Long-Term Tillage and Crop Rotation Effect on Yield and Soil Carbon in North Central Iowa

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Introduction

Tillage and crop rotation systems have significant long-term effect on soil carbon, soil health, productivity, and the physical, chemical, and biological components of soil quality. Furthermore, 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 soil types and climate conditions in the state. The objective of this study was to evaluate the long-term effects of five tillage systems and three crop rotations on soil productivity and quality.

Materials and Methods

This study started in 2002 at seven Iowa State University Research and Demonstration Farms including the Northern Research Farm (NRF) at Kanawha, and has continued through 2018. The experimental design is a randomized complete block with five tillage treatments per block, replicated four times. Tillage treatments include no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP). The crop rotation systems are corn-soybean (C-S), corn-corn-soybean (C-C-S), and corn-corn (C-C). Each tillage treatment plot is 30 ft. wide (12 rows) and 90 ft. long. Prior to establishing the experiment, baseline soil samples were collected in 2002 at 0–6, 6–12, 12–18, and 18–24 in. depths and analyzed for total carbon (C) and total nitrogen (N). Soil sampling after establishing the experiment has occurred every two years at the same depths, and analyzed for total C and total N. Seasonal nitrogen use efficiency, soil bulk density, and infiltration rate have been conducted depending on availability of funding.

Corn and soybean yields were determined from the center three and five rows of the corn and soybean plot, respectively.

Results and Discussion

The results of corn and soybean yields in 2018 are in Figures 1 and 2, respectively. Corn yields with different tillage systems in the C-C rotation system show yields with ST (91.8 bu/ac), CP (91.3 bu/ac), DR (93.8 bu/ac), and MP (102.7 bu/ac) were not significantly different (Figure 1). However, corn yield in the C-C rotation system with NT (64.8 bu/ac), was significantly different from yields with other tillage systems (Figure 1). The average corn yield in 2018 across all tillage systems was 88.9 bushels/acre, which was 15.5 percent lower than the highest yield 102.7 bushels/acre with the MP tillage system.

Soybean yield in the C-S rotation, with NT (50.1 bu/ac), ST (55.8 bu/ac), and MP (54.1 bu/ac), were not significantly different. Similarly, the yield with CP (48.0 bu/ac), DR (46.7 bu/ac), and NT (50.1 bu/ac) were not significantly different (Figure 2). In the C-C-S rotation system, soybean yield with the different tillage systems were not significantly different (Figure 2). The highest soybean yields in the C-S (55.8 bu/ac) and C-C-S (61.4 bu/ac) rotations in 2018 were with ST. In 2018, the average soybean yield in the C-C-S rotation (58.4 bu/ac) was 14.7 percent higher than the average (50.9 bu/ac) in the C-S rotation. Generally, average soybean yield in 2018 at Kanawha was 54.7 bushels/acre.

Acknowledgements

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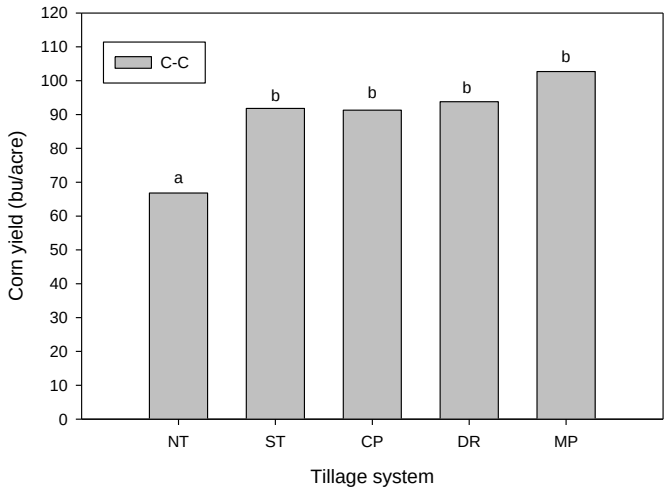

Figure 1. Corn yields in 2018 with five tillage systems in C-C rotation at the Northern Research and Demonstration Farm, Kanawha, Iowa. Corn yields with the same letter are not significantly different at P = 0.05.

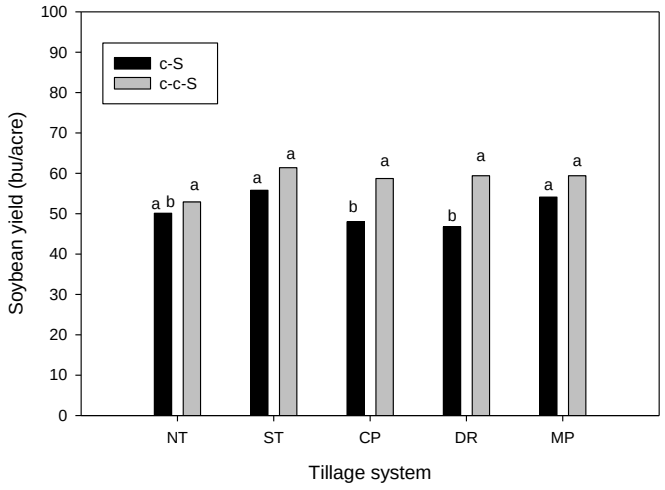

Figure 2. Soybean yield in 2018 with five tillage systems and two crop rotation systems (C-S and C-C-S) systems at the Northern Research and Demonstration Farm, Kanawha, Iowa. Soybean yields with the same letter in the same rotation system are not significantly different at P = 0.05.