Fungi in agriculture: How AMF works with perennial Kernza

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Why study Kernza?

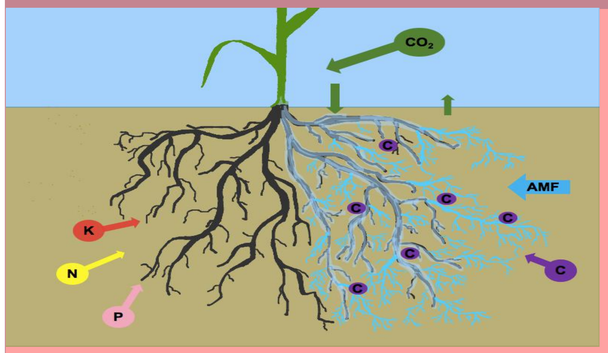
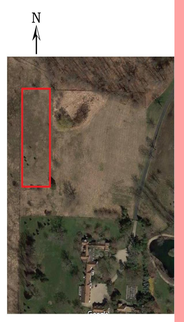


Figure 1. Diagram of arbuscular mycorrhizal fungi (AMF) in roots and its effects.

- Conventional agricultural management practices have been shown to degrade **soil quality**.
- **Perennial cropping strategies** may provide a sustainable alternative to mitigate degradation and improve cropland soils.
- **Kernza** (*Thinopyrum intermedium*) is one such perennial cultivar developed from intermediate wheatgrass. However, questions remain as to Kernza's ability to improve agro-ecosystems.
- ***Arbuscular mycorrhizal fungi*** (AMF) develop symbiotic relationships with a majority of plants and may improve soil quality by storing soil carbon, improving nutrient and water cycling, and facilitating microbial biodiversity.

What are we investigating?

Block 1 Plot A Prairie	Block 1 Plot B Wheat	Block 1 Plot C Fallow
Block 1 Plot D Knz+Alf	Block 1 Plot E Forage	Block 1 Plot F Kernza
Block 2 Plot A Kernza	Block 2 Plot B Fallow	Block 2 Plot C Knz+Alf
Block 2 Plot D Prairie	Block 2 Plot E Forage	Block 2 Plot F Wheat
Block 3 Plot A Fallow	Block 3 Plot B Prairie	Block 3 Plot C Wheat
Block 3 Plot D Kernza	Block 3 Plot E Forage	Block 3 Plot F Knz+Alf
Block 4 Plot A Wheat	Block 4 Plot B Kernza	Block 4 Plot C Fallow
Block 4 Plot D Forage	Block 4 Plot E Knz+Alf	Block 4 Plot F Prairie
Block 5 Plot A Prairie	Block 5 Plot B Knz+Alf	Block 5 Plot C Kernza
Block 5 Plot D Forage	Block 5 Plot E Wheat	Block 5 Plot F Fallow



Plots are 9m x 9m
Aisles are 1m

For Kernza, Kernza+Alfal-fa, & wheat, the distance between rows is 1ft. Thus, 29 rows fit per plot

Figure 2. Field site with six different treatments tested. Plots are 9x9 m. Sample size within each plot is 5x5 m.

Question 1: Does AMF abundance differ among crop treatments: **Wheat, Kernza, Kernza** and **Alfalfa biculture,** and **Forage?**

Question 2: Is there a relationship between AMF abundance and **nutrient concentration** in leaf tissue?

What did we measure?

