Long-Term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity in South Central Iowa

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Introduction

Tillage systems and crop rotation have significant long-term effect on soil health, productivity, and the soil quality components of soil carbon and other physical, chemical, and biological properties of the soil. Additionally, soil tillage and crop rotation control weed and soilborne diseases. There is 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 soil quality.

Materials and Methods

This study started in 2002 at seven Iowa State University Research and Demonstration Farms, including the ISU McNay Research Farm, Chariton, Iowa. The experimental design for the study is a randomized complete block design with four replications. Each plot size is 30 ft (12 rows) by 113.5 ft. Treatments include five tillage systems: no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP) and three crop rotations with corn and soybean. Crop rotation systems at the McNay Research Farm 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 with the C-C system over the five tillage systems since 2008. Prior to establishing the study in 2002 with the five tillage treatments, baseline soil sampling was done at 0–6, 6–12, 12–18, and 18–24 in. depths and analyzed for total carbon and total nitrogen. Subsequent soil sampling after establishing the study has been done biannually at the same depths and analyzed for total carbon and total nitrogen to monitor the long-term effects of tillage and crop rotation on soil total carbon and total nitrogen. Seasonal measurements of nitrogen use efficiency, soil bulk density, and infiltration rate are conducted depending on availability of funding. Corn yields were determined from the center 6 rows of each plot.

Results and Discussion

The 2015 crop at the McNay Research Farm was corn and the results of corn yields are presented in Figure 1.

Overall, the average corn yield in 2015 at the McNay Research Farm was 103.4 bushels/acre. Seven plots in the experiment were very wet and one plot had no corn yield. The highest corn yield (130.7 bu/ac) was in the C-s rotation and the lowest yield (63.0 bu/ac) was in the C-C system. In both the C-C and c-C-s systems, corn yields with all tillage treatments were not significantly different. However, in each rotation the DR system had the highest yield, with 135.2 bushels/acre in the c-C-s and 71.9 bushels/acre in the C-C system. In the C-s system, corn yields with NT, ST, CP, and DR were not significantly different. Similarly, the yields with CP, DR, and MP in the C-s system also were not significantly different. Significant weed pressure and wet conditions contributed to low yields.

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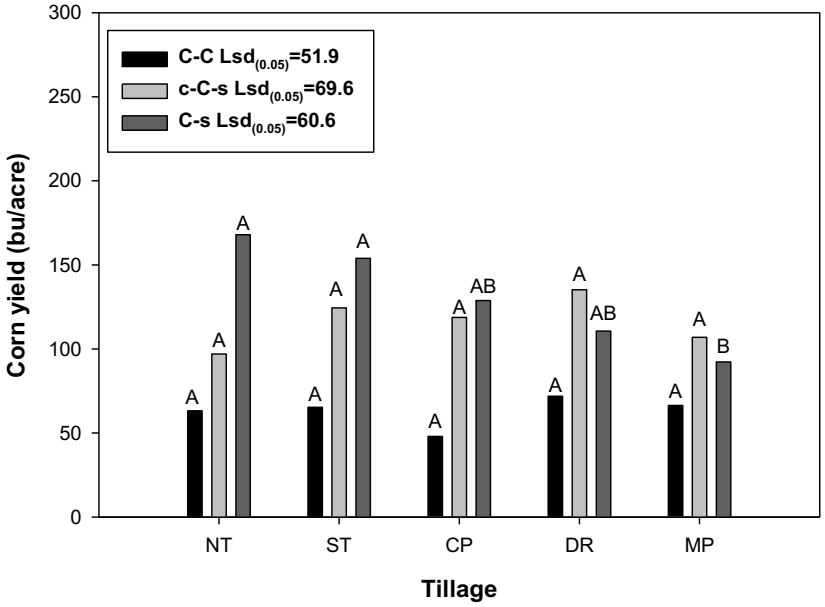

Figure 1. Corn yields with five tillage systems in three rotations (C-C, c-C-s, and C-s) at the McNay Research Farm, Chariton, in 2015. Corn yields for each rotation with the same uppercase letters are not significantly different at P = 0.05.