PLFA ANALYSIS OF SOIL MICROBIAL COMMUNITIES: KEY INSIGHTS FROM ORGANIC ARTICHOKE CROPPING SYSTEMS

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Introduction

This study examines the soil microbial effects of replacing polyethylene row covers in artichoke production with legume and non-legume cover crops (CC) at Rodale Organic Institute in Camarillo, CA. Using cover treatments including polyethylene film mulching (PFM), leguminous cover crops: white clover and crimson clover, and non-leguminous cover crops: buckwheat and kurapia, we analyzed microbial biomass in bacteria, fungi, and protozoans, as well as subgroups such as Gram-positive and Gram-negative bacteria, saprophytes, and mycorrhizae through phospholipid fatty acid (PLFA) testing, Kruskal-Wallis tests, and a Dunn test. We also analyzed Microbial taxonomic diversity through Metabarcoding. Additionally we compared composition and abundance of bacteria through DEseq2.

Results:

PLFA Analysis:

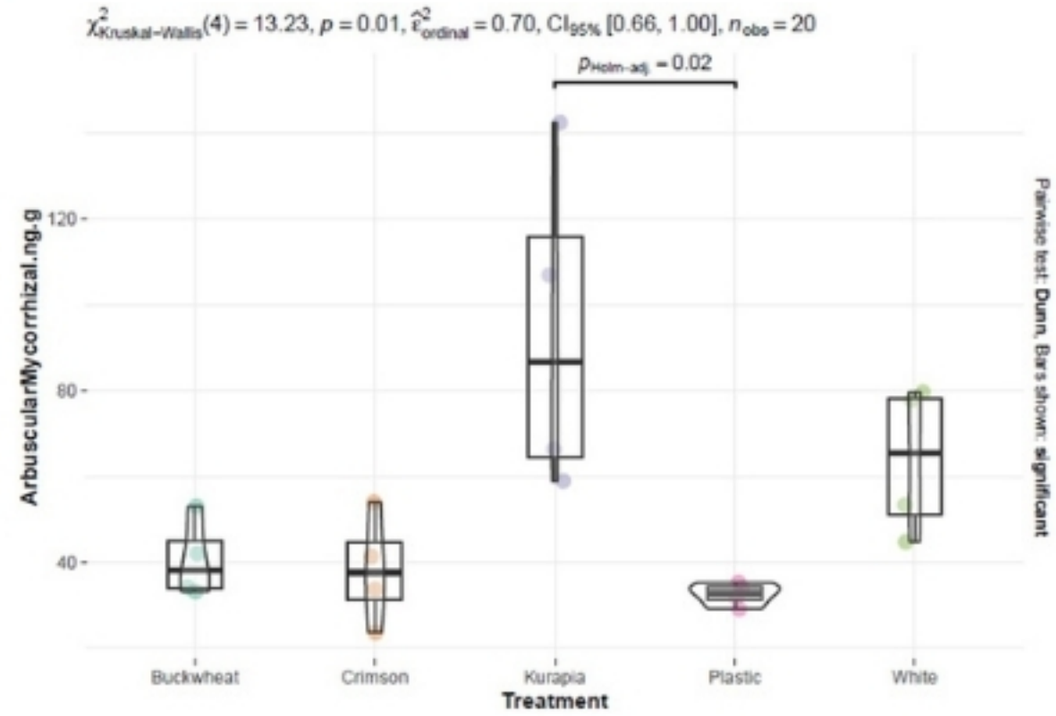

Figure 1. The results of the Kruskal Wallis show that the average mass of Arbuscular Mycorrhizae in the Kurapia treatments was significantly higher than the plastic treatment, at >80 ng/g.

Taxonomic Diversity:

