Soil Management Research Report

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

Report No. 03-02

Conservation Tillage Study, 2003

Conducted by: Sjoerd Duiker (PI), Jim Haldeman, Jennifer Moeny

Location: Penn State Southeast Agricultural Research and Extension Center, Landisville, PA

Collaborators: Dave Johnson, Hoober Inc., Monsanto, and Unverferth

Research Objectives: To evaluate performance of five corn hybrids which vary in relative maturities and suitability ratings for conservation tillage, and measure key soil properties that are likely to influence the performance of the different tillage systems.

Background: Research in the early 1980's showed that no-till produced lower yields than conventional till (moldboard or chisel plowed) at the Penn State Southeast Agricultural Research and Extension Center. However, research from similar agroecological zones shows no yield decrease in no-till corn compared to conventional tillage. Although the benefits of no-till have been confirmed in many studies in different parts of the USA, only 8% of the planted acres was no-tilled in Lancaster County in 2000, while 91% of the planted acres was not under conservation tillage (i.e. it had less than 30% crop residue at the surface at planting). Conservation tillage has important benefits for the environment, but if yields are not competitive its adoption will be inhibited.

Study Description: This study is a cooperative effort between Penn State, Monsanto, C.B. Hoober, and Unferverth to evaluate performance of five corn hybrids (Table 1), with four different tillage systems in 4 replications. The study is a split-plot design and started in 2002. The tillage systems are no-till, zone-till, strip till, and chisel/disk. Pictures of the tillage equipment can be found in the appendix. No-till is planted with an Almaco four-row precision planter. Each planter unit has a double disk opener behind one fluted coulter. Row cleaners are not used in the study. The same planter is used to plant all tillage systems with adjustments made to account for different soil conditions in the tillage systems. Rawson zone-till (made by Unverferth) makes use of three fluted coulters that work a narrow zone of approximately 6 inches to a depth of 3-4 inches. Strip-till was done with a CASE-IH Ecolotill 2500 unit. The unit was mounted with MRD shanks, hiller disks and rolling baskets in 2002. Because this tool reduced the surface residue below 30% after planting, the unit was equipped with no-till shanks and berm tuck'rs to allow less surface residue disturbance to comply with the conservation tillage definition. Tillage treatments are kept in the same plots each year. Plots were 10 feet wide and 20.5 feet long. The study was planted on 5/8/02 and 5/5/03.

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Table 1. Characteristics of hybrids used in this study (Dekalb seed catalog, 2002).*

	Residue Proven	Relative maturity (days)	GDUs to black layer	Emergence	Seedling growth	Root strength	Stalk strength	Drought tolerance	Plant height**	Gray leaf spot resistance
DKC53-34	Y	103	2585	2	2	3	2	3	M	5
DKC58-24	N	108	2650	2	2	3	4	4	M	7
DKC60-09	N	110	2740	2	2	3	4	3	MT	6
DKC60-19	N	110	2750	3	3	4	4	4	MS	8
DKC64-11	Y	114	2800	3	3	4	3	4	MT	6

* Rating Scale: 1-2 Excellent, 3-4 Very Good, 5-6 Good, 7-8 Fair, 9 Poor.
**(M=Medium, MT=Medium tall, MS=Medium short)

Results:

Soil Temperature:

Soil temperature was measured hourly using Watchdog temperature data loggers (Spectrum Technology). Data loggers were installed 2" deep in the seed row of plots of one hybrid, across all reps. Average soil temperature was approximately 2-3 ^{o}F higher in chisel/disk treatment than in no-till (Fig. 1). Zone-till and strip-till increased soil temperature to almost the same as chisel/disk.

Tillage had most effect on soil temperature from approximately 10 am to 4 pm (Fig. 2). On this typical day in May soil temperature at 3 pm was 80 degrees in the chisel/disk soil, whereas it was 74 in the no-till soil. Zone- and strip-till brought the soil temperature almost up to that of chisel/disk.

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Figure 1. Tillage effects on average daily soil temperature (2" below soil surface) in 2002.

