NO-TILL CO'ITON GROWTH CHARACTERISTICS AND YIELD IN *ALABAMA*

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ABSTRACT

Two field experiments in northern Alabama were used to compare cotton (Gossypium hirsutum L.) growth and yields in two no-tillage systems with conventionally tilled cotton. The two no-tillage systems evaluated were: 1) planting into old cotton residue and 2) planting into a wheat (Triticum spp.) cover crop. All cotton was planted flat with a burn-down herbicide applied to kill any vegetation at least 2 weeks prior to planting. The soil type in each test was a Decatur silt loam, which is one of the predominate cotton soil types in northern Alabama.

Cotton yields from all tillage systems were evaluated at one test site from 1988 through 1992. Another test site, established in 1991, was used to evaluate the effect of starter fertilizer rates and placement on cotton growth and yield, as well as differences in soil strength and soil water due to tillage systems.

Cotton yields measured from 1988 through 1992 in cotton no-tilled into old cotton residue or no-tilled into wheat were 90 and 95%, respectively, of the yields from conventionally tilled cotton. Most of these yield differences occurred during the dry seasons of 1988, 1990, and 1991. Little yield differences were found when rainfall was more adequate in 1989 and 1992.

The starter fertilizer test conducted in 1991 and 1992 also indicated increased yields with starter fertilizers in the no-till systems in the dry 1991 season, but not when rainfall was abundant in 1992. Little response to starter fertilizer was measured in conventionally tilled cotton either year. Cotton height measurements made in the starter fertilizer test area found cotton grown no-till into cotton residue produced a much more compact plant than any of the other tillage systems in 1991 and 1992. Soil penetrometer readings taken in 1992 may explain part of these differences; soil strength was greater in cotton residue plots than soil in plots conventionally tilled or no-tilled into wheat. Restricted root growth or decreased water infiltration could possibly be the reason for decreased no-till cotton yields in cotton residue during dry seasons.

Planting a wheat cover crop on these soils seems beneficial to cotton grown with no-tillage. Preliminary research indicates this may be due to better cotton rooting or perhaps better water infiltration than when cotton is no-tilled into cotton residue.

INTRODUCTION

Alabama's most intense cotton production area is located on silty clay Limestone Valley soils located in the northern part of the state. Many of these soils are considered highly erodible and, therefore, must have approved soil conservation plans to meet requirements of the 1985 Farm Bill. Research into conservation tillage systems for cotton grown on these soils has been conducted since the early 1980s. However, only in recent years have many acres of conservation tillage cotton been grown in this region.

Two conservation tillage cover systems used by most north Alabama cotton farmers are: 1) planting no-till into old cotton residue and 2) planting no-till into a wheat cover killed at least 2 weeks prior to planting. Essentially, all cotton is planted flat with very little cotton planted on raised beds.

Planting into old cotton residue is preferred by most farmers because of the ease of stand establishment and time and costs involved in planting wheat in the fall. Research by Brown et al. (1985), however, indicated possible weed control and cotton growth problems when cotton was planted into old cotton residue. Reduced cotton stalk height has often been measured when cotton is planted into old cotton residue compared with cotton planted into a small grain cover or conventionally tilled soils (Burmester, unpublished data). The reasons for these reductions have not been explained.

Increased cotton yield responses to starter fertilizer have been reported by Touchton et al. (1986) in conservation tillage cotton systems in Alabama. Higher nitrogen fertilizer rates are usually needed by cotton planted into a small grain cover compared with cotton planted conventionally or into old cotton stubble, (Brown et al., 1986).

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To help explain differences in cotton response to no-tillage systems, a cotton crop rotation test was modified in 1987 to include the two most common no-tillage systems used in this area. Yields from cotton planted no-till into wheat cover and into old cotton residue were compared with conventionally tilled cotton from 1988 to 1992. The use of starter fertilizers in conservation-tillage cotton was also evaluated in another test area in 1991 and 1992. Soil penetrometer and soil moisture readings were also taken in this test area during 1992.

