Reducing Surface Disturbance with No-Till and Low-Till Systems for Cotton in the Mid-South

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INTRODUCTION

Producers are trying to reduce input costs and soil erosion while improving water quality eliminating trips across the field. In-row subsoil tillage with the Paratill may be a possible solution. The Paratill is a deep tillage tool with high horsepower requirements that reduces soil surface disturbance. A lower draft deep-tillage tool, with reduced soil surface disturbance, was deslgned by Tupper in 1993 (Tupper, 1994). This deep-tillage tool, referred to as the low-till parabolic subsoiler, utilizes a straight parabolic-shaped shank positioned at a 28^{o} angle from the vertical (away from the center of the subsoiler) to reduce the amount of soil surface disturbance. This angle allows the shank to run in fractured soil, even under less than ideal soil moisture (wetter) conditions, thus reducing draft requirements. The leading edge of the shank was cut at a 45" angle, providing a sharp edge to reduce soil lift and further reduce draft requirements. With the use of the low-till parabolic subsoiler, deep subsoil tillage can be accomplished with minimum surface disturbance followed by no addtional tillage after planting. Other studies have shown increased yield responses with deep-band K. In-row subsoiling and deep-band K with minimum soil disturbance can reduce tillage trips and soil erosion, enhance water infiltration, maintain yields, and improve economic returns. Mid-South cotton *(Gossypium hirsutum* L.) producers have expressed a great interest in this system.

Summarizing 2 yr of research with subsoil tillage equipment, Tupper (1977) reported increased lint yield, a reduced power requirement, and a 43.4% reduction in wheel slippage with the parabolic design as compared to the conventional straight shank design. Smith and Williford (1988) reported that the parabolic subsoiler designed by Tupper required 30.2% less fuel per acre than the conventional subsoiler while worlung an average of 0.8 in deeper. The low-till shank pulls easier than the conventional parabolic shank, thus increased fuel efficiency should be realized with the low-till design.

Low soil test K in the subsoil can be corrected with deep banding fertilizer K directly under the drill row (Tupper, 1992, Tupper et al., 1992 a,b). In several studies across the Delta, soil test K levels were significantly correlated to lint yields at three soil sample depths (0 to 6 in., 6 to 12 in., and 12 to 18 in.) in non-irrigated solid planting, and in irrigated solid and skip-row plantings (Tupper, 1992). Lint yields have been improved the most when deep banding on soils which are low in soil test K, have desirable pH (6.0 - 6.8), and produce a deep root system. In order to get K into the subsoil, an applicator for deep banding low concentrations of dry material was designed and built at Stoneville, MS, during 1985 (Tupper and Pringle, 1986). This equipment was designed and built to provide an economical yet practical means of supplying K to the subsoil. By combining this technology with low-till parabolic subsoiler design, it should be possible to provide K to the subsoil with only minimal soil surface disturbance. This research project should provide producers with answers to help in the decision making of selecting tillage practices and provide solutions to several unanswered questions. Our objectives were to: 1) develop new production systems with the low-till parabolic subsoiler with minimum surface disturbance, improve soil potassium levels, and maintain or improve lint yields with increased economic returns, 2) compare the new production system to a no-till system and a conventional tillage system for cotton *(Gossypium hirsutum* L.) production with the low-till parabolic subsoiler, and 3) determine the changes in cost and returns with in-row-direction limited soil disturbance deep tillage systems.

MATERIALS *AND* METHODS

A dryland experiment was initiated in 1994 on Bosket very fine sandy loam and Souva silt loam soil at the Delta Research and Extension Center. The experiment was designed in a randomized complete block with 12 treatments replicated four times. The main

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(controlling) treatments were: 1) no-till, 2) low-till parabolic subsoiler in-row direction with a light do-all to smooth the drill area, and 3) low-till parabolic subsoiler, hip, seedbed conditioner, and cultivate. The four other factorial treatments were: 1) check – no K, 2) 100 lb K_2O/a surface broadcast, 3) 150 lb K_2O/a deep band (applied to surface in no-till plots), and 4) 100 lb K_2O/a surface broadcast plus 150 lb K_2O/a deep band (applied to surface in no-till plots). Plots consisted of four 40-in rows, 95 ft. long.

