2007

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

Mahdi Al-Kaisi
Iowa State University, malkaisi@iastate.edu

Mark A. Licht
Iowa State University, lichtma@iastate.edu

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

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

Mahdi Al-Kaisi, associate professor
Department of Agronomy
Mark Licht, crops field specialist
ISU Extension

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 2003. 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 tillage treatments were split and half was used for the corn-corn-soybean rotation and corn-soybean rotation. 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 for depths 0–6, 6–12, 12–18, and 18–24 in. and will be analyzed for total carbon and total nitrogen.

The plot size was 12 rows × 100 ft. Yield was determined from the center six 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 bi-yearly or more basis. Seasonal measurements such as nitrogen use efficiency, soil bulk density, and infiltration rate were conducted on selected sites depending on availability of funding.

Results and Discussion

In 2003, yield of corn after soybean showed no significant difference with all tillage systems. However, in 2005, corn yield following soybean of no-tillage and strip-tillage were lower than those of other tillage systems (Table 1).

In 2003, first-year corn yields for the corn-corn-soybean rotation with all tillage systems were not different (Table 2). In 2005, first-year corn yields with both no-tillage and strip-tillage were lower that those with other tillage systems. But in 2006, moldboard plow yield was lower than corn yield of all other tillage systems.

However, in 2003, 2004, and 2006, no-tillage second-year corn yield in corn-corn-soybean rotation was lower than that of other tillage systems (Table 2). These yield responses with different tillage systems reflect season and tillage systems differences.

Soybean yields in 2004 and 2006 with both crop rotations did not show significant differences in soybean yield with all tillage systems, which indicate the minimum effect of tillage on soybean response, but conventional tillage showed some advantage in 2005 over conservation tillage with corn-corn-soybean rotation (Tables 1 and 2).

Acknowledgments

We would like to thank Jim Secor and Nicholas Piekema for their help in setting up, planting, and harvesting the experiment.

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

	Corn (**C**/s)		Soybean (c/**S**)	
	2003	2005	2004	2006
	- - - - - - bushels/acre - - - - - -			
No-tillage	164.1	134.9	65.2	52.8
Strip-tillage	159.1	137.8	65.3	53.0
Deep rip	171.4	150.8	66.3	50.7
Chisel plow	165.8	152.9	66.9	50.6
Moldboard plow	161.3	160.4	68.2	51.9
$LSD_{(0.05)}$ [a]	26.9	10.8	4.0	5.7
5-tillage average	164.3	147.4	66.4	51.8

[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 ISU McNay 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**)	
	2003	2005	2006	2003	2004	2006	2004	2005
	- - - - - - - - - - - - - - - - - - bushels/acre - - - - - - - - - - - - - - - - - -							
No-tillage	153.1	135.8	156.8	145.4	129.0	116.1	64.9	50.9
Strip-tillage	166.2	136.7	159.9	175.6	140.6	132.8	66.1	52.0
Deep rip	185.5	165.2	153.7	158.4	135.9	134.7	67.3	58.5
Chisel plow	170.5	151.6	148.8	151.4	136.9	129.2	66.3	58.2
Moldboard plow	162.4	161.7	136.0	165.3	140.2	123.0	68.0	60.7
$LSD_{(0.05)}$ [a]	26.6	16.2	16.9	22.7	20.7	15.3	3.2	5.9
5-tillage average	167.5	150.2	151.0	159.2	136.5	127.2	66.5	56.1

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