COVER CROP IMPACTS ON SOIL MICROBIAL PROPERTIES IN COTTON CROPPING SYSTEMS

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Abstract

Continuous cotton production prevalent in the Texas semi-arid regions continues to degrade soil ecosystems and services. Soil microbial proliferation and diversity is a useful soil health indicator in evaluation of cover crop technology introduced in these practices. Phospholipid Fatty Acid (PLFA), soil microbial community analysis method was utilized for both Non-Irrigated and Irrigated cotton. Cool season cover crops were introduced during the winter fallow period over a four-year period. The non-irrigated system consisted of conventional tillage and no-tillage without a cover crop and no-till with a wheat, Austrian winter pea, crimson clover, hairy vetch, and mixed species cover crop. The irrigated system included wheat and mixed species cover crops. Cover crops increased total living biomass, bacteria biomass, fungi biomass and arbuscular compared to no cover crops treatments for both irrigated and non-irrigated cotton compared to no cover crops.

Introduction

Monoculture cotton production is a widespread practice in the semi-arid regions of Texas. This practice has degraded soil resources under the prevalent harsh environments. Conservation practices coupled with cool season cover crops respectively can improve soil health and sustain continuous systems. Cover crops have shown increased nutrient-use efficiency and soil microbial diversity. However precise data on microbial diversity and nutrient cycling is lacking. This study seeks to evaluate and quantify the impact of cover crops and no-till in cotton monoculture practices on soil microbial community diversity in Texas semi-arid regions.

Materials and Methods

This study was conducted at the Texas A&M AgriLife Research Station at Chillicothe, TX on a Grandfield sandy loam; Fine-loamy, mixed, superactive, thermic Typic Haplustalfs soil type. The average annual precipitation is 711mm. The experimental design was randomized complete block design replicated four times. Non-Irrigated treatments were; 1. Conventional tillage (CT), 2. No-tillage (NT), 3. NT wheat, 4. NT with mixed cover crop, 5. NT with crimson cover crop, 6. NT with Hairy vetch and 7. NT with Austrian pea. Pivot Irrigated treatments were; 1. Conventional tillage (CT), 2. NT no-cover, 3. NT Cover (wheat) and 4. NT cover (Mixed). The ET replacement for irrigated study was 85%. Cool season cover crops were planted in winter and cotton seeded in the summer after chemically terminating cover crops. Non-Irrigated treatments seeding rates were; Wheat (34 kg ha^{-1}), Crimson clover (17 kg ha^{-1}), Hairy vetch (22 kg ha^{-1}), Austrian pea (39 kg ha^{-1}) and mix (30 kg ha^{-1}). Irrigated (Pivot): Mix of Rye, wheat, Hairy vetch & Austrian pea at 34kg ha^{-1} and wheat. Soil samples were taken at 0-7.5 cm depth next to the plants and near the rooting structures and immediately stored at 4°C, in May 2017, following five years of cover crops. Phospholipid Fatty Acid (PLFA) soil microbial community analysis method was used. Data collected were analyzed by ANOVA using general linear procedure (SAS Institute, 2008). Mean separation was Fisher's protected least significant difference (LSD) and all analyses were declared significant at 0.05 probability level. Cotton lint yields did not show any significant differences for the 2013 to 2016 period. Non-Irrigated yields ranged from 568 to 630 lb/ac with hairy vetch cover crop treatment trending numerically highest. Vetch lint yield was 5.6% higher than no cover crops treatments.

Results and discussion

Non-Irrigated cotton

Austrian winter pea trended highest in total living biomass, bacteria biomass, fungi biomass and arbuscular compared to all treatments and significant compared to no cover treatments conventional till and no till (Figure 1). Generally, total living biomass was lowest for CT and NT non-cover crops treatments though not always significant. Fungi and bacteria are major decomposers essential in nutrient cycling with the former being more efficient in assimilating and storing nutrients (Parton et al., 1987).

