COTTON RESPONSE TO IN-ROW SUBSOILERS

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Abstract

Subsoiling soils with hard pans is a very common practice for cotton production. The conventional parabolic subsoiler used in the fall at a 45° angle to the row direction has become the standard practice. New federal legislation requires most producers to change land preparation methods to reduce soil losses from fields. New subsoilers have been designed to reduce soil surface disturbance. Two of these are the Paratill® and low-till parabolic subsoilers. Combinations of 45° conventional subsoiling and in-row subsoiling were studied on two soil types over a 3-year period. The conventional parabolic subsoiler ran in the fall at a 45° angle to row direction combined with the low-till parabolic subsoiler used in-row in the spring was the most consistent treatment of the 20 treatments studied on the two soil types. The combination deep tillage treatment averaged 44 and 64 lb lint/A higher yield than the best single in-row subsoiling treatment for Bosket very fine sandy loam (Paratill in the fall) and Forestdale silty clay loam (low-till in the fall) soils, respectively. Producers who farm non-irrigated cotton on soils that respond to subsoiling may want to try this combination tillage system.

Introduction

Subsoiling implements were designed to open up dense or impervious layers of soil for improved root penetration, water infiltration, and soil aeration. Using the subsoiler on soils with hardpans is a very common practice for cotton production on many soils in the Mississippi Delta. Lint yield increases have been reported, especially on sandy loam and silt loam soils, where soil compaction is a serious problem (Tupper, 1977). Early research by Grissom et al. (1956) showed that subsoiled treatments produced significantly higher lint yields than conventional middlebuster treatments.

A new subsoiler design was introduced by Tupper (1974) using a parabolic curved shank. Summarizing two years of research, Tupper (1977) reported increases in lint yield, a reduction in power requirements, and a 43.4% reduction in wheel slippage with the parabolic subsoiler 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. In 1975, Cooke et al. (1975) reported that less than 33% of the Mississippi Delta cotton producers were subsoiling. By 1992, Martin and Hamill (1992) reported that over 71% of Mississippi Delta cotton producers were subsoiling.

New federal legislation will require most producers to make changes in land preparation methods to reduce soil losses from fields. Other subsoilers have been developed to reduce surface disturbance like the Paratill® (manufactured by Tye Company or Bingham Brothers, Inc.) commonly referred to as the "bent legged" or "L-shaped" shanks. This subsoiler reduced surface disturbance of the soil but producers have noted higher horsepower requirements with this implement.

Tupper (1994) designed the low-till parabolic subsoiler at the Delta Research and Extension Center in the spring of 1993. The parabolic shanks are positioned at a 28° angle from the vertical plane in the direction of travel. The shanks were cut from 1 1/2 inch T-1 steel with 321 Brinnel Hardness Number (BHN). The upper side of the leading edge of the shank was cut at a 45º angle to provide a sharp edge to reduce soil lift or surface disturbance, and draft power requirement of the shank. The foot is 3 inches wide and 12 inches long. It has a 22 1/2° approach angle for minimum draft (Tanner, 1960) and a minimum 360 BHN on the upper and lower surfaces for wear resistance.

The top of each shank was directed away from the center of the tool bar for increased trash clearance. The shanks are set at a 28° angle from vertical to run inside the rupture planes developed by the foot, even when soil conditions are wetter than ideal for good fracture.

Objective

The objective of this research was to compare the Paratill and low-till parabolic subsoilers in-row with the conventional parabolic subsoiler used at a 45° angle to the row direction on a Bosket very fine sandy loam and Forestdale silty clay loam soil (two separate locations).

Methods and Materials

Field studies were initiated in the fall of 1993. The tests were arranged in a split plot design with two main plots (1) not subsoiled and (2) subsoiled at a 45° angle to the row in the fall with a conventional parabolic subsoiler. The sub-plots consisted of 5 treatments: (1) check (no subsoiling), (2) Paratill in-row, fall, (3) Paratill in-row, spring, (4) low-till parabolic in-row, fall, and (5) low-till parabolic in-row, spring and each of the five treatments had (1) check or (2) alternate middle chisel operated 12-inches deep in non-traffic middles after emergence. The tests were arranged in a 5x2 factorial design for 20 total treatments with six replications on two soil types: Bosket very fine sandy loam soil and Forestdale silty clay loam soil. Plots were four 40-inch rows wide with the center two rows harvested for yield. The plots were 90 and 100 ft long for Bosket very fine

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sandy loam and Forestdale silty clay loam soil types, respectively. 'DES 119' cotton seed was planted on both soil types in 1994 and 1995. In 1996, 'SG 125' was planted on the Bosket very fine sandy loam study and 'SG 501' on the Forestdale silty clay loam study.