MATERIALS AND METHODS

Replicated field studies located on the Alabama Agricultural Experiment Station, Belle Mina, AL, were used to evaluate cotton conservation-tillage systems for the area of northern Alabama. Conservation-tillage treatments in tests included cotton planted no-till into a wheat cover or into old cotton residue. All no-till plot areas received a 1 quart burndown application of Roundup herbicide to kill all vegetation at least 2 weeks prior to planting. Conventionally tilled areas were turned in the fall with leveling and smoothing in the spring. Wheat areas were lightly disked in the fall before wheat was planted with a grain drill. Nitrogen as ammonium nitrate was applied at rates of 60 and 30 lb/A at planting and at mid-squaring, respectively, to all plots. The soil type was a Decatur silt loam (Rhodic Paleudult) and is the predominate soil type on which cotton is grown in northern Alabama.

In 1987, a cotton crop rotation experiment established in 1979 was modified to include plots of continuous no-till cotton planted into either a wheat winter cover or an old cotton residue. All plots were eight rows, 50 ft long. Cotton yields were obtained from 1988 to 1992 by mechanically picking the middle four rows from each plot.

In 1991 and 1992, placement of starter fertilizers was evaluated in another test area. Liquid fertilizers, 11-0-0 and 11-37-0, were applied to supply N and P_2O_5 rates of 0-0, 15-0, and 15-50 Ib/A. These starter fertilizers were placed in a 4-inch band over the seed furrow or placed 2x2 at planting in all tillage treatments. The experimental design was a split plot with three replications. Tillage was in whole plots and starter fertilizer treatments were in split plots. The cotton variety DPL 50 was used both years. Cotton stand counts were taken approximately 4 weeks after cotton planting each season. Cotton height measurements were taken approximately 5 and 10 weeks after planting each year. Cotton yields were determined by mechanically picking the two center rows from each plot.

In 1992, soil compaction and soil moisture content were measured in the no-starter check plots in each tillage treatment. Fifteen soil penetrometer readings were made in nontrafticked middles 2 weeks after cotton emergence and in mid-August. Measurements were made using a hand-held Bush recording soil penetrometer (Mark I Model 1979; Findlay, Irvine Ltd., Penicuik, Scotland). Soil volumetric moisture content was measured at three depths (8, 16, and 24 inches). Parallel-paired, stainless steel rods, 0.25 inches in diameter, were installed in-row, 20 inches from the row in a traffic middle and 20 inches from the row in a nontrafficked middle. A Tektronix 1502B cable tester was used to measure soil water using the time-domain reflectometry (TDR) method as developed by Topp and Davis, (1985). Four measurements were made during the boll development period in 1992.

RESULTS AND DISCUSSION

Rainfall and degree day (DD) **60** accumulation differed greatly during the north Alabama growing seasons of 1988 through 1992 (Table 1). Three of the years (1988, 1990, and 1991) are eonsidered drought years with at least one of the summer months being extremely dry. The DD60 accumulations during the summer months were generally consistent except for 1992 when only 81% of average (previous 4 years) DD60s were accumulated.

Seed-cotton yields, measured in the cotton rotation plot area, followed the rainfall pattern closely, with extremely low yields during the 1988, 1990, and 1991 seasons. Cotton yield differences between tillage systems were greatest during these dry seasons (Table 2). Seed-cotton yields of cotton planted no-till into old cotton residue were consistently lower than cotton no-tilled into wheat or conventionally tilled in all three drought years. Cotton yields planted into wheat residue were equivalent to conventionally tilled cotton yields in 1988 and 1990 but lower than conventional cotton yields in 1991 and 1992. Little cotton yield differences were found between tillage treatments during the wetter 1989 season.

Cotton stand counts made in the starter fertilizer test revealed that starter fertilizer source or placement had no effect on final stand (Table 3). Tillage treatments had no effect on final cotton stand in 1991, but in 1992, conventionally tilled cotton plots had slightly higher plant populations than either no-till

Table 1. Rainfall and DD60 accumulation (June-August) for 1888 to 1992 growing seasons.

