

Table 6. Treatments ranked by lint yield and range over the four years for each variety. Stoneville, MS.

Place	Potassium Rate (lbK <sub>2</sub> O/A)	Cotton Variety			
		DES 119		DP 5415	
		Rank <sup>1/</sup>	Range <sup>2/</sup>	Rank	Range
Surface	80	6	1-9	6.5 <sup>4/</sup>	1-8
	120	7.5	1-9	8	3-10
	160	9	6-9	9	6-9
Deep	80	3	2-7	5	2-9
	120	2	1-6	1	1-5
	160	1	1-5	2	2-4.5
Split	80	7.5	4-8	3	2-4.5
	120	4	2-7	6.5	4-8
	160	5	3-8	4	1-7
Check	---	10	10-10	10	7-10

Place	Potassium Rate (lbK <sub>2</sub> O/A)	Cotton Variety				Average Rank <sup>3/</sup>
		LA 887		SG 501		
		Rank <sup>1/</sup>	Range <sup>2/</sup>	Rank	Range	
Surface	80	9	5-9	7	3-9	7
	120	8	3-8	9	4-9	8
	160	5.5	2-8	8	3-9	9
Deep	80	2.5	1-5	2.5	2-8	3
	120	1	1-6	1	1-2	1
	160	2.5	1-9	4	1-7	2
Split	80	7	3-9	5	2-8	5
	120	4	2-8	2.5	3-5	4
	160	5.5	4-9	6	3-7	6
Check	---	10	10-10	10	10-10	10

<sup>1/</sup>Mean rank over the four years.

<sup>2/</sup>Range or ranking during the four years.

<sup>3/</sup>Average rank over the four years for the four varieties.

<sup>4/</sup>Mean ranking used for a tie.



### DEVELOPING CONSERVATION TILLAGE SYSTEMS FOR COTTON IN THE TENNESSEE VALLEY: IN-ROW TILLAGE AND COVER CROP EFFECTS

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#### Abstract

Declining cotton (*Gossypium hirsutum* L.) yields have plagued farmers trying to eliminate tillage from their farms in the Tennessee Valley Region of North Alabama. Many farmers have tried to reduce tillage to meet conservation compliance programs, but have found inadequate rooting systems due to excessive soil compaction severely reduced yields. Experiments were initiated in this region in 1995 to develop conservation tillage systems that incorporated rye (*Secale cereale* L.) cover crops and in-row tillage as a method of maintaining surface cover and disrupting root-impeding layers. This research project also investigated energy requirements of shallow tillage (7") and deep tillage (13") performed in the fall and spring. Seed cotton yields similar to conventional cropping systems were found using the rye cover crop with no-tillage. Decreased yields were found when any form of spring tillage was used. Slightly improved yields occurred when shallow fall tillage was used with a winter

cover crop. This conservation tillage practice may offer the best alternative for farmers trying to reduce the negative effects of soil compaction, maintain adequate residue cover, and improve seed cotton yield.

#### Introduction

Cotton farmers in the Tennessee Valley Region of North Alabama have experienced problems maintaining yields when their highly erodible soils were placed in conservation tillage systems. Many of these soils have been conventionally farmed for more than 100 years. USDA-NRCS (Natural Resource Conservation Service) has mandated that these soils be managed using conservation tillage systems for the farmers to participate in farm programs. Traditional methods of moldboard plowing, chisel plowing, and disking do not leave adequate amounts of crop residue on the surface to meet compliance standards and protect soil from erosion. Because of low amounts of residue produced by cotton, minimum or no-tillage is often required to maintain adequate surface residue coverage.

Soil compaction problems also plague this region, with soil containing platy structure and exhibiting considerable strength at relatively shallow depths, particularly in no-till fields. Many cotton tap roots have bent at 90-degree angles at depths of less than 6 inches when cotton was directly planted back into the previous year's cotton stubble. Management systems are needed to either loosen the soil profile or increase soil moisture in order to reduce soil strength and increase rooting depth.

This research effort was targeted toward developing minimum tillage systems that would minimally disturb the soil while maintaining adequate surface residue coverage. The timing of the tillage was also investigated to determine whether tillage performed in the fall (when time is readily available) would benefit cotton as much as spring tillage performed immediately before planting. Cover crops were also used to generate additional surface residue and to retain soil moisture.

