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Cotton Response to Subsoiling and Chiseling of Sandy Loam Soil

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Summary

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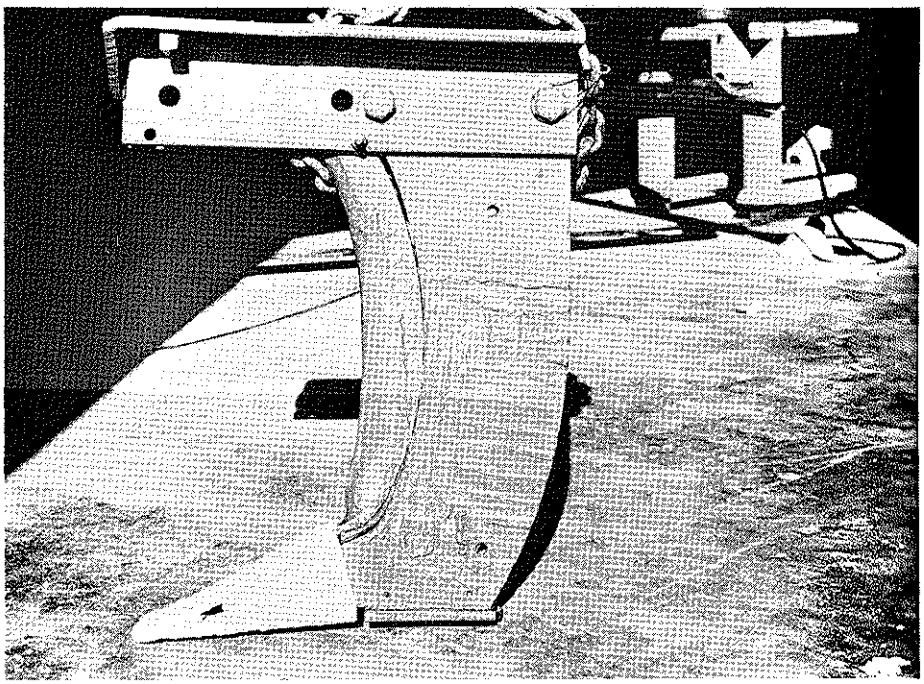
The major hardpan of the test site was between 9 and 12 inches below the soil surface. Both subsoilers penetrated the pan, but the chisel operated above it and generally had a detrimental effect when used either with or without subsoiling, the exception being in 1977 with the Parabolic Subsoiler.

Total lint yields in the fourth year of the study were highest on plots that were chiseled after subsoiling with the Stoneville Parabolic Subsoiler, but did not differ significantly from the check or from the other treatments. Measurements of earliness, taproot length and residual soil strength for the check in the fourth year of the study did not differ significantly from those for the deep-tillage treatments.

