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Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

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Abstract
Tillage and crop rotation systems have major long-term effects on soil productivity and soil quality, soil carbon, and other soil physical, biological, and chemical properties. Additionally, tillage systems and crop rotation controls weed and soilborne diseases. There is a need for a well-defined, long-term tillage and crop rotation study across the different soil types and climate conditions in the state. The objective of this study was to evaluate the long-term effects of different tillage systems and crop rotations on soil quality and corn and soybean yields.

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Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

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Introduction

Tillage and crop rotation systems have major long-term effects on soil productivity and soil quality, soil carbon, and other soil physical, biological, and chemical properties. Additionally, tillage systems and crop rotation controls weed and soilborne diseases. There is a need for a well-defined, long-term tillage and crop rotation study across the different soil types and climate conditions in the state. The objective of this study was to evaluate the long-term effects of different tillage systems and crop rotations on soil quality and corn and soybean yields.

Materials and Methods

This study started in 2002 and 2003 on eight Iowa State University Research and Demonstration Farms, including the ISU Northeast Research and Demonstration Farm, Nashua, Iowa, in 2003. Treatments include five tillage systems: no-tillage (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP). Crop rotations adopted at the Nashua site were corn-corn-soybean (C-C-S), corn-soybean (C-S), and continuous corn (C-C) over each tillage system. The experimental design was a randomized complete block design with four replications. Each plot size is 30 ft by 100 ft. In 2008, a C-C rotation was included in the study at Nashua after the 2007 corn crop year to replace one of two C-C-S blocks. Initial soil sampling for baseline data prior to implementing the tillage treatments was done in 2002 for the C-S and C-C-S rotations and in 2008 for C-C. Baseline data soil samples were collected at 0–6, 6–12, 12–18, and 18–24 in. depths and analyzed for total carbon and total nitrogen. Subsequently, soil sampling has been done bi-annually. Corn and soybean yields were determined from the center 6 and 5 rows of each corn and soybean plot, respectively. Seasonal nitrogen use efficiency, soil bulk density, and infiltration rate measurements will be conducted depending on funding availability.

Results and Discussion

Results for corn and soybean yields in 2013 are summarized in Figures 1, 2, and 3. Figure 1 shows a comparison across tillage systems for corn. Figure 2 shows a comparison of rotations within each tillage system for corn.

Overall, corn yields in the C-C rotation for all tillage systems were not significantly different, except for CP compared with NT, ST, and DR. Corn yields with C-S rotation with NT and ST were significantly lower than yields with other tillage systems. However, the corn yield with C-C-S rotation was significantly higher with CP than all other tillage systems (Figure 1).

When averaged across all tillage systems, corn yield in the C-C-S rotation (233 bu/acre) was 11.4 percent, and C-S (228 bu/acre) was 9.2 percent more than C-C (209 bu/acre).

Corn yields of rotations within each tillage system are summarized in Figure 2. Generally, corn yields in the C-S and C-C-S rotations were not significantly different, but both yields (C-S and C-C-S) with DR and CP yields were significantly more than yields in C-C.

Soybean yields are summarized in Figure 3. Soybean yields with different tillage systems were generally not significantly different, except between NT and DR, and DR and CP yields.

Acknowledgements

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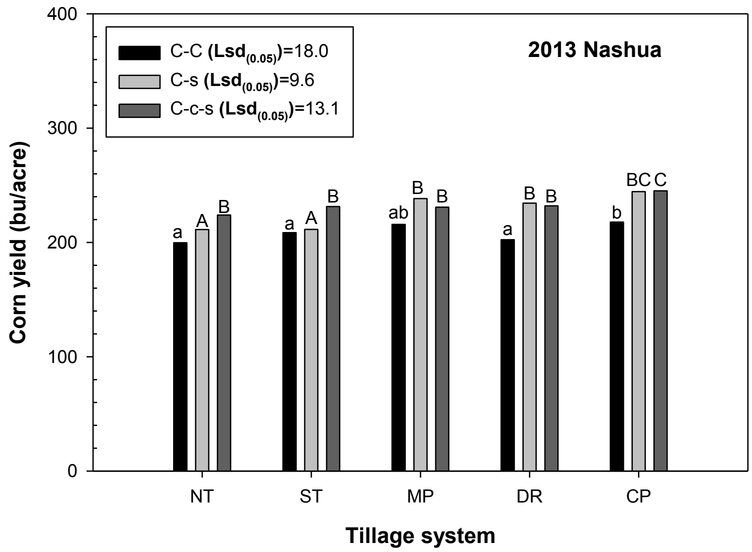