Initially, soil samples were taken from 0- to 6-in and 6- to 15-in deep in the drill. Soil test recommendations suggested 80lb K_2O/a for the 0- to 6-in soil sample depth (topsoil) and 120 lb K_2O/a for the 6- to 15-in soil sample depth (subsoil). Applications were increased by 25% for both samples (100 lb of K_2O/a and 150 lb K_2O/a) and applied as single and combination treatments. The surface 100 lb K_2O/a treatment was broadcast applied and the deep 150 lb K_2O/a treatment was banded 6- to 15-in deep in the dnll row with a continuous band 9 in tall and 2 in wide. All no-till K treatments were surface broadcast in order to maintain its no-till status as a treatment.

A solid planting pattern was used with 'DES 119' variety planted in 1994, 1995, and 'SG 125' variety in 19%. The eight deep tillage treatments were subsoiled 23 September 1993, 3 November 1994, and 13 October 1995, respectively, for the 1994, 1995, and 1996 crops. The potassium treatments were applied 23 September 1993, 23 March 1995, and 26 February 1996, for the three crop years, respectively. Weeds were controlled as needed for each tillage system. A number of weed counts were made. during the experiment, but are not reported in this paper. Insects were controlled as needed during each growing season.

After defoliation, two center rows of each plot were spindle picked twice for yield determination. Representative samples of seed cotton (replications combined) were taken from each treatment at both first and second harvest and ginned to determine the lint percents used for calculating lint yield of each plot. A small scale ginning system (20 saw gin with the USDA recommended ginning practices) was provided by the USDA Ginning Laboratory at Stoneville. Data were subjected to analysis of variance and a 5% level of significance was chosen to separate means using Fisher's Protected LSD procedures.

RESULTS AND DISCUSSION

Lint yield data for 1994, 1995, 1996, and the 3-year average are given in Table 1. In 1994, in the treatment average the two highest K treatments (150 and 250) were higher in lint yield than the check (0). Five of six treatments at these K levels were sigruficantly higher than the conventional cultivated check treatment. Good rainfall throughout the 1994 growing season provided a good water supply for the no-till treatments.

In 1995, the deep band treatments (150) were the best treatments because of the late drought and the development of deeper root systems were able to hold up these treatments much longer into the drought before wilting began in the heat of the day. In both tillage systems, the deep 150 lb K_2O/a treatment produced sigruficantly more lint than the check (0) treatment. On the average, 150 lb K_2O/a also produced more lint than the check (0) treatment. In the treatment means, both tillage systems produced more lint than the no-till system. Conventional tillage produced more lint (84 lb/a, 10.8%) than the no-till on the average in 1995.

In 1996, only one treatment produced more lint yield than the no-till check (0) treatment. The low-till subsoiler, seedbed conditioner, with deep band 150 lb K_2O/a treatment produced a significantly higher lint yield. The 150 lb K_2O/a treatment produced more lint than the nc-till check (0). Conventional tillage produced more lint (100 lb/a, 10.8%) than no-till, on the average, in 1996.

In the 3-41 average, surface treatments of 100, 150, and 250 lb K_2O/a did not improve no-till lint yields over the check (0) or conventional tillage check (0) treatments. However, with the low-till subsoiler, seedbed conditioner with the deep band 150 lb K_2O/a treatment increased lint yield over the no-till and conventional tillage check (0). Overall, the 150 and 250 lb/a rates of K improved lint yield over the check (0). The 3-yr averages for tillage systems were not shown because of the significant interaction with year.

Figure 1 shows the percent residue cover the day after the stalks were shredded. Counts were made on 6-inch intervals over a 50 A chain stretched from row middle across four rows to row middle. Before any tillage treatments were performed, treatments were virtually alike in residue coverage. Figure 2 shows the percent residue after weathering up to 4 April, subsoiling, deep fertilizer applications, and hipping had been done in the low-till and conventional tillage treatments. Figure 3 shows the percent residue coverage the day after planting. The low-till treatments were lightly seedbed conditioned and conventional tillage treatments were seedbed conditioned. The low-till system at that point averaged 13% residue cover as compared to 27% for no-till and 4% for conventional tillage. Even though the low-till treatments do not maintain the higher levels of residue coverage that the no-till treatments maintained, they had two to three times more residue cover than conventional tillage and yields were considerably higher when 150 lb K_2O/a was deep band than in the no-till treatment when 150 lb K_2O/a was surface broadcast. Figure 4 graphs the 3-yr average lint yield, illustrating the average yields for the study.