#### Materials and Methods

Fall tillage treatments were first applied in the fall of 1994 at the AAES Tennessee Valley Substation in Belle Mina, AL. The soil type in this region is predominantly a Decatur silt loam (clayey, kaolinitic, thermic Rhodic Paleudult). The field had been used for conventional cropped cotton for many years previous to this experiment. The plots are four 40-inch rows wide by 30 ft. long. The experimental design consists of a randomized complete block with 2x2x3 factorial treatments with an additional treatment of conventional tillage. The three factors are: 1) cover crop (none or rye), 2) tillage timing (fall or spring), and 3) tillage depth (none, shallow, or deep). The depth of tillage was established by taking multiple cone-index profiles of the field and determining the depth and thickness of the root-impeding layer. This layer was located at an approximate depth of 6 inches and extend downward for about 1 inch. Therefore, the shallow depth of tillage was chosen as 7 inches and the deep depth of tillage was set to be at 13 inches. An experimental Yetter™ implement with in-row subsoilers that could be adjusted to operate at both shallow and deep depths was used for all tillage treatments. Residue managers that consisted of fingered wheels and fluted coulters were used to move residue away from the shanks. Closing disks were also mounted on the rear of the shank to create a small bedded region approximately 12 inches wide and 4 inches high that could be planted into. The conventional tillage treatment consisted of fall disking and chiseling followed by disking and field cultivating in the spring prior to planting.

Soil strength and soil moisture measurements were taken both spring and fall immediately before and after tillage treatments were applied. Soil strength was determined by using a tractor-mounted multiple-cone penetrometer (ASAE, 1997) and then calculating the cone index. Five penetrometer probes were inserted 1) in the row, 2) midway between the row and the untrafficked row middle (10 inches from the row), 3) in the

untrafficked row middle (20 inches from the row), 4) midway between the row and the trafficked row middle (10 inches from the row), and 5) in the trafficked row middle (20 inches from the row). Soil moisture was determined gravimetrically (105° C) at shallow (0-6 inches) and deep (6-12 inches) depths.

Tillage energy was measured by using a tractor-mounted three-point hitch dynamometer that was capable of measuring draft, vertical, and side forces. This device was attached to the Yetter™ implement and measured tillage forces for all spring and fall tillage treatments.

Cotton yields were obtained for the growing seasons of 1995, 1996, and 1997. Data were analyzed using SAS and a randomized complete block model. Also, contrasts were used to individually compare the conservation tillage treatments to the conventional tillage treatment. A predetermined significance level of  $P \leq 0.05$  was chosen to separate treatment effects.

### Results and Discussion

The most recent cone index measurements taken in the row in the fall of 1997 show the benefits afforded to those plots that were tilled the previous fall (Figure 1). The filled symbols that indicate the deep tillage treatment show the loosened soil depth extends down to approximately 13 inches while the shallow tillage treatment loosens a zone down to about 7 inches. These profiles contrast greatly with the soil conditions in plots that received no tillage. The effect of the cover crop seems to slightly increase cone index at most depths for all tillage treatments.

The cotton yield of 1995 is not reported in this paper because of a severe boll worm infestation that severely decreased seed cotton, particularly in those plots with larger and healthier plants. Statistical analysis of the 1996 yield (which was aided by ample rainfall; Table 1) only shows a cover crop effect. When the conventional tillage treatment was contrasted with the other factors, only the effect of the rye cover crop was close to being significant ( $P \leq 0.0583$ ). Statistical analysis of the 1997 yield (which was drought stressed; Table 1) showed many significant effects: tillage timing, tillage depth, and cover crop. The conventional tillage treatment was found to be superior to spring tillage treatments, deep tillage treatments, and no cover crop treatments.

As expected, similar energy requirements were found for each of the three sets of yearly energy data (Table 2). The previous fall and spring's energy data were included together for statistical analysis because of their combined respective influence on the crop. In the first two years' analysis, the effect of timing of tillage (either spring or fall) was significant. Fall tillage usually required lesser horsepower requirements, with the exception of the first year's data at the deeper tillage depth. Also, in each of the three years, the effect of tillage depth was significant. Shallow tillage (approximately 7") usually required 50% of the horsepower requirements of deep tillage (approximately 13"). In the second and third year's analysis, a trend existed that indicated that a cover crop caused an increase in tillage forces. The large amounts of residue that had to be sheared or moved by the residue managers may have contributed to these increased draft forces.