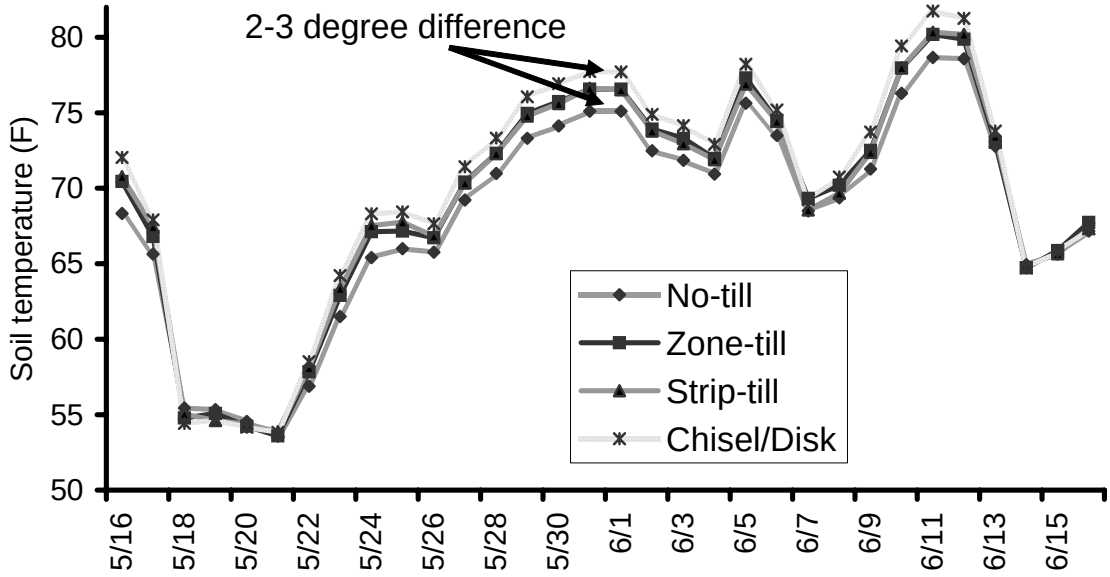
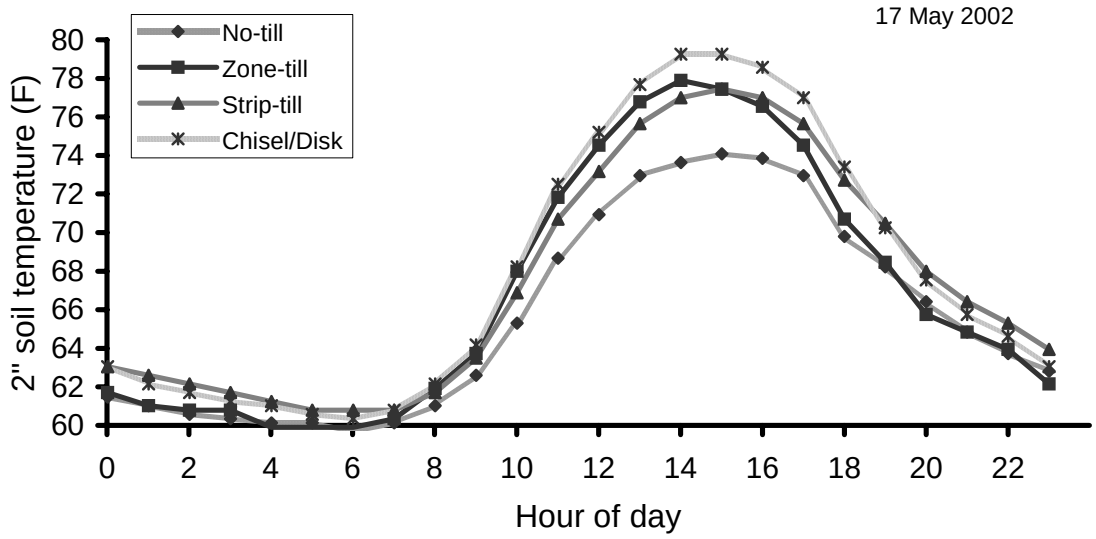


Figure 2. Soil temperature at 2" depth during a 24-hr period on a sunny day in May 2002



Residue Cover: Residue cover was sorghum-sudan grass in 2002 and corn in 2003. Residue cover in 2003 was low in all tillage treatments because of very low corn grain and straw yields in 2002. Residue cover was significantly different between tillage treatments in 2003 (see Table 2, Fig. 3). No-till had the highest residue cover, followed by zone- and strip-till, and chisel/disking had the lowest residue cover. In this year with low residue cover to start with, both zone- and

