species under nursery conditions. Moderate performance was observed in *Mimusops elengi* (3.5), while both *Swietenia macrophylla* and *Caesalpinia decapetala* performed poorly. The superior germination value of *Inga dulcis* is particularly encouraging for its wider adoption in reforestation and agroforestry systems.
- **Seedling Vigour Index (SVI):** The seedling vigour index (SVI) reflects both germination and seedling growth performance. *Inga dulcis* recorded the highest SVI (2790), indicating strong seedling establishment potential. *Acacia mangium* (1980) and *Acacia auriculiformis* (1575) also exhibited robust seedling vigour, supporting their role in fast-growing plantation

programs (Orwa *et al*., 2009) [10]. In contrast, *Mimusops elengi* displayed moderate vigour (1050), while *Swietenia macrophylla* and *Caesalpinia decapetala* showed negligible vigour, further confirming their propagation challenges. Line graph (Fig.1.) illustrating interspecific differences in germination percentage, germination energy, germination value, and seedling vigour index. *Inga dulcis* consistently outperformed other species, while *Swietenia macrophylla* and *C. decapetala* showed very poor performance.

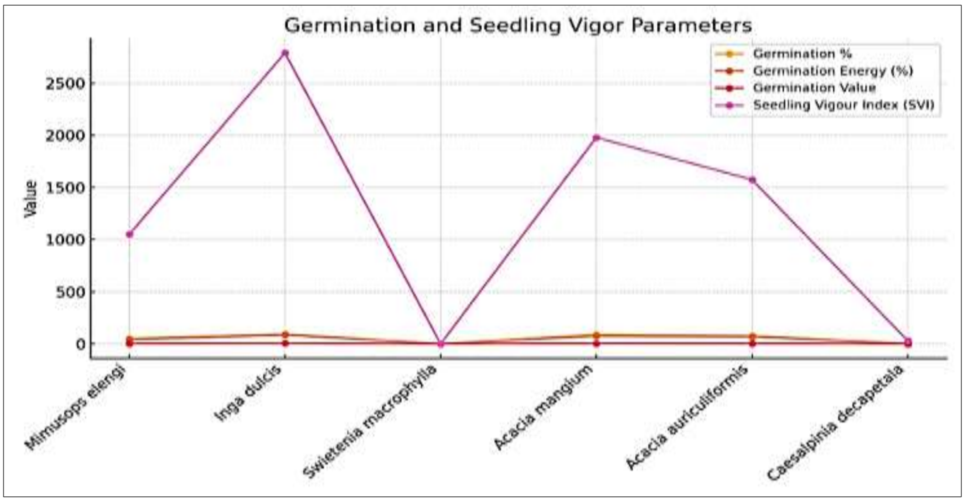

Fig 1: Germination performance of Six Multipurpose Trees

Fig 2: Seed collection, extraction, treatment and sowing of seeds of *Swietenia macrophylla* (Mahogany seeds

Fig 3: Seed Collection, extraction, sowing and germination of *Mimusops elengi*

Fig 4: Seed Collection, extraction, sowing and germination of *Caesalpinia decapetala*

Fig 5: Seed Collection, Extraction, Sowing and Seed germination study in *Inga dulcis*

Fig 6: Seed Collection, Extraction and Seed germination study in *Acacia auriculiformis*

