2005

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

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

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

Abstract
Tillage systems and crop rotation have significant 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 definite need for well-defined, long-term tillage and crop rotation studies across the different soils and climate conditions in Iowa. 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, assistant professor
Mark Licht, program specialist
Beth Larabee, research associate
Department of Agronomy

Introduction

Tillage systems and crop rotation have significant 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 definite need for well-defined, long-term tillage and crop rotation studies across the different soils and climate conditions in Iowa. 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 ripper, and moldboard plow) and two crop rotations of corn-corn-soybean and corn-soybean across several soil associations. Two sites (sites 1 and 2) were used for corn-corn-soybean rotation to ensure that the same crop is available each year for comparison with the corn-soybean rotation. The experimental design was a completely randomized 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 be analyzed for total carbon and total nitrogen. Subsequent soil samples were collected in 2004 at depths of 0–6, 6–12, 12–18, and 18–24 in. and will be analyzed for total carbon and total nitrogen.

The plot size is 12 rows × 100 ft. Yield is determined from the center 6 rows of each corn plot and 5 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, infiltration rate, etc., will be conducted on selected sites depending on availability of funding.

Results and Discussion

First-year corn yields of the corn-corn-soybean rotation for the 2003 growing season averaged 153 bushels/acre (Table 1). Moldboard plowing yielded significantly less than the other four tillage system due to reduced stands from wet soil conditions after planting and subsequent replanting. Soybean yield in the corn-corn-soybean rotation averaged 28 bushels/acre. There were no significant differences among any of the five tillage systems (Table 1).

In 2003 the corn-soybean rotation corn yields averaged 136 bushels/acre (Table 2). No-tillage had lower yields compared with the other four tillage systems. Soybean yield in the corn-soybean rotation averaged 24 bushels/acre. Chisel plowing had higher yields than the other four tillage systems.

In 2004, corn yield for first-year corn and second-year corn in a corn-corn-soybean rotation averaged 214 and 201 bushels/acre, respectively (Table 1). No-tillage was significantly lower than the other four tillage systems for first-year corn. For second-year corn, moldboard plowing and chisel plowing yielded significantly better than both strip tillage and no-tillage.

In 2004, corn yields in the corn-soybean rotation averaged 218 bushels/acre (Table 2). Deep rip was significantly greater than strip tillage; however, no-tillage was significantly lower than the other four tillage treatments of the same rotation. Soybean yield in the corn-soybean rotation averaged 61 bushels/acre with no significant differences among all tillage treatments (Table 2).

It is too early to make any conclusions about the effects of tillage systems or the crop rotations effects on yield since these systems have only been in place two years.

Acknowledgments

We would like to thank Ken Pecinovsky and Ralph White for their time and labor for plot setup, planting, and harvesting. We would also like to thank Monsanto and Pioneer seed companies for seed and crop protection chemicals.

Table 1. Grain yields from tillage treatments in corn-corn-soybean rotation at Northeast Iowa Research Farm.

	Site1 (C-c-s) †	Site 2 (c-c-S)	Site 1 (c-C-s)	Site 2 (C-c-s)
Tillage	2003		2004	
	- - - - - - - - - - bushels / acre - - - - - - - - - -			
Moldboard	136‡ c	29 a	214 a	221 a
Deep rip	168 a	26 a	202 bc	221 a
Chisel plow	158 ab	29 a	209 ab	219 a
Strip tillage	150 bc	28 a	196 c	216 a
No-tillage	155 ab	28 a	184 d	195 b
$LSD_{0.05}$	14	NS§	8	8

*For corn-corn-soybean rotation at site 1, corn was established as a first year crop in the rotation. For site 2, soybean was established as the first crop in a corn-corn-soybean rotation.
†Upper case letter indicates current crop in the rotation.
‡Replanted due to weather.
§Differences are not statistically significant.
Values with the same letter do not differ.

Table 2. Grain yields from tillage treatments in corn-soybean rotation at the Northeast Iowa Research Farm.

	Site 1 (C-s) †	Site 2 (c-S)	Site 1 (c-S)	Site 2 (C-s)
Tillage	2003		2004	
	- - - - - - - - - - bushels / acre - - - - - - - - - -			
Moldboard	113‡ a	23 bc	62 a	224 ab
Deep rip	143 a	25 b	63 a	229 a
Chisel plow	142 a	27 a	61 a	226 ab
Strip tillage	145 a	24 bc	60 a	218 b
No-tillage	135 b	23 c	60 a	194 c
$LSD_{0.05}$	17	1	3	8

†Upper case letter indicates current crop in the rotation.
‡Replanted due to weather.
Values with the same letter do not differ.