Year	Rainfall (in.) June	July	Aug.	Total	DD60 June	July	Aug.	Total
1988	0.29	3.89	1.56	5.74	525	609	655	1789
1989	12.64	5.52	1.61	19.77	434	568	536	1538
1990	3.54	3.66	1.22	8.42	520	587	626	1733
1991	1.57	1.98	3.69	7.24	527	607	597	1731
1992	8.34	5.64	3.80	17.78	389	569	421	1379

Table 2. Seed-cotton yields in conservation tillage systems and conventional planted cotton at the Tennessee Valley Substation, 1988-1992

Tillage System	Seed Cotton Yields (1b/Al 1988	1989	1990	1991	1992	Avg.
Conventional	1400	2780	1700	1110	3160	2030
No-Till Cotton Stubble	1140	2440	1510	920	3150	1830
No-Till Wheat	1380	2490	1840	960	2990	1930
LSD (0.10)	140	430	140	30	160	

Table 3. Effect of tillage systems and starter fertilizers on cotton stand in 1991 and 1992.

Fertilizer N P_2O_5	Placement	Conventional 91	92	Stubble 91	92	Wheat 91	92
lb/A		plants/ 6 ft					
0-0		23	33	23	29	27	29
15-0	Band	28	32	30	27	19	22
15-0	2x2	24	30	23	26	23	26
15-50	Band	22	33	19	31	24	25
15-50	2x2	23	33	24	25	21	27
LSD (0.05)		NS	NS	NS	NS	NS	7

system (Table 3). These differences in 1992 were due to wetter soil conditions in the no-till areas at planting, which caused greater soil crusting than found on the drier conventionally planted cotton.

Starter fertilizer had no consistent effect on early-season cotton heights (Table 4). However, a consistent cotton height difference caused by starter fertilizers was measured in cotton no-tilled into wheat cover each year at early bloom (Table 4). In both years, the starter fertilizer 15-50 placed 2x2 or banded and the starter fertilizer 15-0 placed 2x2 increased cotton heights compared with no-starter treatment. Also, at early bloom, cotton no-tilled into cotton residue was consistently shorter than cotton planted into conventional tillage or cotton planted no-till into wheat (Table 4). In 1992, early-season height of cotton planted into wheat was about 1 inch taller than conventional or no-till cotton planted into stubble, regardless of any starter fertilizer.

Early-season soil penetrometer readings (Fig. 1) revealed higher resistance to penetration from 0 to 12 inches in the no-till cotton stubble and wheat cover areas than in the soil areas conventionally tilled. However, below 12 inches, the soil in the wheat cover consistently showed less resistance to penetration (2 to 6 bars) than soil conventionally tilled or no-tilled with cotton residue.

Soil penetrometer readings in August were much higher due to the drier soil conditions, and measurements could only be taken to a depth of 12 inches. The no-till with cotton residue plots again had much higher resistance to penetration at all depths compared with the no-till wheat soil areas or conventionally tilled cotton areas. No-tillage into wheat had greater soil resistance to penetration from 0 to 8 inches than soil conventionally tilled. However, at 10 to 12 inch depths, soil in the no-till wheat areas averaged 11 and 16 bars less resistance compared with the conventional tillage.

Volumetric soil moisture readings in 1992 were high most of the growing season due to abundant summer rainfall. The average of four summer measurements indicated a trend toward lower moisture at the 8-inch depth in the conventional tillage row middles compared with the no-tillage systems (Table 5). This was due either to greater cotton root concentration or, more probably, to moisture loss from cultivations. At the 16-inch depth in the nontrafficked middles, conventionally tilled soil again had lower soil moisture than either no-till cover system (Table 5). This was apparently due to greater concentration of cotton roots in this region. At the 24-inch depth, soil moisture in the no-till wheat areas tended to be lower than either the no-till cotton residue area or conventionally tilled soil (Table 5). Greater cotton root density and water extraction at these soil depths agreed with soil penetrometer readings and indicated less compaction at lower depths in the no-till wheat areas.