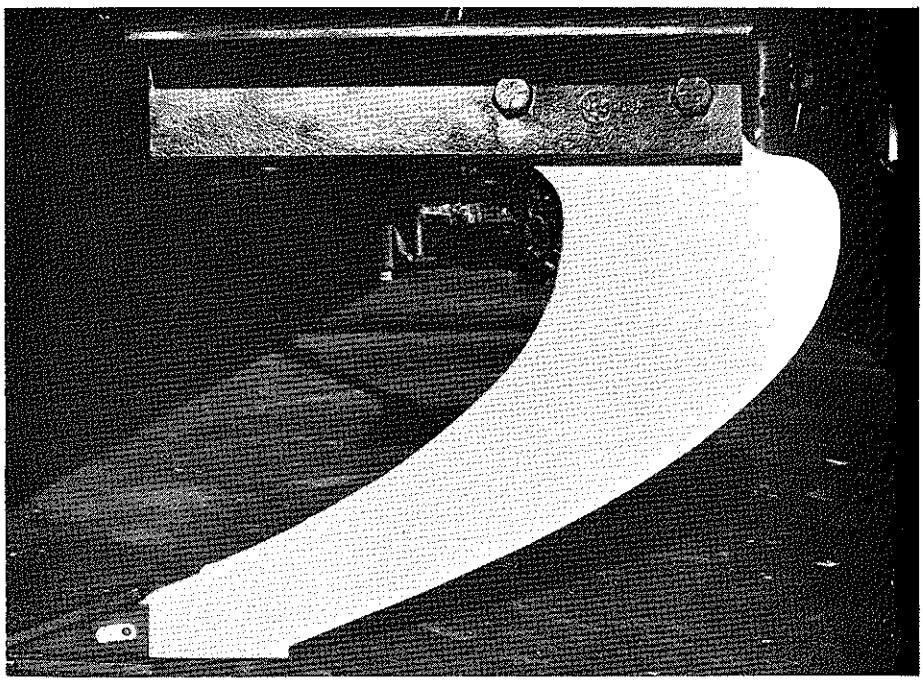
Lint yields of the check (averages of three years for which data were taken) did not differ significantly from those for the deep-tillage treatments. First-harvest lint yields averaged over the same three years were highest on the treatments subsoiled conventionally or with the Parabolic Subsoiler, but percentages of total yield from these plots at first harvest did not differ significantly from the check. Taproots were longest (three-year average) for the parabolic-subsoiled treatment but were not significantly longer than for the conventionally subsoiled treatment and plots chiseled after subsoiling with the Parabolic Subsoiler. The three-year average residual soil strength of deep-tilled treatments did not differ significantly from that of the check.

In averaging all plots subsoiled with the Parabolic Subsoiler as compared to the non-subsoiled plots, lint at second harvest, total lint and cottonseed harvested were higher, taproots were longer and residual soil strength was lower for parabolic subsoiling.

On Bosket fine sandy loam soil, the spring tine chisel decreased the total lint harvested and delayed maturity.



Conventional Subsoiler used in the trial.



Stoneville Parabolic Subsoiler

Cotton Response to Subsoiling and Chiseling of Sandy Loam Soil

Cotton yield increases from subsoiling or deep tillage of sandy, sandy loam and silt loam soils have been reported in the Delta of Mississippi (3,5,9). Many areas outside the Delta also have reported that deep tillage has resulted in significant increases in cotton yields where soil compaction problems limit water intake and storage and root development (2,4).

Veihmeyer and Hendrickson (10) found that root penetration problems occurred at much lower densities on clay soils than on sandy soils because of smaller size of pores. Research indicated that roots of plants, growing in a rigid system where soil particles cannot be moved aside, cannot penetrate pore spaces with diameters smaller than the root tip diameter (12). Taylor and Gardner (7) reported that cotton roots can penetrate a nonporous region only if it is not rigid. Deep tillage of compact soils increases root penetration by increasing pore size and reducing the rigidity of soil particles, along with other benefits; e.g., increased water infiltration and oxygen content of the tilled area.

Severity of soil compaction is influenced by the soil management system used. Vomocil, et al (11) found that the rate of water infiltration into soil was reduced after a tractor had operated on tilled soil, with drawbar pull of the tractor increased as a means of increasing wheel slippage and compaction. Water run-off and erosion usually increase when the water-infiltration rate of soil decreases.

These studies suggest that minimum or reduced soil-management tillage systems will help increase the intake of water, reduce erosion, increase aeration and improve root penetration. Machine design and operation will have to be integrated into a workable soil-management system before optimum compaction control can be attained.