The cotton yield data indicates that the presence of a cover crop provides the greatest potential for improving yields with conservation tillage systems. Comparable yields with conventional farming systems can be achieved through the use of a cover crop. Fall tillage also seems to offer slight benefits over no-tillage and substantial benefits over spring tillage. Tilling deeper than necessary to disrupt the hardpan was also found to not increase yields, but actually caused yield decreases. The 25 hp energy requirements of the shallow tillage treatment make it possible for farmers to till 8 rows at a time with their large tractors to ameliorate the effects of severe surface soil compaction. Most farmers are reluctant to till less than this width because of the time and energy costs involved. Farmers adopting conservation tillage systems that include cover crops and shallow fall in-

row tillage should receive excellent soil protection from erosion, reduced soil compaction effects, and superior crop yields.

### Summary

Competitive crop yields with conventional tillage systems were obtained by conservation tillage systems that incorporated cover crops. Slightly increased, seed cotton yields were obtained by using shallow fall tillage that only went deep enough to disrupt the root-impeding layer. Energy measurements indicate that farmers wishing to utilize this conservation tillage practice can till 8-rows at a time with their large tractors and minimize the negative effects of soil compaction and root-impeding layers.

### Disclaimer

The use of companies, tradenames, or company names does not imply endorsement by USDA-ARS or Auburn University.

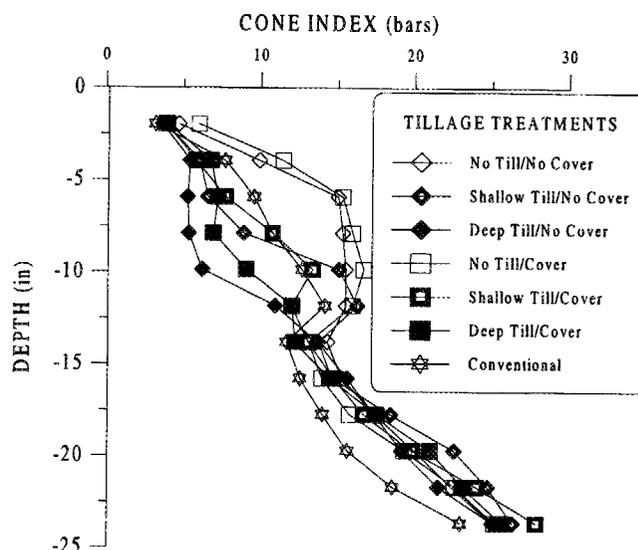


Figure 1. Cone index profiles of tillage treatments performed in fall taken immediately beneath the row.

Table 1. Seed Cotton Yields

Tillage Treatment	Cover Crop	1996 Seed Cotton Yield (lbs./ac)	1997 Seed Cotton Yield (lbs/ac)	Average (lbs/ac)
No-Till	Yes	3534	2838 ab*	3186
Fall-shallow	Yes	3689	3000 a	3345
Fall-deep	Yes	3651	2690 abcd	3170
Spring-shallow	Yes	3709	2491 bcde	3100
Spring-deep	Yes	3575	2456 cde	3015
Conventional	No	3338	2823 abc	3081
No-Till	No	3332	2567 bcd	2951
Fall-shallow	No	3242	2420 de	2831
Fall-deep	No	3414	2393 de	2904
Spring-shallow	No	3512	2380 de	2946
Spring-deep	No	3479	2162 e	2821

\*Within each year, means with the same letter are not significantly different at  $\alpha = 0.05$  (LSD test).

Table 2. Tillage Draft Energy

Tillage Treatment	Cover Crop	1995 Crop Year Draft Energy (hp)	1996 Crop Year Draft Energy (hp)	1997 Crop Year Draft Energy (hp)	Average (hp)
Fall-shallow	Yes	27.2 bc*	15.6 e	30.6 c	24.5
Fall-deep	Yes	56.3 a	35.7 b	58.7 a	50.2
Spring-shallow	Yes	19.4 c	26.1 cd	48.3 ab	31.3
Spring-deep	Yes	27.1 bc	60.7 a	47.1 ab	45.0
Fall-shallow	No	24.9 bc	14.8 e	27.6 c	22.4
Fall-deep	No	55.3 a	31.7 bc	52.2 a	46.4
Spring-shallow	No	21.2 bc	21.9 de	36.8 bc	26.6
Spring-deep	No	30.1 b	56.8 a	48.0 ab	45.0

\*Within each year, means with the same letter are not significantly different at  $\alpha = 0.05$  (LSD test).



**ULTRA-NARROW ROW COTTON: TILLAGE, COVER CROPS AND NITROGEN**

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**Abstract**

Recent research has shown that ultra-narrow row cotton (*Gossypium hirsutum* L.) production on marginal lands may be an economically feasible production scheme. No-tillage ultra-narrow row cotton would reduce soil erosion and enable growers to meet USDA-NRCS conservation compliance guidelines. Growers could expand cotton production with less capital. Recent advances in weed control, e.g., cotton varieties tolerant to glyphosate and bromoxynil, and new options for over-the-top weed control like pyriithiobac and sethoxydim, have eliminated one of the major constraints to ultra-narrow row or drilled cotton. Short season varieties and PIX® plant growth regulator have also increased the feasibility of this system.

