Winter Cover Crops, Fall Applied Poultry Litter, and N Fertilization Effects on Soil Quality Indicators.

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Introduction

Soil quality indicators are necessary to help improve sustainability of agro-ecosystems. A better understanding of soil quality/health relationships to crop production is needed. In Mississippi, corn production in 2015 was 89,725,000 bushels grown widely on approximately 2,022 farms, and the value of corn production was approximately $343 million (MSU Extension Service, 2014). Poultry production has the second highest value next to all crop production (Collin, 2012). There are more than 2000 poultry farms in the state which produce approximately 200 ton of litter per a year that could be available for use as a soil amendment as well as a nutrient source (Heatherly, 2014). In addition, cover crops, which are grown during the winter period can serve to improve soil physical, chemical, and biological properties. Studies have reported on the ability of cover crops to scavenge soil NO_3^- enhance pore size distribution, biologically fix N_2, reduce fertilizer N costs, and increase or enhance soil microbial activity (Dabney et al., 2001, Nyakatawa et al., 2002, Zablotowicz et al., 2011). For this reason, studying soil properties can help to understand relationships between soil management and resulting properties and ultimately contribute to sustaining productivity.

Objectives

- To determine the effects of cover crop systems with and without fall applied poultry litter to N fertilization on selected soil properties of undisturbed (inter-rows) and disturbed (corn rows) soil areas under strip till management.

Material and Methods

- W.B. Andrews Agricultural Research Systems Farm at Mississippi State, MS
- Marietta fine sandy loam (siliceous, active thermic Fluvaquentic Eutrudepts)
- split-split plot randomized complete block design.
  - Main plot factor is twelve treatments including fertilizer N rates of 0, 56, 112, 168, and 224 kg N ha^{-1} as NH_4NO_3, and two species of cover crops (cereal rye and hairy vetch) with and without fall applied poultry litter at 1 ton/acre.
  - Split-plot factor consists of two sampled positions in each plot: undisturbed area (inter-rows), disturbed area (corn-rows) (Fig. 1).
  - The split-split plot factor of soil depths of 0- to 5-cm, 5- to 10-cm, 10- to 15-cm, and 15- to 30-cm for soil bulk density, and total C and N analysis, and 0- to 5-cm, and 5- to 15-cm for enzyme analysis.
- Twelve treatments were randomized within four blocks; plots consisted of four rows at a spacing of 0.97 m (38 inches) and a length of 12.19 m (40 feet) with strip tillage performed prior to planting.
- For bulk density and total C and N determination, soil cores 5-cm in diameter were obtained with a hydraulic soil sampling probe (Giddings Machine Co., Fort Collins, CO) mounted on a tractor.
- Soil samples at corn planting and then every two weeks up to one month were collected from corn-rows and inter-rows and were stored in a refrigerator.
- Total C and N were analyzed using a dry combustion analyzes (Carlo Erba NA 1500, Beverly, MA).
- Soil enzymatic activity was determined using the assay described by SchnÜrer and Rosswall (1982) and Adam and Duncan (2001).

