Temporal Variability in Soil Microbial Properties in Claypan Soils

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Introduction

Soil is the basis of plant and animal health. There are four million ha of claypan soils in the Midwestern United States, including Kansas, Missouri, Illinois, and Oklahoma[1]. Claypan soils are soils with a sharp increase in clay content over an abrupt boundary below the topsoil. Claypan soils create serious limitations to crop production by restricting root development and water movement. Previous research showed that the response to crop management practices including crop rotation, irrigation, and tillage may be different on claypan soils than on well-drained soils[2]. Plants rely on soil microbes to decompose organic matter to make nutrients available for plants. Therefore, soil microbial properties can potentially indicate how well the soil microenvironment supports root growth and hence the productive capacity of the soil[3]. The temporal change in soil microbial properties with crop rotation is poorly characterized in claypan soils.

Hypotheses: soil microbial activity responds to environmental cues and crop growth:

- Spring rainfall rewets the soil resulting in a flush of microbial activity.
- Hot, dry summer weather restricts microbial activity and biomass.
- Crop residues input increases microbial activity and community .
- Soil microbial properties from no-till (NT) will be greater than from conventional tillage (CT).

Objective

To assess how claypan soils and tillage mediate changes in soil microbial properties with time in the corn/winter wheat/ soybean rotation system of the Central Great Plains.

Approach and Design

- Crops were grown in Southeast Kansas in a RCBD design with 3 blocks (9 x 45 m^2) and repeat measurements. Fertilization, weed and pest control were proceeded for optimal productivity.
- Crop rotation: corn/ winter wheat/soybean, with all crops grown each year, replicated over two years in plots.
- Treatment: tilled or no-till
- Soil sampling: at physiological stages of the crops as outlined in Fig 1.

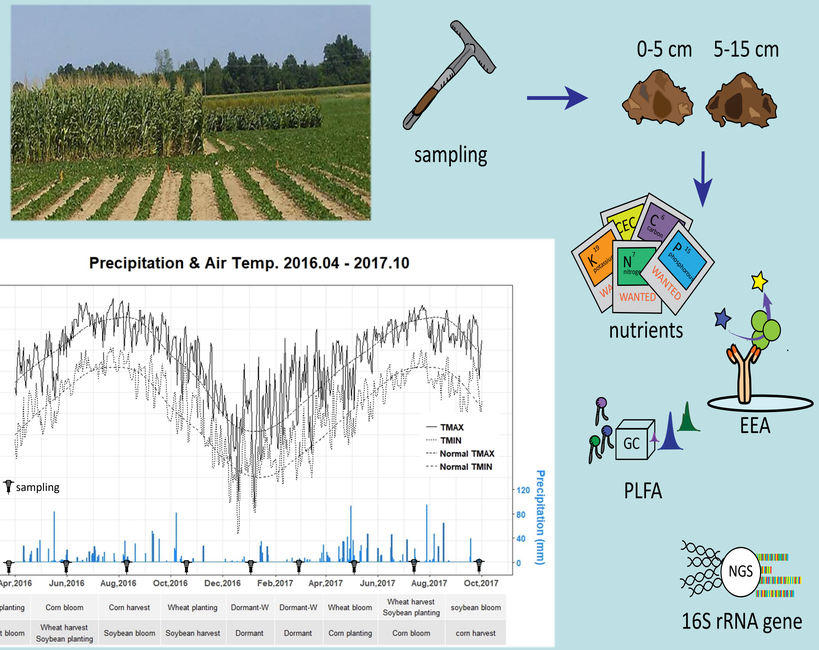


Figure 1. Weather dynamics and sampling schedule in this study.

Preliminary Results

Data were analyzed through: 1. Effect of crop development on enzyme activities and microbial community composition; 2. Effects of weather conditions on microbial properties; 3. NT v.s. CT; 4. Soil dynamics in top 5 cm and in 5-15 cm; 5. Interaction between soil physical, chemical, and biological properties.