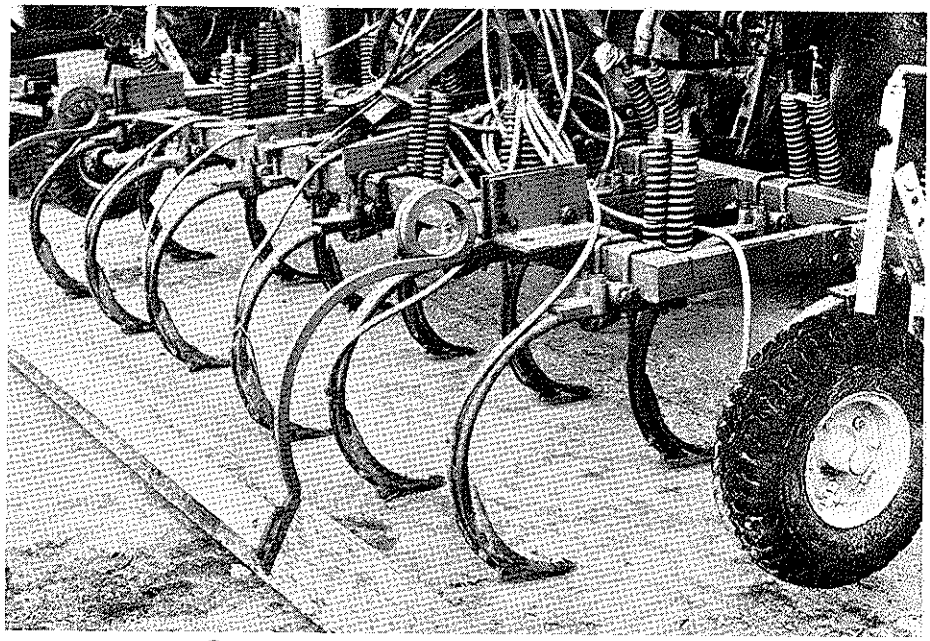
Studies of a Bosket fine sandy loam by Spurgeon et al (6) showed that cotton yields were higher after limited seedbed preparation than after disking and chiseling twice after subsoiling. The limited seedbed preparation consisted of subsoiling at an angle to the row and hipping over the old stubble.

The Stoneville Parabolic Subsoiler was designed in 1972 (8). Field tests comparing the Parabolic Subsoiler with a conventionally designed subsoiler showed decreased horsepower requirement, increased width of soil fracture and a 43.4% reduction in tractor wheel slippage for subsoiling with the Parabolic Subsoiler (9).

Procedure

Tests on a Bosket fine sandy loam were conducted at the MAFES Delta Branch in 1974, 1975, 1976* and 1977. The experiment was a factorial arrangement of a randomized block design with four replications, and each plot was six 40-inch wide and 100-ft long rows. The identity of each plot was retained throughout the four years of the trial.

The deep-tillage treatments tested were (1) check - no subsoiling, (2) subsoiling 16 inches deep in the drill with a conventional subsoiler, and (3) subsoiling 16 inches deep in the drill with the Stoneville Parabolic Subsoiler. Each of the deep-tillage treatments had one of two additional tillage



Spring Tine Chisel Used in the Trial

**Dates of treatment and results of the 1976 trial are not reported because data were destroyed by a picking error.*

treatments---(1) none - no chiseling, and (2) chiseling 7 inches deep with a spring tine chisel on 12-inch centers in the row direction. Cultural practics on all plots were identical except for the tillage treatments.

Subsoiling was done February 28, 1974, January 30, 1975 and February 17, 1977 and chiseling was done March 6, 1974, March 24, 1975 and February 25, 1977. Dates of tillage differed because of variations in soil conditions and weather from one year to another.

All plots were hipped over the old stubble (6) before applying a 32% urea-ammonium nitrate solution (80 lbs/acre), and the plots were hipped again. A bed conditioner (Do-All) was used to knock the beds down ahead of the planter, and 'Stoneville 213' seed (20 lbs/acre) were planted April 26, 1974, April 28, 1975 and April 26, 1977.

Diuron was applied pre-emergence and conventional cultivation and postemergence weed control practices were used. Insecticides were applied by air as needed.

The tests were defoliated at maturity, and the center two rows of each plot were harvested twice each year with a spindle picker.