Representative seedcotton samples were taken from each plot for the 20 treatments on each soil type during first and second harvest. The samples were ginned (replications combined) to determine the lint percent used to calculate the lint yield of each plot. A small scale ginning system (20 saw gin using USDA recommended ginning practices) was provided by the USDA Ginning Laboratory in Stoneville. The two experiments were repeated yearly from 1994 to 1996 with tillage treatments assigned to the same plots each year. Data were subjected to analysis of variance and means were separated by Fisher Protected Least Significant Difference procedure at the 5% level of significance.

Results and Discussion

Data are presented in Table 1 for the Bosket very fine sandy loam soil type for 1994, 1995, 1996, and the 3-year average. A significant interaction occurred in 1995 between subsoiling x tillage system x chisel thus main effects are not given in the table. No other treatment interactions occurred for Bosket very fine sandy loam soil during the 3-year study. The conventional parabolic ran in the fall at a 45° angle to row direction had a strong positive influence on lint yield. The low-till parabolic subsoiler ran in-row in the spring after the 45° angle fall subsoiler treatment tended to provide additional lint yield 2 out of 3 years and the 3-year average. In the 3-year average, two treatments significantly increased lint yield over no deep tillage (917 lb/A). They were: (1) the 45° fall subsoiling plus the Paratill in-row, fall with the alternate middle chisel (1020 lb/A), and (2) the 45° fall subsoiling combined with the low-till parabolic subsoiler in-row, spring (1,044 lb/A). This treatment never was lower than third of the 20 treatments and ranked first in 1995, 1996, and the 3-year average. The best single in-row subsoiler treatment was the Paratill in the fall (1000 lb/A), some 44 lb lint/A lower in yield over the 3-year average.

Data from the Forestdale silty clay loam soil are given in Table 2. No significant interactions between treatments occurred on Forestdale silty clay loam soil during the study. The conventional parabolic subsoiler ran in the fall at a 45° angle to row direction significantly increased overall lint yields in 1995, 1996, and the 3-year average. When averaged over years, all in-row tillage systems increased lint yields significantly on the Forestdale silty clay loam soil. Sixteen of the 20 tillage treatments significantly increased lint yield in the 3-year study over the no deep tillage check treatment. Again the conventional parabolic subsoiler ran in the fall at a 45° angle to row direction combined with the low-till parabolic subsoiler ran in the spring in-row never ranked lower than fourth among the 20 treatments and was the leading treatment in 1996 and the 3-year average (874 lb lint/A). The best single in-row subsoiler treatment was the low-till fall (810 lb/A) some 64 lb lint/A lower in yield over the 3-year average.

Data from the two soil types are combined in Table 3. Several interactions occurred with combined data from the two soil types. When interactions occurred, main effects are not listed in this table. With combined soil types, the conventional parabolic subsoiler ran in the fall at a 45° angle combined with the low-till parabolic subsoiler ran in the spring in-row was ranked no lower than second of the 20 treatments in any year and was ranked first in 1996 and the 3-year average was 959 lb lint/A. Compared with this treatment, the best single in-row subsoiler treatment was the Paratill fall (900 lb lint/A), some 59 lb lint/A lower in yield for the 2 soil types in the 3-year average.

Summary

The conventional parabolic subsoiler ran in the fall at a 45° angle to the row combined with the low-till parabolic ran in the spring in-row was the most consistent treatment of the 20 treatments studied on both soil types during the 3-year study. This combination deep tillage treatment averaged 44 and 64 lb lint/A higher yields than the best single in-row subsoiling treatment for Bosket very fine sandy loam (Paratill in the fall) and Forestdale silty clay loam (low-till in the fall) soils, respectively. The low-till parabolic subsoiler did not produce significantly higher lint yields than the Paratill, however, a trend for slightly higher yields was noted. Data from earlier work by Tupper (1995) showed that the low-till subsoiler was easier to pull than the Paratill under the same soil conditions. Producers who farm non-irrigated on soils that respond to subsoiling may want to try this combination tillage system on their farm. Some producers are using the low-till parabolic subsoiler in the fall at a 45° angle to the row direction, although this treatment was not included in the study.

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Table 1. Effect of deep tillage with conventional parabolic, Paratill, and low-till parabolic subsoilers with or without alternate middle chisel, Bosket very fine sandy loam soil, Stoneville, MS, 1994, 1995, 1996, and 3-year average.

