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Crop Production in a Wheat-Cotton Doublecrop Rotation with Conservation Tillage

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Research Question

Conservation tillage can conserve and improve natural resources and increase crop productivity, but it must be adapted and optimized for the cropping systems of a physiographic area. Cotton production has dramatically increased in the Southeast, but the roles of doublecropping systems and continuous conservation tillage have not been clearly defined for cotton. In addition, the performance of cotton cultivars grown under continuous conservation tillage in short seasons has not been determined. In this study, our objectives were (i) to determine the influence of continuous conservation tillage on doublecropped wheat-cotton grown on a Coastal Plain soil and (ii) to determine the performance of specific cultivars to late planting and conservation tillage.

Literature Summary

Long-term conservation tillage with a corn rotation has been found to increase the organic matter content and crop yield potential of a Norfolk loamy sand in South Carolina. However, in other studies, crop residues alone were not sufficient to maintain the soil C content of southern Piedmont soils once the soil had been converted from conservation to conventional tillage. Higher wheat yields have been reported for Coastal Plain soils with conventional tillage as a result of poor stands in conservation tillage, but improved planting systems for wheat conservation tillage were equal to or better than conventional tillage. In dryland conditions of the Texas southern High Plains, reduced tillage of rotated or continuous cotton was superior to conventional tillage of continuous cotton. In central Arkansas, there was a 35 to 65% yield reduction of doublecropped cotton compared with full-season cotton. At Tifton, GA, yield of doublecropped cotton was 54% of the full-season cotton for stubble planting and 71% for planting after stubble burning and bottom plowing. It was concluded at Tifton that yield of doublecropped cotton could be improved by development of earlier cultivars. The evaluation of the effects of long-term conservation tillage on production of cotton in the Coastal Plain soils has not been evaluated.

Study Description

From 1988 to 1994, we investigated a 2-yr rotation of corn (data not reported in this manuscript) and doublecropped wheat-cotton on plots that had been in continuous conservation vs. conventional tillage since 1979. The experimental site was located near Florence, SC, on a 6.55-acre plot of Norfolk loamy sand. Conventional tillage consisted of multiple diskings and cultivations; surface tillage was eliminated for conservation tillage. Cotton planting dates ranged from 7 to 18 June, and 5 of the 7 yr had more than145 frost-free days. Three full-season cultivars 'PD 1,' 'PD 3,' and 'Deltapine (DP) 90,' were compared with two shorter season cultivars, DP 20' and DP 50.' In 1994, the PD cultivars were eliminated from the experiment, and 'Stoneville (St) 132,' 'St 453,' and 'St 907' were compared with the three DP cultivars.

Applied Questions

Was wheat and cotton production better under conservation tillage than under conventional tillage?

In 1991, wheat yields were 31% higher for conservation than conventional, and in 1992, wheat yields were 62% lower for conservation tillage. Otherwise, the wheat yields were not significantly different for tillage. The 5-yr means of 2039 and 2057 lb/acre for conservation and conventional tillage, respectively, were

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close to the South Carolina average for the study period, 2400 lb/acre. The DP cotton cultivars grown under conservation tillage were consistently higher in yields than those grown under conventional tillage. PD 1 yielded better under conventional tillage. Seed cotton yields ranged from about 500 to 2200 and 300 to 1850 lb/acre for conservation and conventional tillage cotton, respectively (Tables 1 and 2).

Did the short season reduce cotton yields?

Doublecropped cotton production was affected greatly by growing conditions, particularly at planting and harvest. Delays in planting because of drought or excess rainfall can cause loss of growing days or stand failure, and early frost can reduce or eliminate yield. During the cotton growing seasons, rainfall ranged from 20 to 36 in. Frost-free days ranged from 123 to 163, and heat units ranged from 1846 to 2273°F. Early season freezes (123 to 125 frost-free days) ruined the late-planted cotton crops in 1988 and 1992 because the cotton bolls had not opened prior to the freezes. A June drought caused crop establishment failure in 1993. This underlines the importance of sufficient water to insure stand establishment and reduce risk when short-season cotton is planted immediately after wheat harvest. The best yields were in 1991 when the mean of doublecropped PD 3 was 60 and 48% of the full-season PD 3, respectively, under conservation and conventional tillage. The shorter season DP 20 was about the same with mean yields of 62 and 46%, respectively, under conservation and conventional tillage.

Were cultivars different in yield?

The ranking of yields for the DP cultivars corresponded to their order of earliness, with DP 20 highest and DP 90 lowest. All three DP cultivars were consistently higher in yield with conservation tillage than with conventional tillage. The PD cultivars were less consistent in their response to conservation tillage, and PD 1 had a higher mean yield for conventional tillage. However, these results consistently indicated that the early DP cultivars (20 and 50) were superior to the PD cultivars for production under conservation tillage at the latitude of this investigation. PD cultivars were similar to the later-maturing cultivar, DP 90. The three DP cultivars produced higher yields than did the St cultivars.

