2011

Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

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

Brad Oneal
Iowa State University

Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

Abstract
Tillage system and crop rotation have a major 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 affects on weed and soil disease control. There is a need for well-defined, longterm tillage and crop rotation studies across 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
RFR A1032, Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

Long-term Tillage and Crop Rotation Effects on Soil Carbon and Soil Productivity

RFR-A1032

Mahdi Al-Kaisi, associate professor
Brad Oneal, research associate
Department of Agronomy

Introduction

Tillage system and crop rotation have a major 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 affects on weed and soil disease control. There is a need for well-defined, long-term tillage and crop rotation studies across 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 starting in 2002 and continuing through 2010. The study on the Northwest Research Farm, Sutherland, IA, was established in 2003. Treatments include five tillage systems (no-till, strip-tillage, chisel plow, deep rip, and moldboard plow) and three crop rotations of corn-corn-soybean, corn-soybean, and corn-corn across the five tillage systems and several soil associations. Initial soil samples were collected in 2002 prior to implementing the tillage treatments. Soil samples were subsequently collected in 2004, 2007, and 2009. The soil samples were collected from all sites for depths of 0–6, 6–12, 12–18, and 18–24 in. and were analyzed for total carbon and total nitrogen. The experimental design was a randomized complete block design with four replications.

The plot size was 24 rows by 100 ft. Yield was determined from the center five rows of each plot. Long-term effects of tillage and crop rotation on total soil carbon and total nitrogen will be monitored bi-yearly. 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

The results show some differences in corn yield between tillage systems (Table 1 and 2). Generally, corn yields for both rotations show no differences between tillage systems, except in some years. The observed yearly variations were due to growing season differences in yield performance of corn.

Generally, no-till and strip-tillage yields were very comparable to other tillage systems, except in a few years, where conventional tillage out performed no-till and strip-tillage. No-till and strip-tillage yields were lower than other tillage systems in a continuous corn system that was established in 2008. This difference was apparent for the second and third year of continuous corn.

Regardless of the tillage system or crop rotation, soybean yields show no significant differences across all years.

Acknowledgements

We would like to thank Ryan Rusk and his team for their time and labor for plot setup, planting, and harvesting.

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

	Corn (**C**/s)				Soybean (c/**S**)				C/c		
	2004[a]	2006	2008	2010	2003	2005	2007	2009	2008	2009	2010
	bushels/acre										
No-tillage	87.4	170.7	221.2	189.9	38.6	75.1	61.7	61.3	190.0	122.2	179.3
Strip-tillage	93.5	169.0	217.1	189.3	37.1	72.3	59.9	58.3	183.8	119.9	176.4
Deep rip	97.3	177.0	220.2	205.7	37.4	69.0	62.5	59.6	194.8	155.4	194.3
Chisel plow	100.9	182.9	217.8	210.6	39.5	70.3	63.5	60.6	200.0	164.6	206.6
Moldboard plow	98.9	186.6	226.5	212.5	37.1	71.6	65.6	60.3	187.4	179.4	202.3
$LSD_{(0.05)}$[b]	10.9	7.7	10.3	17.7	4.9	4.2	3.3	6.2	20.0	15.7	11.8
5-tillage avg	95.6	177.2	220.6	201.6	37.9	71.7	62.6	60.0	191.2	148.3	191.8

[a]Yields were depressed from normal years due to severe hail damage in late summer.
[b]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.

Table 2. Corn and soybean yields under a corn-corn-soybean rotation at the Northwest Research Farm. Yields were corrected to 15.5 and 13.0 percent for corn and soybean, respectively.

	Corn (**C**-c-s)				Corn (c-**C**-s)				Soybean (c-c-**S**)				
	2004[a]	2005	2007	2008	2003	2005	2006	2009	2003	2004[a]	2006	2007	2010
	bushels/acre												
No-tillage	87.2	203.7	155.5	220.7	105.8	197.7	152.3	151.0	37.5	43.5	57.5	62.9	61.5
Strip-tillage	88.6	206.6	155.4	213.6	115.1	194.9	153.3	157.2	37.8	46.3	60.0	62.4	63.4
Deep rip	94.4	203.6	169.9	219.4	116.9	200.7	181.0	195.9	39.3	42.0	66.3	64.7	62.0
Chisel plow	98.7	205.4	177	219.2	111.2	199.3	174.1	186.6	40.2	39.6	65.9	62.5	60.6
Moldboard plow	100.0	202.9	173.9	218.7	124.6	200.4	178.7	194.5	38.4	38.3	70.1	64.5	61.5
$LSD_{(0.05)}$[b]	13.1	6.9	14.5	13.9	24.8	5.5	11.3	14.8	3.1	6.3	4.8	4.3	2.1
5-tillage avg	93.8	204.4	166.3	218.3	114.7	198.6	167.9	177.0	38.6	41.9	64.0	63.4	61.8

[a]Yields were depressed from normal years due to severe hail damage in late summer.
[b]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are statistically different.