Subsoil	In-row		Alter.				
45°	Sub-		middle	Lint yield			
to row	soiler	Time	chisel	1994	1995	1996	avg
				----------(lb/A)----------			
No	No	No	No	1029[1]	799[2]	923[3]	917[4]
No	No	No	Yes	960	739	852	850
No	Para	Fall	No	1120	908	972	1000
No	Para	Fall	Yes	1038	773	941	917
No	Para	Spr.	No	1058	826	975	953
No	Para	Spr.	Yes	1103	844	954	967
No	Low	Fall	No	1098	799	948	948
No	Low	Fall	Yes	1153	880	968	1000
No	Low	Spr.	No	1041	823	910	924
No	Low	Spr.	Yes	1018	772	906	899
Yes	No	No	No	1117	875	1021	1004
Yes	No	No	Yes	1143	859	1021	1008
Yes	Para	Fall	No	1100	823	921	948
Yes	Para	Fall	Yes	1156	888	1017	1020
Yes	Para	Spr.	No	1113	886	1018	1006
Yes	Para	Spr.	Yes	1110	830	980	973
Yes	Low	Fall	No	1132	881	995	1002
Yes	Low	Fall	Yes	1124	824	931	960
Yes	Low	Spr.	No	1141	919	1072	1044
Yes	Low	Spr.	Yes	1130	909	1003	1014
				Treatment Means			
No	--	--	--	1062[5]		935[6]	938[7]
Yes	--	--	--	1127		998	998
--	No	No	--	1062[8]		954[9]	945[10]
--	Para	Fall	--	1103		963	971
--	Para	Spr.	--	1096		982	975
--	Low	Fall	--	1127		960	978
--	Low	Spr.	--	1083		972	970
--	--	--	No	1095[11]		975[12]	975[13]
--	--	--	Yes	1093		957	961

[1] LSD 5% = 127.8 for comparing 1994 lint yield means.
[2] LSD 5% = 101.8 for comparing 1995 lint yield means.
[3] LSD 5% = 114.7 for comparing 1996 lint yield means.
[4] LSD 5% = 100.4 for comparing 3-year average lint yield means.
[5] LSD 5% = 40.4 for comparing conventional parabolic subsoiler in fall at 45°angle to row, 1994 lint yield means.
[6] LSD 5% = 36.2 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 1996 lint yield means.
[7] LSD 5% = 31.7 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 3-year average lint yield means.
[8] LSD 5% = 63.8 for comparing in-row tillage systems 1994 lint yield means.
[9] LSD 5% = 57.3 for comparing in-row tillage systems, 1996 lint yield means.
[10] LSD 5% = 50.1 for comparing in-row tillage systems, 3-year average lint yield means.
[11] LSD 5% = 40.4 for comparing alternate middle chisel, 1994 lint yield means.
[12] LSD 5% = 36.2 for comparing alternate middle chisel, 1996 lint yield means.
[13] LSD 5% = 31.7 for comparing alternate middle chisle, 3-year average lint yield means.
Abbreviations: Alter. = alternate, Par = Paratill, Low = low-till, Spr. = spring.

Table 2. Effect of deep tillage with conventional parabolic, Paratill, and low-till parabolic subsoilers with or without alternate middle chisel, Forestdale silty clay loam soil, Tribbett, MS, 1994, 1995, 1996, and 3-year average.

Subsoil 45° to row	In-row Sub-soiler	In-row Time	Alter. middle chisel	Lint yield 1994	1995	1996	avg
				----------(lb/A)----------			
No	No	No	No	837[1]	735[2]	481[3]	684[4]
No	No	No	Yes	910	743	579	744
No	Para	Fall	No	881	869	651	800
No	Para	Fall	Yes	824	791	759	791
No	Para	Spr.	No	883	787	657	775
No	Para	Spr.	Yes	859	768	643	756
No	Low	Fall	No	868	850	713	810
No	Low	Fall	Yes	823	864	769	819
No	Low	Spr.	No	920	799	620	780
No	Low	Spr.	Yes	878	796	594	756
Yes	No	No	No	835	810	767	804
Yes	No	No	Yes	842	785	704	777
Yes	Para	Fall	No	893	855	746	831
Yes	Para	Fall	Yes	849	871	755	825
Yes	Para	Spr.	No	897	868	706	823
Yes	Para	Spr.	Yes	941	870	722	844
Yes	Low	Fall	No	849	841	804	831
Yes	Low	Fall	Yes	931	861	802	865
Yes	Low	Spr.	No	930	874	818	874
Yes	Low	Spr.	Yes	959	890	719	856
			Treatment Means				
No	--	--	--	868[5]	800[6]	647[7]	772[8]
Yes	--	--	--	892	852	754	833
--	No	No	--	856[8]	768[10]	633[11]	752[12]
--	Para	Fall	--	862	847	728	812
--	Para	Spr.	--	895	823	682	800
--	Low	Fall	--	868	854	772	831
--	Low	Spr.	--	921	840	688	816
--	--	--	No	879[13]	829[14]	696[15]	801[16]
--	--	--	Yes	881	824	705	803

