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

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

Introduction

Tillage system and crop rotation have a significant long-term effect on soil productivity and soil quality components such as soil carbon and other soil physical, biological, and chemical properties. In addition, both tillage and crop rotation have effects on weed and soil disease control. There is a 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 the long-term effects of different tillage systems and crop rotations on soil productivity.

Materials and Methods

This study began in 2003 on eight ISU Research and Demonstration Farms in 2003, including the Ag Engineering/Agronomy Research Farm, Boone, and continued through 2014. Treatments include five tillage systems: no-till (NT), strip-tillage (ST), chisel plow (CP), deep rip (DR), and moldboard plow (MP) and various crop rotations with corn and soybean across the five tillage systems. In 2008, a continuous corn rotation was added to the experiment after the 2007 corn crop year. Therefore, the study has continued since 2008 with the following rotations: C-S, C-C-S, and C-C over five tillage systems. Initial soil samples were collected in 2003 prior to implementing the tillage treatments for C-S and C-C-S rotations and in 2008 for C-C baseline. Soil samples have been subsequently collected every two years. The soil samples were collected for depths 0–6, 6–12, 12–18, and 18–24 in. and analyzed for total carbon and total nitrogen. The experimental design is a randomized complete block design with four replications. Each plot size is 12 rows (30 ft) by 90 ft for the C-C-S and C-S rotations and 12 rows (30 ft) by 60 ft for the continuous corn (C-C). Corn and soybean yields are determined from the center 4 and 6 rows of each plot, respectively. The long-term effects of tillage and crop rotation on soil total carbon and total nitrogen have been monitored bi-annually. Seasonal measurement of nitrogen use efficiency, soil bulk density, and infiltration rate depends on availability of funding.

Results and Discussion

Corn and soybean yields with five tillage systems in 2014 are shown in Figure 1 and 2, respectively.

In the C-C-S rotation, corn yields were not significantly different (Figure 1). However, yields in the C-C rotation were significantly different. Average corn yield in the C-C-S rotation was 173 bushels/acre and 33 percent higher than the C-C average (117 bu/acre). Corn yields in the C-C-S rotation with MP, DR, and CP were greater than NT and ST. In the C-C rotation, corn yield with NT was least, ST and MP intermediate, and DR and CP highest ($P = 0.05$) (Figure 1). Average corn yield with MP, DR, and CP (178 bu/ac) in C-C-S was 9 percent higher than the average for NT and ST (166 bu/acre). In the C-C rotation, average corn yield with MP, CP, and DR (120 bu/ac) was 12 percent higher than NT (106 bu/ac) and 4 percent higher than ST (116 bu/ac). Soybean yields in the C-S rotation were not significantly different. Soybean average yield in 2014 was 44 bushels/acre.

Acknowledgements

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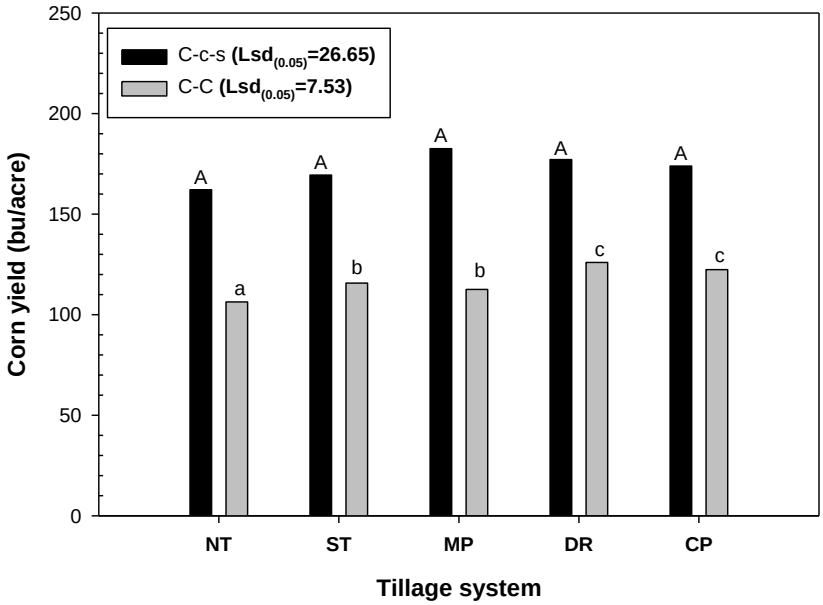

Figure 1. Corn yields with five tillage systems for two rotations (C-C and C-C-S) at the ISU Ag Engineering/Agronomy Research Farm (Boone) in 2014. Corn yield for each rotation with the same lowercase or upper case letters are not significantly different at P = 0.05.

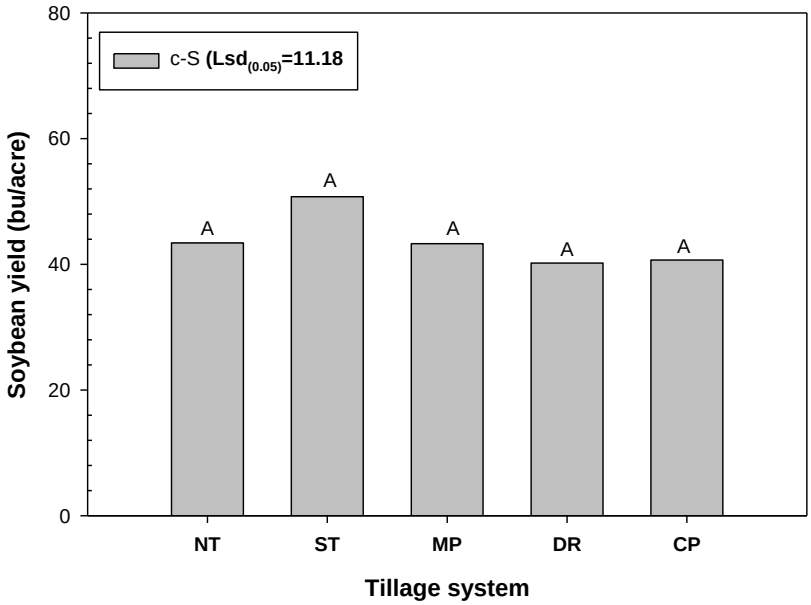

Figure 2. Soybean yield in a C-C-S rotation for five tillage systems at the ISU Ag Engineering/Agronomy Research Farm (Boone) in 2014. Soybean yields with the same uppercase letters are not significantly different at P = 0.05.