2006

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

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Abstract
Tillage system and crop rotation have significant long-term effects on soil productivity and soil components such as soil carbon as well as on 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 the state. The objective of this study is to evaluate the long-term effects of different tillage systems and crop rotations on soil productivity.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

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

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Introduction

Tillage system and crop rotation have significant long-term effects on soil productivity and soil components such as soil carbon as well as on 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 the state. 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 conducted on eight Iowa State University Research and Demonstration Farms in 2002. Treatments included two crop rotations of corn-corn-soybeans and corn-soybean across five tillage systems (no-tillage, strip-tillage, chisel plow, deep ripper, and moldboard plow) and several soil associations. The experimental design was a randomized complete 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 at depths of 0–6, 6–12, 12–18, and 18–24 in. and will be analyzed for total carbon and total nitrogen concentration. Subsequent soil samples were again collected in 2004 from all sites for depths of 0–6, 6–12, 12–18, and 18–24 in. and will also be analyzed for total carbon and total nitrogen concentration.

The plot size was 8 rows × 80 ft. Yield was determined from the center three rows of each corn plot and five rows of each soybean plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen will be monitored on a biannual basis or more often. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate will be taken on selected sites depending on availability of funding.

Results and Discussion

The average corn yields across all tillage systems for the corn-soybean rotation in 2003, 2004, and 2005 were 208.5, 169.3, and 173.4 bushels/acre, respectively (Table 1). In both 2003 and 2005 there were no significant differences between tillage system yields, but in 2004 no-tillage yield was significantly lower than those of all other systems.

The average soybean yields across all tillage systems for the corn-soybean rotation in 2003, 2004, and 2005 were 40.5, 56.9, and 69.8 bushels/acre, respectively (Table 1). In 2003, no-tillage yield was lower than those of all other systems; however, in 2004 there were no significant differences, and in 2005 no-tillage yield was significantly greater than yields of other systems.

The average first-year corn yield across all tillage systems in 2005 for the corn-corn-soybean rotation was 163.2 bushels/acre (Table 2). There were no significant differences in yield among tillage systems.

The average second-year corn yield across all tillage systems for the corn-corn-soybean rotation in 2003 was 146.4 bushels/acre (Table 2). No-tillage yield was significantly lower than those with other systems.

The average soybean yields across all tillage systems for the corn-corn-soybean rotation in 2004 was 59.2 bushels/acre (Table 2). There

were no significant differences in yield between tillage systems.

Acknowledgments

We would like to thank Kevin Van Dee and Myron Rees for their time and labor for plot setup, planting, and harvesting.

Table 1. Corn and soybean yields under a corn-soybean rotation at the Southeast Research Farm. Yields are corrected to 15.5% and 13.0% for corn and soybean, respectively.

	Corn (**C**/s)			Soybean (c/**S**)		
	2003	2004	2005	2003	2004	2005
	- - - - - - - - - - - bushels/acre - - - - - - - - - - -					
No-tillage	212.8	180.0	171.3	38.7	55.1	77.2
Strip-tillage	205.9	190.7	168.3	39.5	55.9	69.8
Deep rip	209.7	200.2	171.0	42.2	57.7	70.2
Chisel plow	211.6	207.9	177.4	40.6	55.7	69.5
Moldboard plow	202.7	214.0	179.2	41.7	58.3	69.8
$LSD_{(0.05)}$[a]	16.1	22.8	13.9	3.2	3.3	5.4
5-tillage average	208.5	169.3	173.4	40.5	56.9	69.8

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are significantly different.

Table 2. Corn and soybean yields under a corn-corn-soybean rotation at the Southeast Research Farm. Yields are corrected to 15.5% and 13.0% for corn and soybean respectively.

	Corn (**C**-c-s)	Corn (c-**C**-s)	Soybean (c-c-**S**)
	2005	2003	2004
		- - - - - - - - - - - bushels / acre - - - - - - - - - - -	
No-tillage	165.5	129.8	57.6
Strip-tillage	158.8	149.0	59.7
Deep rip	163.9	146.1	60.0
Chisel plow	163.3	157.7	59.8
Moldboard plow	164.3	149.4	58.8
$LSD_{(0.05)}$[a]	8.6	25.6	2.6
5-tillage average	163.2	146.4	59.2

[a]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are significantly different.