EFFECT OF WINTER COVER ON SOIL MOISTURE CONTENT IN CONVENTIONAL AND STRIP TILLAGE COTTON

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ABSTRACT

Moisture stress frequently limits crop productivity on the coarse-textured soils of the Southeastern Coastal Plain. Our objective was to determine the effect of winter cover and tillage on soil moisture levels and cotton (Gossypium hirsutum L.) yield. Cotton was grown following rye (Secale cereale L.) or winter fallow with conventional (incorporation of all surface residues followed by in-row subsoiling) and strip (in-row subsoiling only) tillage in 1991 and 1992. Soil type was Norfolk loamy sand (fine, loamy, siliceous, thermic, Typic Kandiudult). In 1992, soil moisture was monitored daily using gypsum blocks placed at 20 and 46 cm below a center row of each plot. In the strip tillage system, lint yield was 434 and 224 kg ha^{-1} higher following rye than fallow in 1991 and 1992, respectively. No yield differences between the cover treatments occurred with conventional tillage. Soil moisture content in 1992 was higher following rye than fallow in both tillage systems, but the difference was greater with reduced tillage. These results indicate that a rye cover crop in strip tillage on coarse-textured soils increases cotton productivity by increasing available soil moisture.

INTRODUCTION

Current recommendations for cotton production following a winter cover crop include killing the winter cover at least 2 weeks before planting. Part of the reason for the early kill is to prevent the winter cover from depleting seedbed moisture. Low seedbed moisture can reduce seedling emergence and final stands (Karlen, 1989). Though the influence of winter cover crops on seedbed moisture at planting is well understood, less is known about how seasonal soil water supplies are influenced by growing winter crops. Increased surface residue from the winter crop could potentially increase rainfall infiltration and the moisture supplying capacity of the soil throughout the growing season.

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When seedbed moisture does not limit stand establishment, small increases in cotton yield have been found when rye is used as a winter cover on Eastern Coastal Plain soils. For example, in a 3-year study, green-manured rye increased cotton lint yield 140 kg ha^{-1} more than a fallow treatment when both were supplied with 56 kg N ha^{-1} (Bauer et al., 1993). Since some of the more productive soils of the Southeastern Coastal Plain have surface horizons with low available water holding capacities (0.06 to 0.10 g/g) (Campbell et al., 1974), improved soil-water relationships may be partially responsible for these yield increases.

We initiated a study in 1990 to determine the effects of tillage method and cover crop destruction date on cotton grown on a coarse-textured soil. In 1992, soil moisture data were collected from these plots. In this report, we present the results on the effect of a rye winter cover crop on soil moisture in conventional and strip tillage production systems.

MATERIALS AND METHODS

The experiment was conducted on a Norfolk loamy sand at the Clemson Pee Dee Research and Education Center in Florence, SC. Rye ('Vita-graze') was seeded with a grain drill at a rate of 122 kg ha^{-1} in the fall of both 1990 and 1991. In 1990, the experimental field was disked and bedded before planting rye. After the cotton stalks were shredded in the fall of 1991, bedders were used to place a small amount of soil (2.5 cm or less) onto the existing beds of all plots before rye seeding.

The conventional tillage treatment consisted of disking to a depth of 15 to 20 cm, reforming the beds, in-row subsoiling, and between-row cultivations after cotton emergence. The strip tillage treatment consisted of in-row subsoiling only.

Total N application in all plots was 78 kg ha^{-1}. Lime and other plant nutrients were applied based on soil test results and Clemson University Extension recommendations. Cotton ('Coker 315') was planted with a four-row Case-IH 900 series no-till planter on May 8, 1991 and May 10, 1992. Row width was 0.97 m. In the strip tillage plots, paraquat was applied to desiccate all vegetation before planting. Herbicides, applied at recommended rates, were applied to all plots for weed control. Herbicides were applied with a directed sprayer into the midrows of the strip tillage plots when cultivation was used in the conventional tillage treatment. Handweeding was also used in all plots. Pyrethroid and organophosphate insecticides were applied as needed to control insect pests.

Soil moisture was determined with a Delmhorst KS-D1 soil moisture tester in 1992 only. Four gypsum blocks, two at the 20-cm and two at the 46-cm depth, were buried below a middle row of each plot. Measurements were taken daily (Monday through Friday, except holidays) between 7:30 and 9:00 a.m. Soil moisture was monitored from May 28 through August 29.

Biomass of the winter covers (winter weeds in the winter fallow plots or the rye winter cover) was determined by drying a 1 m^2 sample from two areas of each main plot (winter covers) in late April of each year. Shortly before harvest, plant height was measured on five plants in each plot. Two interior rows were harvested with a two-row spindle picker on October 9, 1991 and October 22, 1992 for yield determinations. Lint yield was calculated after saw-ginning a grab sample from the harvest bag and multiplying seedcotton yield by lint percent.

The experimental design was a randomized complete block in a split-split plot arrangement with winter cover on main plots and tillage on subplots. Sub-subplots were date of winter cover incorporation/desiccation (either 5 or 15 days before cotton planting). The experiment had four replicates. All data collected were subjected to analysis of variance. Since date of incorporation/desiccation had no significant ($P<0.05$) impact on any of the dependent variables, data presented were averaged over the incorporation/desiccation dates.

RESULTS AND DISCUSSION

Rye biomass production was similar between years, averaging 2556 kg ha^{-1} in 1991 and 2472 kg ha^{-1} in 1992. Winter weed dry matter production was greater in the second year of the study, averaging 551 kg ha^{-1} in 1991 and 1011 kg ha^{-1} in 1992.

