**MYCORRHIZAL SEED SOAK AND SOIL INTEGRATION**

**INOCULATION ON WILDFLOWER GERMINATION AND SEEDLING**

**ESTABLISHMENT**

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There have been enormous number of studies related to the positive impacts of using fungi mycorrhiza in organic gardening and turf management. These studies have shown that endomycorrhiza provide protection against pathogens and stimulates productivity of crops. However, there has been both few studies and literature on the adoption of using mycorrhiza in the establishment of wildflowers.

This 10-week study used an initial mycorrhiza priming seed soak or incorporated mycorrhiza in seed bed of pre-emergent wildflower seed/plants. The study hypothesized that the inoculation of the seeds or the soil integration of the mycorrhiza would improve germination/emergence, decrease damping off and improve biomass of seedling stand compared to control. Measurements conducted were plant emergence, root to shoot length, and biomass. Uniform rates of seed dispersal and irrigation were maintained for all three tested groups.

Wildflower establishment is significantly promoted with the prior integration of endomycorrhiza before seeding. Representative findings from 10-week study realized 200% increase in plot biomass over control.

Introduction

The benefits of wildflower plantings are many. Depending on the wildflower site, economical, educational, recreational, ecological, and aesthetic advantages may exist. There are several ecological benefits of a wildflower meadow. Wildflowers can improve water quality by decreasing amounts of runoff of pesticides, petroleum products, lead, and sediments . Increased water quality and reduction in air pollution can be realized compared to turf areas because of the wildflower plant’s ability to trap and hold pollutants related to its increased vegetative biomass. Once trapped, pollutants are not able to runoff as pollution to the groundwater, thereby improving water quality. Wildflowers anchor soil with deep dense rooting to stabilize eroding slopes, river or stream banks, and beach dunes. Wildflower plantings use little, if any, pesticides thereby the potential for offsite movement of pesticides is decreased. Wildflower meadows can act as greenways, with wildlife using them for food, shelter, and transportation corridors. Wildflower plantings aid in habitat restoration and protection by attracting birds and insects, especially butterflies. From an educational and recreational standpoint, wildflower plantings afford people the opportunity to observe, interact, appreciate, and understand more about natural settings. Wildflower native plantings can be used to educate and offer an opportunity for activities such as walking, running, bird watching, and photography. Native wildflowers store significant amounts more carbon than turf grass which has much shorter roots and thus stores much less carbon.

In urban areas there is an increased interest in using native wildflowers alongside roadways or residences replacing what is most often planted in turf grass. These wildflower plantings or pocket meadows are small, native plantings inspired by the natural landscape. They offer the same ecological benefits of wild meadows, but on a smaller, more manageable scale. One advantage of established pocket meadows is the decrease in maintenance time compared to other flowering gardens or turfgrass. However, many of these small meadow projects are frustrated from the beginning as poor germination of seed or subsequent rooting is not successful. We hypothesize that the reduced germination and root development of wildflower seed is linked with ineffective fungal communities at restored sites. Many of these former turfgrass sites are plowed, sprayed with herbicides, or some form of solarization is used to kill grass and weeds. Mycorrhizal fungal communities are beneficial to host plants because they collect and deliver soil nutrients, provide drought resistance, and induce resistance to herbivores and pathogens. Therefore, disturbed planting sites may limit the reestablishment of wildflower species that strongly benefit from these fungal communities.

Literature Review

The below study concluded that mycorrhizal amendments have significant positive contributions to prairie grass establishment. Additionally, findings from this study found that the mycorrhiza decreased the number of weeds and non-native plant establishment.

We conclude that adding a diverse AM fungal community with known beneficial isolates of AM fungi can facilitate the establishment of a late successional prairie community by inhibiting non-desirable native weeds and non-native plant species while simultaneously improving late successional plant growth, fecundity, richness, and seed recruitment. We conclude that adding a diverse mixture of multiple beneficial species of AM fungi in combination with prairie seeds and plugs can drive plant community dynamics towards high-quality native plant community, rich in highly conservative late successional species in as little as two growing seasons. (Koziol, L, 2017)

The below study investigated the use of mycorrhizae on the establishment of switchgrass. The study reported significant increases in plant height, root length, and biomass.

Seed dormancy and slow seedling establishment are two major concerns in  switchgrass (Panicum virgatum L.) production, often resulting in a poor stand with reduced productivity. Studies were conducted to investigate the stability of artificial associations between switchgrass and the ectomycorrhizal fungus and to evaluate the potential benefits of this novel association in seed germination and biomass production. The positive effects of the associations were reflected in plant height, root length, and biomass production. Inoculated plants produced as much as 75%, 113%, and 18% more shoot biomass than un-inoculated control plants in the first, second, and third harvest, respectively, with no consequent reduction in root biomass. This study illustrates the great potential of microbial associations to increase biomass production and productivity of switchgrass. (Ghimire, 2009)

The below literature review summarized findings related to investigations in the germination and seedling establishment of crops using coated seeds. This biopriming using various fungi inoculants have proven successful in plant disease and pathogen suppression.

  Studies have shown that coating seeds with PBM can assist crops in improving seedling establishment and germination or achieving high yields and food quality, under reduced chemical fertilization. The right combination of biological control agents applied *via* seed coating can be a powerful tool against a wide number of diseases and pathogens. Less frequently, studies report seed coating being used for adaptation and protection of crops under abiotic stresses. Notwithstanding the promising results, there are still challenges mainly related with the scaling up from the laboratory to the field and proper formulation, including efficient microbial combinations and coating materials. (Rocha,L.,2021)

Material and Methods

The site for this study was selected in May 2020. This site was former soccer field that had not been used for 4 years. No herbicide or fertilization had been applied doing that period. A soil test of site revealed no needed amendments. Site was covered with two layers of weed barrier for the period of May 2020 to October 2021. This weed barrier was effective in killing all grass and weeds from site. Site was raked gently of dead debris before seed was applied. The site measured 45 feet by 15 feet for total of 675 sq. ft. The site was equally divided in three equal measurements of 225 sq.ft for each study groups. Site #1 was designated for seed applied that had been soaked in liquid mycorrhizae for 14 hours. Site #2 was designated for the incorporation of raked in dry mycorrhizae before seed applied. Site #3 was control area where no application of mycorrhizae took place before seed application.