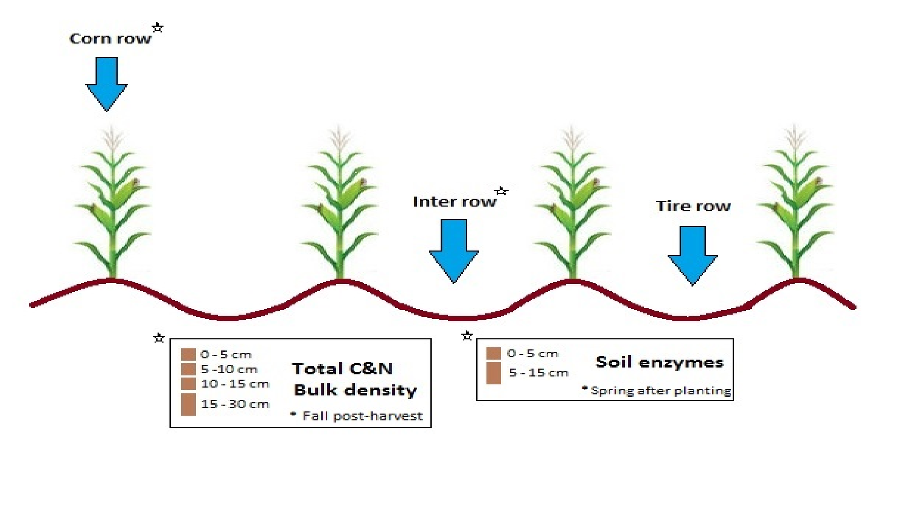
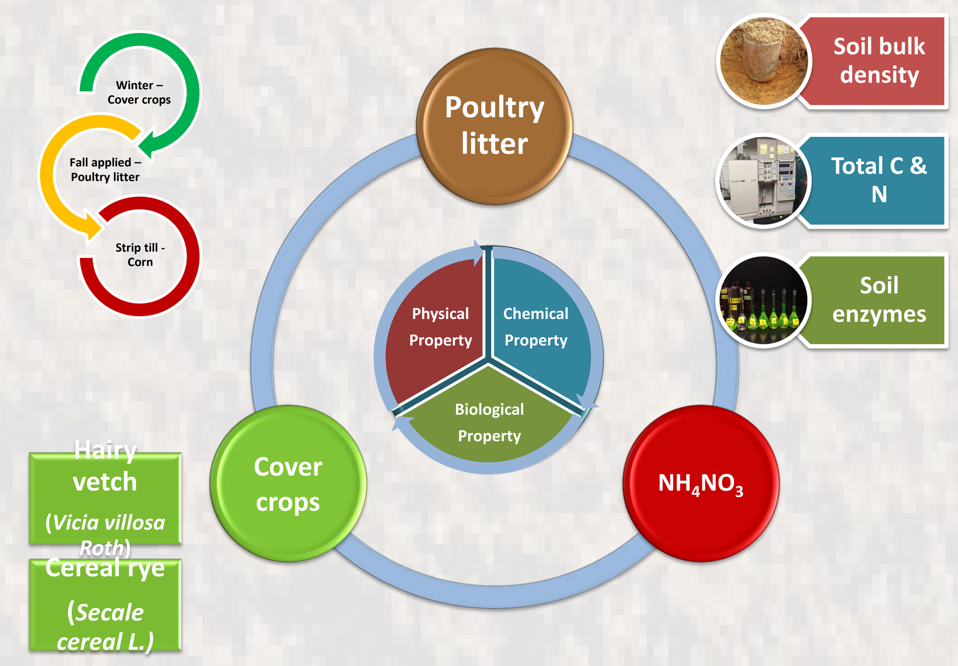


Figure 1. Horizontal plot illustration shows areas of soil sampling and soil depths for different analyses



