Minimum Tillage of Corn in Perennial Sod:[1] A Three-year Study with Energy Implications

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Minimum tillage (often termed no-tillage since only a small fraction of the soil is tilled) for corn *(Zea mays* L.) was compared with conventional tillage (plowing, harrowing, and planting) in Pensacola bahiagrass *(Paspalum notatum* Flugge) sod for 3 years on Scranton fs, a siliceous, thermic Humaqueptic Psammaquent. If yield returns were equivalent, energy savings would be important (2).

In 1976, there were no differences in corn yields for conventional versus no-tillage when rows were 45 cm apart. When rows were 90 cm apart, yields were higher for the conventional method but not at the 5% level of probability. Responses were the same for Funks G-4708 and Pioneer 3369A cultivars.

In 1978, conventional tillage was compared with no-tillage with and without subsoiling for four corn cultivars. With subsoiling there were no yield differences between no-tillage and conventional but methods of tillage interacted with subsoiling. There was a large response to subsoiling for both the no-tillage method and the conventional method of tillage, but greater for no-tillage. As a result, the no-tillage method gave higher yields than the conventional method under subsoiling.

The yield responses, over tillage methods, for subsoiling were related to stand. Stands (plants/ha) were improved by subsoiling but more so for no-tillage. Forage yields correlated with grain yields but bahiagrass regrowth yields at harvest were better when corn yields were low. This suggests that the better groundcover of the higher yielding treatments shaded out undergrowth.

Tillage methods did not affect yields in 1979 although subsoiling improved the plant population.

For the three years of the experiments, grain yields for no-tillage were superior or as good as the conventional method when narrow rows were used and the soil was subsoiled beneath the row to 35 cm. The need for subsoiling interacted with season; in 1978 there was a benefit but in 1979 there was no effect.

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The no-tillage method of planting row crops has been widely adopted in many states. An exception is Florida. Yet research has shown that in most instances yields could be comparable to conventional methods if the best stand and row widths are adopted (3,4,5,6,7). Comparable yields would make the no-tillage method preferable because the method offers additional flexibility in planting and savings in time, machinery, and energy over-the conventional method. The no-tillage practice has been evaluated by Gallaher (1) and Robertson and Prine (8).

METHODS

In 1976, the experiment was a factorial of two cultivars: Funks G-4708 and Pioneer 3369A; two methods of planting: conventional, which included rotatilling, harrowing, and planting with the no-till planter and no-till which had once-over with the no-till planter; and two row widths: 90 and 45 cm. Treatments were replicated four times. The no-till planter was made by Allis Chalmers and had the serrated coulters. It had attachments to apply fertilizer: 880 kg/ha of 4-3.4-6.6 (N-P-K); carbofuran 2,3-Dihydro-2, 2-dimethyl-7-benzofuranyl methylcarbamate; and liquid herbicides: 2-ch1oro-4-ethy1amino-6-isopropy1-amino-1,3, 5-triazine (atrazine) and N (Phosphonomethyl) glycine (glyphosate or roundup). Plots consisted of 6 rows, 90 cm apart, and 12.3 meters long. The 45 cm row width was obtained by doubling back between the 90 cm rows.

In 1978 and 1979, the experiments were factorials of two subsoil treatments: subsoiled to 36 cm depth beneath row and a check; and 4 cultivars: Funks G-4507, DeKalb XL18, DeKalb XL12, and Pioneer 3958, replicated 4 times. Plots consisted of 6 rows spaced 76 cm apart. At maturity, grain yields were calculated at 15% moisture and stover (stalks, less ears) and undergrowth yields on an oven-dry basis.

In 1978, corn received 900 kg/ha 4-3.4-13.3 (N-P-K) at planting. Carbofuran was applied at the rate of 22 kg/ha beside the row and to control weeds glyphosate and atrazine werebroadcast over the soil surface at the rate of 4 liters and 3 kg/ha (actual), respectively. About 30 days after planting, 420 kg/ha of NH_4NO_3 was applied as a sidedressing. Following harvest in middle August, 3 soybean [*Glycine max* (L.) Merr.] cultivars, 'Jupiter,' 'UF V-1,' and 'Cobb,' and sunflowers (*Helianthus* sp 'Sungrow 380A') were planted with the no-till planter following the corn cultivars to study residual effects of tillage and subsoiling.

On March 27, 1979, corn received 350 kg/ha of 4-3-17.5 (N-P-K) beside the row and 3 kg/ha (actual) of atrazine and of 2-chloro-2', 6'-diethyl-N-(Methoxymethyl) acetanilide (Alachlor) and 4 liters/ha glyphosate broadcast during the planting once-over operation. Bahiagrass frosted just before treatment and since there was a possibility glyphosate might not work, we post directed 1, l'-dimethyl-4, 4'-bipyridinium ion (paraquat) at the rate of 1 liter/ha on April 28. On May 11, the corn was sidedressed with a mixture of 15-0-12.5 (N-P-K) and NH_4NO_3 at the rate of 350 and 420 kg/ha, respectively.