The seed used for this study was a Fall Maximum Seed Mix purchased from American Meadows Seed Co. The mix is a combination of Fall and Summer blooming Perennials and Annuals.

Perennials included in seed: Hyssop, Butterfly Weed, Aster Coreopsis, Blanket Flower, Ox Eye Sunflower, Echinacea, Blazing Star, Blue Flax, Lupine, Penstemon, and Bee Balm.

Annuals included in seed: Cornflower, Cosmos, Plains Coreopsis, Chinese Forget-Me-Nots, California Poppy, Baby’s Breath, Candytuft, Scarlet Flax, Sweet Clover, Red Poppy.

The seed amount applied to each of the 3 study plots was ¼ lb. of seed. The mycorrhizae applied to the soil integrated study group was 2 lb. of dry fine MycoApply Endomycorrhiza. For the seed soak study group 1/8 lb. of MycoApply Endomycorrhiza was mixed with water to soak seeds.

Seeds were hand distributed and raked for even distribution on Oct. 7th, 2021. Moisture was evenly applied.

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Measurements

4 Weeks after initial seed dispersal measurements of emerged wildflowers were taken. 16 sq. centimeter samples representing the largest populated plant density from each study plot were extracted. The total dry biomass of each sample was weighed. Fifteen plants with largest root to shoot length from each study group were bundled to measure average length. 10 Weeks after initial seed dispersal the same biomass and root to shoot bundle measurements were repeated.

Findings

As hypothesized the integration of the endomycorrhiza showed significant gains in wildflower establishment. The germination rates, root to shoot measurements and total biomass of the mycorrhizal soil integrated test plot outpaced both the control group and the mycorrhizal seed soak group by significant margins. (See Table One) While the mycorrhizal seed soak group showed lower rates of biomass compared to soil integrated group it did show improved biomass and root to shoot measurements compared to control. There was approximately 200% more plant biomass in the mycorrhizae soil integrated plot then the average of the other two plots.

**Table One: Seed Plot Measurements**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Plot #1 Seed Soak** | **Plot #2 Soil Integrated** | **Plot #3 Control** |
| **Week 4: Plant Coverage %** | **90 %** | **100+ %** | **90%** |
| **Week 10: Plant Coverage %** | **95%** | **100+ %** | **90%** |
| **Week 4: Sample Biomass- Grams** | **6 gr.** | **24 gr.** | **4 gr.** |
| **Week 10: Sample Biomass- Grams** | **11 gr.** | **30 gr.** | **9 gr.** |
| **Week 4: Root to Shoot Bundle Average Length** | **10 cm.** | **13.0 cm.** | **9 cm.** |
| **Week 10: Root to Shoot Bundle Average Length** | **11.5 cm.** | **15.0 cm.** | **10 cm.** |

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***Figure 1. Plot 1. Seed Soak 10/7-11/7***

Calendar

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***Figure 3. Plot 2. 4 Weeks Soil Incorporated 10/7- 11/7***

A group of pineapples

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***Figure 5. Plot 3. 4 Weeks Control. 10/7-11/7***

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***Figure 6. Plot 3. 10 Weeks Control 10/7-12/18***

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Conclusion.

The establishment of wildflower/meadow sites can be promoted with the use of the fungus endomycorrhiza as a biopriming agent. These beneficial fungi greatly increase the effective rooting area of plants, thereby enhancing plant growth, vigor, and tolerance of environmental extremes. The mycorrhizal fungi colonize roots and extend into the surrounding soil forming an essential link between plant and soil resources. This fungal support can be important as many wildflower sites have been plowed or the previous grass/weeds treated with herbicides or solarized. A strong stand of rooted and established wildflowers in the near-term weeks shortly following germination can suppress the encroachment of weeds. With a fall sowing of wildflower seeds the strong vigor of rooting provided by the mycorrhizae would ready plants for spring takeoff.

This study used a seed mix of perennials and annuals. Subsequent studies should be undertaken on specific wildflowers. Further studies should be conducted on appropriate rates of mycorrhizal application.

References

Ghimire, S.R., Charlton, N.D. & Craven, K.D. The Mycorrhizal Fungus, *Sebacina vermifera*, Enhances Seed Germination and Biomass Production in Switchgrass (*Panicum virgatum* L). *Bioenerg. Res.* **2,**51–58 (2009). <https://doi.org/10.1007/s12155-009-9033-2>

Koziol, L., Bever, J. D., & Nuñez, M. (2017). The missing link in grassland restoration: arbuscular mycorrhizal fungi inoculation increases plant diversity and accelerates succession. Journal of Applied Ecology, 54(5), 1301–1309.

https://doi-org.proxy- es.researchport.umd.edu/10.1111/1365-2664.12843

Rocha, I., Ma, Y., Souza-Alonso, P., Vosátka, M., Freitas, H., & Oliveira, R. S. (1AD, January 1). *Seed coating: A tool for delivering beneficial microbes to agricultural crops*. Frontiers. Retrieved December 25, 2021, from https://www.frontiersin.org/articles/10.3389/fpls.2019.01357/full