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Assessment of Arbuscular Mycorrhizal (AM) Fungal Diversity in *Gmelina arborea* Roxb. and *Melocanna baccifera* (Roxb.) Kurz

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Abstract

A study was conducted at ICFRE-RFRI, Jorhat, Assam, to investigate the diversity and colonization patterns of arbuscular mycorrhizal (AM) fungi associated with *Gmelina arborea* Roxb. and *Melocanna baccifera* (Roxb.) Kurz. Four AM fungal genera—*Glomus*, *Acaulospora*, *Scutellospora*, and *Gigaspora*—were identified, with *Glomus* emerging as the predominant genus. The isolated spores exhibited considerable morphological variation in terms of shape, wall architecture, pigmentation, and hyphal attachment. Root colonization was recorded in *G. arborea* (48%), whereas no colonization was observed in *M. baccifera*, potentially attributable to host specificity or elevated soil phosphorus levels. These findings underscore the ecological significance of AM fungi in promoting seedling establishment and growth, and highlight the necessity for further investigation into host-specific AM fungal strains to enhance sustainable forestry and reforestation initiatives.

Keywords: *Mycorrhizal*, *root colonization, diversity*

Introduction

Arbuscular mycorrhizal (AM) fungi are vital soil microorganisms that establish symbiotic associations with the roots of most terrestrial plant species (Smith & Read, 2010). Through the formation of specialized structures known as arbuscules, AM fungi enhance the uptake of essential nutrients such as phosphorus, nitrogen, and various micronutrients. In exchange, host plants supply carbohydrates to the fungi, fostering a mutually beneficial relationship that also contributes to improved soil structure and microbial activity (Rillig et al., 2001; Clemmensen et al., 2013). The ecological and agronomic significance of AM fungi has garnered increasing attention due to their potential to reduce dependence on chemical fertilizers and bolster plant resilience against abiotic stresses including drought, salinity, and heavy metal toxicity (Begum et al., 2019).

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Gmelina arborea, a fast-growing and economically important timber species, has demonstrated substantial benefits from AM fungal inoculation, including enhanced growth performance, nutrient acquisition, and survival rates. Studies have further shown that synergistic interactions between AM fungi and other beneficial soil microbes can amplify these effects, particularly under suboptimal soil conditions (J.G., 2019). Similarly, *Melocanna baccifera*, a prominent bamboo species, forms effective symbiotic relationships with AM fungi, contributing to improved plant vigor, biodiversity support, and soil restoration. The integration of AM fungal spores or colonized root fragments into nursery substrates or seed treatments has been shown to promote seedling establishment, increase shoot and root biomass, and elevate survival rates. Moreover, the role of soil microbial communities in bamboo plantations has been linked to enhanced phytoremediation potential and stress tolerance, as revealed through advanced microbial characterization techniques (Fuke et al., 2021).

Both *Gmelina arborea* and *Melocanna baccifera* hold significant ecological and silvicultural value. Investigating the diversity and optimizing the cultivation of native AM fungal strains associated with these species can inform the development of cost-effective, environmentally sustainable bio-inoculants. Such strategies are crucial for afforestation, agroforestry, and land restoration initiatives, particularly in nutrient-deficient or degraded ecosystems. The present study aims to document the diversity of AM fungi associated with these host plants and to deepen our understanding of their native symbiotic relationships, thereby contributing to region-specific biofertilizer solutions that enhance nursery performance and field survival of planting stock.

Materials And Method

Study site and sample preparation

The present study was conducted at the ICFRE–Rain Forest Research Institute (RFRI), Jorhat, Assam, to assess the diversity of arbuscular mycorrhizal (AM) fungi associated with *Gmelina arborea* and *Melocanna baccifera*. Root and rhizospheric soil samples were collected using purposive sampling (Patton, 1990) from a depth of 0–20 cm in four cardinal directions around each plant. The collected soil samples were homogenized, suspended in distilled water, and allowed to settle overnight to facilitate spore separation.

AM fungal spores were extracted using the wet sieving and decanting method (Gerdemann & Nicolson, 1963), employing a series of sieves with varying mesh sizes to isolate spores of different diameters. The recovered spores were examined under a compound microscope, and identification was carried out based on morphological characteristics such as spore size, shape, wall structure, color, and hyphal attachment. Taxonomic classification was performed using standard mycorrhizal identification manuals, databases, and relevant literature.

