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Plant-Mycorrhizal Microcosm Systems

October 2026

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U.S. DEPARTMENT of ENERGY

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Abstract

This project established compartmented microcosms to support controlled studies of plant-arbuscular mycorrhizal fungal interactions the collection of roots and extraradical fungal hyphae for downstream analyses. Sudangrass was grown in a soil compartment enclosed by nylon mesh and surrounded by sand, allowing fungal hyphae to extend into a separate sampling region while restricting root access. A complementary 3D-printed polypropylene microcosm prototype was developed for simplifying microcosm assembly in experiments using smaller plants. The prototype incorporated separate soil and sand compartments divided by a perforated baffle covered with nylon mesh. Preliminary assembly testing evaluated sand containment and mesh stability. Together, these efforts established an experimental setup and a prototype for future refinement of hyphal sampling workflows.

Summary

This LDRD project established microcosm systems to investigate plant-arbuscular mycorrhizal fungi-soil interactions.

Acknowledgments

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Acronyms and Abbreviations

AMF Arbuscular mycorrhizal fungi

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1.0 Introduction and Objective

Arbuscular mycorrhizal fungi (AMF) form symbiotic relationships with plant roots, receiving plant-derived carbon in exchange for nutrients.[1] Their hyphae extend into the surrounding soil, contributing to nutrient and water acquisition and organic matter formation. Understanding these plant-fungal interactions belowground requires experimental systems that allow plant roots and fungal hyphae to be sampled separately. This project established compartmented microcosms to study plant-AMF interactions and support sample collection for downstream analyses.

1.1 Methods

Pot microcosms were assembled using a modified version of International Collection of (Vesicular) Arbuscular Mycorrhizal Fungi (INVAM) [2] protocol (https://invam.ku.edu/harvesting-hyphae). The drainage holes of 2 L plastic pots were lined with mesh to prevent sand loss, and a level base layer of sand (200 g) was added. Soil mixture (335 g) was thoroughly mixed with 50 mL of live or autoclaved fungal inoculum (purchased from INVAM) in a 1 L graduated cylinder. The cylinder opening was covered with a 30 × 30 cm nylon mesh square secured with paper tape, and the cylinder was inverted into the center of the pot. Sand (1,250 g) was added around the cylinder, after which the tape and cylinder were carefully removed, leaving a central soil compartment enclosed by nylon mesh and surrounded by sand (Fig. 1). All materials were sterilized prior to use.

