Cotton Response to Reduced Tillage and Cover Crops in the Southeastern Coastal Plain

Philip J. Bauer, Warren J. Busscher, and Judith M. Bradow
U.S. Department of Agriculture, Agricultural Research Service
Florence, South Carolina, and New Orleans, Louisiana

Abstract

Understanding how cotton *(Gossypium hirsutum* L.) responds to alternative production practices will improve management of the crop in those systems. Our objective was to determine the influence of a rye cover crop and reduced tillage on soil strength, cotton development, and lint yield. Treatments consisted of winter cover [rye *(Secale cereale* L.) and fallow], surface tillage (disking and none), and deep tillage (in-row subsoiling and none). Differences in soil strength occurred between treatment combinations, but because of sufficient precipitation during the growing season, deep tillage did not impact any other variable. Following winter fallow, there were no differences in the initiation of reproductive growth or crop yield between disking and no surface tillage. The presence of a rye surface mulch, however, delayed flower initiation. Cotton lint yield was not influenced by surface tillage following winter fallow. Following rye, cotton yield and plant populations were lower when the residues were left on the surface. Although further verification is needed, production aids such as crop growth simulation models may require modification for application in situations where cotton is grown in fields with large amounts of surface residues.

Introduction

Surface residues are an important component of conservation tillage crop production systems in the southeastern United States of America. Langdale et al. (1990) concluded that a cropping system that included both cool- and warm-season annual crops was needed for successful production of sorghum *[Sorghum bicolor* (L.) Moench] and soybean *[Glycine max* (L.) Merrill] with conservation tillage on Piedmont sandy loam soils. In continuous monocropped cotton, residues atter harvest are low and, because of the long growing season needed by the crop, doublecropping with a winter small grain cash crop is not possible for much of the region. Winter annual cover crops, seeded in the fall and terminated before planting in the spring, can provide adequate surface residues for conservation tillage production of cotton.

Beyond erosion control, a primary benefit of surface residues in conservation tillage is improved soil water status. In-row subsoiling on coastal plain soils is done to disrupt a root-restricting E horizon that limits root growth into the clay-textured B horizon. If combined with controlled traffic, residues from cover crops may alleviate the need for annual deep tillage on these soils, as prescribed by Busscher et al. (1986a).

Changes in soil conditions with use of reduced tillage and cover crops influence crop development. Compared to conventional tillage cotton, conservation tillage cotton differs in boll size and distribution within the canopy (Hoskinson and Howard, 1992). Stevens et al. (1992) found that cotton seeded into wheat cover crop stubble had fewer flower buds on mainstem nodes five through eight than conventional tillage cotton. For optimal cotton crop management, an understanding of plant development is needed. Our objective was to determine the influence of a rye cover crop and reduced tillage on soil strength, cotton development, and lint yield.

Philip J. Bauer and Warren J. Busscher, USDA-ARS, Coastal Plains Soil, Water, and Plant Research Center, P.O. Box 3039, Florence, SC 29502. Judith M. Bradow, USDA-ARS, Southern Regional Research Center, New Orleans, LA.

Materials and Methods

We conducted this experiment in 1994 at the Clemson University Pee Dee Research and Education Center near Florence, SC. Cover crop and surface tillage plots were established in the fall of 1990. Results from experiments in 1991 and 1992 have been reported previously (Bauer and Busscher, 1993). Cotton was grown on the plots in 1993, but plots were not harvested because of drought. All plots were in-row subsoiled in 1993. Treatments in 1994 consisted of winter cover (rye and fallow), surface tillage (disking and none), and deep tillage (in-row subsoiling and none). The soil was a Norfolk sandy loam (fine, loamy, siliceous, thermic, Typic Kandiudult).

The experimental design was randomized complete block with treatments in split-split plot arrangement. Main plots were winter cover, subplots were surface tillage, and sub-subplots were deep tillage. The experiment had four replicates. Sub-subplot sue was 12.7 feet wide (four 38-inch rows) by 50 feet long.

