A Study on the Effects of Mycorrhizae on *Desmanthus illinoensis* and *Monarda fistulosa* Plant Growth

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Introduction

Approximately 80% of all plant species form a symbiotic relationship with a fungi known as mycorrhizae (Duncan *et al.*, 2013). Mycorrhizae act as an extension to the plants' roots, so that the plant has increased uptake of water and nutrients, and the fungus gets carbohydrates from the plant carrying out photosynthetic processes (Gerdemann *et al.*, 1968). Mycorrhizae increases fruit set and pathogen resistance. (Babaj *et al.*, 2014). A study was conducted an in-depth analysis on exactly how the mycorrhiza affects plant growth. The study suggests mycorrhiza also aid plant growth by increasing the plant's ability to fight off pathogens (Sandhya *et al.*, 2013). The increased uptake of water and nutrients by the plant should lead to increases in traits such as stem height, number of leaves, and overall plant biomass. Although we know a positive relationship occurs between plants and mycorrhizae, the effects of commercial mycorrhizae are less clear. We tested the effects of commercial mycorrhizae on two native prairie species; *Desmanthus illinoensis* and *Monarda fistulosa* and compared with the efficiency of wild mycorrhizae naturally occurring in native soil.

We hypothesize commercial mycorrhizae will have a positive effect on the plants, with increased stem height, greater number leaves, and greater plant biomass. We also predict the positive effect to be greater with the commercial than the wild mycorrhizae because people specifically engineering the commercial mycorrhizae are able to provide all ingredients needed for optimal growth; they are essentially able to create the best mycorrhizae with optimal strains.

Materials & Methods

We used natural mycorrhizae from a compound of soil and commercialized mycorrhizae with the brand name, Sustainable Agricultural Technologies Endomycorrhizae. We measured effects on two plant species; *Desmanthus illinoensis* and *Monarda fistulosa*. The 2 types of soil used were live and sterile. Our 4 treatment groups were: live inoculated, sterile inoculated, live non-inoculated, and sterile non-inoculated. There were a total of 48 plants. We used a ruler with centimeters to measure the stem height, which is one of the most detectable ways to determine if the plant has benefitted from the mycorrhizae. We then counted the leaves on each plant: *Desmanthus illinoensis* had compound leaves while *Monarda fistulosa* had simple leaves. During the last week of the experiment, we harvested the plants by separating the soil from the roots and placing the entire plant in paper bags to prepare for measuring the biomass. All of the measurements of our traits, as well as the survivorship per week, were entered into an Excel spreadsheet. We used a two-way ANOVA statistical analysis in the program SPSS to produce graphs and tables using the p-values. The p-values, which are considered significant if they are equal to or less than 0.05, represent a test of the effects on the plant traits. Using these values, we can determine if the treatment groups did or did not affect the stem height, number of leaves, and biomass.

Key:
- LI=live inoculated
- LN=live non-inoculated
- SI=sterilized inoculated
- SN=sterilized non-inoculated

Results

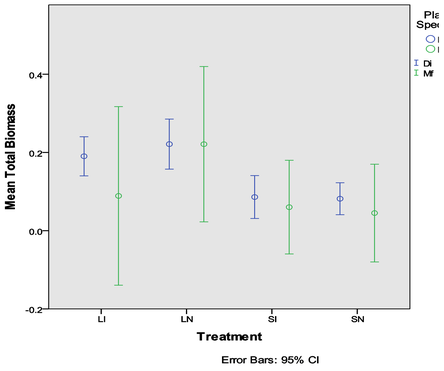

Figure 1: The comparison of total biomass of all treatments for both species during the last week of data collection.

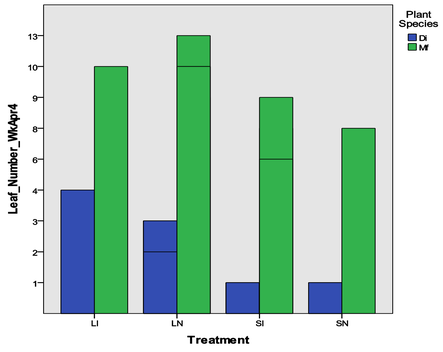

Figure 2: The comparison of the leaf number of all treatments for both species during the last week of data collection.

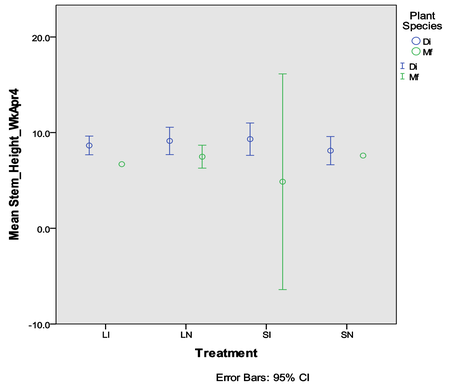

Figure 3: The comparison of the stem height of all treatments for both species during the last week of data collection.

We believed that the commercial mycorrhizae would provide the most increase in the selected plant traits (stem height, number of leaves, and biomass). Using a two-way ANOVA test in SPSS, we found that the soil treatment had a statistically significant effect on the total biomass (p=.003) but not on the stem height (p=.856) or the number of leaves (p=.088). Based on Figure 1, the live soil, both inoculated and non-inoculated, had the greater effect on total biomass compared to the 2 sterile treatment groups. According to Figure 2, the number of leaves was affected greater by the live treatment groups rather than the sterile soil treatments. Both Figures 1 and 2 depict that the treatment groups were consistent in the effects on the traits.

Trait	F Statistic	Overall treatment Effect	Live vs. Sterilized Soil	Inoculate vs. No Inoculate	Sterilization-Inoculate Interaction
Stem Height	2.467	0.045	0.496	0.365	0.011
Leaf Number	75.215	0.000	0.000	0.649	0.000
Biomass	2.160	0.060	0.003	0.316	0.254

Table 1: Statistical p-values for the plant traits from a two-way ANOVA test in SPSS.

Conclusions

We reject our initial hypothesis that commercial mycorrhizae would produce better results than the wild mycorrhizae, as there were no significant differences in stem height, number of leaves, or biomass. However, we did find that the live soil and sterile soil treatment groups had consistent effects on both species. Although *Monarda fistulosa* has much higher number of leaves then the *Desmanthus illinoensis*, we believe this is due to species differences rather than effects of the mycorrhizae (Figure 2). Nevertheless, we found that live soil treatments produced increased total biomass, and number of leaves over the sterile soil treatments (Figure 1 and 2). We believe this is due to mycorrhizae forming local adaptations to its native soil (Rua et al., 2016). The live soil collected for this experiment was collected in soil that these prairie plants are native to. This adaptation could have caused greater growth than seen in the sterile soil treatments. However, this growth was not the case with the stem height; tem height was consistent through all treatments. There is great variability within the sterile inoculated treatment of *Monarda fistulosa*. We believe this is due to one of our plants being very small, and the rest being quite larger.

We ended the experiment with quite a few plants that did not survive. This could be attributed to the small size of the *Monarda fistulosa* at the time they were planted. We had to use forceps to hold the tiny plant above the soil line. The plants of this species that ended up surviving, grew significantly and developed many leaves. By the end of the 4 weeks, *Desmanthus illinoensis* looked very similar to when they were first planted. It is possible that the traits we chose to test were not plastic; meaning no matter how the plant is treated, those plant traits will stay the same regardless. In the future, a similar experiment could be conducted but over a longer period of time. We believe that with more time, there would be more statistically significant differences in the effects of the two types of mycorrhizae on plant growth.

Literature Cited

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