***Treatments: Fertilizer N rates = 0, 56, 112, 168, 224 kg ha-1 N; H = Hairy vetch; R = Rye; PL = Poultry litter**

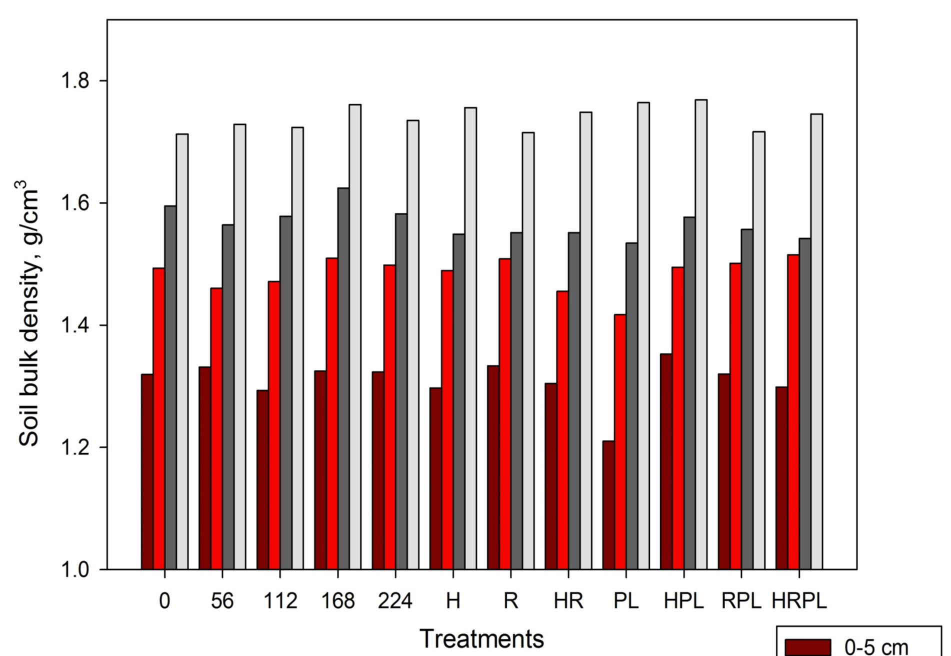


Fig. 2 Average soil bulk density as affected by soil depth on corn rows after corn harvest in fall 2015

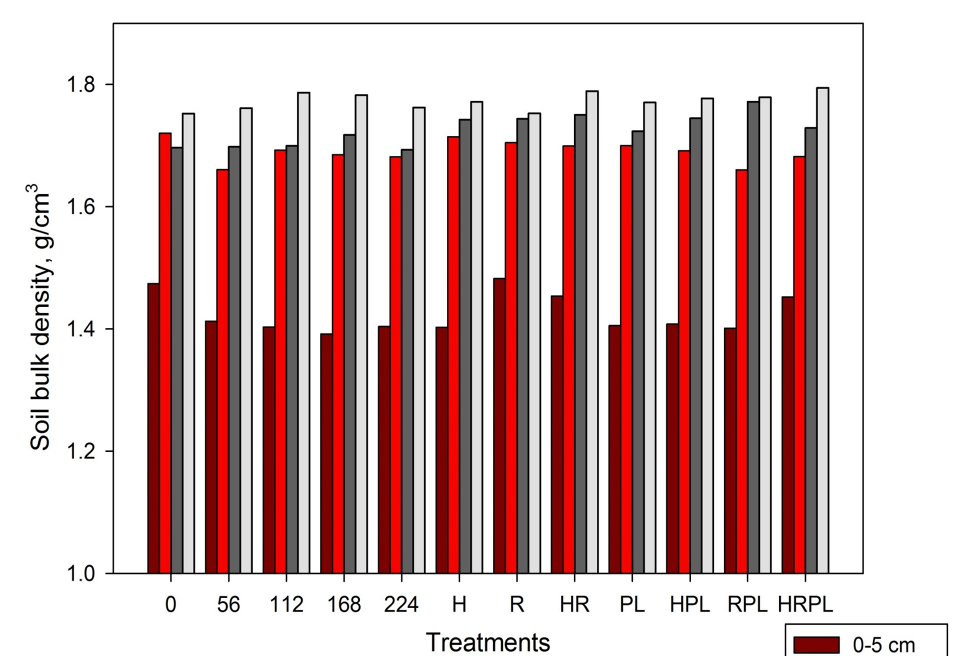


Fig. 3 Average soil bulk density as affected by soil depth on inter-rows after corn harvest in fall 2015