Analysis of AMF colonization in Root

For root colonization analysis, Roots were washed and cut into 1-cm segments, then cleared in 10% KOH at 90°C for 2–3 hours. After rinsing, samples were acidified with 2% HCl and thoroughly washed. The roots were then stained with aniline blue and examined under a compound microscope to observe AM fungal colonization (Nusantara et al., 2012).

Spore Abundance and Root Colonization

Relative Abundance of Spores:

Calculated to understand the dominance of each AM fungal genus using the formula by Shi et al. (2006):

$$R.A\% = \frac{Number\ of\ spores\ of\ a\ genus}{Total\ no.of\ spores} \times 100$$

Root Colonization Percentage:

Assessed by the proportion of infected root segments using the formula by Setiadi et al. (1992).

$$R.I\% = \frac{Number\ of\ positive\ segments}{Total\ observed\ segment} \times 100$$

These calculations help quantify the diversity and extent of AM fungal associations in the studied plant roots.

Result and Discussion

Analysis of rhizospheric soil and root samples from *Gmelina arborea* and *Melocanna baccifera* revealed the presence of five arbuscular mycorrhizal (AM) fungal genera: *Glomus*, *Acaulospora*, *Scutellospora*, *Gigaspora*, and *Septoglomus*. Among these, *Glomus* emerged as the most dominant genus in both host species, reflecting its broad ecological adaptability and competitive advantage. Its prevalence is likely attributed to rapid spore germination and smaller spore size, which facilitate efficient colonization and dispersal (Puspitasri et al., 2012).

Acaulospora, the second most abundant genus, produces spores on saccules and is well-adapted to nutrient-deficient soils, suggesting its resilience in low-fertility environments (Souza, T., 2025). *Scutellospora* was moderately represented and is distinguished by multilayered spore walls, which confer durability under adverse conditions (Kew et al., 2010). *Gigaspora* was detected in lower abundance and exclusively in *M. baccifera*, characterized by its large, structurally protected spores that may limit its distribution but enhance survival in specific niches (Stumer, S.L., 2012). *Septoglomus* appeared in minimal quantities, indicating either limited ecological compatibility or competitive exclusion by other genera.

The observed variation in spore abundance and distribution across the two host species suggests differential fungal adaptability, influenced by soil physicochemical properties and host-specific preferences. These findings underscore the importance of understanding AM fungal community composition for optimizing symbiotic efficiency in forestry and restoration practices.

Table 1: Relative Abundance of Spores on Samples in Each Study Site

Plants Species	Relative Abundance (%)			
	Glomus	Acaulospora	Scutellospora	Gigaspora
Gmelina arborea Roxb.	53.3%	23.3%	6.6%	16.6%
Melocanna baccifera (Roxb.) Kurz.	56.6%	9.3%	13.3%	14%

Root Colonization

Microscopic examination of root samples revealed a 48% colonization rate by arbuscular mycorrhizal (AM) fungi in *Gmelina arborea*, indicating a well-established symbiotic association. In contrast, no colonization was detected in *Melocanna baccifera*, suggesting potential host-specific incompatibility or inhibitory soil conditions. One plausible explanation for the absence of fungal structures, particularly vesicles, in *M. baccifera* is elevated soil phosphorus levels, which are known to suppress AM fungal colonization and development. Additionally, species-specific plant–fungus interactions may influence the establishment and morphology of symbiotic structures. Vesicles, which serve as intracellular storage organs for lipids and other nutrients, may not form during early colonization stages or under certain environmental and physiological constraints (Balzergue et al., 2013). These findings highlight the complexity of AM symbiosis and underscore the need for targeted studies to elucidate host compatibility and soil nutrient dynamics in bamboo-associated mycorrhizal systems.

Spore Morphology

Morphological Characterization of AM Fungal Spores

Morphological analysis of arbuscular mycorrhizal (AM) fungal spores isolated from rhizosphere:
Soil samples revealed five distinct genera: *Glomus*, *Acaulospora*, *Scutellospora*, *Gigaspora*, and *Septoglomus*. Identification was conducted based on key diagnostic features including spore shape, wall architecture, pigmentation, and hyphal attachment.