Fig 7: Seed collection, Seed treatment and seed germination of *Acacia mangium*

Comparative Analysis

Overall, the study demonstrates clear interspecific differences in germination and seedling vigour. Figure 2 shows Stepwise process showing handling of mahogany seeds. Despite standard treatments, germination was not achieved, confirming their recalcitrant and highly sensitive nature. Figure 3 shows Sequential representation of fruit handling, seed cleaning, and nursery sowing. Moderate germination was achieved, consistent with intermediate storage behavior of the species. Figure 4 depicts processing of hard-coated seeds. Despite scarification and soaking, germination remained very low (1.6%), reflecting strong dormancy. Figure 5 shows stepwise documentation of pod opening, seed cleaning, and nursery establishment. This species showed rapid germination (93%) and strong seedling vigour (SVI 2790). Figure 6 depicts seed preparation and germination following hot-water treatment. The species achieved 77% germination and moderate seedling vigour, confirming its suitability for plantations. Figure 7 demonstrates the effectiveness of pre-sowing treatments such as hot water immersion for breaking seed dormancy. High germination percentage (90.7%) and vigour (SVI 1980) were recorded. *Inga dulcis* consistently outperformed other species across all parameters, making it a strong candidate for large-scale agroforestry and reforestation projects. Both *Acacia mangium* and *Acacia auriculiformis* also performed well, corroborating their widespread use in plantation forestry. On the other hand, the failure of *Swietenia macrophylla* to germinate and the poor performance of *C. decapetala* underscore the need for further research on overcoming dormancy and improving propagation techniques for these species.

These findings reinforce the importance of species-specific seed handling and pre-sowing treatments for enhancing propagation success (Baskin & Baskin, 2014; Sacandé *et al*., 2004). They also provide practical insights for nursery managers, foresters, and conservation practitioners engaged in tropical reforestation and agroforestry initiatives.

4. Conclusion

The study demonstrates significant interspecific variation in germination performance and seedling vigor among the six tree species evaluated. *Inga dulcis* emerged as the most promising species, exhibiting superior germination percentage, energy, germination value, and seedling vigor. *Acacia mangium* and *Acacia auriculiformis* also showed strong performance, indicating their suitability for reforestation and agroforestry programs. In contrast, *Swietenia macrophylla* and *Caesalpinia decapetala* displayed poor germination and seedling vigor, highlighting the need for further research to overcome seed dormancy and improve propagation techniques. These findings offer practical insights for forestry practitioners and policymakers in selecting appropriate species for reforestation initiatives, thereby supporting sustainable forest management and ecological restoration.

5. Competing Interests

Authors have declared that no competing interest exist.

References

1. Baskin CC, Baskin JM. Seeds: Ecology, biogeography, and evolution of dormancy and germination. 2nd ed. Academic Press; 2014.
2. FAO. Global forest resources assessment 2020. Food and Agriculture Organization of the United Nations; 2020. Available from: https://www.fao.org/documents/card/en/c/ca9825en
3. Grogan J, Barreto P. Big-leaf mahogany on CITES Appendix II: Big challenge, big opportunity. Conservation Biology. 2005;19(3):973–976. https://doi.org/10.1111/j.1523-1739.2005.00231.x
4. Harwood CE. *Acacia mangium* Willd.: Ecology and silviculture. CIFOR; 1998.
5. Hong TD, Ellis RH. A protocol to determine seed storage behaviour. International Plant Genetic Resources Institute; 1996.
6. Jose S. Agroforestry for ecosystem services and environmental benefits: An overview. Agroforestry Systems. 2009;76(1):1–10. https://doi.org/10.1007/s10457-009-9229-7
7. Leakey RRB. Living with the trees of life: Towards the transformation of tropical agriculture. CABI; 2017.
8. Nair PKR. Grand challenges in agroecology and land use systems. Frontiers in Environmental Science. 2014;2:1–6. https://doi.org/10.3389/fenvs.2014.00001
9. Nikhil R, Sharma P, Kumar A. Influence of pre-sowing treatments on seed germination of *Mimusops elengi*. Journal of Tropical Forestry. 2024;40(2):115–122.
10. Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. *Agroforestree database:* A tree reference and selection guide version 4.0. World Agroforestry Centre; 2009.
11. Parrotta JA. *Caesalpinia decapetala*. USDA Forest Service, International Institute of Tropical Forestry; 2000.
12. Roshetko JM, Evans DO, Sanchez EA. Agroforestry species and technologies: A compilation of the highlights and factsheets. World Agroforestry Centre; 2007.
13. Sacandé M, Joker D, Dulloo ME, Thomsen KA. Comparative storage biology of tropical tree seeds. International Plant Genetic Resources Institute; 2004.