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

Abstract

Tillage system and crop rotation have a 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 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 a 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 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

This 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 rip, and moldboard plow) and two crop rotations of corn-corn-soybean and corn-soybean across the five tillage systems and several soil associations. Two sites were used for corn-corn-soybean rotation to ensure that the same crop is available each year for comparison with 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 were analyzed for total carbon and total nitrogen.

The plot size is 12 rows × 100 ft. Yield is determined from the center six rows of each corn plot and five rows of each soybean plot. Long-term effect 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 2006, the corn-soybean rotation corn yields averaged 190.5 bushels/acre (Table 1). No-tillage had lower yields compared with the other tillage treatments. Soybean yields in the corn-soybean rotation averaged 56.5 bushels/acre. There were no differences among tillage systems.

In 2006, first-year corn yields for the corn-corn-soybean rotation averaged 202.3 bushels/acre (Table 2). No-tillage had lower yields compared with the other tillage treatments. Soybean yields in the corn-corn-soybean rotation averaged 61.7 bushels/acre. There were no differences between any of the five tillage systems.

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

	Corn (<u>C</u> /s)				Soybean (c/ <u>S</u>)			
	2003	2004	2005	2006	2003	2004	2005	2006
	----- bushels/acre -----							
No-tillage	135.5	194.7	185.8	172.4	22.6	60.1	65.6	55.4
Strip-tillage	145.3	218.0	206.9	195.5	24.5	59.9	67.0	56.3
Deep rip	143.0	228.8	208.8	195.6	24.8	62.8	61.5	56.8
Chisel plow	141.6	225.6	204.9	195.3	26.9	61.5	60.5	55.9
Moldboard plow	113.3	224.0	213.0	193.7	23.2	62.5	61.6	57.9
LSD _(0.05) ^a	16.4	8.0	9.0	14.9	2.0	2.9	3.2	3.4
5-tillage average	135.7	218.2	203.9	190.5	24.4	61.4	63.2	56.5

^aLeast 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 Northeast Research Farm. Yields are corrected to 15.5 and 13.0% for corn and soybean, respectively.

	Corn (<u>C</u> -c-s)		Corn (c- <u>C</u> -s)			Soybean (c-c- <u>S</u>)		
	2004	2006	2003	2004	2005	2003	2005	2006
	----- bushels / acre -----							
No-tillage	194.9	189.9	154.6	183.7	181.9	28.2	68.3	61.7
Strip-tillage	216.1	202.2	149.7	196.4	190.9	28.4	66.8	62.7
Deep rip	221.3	207.1	168.3	202.3	196.2	26.5	64.9	61.4
Chisel plow	218.9	207.1	157.9	209.5	197.7	29.3	64.3	60.3
Moldboard plow	221.1	205.3	136.5	214.3	208.8	29.1	61.9	62.4
LSD _(0.05) ^a	8.1	9.3	16.3	8.2	12.0	3.8	2.5	2.7
5-tillage average	214.5	202.3	153.4	201.2	195.1	28.3	65.2	61.7

^aLeast significant differences (LSD_(0.05)) are based on a Fisher test. Yield differences greater than the least significant difference are significantly different.