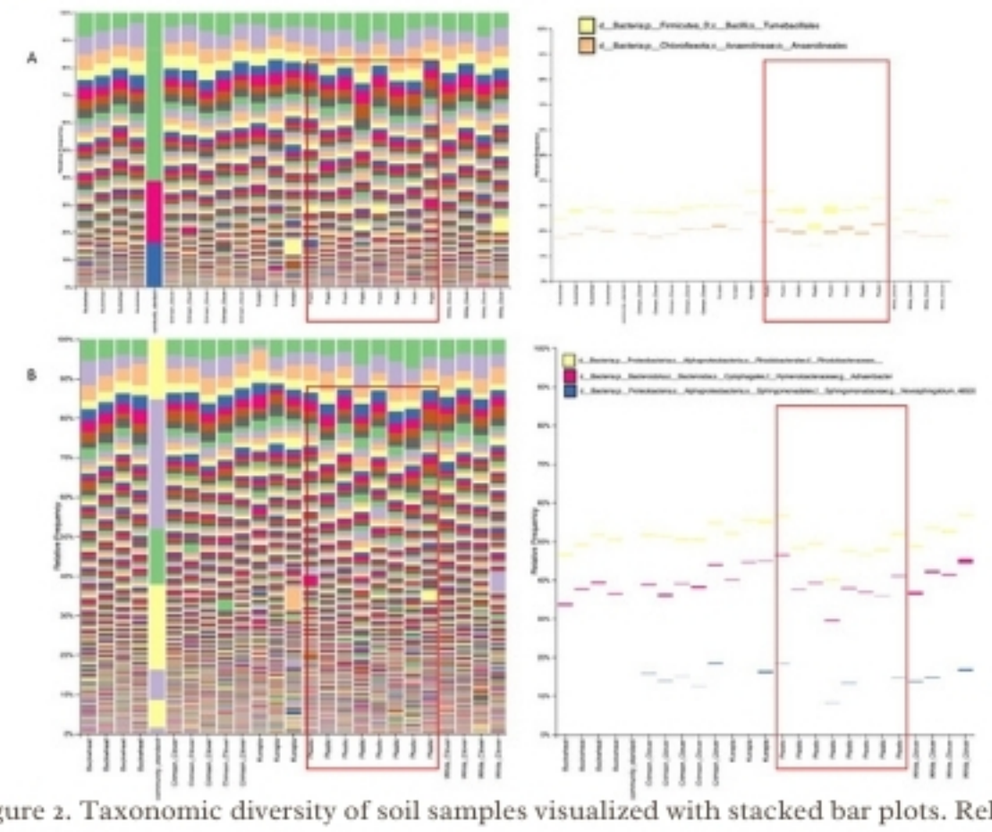

Figure 2. Taxonomic diversity of soil samples visualized with stacked bar plots. Relative frequency of all taxa (left) and selected taxa (right) are displayed for each sample. (A) Data sorted by Order, showing evidence of increase Tumebacillales and Anerolineales order taxa. (B) Data sorted by Genus, showing evidence of increased *Adhaeribacter* in white clover treatment when compared to PFM.

Differential Abundance Analysis:

OTU	baseMean	log2FoldChange	lfcSE	Stat	pvalue	padj
Sphingobium sp.	6.437166	-27.2358	3.9184	-6.95075	3.63E-12	2.63E-09
Phycicoccus sp.	16.69115	7.643712	1.890216	4.043829	5.26E-05	0.007604
Adhaeribacter sp.	108.974	1.422866	0.317544	4.480846	7.43E-06	0.001792
Rhodobacter sp.	6.527468	-29.836	4.491545	-6.6427	3.08E-11	1.11E-08

Table 1. The significant results of the DEseq2 differential abundance analysis are provided (p<0.01 FDR cutoff was used). The Contrast was between White Clover and Plastic treatment microbial communities. The genera with the positive log fold change values were differentially abundant in White Clover soil communities; the genera that had negative log fold change values were more abundant in Plastic treated soil communities.

- The results showed that the cover treatment was significant in:
  - Determining the functional diversity index; plastic tended to have a lower functional diversity index than white clover (p=0.015); the Dunn Test was negative (p-adj=0.076).
  - Determining the mass of Arbuscular mycorrhizae in plots (p=0.010). Arbuscular mycorrhizae biomass was different between the plastic and Kurapia treatments, according to the results (p-adjusted=0.023).
- There were key differences between the White Clover and Plastic microbial communities. In the White Clover vs. Plastic contrast, the following results were indicated: higher in White clover treatments, *Adhaeribacter sp., Phycicoccus sp.*; higher in plastic treatments, *Rhodobacter sp., Sphingobium sp.*

Conclusion:

- Advanced microbial analyses provides insight into how different ground covers shape soil microbial composition.
- Kurapia showed unique benefits in enhancing arbuscular mycorrhizal biomass.
- White clover demonstrated significant enrichment of specific nutrient-cycling beneficial taxa such as *Adhaeribacter sp.*
- PFM was associated with reduced microbial diversity, but with higher amounts of degrading bacteria such as *Sphingobium sp.*

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References: