Alleviating Environmental Stresses in Native Arkansas Plants by Arbuscular Mycorrhizal Fungi Inoculation

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Introduction

- Plant–microbial interactions may play a crucial role in mitigating the extreme stress plants experience.
- Mutualistic microbes have been shown to confer a diversity of benefits on plants:
  - Tolerance to drought (Song et al., 2015), heavy metals (Zhang et al., 2010), or thermal stress (Khan et al., 2012).
  - Enhanced growth and nutrient/water acquisition (Read, 1999).
- Climate projections indicate that temperate forests will be exposed to increased frequency of drought in the near future (Sheffield and Wood, 2008).
- Several Arkansas plant species have been dramatically reduced from their historical levels due to global warming effects, including drought, introduction of diseases, or pests (e.g., invasive species).
- Mycorrhizal fungi help overcome the nutrient deficiency by extending their external hyphae to areas of soil beyond the depletion zone and increasing the absorptive surface of the root (DeLuca et al., 2002).

Objectives

1. To determine if AMF enhance fitness to native plants.
2. To test experimentally if variation in phenotypic plasticity due to AMF inoculation can be reflected under controlled environment in a greenhouse.
3. To determine if AMF can be used in native species habitat restoration.

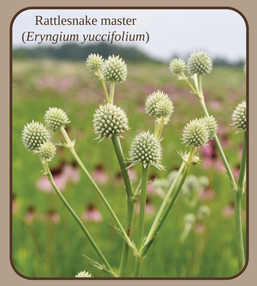
Experimental tests and hypotheses

Experiment 1: Mycorrhizal dependency of native species greenhouse experiment

Hypothesis: native plant species are highly dependent on AMF for increased biomass accumulation and nutrient uptake under stressful environments.

Experiment 2: Assessment of mycorrhizal colonization in wild populations of native plant species

*Hypothesis: P*opulations of native species in dry environments (towards the summit) will have a higher degree of mycorrhizal colonization compared to foothill or bottomland populations due to the difference in soil characteristics (higher nutrients and moisture availability).



Rattlesnake master (*Eryngium yuccifolium*)

Mrs. Loewer (*Tradescantia ohioensis*)

Short toothed mountain mint (*Pycnanthemum muticum*)

Western sunflower (*Heilanthus occidentalis*)

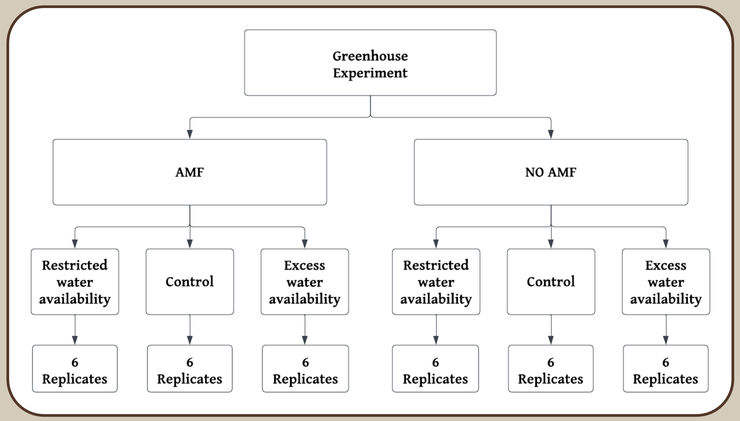
Forest goldenrod (*Solidago arguta*)

Materials and Methods

Experiment 1: Greenhouse experiment

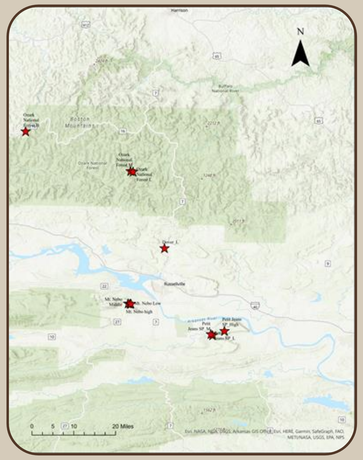
- Experimental plants will be grown from seeds of two native Arkansas plant species.
  - Multiple species - Rattlesnake master (*Eryngium yuccifolium*), Mrs. Loewer (*Tradescantia ohioensis*), Short toothed mountain mint (*Pycnanthemum muticum*), Forest goldenrod (*Solidago arguta*), and western sunflower (*Heilanthus occidentalis*) – are being inoculated with AMF spores to determine suitability for experiment.
  - Chosen plants will undergo a 4-month experimental period before analysis.

Measurements: Height, number of nodes, stem diameter, number of leaves, leaf area, specific leaf area, leaf thickness, Relative growth rate, Leaf chemistry analysis (C, N, and P)



Experiment 2: Field Assessment of mycorrhizal colonization in native plant species

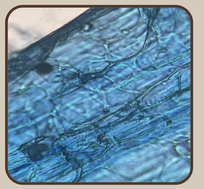
- 10 different locations in Arkansas covering moist to intermediate to dry habitats.
- All the flowering plants within 10X10 m2 plot at each location are sampled.
- Root samples are collected from wild populations.
- Root samples are cut into 1.5 cm fragments, cleared in 15% KOH at 70˚C for 4 hours, rinsed twice with water, bleached with ammoniated H_2O_2, and acidified with 1 N HCl.
- 0.05% Trypan Blue are used to stain mycorrhizal structures.



Results and Discussion

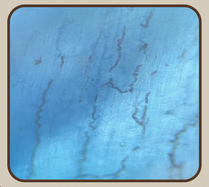
- All the native species screened (6 species) have shown AMF association.
- Plant species are adapted to local environment with the help of AMF.
- AMF help overcome the nutrient deficiency by extending their external hyphae to areas of soil beyond the depletion zone and increasing the absorptive surface of the root (DeLuca et al., 2002).

American Holly (*Ilex opaca)*



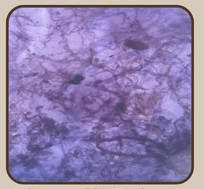
Loblolly Pine (*Pinus taeda)*

Oak (*Quercus* sp.)



Blue Phlox (*Phlox divaricata)*

Phlox (*Phlox* sp.)



White trout lily (*Erythronium albidum*)

Conclusions:

- Arkansas native species have a high degree of mycorrhizal colonization.
- More screening of native plant species across different environment in near future.
- Greenhouse experiment will help in determining if AMF enhance the fitness of native plant in drought environment.

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