Surface and Deep Tillage Effect on Double-Cropped Soybean

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Abstract: Information is needed on optimum conservation tillage soybean production management when the soybean is planted following a wheat grain crop. Our objective was to determine the effect of surface tillage, deep tillage, and row width on double-cropped soybean growth and yield. Surface tillage treatments were disked or not disked. Row width treatments were 7.5 in or 30 in. Deep tillage treatments consisted of fall paratilling before seeding wheat or not paratilling. In the spring, half of the 30-in plots were in-row subsoiled and half of the 7.5-in plots were paratilled, and these were compared to no spring deep tillage. Soybeans were planted in early June in 1994 and 1995. Surface tillage and spring deep tillage impacted plant height at some measurement times through each season, but row width and fall deep tillage did not. Averaged over all treatment combinations, soybeans grown in 7.5-in rows yielded 30.1 bu/ac (1994) and 21.2 bu/ac (1995) more than soybeans grown in 30-in rows. Surface tillage and deep tillage had no effect on yield when the 30-in-row width was used. When the 7.5-in-row width was used, both fall and spring deep tillage increased yield. Disking before planting the 7.5-in-row-width soybeans resulted in yield reductions of 14.2 bu/ac in 1994 and 9.8 bu/ac in 1995, compared to the no surface tillage treatment. Conservation tillage, combined with narrow-row culture and deep tillage, should improve double-crop soybean production in the Coastal Plain.

Introduction

Soybean planted after wheat harvest is a common practice in the southeastern USA. In 1995, approximately 50% of the total soybean acres were seeded after wheat in South Carolina. Conservation tillage systems that left wheat residues on the soil surface were used on about 40% of those double-cropped acres (Gene Hardee, USDA-NRCS, personal communication). Most conservation tillage soybean production was planted in wide-row spacing (30-38 in). Limited data is available on narrow-row ($\leq$10 inches) production of soybean on the Coastal Plain, especially for conservation tillage production. Compared to soybean grown in wide rows, narrow-row soybeans compete better with weeds, have higher pod placement, lose less soil water through evaporation, have greater root dispersion throughout the soil, and reduce soil erosion (Palmer and Privette, 1992).

There is a need for deep tillage to break root restricting layers or hardpans in some Coastal Plain soils (Busscher et al., 1986). Currently, straight-shanked in-row subsoilers are used to disrupt these layers for soybeans grown in wide rows. Touchton et al. (1989) reported that deep tillage before wheat in the fall eliminated the need for in-row subsoiling before planting soybean the following spring. Similarly, Khalilian et al. (1991) found that when using controlled traffic, fall deep tillage with a paratill (bent-leg shank) before planting wheat was adequate for the following interseeded soybean crop.

A better understanding of the influence of surface residues and deep tillage on double-cropped soybean in narrow- and wide-row culture will lead to improved management practices for conservation tillage production. In this report, we present results on the effects of surface and deep tillage on the growth and yield of soybeans produced with narrow- and wide-row widths.

Materials and Methods

The experiment was conducted at Clemson University's Pee Dee Research and Education Center near Florence, SC. A randomized complete block experimental design with four replicates was used in 1994 and 1995. Surface tillage treatments were disk and not disked. Within each surface tillage treatment, all combinations of row spacing (30 in vs 7.5 in), spring deep tillage (deep-tilled vs not deep-tilled), and fall deep tillage (deep-tilled vs not deep-tilled) were evaluated. Deep tillage for the 30-inch-row-spacing treatments was with straight-shanked in-row subsoilers. A paratill with four bent-leg shanks spaced 26 in apart was used for performing deep tillage in the 7.5-in-row-spacing treatments and for all fall deep tillage. Plot size was 10 ft wide and 50 ft long. Plots were established by planting wheat in the fall of 1993, and treatment combinations for each plot were maintained each year.

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Wheat was harvested each spring with a 13-ft-wide combine header equipped with a sicklebar cutter. To maintain uniformity of the wheat residues, the height of the sicklebar was set to leave wheat stubble standing approximately 9 in tall in all plots. All surface tillage plots were disked twice with a 10-ft-wide tandem disk harrow after wheat harvest. We used a John Deere[1] model 7200 four-row planter attached to a KMC subsoiler to plant the wide-row soybeans with deep tillage. The four subsoil shanks were removed from the unit to plant the non-deep-tilled wide-row soybeans. Separate from the planting operation, a four-legged Tye paratill was used for all deep tillage in the narrow-row treatments. The narrow-row treatments were planted with a John Deere model 750 drill. The seeders were set to plant nine seeds/ft in the wide-row treatment and 3 seeds/ft in the narrow-row treatment. 'Hagood' was the soybean cultivar each year.