Samples were ginned on a 20-saw gin with a standard equipment sequence (1).**

Table 1. Yield, earliness and taproot length of 'Stoneville 213' cotton on a Bosket fine sandy loam and residual strength of the soil after deep tillage, by tillage treatment, MAFES Delta Branch, 1974.

Tillage treatment		Seed cotton			Lint				Earliness Lint at	Taproot	Residual soil
Subsoil	Chisel	1st	2nd	Total	1st	2nd	Total	Cottonseed	1st pick	length[1]	strength[2]
		(lbs/acre)							(%)	(in)	(lbs/sq in)
None	None	1921 ab[3]	745 c	2666	614 a	226 b	840 ab	1582	73.2 a	7.0 bc	536
None	Chisel	1755 bc	945 abc	2700	529 b	286 ab	815 ab	1614	65.3 b	6.2 c	564
Conventional	None	1986 a	785 bc	2771	619 a	232 b	851 ab	1642	72.7 a	8.1 abc	546
Parabolic	None	1936 ab	955 ab	2931	583 ab	309 a	892 a	1734	65.4 b	10.3 a	431
Conventional	Chisel	1900 ab	956 abc	2856	561 ab	287 ab	848 ab	1694	66.0 b	7.3 bc	514
Parabolic	Chisel	1697 c	1036 a	2733	481 c	310 a	791 b	1603	60.9 b	9.1 ab	471
					Treatment Means						
None		1838	845 b	2683	572 a	255 b	827	1598	69.2 a	6.6 b	550 b
Conventional		1943	870 b	2813	590 a	260 b	850	1668	69.4 a	7.7 b	530 ab
Parabolic		1817	1015 a	2832	532 b	310 a	842	1668	63.1 b	9.7 a	451 a
	None	1948 a	841 b	2789	605 a	256 b	861 a	1653	70.4 a	8.5	504
	Chisel	1748 b	979 a	2763	524 b	294 a	818 b	1637	64.1 b	7.5	516

[1]Average of 10 consecutive plants from each plot after harvest.

[2]Measurements made about 11 months after subsoiling from 10 readings per plot when soil moisture was high.

[3]Values in each column and group followed by the same letter are not significantly different ($P < .05$) as determined by Duncan's New Multiple Range test.

Table 2. Yield, earliness and taproot length of 'Stoneville 213' cotton on a Bosket fine sandy loam and residual strength of the soil after deep tillage, by tillage treatment, MAFES Delta Branch, 1975.

Tillage treatment		Seed cotton			Lint				Lint at	Taproot	Residual soil
Subsoil	Chisel	1st	2nd	Total	1st	2nd	Total	Cottonseed	1st pick	length[1]	strength[2]
		(lbs/acre)							(%)	(in)	(lbs/sq in)
None	None	2390 ab[3]	838 c	3228 ab	716 ab	277 c	933	1903 ab	72.0 a	6.5 c	474
None	Chisel	1998 b	956 bc	2954 b	611 ab	343 b	954	1732 b	63.8 bc	6.9 c	470
Conventional	None	2419 ab	974 b	3393 ab	746 a	348 b	1094	1991 ab	68.3 ab	9.7 a	366
Parabolic	None	2557 a	987 b	3544 a	733 a	367 ab	1120	2093 a	67.2 ab	10.1 a	375
Conventional	Chisel	2042 ab	1160 a	3202 ab	575 b	411 a	986	1888 ab	58.2 c	7.4 bc	349
Parabolic	Chisel	2176 ab	996 b	3172 ab	652 ab	351 b	1003	1814 ab	64.5 b	9.1 ab	393
					Treatment Means						
None		2194	897 b	3091	663	310 b	973	1817	67.9 a	6.7 c	472 b
Conventional		2231	1067 a	3298	660	380 a	1040	1939	63.2 b	8.5 b	357 a
Parabolic		2366	992 a	3358	702	359 a	1061	1953	65.9 ab	9.6 a	384 ab
	None	2455 a	933 b	3388	738 a	331 b	1069 a	1995 a	69.1 a	8.8	405
	Chisel	2072 b	1037 a	3109	613 b	368 a	981 b	1811 b	62.2 b	7.8	404

[1]Average of 10 consecutive plants from each plot after harvest.