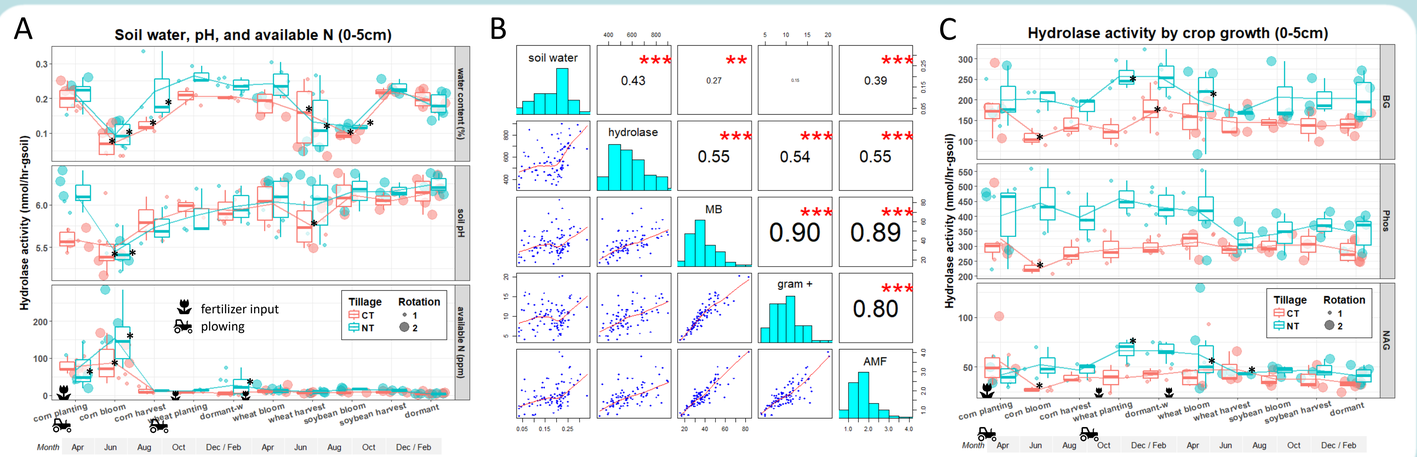


Figure 2. A) Changes in soil properties with crop development by NT/CT; B) Pairs plot between soil properties. MB: microbial biomass; gram +: gram-positive bacteria; AMF: arbuscular mycorrhizal fungus. Hydrolase activity increased with MB and PLFA community were observed; C) Changes in soil hydrolase activities with crop development by NT/CT. BG: β-glucosidase, C-requiring enzyme; Phos: acid phosphatase, P-requiring enzyme; NAG: N-actylglucosaminidase, N-requiring enzyme. *0.9 confidence interval with adjacent phases.

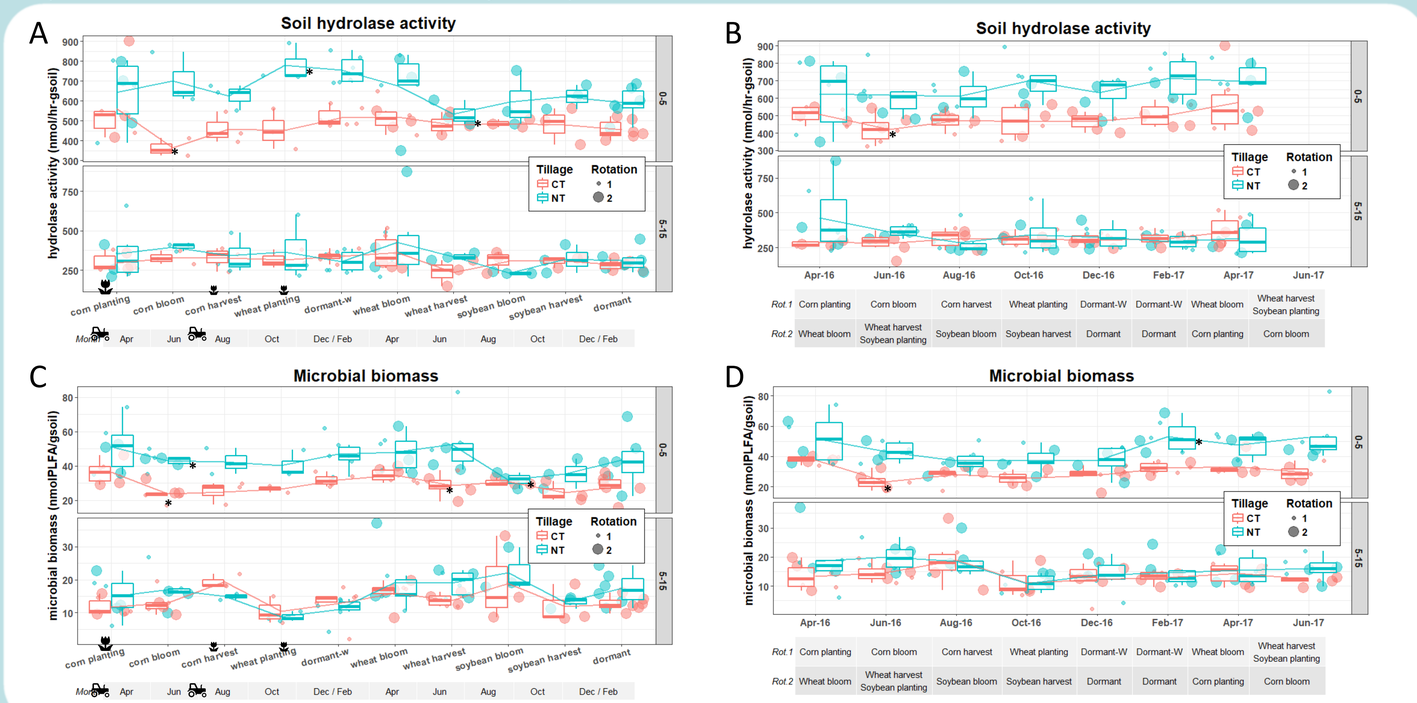
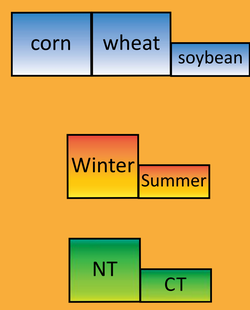


Figure 3. Changes in soil microbial properties with crop development and time by NT/CT at different depths. A, B) Soil hydrolase activity was lowest in June under corn in CT and wheat-harvest in NT. In winter, soils with wheat had greater activity than bare soil in NT; C, D) Microbial biomass was lowest under corn in CT in June but highest in NT in February. MB in Feb was greater than in Dec. There was no significant difference between crops in summer. Both hydrolase and MB were greater under corn and wheat growing instead of soybean in NT. *0.9 confidence interval with adjacent phases.

Preliminary Findings

- Microbial activities are more dependent on crop development than seasonal dynamics.
- The crop affected microbial properties with similar activities in wheat and corn, and less activity in soybean.
- The greatest hydrolase activity and biomass were measured in winter, while summer had the lowest.
- Microbial communities were greater in NT and more responsive to environmental factors than in CT.
- 0-5 cm was greater and more responsive to environmental factors than 5-15.



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