CONCLUSIONS

The low-till subsoiler, seedbed conditioner treatment with deep band 150 lb K2O/a may be a good alternative system rather than no-till in the Mississippi Delta on relatively flat sandy loam soil types. Additional research is being done at this time to combine the low-till parabolic subsoiler and the deep band dry materials applicator into one piece of equipment. Additional work will be done to look at the economics of the new tillage system which is not complete at this time.

ACKNOWLEDGMENTS

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Table 1. 1. Effect of tillage system, potassium rate, and placement on lint yield, Stoneville, MS, 1994, 1995, 1996, and 3-year average (1994-1996).

Tillage system	K Rate	K Placement	Lint yield 1994	Lint yield 1995	Lint yield 1996	Lint yield 3-yr Avg
	(lb K_2O/A)		----------------	(lb/A)	----------------	
No-till	0	--	1021	799	923	914
	100	Surface	1025	772	900	899
	150	Surface[1/]	1081	761	932	924
	250	Surface[1/]	1093	779	948	940
Low-till	0	--	928	746	866	847
(Low-till Sub and	100	Surface	1027	854	1003	961
Seedbed	150	Deepband	1098	890	1068	1019
Conditioner)	250	Split[2/]	1099	834	1005	979
Conventional	0	--	946	793	1002	914
(Low-till Sub, Hip,	100	Surface	1013	848	1033	965
Seedbed Conditioner	150	Deepband	996	928	1047	991
& cultivate)	250	Split[2/]	1069	878	1018	988
LSD (5%)			114	99	137	100
	Treatment means					
Tillage system						
No-till			1055	778	925	--[3/]
Low-till Sub., Seedbed Conditioner			1038	831	985	--
Low-till Sub., Hip, Seedbed Conditioner. Cultivate			1006	862	1025	--
LSD (5%)			57	49	69	
Potassium system						
	0	--	965	779	930	891
	100	Surface	1021	825	978	942
	150	Deepband	1058	860	1015	978
	250	Split	1087	830	990	969
LSD (5%)			66	57	79	58

[1/]No-till required all K to be surface applied.
[2/]Split: 100 lb K_2O/A surface, 150 lb K_2O/A deep band
[3/]Interaction significant at the 0.01% level.

