EFFECT OF MYCORRHIZA INOCULATION ON BIOMASS AND CHLOROPHYLL CONTENT

Bailey Baskin, Martha Brand , Cory Dunsworth, Sotheby Shedeck

Department of Plant Biology, Ecology, and Evolution | Oklahoma State University | Stillwater, OK

Introduction

- In our experiment we measured the relationship between Desmanthus illinoensis (Di) and Monarda fistulosa (Mf) and commercial mycorrhizae inoculum by determining the content of cholorphyll as well as measuring the final above- and belowground biomasses.
- Mycorrhizal fungi are found in legumes and perennial forbs and are essential for maintaining the soil and provides nutrients through root hairs that stimulate plant growth and aid in the photosynthesis process.
- Plants in symbiosis with mycorrhizal fungi have greater shoot length, leaf area, leaf count, and root growth resulting in a greater dry plant mass (Estrada-Luna et al., 2000).
- Leafs with higher chlorophyll content and a higher photosynthetic rate in the presence of arbuscular mycorrhizae (AM) associations will make the plant able to have greater ability to fixate carbon as well as allowing for carbohydrate accumulation, thus allowing for more growth, benefiting in a larger plant mass (Ma, S. et al., 2016).
- We hypothesize that sterile, non-inoculated specimens will yield the lowest final biomass due to the decreased production of chlorophyll thus a lower photosynthetic rate and decreased adsorption and uptake of vital nutrients caused by the lesser amount of root hairs compared to its inoculated counterparts.

Methods

- We worked with a commercial inoculum and two plant species divided into eight subsections.
- Each species was divided into two groups, one with inoculum and one without added inoculum.
- Each subset of the plants was then planted in sterilized or unsterilized soil resulting in the eight test groups (see Image 1).
- For the duration of the experiment, chlorophyll content was tested and recorded for each specimen using the SPAD meter. This testing occurred once weekly for 3 weeks.
- At experiment's end, we gently removed the soil and roots from the pot then carefully liberated the roots from the soil with a water bath (see Image 2) before drying and bagging the plants to be measured the following week (see Image 3).

Di and Mf specimens potted and labeled.

Mf specimens post-bath.

Dry--separate above and below ground mass.

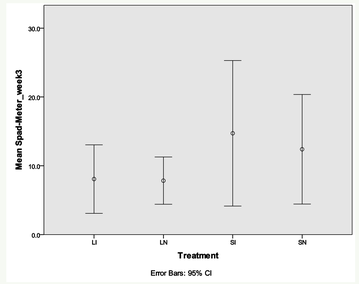

Figure 1:
Effect of soil and inoculum treatment on Di chlorophyll content.

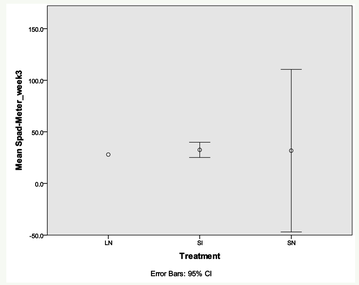

Figure 2:
Effect of soil and inoculum treatment on Mf chlorophyll content.

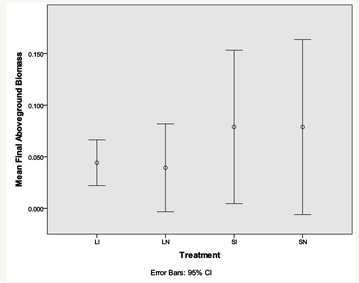

Figure 3:
Effect of soil and inoculum treatment on aboveground biomass for all specimens.

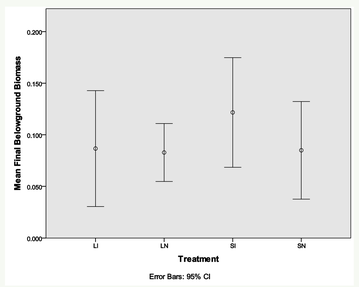

Figure 4:
Effect of soil and inoculum treatment on belowground biomass of all specimens.