Cotton lint yields in the starter fertilizer test area averaged about 1 bale in 1991 and 2 3 bales in 1992. Starter fertilizers in 1991 increased cotton yields in both no-tillage systems while starter fertilizers had no effect on conventionally tilled cotton (Table 6). In 1991, all starter fertilizers and placements increased cotton yields in the wheat cover system while only starter fertilizer placed 2x2 increased cotton yields in the cotton residue cover system compared with no-starter. In 1992, no consistent responses to tillage or starter fertilizers were found, although the 15-50 starter fertilizer banded increased cotton yields in the conventionally tilled areas.

Results of these two studies indicate growth differences between cotton planted no-till into wheat or cotton residue compared with conventionally tilled cotton planted in northern Alabama. Cotton grown no-till into cotton residue produced a much more compact cotton plant than in all other tillage systems. Cotton yields measured from 1988 to 1992 also indicated up to a 10% yield reduction when cotton was planted no-till into cotton residue compared with conventionally tilled cotton. Greatest yield reductions with no-tillage cotton planted into cotton residue seem to have occurred during dry seasons. Preliminary results indicate starter fertilizers to be beneficial in increasing no-tillage cotton yields, especially in dry years. Penetrometer readings in 1992 also indicated that soil in the no-tillage stubble area was more compact, possibly limiting root growth or water infiltration. However, with a wheat cover system, lower soil penetrometer readings and lower soil moisture measurements indicate better cotton root development at soil depths below 12 inches.

Table 4. Effects of tillage systems and starter fertilizers on cotton height in 1991 and 1992.

Starter Fertilizer			Heights (in.) 1991		Heights (in.) 1992	
N P_2O_5 lb/A	Place- ment	Tillage	June 4	July 2	June 1	July 16
0-0	-	Conv.	8.0	24.0	3.8	31.3
15-0	Band	Conv.	8.0	25.3	4.3	32.0
15-0	2x2	Conv.	8.0	26.0	3.9	32.3
15-50	Band	Conv.	8.0	27.0	4.1	31.3
15-50	2x2	Conv.	9.0	24.3	4.3	32.3
0-0	-	Stubble	7.7	21.3	4.2	30.0
15-0	Band	Stubble	8.0	21.0	4.2	28.3
15-0	2x2	Stubble	7.3	21.7	4.0	30.3
15-50	Band	Stubble	8.0	21.3	4.3	30.3
15-50	2x2	Stubble	8.0	22.0	4.3	31.0
0-0	-	Wheat	9.0	23.0	5.2	31.0
15-0	Band	Wheat	9.0	24.0	4.9	31.0
15-0	2x2	Wheat	8.0	26.0	5.2	34.3
15-50	Band	Wheat	8.0	27.0	5.3	33.0
15-50	2x2	Wheat	9.0	26.0	5.3	35.6
LSD (0.05)			0.8	2.2	0.3	3.1

Table 5. Effect of tillage systems on volumetric soil moisture at three depths and three positions from the cotton row.

Position	Depth (in)	Volumetric soil moisture (%) Conv.	Wheat	Stubble
In Row	8	22.4	22.5	21.5
Non-Traffic Middle	8	20.6	24.4	25.8
Traffic Middle	8	23.1	27.1	24.9
In Row	16	30.7	32.1	28.4
Non-Traffic Middle	16	26.8	30.1	29.0
Traffic Middle	16	32.1	29.6	29.8
In Row	24	32.4	30.6	34.7
Non-Traffic Middle	24	35.6	31.0	32.5
Traffic Middle	24	31.8	33.1	36.5