Glomus spores (Fig. 1a–1c, 2g, 3i–3k, 5r) were globose to subglobose, with smooth to slightly roughened surfaces, ranging in color from pale yellow to brown. These spores exhibited subtending hyphae with a clearly defined basal pore, a characteristic trait of the genus. *Acaulospora* (Fig. 1h, 2e, 2h, 4m, 4o) produced globose to subglobose spores with multilayered, smooth walls, colored from light yellow to reddish-brown, and formed laterally on a saccule. *Scutellospora* (Fig. 2f, 4n) spores were notably large and irregular in shape, with rough, double-layered walls and pigmentation ranging from pale yellow to blackish, indicative of their structural resilience in adverse conditions.

Gigaspora (Fig. 5q) was characterized by very large globose spores with thick, multilayered walls and a distinctive bulbous suspensor. These spores varied in color from white to orange, and the associated hyphae were bulbous or funnel-shaped. *Septoglomus* (Fig. 1d) formed globose to subglobose spores with multilayered walls, colored pale yellow to dark brown, typically occurring singly or in loose clusters.

The morphological diversity observed among these genera reflects their ecological adaptations and functional roles in symbiotic interactions with host plants. These findings contribute to a deeper understanding of AM fungal taxonomy and their potential application in sustainable soil and plant health management.