RESULTS AND DISCUSSION

Corn grain yields were not significantly different at the 5% level of probability in 1976 for planting treatments, cultivars, or row width (Table 1). Conventional planting was somewhat better than no-till at the 90-cm row width for both cultivars but the difference was reduced considerably at the 45-cm row width. Probably the closer rows shaded out undergrowth and reduced competition for nutrients and water. In succeeding years, 75-cm rows were planted.

The best response in 1978 was for subsoiling. Both corn grain and forage yields were increased (Table 2). The higher forage under subsoiling crowded out undergrowth so that weed and bahiagrass growth following subsoiling was lower than the check. The effects of tillage methods over subsoiling and cultivars were not different. Grain and forage yield for Funks G-4507 and grain yield for Pioneer 3958 were significantly higher than DeKalb XL18 and XL12. Cultivars did not affect undergrowth.

Although the overall effectsof tillage methods were not different, they did interact with subsoiling. The interaction for corn grain yields is shown in Table 3. Without subsoiling, no-till corn grain yield was significantly lower than conventionally-planted corn. However, with subsoiling no-till corn grain yields were higher than the check. Probably subsoiling increased root depth and access to water and the advantage was enhanced under no-till planting since evaporation from the residue covered surface was reduced so that moisture supplies down the profile were greater. Additional benefit for subsoiling was evident in stands (Table 4). Stands were significantly higher for subsoiled corn compared to check but methods of tillage had little effect on stand. Ears per plant were not affected by subsoiling or planting methods.

Nutrient composition of the corn stover was not affected greatly by subsoiling (Table 5). The differences in uptake that occurred (Table 6) were essentially related to yield differences (Table 2). Subsoiling reduced the uptake of nutrients in the undergrowth because corn grew better and competed with the undergrowth for nutrients and water. For methods of planting, uptake of nutrients in the undergrowth was better from the conventional treatment possible because of the composition of the undergrowth. There were more weeds and less bahiagrass for conventional compared to no-till and since undergrowth contained more nutrients following conventional planting, the weeds must have been higher in nutrients than bahiagrass.

Soybeans were planted late (August 15) and yields were low, averaging 980 and 880 kg/ha for 'Jupiter' and 'UF V-1' cultivars, respectively. 'Cobb' soybeans and sunflowers gave no consistent yields. There was no residual effects due to tillage and subsoiling on the 'Jupiter' and 'UF V-1' soybean yields.

In 1979, low rainfall in the latter stages of growth reduced grain yields. Subsoiling and tillage had no effect on yield or ears per plant. However, subsoiling again improved the stand. There were almost 52,000 plants/ha for the subsoiled beans compared to 46,400 plants/ha on the check. Funks G-4507 had the highest yield similarly to the 1978 results, but Pioneer 3958 yielded significantly less than Funks G-4507 as compared to 1978 where yields were about the same. Yields and uptake of N for the stover corresponded to grain yields. The overall stover/grain yield ratio in 1978 and 1979 was 1.84 and 1.58, respectively.

SUMMARY

In 1976 and 1979, the conventional practice of planting corn gave yields no different from the no-tillage method. Since costs of planting by the no-tillage method are definitely lower (2), it follows that it would be more economical to plant corn by the no-tillage practice.

In 1978, corn yields obtained from the conventional practice was more than by no-tillage; 4470 vs 3370 kg/ha, respectively (Table 3). The value of the yield difference (1100 kg/ha) would probably more than make up for the savings in using the no-tillage compared to the conventional method (2). However, when both methods had the added practice of subsoiling, there was increased yields far both methods of planting and the increase was enough greater for no-tillage that it was superior to the conventional method; 5643 vs 5258 kg/ha, respectively (a 385 kg/ha yield difference).

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Table 1. 1976 corn grain yield data testing row width and no-tillage on two cultivars.

Treatments	N[‡]	Cultivars[†] Funks G-4708	Pioneer 3369A	Average over cultivars
		Bows spaced 90 cm, kg/ha		
Conventional	4	5240	5130	5180
No-till	4	4880	4360	4620
		Rows spaced 45 cm, kg/ha		
Conventional	4	4730	5330	5030
No-till	4	4800	5400	5100
		Average over spacing, kg/ha		
Conventional	4	4980	5240	5110
No-till	4	4840	4880	4860
	8	4910	5060	

'Funks G-4708 is an early-maturing cultivar and Pioneer 33698 is a medium maturing cultivar.

‡Number of observations.

Table 2. 1978 yield data in no-tillage experiment on corn on Scranton fs.

