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Long-term Tillage and Crop Rotation Effect on Yield and Soil Carbon

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Abstract
Tillage system and crop rotation have major long-term effects on soil productivity and soil quality components of soil carbon and other soil physical, biological, and chemical properties. Additionally, soil tillage and crop rotation controls weed and soil borne diseases. There is a need for a well-defined, long-term tillage and crop rotation study across the different soils 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 productivity and quality.

Keywords
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Long-term Tillage and Crop Rotation Effect on Yield and Soil Carbon

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Introduction

Tillage system and crop rotation have major long-term effects on soil productivity and soil quality components of soil carbon and other soil physical, biological, and chemical properties. Additionally, soil tillage and crop rotation controls weed and soil borne diseases. There is a need for a well-defined, long-term tillage and crop rotation study across the different soils 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 productivity and quality.

Materials and Methods

This study was established in 2002 on eight ISU Research and Demonstration Farms including the ISU Northern Research Farm, Kanawha, Iowa. Treatments included five tillage systems: no-tillage (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), moldboard plow (MP), and different crop rotations of corn and soybean. Crop rotations included corn-corn-soybean (C-C-S), corn-soybean (C-S), and continuous corn (C-C) across the five tillage systems. The experimental design was a randomized complete block design with four replications. The plot size was 12 rows by 90 ft. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. The soil samples were collected from depths 0-6, 6-12, 12-18, and 18-24 in. depths and were analyzed for total carbon and total nitrogen. Subsequently, soil sampling was done biannually at the same depths and analyzed for total carbon and total nitrogen. Yields were determined from the center three rows of each corn plot and five rows of each soybean plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen have been monitored biannually. Depending on the availability of funding, seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate have been conducted.

Results and Discussion

Corn yields in 2013 are presented in Figures 1 and 2. Figure 1 shows a comparison across tillage systems for corn. Figure 2 shows a comparison of rotations within each tillage system for corn. Corn yields in C-C rotation for MP and DR were significantly higher than NT and ST. Overall, the average corn yield across MP, DR, and CP (205 bu/acre) was 25 percent more than the average for NT and ST (164 bu/acre) in the C-C systems (Figure 1).

Corn yields in C-S rotation followed a similar trend as the yields in the C-C system. MP corn yield was significantly more than NT and ST, and DR and CP corn yields were similar to NT and ST. In the C-C-S rotation, corn yields with ST, MP, DR, and CP were significantly more than the NT yield (Figure 1).

The corn yields with C-S and C-C-S rotations for NT, ST, and CP were significantly greater than C-C. But there were no differences between MP, DR, and CP corn yields (Figure 2). The average corn yield across all tillage systems in the C-S rotation (213 bu/acre) was 13.5 percent more, and in C-C-S (217 bu/acre) 15.1 percent more than the average yield across all tillage systems in the C-C rotation (185 bu/acre), respectively.

Acknowledgements

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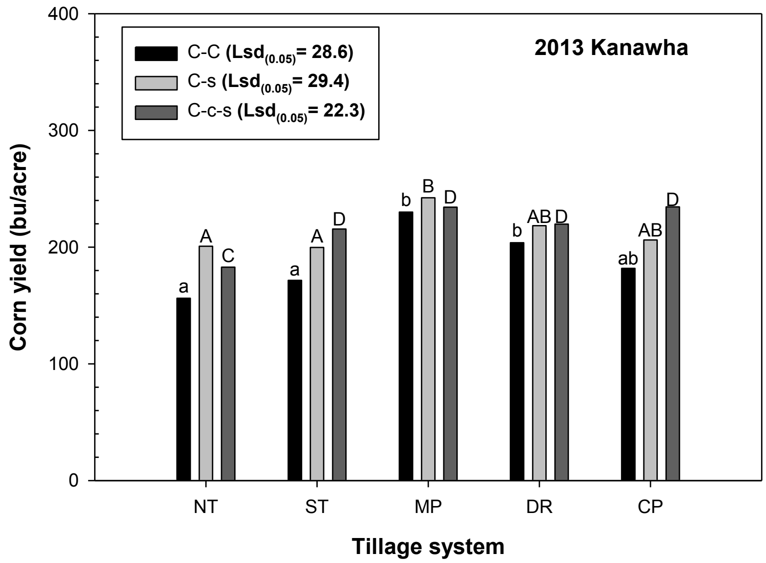

Figure 1. Corn yields for five tillage systems within three rotations (C-C, C-S, and C-C-S) at the ISU Northern Research Farm, Kanawha, IA in 2013. Corn yields within each rotation system with the same lowercase or uppercase letters are not significantly different at P=0.05.

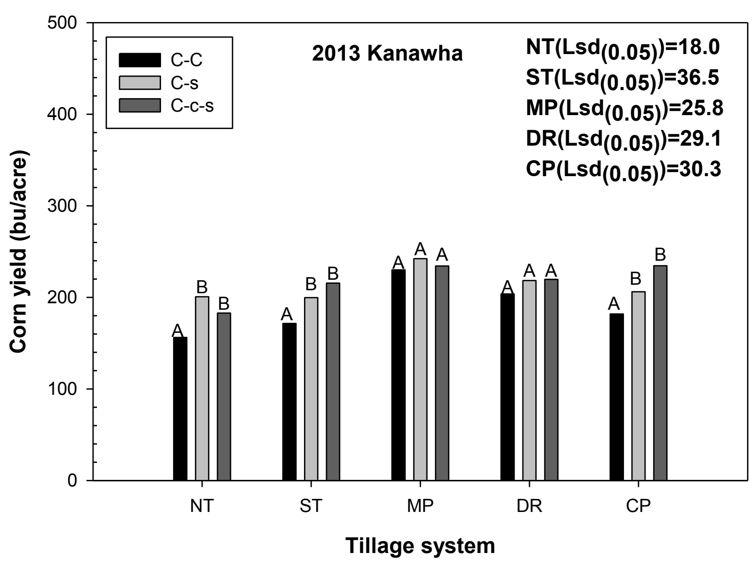

Figure 2. Corn yields for three rotations (C-C, C-S, and C-C-S) within five tillage systems at the ISU Northern Research Farm, Kanawha, IA in 2013. Corn yields for three rotations compared within each tillage system with the same uppercase letters are not significantly different at P=0.05.