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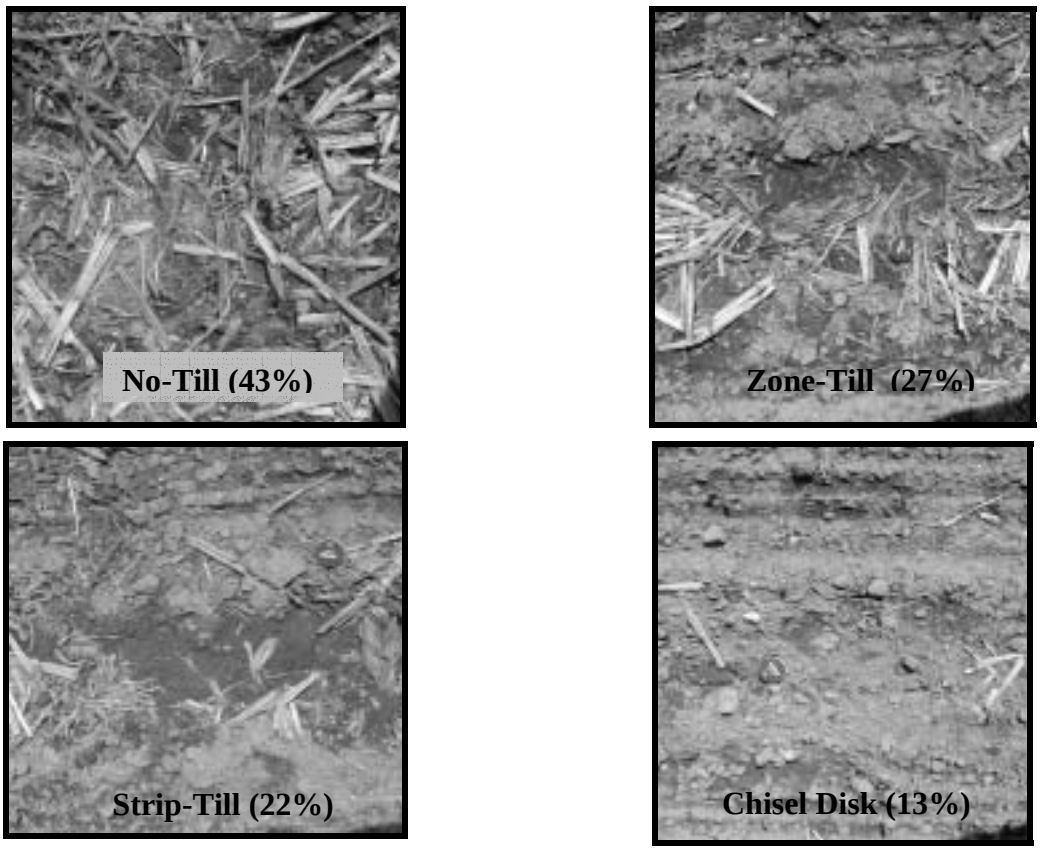
strip-till reduced residue cover to unacceptably low values. This meant that residue cover was below that required for conservation tillage any tillage was done.

Table 2. Residue cover obtained with different tillage systems

Tillage	Residue cover
	(%)
No-till	43
Zone-till	27
Strip-till	22
Chisel/Disk	13
LSD (α=0.05)	*10.7*

Figure 3. Residue cover in 2003 as affected by tillage system.



Corn Yields: Corn yields in 2002 and 2003 showed no difference among the tillage systems (Table 3). The absence of a yield reduction in no-till compared to chisel/disk was an important

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finding. It contradicts the results of the tillage experiment conducted in the 1980s at this site. Although the conclusions are somewhat preliminary because they are based on two years of data only, they reflect what was obtained in very contrasting climatic conditions. The year 2002 was a very dry year, whereas 2003 was a very wet year. Because the yield depression in no-till was limited to the drought years in the earlier experiment, the 2002 results strongly suggest that there is no reason to fear yield depressions in no-till if an optimum plant population can be established. The results show that deep or shallow in-row tillage is not necessary on this soil to produce competitive yields in conservation tillage.

