

Soil Management Research Report

Penn State University

Department of Crop and Soil Sciences
116 ASI Bldg. University Park, PA 16802

Report No. 03-01

Tillage Evaluation Study, 2003

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Location: Fry K field, Rock Springs, PA

Collaborators: Scott Harkcom, Ron Hoover

Research Objectives: To evaluate differences in crop growth and yield, and soil health using six different tillage systems.

Background: Six tillage treatments were started in 1978 at the Russell E. Larson Agricultural Research Center in Rock Springs in Centre County, Pennsylvania. The plots have been planted in corn every year since the beginning of the study with the exception of 1986 when Ogle oats were planted, and 1993 when soybeans were planted in some of the plots. The six tillage treatments have remained as originally established, except for the “disked once” treatment which was discontinued to introduce the zone-till treatment in 2001. With collaboration from the staff at the Larson Agronomy Research Farm at Rock Springs, this study was continued in 2003 in the Fry K field.

Study Description: The study is a randomized complete block design with six tillage treatments replicated four times. The soil types within the study are Hagerstown (HaB, HaC, HcB), Hublersburg (HuB), and Nolan (No). Each plot is 45' wide and approximately 760' long. The six tillage treatments in this study are (from more to less intensive tillage): Moldboard, Disk 2x, Chisel/Disk, Chisel, Zone till, and No-till. All tillage is done in the spring. The moldboard plots are moldboard plowed to a depth of 14", disked with a disk harrow, and then harrowed with a spring-tooth harrow and packed with a cultimulcher. The disked treatment is disked two times to a depth of 8" with a Miller disk plow. The Chisel/disk treatment is chisel plowed to a depth of 10", and subsequently disked with a disk harrow. In the Zone-till plots 6" wide zones were prepared with three fluted coulters per row to a depth of 6". In 2001 these coulters were mounted on the planter. This gave poor results because of insufficient weight on the planter resulting in significantly reduced plant populations in the Zone-till treatment. In 2002 and 2003 Zone-till was therefore done with a zone-till cart prior to planting. In the No-till treatment no tillage is done. All tillage treatments were planted with a 6-row John Deere 1780 Narrow Row Max Emerge Plus drawn planter on 30" row spacing with vacuum metered seed and dry fertilizer. Solid starter fertilizer is injected 2" besides, and 2" below the corn seed. Insecticide and fungicide are applied in a T-band in the corn seed row. Corn rows are oriented SW → NE and are parallel to West Whitehall Road. Soil tests are used to determine fertilizer rates. Lime was last applied in 2000 at a rate of 2000 lb/A.

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Results:

In this report we will focus on the differences between Moldboard, Chisel/disk, Zone-till and No-till only.

Emergence: Emergence was counted on June 5, 2003, in the Zone-till, Chisel/Disk, No-till and Moldboard treatments (Table 1). Emergence in the No-till, Moldboard, and Chisel/disk treatments were not different from each other, but the Zone-till treatment showed significantly lower emergence than the remaining treatments. The reason why emergence was lower in Zone-till is not well understood.

Table 1. Corn emergence as affected by tillage systems (2003).

Tillage System	Emergence (plants/A)
No-Till	25,200
Zone-Till	22,700
Chisel/Disk	24,500
Moldboard Plow	25,200
<i>LSD (0.05)</i>	<i>1760</i>

Corn Height: Corn height was measured 8 weeks after planting from 2001-2003. The measurements were taken at the end of June of 2001, beginning of July of 2002, and at the end of July of 2003. Significant differences in corn height were found between treatments in 2003 only, with the Moldboard treatments being significantly shorter than the other tillage treatments (Table 2). No-till usually lags behind in height compared to the other treatments, but the difference is never great enough to be statistically significant. The cooler soil under no-till delays early growth, but if the effects disappear 8 weeks after planting it is not likely that yields will be negatively affected. Although moldboard plowing results in faster warming of the soil in spring, we believe over the years a gradual decrease in soil quality has taken place resulting in poorer conditions for plant growth in this treatments compared to the other, less intensive tillage treatments.

Table 2. Corn height as affected by tillage systems (2003).

Tillage system	Corn height (inches)		
	2001	2002	2003
No Tillage	23	23	65
Zone Tillage	26	26	63
Chisel/Disk	26	26	66
Moldboard Plow	24	24	61
<i>LSD (0.05)</i>	<i>NS</i>	<i>NS</i>	<i>3.9</i>

NS=no significant difference.

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Residue: Residue cover was measured with the transect method. The residue cover showed significant differences between tillage treatments and ranged from 3% in the moldboard plow treatment to 79% in the no-till treatment (Table 3). Note that only the No-till and Zone till treatments are classified as conservation tillage (>30% crop residue cover after planting). The more intensive tillage treatments of Moldboard plow and Chisel/Disk disturb the surface residue resulting in less residue cover on the surface.

Table 3. Surface residue as affected by tillage systems.

Tillage system treatment	Residue cover (%)
No Tillage	79
Zone Tillage	62
Chisel/Disk	17
Moldboard Plow	3
<i>LSD (0.05)</i>	<i>11.3</i>

Grain yield: Long-term yields did not differ significantly between treatments (Table 4). Yields vary widely from year to year, and sometimes one treatment has higher yields than another. There is no obvious trend in yield improvement in conservation tillage systems such as no-till and chisel/disk compared to moldboard plowing. However, there in 2001 and 2002 the yields of Moldboard were lower than in no-till, which may be an indication of decreasing soil quality due to intensive tillage. Lower yields in 2001 of the Zone-till treatment are due to difficulties in the field with the Zone till equipment. Lower yields of Zone-till in 2003 (although not significantly lower) are probably due to the lower plant populations.

Table 4. Corn yield at harvest as affected by tillage system.

Tillage System	1978-2003	1999	2000	2001	2002	2003
	----- (bu/A) -----					
No Tillage	100	126	100	133	73	137
Zone Tillage	-	-	-	94	73	128
Chisel/Disk	101	126	105	132	69	136
Moldboard Plow	98	118	96	122	57	135
<i>LSD (0.05)</i>	<i>NS</i>	<i>10.1</i>	<i>11.0</i>	<i>15.2</i>	<i>9.8</i>	<i>NS</i>

NS=no significant difference.

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Conclusions: The results of this study show that yield differences due to tillage treatments were not significant. However, there are indications of a gradual soil quality decline in the intensively tilled Moldboard treatment. Zone-till performed no better, and sometimes worse than the No-till treatment, indicating there is no benefit to do in-row tillage in our agro-ecoregion. Although Chisel/disking is usually considered to be conservation tillage, we measured insufficient residue cover in this treatment to be qualified this way. This seems typical of Pennsylvania conditions and calls for a reconsideration of chisel plowing as a conservation tillage practice. Only Zone-till and No-till qualified as conservation tillage in our study. This study indicates that the use of no-till systems results in yields comparable to other tillage systems, while significantly improving the amount of surface residue. The improvement in the amount of surface residue in no-till will help to reduce soil erosion, and the resulting loss of nutrients. Our study therefore indicates that no-till is a best management practice in central Pennsylvania.

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