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

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Introduction

Tillage and crop rotation systems have significant long-term effects 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 of Iowa. The objective of this study was to evaluate the long-term effects of different tillage and crop rotation systems on soil productivity and soil quality.

Materials and Methods

This experiment was initiated at the McNay Research Farm, Chariton, Iowa, in 2002 and has continued through 2020. The experimental design is a randomized complete block with four replications. Each plot size is 30 ft wide (12 rows) and 113.5 ft long. 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: corn-corn-soybean (C-C-S), corn-soybean (C-S), and continuous corn (C-C). The C-C 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 the C-C system. Prior to establishing the study in 2002, 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. Since 2002, soil sampling has been done every two years at the same depths and analyzed for total carbon and total nitrogen. Corn and soybean yields were determined from the center 8 rows and all 12 rows of each plot, respectively.

Results and Discussion

The results of corn and soybean yields in 2020 at the McNay Farm are shown in Figures 1 and 2, respectively.

One plot each of NT and MP in the C-C rotation had considerable ponding but were included in the analysis because they had yields similar to other plots without ponding. Corn yields in 2020 in the C-C rotation with tillage systems NT (111.3 bu/ac), CP (113.4 bu/ac), and DR (110.1 bu/ac), were not significantly different from any treatments. The only statistically significant difference was between ST (127.3 bu/ac), the highest yielding tillage system, and MP (95.5 bu/ac), the lowest yielding tillage system (Figure 1).

Corn yields in the C-c-s rotation system with NT (178.3 bu/ac), ST (213.4 bu/ac), CP (179.4 bu/ac), DR (192.3 bu/ac), and MP (190.0 bu/ac) were not significantly different (P = 0.43, Figure 1). The average corn yield in the C-C and C-c-s rotation systems across all tillage systems were 111.5 bushels/acre and 190.7 bushels/acre, respectively.

For soybean yields in the c-S rotation in 2020, ST (48.4 bu/ac) had significantly higher yield than CP (41.6 bu/ac), DR (42.5 bu/ac), and MP (43.1 bu/ac), which were not different from each other. NT (44.6 bu/ac) was not statistically significant from any of the treatments.

Overall corn and soybean yields at McNay in 2020 were 151.1 bushels/acre and 44.1 bushels/acre, respectively.

Acknowledgements

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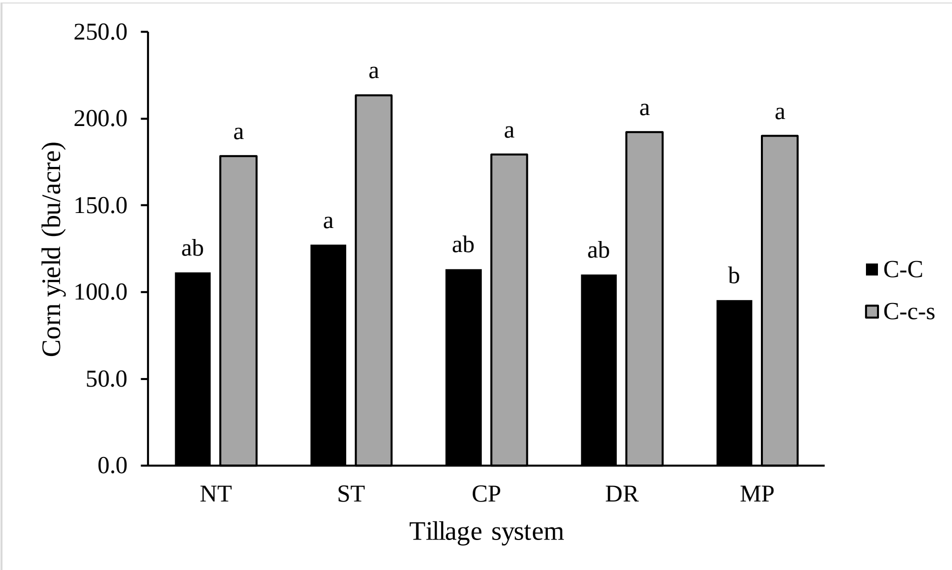

Figure 1. Corn yields with five tillage systems in two crop rotation systems (C-c-s and C-C) at the McNay Research Farm in 2020. Corn yields in the same rotation system with the same letter are not significantly different at $P \leq 0.05$ (NT = no-till; ST = strip-tillage; CP = chisel plow; DR = deep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

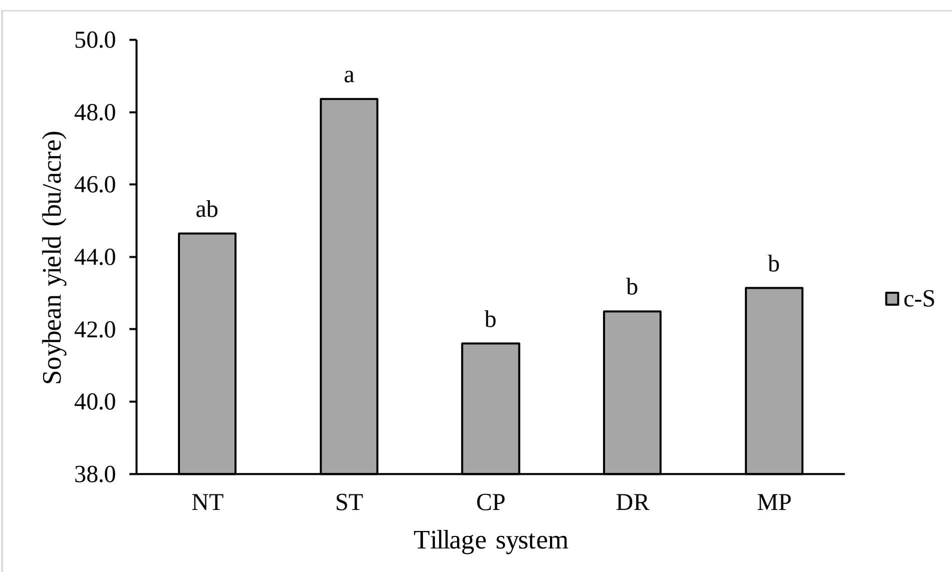

Figure 2. Soybean yields with five tillage systems in corn-soybean rotation (c-S) at the McNay Research Farm in 2020. Soybean yields with the same letter are not significantly different at $P \leq 0.05$ (NT = no-till; ST = strip-tillage; CP = chisel plow; DR = deep rip; MP = moldboard plow; c-S = corn-soybean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