2007

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

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Abstract
Tillage system and crop rotation have long-term effects 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 well-defined, long-term tillage and crop rotation studies 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.

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 long-term effects 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 well-defined, long-term tillage and crop rotation studies 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

The study was conducted 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 of corn-corn-soybean and corn-soybean across the five tillage systems 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 for depths 0–6, 6–12, 12–18, and 18–24 in. and were analyzed for total carbon and total nitrogen. Subsequent soil samples were collected in 2004 from all sites for depths 0–6, 6–12, 12–18, and 18–24 in. and were analyzed for total carbon and total nitrogen.

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 were monitored on a bi-yearly or more basis. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate will be conducted on selected sites depending on availability of funding.

Results and Discussion

The average corn yield across all tillage systems for the corn-soybean rotation in 2006 was 190.2 bushels/acre (Table 1). In 2006, moldboard plow yields were greater than strip-tillage; all other comparisons were not statistically different.

The average soybean yield across all tillage systems for the corn-soybean rotation in 2006 was 58.2 bushels/acre (Table 1). In 2006, moldboard plow yield was more than any other tillage comparisons.

The average second year corn yield across all tillage systems for the corn-corn-soybean rotation in 2006 was 205.9 bushels/acre (Table 2). Moldboard plow yields were greater than chisel plow, strip-tillage, and deep rip treatments. Additionally, no-tillage yields were greater than the chisel plow treatment.

Acknowledgments

We would like to thank Kevin Van Dee for his time and labor with plot setup, planting, and harvesting.

Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU 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	2006	2003	2004	2005	2006
	- - - - - - - - - - - - - - - - - bushels/acre - - - - - - - - - - - - - - - - -							
No-tillage	212.8	180.0	171.3	189.1	38.7	55.1	71.8	56.8
Strip-tillage	205.9	190.7	168.3	182.1	39.5	55.9	69.8	55.1
Deep rip	209.7	200.2	171.0	185.7	42.2	57.7	70.2	56.0
Chisel plow	211.6	207.9	177.4	184.6	40.6	55.7	69.5	58.5
Moldboard plow	202.7	214.1	179.2	209.3	41.7	58.3	69.8	64.6
$LSD_{(0.05)}$[a]	16.1	22.8	13.9	25.0	3.2	3.3	5.4	4.2
5-Tillage average	208.5	198.6	173.4	190.2	40.5	56.5	70.2	58.2

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

Table 2. Corn and soybean yields under a corn-corn-soybean rotation at the ISU 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	2006	2004
	- - - - - - - - - - - - - bushels/acre - - - - - - - - - - - - -			
No-tillage	165.6	129.8	208.3	57.6
Strip-tillage	158.8	149.2	205.4	59.7
Deep rip	163.9	146.1	201.0	60.0
Chisel plow	163.3	157.7	196.4	59.8
Moldboard plow	164.3	149.4	218.4	58.8
$LSD_{(0.05)}$[a]	8.6	25.6	10.6	2.6
5-Tillage average	163.2	146.4	205.9	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.