Cotton lint yield was more than two times greater in 1991 than 1992 (Table 1). In 1992, cool spring and early-summer temperatures delayed seedling growth and the eventual crop harvest.

Table 1. Effect of winter cover and tillage on cotton plant height and yield at Florence, SC.

Winter Cover	Tillage	Plant Height 1991	Plant Height 1992	Lint Yield 1991	Lint Yield 1992
		----- cm ------		----- kg/ha ----	
Fallow	CT†	80	68	1133	446
	ST	71	57	952	267
Rye	CT	77	69	1322	563
	ST	82	77	1386	491
LSD(0.05)		12.5	15.5	428	145

† CT = Conventional Tillage, ST = Strip Tillage.

Even though cotton yields in the 2 years differed considerably, the cotton plant responses to tillage and winter cover treatments were similar between years. In both years, plant height was not significantly ($P<0.05$) affected by winter cover treatment in conventional tillage. Under conventional tillage, small numerical but not statisically significant ($P<0.05$) increases were found in both years following the rye cover crop (Table 1). This response is similar to previous findings using rye as a green manure on this soil type (Bauer et al., 1993). In the strip tillage system, cotton following rye grown for a surface mulch had greater lint yield in both years and greater plant height in 1992 than cotton grown following winter fallow (Table 1).

We did not detect a difference in soil moisture among treatments before early July or after mid-August in 1992 (data not shown). Soil moisture contents during an extended dry period, which occurred from July 1 (beginning at about first bloom) through August 14, are presented in Figures 1 and 2.

Drying of the surface layer (20-cm depth) occurred a few days earlier in the fallow winter cover treatment than the rye winter cover treatment for both tillage systems (Fig. 1). Within tillage systems, the rate of soil drying was quite similar between the rye and fallow winter cover treatments.

In contrast to the surface horizon, little difference in soil moisture content was found between rye and fallow treatments at the 46-cm depth when conventional tillage was used (Fig. 2, top). However, in the strip tillage plots, the rye surface mulch delayed soil

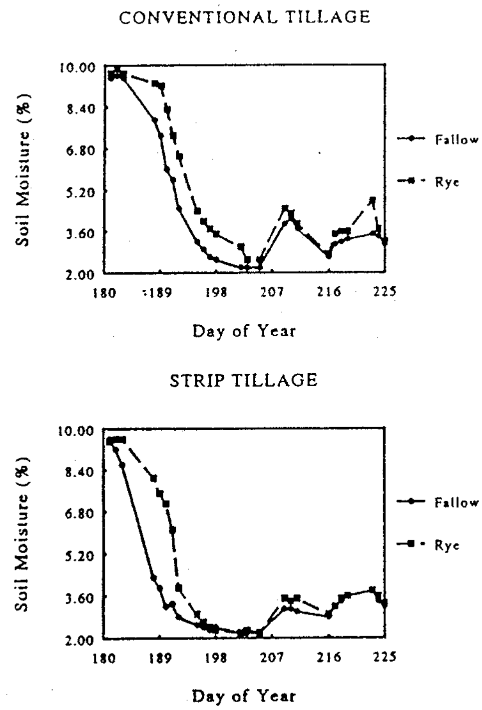

Figure 1. In-row soil moisture content at the 20-cm depth of cotton following winter cover treatments of rye or fallow in conventional (top) and strip (bottom) tillage systems.

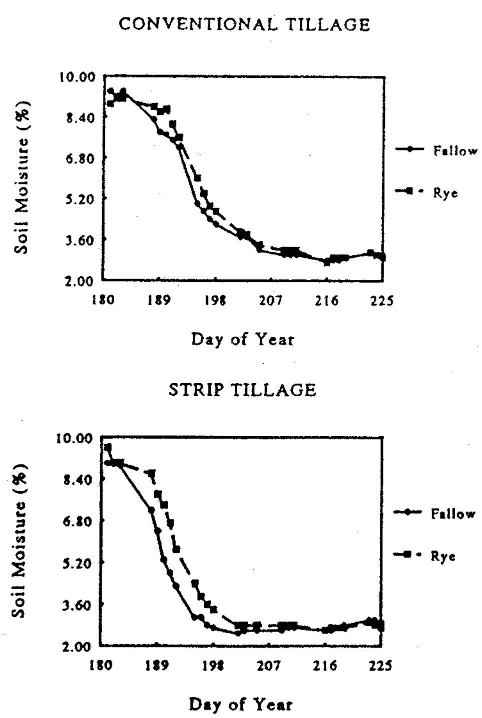

Figure 2. In-row moisture content at the 46-cm depth of cotton following winter cover treatments of rye or fallow in conventional (top) and strip (bottom) tillage systems.

moisture depletion by several days (Fig. 2, bottom). As found in the surface layer, the rate of soil drying within a tillage system was similar between the winter cover treatments. It is unclear why soil moisture differences between the winter covers occurred at the 46-cm depth in the reduced tillage systems but not in the conventional. Differences in root growth patterns or soil physical conditions may have been involved.

In summary, we found greater differences in height and yield between the fallow and rye winter cover treatments in the strip tillage system than in conventional tillage both years of this study. Soil moisture data from one year of study suggest that differences in soil moisture status may be responsible for the greater response in the strip tillage treatment. Delays in moisture stress, especially during the flowering cycle when young bolls are susceptible to shedding, could account for the increased productivity of cotton following a rye winter cover.

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