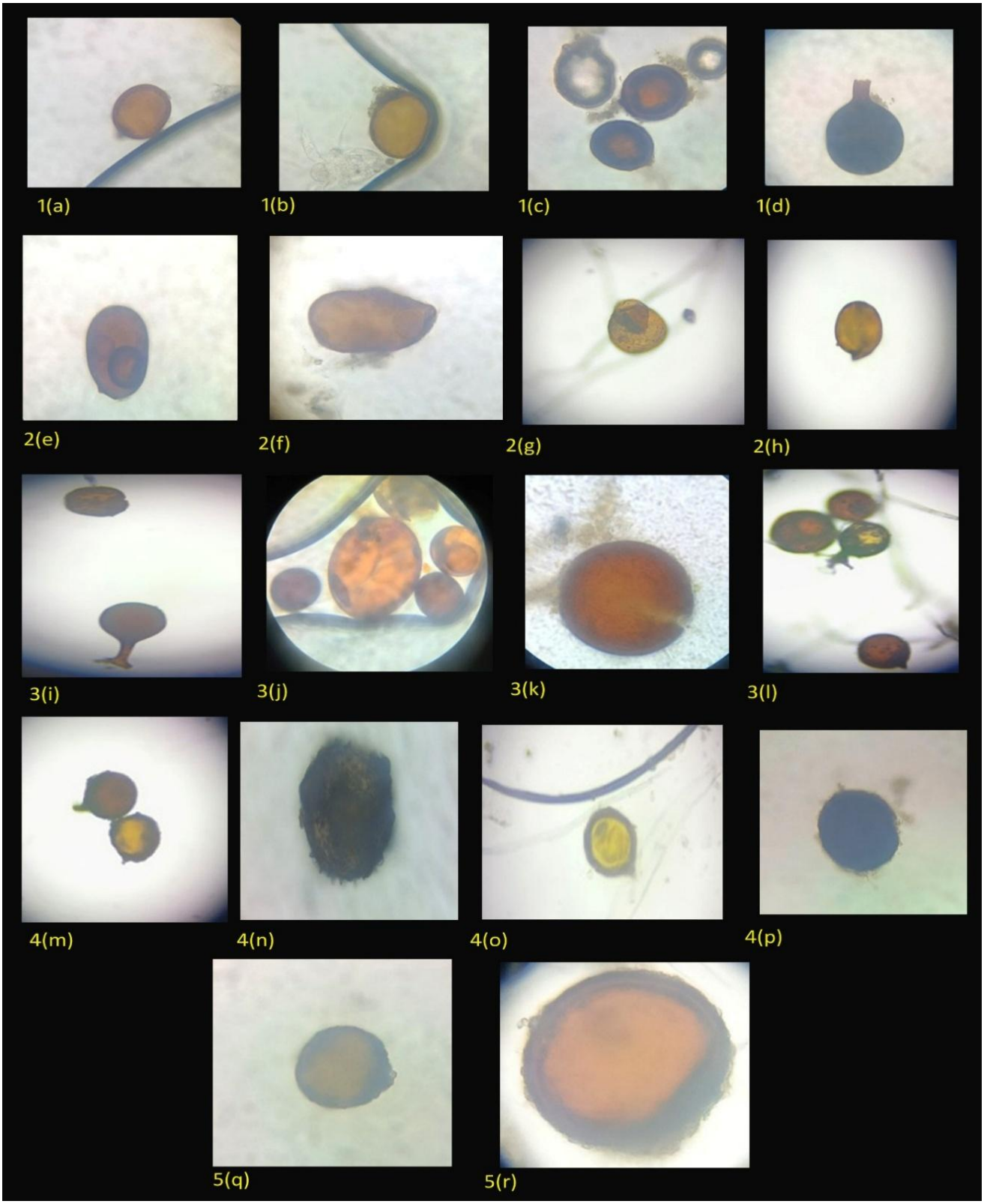

Fig.1: *Arbuscular Mycorrhizal* (AM) fungal spores

Conclusion

This study explored the diversity of arbuscular mycorrhizal (AM) fungi associated with *Gmelina arborea* and *Melocanna baccifera* in the rhizospheres of selected sites at ICFRE-RFRI, Jorhat, Assam. Four AM fungal genera—*Glomus, Acaulospora, Scutellospora, and Gigaspora*—were identified, with Glomus being the most dominant. Notably, root colonization occurred only in G. arborea (48% rate), suggesting possible host specificity or environmental influences, as M. baccifera showed no root infection despite spore presence.

The findings underscore the potential of AM fungi in nursery practices, where they enhance nutrient uptake, seedling growth, and resistance to pathogens, reducing reliance on chemical fertilizers. Future research should focus on identifying effective AM fungal strains for specific hosts and assessing their long-term benefits under field conditions, contributing to sustainable forestry and ecological restoration efforts.

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Declarations
Conflict of interest: The authors declare that they have no conflict of interest

Reference

1. **Balzergue, C., Chabaud, M., Barker, D. G., Bécard, G., & Rochange, S. F. (2013).** High phosphate reduces host ability to develop arbuscular mycorrhizal symbiosis without affecting root calcium spiking responses to the fungus. *Frontiers in Plant Science*. *4: 426.* https://doi.org/10.3389/fpls.2013.00426
2. **Clemmensen, K. E., Bahr, A., Ovaskainen, O., Dahlberg, A., Ekblad, A., Wallander, H., Stenlid, J., Finlay, R. D., Wardle, D. A., & Lindahl, B. (2013).** Roots and associated fungi drive long-term carbon sequestration in boreal forest. *Science*. *339*(6127):1615–1618. https://doi.org/10.1126/science.1231923
3. **Gerdemann, J. W., & Nicolson, T. H. (1963).** Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. *Transactions of the British Mycological Society*, *46*(2): 235–244. https://doi.org/10.1016/S0007-1536(63)80079-0
4. **Nusantara, A. D., Bertham, Y. H., & Mansur, I. (2012).** *Bekerja dengan fungi mikoriza arbuskula*. Bogor: SEAMEO BIOTROP.

5. **Patton, M. Q. (1990).** *Qualitative evaluation and research methods* (2nd ed.). Thousand Oaks, CA: SAGE Publications.
6. **Puspitasari, D., Purwani, K. I., & Muhibbudin, A. (2012).** Eksplorasi Vesicular Arbuscular Mycorrhiza (VAM) Indigenous pada Lahan Jagung di Desa Torjun, Sampang Madura. *Jurnal Sains dan Seni ITS*, *1*(1). https://doi.org/10.12962/j23373520.v1i1.1234
7. **Rillig, M. C., Wright, S. F., Nichols, K. A., Schmidt, W. F., & Torn, M. S. (2001).** Large contribution of arbuscular mycorrhizal fungi to soil carbon pools in tropical forest soils. *Plant and Soil*, *233*: 167–177. https://doi.org/10.1023/A:1010364221163
8. **Schüßler, A., & Walker, C. (2010).** *The Glomeromycota: A species list with new families and new genera.* Gloucester: Arthur Schüßler & Christopher Walker. The Royal Botanic Gardens, Kew and Botanische Staatssammlung Munich.
9. **Shi, Z. Y., Chen, Y. L., Feng, G., Liu, R. J., Christie, P., & Li, X. L. (2006).** Arbuscular mycorrhizal fungi associated with the Meliaceae on Hainan Island, China. *Mycorrhiza*, *16*: 81–87. https://doi.org/10.1007/s00572-005-0026-2
10. **Smith, S. E., & Read, D. J. (2010).** *Mycorrhizal symbiosis.* 3rd ed. London: Academic Press.
11. **Souza, T. (2015).** *Handbook of arbuscular mycorrhizal fungi*. Cham: Springer. P. 153

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