Figure 1. Corn yields for five tillage systems within three rotations (C-C, C-S, and C-C-S) at the ISU Northeast Research Farm, Nashua, IA, in 2013. Corn yields compared across the five tillage systems with the same lower or uppercase letter are not significantly different at P=0.05.

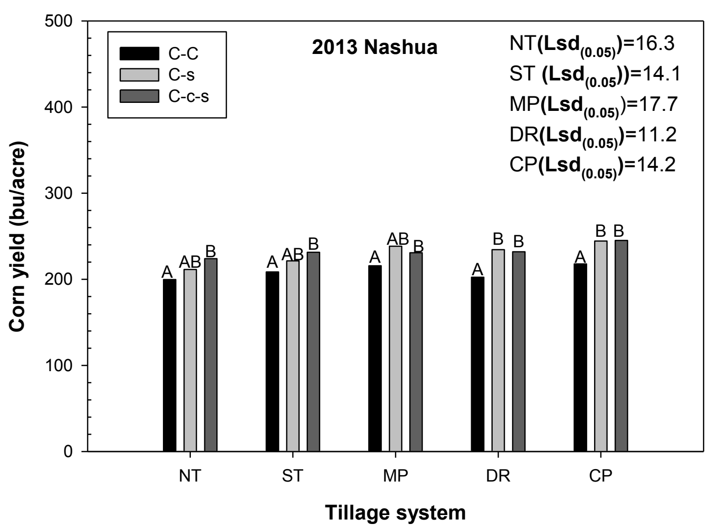

Figure 2. Corn yields with three rotations (C-C, C-S, and C-C-S) within five tillage systems at the ISU Northeast Research Farm, Nashua, IA, in 2013. Corn yields for three rotations compared within each tillage system with the same uppercase letter are not significantly different at P=0.05.

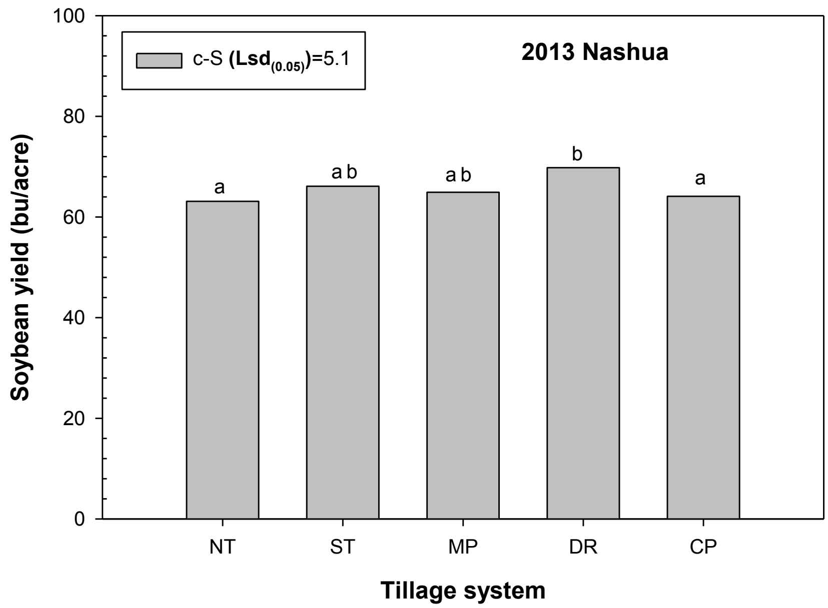

Figure 3. Soybean yields in C-S rotation with five tillage systems at the ISU Northeast Research Farm, Nashua, IA, in 2013. Soybean yields with the same lowercase letter are not significantly different at P=0.05.