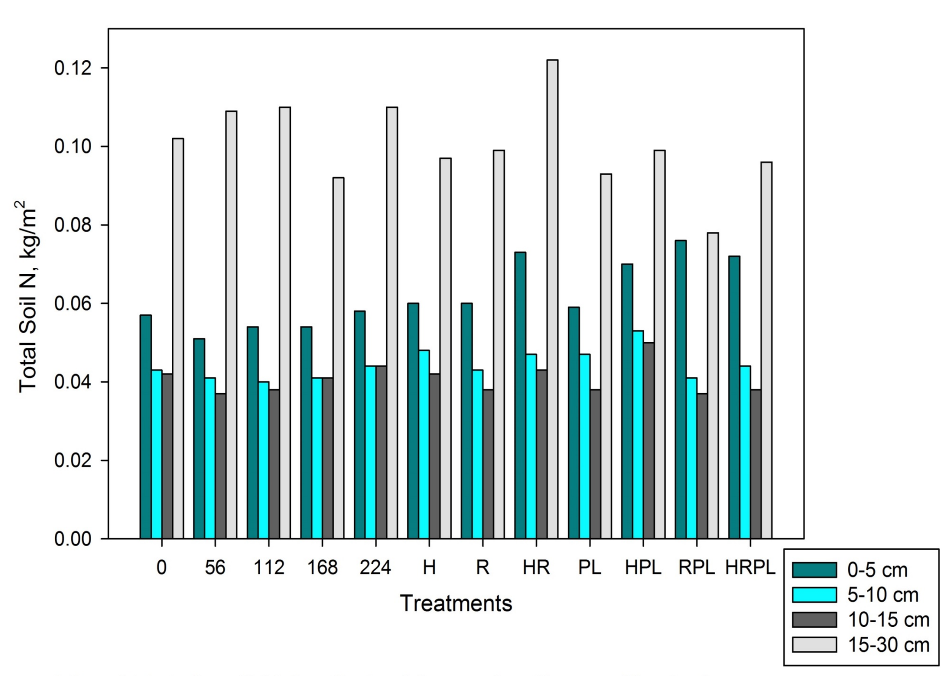


Fig. 4 Total soil N for 0- to 30-cm depth as affected on corn rows after corn harvest in fall 2015

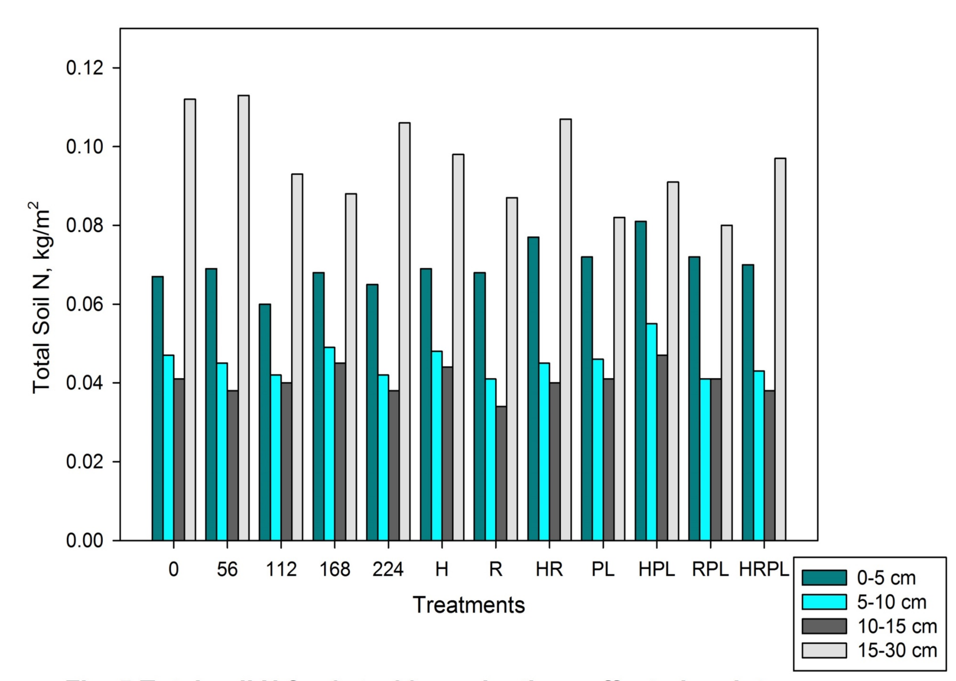


Fig. 5 Total soil N for 0- to 30-cm depth as affected on inter-rows after corn harvest in fall 2015