[2]Measurements made about 11 months after subsoiling from 10 readings per plot when soil moisture was high.

[3]Values in each column and group followed by the same letter are not significantly different ($P < .05$) as determined by Duncan's New Multiple Range Test.

***Cotton was ginned at the U. S. Cotton Ginning Research Laboratory at Stoneville, Mississippi.*

Results

Total lint yield in 1974 was highest for parabolic subsoiling but differed significantly ($P < .05$) only from the parabolic subsoiling plus chiseling treatment (Table 1). The highest lint yield in 1975 was from the parabolic-subsoiled plots but was not significantly different from yield of other plots (Table 2). Lint yield in 1977 was highest with parabolic subsoiling plus chiseling but was not significantly higher than yield of other plots (Table 3). The highest three-year average yield was from the parabolic-subsoiled treatment but was not significantly higher than that of the check (Table 4).

Table 3. Yield, earliness and taproot length of 'Stoneville 213' cotton on a Bosket fine sandy loam and residual strength of the soil after deep tillage, by tillage treatment, MAFES Delta Branch, 1977.

Tillage treatment		Seed cotton			Lint				Lint at	Taproot	Residual soil
Subsoil	Chisel	1st	2nd	Total	1st	2nd	Total	Cottonseed	1st pick	length[1]	strength[2]
		(lbs/acre)							(%)	(in)	(lbs/sq in)
None	None	1815	639 ab[3]	2454	597	211 ab	808	1500	74.1 bc	7.1	565 ab
None	Chisel	1769	632 ab	2401	572	213 ab	785	1442	73.0 c	6.9	686 ab
Conventional	None	1826	618 ab	2444	600	210 ab	810	1465	74.3 bc	9.1	520 ab
Parabolic	None	1920	516 ab	2436	650	171 bc	821	1475	79.4 ab	8.3	651 ab
Conventional	Chisel	1915	475 b	2390	642	155 c	797	1479	80.8 a	7.7	714 ab
Parabolic	Chisel	1929	675 a	2604	631	235 a	866	1752	72.8 c	8.9	389 a
				Treatment Means							
None		1792	636	2428	585 b	212	797	1471	73.5	7.0	626
Conventional		1879	546	2416	621 ab	183	804	1472	77.6	8.4	617
Parabolic		1925	595	2520	640 a	203	843	1614	76.1	8.6	520
	None	1853	591	2444	616	197	813	1480	75.9	8.2	579
	Chisel	1871	594	2465	615	201	816	1588	75.5	7.8	596

[1]Average of 10 consecutive plants from each plot after harvest.

[2]Measurements made about 11 months after subsoiling from 10 readings per plot when soil moisture was high.

[3]Values in each column and group followed by the same letter are not significantly different ($P < .05$) as determined by Duncan's New Multiple Range Test.

Table 4. Yield, earliness and taproot length of 'Stoneville 213' cotton on a Bosket fine sandy loam and residual strength of the soil after deep tillage, by tillage treatment, MAFES Delta Branch, averages of 1974, 1975 and 1977.

