RELATIONSHIP BETWEEN COLONIZATION RATES OF ARBUSCULAR MYCORRHIZAL FUNGI AND WOODY PLANT GROWTH

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Background

Agriculture and other forms of anthropogenic land use has been found to have lasting negative effects on the microbial soil communities over the short and long term (Fichtner et al., 2014; Oehl et al., 2004). Research shows the positive effects arbuscular mycorrhizal fungi (AMF) richness has on the early stages of ecological succession in disturbed Tibetan grasslands (Mao et al., 2019), which makes the potential applications of AM fungi in ecosystem restoration evident for disturbed areas, like previously clear-cut forests or cropland.

Although we do know the positive effects of AM relationships (Figure 1), our understanding of the role AM fungi plays in the forests of the Northeastern United States is quite limited. One of the key steps in uncovering the utility of AM fungi in forest management/restoration is to understand the relationship between the rates of AMF and woody plant colonization and growth. Research regarding this relationship has potential to change our approach to restoration projects.

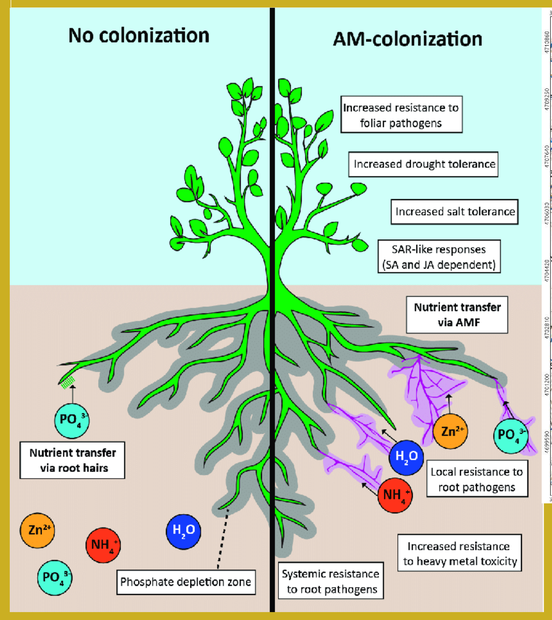

Figure 1: This figure shows the benefits that come with AM colonization, including an increased resistance to biotic and abiotic factors, as well as increased nutrient uptake (Jacott et al., 2017)

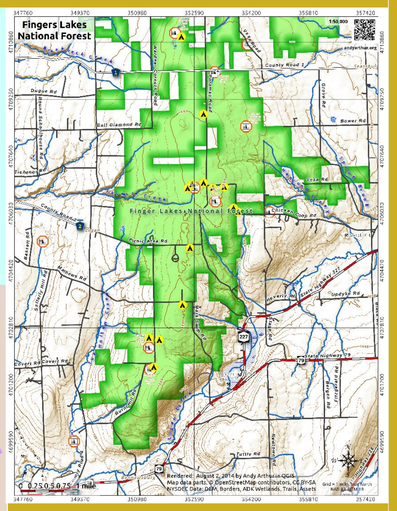

Figure 2: Map of the Finger Lakes National Forest. The boxed pattern is a result of the land's history in agriculture.

Hypothesis

- *I hypothesize that there is a relationship between the rates at which arbuscular mycorrhizal fungi and timber saplings colonize formerly disturbed topsoil in the Northeastern United States.*

Methods

The research conducted will be a manipulative field study in which 10 sites are randomly selected within the Finger Lakes National Forest (Figure 2) (chosen for its history of soil disturbance and lack of vast elevation differences). After being selected, measurements of AMF richness will be conducted at the sites using the methods of Mao et al. (2019). Measurements of soil moisture and pH will also be collected before any manipulations occur.

After this data is collected, cloned Northern Red Oak saplings (chosen for being the most common tree in New York and for its demand as timber (United States Department of Agriculture, 2014)) will be planted at 10 randomly selected points within each site for a total of 100 planting sites. The height and diameter (in inches) of the saplings will be measured before planting, and then once a month for three years to get a before measurement of sapling growth rates for all the sites.

Following these control measurements, five sites will be randomly selected to be clear cut and turned into a monoculture corn farm in order to further disturb the soil. This land will be harvested for two seasons, while the rest of the sites are left undisturbed. Following this, AMF richness will be measured once a month in order to observe the rate of colonization on the degraded soils. At the same time, Red Oak saplings will be planted in all of the sites and measured as they were before in order to observe any changes in growth rates over the course of three years (same as before).

Figure 3: an image of a Northern Red Oak leaf and acorn (Michaux , 1819)

Analysis

The study will give us measurements of AMF richness and of sapling growth rates (inches diameter/month and inches height/month) before and after disturbance in a Northeastern forest. These rates can then be looked at to see how they correlate with each other from month to month.

My prediction is that AMF richness will be highest before disturbance, lowest after disturbance, and that AMF richness will be directly related to the rate of growth for the saplings. If this is true, then as the AMF richness increases, so would the rate at which the saplings grow. It is also crucial to consider and account for the changes in soil moisture/pH, precipitation, and sunlight when looking at the changing rates.

Literature cited: Arthur, A. (2014). [Web log post]. Retrieved from https://andyarthur.org/map-finger-lakes-national-forest.html; Fichtner, A., et al. (2014), Soil Biology and Biochemistry, 70, pp. 79-87; Jacott, C. N., et al. (2017). Agronomy, 7(4), 74th; Mao, L., et al. (2019), Soil Biology and Biochemistry, 134, pp. 131-141; Michaux, F. A., et al. (1857). The North American sylva... .. Philadelphia: D. Rice & A.N. Hart.; Oehl, F., et al. (2004), Oecologia, 138, pp. 574–583; Riemann, R., et al. (2014). Modeled distributions of 12 tree species in New York. 10.2737/NRS-RMAP-5.