COMPARISON OF TILLAGE PRACTICES FOR COTTON PRODUCTION ON ALLUVIAL SOILS IN NORTHEASTERN LOUISIANA

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INTRODUCTION

Advances in equipment and herbicide technology have contributed greatly to the increase in producer acceptance of reduced tillage practices in northeastern Louisiana. Reduced soil erosion (Hutchinson et al., 1991), increased soil organic matter (Boquet and Coco, 1993) and reduced soil moisture evaporation (Wilhelm et al., 1986) are just some of the documented benefits from no-tillage. Reduced tillage, in many instances, has also led to lower equipment and fuel costs and savings in time and labor (Laws, 1993). In addition, cover crops have been found to be an important component of conservation tillage systems (Hutchinson et al., 1991; Ebelhar et al., 1984).

Although erosion is not a serious problem on many of the clay soils in the Mississippi River Delta, cotton (*Gossypium hirsutum* L.) production has still benefitted from reduced tillage practices primarily by allowing producers to plant in a more timely fashion (Boquet and Coco, 1993). Spring tillage on clay soils often results in a cloddy, dry seedbed in which it is difficult to obtain a uniform plant stand.

On clay soils, deep tillage to relieve compaction has traditionally been considered unnecessary due to the natural shrinking and swelling that these soils undergo as the moisture content cycles from wet to dry. It has been speculated (Smith and Whitten, 1992) that while clays do not develop compaction pans typical of lighter-textured soils, they may develop compacted blocks of soil beneath the plow layer. The effect of this soil condition is to confine plant roots to the soil volume near the block surfaces. The density of the blocks prevents or severely restricts root growth into the clay block, and roots that do grow from one block surface to another are often broken when the blocks dry and shrink. Results from previous tillage studies failed to demonstrate crop response to deep tillage on clay soil (Raney et al., 1954; Saveson et al., 1958; Tupper, 1978; Heatherly, 1981). However in these studies, the tillage operations were performed in the spring when the subsoil was most likely wet from winter rainfall. Recently, Smith (1995) indicated that deep tillage in the fall, when the soil profile was dry, was beneficial for cotton growth and yield on a Tunica clay. There is a lack of information on the interaction between deep tillage in the fall and various conservation tillage practices on clay soils in Louisiana.

On the medium- and coarse-textured alluvial soils in northeastern Louisiana, compaction is a yield-limiting factor unless some form of deep tillage is performed (Crawford, 1979; Saveson et al., 1958). In northeastern Louisiana, these soils have typically been under a mono-crop production system that utilizes extensive surface tillage to control weeds, prepare seedbeds and incorporate herbicides. Although these soils are highly productive, the combination of extensive tillage and mono-crop culture have contributed to low organic matter levels (< 1.0%) in many fields. As the use of conservation tillage practices and winter cover crops has been shown to result in increases in soil organic matter levels (Hutchinson et al., 1991; Millhollon and Melville, 1991), some combination of these practices might lead to improved growth and yield of cotton on these soil types. Therefore, the objectives of this study were to: 1) determine the optimum combination of cover crop and tillage necessary to maximize cotton production while maintaining or increasing soil productivity and 2) examine the effect of deep tillage in conjunction with cover crops and reduced tillage practices on cotton production.

METHODS

A field study was initiated in the fall of 1996 on a Commerce silt loam (fine-silty, mixed, nonacid, thermic Aeric Fluvaquent) and on a Sharkey clay (very-fine, montmorillonitic, nonacid, thermic, Vertic Haplaquepts) at the Northeast Research Station near St. Joseph, Louisiana. A total of 16 treatments were established with combinations of tillage systems {no-till (NT), conventional till (CT), reduced-till (RT)), winter cover crops [winter wheat (*Triticum aestivum* L.), hairy vetch (*Vicia villosa* L.), and native vegetation], in-season cultivation, and fall sub-soiling} summarized in Table 1. Treatments were only slightly different on the two soil types with CT on the silt loam including disking in the fall and spring prior to seedbed preparation, while on the clay CT involved only hipping in the fall and spring. The RT treatments on the silt loam were hipped in the fall and spring, while on the clay the RT treatment involved hipping and rolling in the fall and no additional tillage in the spring. Experiment design for both tests was a randomized complete block with four

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replications. Plot size was four rows (40-in. row spacing) by 65 ft.