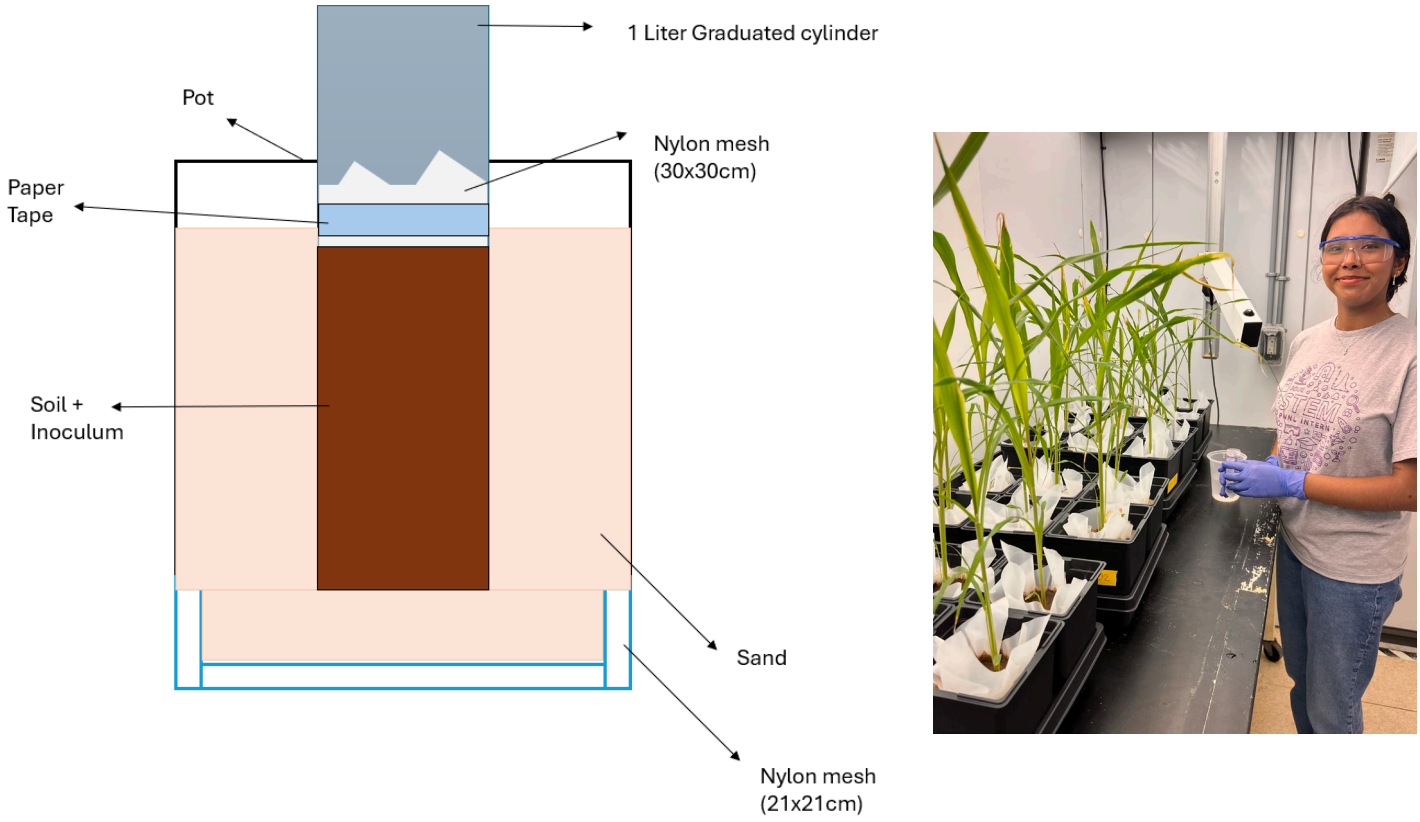

Figure 1. Compartmented pot setup (left) and Sorghum sudangrass growth in compartmented microcosms (right).

A 3D-printed polypropylene (PP) microcosm prototype was also developed to simplify assembly and facilitate hyphal collection for subsequent experiments especially with smaller plants. The design included separate soil and sand compartments divided by a PP baffle with 5 mm holes and nylon mesh secured on both sides using zinc-plated 6-32 screws. The mesh barrier was intended to permit fungal hyphal passage while excluding roots and retaining the compartment substrates. Preliminary testing involved filling one compartment with sand to assess sand containment and mesh stability.

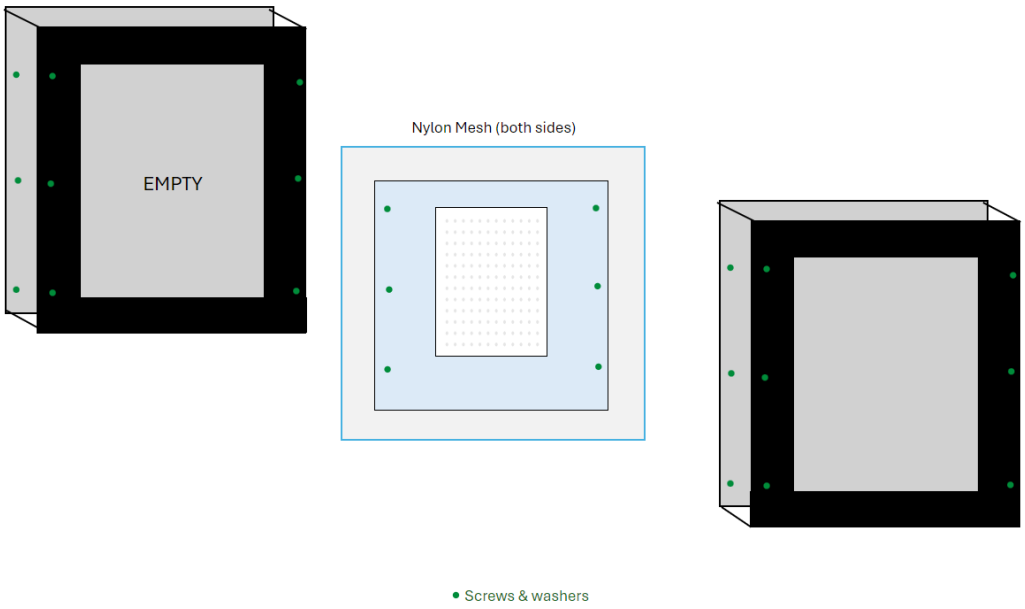

Figure 2. Experimental prototype layout including two hollow boxes and a baffle (center).

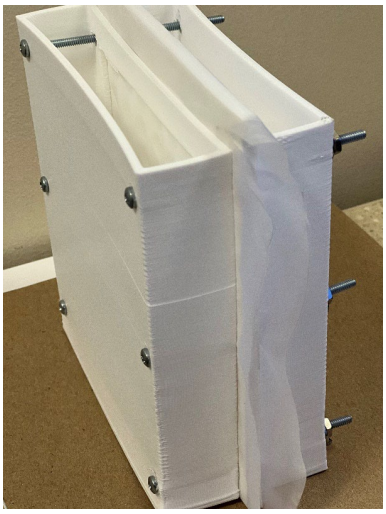

Figure 3. Prototype of 3D printed compartmented microcosm

Further evaluation of the prototype will assess its suitability for plant growth and recovery of root and fungal material for analyses.

2.0 References

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