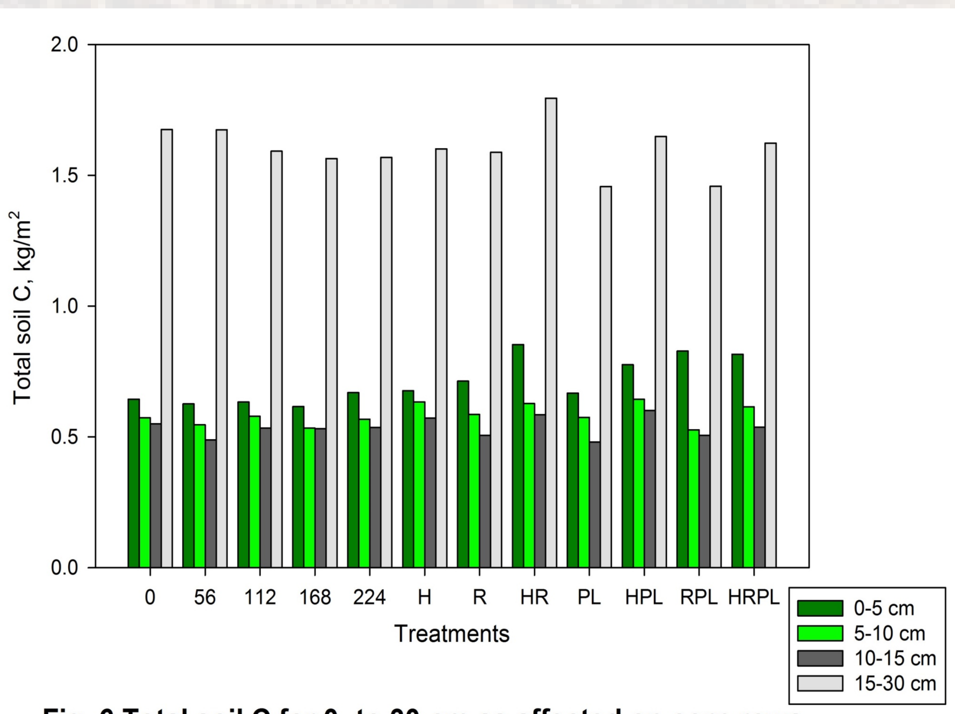


Fig. 6 Total soil C for 0- to 30-cm depth as affected on corn rows after corn harvest in fall 2015