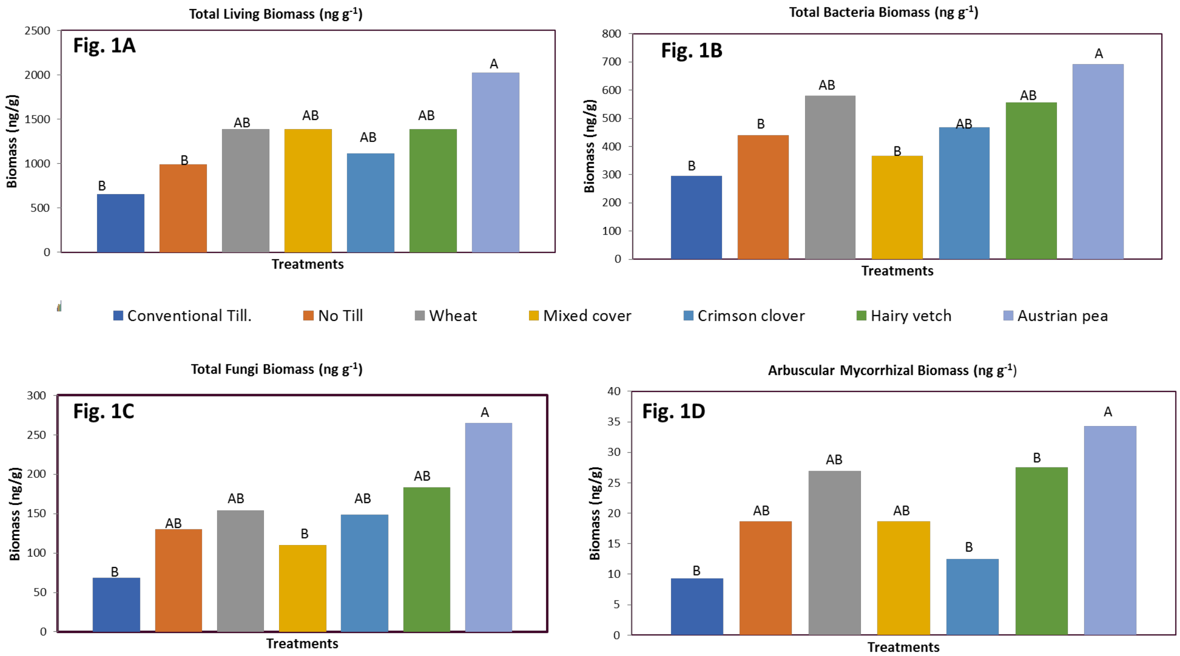

Figure 1: Non-Irrigated Cotton microbial biomass

<u>Pivot Irrigated Cotton</u>

The NT cover, with wheat as a cover crop recorded the highest total living biomass, bacteria biomass, fungi biomass and arbuscular biomass compared to all treatments and significant relative to no cover CT and NT treatments (Figure 2). Although NT mixed cover was numerically second highest, total bacteria biomass was very comparable with CT and NT non-cover crops treatments (Figure 2B). Arbuscular mycorrhizal fungi are credited for soil aggregates stability and efficiency in nutrient acquisition (Rilling and Mummey, 2006). Cotton lint yields did not show any significant differences for the 2013 to 2016 period. Pivot-Irrigated lint yields ranged 1120 to 1240 lb/ac, with mix cover crop treatment trending numerically highest. Mixed cover crop lint yield was 6.7% greater in comparison to no cover crops treatments.

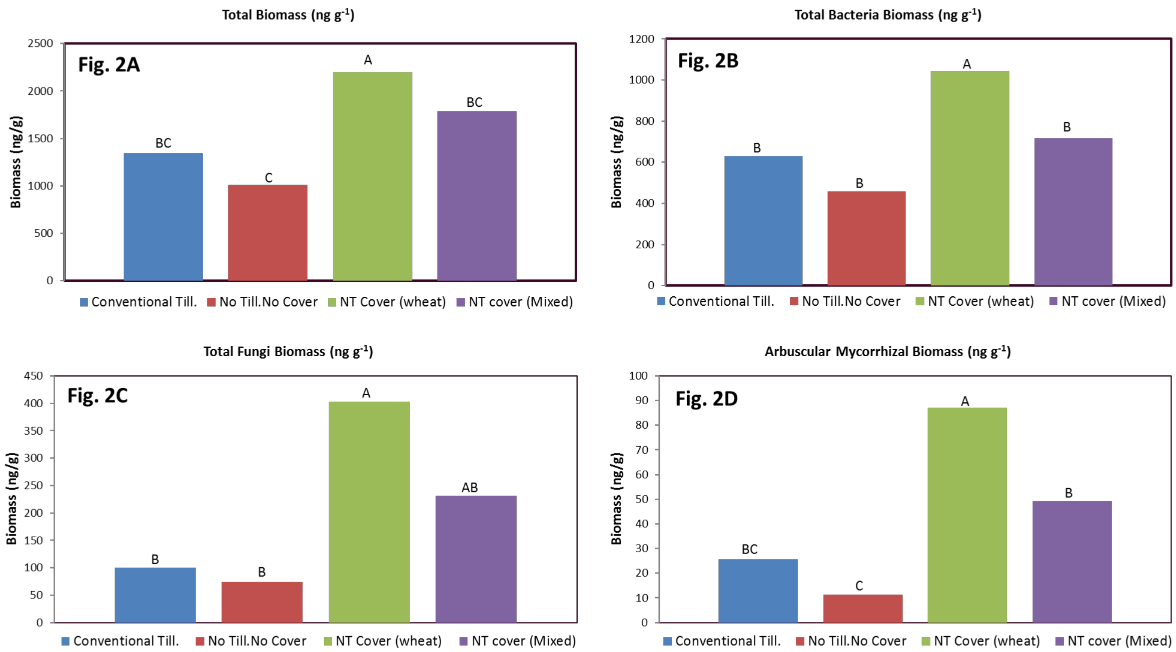

Figure 2: Pivot Irrigated Cotton microbial biomass

Summary

Cover crops generally increased total living biomass, bacteria biomass, fungi biomass and arbuscular compared to no cover crops treatments for both irrigated and non-irrigated cotton. Conventional till always had least microbial biomass under non-irrigated dryland cotton. Bacterial and fungal biomass was highest under Austrian pea cover crop under non-irrigated cotton and NT wheat cover under irrigated cotton. Average lint yields spanning 4-year period did not show any significant differences among treatments for both irrigated and non-irrigated cotton.

References

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