There is grower interest in this system but there are many knowledge gaps in the management scheme for ultra-narrow row cotton. One of the major questions to be answered by research is defining fertility requirements of this type system, especially in regards to nitrogen management. Nitrogen management is further complicated by tillage and cover crop systems and no work has been done on cover crop effects on ultra-narrow row cotton. The objective of this research was to determine the optimum nitrogen rate under different winter covers and tillage systems for ultra-narrow row cotton grown on marginal Coastal Plain soils.

This experiment was conducted during 1996-97 on a Wagram loamy sand (loamy, siliceous, thermic Arenic Paleudults) in eastern SC and a Norfolk loamy sand (fine-loamy, siliceous, thermic Typic Kandiudults) in east-central AL. In AL, cotton varieties were Stoneville 132 in 1996 and Paymaster 1330 BG/RR in 1997. In SC, Stoneville 474 was used in 1996 and 1997. A no-till drill with 8-inch drill spacings was used to plant the cotton. Seeding rates were 250,000 and 210,000 seed/A in 1996 and 1997,

respectively, in AL and 150,000 seed/A in SC. Planting dates ranged from 27 May to 4 June. Cover crops were killed 14-21 days prior to planting using burndown herbicides and a mechanical roller. Preemergence applications of fluometuron and pendimethalin were used for weed control at all sites both years. In 1997 in AL, glyphosate was also applied over-the-top at 4-true leaves. In AL, four 8 oz./A applications of PIX® were applied at approximately 10-day intervals; in SC only one 8 oz./A application was made to the cotton. Cotton in AL was harvested with a stripper fitted with a finger harvester while in SC it was hand picked.

At both locations, the experimental design was a split-split plot design of four replications. Main plots were cover crops, sub-plots were tillage systems, and sub-sub plots were N rates. Cover crops were 1) winter fallow, 2) black oat (*Avena strigosa* Schreb.) and 3) winter legume [white lupin - *Lupinus albus* (L.) in AL and Austrian winter pea - *Pisum sativum* (L.) in SC]. Tillage treatments were 1) conventional (disk, chisel plow, disk and field cultivate) and 2) no-tillage. Nitrogen rates were 0, 40, 80, and 120 lb N/A.

Yield response varied with location and year, as a result of rainfall, cover crop biomass, and thrip (*Frankliniella* spp.) and weed pressure. The AL site, with a higher plant population (averaging about 200,000 plants/A) and somewhat more productive soil, demonstrated a greater response to treatments. Final plant stands (plants/A) ranged from 190,000 to 220,000 in AL and from 83,000 to 126,000 plants in SC. Seed depth control and thrips were factors in stand losses in SC. Stands were reduced from 8 to 21% (dependent on location and year) with legume covers and no-tillage but within a location and chosen plant density, stands did not affect lint yield. In 3 of 4 site-years, highest lint yields (mean of 1330 lb/A) were obtained with a legume cover crop and 60 to 80 lb N/A (determined from regression analysis). Eighty (80) lb N/A was generally required for maximum yield following winter fallow or black oat cover crops, but the yield potential was less with these covers compared to winter legumes. An exception occurred in SC in 1997 when yields were reduced following Austrian winter pea, due to delayed maturity and unusually cool and wet weather in early fall. Cover crop effect on yield potential generally followed the order legume>black oat>winter fallow and was related to biomass production of the winter cover, as well as to type of cover. Tillage effects and interactions varied with cover crop, location, and year. No-tillage into a white lupin cover crop that produced 6800 lb dry matter/A resulted in the greatest lint yield (1390 lb/A) in the study. Our results suggest that ultra-narrow row cotton is a viable option for Coastal Plain soils with low productive potential. Further research on ultra-narrow row cotton is needed on PIX® rates, planting dates, plant populations, variety selection, fertility maintenance, and lint quality.

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**EFFECT OF N RATE AND PLACEMENT ON NO-TILLAGE COTTON**

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**Abstract**

Information on nitrogen (N) application methods and rates for no-tillage (NT) cotton (*Gossypium hirsutum* L.) production is limited. Research was initiated in 1994 and continued through 1997 on a Loring silt loam at the Milan Experiment Station. Research was also initiated in 1996 and