# Persistence of Tree Nursery Root Fungal Communities During Transplanted Seedling Establishment

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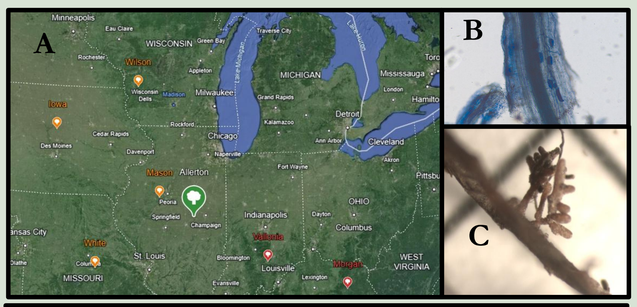
## Background

- **Ambitious reforestation projects targeted to combat climate change will require efficiency of the reforestation pipeline.**
- **One significant bottleneck in this process is the successful transplantation of bare root nursery-grown seedlings.**
- **Traditional nursery practices such as fumigation for pathogens can potentially limit or alter the development of beneficial mycorrhizal associations of tree seedlings.**
- **Mycorrhizal fungi are key mediators of tree tolerance to stress and may be a tool to increase transplanting success in changing climates.**
- **Therefore, it's essential to strike a balance between optimizing nursery conditions for seedling growth, preserving beneficial mycorrhizal associations, and limiting pathogen spread.**

