The Effect of Cover Crop Root Interactions on Soil Health and Fe Availability in Organic Pears

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Introduction

- **Cover crops** can serve as a versatile toolbox to address deficiencies and manage soil health sustainably however they can also compete for resources.
- **Soil health** is the improvement of soil quality and function of biological, chemical, and physical properties. Cover crops increase soil health by increasing organic matter content, infiltration, and resource retention.
- **Iron chlorosis** is common in woody crops (i.e. pear) grown on calcareous soils. Grasses and legumes can increase Fe availability through root[1] and residue inputs.
- **We designed an experiment** with legume cover crop mixes to evaluate its impact on Fe availability and iron chlorosis in organic pears under calcareous soil conditions.
- **Significance:** Assess utilization of cover crops to address iron chlorosis while improving soil health in organic and orchard production.

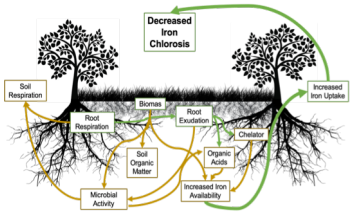

Figure 1: Conceptual diagram of cover crop rhizosphere dynamics

Figure 2: Iron chlorosis symptoms in experimental field

Objectives

(i) Analyze changes in the Fe cycling of the system with changes in soil nutrient availability (i.e. pH, residue inputs) and crop nutrient status.

(ii) Determine whether pear roots preferentially favor growth in a grass-legume cover vs. a legume-only cover crop and evaluate changes in root traits.

We hypothesize that the grass-legume cover crop will increase soil organic matter, soil Fe availability, and pear Fe nutrient status compared to the control.

Methods

Field Site: Located near Kelseyville, CA in a 60-year old Bartlett pear orchard transitioned to organic in 2011. The site is characterized by clay loam calcareous soils with a Mediterranean climate.

Experimental Design: 8-acre field with cover crop treatments in alternating rows and an adjacent 12-acre field mowed as the control. The three cover crop treatments are: (A) legume only - 20% vetch, 35% peas, and 45% fava, (B) legume-grass, 40% oats, 10% vetch, 20% peas, 30% fava, and (MC) mechanical control. The cover crop was terminated 8 weeks before harvest by disking 10 cm deep.

Sample Colletion: Leaf, root, and soil samples were collected at spring flush, before harvest (summer), and before dormancy (fall) with ten replicates. Soil and root samples were collected in 20 cm increments down to a depth of 1 m.

Data Analysis: Statistical analysis was performed using ANOVA and pair-wise comparisons.

Results & Discussion

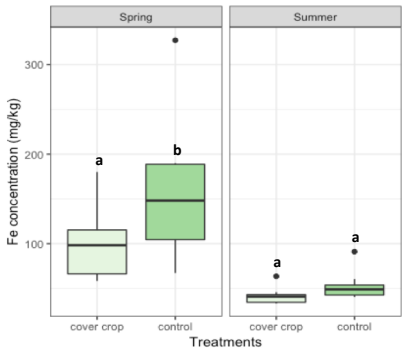

Figure 3: **Total leaf Iron.** In the spring, there was a significant decrease in leaf Fe in the cover crop treatment compared to the control.

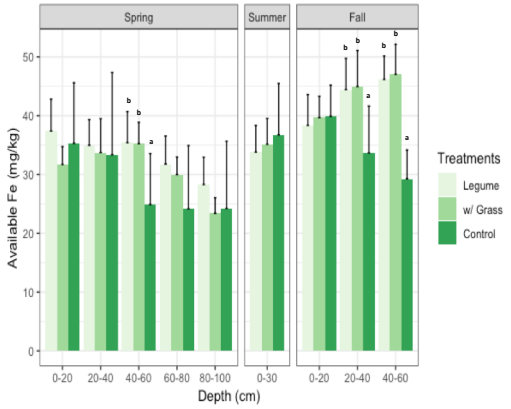

Figure 4: **Soil Bioavailable Iron.** There was an overall non-significant increase in soil Fe availability with cover cropping.