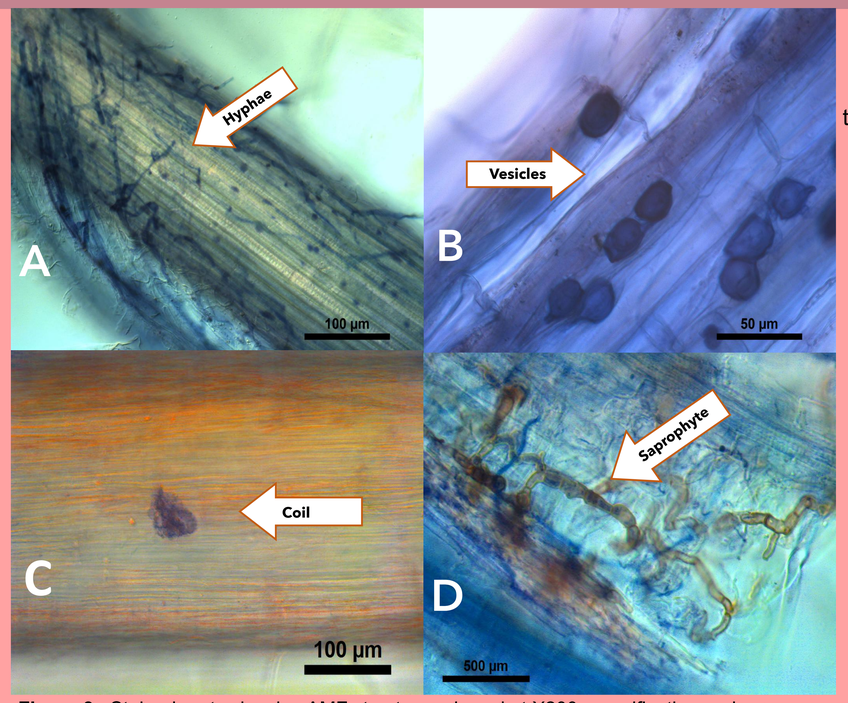


Figure 3. Stained roots showing AMF structures viewed at X200 magnification under a light microscope.

%Root Length Colonized

Eight samples (to 10cm depth) were taken in each plot. Sub-samples were stained using the protocol of Koske and Gemma (1999) and AMF colonization was quantified (McGonigle et al., 1990).

AMF structures observed (Fig. 3) : **Hyphae** (A) transport and consume nutrients. **Vesicles** (B) store carbon in the form of lipids. **Coils** (C) and **Arbuscules** are branched structures used for nutrient exchange between host and AMF. **Saprophytes** (D) are fungi often found in soils that feed on dead tissue.

Leaf Tissue C:N

Eight tissue samples from apical leaves were collected per plot. Next samples were dried, homogenized, and analyzed for C:N via elemental analyzer.

Results

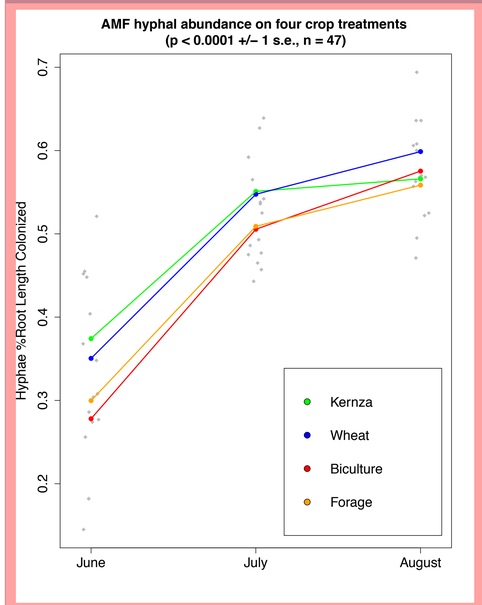


Figure 4. Comparison of AMF hyphae (%RLC) quantified on four crop treatment across three months. All treatments increase in hyphal abundance from June to August. Our results show that the point in growing season is the most significant predictor in hyphal colonization.