Deep tillage operations on the appropriate plots were conducted with a Paratill following cover crop planting in October 1996. Cotton cultivar 'Suregrow 501' was planted 5 May 1997 using ripple coulters mounted on the planter. Management of the cover crops prior to planting (4 weeks before planting) in the no-till plots consisted of 1) an application of glyphosate (1.0 lb ai/acre) followed by paraquat (0.75 lb ai/acre) on the wheat plots; 2) an application of paraquat (1.0 lb ai/acre) and cyanazine (0.75 lb ai/acre) followed by paraquat (0.75 lb ai/acre) on the vetch plots; 3) an application of paraquat (0.75 lb ai/acre) and cyanazine (0.75 lb ai/acre) on the native plots. Preemergence weed control in all plots consisted of a broadcast application of pendimethalin (1.0 lb ai/acre) plus fluometuron (1.2 lb ai/acre). All appropriate NT, CT and RT treatments were cultivated twice. Additional herbicide applications included broadcast application of pyrithiobac (0.079 lb ai/acre), post-directed application (banded) of prometryn plus MSMA (0.31 and 1.0 lb ai/acre) and a layby application (broadcast) of cyanazine and MSMA (1.1 and 1.65 lb ai/acre).

Based on past work with these cover crops, nitrogen fertilization of the cotton was adjusted to 60 lb N/acre following vetch, 120 lb N/acre following wheat with the other plots receiving 90 lb N/acre. The middle two rows were harvested from each plot 17 October with a spindle picker. On 22 October 1997, following cotton stalk destruction, the wheat and vetch cover crops were planted in the respective plots. The next day, treatments were split for deep tillage using a Paratill, and the appropriate treatments were disked or hipped.

All data were analyzed using the ANOVA or GLM procedures of SAS (SAS Institute, 1989). In order to assess individual treatment factor effects, contrast statements were used following the GLM procedure.

RESULTS

Two days after planting, soil temperature was lower (3 to 5 F) in the furrow (2-in. depth) in the vetch plots compared to the conventional or reduced tillage treatments on both soil types (data not shown). Although the wheat plots were numerically lower than the conventional plots, the differences were not significant. The differences in soil temperature could help to explain some of the observed differences in early growth.

Commerce Silt Loam

Nodes above white flower (NAWF) was affected by some of the treatment factors. With regard to NAWF values recorded on 30 July, the no-till plots had a higher value than conventional or reduced tillage treatments (5.2 vs 4.6 or 4.7), indicating a slight delay in maturity. On the same date there were no differences in NAWF between no-till plots with respect to cultivation (5.2 vs 5.2). Within the no-till plots at this date, cotton in vetch treatments was later maturing than cotton in the plots with a wheat cover crop or native cover (5.4 vs 5.1 or 5.1). This could be partially explained by the lower early soil temperatures, which could have reduced early plant vigor. There was also a difference in NAWF at this date between the plots that were sub-soiled and the plots that were not (5.2 vs 4.9).

Cotton yield was also affected by some treatment factors; contrast statements were again used in order to examine the influence of individual treatment variables. There was no difference in yield between the no-till treatments and the conventional or the reduced till treatments. There was also no difference in yield between the no-till plots that were cultivated and those that were not. With respect to the cover crops, there was no difference between the wheat and the native treatments. However, both the wheat and the native were higher than the vetch treatments (2641 and 2651 vs 2470 lb seedcotton/acre). This could be related to the soil temperature differences seen following planting, which might result in poor early-season plant vigor in the vetch plots. Within the conventional and the reduced till plots, there was no yield difference between the plots that were sub-soiled and those that were not. This is in contrast to the data from 1996, where sub-soiled plots yielded more than non sub-soiled plots. This may indicate that sub-soiling is not necessary every year on this soil type. Within the no-till treatments, sub-soiling actually resulted in a significant decrease in seedcotton yield of 192 lb/acre. As the mechanical action of the sub-soiling results in a reduced and uneven planting bed, some of the decrease in yield may be due to stand establishment. Although there were no statistical differences in stand density, the decrease in yield could be related to stand uniformity, which was much more variable in the no-till plots than were sub-soiled. Overall, the no-till treatment that was not cultivated or sub-soiled and had only native winter cover was numerically the highest yielding treatment in the test at 2880 lb seedcotton/acre (Table 1).

