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

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Introduction

Tillage systems and crop rotation have a significant long-term effect on soil carbon, soil productivity, and the physical, chemical, and biological indicators of soil quality and health. Additionally, soil tillage and crop rotation have effects on weed and soil disease control. There is 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.

Materials and Methods

This study started in 2003 on seven Iowa State University Research and Demonstration Farms including the Ag Engineering/Agronomy (AEA) Farm in Boone and continued through 2018. The experimental design is a randomized complete block with five tillage systems and three crop rotation systems, replicated four times. Treatments include no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP). The three crop rotation systems are corn-soybean (C-S), corn-corn-soybean (C-C-S), and corn-corn (C-C). Prior to implementing the tillage treatments, initial soil sampling was done in 2003 at depths of 0–6, 6–12, 12–18, and 18–24 in. and analyzed for total carbon and total nitrogen as the baseline soil data. Soil samples have been collected every two years since 2003 at the same soil depths. Each plot size is 30 ft wide (12 rows) and 90 ft long for the C-C-S and C-S rotations. In the C-C rotation, each plot is 30 ft wide (12 rows) and 60 ft long. Corn and soybean yields are determined from the center 4 and 6 rows of each plot, respectively. The long-term tillage and crop rotation effects on soil total carbon and total nitrogen have been monitored every two years. Seasonal measurement of nitrogen use efficiency and water infiltration rate depends on availability of funding.

Results and Discussion

Corn and soybean yields in 2018 at the AEA Farm are shown in Figures 1 and 2.

Corn yields in the C-C with NT (156.3 bu/ac), ST (159.2 bu/ac), CP (172.1 bu/ac), DR (163.4 bu/ac), and MP (175.6 bu/ac) were not significantly different (Figure 1). In the C-C-S rotation system, corn yield with NT (93.6 bu/ac) and ST (105.7 bu/ac) were not significantly different. Similarly, corn yield with CP (139.2 bu/ac) and DR (140.8 bu/ac) and MP (134.5 bu/ac) were not significantly different, but significantly different from the NT and ST corn yields (Figure 1). The average corn yields in the C-C and C-C-S rotation systems were 165.3 bushels/acre and 122.8 bushels/acre, respectively. The 2018 average corn yield at the AEA Farm was 144.0 bu/acre.

Soybean yield in the C-S rotation in 2018 with NT (64.0 bu/ac), ST (55.8 bu/ac), CP (62.8 bu/ac), DR (61 bu/ac), and MP (58.4 bu/ac) were not significantly different (Figure 2). The average soybean yield in 2018 at the AEA Farm was 60.4 bushels/acre.

Acknowledgements

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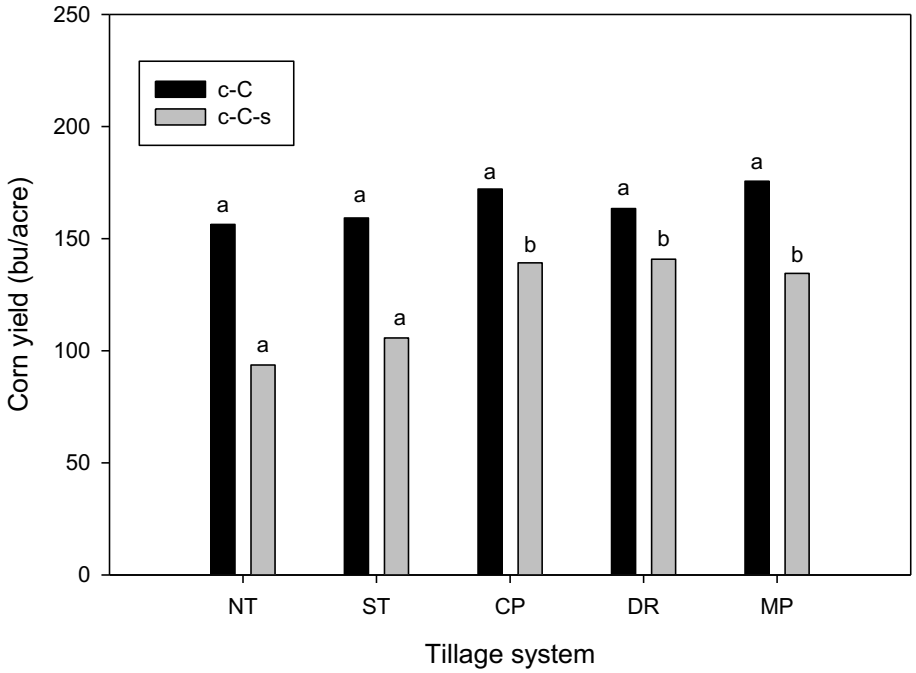

Figure 1. Corn yields with five tillage systems in two rotations (C-C, C-C-S) at the Ag Engineering/Agronomy Research Farm (Boone) in 2018. Corn yields in the same crop rotation with the same letter are not significantly different at P = 0.05.

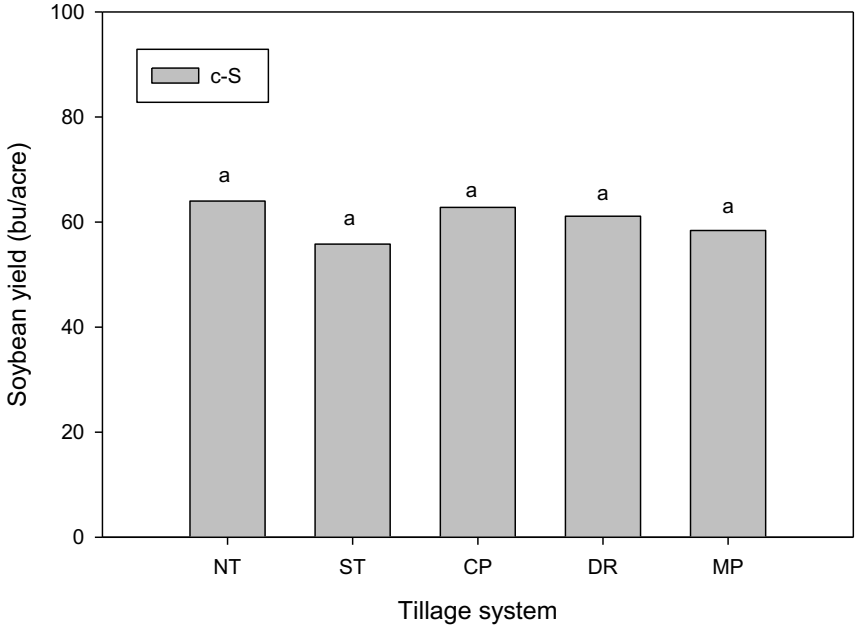

Figure 2. Soybean yields with five tillage systems in a corn-soybean (C-S) rotation system at the Ag Engineering/Agronomy Research Farm (Boone) in 2018. Soybean yields of tillage systems with the same letter are not significantly different at P = 0.05.