Key: SI=sterilized, inoculated SN=sterilized, no inoc. LI=live soil, inoculated LN=live soil, no inoc.

Results

- The presence or absence of inoculum in the treatment of Di specimens had no significant effect on the chlorophyll content while the treatment of the soil did cause a significant difference in chlorophyll content (see Figure 1). This is supported by the anova analysis which states our F value as .252 and our P value as .622 (over the threshold of significance—0.50).
- The soil treatment for our Di species had a significant impact on chlorophyll content. Sterilized soil treatment resulted in a higher chlorophyll content than the non-sterilized soil treatment groups (see Figure 1). (F=4.872 and P=.042—well over 0.50).
- The species Mf had no significant differences in chlorophyll content in response to inoculation or soil sterilization (see Figure 2) (F=.022 and P=.891).
- The addition of inoculum to both species had no significant effect on the final weight of their aboveground biomass (see Figure 3). However, we can see in the same figure that the treatment of the soil played a significant role in mass development—sterilized soil being the more conducive growing medium (F=1.619 and P=.214).
- The belowground biomass of inoculated species was significantly higher than that of the sans-inoculum specimens as seen in Figure 4 (F=.970 and P=.334). The sterilized soil treatment also significantly increased the belowground biomass of the specimens (F=.817 and P=.3740 (see Figure 4).

Conclusions

When reviewing the data and considering the results of our anova analysis, a theme appears that suggests the inoculation of our specimens with commercial AM did not affect the development of the plants negatively or positively (except in regard to both species' belowground biomasses). Given that chlorophyll content was unaffected by this treatment, it would seem that the presence of the fungi does not hinder or aid the plant in the production of nutrients through photosynthesis. However, this data may be affected by the relative inconsistency of our SPAD meter readings due to the Di species' sparsity of leaves as well as the low survival rate of the Mf species following transplant. Inoculation contributed to belowground biomass, as the fungi intertwines itself with the roots of the plant, adding its own mass to that of the plant's roots. The sterilization of the soil did yield positive results for all variables. This result may be attributed to the fact that sterilization exterminates all parasitic organisms that had been living in the live soil. Since our species were both quite frail, eliminating any competing elements from the soil allowed for the development of substantial, more productive plants.

References

Allen, M.F., et al. "Comparative Water Relations and Photosynthesis of Mycorrhizal and Non-Mycorrhizal Bouteloua Gracilis H.B.K. Lag Ex Steud." *New Phytologist*, vol. 88, no. 4, Aug. 1981, pp. 683-693.

Estrada-Luna, A.A., Davies Jr., F. & Egilla, J. Mycorrhiza. 2000, Mycorrhizal fungi enhancement of growth and gas exchange of micropropagated guava plantlets (Psidium guajava L.) during ex vitro acclimatization and plant establishment. *Mycorrihza* 10: 1-8

Gerschefske, D.K., B.A. Daniels Hetrick and G. W. T. Wilson. 1988, Relationship of soil fertility to suppression of the growth response of mycorrhizal big bluestem in non-sterile soil.

Ma, Z., Bielenberg, D. G., Brown, K. M. and Lynch, J. P. (2001), Regulation of root hair density by phosphorus availability in *Arabidopsis thaliana*. Plant, Cell & Environment, 24: 459–467. Song-Mei S., Ke Chen, Yuan Gao, Bei Liu, Xiao-Hong Yang, Xian-Zhi Huang, Gui-Xi Liu, Li-Quan Zhu, and XinHua He, Front Microbiol. 2016, Arbuscular mycorrhizal fungus species dependency governs better plant physiological characteristics and leaf quality of mulbery (*Morus albaa L.)* seedlings. *Front Microbiol.* 2016. Frontiers in microbiology.

Wilson, G.W.T., et al. "Effects of Mycorrhizae on Growth and Demography of Tallgrass Prairie Forbs." American Journal of Botany, vol. 88, no. 8, 2001, pp. 1452-1457