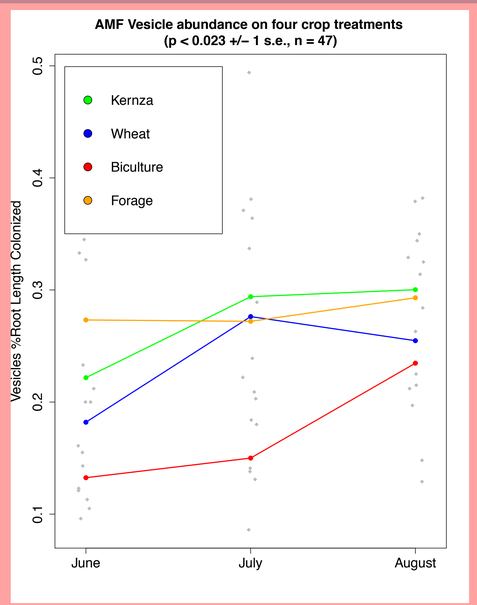


Figure 5. Comparison of AMF vesicles (%RLC) quantified on four crop treatment across three months. Our results show the significant predictor is crop treatment in vesicles colonization.

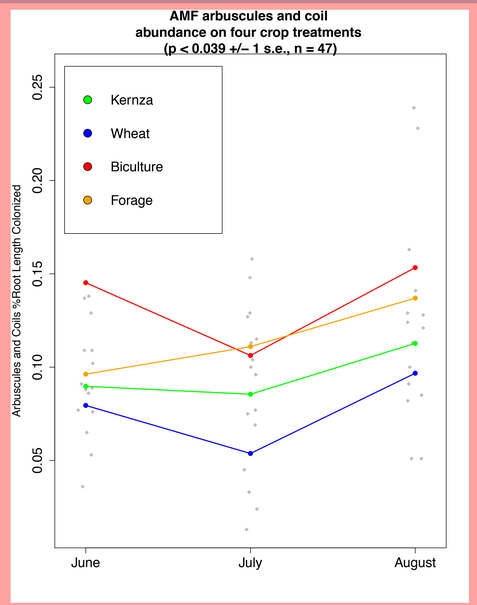


Figure 6. Comparison of AMF arbuscules and coils (%RLC) quantified on four crop treatment across three months. Figure 6 shows that crop treatments is the significant predictor in arbuscule and coil colonization.

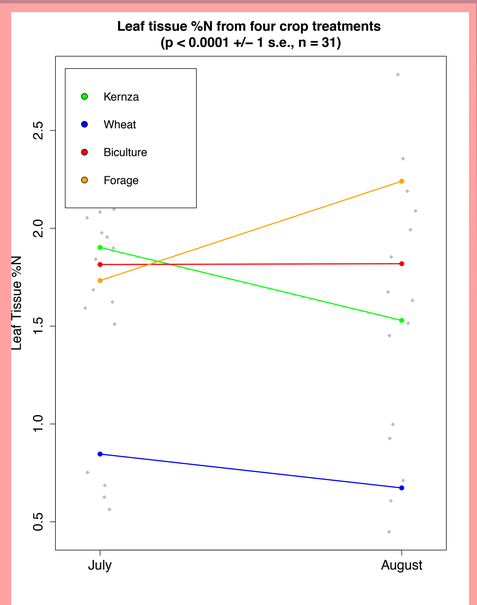


Figure 7. Nitrogen concentration in leaf tissue on four crop treatments across three months. Our results show crop treatment to be the most significant predictor in nitrogen in the leaf tissues.

Discussion

- Our findings suggest that annual wheat is more suitable for hyphal colonization and perennial Kernza has the highest vesical colonization at the end of the growing season.
- However, hyphal colonization could differ in crops treatments after the establishment year and would require further investigation in the following growing season.
- Further research on Kernza is needed to better understand its specific traits to reduce soil degradation rates and to improve sustainable agricultural management.

Acknowledgments

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References: McGonigle, T.P., M.H Miller, D.G. Evans, G.L Fairchild, and J.A. Swan. 1990. A new method which gives an objective measure of colonization of roots by vesicular-arbuscular mycorrhizal fungi. New Phytologist. 115: 495-501