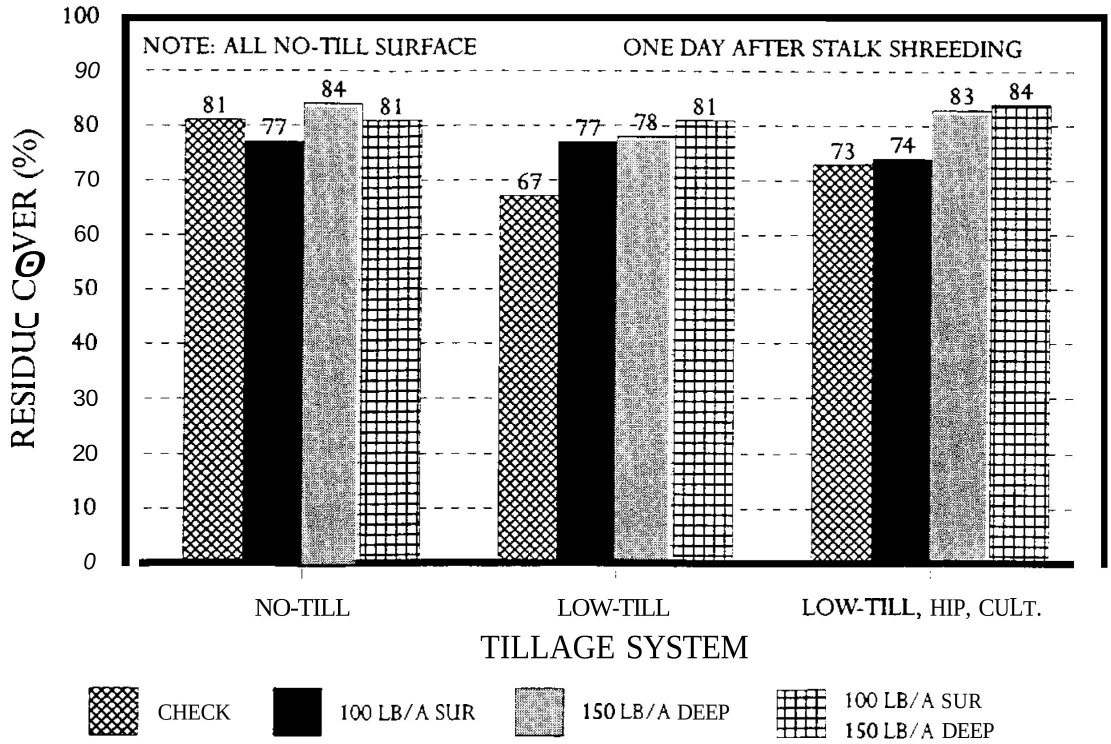

Figure 1. Effect of tillage, potassium rate and placement on surface residue, 10/12/1995

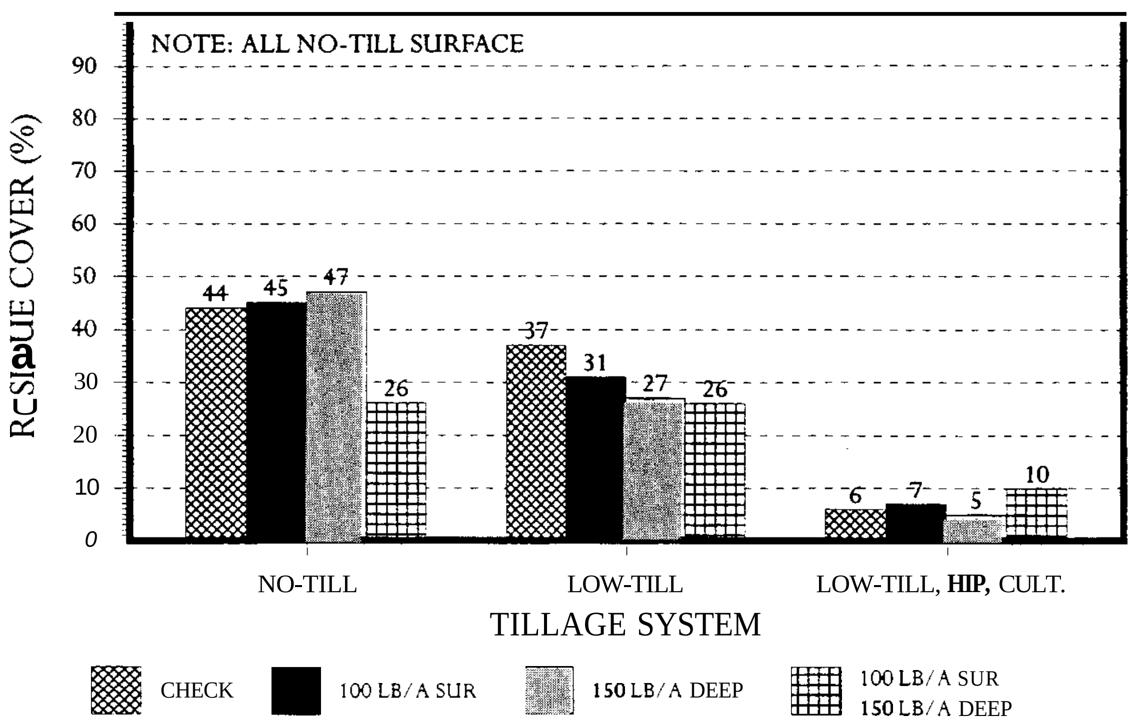

Figure 2. Effect of tillage, potassium rate and placement on surface residue, 4/4/1996