Tillage treatment		Seed cotton			Lint				Lint at	Taproot	Residual soil
Subsoil	Chisel	1st	2nd	Total	1st	2nd	Total	Cottonseed	1st pick	length[1]	strength[2]
		(lbs/acre)							(%)	(in)	(lbs/sq in)
None	None	2042 ab[3]	740 b	2782 ab	643 ab	237 b	880 abc	1661 ab	73.1 a	6.9 b	523 ab
None	Chisel	1841 c	845 ab	2686 b	571 c	280 a	851 c	1596 b	67.4 cd	6.7 b	573 b
Conventional	None	2077 ab	792 ab	2869 ab	655 a	263 ab	918 ab	1699 ab	71.8 ab	9.0 a	477 ab
Parabolic	None	2137 a	833 ab	2970 a	662 a	282 a	944 a	1767 a	70.6 abc	9.5 a	486 ab
Conventional	Chisel	1952 abc	864 a	2816 ab	593 bc	284 a	877 bc	1687 ab	68.3 bcd	7.5 b	525 ab
Parabolic	Chisel	1934 bc	902 a	2836 ab	588 bc	298 a	886 abc	1723 ab	66.1 d	9.0 a	418 a
				Treatment Means							
None		1941	793	2734 b	607	259 b	866 b	1629 b	70.2	6.8 c	549 b
Conventional		2014	828	2842 ab	624	274 ab	898 ab	1693 ab	70.0	8.2 b	501 ab
Parabolic		2036	867	2903 a	625	290 a	915 a	1745 a	68.4	9.3 a	452 a
	None	2086 a	788 b	2874	653 a	261 b	914 a	1709	71.8 a	8.5	496
	Chisel	1909 b	870 a	2779	584 b	288 a	872 b	1669	67.3 b	7.7	506
Year											
1974		1866 b	910 a	2776 b	564 b	275 b	839 b	1645 b	67.2 b	8.0	510 a
1975		2264 a	985 a	3249 a	676 a	349 a	1025 a	1903 a	65.7 b	8.3	404 b
1977		1862 b	593 b	2455 c	615 b	199 c	814 b	1519 b	75.7 a	8.0	587 a

[1]Average of 10 consecutive plants from each plot each year after harvest.

[2]Measurements made about 11 months after subsoiling from 10 readings per plot each year when soil moisture was high.

[3]Values in each column and group followed by the same letter are not significantly different ($P < .05$) as determined by Duncan's New Multiple Range Test.

Lint yields at first harvest in 1974 and 1975 were highest on conventionally subsoiled plots but did not differ significantly from the check. The largest first-harvest lint yield in 1977 was on parabolic-subsoiled plots, but the percentage of total yield picked at first harvest differed significantly only from the chiseling only and the parabolic-subsoiling plus chiseling treatments. First-harvest lint yields averaged over the three years were highest on plots subsoiled with the Parabolic Subsoiler or subsoiled conventionally, but percentages of total yield from these plots at first harvest did not differ significantly from the check.

Taproots generally were shorter on the check and on plots that were chiseled only. The longest taproots in 1974 and 1975 were found on the parabolic - subsoiled treatment, significantly longer than those from the check, chiseling only or conventional subsoiling plus chiseling. Taproots in 1977 were longest on conventionally subsoiled plots but were not significantly longer than for the check or the other treatments. The three-year average length of taproots from the parabolic-subsoiled plots was 9.5 inches, significantly longer than those from the check, chiseling only or conventional subsoiling plus chiseling.

Soil strength about 11 months after deep tillage generally was more variable than other measurements but tended to be lower after subsoiling and was highest after chiseling only. Residual soil strength in 1974, 1975 and 1977 was lowest after parabolic subsoiling, conventional subsoiling plus chiseling and parabolic subsoiling plus chiseling, respectively.

In averaging the treatment means over the three-year period, the Parabolic Subsoiler increased the amount of lint at second harvest, total lint and cottonseed harvested, significantly more than non-subsoiled treatments. The taproots were significantly longer for the parabolic subsoiled plots. Residual soil strength was significantly lower for the parabolic subsoiled plots approximately 11 months after subsoiling when compared to the non-subsoiled treatments.

In this test on Bosket fine sandy loam soil, the spring tine chisel increased second harvest lint yield but decreased first harvest and total lint yields, as well as delaying maturity significantly.

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