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

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Mahdi Al-Kaisi, professor
David Kwaw-Mensah, research associate
Department of Agronomy

Introduction

Tillage systems and crop rotation systems have significant long-term effects on soil health and productivity and the soil quality components of soil carbon and other physical, chemical, and biological properties of the soil. Furthermore, 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 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 McNay Research Farm in south central Iowa, and has continued through 2016. The experimental design is a randomized complete block with four replications. Each plot size is 30 ft wide (12 rows) by 113.5 ft long. Treatments include five tillage systems: no-tillage (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 over the five tillage systems. Prior to establishing the study in 2002, baseline soil samples at 0–6, 6–12, 12–18, and 18–24 in. depths were analyzed for total C and total N. Subsequent soil sampling after establishing the study has been every two years at the same depths and analyzed for total C and total N to monitor the long-term effects of tillage and crop rotation on soil total carbon and total nitrogen. Seasonal nitrogen use efficiency, soil bulk density, and infiltration rate measurements are conducted, depending on availability of funding. 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 yields at McNay in 2017 are shown in Figure 1.

In the C-C rotation, corn yields were not significantly different (Figure 1). In the C-S and C-C-S rotations, corn yields with NT and ST were not significantly different. Similarly, corn yields in the CP, DR, and MP systems were not significantly different. However, in the C-C rotation, the highest corn yield (91 bu/acre) was with ST and in the C-C-S rotation, the highest corn yield (123.7 bu/acre) was with DR. In the C-S system, corn yield with NT (92.9 bu/acre) and ST (80.1 bu/acre) were not significantly different. Similarly, corn yield with CP (114.2 bu/acre), DR (111.0 bu/acre), and MP (126.7 bu/acre) were not significantly different. The average corn yield in the C-S, C-C-S, and C-C rotations were 105.0 bushels/acre, 87.3 bushels/acre, and 82.9 bushels/acre, respectively. Overall corn yield at McNay in 2017 was 91.7 bushels/acre.

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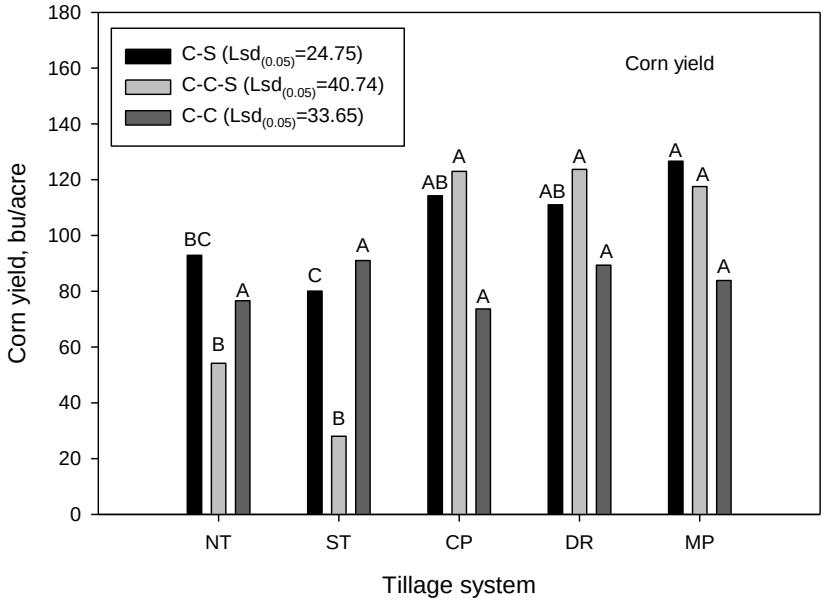

Figure 1. Corn yields with five tillage systems in three crop rotation systems (C-S, C-C-S, and C-C) at the McNay Research Farm. Corn yields in a rotation system with the same uppercase letter are not significantly different at P = 0.05.