Integrating Nutrient Cycling Research with Sustainable Agricultural Practices and Outreach

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Introduction

Sustainable agriculture is the ability to meet current food and textile needs while preserving the ability of future generations to meet their needs. Nutrient cycling plays a crucial role in these practices. Efficient nutrient cycling can improve soil health by supporting diverse microbial communities and maintaining organic matter. It minimizes nutrient runoff and leaching which helps preserve water quality. These projects focused on the importance of nutrient cycling and biodiversity through sustainable gardening, the role of bacteria and fungi in the rhizosphere, soil sampling and analysis of nutrients in the soil.

Methods

- Science communication
- Community Outreach
- Soil and water sampling from Ore Knob and Robeson County
- Soil and plant nutrient analysis
- 16s rRNA and ITS genome sequencing

Discussion

The introduction of *Pseudomonas fluorescens* (Pf) and *Saccharomyces cerevisiae* (Sc) extracellular vesicles (EVs) into sterile soil led to significant changes in the soil microbiome. EVs are membrane bound structures released by cells into the extracellular environment. By studying EVs in the soil, we can understand how different organisms interact and influence nutrient such as nitrogen, phosphorus, carbon, potassium, and sulfur. *S. cerevisiae* can produce phosphatases that can be contained in its extracellular vesicles, released and made available for plants. Practiced use of composting, cover cropping, irrigation, etc. to promote sustainable practices in the student garden. The food harvested from this garden was donated to FARM Café. Worked with veterans wanting transitioning to farming by touring local farms and commercial kitchens. Worked with high school students on the importance of sustainable practices, characterization and analyzation, and microscopy. A presentation on each topic with activities was done. A soil sample demonstration was done in Robeson County.

Results

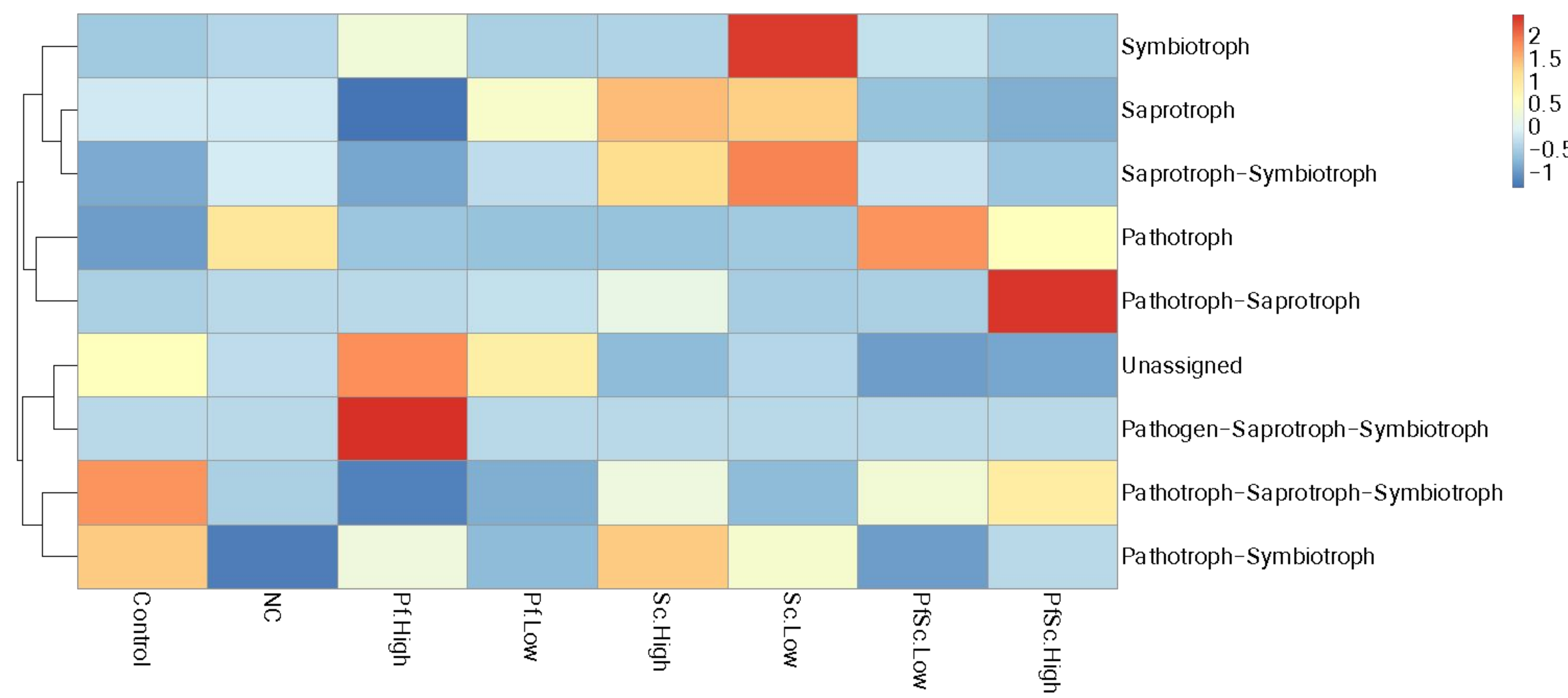

Figure 1. Heatmap of predicted trophic interactions from different treatment groups