After the cotton stalks were shredded in the fall of 1993, rye (110 pounds of seed acre) was seeded with a John Deere

750 grain drill on October 19 in rows spaced 7.5 inches apart.

Winter cover above-ground biomass was determined on April 25 by drying a 11.5-ft^2 sample from each surface tillage subplot in the fallow main plots and a 6.4-ft^2 sample from each surface tillage subplot in the rye main plots. On May 3, the appropriate plots were either disked or dessiccated with paraquat. The deep tillage plots were subsoiled within 6 inches of the 1993 rows with a KMC four-row subsoiler prior to planting in an operation separate from seeding. Cotton ('DES 119') was seeded within 6 inches of the 1993 rows on May 18 with a four-row Case-IH 900 series planter equipped with Yetter wavy coulters.

Nitrogen (80 lb N/acre as ammonium nitrate) was applied in a split application, with half applied at planting and the other half applied a month after planting. The N was banded approximately 4 inches deep and 6 inches from the cotton rows at each application time. Lime, P, K, S, B, and Mn were applied based on soil test results and Clemson University Extension recommendations. Weed control was accomplished with a combination of herbicides, cultivation (disked plots only), and hand-weeding. Aldicarb (0.75 lb ai/A) was applied infurrow and other insecticides were applied as insect pest infestations warranted.

Soil strength was measured in early June with a 0.5-inch diameter, 30° solid angle cone tip, hand-operated, recording penetrometer (Carter, 1967). Strength measurements were recorded to a depth of 24 inches at nine positions across one row (from a nontraffic midrow to a traffic midrow). These measurements were made at three locations in each sub-subplot. Data were digitized into the computer using the method described by Busscher et al. (1986b). Data were log transformed before analysis for normalization (Cassel and Nelson, 1979).

Cotton plant populations were determined by counting plants in 30 feet of one row in each sub-subplot on June 6. White bloom counts were made daily in July and August (Monday-Friday) on 6.8 feet of one interior row in each sub-subplot. Cotton was chemically defoliated on October 18 and two interior rows were harvested with a two-row spindle picker on November 9. Lint percent was calculated by saw-ginning a sample of seedcotton from each harvest bag. Lint yield was estimated by multiplying seedcotton yield by lint percent.

Analysis of variance was performed on all data. When sources of variation were significant at P=0.05, means were separated by computing a least significant difference at the P=0.05 level.

Results and Discussion

As stated previously, drought resulted in no cotton yield in the experiment in 1993. Total N applied in that year was 80 lb N/acre and the 1993-1994 rye winter cover produced abundant biomass because of the high amounts of residual N, especially in the conservation tillage treatment (Table 1). Winter weed production was similar to that in previous years (Bauer and Busscher, 1993) and was not affected by surface tillage treatment (Table 1).

Table 1. Winter cover biomass production.

Winter Cover	Tillage: Nondisked	Tillage: Disked	Mean
	lb/A		
Fallow	1,017[1]	1,412	1,215
Rye	5,169	3,579	4,373

[1] LSD (0.05) for comparing tillage means within a cover crop is 651 lb/A.

Soil strength was similar for all in-row subsoiled plots, regardless of winter cover or surface tillage treatment. In the nonsubsoiled, nondisked plots, the soil disruption pattern from the subsoiling that occurred in 1993 was still evident in 1994. For those plots, the soil depth under the row where penetration resistance was 20 bars was about 11 inches, regardless of winter cover treatment (data not shown). Depth to 20 bars penetration resistance was also about 11 inches in the in-row subsoiled plots. These results are similar to those found by Khalilian et al. (1991). They reported that soil loosening from deep tillage with a paratill was evident 11 months after tillage when controlled traffic was used in a wheat/soybean doublecrop conservation tillage system.

