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Long-Term Effects of 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 physical, biological, and chemical properties of soil. 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.

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Long-Term Effects of 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 physical, biological, and chemical properties of soil. 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 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. 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 also be 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 will be analyzed for total carbon and total nitrogen.

The plot size was 12 rows × 90 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 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 193.0, 185.1, and 168.3 bushels/acre, respectively (Table 1). In 2003 there were no significant differences between tillage system yields, but in 2004 no-tillage yield was significantly lower than deep rip, chisel plow, or moldboard plow tillage. In 2005, no-tillage and strip-tillage yields were significantly less than yields from deep rip, chisel plow, or moldboard plow systems.

The average soybean yields for the corn-soybean rotation across all tillage systems in 2003, 2004, and 2005 were 39.2, 57.2 and 53.5 bushels/acre, respectively (Table 1). In all years there were no significant differences among the five tillage systems.

The average first-year corn yields across all tillage systems for the corn-corn-soybean rotation in 2004 was 190.9 bushels/acre (Table 2). No-tillage yield was significantly less than yields from strip-tillage, chisel plow, or moldboard plow systems.

The average second-year corn yields across all tillage systems for the corn-corn-soybean rotation in 2005 was 221.5 bushels/acre (Table 2). Moldboard plow yield was significantly

higher than those of no-tillage, strip-tillage, and chisel plow systems.

The average soybean yields across all tillage systems for the corn-corn-soybean rotation in 2003 was 31.7 bushels/acre (Table 2). Strip-tillage soybean yield was significantly less than those of other tillage systems.

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Table 1. Corn and soybean yields under a corn-soybean rotation at the ISU Kanawha Research Farm.[1]

	Corn (**C**/s)			Soybean (c/**S**)		
	2003	2004	2005	2003	2004	2005
	- - - - - - - - - - - bushels/acre - - - - - - - - - - -					
No-tillage	187.7	172.4	136.6	38.2	56.5	54.6
Strip-tillage	191.7	181.1	146.0	38.0	57.8	54.1
Deep rip	190.7	188.8	181.3	39.4	57.1	53.1
Chisel plow	198.3	192.2	189.2	39.9	56.8	52.2
Moldboard plow	196.7	191.2	188.5	40.7	57.8	53.5
$LSD_{(0.05)}$[2]	32.2	11.2	24.7	3.7	4.4	3.5
5-tillage average	193.0	185.1	168.3	39.2	57.2	53.5

[1]Yields are corrected to 15.5 and 13.0% for corn and soybean respectively.
[2]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 Kanawha Research Farm.[1]

	Corn (**C**-c-s)	Corn (c-**C**-s)	Soybean (c-c-**S**)
	2005	2003	2004
	- - - - - - - - - - - bushels/acre - - - - - - - - - - -		
No-tillage	174.1	214.0	37.4
Strip-tillage	192.3	220.1	34.9
Deep rip	188.5	223.2	38.9
Chisel plow	198.6	218.3	37.5
Moldboard plow	200.9	232.0	39.3
$LSD_{(0.05)}$[2]	14.5	9.7	2.4
5-tillage average	190.9	221.5	31.7

[1]Yields are corrected to 15.5 and 13.0% for corn and soybean respectively.
[2]Least significant differences ($LSD_{(0.05)}$) are based on a Fisher test. Yield differences greater than the least significant difference are significantly different.