Nitrogen Fertilization and Cover Cropping Impacts on Soil Carbon Sequestration on a silt Loam soil in West Central Illinois

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Introduction

Soil carbon sequestration, important to enhancing soil quality and mitigating the global climate change, depends on the amount of crop residue returned to the soil and the attendant soil and crop management practices. Practices which increase residue and/or plant growth result in mid to long-term build up of soil organic matter (SOM) (Robinson et al. (1994), Lal et al. (1999). Since carbon (C) and nitrogen (N) are the major constituents of SOM and their proportionality (C: N ratio) is relatively constant across a range of agricultural soils, an adequate supply of N is required to sequester SOM. An efficient N fertility program helps to sequester atmospheric CO2 into soil organic carbon (SOC) by increasing plant growth and eventually return of organic C to the soil for storage as SOM. Hence long-term experiments dealing with management of fertilizers, especially N, and other cultivation practices could be a suitable tool for estimating the changes in soil carbon stock as these practices are universally adopted by the farmers. Hence this study has been conducted to quantify the SOC and SON pool as influenced by the crop management practices such as N fertilization, cover cropping and crop rotation.

Objective

- Determine depth distribution of bulk density, SOC and SON pool as influenced by cover cropping, cropping systems and various N levels.
- Determine effects of different rates of N on agronomic productivity of corn.

Methods

- Soil sampling was conducted from a long-term plot (20 years) at the Northwestern Illinois Agricultural Research and Demonstration Center. The experimental design was split-split plot within a randomized complete block. The soil type is Muscatine silt loam.
- Main plot treatments were: continuous corn (*Zea mays*) (CCC), and two rotation plots with corn and soybean (*Glycine max*) grown in alternate years (CSB and SBC respectively). Subplot treatments were plots with and without oats (*Avena sativa*) grown as cover crops. The split-split plot treatments were five N rates (0 (N_0), 70 (N_1), 135 (N_2), 200 (N_3) and 270 (N_4) kg N ha^{-1}).
- Core soil samples were collected during spring 2004 from each plot up to 90 cm depth.
- Soil bulk density determined by the core method. SOC and SON measured using Vario Max CN Analyser (Model V5.3 2002). Grain yield of corn was recorded and expressed by averaging across cropping systems and cover cropping for different N levels for 2004.

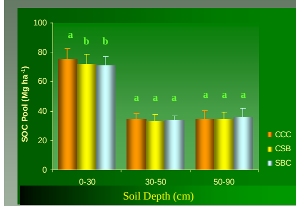

Figure 1: Cropping Systems Effects on Depth Distribution of SOC Pool.

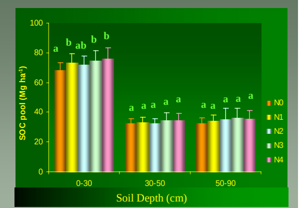

Figure 2: Nitrogen Fertilization Effects on Depth Distribution of SOC Pool.

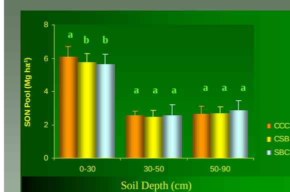

Figure 3: Cropping Systems Effects on Depth Distribution of SON Pool.

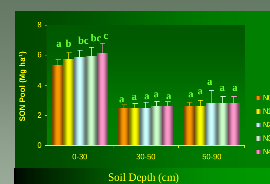

Figure 4: Nitrogen Fertilization Effects on Depth Distribution of SON Pool.

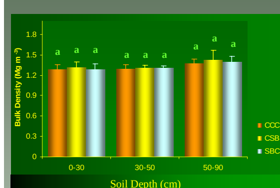

Figure 5: Cropping Systems Effects on Depth Distribution of Soil Bulk Density.

Figure 6: Nitrogen Fertilization Effects on Depth Distribution of Soil Bulk Density.

Results

- SOC storage at 0-30 cm depth was significantly higher for continuous corn (CCC) than corn in rotation with soybean (p = 0.014; Figure 1).
- SOC pool at 0-30 cm depth was highest (75.8 Mg ha-1) for N4 level and lowest (68.4 Mg ha-1) for N0 level (p = 0.008; Figure 2).

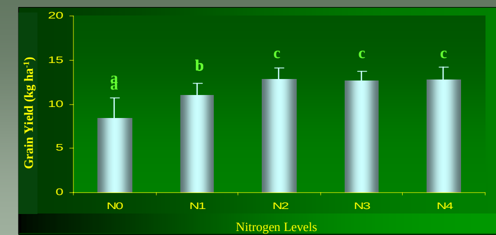

Figure 7: Nitrogen Fertilization Effects on Corn Grain Yield (averaged across cropping systems and cover cropping for 2004).

- Continuous corn resulted significantly higher SON pool also at 0-30 cm depth compared to rotation corn (p = 0.001; Figure 3).
- N fertilization showed increasing SON build up, with highest value of 6.1 Mg ha-1 for N4 level and lowest (5.4 Mg ha-1) for N0 level (p = 0.0003; Figure 4).
- Soil bulk density did not change significantly with different cropping systems (Figure 5), but decreased with increasing N rates (p = 0.025; Figure 6).
- None of the treatments showed significant difference below 30 cm depth.
- Cover cropping did not have an influence on soil properties as it was not included as a treatment in the experiment until 2001.
- Corn grain yield recorded significant increase with N fertilization (p = <0.0001; Figure 7).

Conclusions

This study showed that scientific agricultural management practices such as N fertilization and crop rotation contribute not only to the enhanced crop productivity but also to the build up of soil organic matter. The effects are significant only up to 30 cm depth. As soil carbon sequestration has a significant impact on the global climate change, widespread adoption of these crop management practices substantially contribute to cleaner environment without affecting the crop yield.

References

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