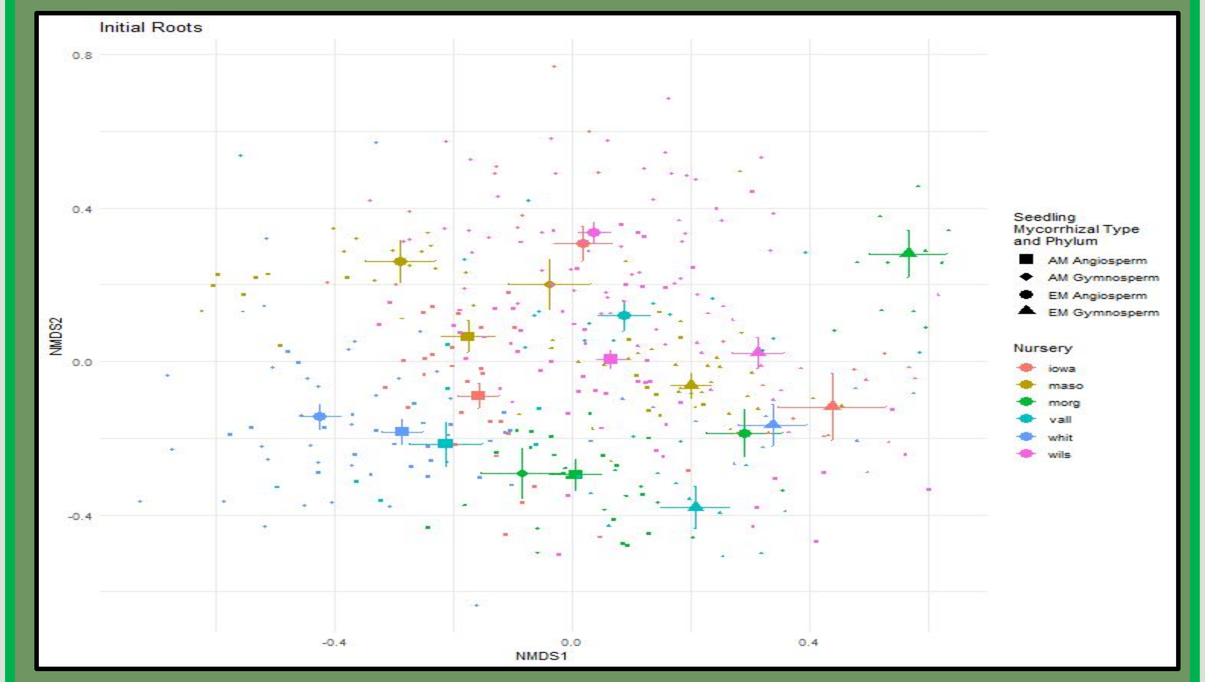
## Methods

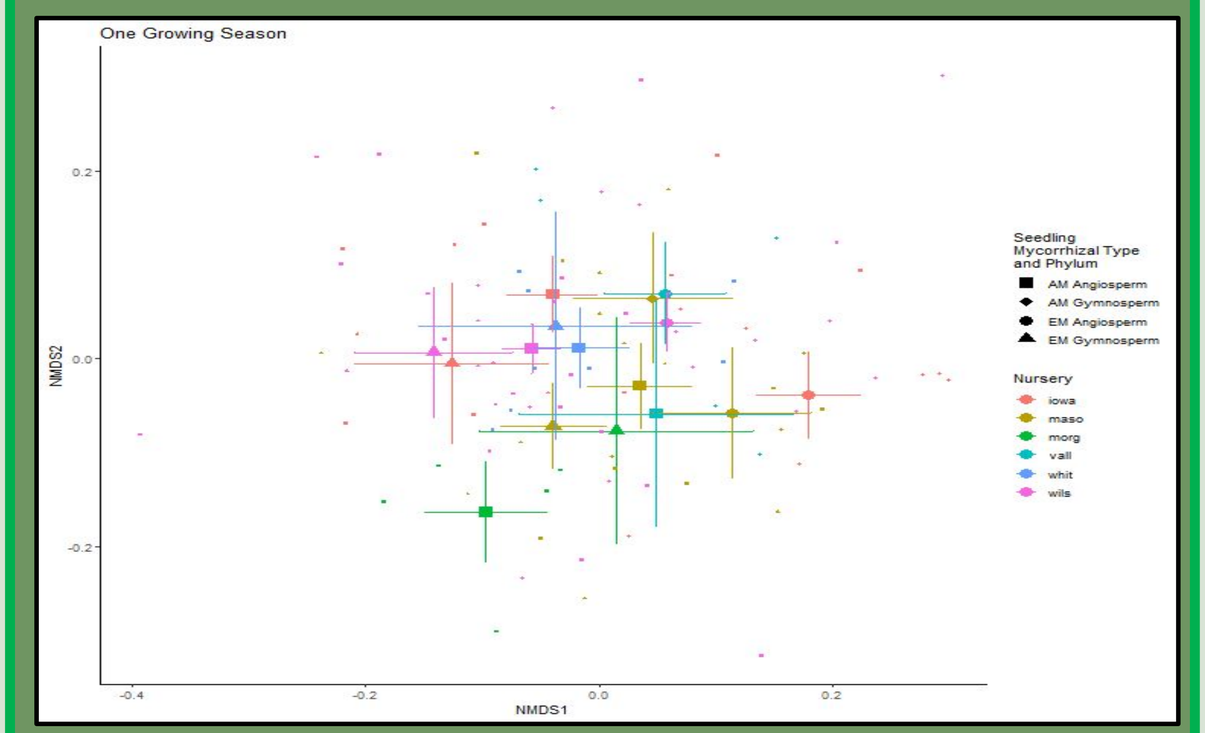


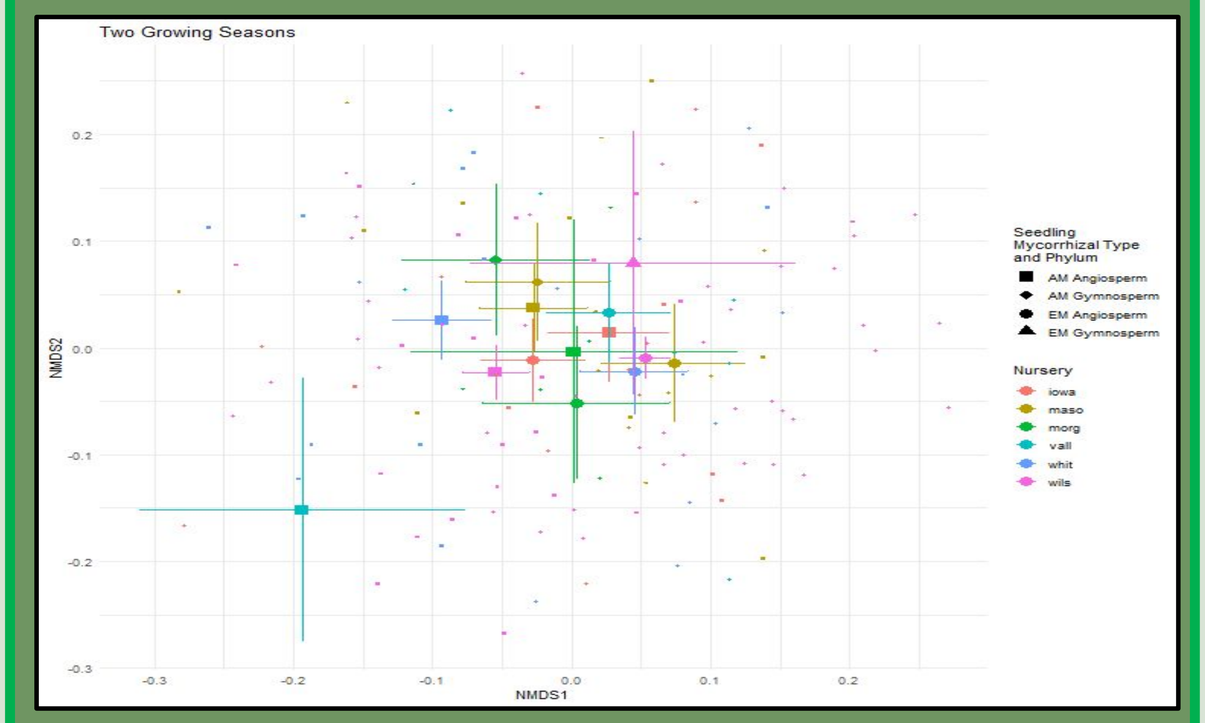

A. Google Earth Image of nursery locations and transplanted site B. arbuscular mycorrhizal fungi inside an *Ulmus* root C. ectomycorrhizal fungal mantle on *Carya* root

- **Obtained seedlings from six public bare root nurseries (IA, IL, IN, KY, MO and WI) in two years 2021 and 2022.**
- **4-8 species from nursery, including angiosperms and gymnosperms, and species that associate with both arbuscular mycorrhizal (AM) and ectomycorrhizal (EM) fungi.**
- **Tree seedling were planted into an old growth forest in central IL for two growing seasons.**
- **Characterized the fungal communities on seedling roots using the ITS2 gene; Permutation MANOVA tested whether fungal composition differed by nursery, seedling mycorrhizal type, and tree phylum.**

## *NMDS Plots of Nursery Tree Root Communities*




Colors indicate nursery; shapes indicate ectomycorrhizal (EM) angiosperms, EM gymnosperms, arbuscular mycorrhizal (AM) angiosperms and AM gymnosperms using error bars. AM Angiosperm include *Acer*, *Jugans*, *Prunus*, *Platanus*, and *Ulmus* and AM Gymnosperm is *Taxodium distichum*. EM Angiosperm include *Betula*, *Carya*, *Quercus* and *Tilia* and EM gymnosperm were several species of *Pinus*. Nurseries are: Iowa, Maso (IL), Morg (KY), Vall (IN), Whit (MO), Wils (WI).

## Results

- **Fungal communities differed strongly among nurseries in initial roots, one and two growing after transplanting (perMANOVA, $R^2 = 0.104$, $P < 0.001$, $R^2 = 0.062$, $p < 0.001$ , $R^2 = 0.048$ , $p< 0.001$).**
- **The effect of nursery becomes weaker after two growing seasons.**
- **Fungal communities differed between tree genera, mostly due to different mycorrhizal types and phylum, but nursery variation persisted within these categories.**

## Conclusions & Next Steps

- **Fungal communities originating from tree nurseries remained intact after planting into an old growth forest. These communities may serve as a source to spread both pathogenic and beneficial fungi.**
- **It is essential to determine whether fungal communities originating from tree nurseries either facilitate or hinder the establishment and growth of reforested trees.**
- **Future work should include nursery tree fungal community function in both mature forests and disturbed sites (post-agriculture and fire) and under different climate zones.**
- **To optimize restoration success, a better understanding of the underground fungal systems for each nursery location, nursery practice, tree species, and reforestation site are necessary.**
- **Capitalizing on relationships of tree seedlings that form in the nursery has the potential enhance restoration success.**
- **This understanding will help determine the most suitable inoculation practices to enhance healthy forest ecosystems.**

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