Fertility and weed control used in the experiment were as described by Busscher et al. (1995). Plant height was determined during each growing season by randomly selecting an area in the middle of each plot and measuring the height of five adjacent plants. Measurements were made in late July of 1995 and throughout August of both years. Yield was determined by hand-harvesting 20 ft of row (randomly selected in 39-in sections) from the middle of each plot. After sampling for yield, the remainder of each plot was combine harvested to uniformly distribute the soybean residues.

Data were analyzed with analysis of variance. Treatment means from significant effects were separated by calculating a protected least significant difference with P=0.05.

Results

Row width and fall deep tillage did not influence plant height at any measurement time in either year of the study. On August 1, 1994, soybeans in the disked treatments were 1.4 in shorter than the soybeans growing in wheat stubble ($P \leq 0.01$) (data not shown). At later measurement dates, no differences between disked and nondisked plots were found. In 1995, soybeans in the disked treatment were 1.3 in shorter on 21 July ($P \leq 0.01$) and 1.1 in shorter on 28 July ($P \leq 0.05$) than the soybeans grown with wheat surface residues; but as in 1994, there were no differences at later sampling dates (data not shown). No interactions between spring deep tillage and surface tillage occurred on any sampling date.

In August of both years, soybean plants grown with spring deep tillage were one to two in taller than those grown without spring deep tillage at most sampling times (Figure 1). Since deep tillage allows for greater root penetration of the soil, the greater plant height for the deep-tilled treatment was probably due to better plant water relations for those plants during August of both years.

For soybean yield, significant row width × surface tillage, row width × spring deep tillage, and row width × fall deep tillage interactions occurred both years. No three-way or four-way interactions occurred in either year. Averaged over all treatment combinations, the soybean grown in narrow rows yielded 30.1 bu/ac (1994) and 21.2 bu/ac (1995) more than soybean grown in wide rows. At the higher yield level, narrow-row soybean yields were affected by the soil management treatments in our experiment, while the lower yielding wide-row soybeans were not (Table 1). There were no yield differences between surface tillage treatments or either fall or spring deep tillage treatments for the wide-row soybeans in either year of the study. In narrow-row culture, soybean yield for the non-disked treatment was 14.2 bu/ac higher than the disked treatment in 1994 and 9.8 bu/ac higher than the disked treatment in 1995. Spring deep tillage increased yield by 17 bu/ac in 1994 and 15 bu/ac in 1995. Both years, the residual effects of fall deep tillage resulted in a 7.4-bu/ac increase over no fall deep tillage in the narrow-row soybeans.

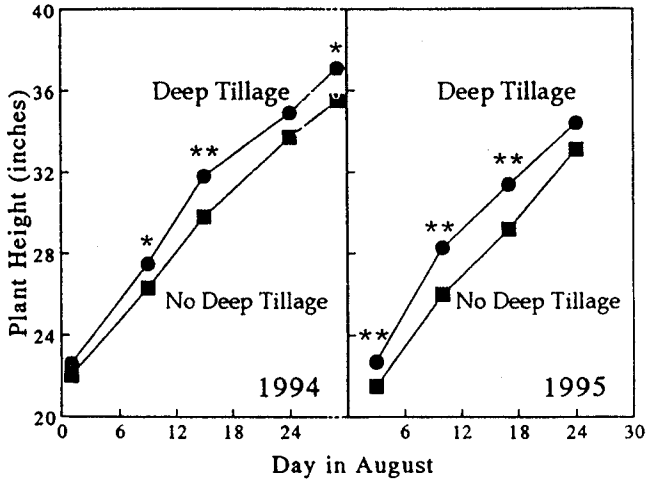

Figure 1. Effect of spring deep tillage on soybean plant height during August of 1994 and 1995. *, indicate treatment means were significantly different at P=0.05 and P=0.01, respectively.**

Summary

Surface and deep tillage influenced plant height to the same degree for soybeans in both row widths, but yield differences due to tillage occurred only for narrow-row culture. Yield limiting factors in wide-row culture need to be identified. These results indicate there is a potential to improve conservation tillage soybean production in the Coastal Plain by using narrow-row culture and deep tillage. Other management factors, such as variety selection, optimum soil fertility, and insect pest thresholds need to be defined for this production system.

[1] Mention of a trade name is for information only and does not imply an endorsement to the exclusion of other products that may also be suitable by the USDA or Clemson University.

Table 1. Effect of row width, surface tillage, and deep tillage on soybean yield in 1994 and 1995. Values followed by the same letter within a tillage comparison and year are not significantly different ($P \leq 0.05$).

Tillage Variable	1994		1995	
	Row Width			
	30	7.5	30	7.5
Surface	bu/ac			
Disked	42.1a	66.8b	29.8a	46.7b
Not Disked	46.0a	81.6c	32.0a	57.5c
Spring Deep				
Yes	45.6a	82.7c	31.9a	59.6c
No	42.5a	65.7b	29.9a	44.6b
Fall Deep				
Yes	43.8a	77.9c	31.4a	55.8c
No	43.8a	70.5b	30.4a	48.4b

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