Table 3. Corn yields (15.5% moisture) obtained with different tillage systems

Tillage	Yield	
	2002	2003
	(bu/A)	
No-till	75	188
Zone-till	75	187
Strip-till	73	182
Chisel/Disk	70	187
LSD (α=0.05)	*NS*	*NS*

NS = no significant difference.

Yield differences occurred between corn hybrids in both 2002 and 2003 (Table 4). The yield difference was as high as 30 bu/A in the most contrasting cases. In 2002, the highest yielding hybrid was DKC 60-09, followed by DKC 64-11. The lowest yielding hybrid was DKC 60-19 in 2002, and the other hybrids produced yields intermediate between these. In 2003, the highest yielding hybrid was DKC 64-11. DKC 53-34 and 60-09 produced slightly lower yields, followed by DKC 60-19. The lowest producing hybrid was DKC 58-24 in 2003. The results show that DKC 64-11 and 60-09 are the highest yielding hybrids, whereas DKC 53-34 is an excellent hybrid in a short relative maturity group. DKC 58-24 and 60-19 did not perform as well as the other hybrids.

Table 4. Corn yields (15.5% moisture) of hybrids used in this study

	Yield	
Hybrid	2002	2003
	(bu/A)	
DKC 53-34	70	190
DKC 58-24	73	169
DKC 60-09	80	191
DKC 60-19	63	181
DKC 64-11	79	199
LSD (α=0.05)	*7.9*	*8.4*

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Whereas there were differences in yields between hybrids, there was no interaction between tillage system and hybrid. This means that the hybrids that perform well in one tillage system also performed well in the other tillage systems. The results suggest that top hybrids perform well in conventional as well as in conservation tillage.

Grain moisture contents were immediately related to the relative maturity class of the hybrids grown, with the short duration hybrids having the lowest moisture content, and the longer duration hybrids having the highest moisture content (Table 5). Tillage did not affect moisture content of the corn in either 2002 or 2003.

Table 5. Hybrid differences in grain moisture content at harvest.

	Grain moisture content	
Hybrid	**2002**	**2003**
	(%)	
DKC 53-34	17.4	20.7
DKC 58-24	19.7	20.9
DKC 60-09	19.9	23.5
DKC 60-19	21.0	23.2
DKC 64-11	22.8	27.6
LSD (α=0.05)	*0.57*	*0.69*

Conclusions: We observed no difference in yield due to tillage system in two years with very contrasting climatic conditions. Although early season soil temperature was increased with the use of in-row or broadcast tillage, no yield increase resulted. However, residue cover was reduced with zone-till, strip-till, and chisel/disking below that required for conservation tillage. Only no-till met the requirements of conservation tillage. There were hybrid differences in corn grain yields, with DKC 64-11 and 60-09 being the highest yielding hybrids, and DKC 53-34 being a very competitive short season corn hybrid. DKC 58-24 and 60-09 fared less well compared to the other hybrids in this study. The results of this experiment suggest no-till should be the recommended best management practice in the southeast of Pennsylvania. The results indicate that no in-row tillage is needed for optimal yields, whereas they can easily reduce residue cover below 30%, the required residue cover for conservation tillage.

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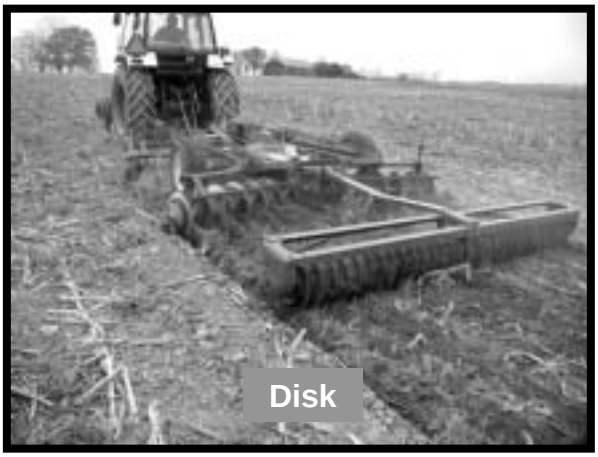
Appendix 1



CASE-IH Ecolotill 2500
with no-till shanks and berm tuck'rs
(used in 2003)

CASE-IH Ecolotill 2500
strip till unit with MRD shanks, hiller disks and rolling basket (used in 2002)

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