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

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Introduction

Tillage systems and crop rotation significantly affect soil carbon and soil productivity in the long-term, including the physical, biological, and chemical soil quality indicators. Additionally, tillage systems and crop rotations control weed and soilborne 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 at the Armstrong Research Farm, Lewis, Iowa, is one of seven long-term tillage studies established in 2002 and 2003 at seven Iowa State University Research and Demonstration Farms across Iowa. At the Armstrong Research Farm, experimental treatments include five tillage systems and three crop rotations in a randomized complete block experimental design replicated four times. Tillage treatments include no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP). The three crop rotation treatments are corn-soybean (C-S), corn-corn-soybean (C-C-S), and corn-corn (C-C) rotation systems. Initial soil sampling for baseline soil data was done in 2001 at 0-6, 6-12, 12-18, and 18-24 in. soil depths and analyzed for total carbon and total nitrogen. Subsequently, soil sampling has been done every two years at the same soil depths and analyzed for total carbon and total nitrogen. Plot sizes are 50 ft wide (20 rows) and 65 ft long. Yields were determined from the center four rows of each plot. The long-term effects of tillage and crop rotation on total soil carbon and total nitrogen have been monitored every two years. However, depending on the availability of funding, additional seasonal measurements of nitrogen use efficiency and water infiltration rate have been conducted.

Results and Discussion

The results of corn yield with five tillage systems and two crop rotations C-s and C-C at the Armstrong Farm in 2020 are shown in Figure 1. The results of soybean yield with five tillage systems and c-c-S rotation in 2020 are shown in Figure 2.

Corn yields with all five tillage systems (NT, ST, CP, DR, and MP) in the C-C rotation system were not significantly different (P = 0.3678, Figure 1). In the C-s rotation, MP (186.9 bu/acre) yielded significantly higher than ST (166.7 bu/acre) and NT (160.3 bu/acre), and CP (178.9 bu/acre) and DR (175.0 bu/acre) also were significantly higher than NT. The average corn yields across all tillage systems in the C-C and C-s rotations were 122.5 bushels/acre and 173.6 bushels/acre, respectively. The average corn yield in the C-s rotation was 41.7 percent higher than the average yield in the C-C rotation. Overall, the average corn yield across all tillage systems and two crop rotations (C-C and C-s) in 2020 at the Armstrong Farm was 148.0 bushels/acre.

Soybean yields were significantly higher in MP (67.6 bu/acre) than CP (62.5 bu/acre), ST (61.5 bu/acre), and NT (61.7 bu/acre), while DR (64.2 bu/acre) was within the least significant difference of these four tillage

systems. The average soybean yield across all tillage systems was 63.5 bushels/acre.

Acknowledgements

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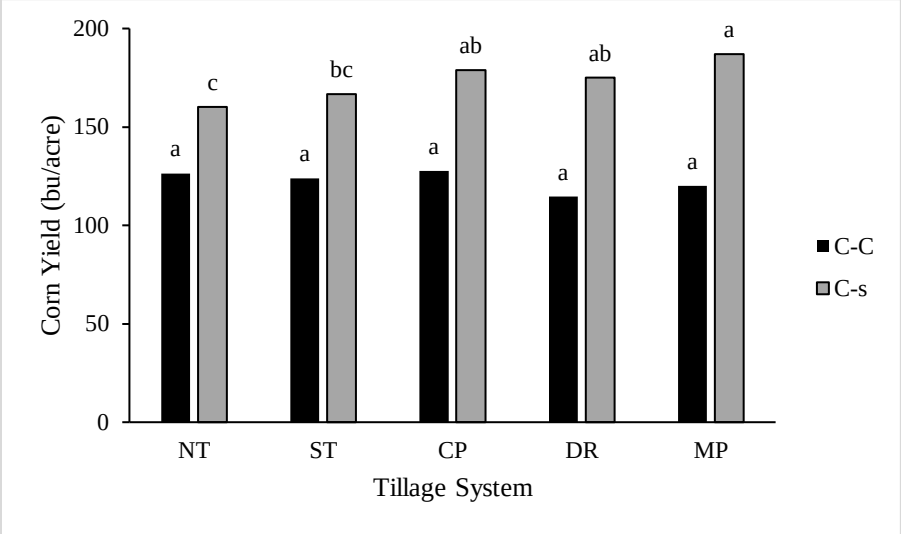

Figure 1. Corn yields with five tillage systems in two crop rotation systems (C-C and C-s) at the Armstrong Farm in 2020. Corn yields with the same letter in the same rotation and different tillage systems are not significantly different at P = 0.05 (NT = no-till; ST = strip-tillage; CP = chisel plow; DR = deep rip; MP = moldboard plow; C-C = corn-corn rotation, C-s = corn=soybean rotation).

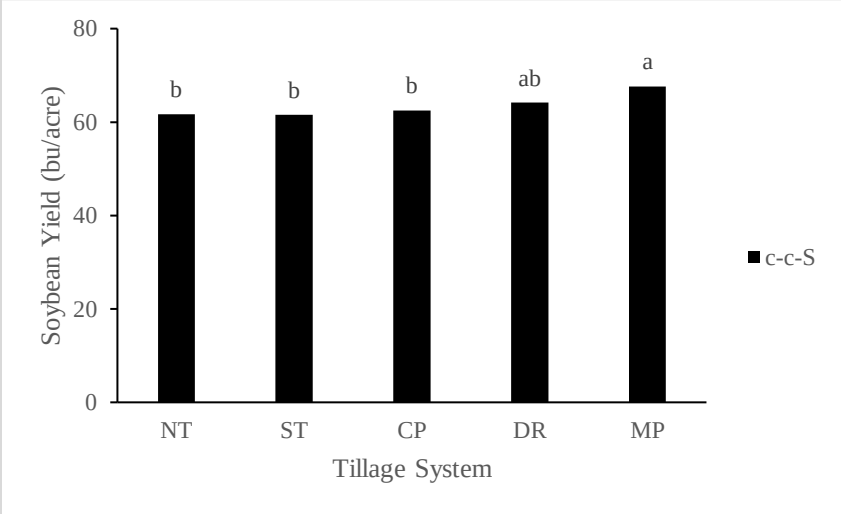

Figure 2. Soybean yields with five tillage systems in a c-c-S crop rotation system at the Armstrong Farm in 2020. Soybean yields with the same letter in different tillage systems are not significantly different at P = 0.05 (NT = no-till; ST = strip-tillage; CP = chisel plow; DR = deep rip; MP = moldboard plow; c-c-S = corn-corn-soybean rotation).