[1] LSD 5% = 88.4 for comparing 1994 lint yield means.
[2] LSD 5% = 84.0 for comparing 1995 lint yield means.
[3] LSD 5% = 138.7 for comparing 1996 lint yield means.
[4] LSD 5% = 76.7 for comparing 3-year average lint yield means.
[5] LSD 5% = 27.9 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 1994 lint yield means.
[6] LSD 5% = 26.6 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 1995 lint yield means.
[7] LSD 5% = 43.8 for comparing conventional parabolic subsoiler in fall at 45°angle to row, 1996 lint yield means.
[8] LSD 5% = 24.2 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 3-year average lint yield means.
[9] LSD 5% = 44.1 for comparing in-row tillage systems 1994 lint yield means.
[10] LSD 5% = 42.0 for comparing in-row tillage systems, 1995 lint yield means.
[11] LSD 5% = 69.2 for comparing in-row tillage systems, 1996 lint yield means.
[12] LSD 5% = 38.3 for comparing in-row tillage systems, 3-year average lint yield means.
[13] LSD 5% = 27.9 for comparing alternate middle chisel, 1994 lint yield means.
[14] LSD 5% = 26.6 for comparing alternate middle chisel, 1995 lint yield means.
[15] LSD 5% = 43.8 for comparing alternate middle chisel, 1996 lint yield means.
[16] LSD 5% = 24.2 for comparing alternate middle chisle, 3-year average lint yield means.
Abbreviations: Alter. = alternate, Par = Paratill, Low = low-till, Spr. = spring

Table 3. Effect of deep tillage with conventional parabolic, Paratill, and low-till parabolic subsoilers with or without alternate middle chisel, average two soil types, 1994, 1995, 1996, and 3-year average.

Subsoil 45° to row	In-row Sub-soiler	In-row Time	Alter. middle chisel	Lint yield 1994	1995	1996	avg
				----------(lb/A)----------			
No	No	No	No	933[1]	767[2]	702[3]	801[4]
No	No	No	Yes	935	741	716	797
No	Para	Fall	No	1000	888	812	900
No	Para	Fall	Yes	931	782	850	854
No	Para	Spr.	No	970	806	816	864
No	Para	Spr.	Yes	981	806	798	862
No	Low	Fall	No	983	824	830	879
No	Low	Fall	Yes	988	872	869	909
No	Low	Spr.	No	980	811	765	852
No	Low	Spr.	Yes	948	784	750	827
Yes	No	No	No	976	842	894	904
Yes	No	No	Yes	992	822	863	892
Yes	Para	Fall	No	996	839	834	890
Yes	Para	Fall	Yes	1002	879	886	922
Yes	Para	Spr.	No	1005	877	862	914
Yes	Para	Spr.	Yes	1025	850	851	909
Yes	Low	Fall	No	991	861	899	917
Yes	Low	Fall	Yes	1028	842	867	912
Yes	Low	Spr.	No	1036	897	945	959
Yes	Low	Spr.	Yes	1045	899	861	935
			Treatment Means				
No	--	--	--	965[5]			
Yes	--	--	--	1009			
--	No	No	--	959[6]			
--	Para	Fall	--	982			
--	Para	Spr.	--	995			
--	Low	Fall	--	997			
--	Low	Spr.	--	1002			
--	--	--	No	987[7]		836[8]	888[9]
--	--	--	Yes	987		831	882
Bosket very fine sandy loam				1094[10]	843[11]	966[12]	968[13]
Forestdale silty clay loam				880	826	700	802

[1] LSD 5% = 86.6 for comparing 1994 lint yield means.
[2] LSD 5% = 68.9 for comparing 1995 lint yield means.
[3] LSD 5% = 93.5 for comparing 1996 lint yield means.
[4] LSD 5% = 65.0 for comparing 3-year average lint yield means.
[5] LSD 5% = 27.4 for comparing conventional parabolic subsoiler in fall at 45° angle to row, 1994 lint yield means.
[6] LSD 5% = 43.3 for comparing in-row tillage systems, 1994 lint yield means.
[7] LSD 5% = 27.4 for comparing alternate middle chisel, 1994 lint yield means.
[8] LSD 5% = 29.6 for comparing alternate middle chisel, 1996 lint yield means.
[9] LSD 5% = 20.6 for comparing alternate middle chisel, 3-year average lint yield means.
[10] LSD 5% = 27.4 for comparing soil type, 1994 lint yield means.
[11] LSD 5% = 21.8 for comparing soil type, 1995 lint yield means.
[12] LSD 5% = 29.6 for comparing soil type, 1996 lint yield means.
[13] LSD 5% = 20.6 for comparing soil type, 3-year average lint yield means.
Abbreviations: Alter. = alternate, Par = Paratill, Low = low-till, Spr. = spring