



Mississippi Corn Promotion Board 2022 Progress Report

Project

Title: Long-term study on the impact of cover crop on soil microbiome function affecting C and N inputs in Corn production systems.

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Project Summary (Issue/Response)



Maintaining properties of soil health in agroecosystems is vital for agricultural productivity and sustainability. The soil microbial communities' abundance and activity are essential metrics of soil health following the successful integration of cover crops in corn production systems. This is due to the fact that soil microbial communities play crucial roles in nutrient cycling, soil aggregation, and water-holding capacity, which are the principal advantages of cover crop adoption. However, the practical implications of cover crops and their differed functional impacts on ecosystem services deserve further investigation. To address this knowledge gap, we proposed this experiment on existing long-term cover crop trial plots with the following objectives: 1) To identify microbial functional groups involved in C and N dynamics in a cover crop-Corn production system. 2) To determine the effect of cover crops on C and N sequestration and stabilization that would help the C and N budgeting in a corn production system. This study was conducted at two locations in Mississippi (Starkville and Newton) and will be continued for another two years. This experiment was arranged as a strip plot design with three replications consisting of two factors: A) nitrogen dosage (0 lbs. nitrogen and 100 lbs. nitrogen) and B) cover crop treatments (Control, Ryegrass, Balansa, Radish, Red clover, Oats + Radish, and Ryegrass + Radish + Red clover). In both the locations, cover crops were planted during the second week of October and terminated during the first week of April. Corn was planted in all cover crop plots after termination. Soil samples were collected before sowing cover crops and following termination.



Project Results/Outcomes

Soil microbial DNA sequencing: Soil microbial DNA was isolated using DNeasy PowerSoil kit, and DNA samples were sent to Novogene laboratories to perform amplicon sequencing for bacterial (16s rRNA) and fungal (ITS2 rRNA) genes. DNA sequence data processed by QIIME2 pipeline. Soil physio-chemical parameters such as pH, total C (%), total N (%), and organic matter (%) were measured in this study.

Changes in soil bacterial community diversity: At Starkville location, the Shannon diversity index showed significant differences ($p < 0.05$) for the nitrogen treatment, whereas cover crop treatment had no significant differences. Richness (Chao1) had consistently significant differences among nitrogen and cover crop treatments. In Newton, nitrogen and cover crops treatments had significant differences in the Shannon diversity index, whereas richness (Chao1) showed cover crops had a significant effect on the alpha diversity of microbial communities. After the first year of management practices, fungal alpha diversity indices (Shannon diversity index and Chao1) did not significantly differ among cover crops and nitrogen treatments. Richness (Chao1) had significant differences between locations.

PCoA analysis of the Bray-Curtis method was used to visualize the beta diversity changes in the bacterial populations. The bacterial populations were significantly different ($p < 0.05$) between locations Starkville and Newton, which accounts for 41% of

Project Results

the variation (Figure 1). The fungal community compositions were significantly different ($p < 0.05$) between locations, which accounts for 31% of the variation, but there were no significant differences observed for cover crops and nitrogen treatments.

Changes in soil physio-chemical properties:

Soil physiochemical characteristics under different cover crops is shown in Table 1. Total Carbon and Total Nitrogen were slightly increased in soils after cover crop integration. However, there were no significant differences in soil properties.

The first-year results showed that different management practices i.e., cover cropping and nitrogen dosage had minor impacts on the soil properties. However, the soil bacterial communities and fungal communities had significant differences in both locations, and we identified cover crops and nitrogen fertilizers affecting both alpha and beta diversity for bacterial communities. Further, long-term research is required to better comprehend the association between cover cropping and nitrogen treatments on microbial abundance, their functional activities, and their relevance to the soil's essential functions.

Cover Crop	Total N (%) ¹	Total C (%)	Organic Matter (%)	pH
Control	0.139 (0.003)	1.33 (0.035)	2.36 (0.06)	5.91 (0.16)
Balansa	0.146 (0.003)	1.43 (0.06)	2.55 (0.07)	5.88 (0.16)
Red Clover	0.145 (0.002)	1.423 (0.04)	2.53 (0.08)	6.01 (0.16)
Rye grass	0.135 (0.005)	1.307 (0.07)	2.32 (0.13)	5.69 (0.13)
Radish	0.147 (0.004)	1.423 (0.06)	2.53 (0.11)	6.1 (0.1)
CC-mix-1	0.146 (0.004)	1.415 (0.07)	2.51 (0.12)	5.77 (0.21)
CC-mix-2	0.138 (0.005)	1.352 (0.06)	2.40 (0.11)	5.75 (0.22)
Location	ns	ns	ns	s
CC*N	ns	ns	ns	ns

¹ Variable in column with no letters are not significant at the 0.05 level using Fisher's protected LSD.

²CC-mix-1 = Oats, Radish

³CC-mix-2 = Ryegrass, radish, and red clover;

Table 1: Soil chemical characteristics

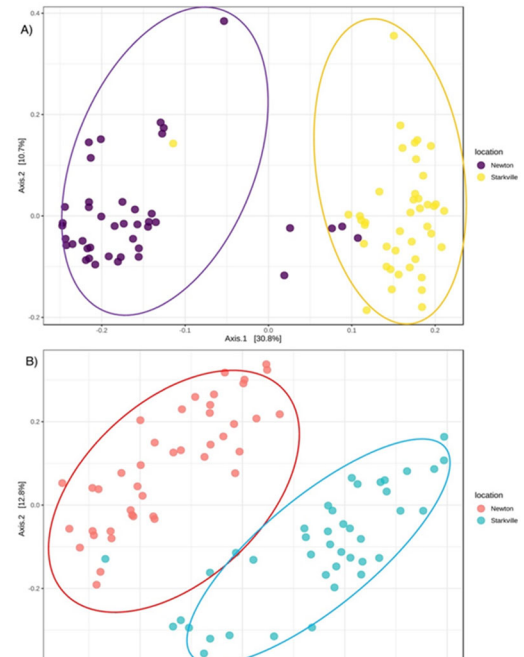


Figure 1. Principal coordinate analysis (PCoA) plot depicting the Bray-Curtis distance matrix for bacterial communities (A) and fungal communities (B) among both locations

Project Impacts/Benefits

The study investigates combinations of N management and cover crops as potential alternatives for bridging the gap between improving crop yields via beneficial soil microbial populations. This study will help meet the challenge of matching sustainable yields of corn production systems with soil health by connecting genomic characterization of the soil microbiome with functional responses that can be applied at the field level to fine-tune cover crops as a soil health-promoting practice for corn production.

Project Deliverables

Mahesh Chinthlapudi, Joshua White, Shankar G. Shanmugam, "Influence of nitrogen application and cover crops on soil microbial communities in the corn production systems." Oral presentation given in South Central Branch of ASM annual meeting in Shreveport, LA, Oct. 27-29, 2022.