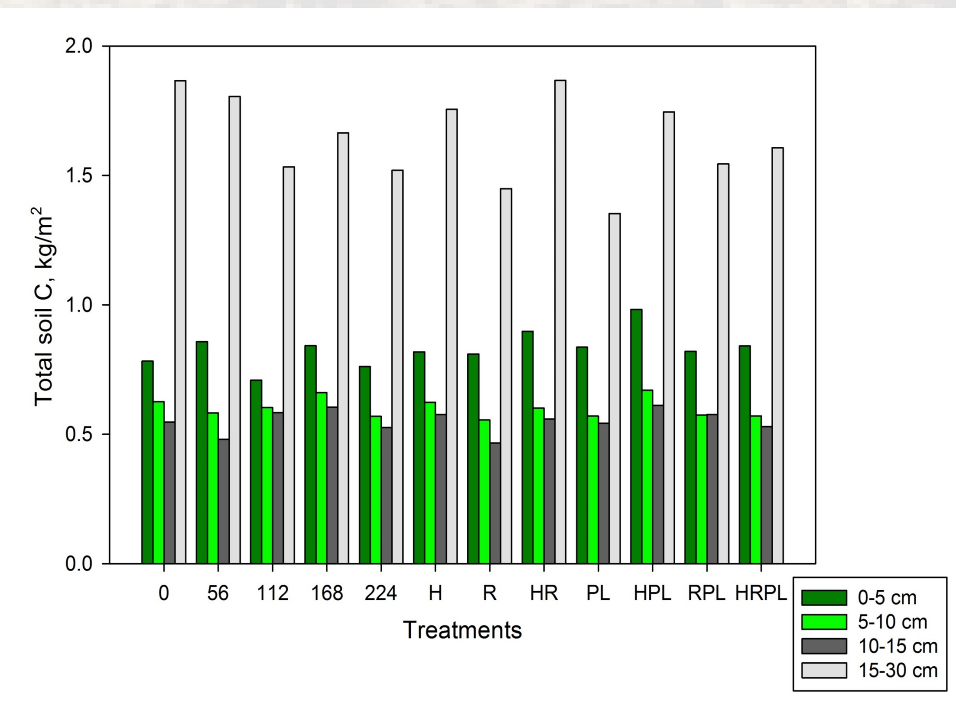


Fig. 7 Total soil C for 0- to 30-cm depth as affected on inter-rows after corn harvest in fall 2015

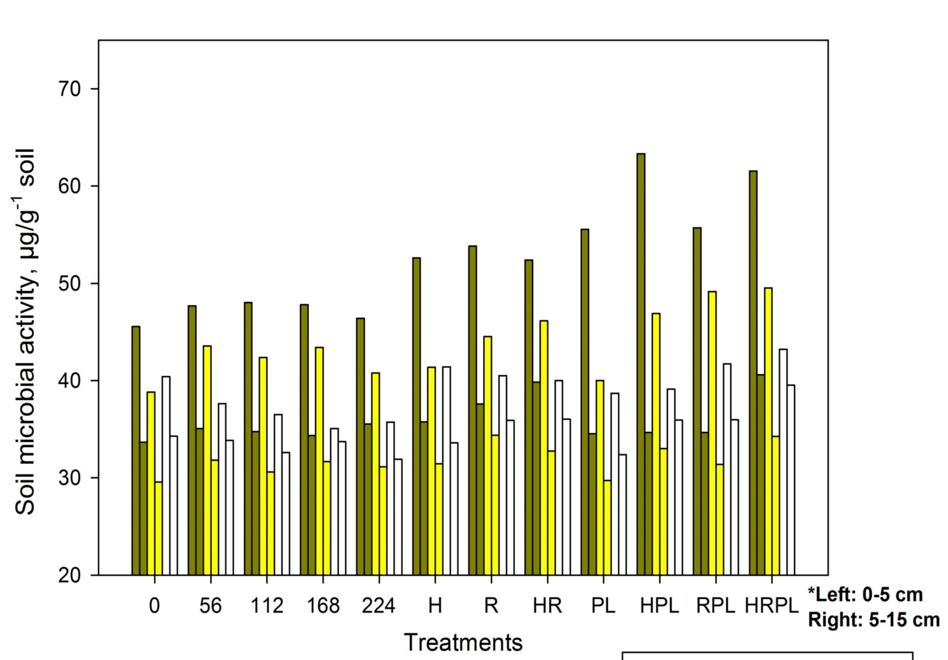


Fig. 8 Average soil enzymatic activity in corn rows as affected by soil depth and dates of soil sampling