Sharkey Clay

There were no treatment differences in NAWF on this soil type. The lack of a difference in NAWF is most likely related to the lack of plant available water in late July and August (circa 1 in. rainfall). With respect to seedcotton yield, the conventional and the reduced-till treatments resulted in higher yields than the no-till treatments (1935 lb/acre vs 1703 lb/acre). The reduced till plots also resulted in more seedcotton than in the conventional till by 287 lb/acre (Table 2). This confirms previous research and is very similar to what many farmers are already doing on this soil type (stale-seedbed).

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Table 1. Treatments used to investigate the effect of conservation tillage practices and winter cover crops on cotton growth and yield on Sharkey clay and Commerce silt loam at the Northeast Research Station near St. Joseph, Louisiana.

	Seedbed Preparation			Cultivation		Sub-soiled		Winter Cover Crop		
Treatment #	no-Till	Fall Bedded	Spring Bedded	Yes	No	Yes	No	Wheat	Hairy Vetch	Native Species
1	**x**			**x**		**x**		**x**		
2	x			x			x	x		
3	x				x	x		x		
4	x				x		x	x		
5	x			x		x			x	
6	x			x			x		x	
7	x				x	x			x	
8	x				x		x		x	
9	x			x		x				x
10	x			x			x			x
11	x				x	x				x
12	x				x		x			x
13		x		x		x				
14		x		x			x			
15			x	x		x				
16			x	x			x			

Table 2. Yield of cotton plants grown in various cover crop and tillage systems on a Commerce silt loam at the Northeast Research Station near St. Joseph, Louisiana, 1997.

Tillage	Cover Crop	Cultivation	Sub-Soil	Seedcotton
				lb/acre
Conventional	None	Yes	Yes	2727
Fall bedded	None	Yes	Yes	2636
No-Till	None	Yes	Yes	2570
No-Till	None	No	Yes	2575
No-Till	Wheat	No	Yes	2560
No-Till	Wheat	Yes	Yes	2520
No-Till	Vetch	No	Yes	2381
No-Till	Vetch	Yes	Yes	2354
Conventional	None	Yes	No	2674
Fall bedded	None	Yes	No	2623
No-Till	None	Yes	No	2580
No-Till	None	No	No	2880
No-Till	Wheat	No	No	2850
No-Till	Wheat	Yes	No	2638
No-Till	Vetch	No	No	2482
No-Till	Vetch	Yes	No	2673
LSD (0.05)				362

Table 3. Yield of cotton plants grown in various conservation tillage systems on a Sharkey clay at the Northeast Research Station near St. Joseph, Louisiana, 1997.

Tillage	Cover Crop	Cultivation	Sub-Soiled	Seedcotton
				lb/acre
Fall bedded	None	Yes	Yes	2097
No-Till	None	No	Yes	1759
No-Till	None	Yes	Yes	1796
Conventional	None	Yes	Yes	1882
No-Till	Vetch	No	Yes	1826
No-Till	Wheat	Yes	Yes	1680
No-Till	Vetch	Yes	Yes	1804
No-Till	Wheat	No	Yes	1698
Fall bedded	None	Yes	No	2053
No-Till	None	No	No	1413
No-Till	None	Yes	No	1615
Conventional	None	Yes	No	1695
No-Till	Vetch	No	No	1836
No-Till	Wheat	Yes	No	1539
No-Till	Vetch	Yes	No	1751
No-Till	Wheat	No	No	1703
LSD (0.05)				413

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