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

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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, tillage systems 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 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) (added 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 2013 are presented 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. Corn yields in C-C rotation for all tillage systems were not significantly different. Yields of corn in C-C-S rotation with NT and ST were significantly lower than that with DR and CP (Figure 1). However, the low yields for this year were a result of dry conditions. When averaged across all tillage systems, corn yield in C-C rotation was 120.9 bushels/acre compared with 179.9 bushels/acre in C-C-S rotation (second year corn). Or, the C-C yield was 33 percent less than the corn yield in the C-C-S (2^{nd} year corn).

Generally, corn yield in C-C-S rotation for DR and CP was greater than that with NT and ST. Overall, the average yield for MP, DR, and CP in C-C-S (187.9 bu/ac) was 12.2 percent more than that of NT and ST (167.5 bu/acre). However, within each tillage system, corn yield in C-C-S was significantly more than yields in C-C (Figure 2).

Soybean yields (Figure 3) were not significantly different for all tillage systems. Average soybean yield across MP, DR, and CP (57.3 bu/acre) was 7.3 percent more than the average for NT and ST (53.4 bu/acre).

Acknowledgements

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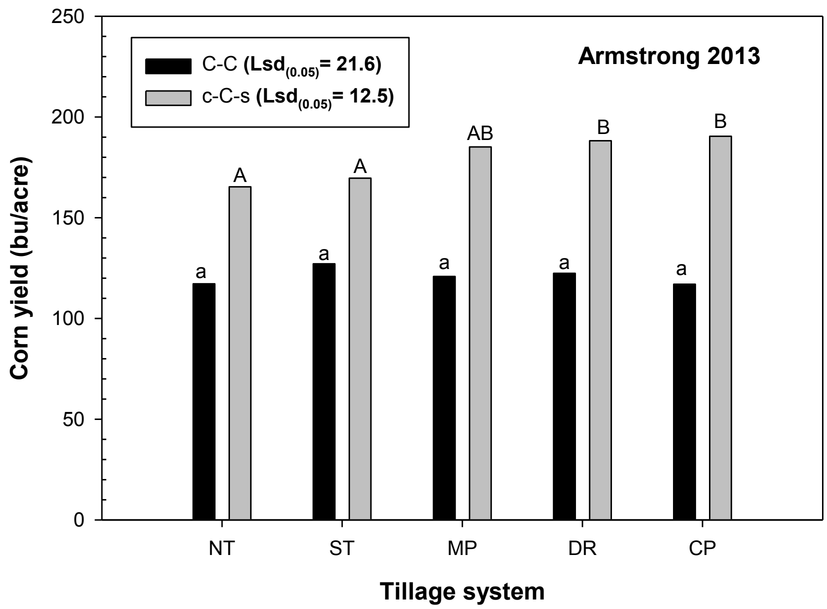

Figure 1. Corn yields for five tillage systems within two rotations (C-C and C-C-S) at the ISU Armstrong Farm, Lewis, IA, in 2013. Corn yields compared across the five tillage systems with the same lower or uppercase letter are not significantly different at P=0.05.

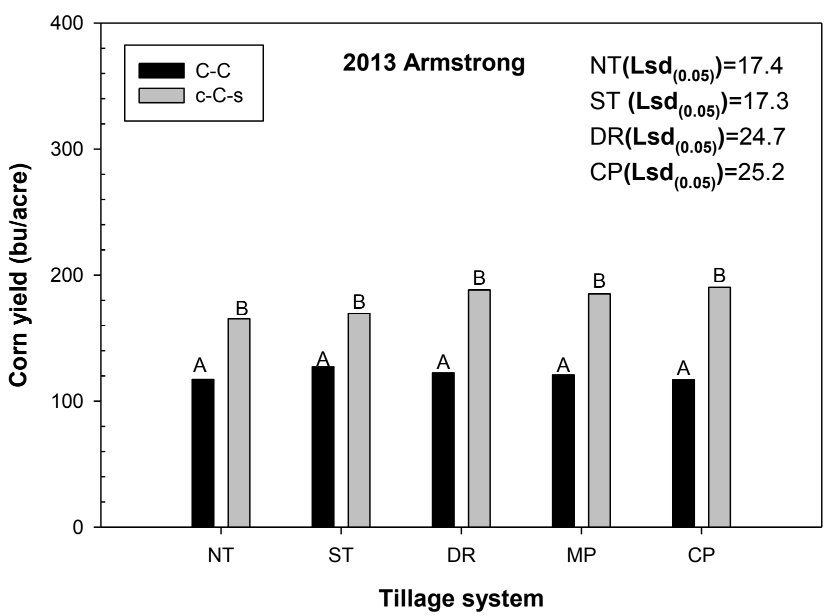

Figure 2. Corn yields with two rotations (C-C and C-C-S) within five tillage systems at the ISU Armstrong Farm, Lewis, IA in 2013. Corn yields for two rotations compared within each tillage system with the same uppercase letters are not significantly different at P=0.05.

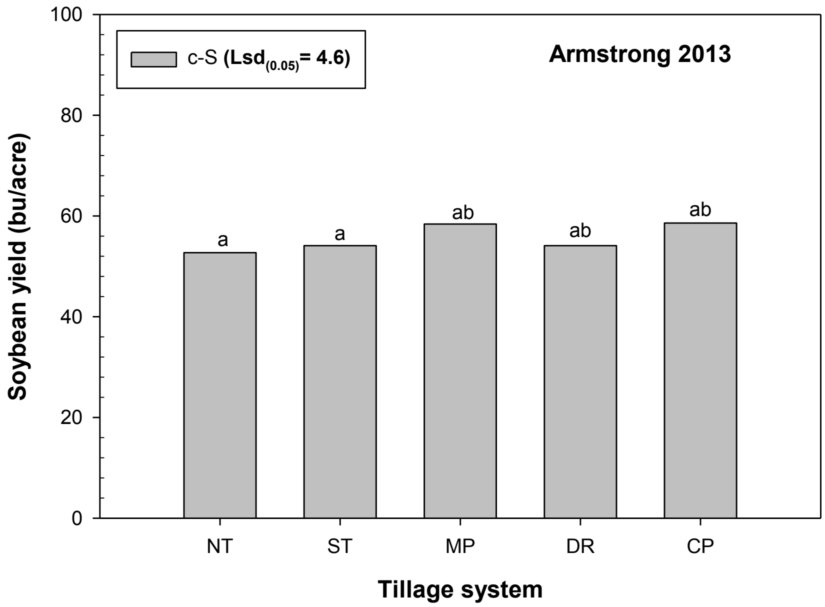

Figure 3. Soybean yields in C-S rotation with five tillage systems at the ISU Armstrong Farm, Lewis, IA, in 2013. Soybean yields with the same lowercase letter are not significantly different at P=(0.05).