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Effects of Long-term Tillage and Crop Rotation on Yield and Soil Carbon

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Abstract
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 definite need for well-defined, long-term tillage and crop rotation studies across the different soils and climate conditions in Iowa. The objective of this study is to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

Keywords
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Disciplines
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Effects of Long-term Tillage and Crop Rotation on Yield and Soil Carbon

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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 definite need for well-defined, long-term tillage and crop rotation studies across the different soils and climate conditions in Iowa. The objective of this study is to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

Materials and Methods

This study was originated on eight Iowa State University Research and Demonstration Farms in 2002. Treatments include five tillage systems (no-tillage, strip-tillage, chisel plow, deep ripper, and moldboard plow) and two crop rotations (corn-corn-soybean and corn-soybean) across the five tillage systems and several soil associations. The experimental design was a completely randomized block design with four replications. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. The soil samples were collected from all sites for depths of 0–6, 6–12, 12–18, and 18–24 inches and were analyzed for total carbon and total nitrogen. Subsequent soil samples were collected in 2004 from all sites for depths of 0–6, 6–12, 12–18, and 18–24 inches and will be analyzed for total carbon and total nitrogen. The plot size is 8 rows × 55 ft. Yield is determined from the center four rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen are monitored on a biannual basis or more often. Seasonal measurements such as nitrogen use efficiency, soil bulk density, infiltration rate, etc., were conducted on selected sites depending on availability of funding.

Results and Discussion

Results of first year (2003) soybean yields for the Western Research Farm are summarized in Figure 1. Soybean yield response to different tillage systems under a corn-soybean rotation was not significant except for no-tillage soybean yield. Soybean yields ranged from 26.7 bushels/acre to 31.2 bushels/acre. First-year tillage systems do indicate that no-tillage had a yield advantage over moldboard plowing, deep ripping, and chisel plowing by 2.9 to 4.4 bushels/acre. Higher no-tillage yields were likely realized due to better soil and moisture conditions.

In 2004, the corn yield ranged from 166 to 184 bushels/acre. Strip-tillage and no-tillage corn yields were significantly lower (11–18 bu/acre) than those of moldboard plow, deep rip, or chisel plow corn yields (Figure 2). Weed pressure from water hemp may have contributed to lower yields in these two tillage treatments. Precipitation was sporadic with 5.5 inches falling in May and only 5.7 inches during June through August, leading to drought stress. This is a reversal of the 2003 growing season where soybeans in strip-tillage and no-tillage systems were more productive. However, it is too early to speculate about the long-term effects of tillage on yield, soil chemical, or soil biological properties since these systems have only been in place two years.

Acknowledgments

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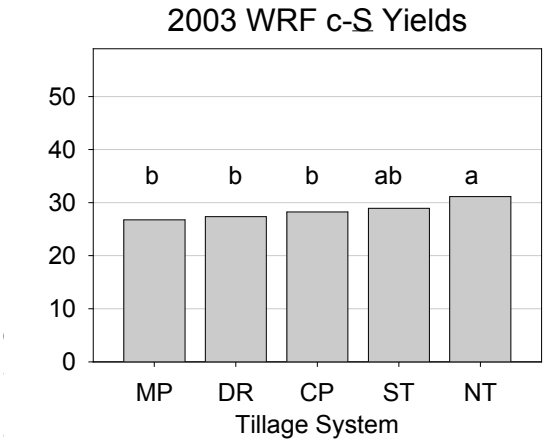

Figure 1. Effect of tillage system on soybean yield in a corn-soybean rotation for 2003 at Castana, Iowa.

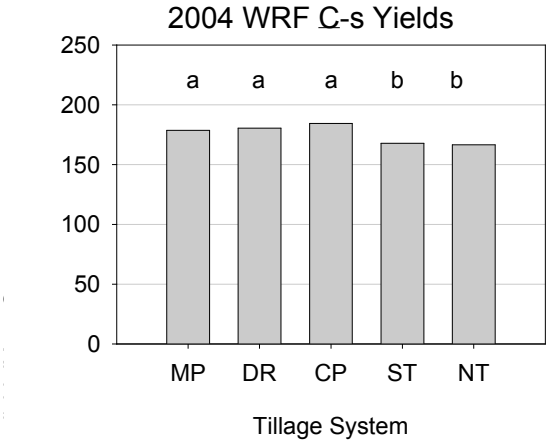

Figure 2. Effect of tillage system on corn yield in a corn-soybean rotation for 2004 at Castana, Iowa.