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 systems have significant long-term effects on soil health, productivity, and the soil quality components of soil carbon and other physical, biological, and chemical soil properties. Additionally, both 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 crop rotations on soil productivity.

Materials and Methods

This study began in 2003 at seven Iowa State University Research and Demonstration Farms, including the Ag Engineering/Agronomy (AEA) Research Farm west of Ames, which has continued through 2015. 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, two with soybean: Corn-soybean (C-S), Corn-corn-soybean (C-C-S) and a continuous corn (C-C) treatment across the five tillage systems. The C-C system was added to the experiment in 2008 after the 2007 crop year. Prior to implementing the five tillage systems for the experiment in 2003, baseline soil sampling was done at 0–6, 6–12, 12–18, and 18–24 in. soil depths. After establishing the experiment, soil sampling has been done biannually at the same soil sampling depths and analyzed for total carbon and total nitrogen. The experimental design is a randomized complete block design with four replications. Each plot size is 30 ft wide (12 rows) and 90 ft long for the corn and soybean rotation systems (C-C-S and C-S) and 30 ft wide and 60 ft long for the continuous corn (C-C). Seasonal measurement of nitrogen use efficiency, soil bulk density, and infiltration rate depends on availability of funding. Corn and soybean yields were determined from the center 4 and 6 rows of each plot, respectively.

Results and Discussion

Corn was the only crop in the 2015 experiment at the AEA Research Farm and the results are presented in Figure 1. In the C-s rotation, corn yields in the conventional tillage systems (CP, DR, and MP) were not significantly different. However, there was a significant difference in corn yields with NT and ST. Similar results in corn yields were obtained in the c-C-s system. In the C-C system, corn yields with CP and MP were not significantly different, but there was a significant difference in the yields with NT, ST, and DR. Corn yields averaged across all tillage systems was highest (175.9 bu/acre) in the c-C-s system and lowest (129.5 bu/acre) in the C-C system.

Overall, corn yield in 2015 at the AEA Farm across all tillage treatments and crop rotations was 158 bushels/acre. The average corn yields in the NT and ST systems, 107.4 bushels/acre, and 134.1 bushels/acre, respectively, were hampered by the onset of northern corn leaf blight, a fungal disease caused by the fungus *Exserohilum turcicum,* and wet field conditions in June (6.9 in.) and August (8.26 in.). A fungicide application was made at the R1 stage of crop growth to help with control of the disease. Late season plant health and

kernel development also was compromised due to the high precipitation in August, causing possible leaching of nitrogen from the soil profile. Rainfall for the year at the Ames site was 44.60 in., 12.37 in. above normal.

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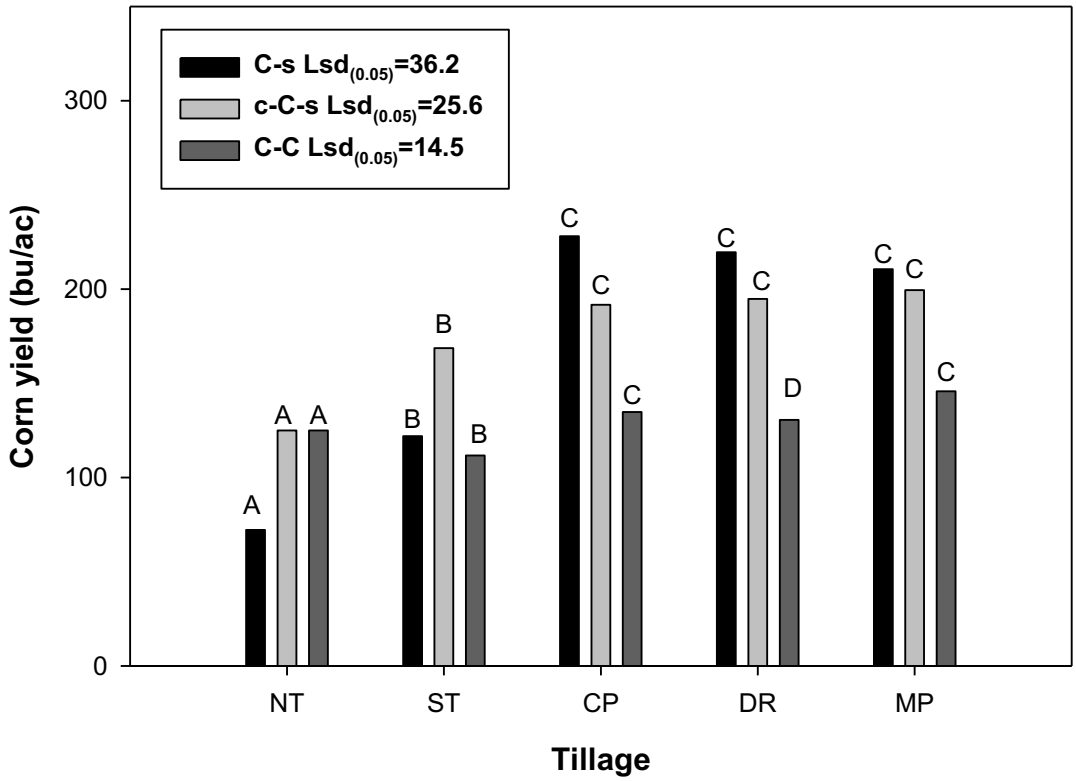

Figure 1. Corn yields with five tillage systems in three rotations (C-s, c-C-s, and C-C) at the AEA Research Farm (Boone) in 2015. Corn yield in each rotation with the same uppercase letters are not significantly different at P = 0.05. Low yield of NT and ST for all rotations was due to weed pressure and northern corn leaf blight coupled with wet conditions.