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

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Abstract
Tillage systems and crop rotation significantly affect soil productivity and quality in the longterm by affecting soil carbon and the soil physical, biological, and chemical properties. Additionally, tillage systems and crop rotations control weed and soil-borne 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 productivity.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences | Natural Resources and Conservation

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Introduction

Tillage systems and crop rotation significantly affect soil productivity and quality in the long-term by affecting soil carbon and the soil physical, biological, and chemical properties. Additionally, tillage systems and crop rotations control weed and soil-borne 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 productivity.

Materials and Methods

This study was established in 2002 and 2003 on eight ISU Research and Demonstration Farms including the ISU Armstrong Research Farm, Lewis, Iowa, in 2002. Five tillage systems and three crop rotations were adopted in a randomized complete block experimental design with four replications. Main plot treatments for the study are tillage systems, which include no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR) and moldboard plow (MP). The crop rotations are corn-corn-soybean (C-C-S), corn-soybean (C-S), and continuous corn (C-C) in 2008 across each tillage system. Initial soil sampling was done in 2001 prior to the study to establish the baseline soil data for the study. Subsequently, soil sampling was done biannually at 0–6, 6–12, 12–18, and 18–24 in. depths and analyzed for total carbon and total nitrogen. The plot size was 20 rows by 65 ft. Yields were determined from the center four rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen have been monitored every two years. 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 and soybean yields for 2014 are presented in Figures 1 and 2, respectively. Corn yields for all tillage systems in the C-S rotation were not significantly different (Figure 1). However, there were significant differences in corn yields in the continuous corn (C-C) system among tillage systems. When averaged across all tillage systems, corn yield in C-S rotation was 207.0 bushels/acre compared with 128.3 bushels/acre in the C-C rotation (38% higher).

Generally, corn yields in the C-S and C-C rotations with MP, DR, and CP were greater than NT and ST. The average corn yield with MP, DR, and CP in C-S (213.5 bu/ac) was 7.6 percent higher than the average for NT and ST (197.2 bu/acre) (Figure 1).

Soybean yield with DR was only significantly higher than NT (Figure 2). Overall, soybean yields with ST, MP, and CP were not significantly different. However, the average soybean yields for MP, DR, and CP (78.3 bu/acre), was 4.3 percent higher than the average for NT and ST (74.9 bu/acre). Average soybean yield across all tillage systems was 76.9 bushels/acre.

Acknowledgements

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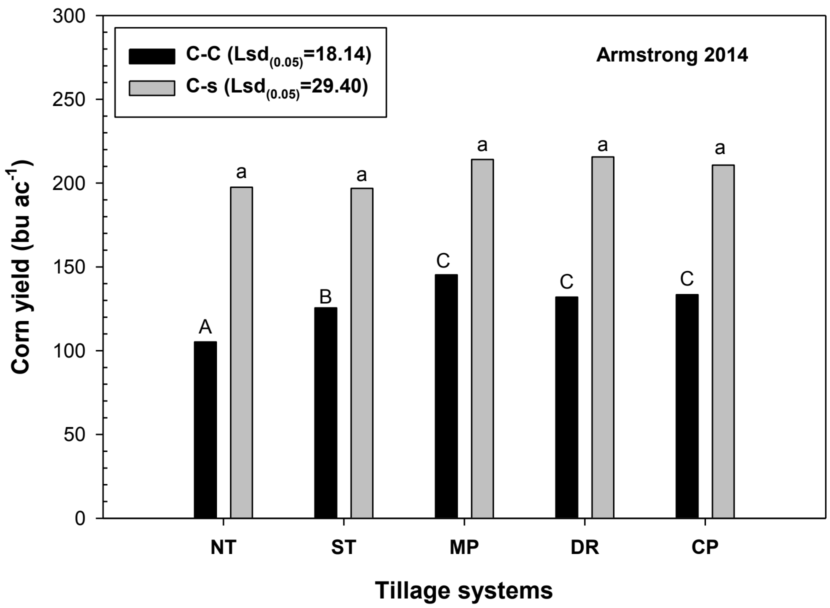

Figure 1. Corn yields for five tillage systems within two rotations (C-C and C-s) at the Armstrong Research Farm in 2014. Corn yields for tillage systems with the same lower or uppercase letter within each rotation system are not significantly different at P = 0.05.

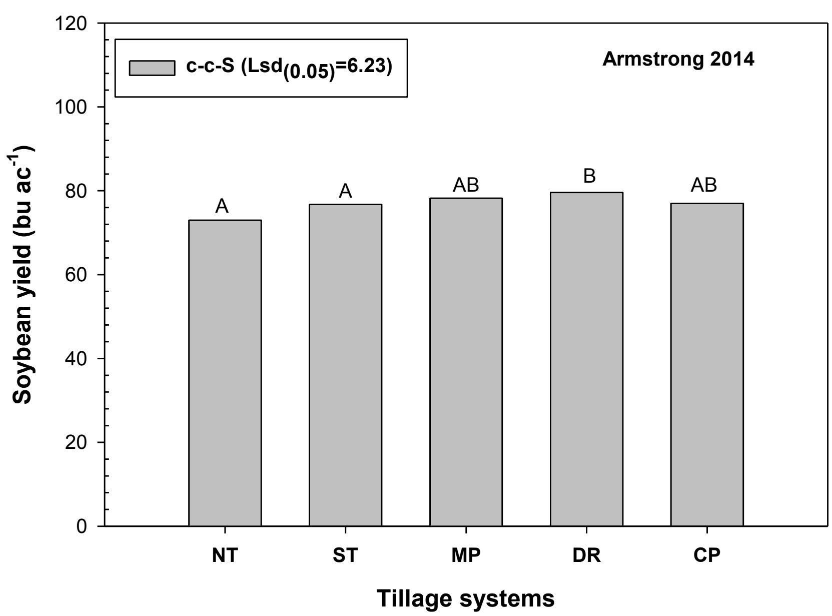

Figure 2. Soybean yields in a c-c-S rotation for five tillage systems at the Armstrong Research Farm in 2014. Soybean yields with the same uppercase letters for tillage systems are not significantly different at P = 0.05.