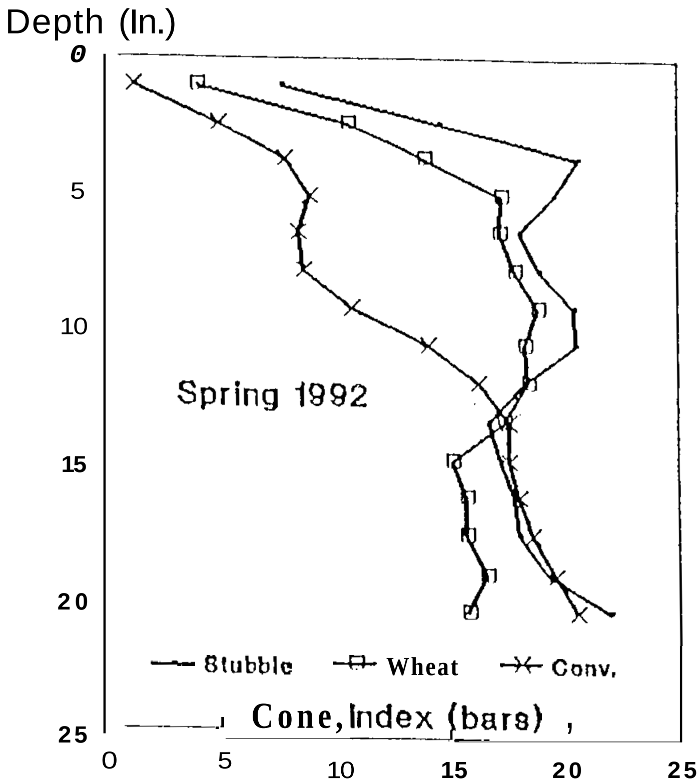

Figure 1. Penetrometer readings in spring 1992 for no-starter treatment in each tillage system.

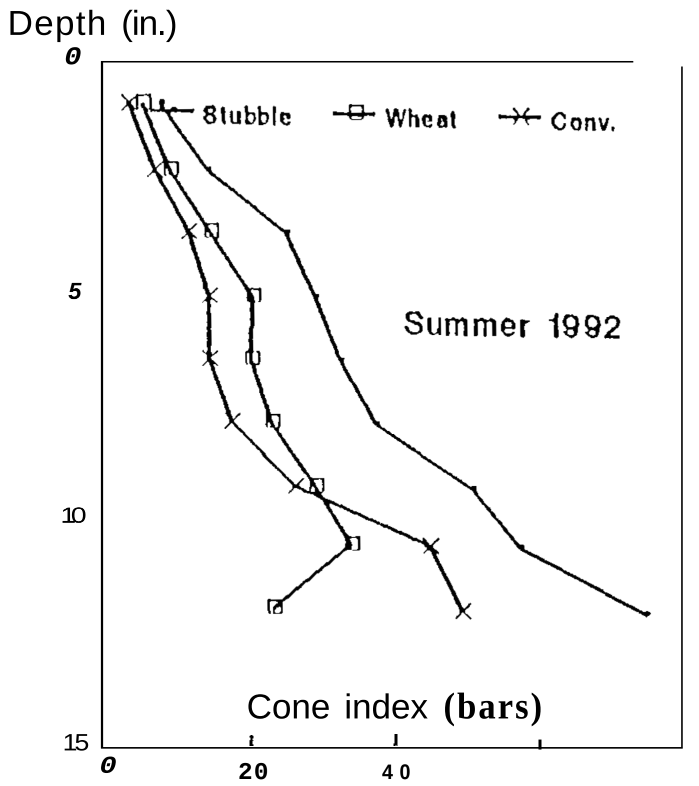

Figure 2. Penetrometer readings in summer 1992 for no-starter treatment in each tillage system.

Table 6. Effect of tillage systems and starter fertilizers on seed-cotton yields.

Starter fertilizer $N\ P_2O_5$	Placement	Tillage	Seed Cotton yield 1991	1992
			------lb/A-------	
0-0	-	Conv.	1436	3307
15-0	Band	Conv.	1550	3376
15-0	2x2	Conv.	1450	3550
15-50	Band	Conv.	1410	3717
15-50	2x2	Conv.	1583	3318
0-0	-	Stubble	1353	3129
15-0	Band	Stubble	1463	3314
15-0	2x2	Stubble	1647	3267
15-50	Band	Stubble	1526	3314
15-50	2x2	Stubble	1647	3387
0-0	-	Wheat	1450	3176
15-0	Band	Wheat	1670	2842
15-0	2x2	Wheat	1670	3187
15-50	Band	Wheat	1620	3398
15-50	2x2	Wheat	1773	3423
LSD (0.10)			165	375

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