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

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Introduction

Tillage systems and crop rotation have major long-term effects on soil productivity and the quality components of soil carbon and soil biological, physical, and chemical properties. Additionally, both 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 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 productivity and soil quality.

Materials and Methods

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

Results and Discussion

Results of 2013 corn and soybean yields are presented in Figures 1, 2, and 3. Generally, corn yields with all tillage systems in C-C and C-S rotations were not significantly different (Figure 1). Overall, the average corn yield across all tillage systems in C-S (57.0 bu/acre) was 34.0 percent more than C-C (42.5 bu/acre) across all tillage systems.

Corn yield differences between C-C and C-S within each tillage system were not significantly different except for NT, MP, and CP where yields with C-S were significantly more than C-C (Figure 2).

Soybean yields with C-C-S rotation are summarized in Figure 3. There were no significant differences in soybean yield across all tillage systems. However, the average with DR and CP (47.2 bu/acre) was 15.4 percent more than the average with NT, ST, and MP (40.9 bu/acre).

Acknowledgements

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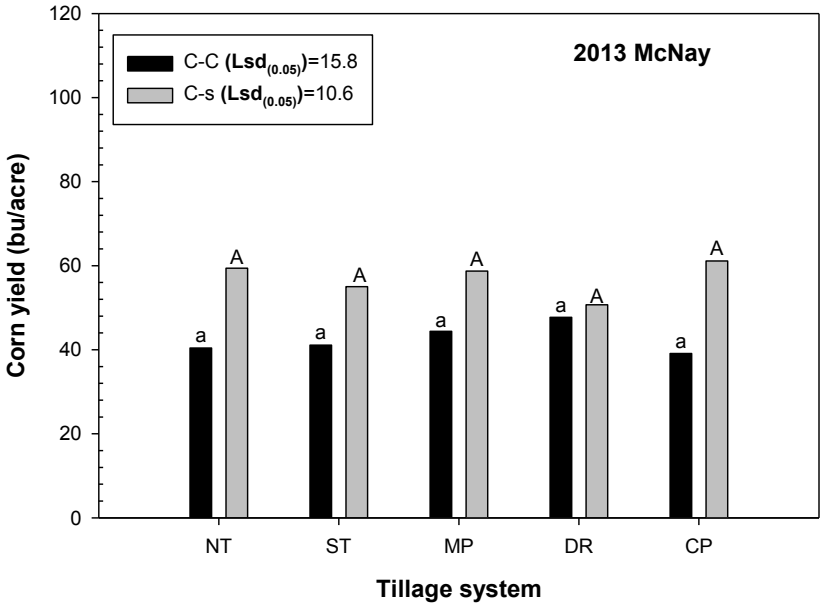

Figure 1. Corn yields with five tillage systems within two rotations (C-C and C-S) at the McNay Research Farm, Chariton, IA, in 2013. Corn yields within each rotation with the same lowercase or uppercase letters are not significantly different at P=0.05.

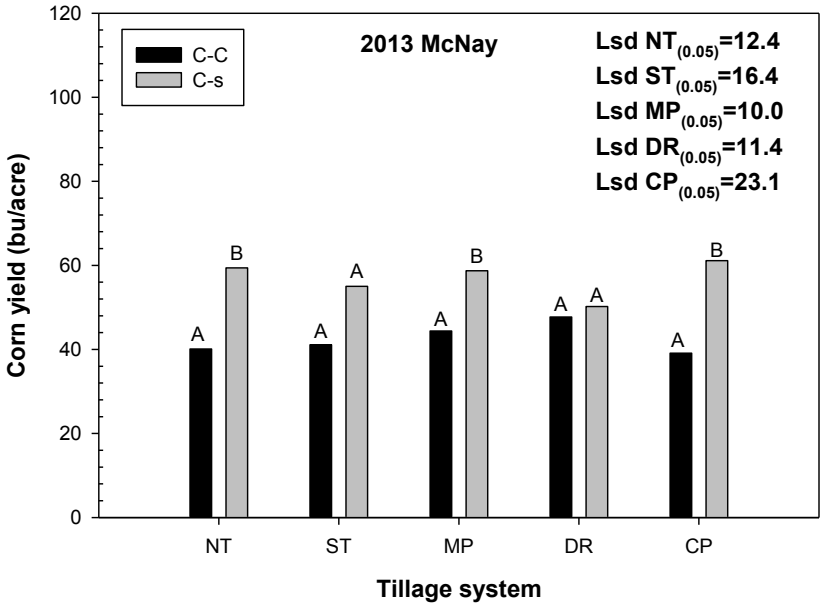

Figure 2. Corn yields with two rotations (C-C and C-S) within each tillage system at the McNay Research Farm, Chariton, IA, in 2013. Corn yields within each tillage system with the same uppercase letter are not significantly different at P=0.05.

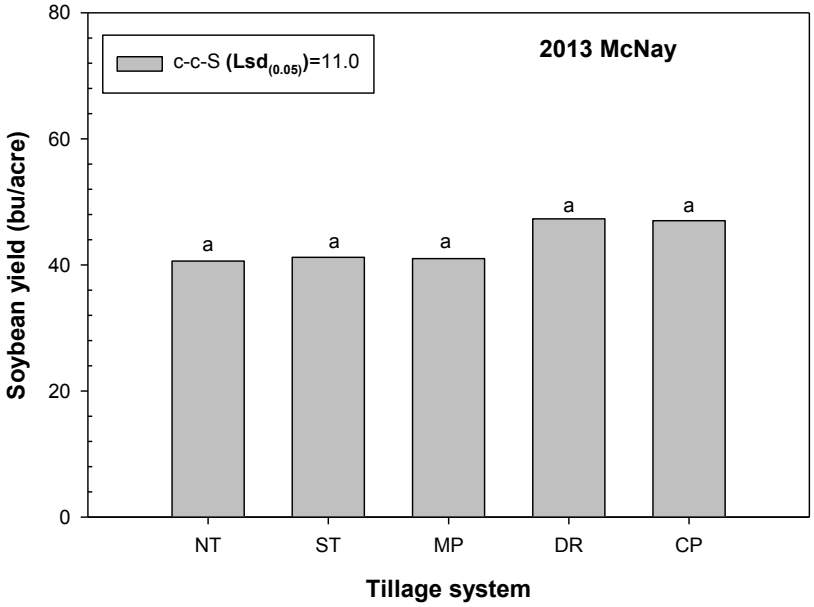

Figure 3. Soybean yields with five tillage systems at the McNay Research Farm, Chariton, IA, in 2013. Soybean yields with the same lowercase letter are not significantly different at P=0.05.