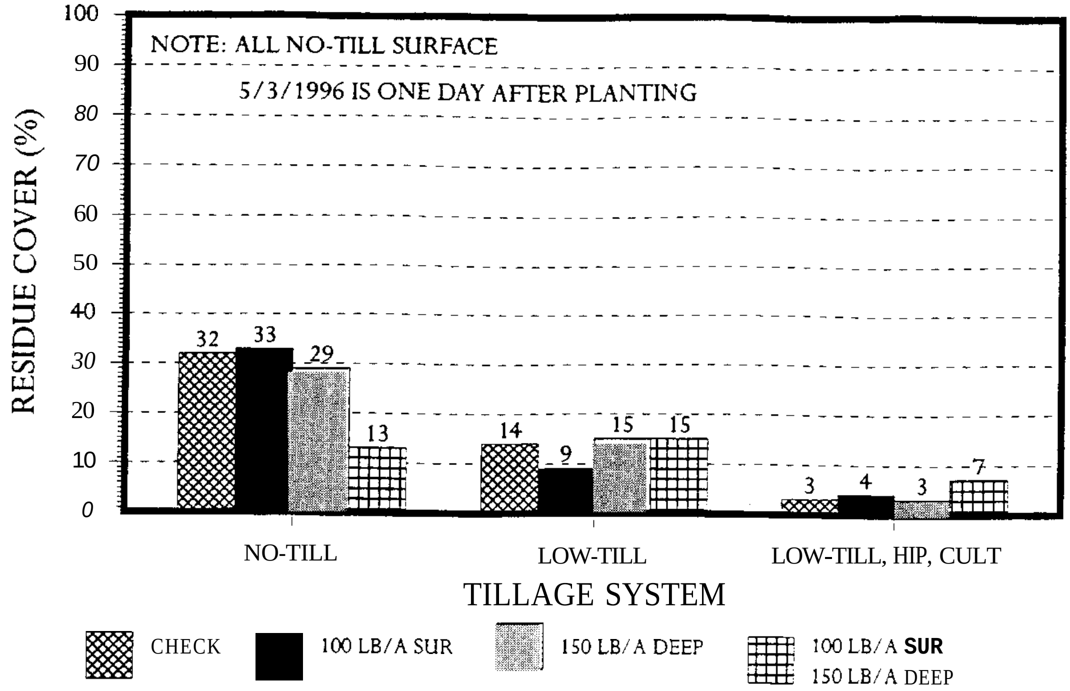

Figure 3. Effect of tillage, potassium rate and placement on surface residue, 5/3/1996

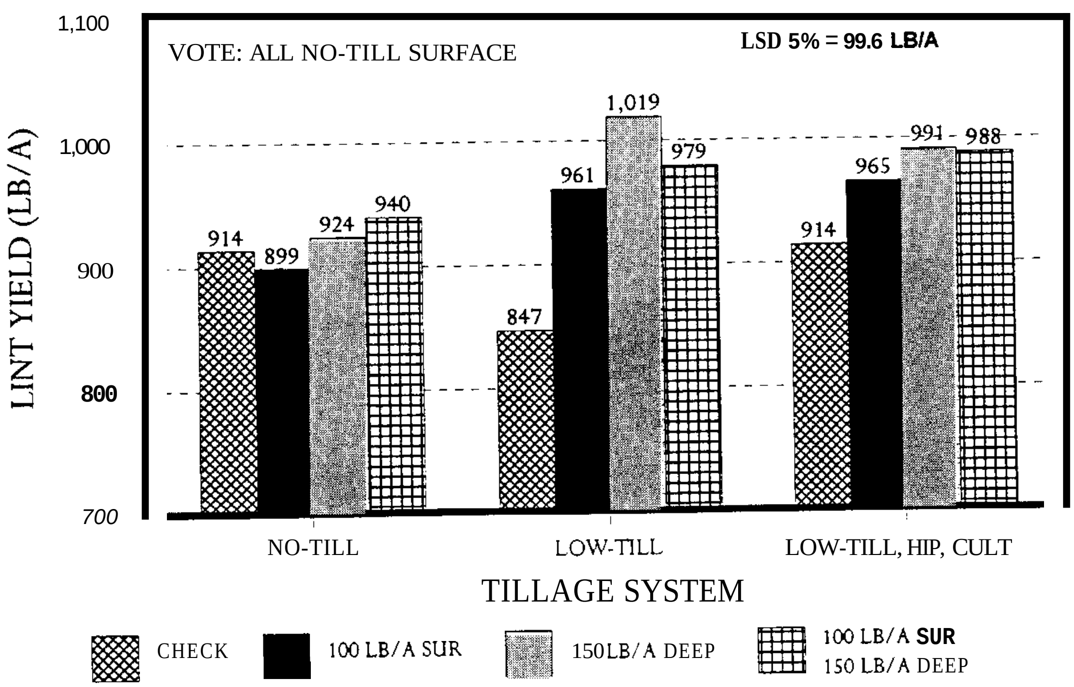

Figure 4. Effect of tillage, potassium rate and placement on lint yield, 3-yr average (1994-1996)