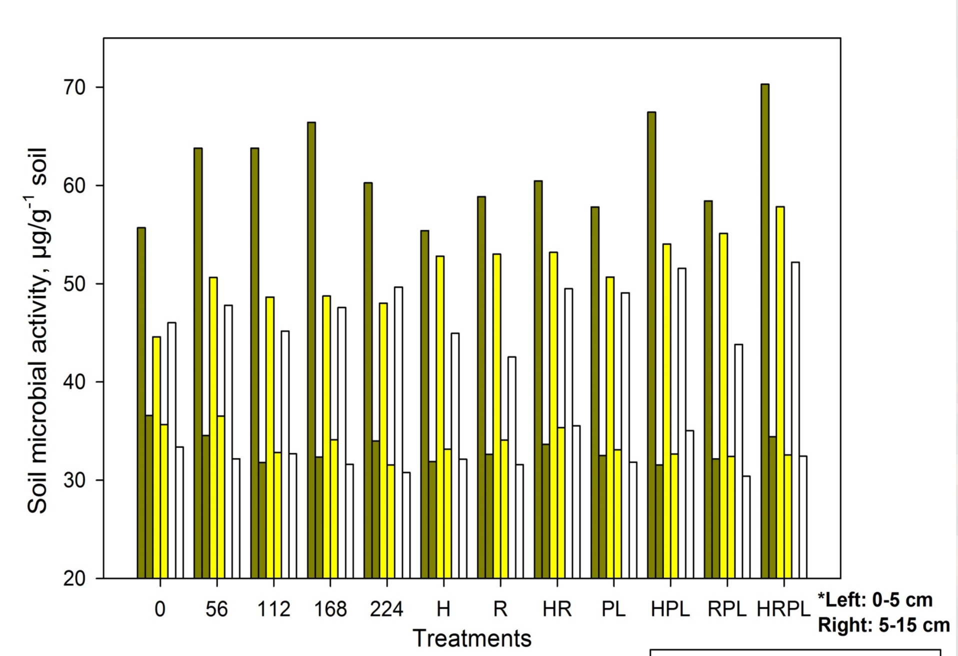


Fig. 9 Average soil enzymatic activity in inter-rows as affected by soil depth and dates of soil sampling

Results and Discussion

- Results indicated greater bulk density, total C and N, and total microbial activity in the inter-rows than corn rows or area disturbed by strip-tillage.
- Based on soil depth, enzymatic activity, total C and N decreased with depth; in contrast, soil bulk density tended to increase with depth.
- Treatment differences were not significant for soil bulk density; however, soil bulk density with poultry litter tended to have the lowest at 1.31 g/cm^3 (Figs. 2-3).
- Total soil N was greatest with vetch-rye bi-culture, vetch with poultry litter, and rye with poultry litter. (Figs. 4-5).
- Based on total soil C results, combinations of rye and vetch bi-culture, and vetch plus poultry litter had the greatest soil C (Figs. 6-7).
- Total microbial activity was greatest at corn planting and then decreased for all treatments up thru four weeks apparently due to lack of rainfall and soil drying(Figs. 8-9).
- Based on treatments, hairy vetch alone, vetch plus poultry litter, and vetch-rye bi-culture with poultry litter had the greatest enzyme activity for both corn rows and inter-rows (Figs. 8-9).

Future research

This study was sampled after three years of treatments indicating short-term results. Future plans include:

- Continuing treatments to determine long-term effects on soil quality/health indicators.

Conclusions

- The combination of winter cover crops with fall applied poultry litter influenced soil quality/health factors more than fertilizer N did.
- Soil bulk density depended more on tillage management rather than cover crops, poultry litter, and fertilizer N rate.
- The 0- to 5-cm soil depth was most influenced by cover crop and poultry litter treatments emphasizing the importance of surface residues to soil health.
- Based on the measured soil quality/health indicators, cereal rye and hairy vetch with poultry litter can increase total soil C and N the most; while, the rye-vetch bi-culture combined with poultry litter resulted in the greatest soil enzyme activity.
- Preliminary results show a strong correlation of enzyme activity with total C and N.

References

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