Treatments	N[†]	Yields: Corn grain	Forage	Undergrowth
		----------kg/ha----------		
Subsoiling				
No	32	3920b[‡]	6760b	2770a
Yes	32	5450a	10460a	2240b
Tillage				
Conventional	32	4860	9090	2531
No-till	32	4510	8130	2480
Cultivars				
Funks G-4507	16	5100a	10740a	2620
DeKalb XL18	16	4030b	7870b	2780
DeKalb XL12	16	4190b	7280b	2410
Pioneer 3958	16	5150a	8540b	2200

'Number of observations.

'Values followed by different letters are different at the 5% level of probability.

Table 3. 1978 corn grain yields showing interaction between subsoiling and no-tillage treatments.

Subsoiling treatment	Planting method	
	Conventional	No-tillage
	--------------kg/ha--------------	
NO	4470A†	3370bB
Yes	5260	5640a

†Values followed by different small letters in between columns and different capital letters in rows are different at the 5% level of probability. Data are averages over four replications and four cultivars.

Table 4. 1978 corn plant population and ears per plant as affected by no-tillage and subsoiling.

Treatments	N[†]	Plants/ha	Ears/plant
Subsoiling			
No	32	46,600b[‡]	0.91
Yes	32	60,200a	0.92
Planting method			
Conventional	32	53,000	0.92
No-tillage	32	53,800	0.91

'Number of observations.

[‡]Values followed by different letters are different at the 5% level of probability.

Table 5. Nutrient composition of corn stover and undergrowth in 1978 as affected by subsoiling and methods of planting.

		Stover				Undergrowth			
		Subsoiling		Methods of planting		Subsoiling		Methods of planting	
Nutrient	N†	No	Yes	Conventional	No-till	No	Yes	Conventional	No-till
		---	---	---	---	%	---	---	---
N	32	0.88	0.88	0.95	0.82	1.19	1.15	1.26	1.08
P	32	0.23a‡	0.22b	0.23	0.22	0.20	0.21	0.24a	0.18b
K	32	0.59	0.60	0.56	0.63	1.81	1.80	2.00a	1.61b
Ca	32	0.10	0.11	0.10	0.11	0.95	0.89	1.48	0.36
Mg	32	0.09	0.08	0.09	0.08	0.23	0.22	0.28a	0.17b
		---	---	---	---	ppm	---	---	---
Cu	32	17	21	18	19	21	17	22a	16b
Fe	32	20	17	19	19	48	48	52a	43b
Mn	32	25	22	23	24	119	118	126	111

† Number of observations.

‡ Values followed by different letters in horizontal rows testing subsoiling and methods of planting for stover and undergrowth, respectively, are significantly different at the 5% level of probability.

Table 6. Uptake of nutrients in corn stover and undergrowth in 1978 as affected by subsoiling and methods of planting.

		Stover				Undergrowth			
		Subsoiling		Method of planting		Subsoiling		Method of planting	
Nutrient	N[†]	No	Yes	Conventional	No-till	No	Yes	Conventional	No-till
		kg/ha							
N	32	60b[‡]	90a	85a	66b	33a	26b	33a	26b
P	32	16b	23a	21a	18b	6a	5b	6a	4b
K	32	39b	62a	51	50	40b	41a	52a	40b
Ca	32	7	12	9	9	26	22	39a	9b
Mg	32	6b	9a	9a	7b	6a	56	7a	4b
cu	32	0.12b	0.22a	0.17	0.17	0.06a	0.04b	0.06a	0.04b
Fe	32	0.14	0.18	0.17	0.15	0.13a	0.10b	0.13a	0.10b
Mn	32	0.16b	0.23a	0.20	0.18	0.34	0.27	0.33	0.28

'Number of observations.

‡Values followed by different letters in horizontal rows testing subsoiling and methods of planting for stover and undergrowth are significantly different at 5% level of probability.

Table 7. 1979 yield data in no-tillage corn experiment on Scranton fs.

Treatments	N†	Grain yield	Plants/ha	Ears/plant	Stover Yield	Stover N uptake
		kg/ha			-------kg/ha-------	
Subsoiling						
No	32	3200	46,400b	0.91	4610	49
Yes	32	3250	51,980a‡	0.91	5610	56
Tillage						
Conventional	32	3230	49,050	0.92	5060	51
No-till	32	3220	49,340	0.90	5160	54
Cultivars						
Funks G-4507	16	4190a	47,200	0.87	8490a	74a
DeKalb XL18	16	3120b	48,850	0.89	5160b	52b
DeKalb XL12	16	3560b	47,550	0.93	3170b	30c
Pioneer 3958	16	3040b	53,190	0.94	3600b	44bc

†Number of observations.

‡Values followed by different letters are different at the 5% level of probability.