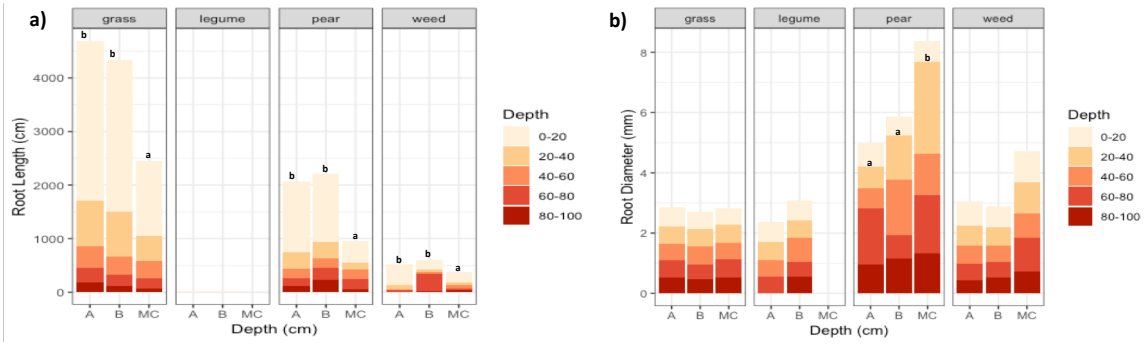

Figure 5: Root Traits (a) total root length (b) average root diameter. The cover crop treatments (A&B) resulted in significant increases in pear root length and decreases in root diameter in the top soil compared to the control (MC).

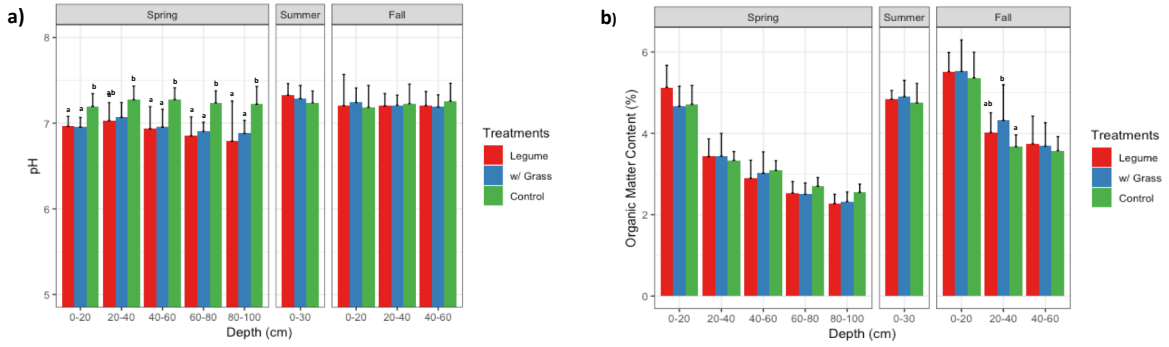

Figure 6: Soil Health Indicators (a) pH (b) soil organic matter. The cover crop treatments significantly decreased the pH in spring prior to termination, which may have resulted in the slight increases in soil Fe observed. The incorporation of cover crops did not significantly increase soil organic matter compared to the control in the first year of the experiment.

Conclusion

- The cover crop treatments did not demonstrate an increase in pear total leaf Fe, therefore the hypothesis was rejected.
- There was a significant decrease in soil pH when the cover crop treatments were present, which may be attributed to microbial activity instead of legumes.
- The increase in soil Fe and root traits for increased Fe uptake did not result in increased pear leaf Fe. This result may be attributed to a physiological limitation of Fe transport[1,2].
- Future research will need to incorporate measurements evaluating Fe transport within the plant and further replication of results.

Future Direction

- Incorporate root Fe measurements
- Add a natural ground cover control and a winter cover crop treatment.
- Determine leaf and soil N from cover crop N additions.
- Determine cover crop water use and effect on crop water status.