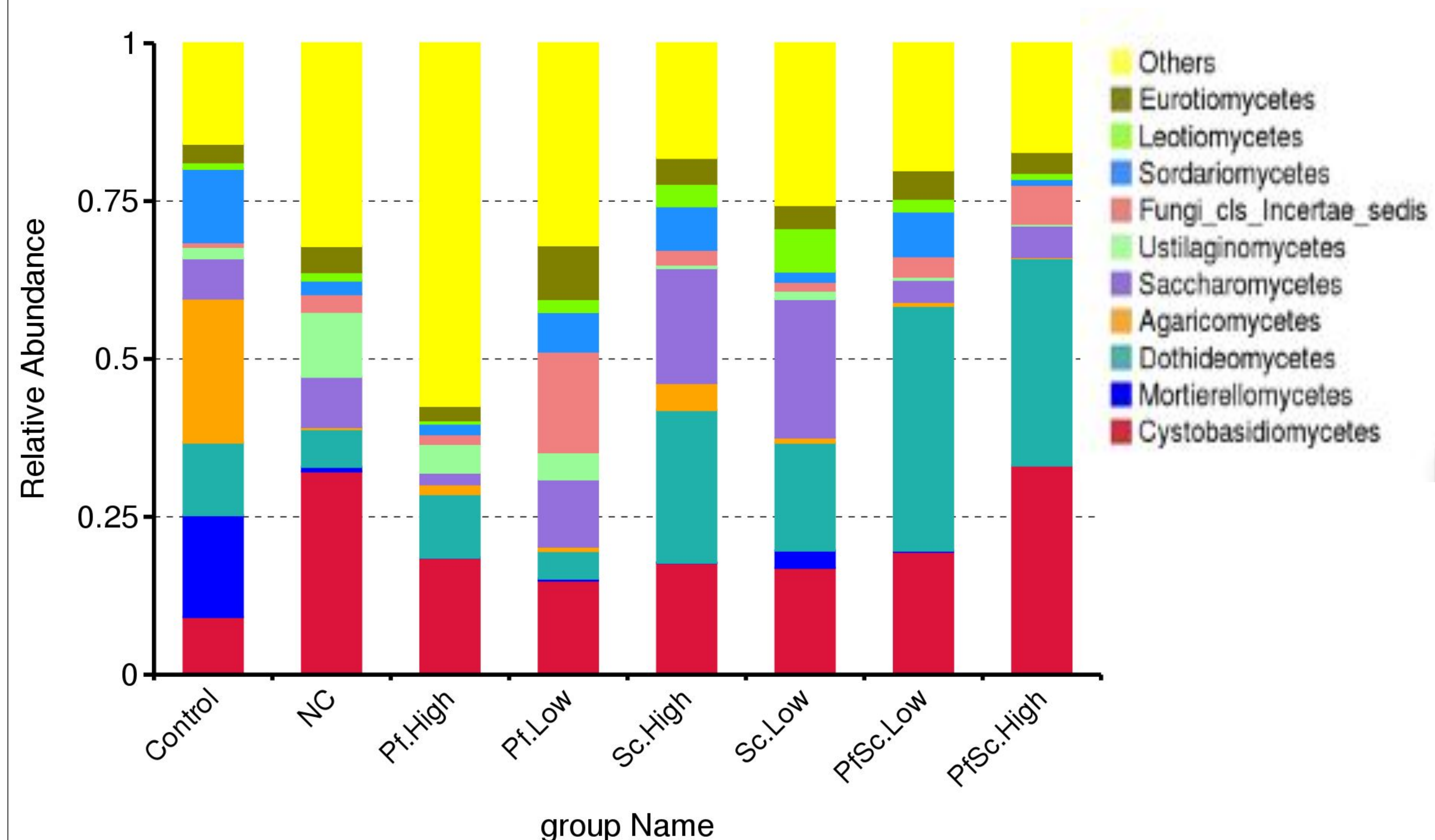

Figure 2. Relative abundance of classes in observed fungal species

Figure 3. Sustainable Garden at Appalachian State

In Figure 1 PfSc-High increases pathotroph-saprotroph functions compared to the control. Sc EVs contribute to increasing saprotroph functions. In Figure 2 the results of relative abundance among classes is displayed. The control shows a diverse abundance of classes within the sample. The combination of Pf and Sc lead to an increase in Dothideomycetes and Cystobasidiomycetes which can help regulate fungal populations and be decomposer in the environment. Their increase could indicate a shift in the fungal community towards organisms breaking down organic matter. This observation aligns with the experience in Figure 3 at the sustainable garden in nutrient cycling.

Sampled water and soil from Ore Knob. In conclusion, beyond the research in the field, there was engagement with local farms through Frontline to Farm, volunteer work at a local food hub, and communication of this science to high schoolers through Upward Bound. Future research would look further into the long-term soil health effect, and what specific mechanisms influence the nutrient cycling process from Pf and Sc EVs, particularly phosphorus cycles.

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