For the nonsubsoiled, disked plots following winter fallow, soil depth to 20 bars resistance was uniformly 5.5 inches across the entire 38-inch row. This finding suggests that a hardpan was formed by the disking operation. The tillage-induced hardpan did not occur when rye was disked into the soil. Even though differences in soil strength occurred, abundant precipitation occurred throughout July, August, and September and deep tillage did not significantly influence any of the other measured variables.

No differences in flower production rate occurred in the disked treatment between the fallow and rye winter cover treatments (Figure 1, top). For both, peak bloom occurred about 65 days after planting. In the nondisked plots, flowering was delayed in the cotton seeded into the rye mulch (Figure 1, bottom). End of season plant mapping indicated that the delay in flowering was partially caused by the first sympodial branches being higher on the mainstem for the cotton grown in the rye mulch (data not shown).

Cotton yield did not differ between nondisked and disked treatments following winter fallow (Table 2). This result is in contrast to the first 2 years after plot establishment where the nondisked treatment yielded less than the disked treat-

Table 2. Effect of cover crops and tillage on cotton lint yield.

Winter Cover	Tillage: Nondisked	Tillage: Disked	Mean
	lb/A		
Fallow	1,264[1]	1,080	1,172
Rye	1,000	1,200	1,100

[1] LSD (0.05) for comparing tillage means within a cover crop is 196 lb lint/A.

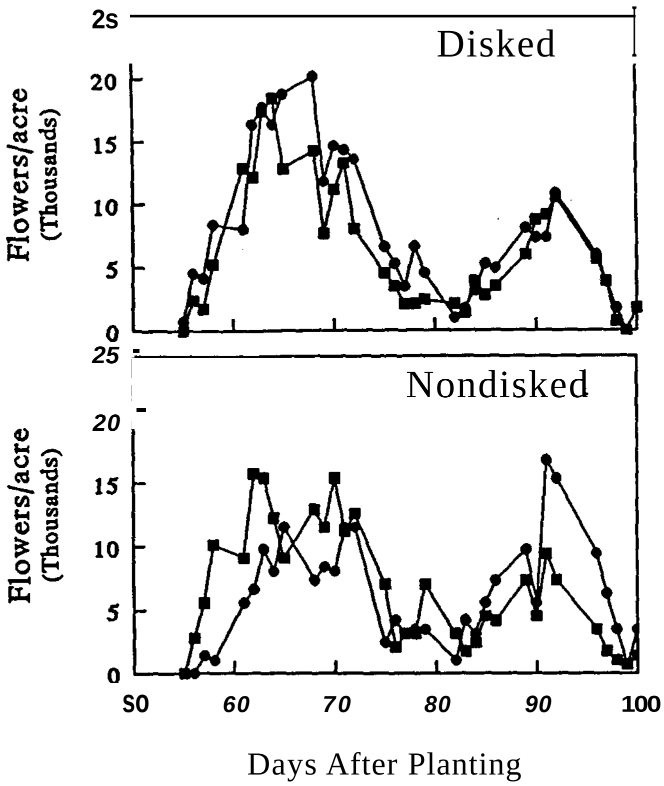

Figure 1. Flower production of cotton grown following winter cover treatments of fallow (squares) and rye (circles) in two tillage systems at Florence, SC.

ment (Bauer and Busscher, 1993). Following rye, the disked plots had greater yield than the nondisked (Table 2), which was partly caused by poorer stands in the nondisked plots (plant stands following rye were 1.3 and 2.0 plants per foot for nondisked and disked treatments, respectively). Also, although we did not quantify it, there was more boll rot in the plots with the rye surface residues, which probably accounted for some yield loss.

In summary, though differences in soil strength between treatment combinations occurred, they did not result in yield differences because of sufficient precipitation. Crop development was influenced by winter cover treatment without disking, but not with disking. The rye surface mulch delayed the initiation of reproductive growth. Although further verification is necessary, crop growth simulation models may require modification for application in situations where cotton is grown in fields with large amounts of surface residues.

Acknowledgment and Disclaimer

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