Table 1. Seed cotton yield of cultivars grown under conservation and conventional tillage from 1989–1992.

Year†	Tillage‡	PD 1	PD 3	DP 20	DP 50	DP 90	Mean§
		lb/acre					
1989	Cst	1236	989	1528	1432	921	1221
	Cvt	1127	1095	1321	1172	822	1107
1990	Cst	626	928	943	1140*	1303*	988
	Cvt	1269*	716	868	558	758	834
1991	Cst	1631	2132*	2190*	1962	1940*	1971
	Cvt	1804	1717	1632	1872	1504	1706
LSD 0.05 for a cultivar in a tillage and year = 376							
LSD 0.05 for a tillage in a year and cultivar = 379							
Mean ‡	Cst	1164	1350	1554*	1511*	1388*	1393
	Cvt	1400*	1176	1274	1201	1028	1216
LSD 0.05 for tillage × cultivar = 219							

* Tillage comparisons are significantly different at the 0.05 level by the least significant difference test.
† Crop failures in 1988 and 1992 were due to early frost, and crop failure in 1993 was due to drought at planting time.
‡ Cst = conservation tillage and Cvt = conventional tillage.
§ P values for the F-test were tillage, 0.01; tillage × year, 0.38; tillage × cultivar, 0.01; year × cultivar, 0.01; year × tillage × cultivar, 0.01.

Table 2. Seed cotton yield of cultivars under conservation and conventional tillage in 1994.

	Cultivars						
Tillage†	St 132	St 453	St 907	DP 20	DP 50	DP 90	Mean*
	lb/acre						
Cst	591	625	664	1109	798	867	776
Cvt	419	314	464	667	772	499	523
Mean	505	470	564	888	785	683	
LSD 0.05 for cultivar = 200							

* Tillage and cultivar were both significantly different at the $P \leq 0.01$ level by the F-test.
† Cst = conservation tillage and Cvt = conventional tillage.

Crop Production in a Wheat-Cotton Doublecrop Rotation with Conservation Tillage

P. G. Hunt,* P. J. Bauer, and T. A. Matheny

Cotton (*Gossypium hirsutum* L.) production has dramatically increased in the Southeast, but the role of conservation tillage in doublecropped cotton systems has not been clearly defined. Therefore, from 1988 to 1994, we investigated doublecropped wheat (*Triticum aestivum* L.) and cotton on plots that had been in continuous conservation vs. conventional tillage since 1979. The experimental site was located near Florence, SC, on a Norfolk loamy sand (fine-loamy, siliceous, thermic Typic Kandiudult). Conventional tillage consisted of multiple diskings and cultivations; surface tillage was eliminated for conservation tillage. Wheat yields were not significantly affected by tillage, but cotton yields were significantly higher for conservation tillage ($P \leq 0.01$). Cotton planting dates ranged from 7 to 18 June, and 5 of the 7 yr had more than 145 frost-free days. Two years had crop failure because of early freezes, and a June drought prevented the planting of cotton in 1 yr. In the 4 yr with harvestable yields, seed cotton yields among the eight cultivars ranged from about 500 to 2200 and 300 to 1850 lb/acre for conservation and conventional tillage, respectively. The early maturing cultivar, 'Deltapine (DP) 20,' had the highest seed cotton yields with means of 1442 and 1123 lb/acre for conservation and conventional tillage, respectively. Development of earlier maturing cotton and wheat cultivars will be important for this cropping system in the northern Coastal Plain portion of the Cotton Belt.

Conservation tillage can conserve and improve natural resources and optimize crop productivity through reduced soil erosion, increased soil organic matter, increased water infiltration, reduced soil compaction, and reduced energy costs (Hudson, 1994; Hunt et al., 1996; Langdale et al., 1992; Bordovsky et al., 1994; and Soileau et al., 1994). However, adoption of conservation tillage in a particular physiographic region requires that the practice fit the soils and cropping systems of that region (Campbell et al., 1984a and 1984b; Harman et al., 1989). For example, Segarra et al. (1991) found that in the dryland conditions of the Texas southern High Plains, reduced tillage for both continuous or rotated cotton was superior to continuous cotton under conventional tillage. Stevens et al. (1992) found that reduced tillage was sometimes better and sometimes worse than conventional tillage for cotton yield in northern Mississippi. The better yields were encouraging because the reduced tillage systems could lessen soil erosion by 70%. In the Coastal Plain, Bauer and Busscher (1996) found that conservation tillage cotton yields were equal to conventional tillage when large amounts of residue were provided by winter cover crops. Karlen and Gooden (1987) reported lower wheat yields for conservation tillage as a result of poor stands. With an improved planting system for wheat, Frederick and Bauer (1996) found that conservation tillage was equal to or better than conventional tillage.

Investigations of rotational systems that include doublecropped wheat and cotton with conservation tillage are limited. Smith and Varvil (1982) reported a 35 to 65% yield reduction of doublecropped cotton compared with full-season cotton grown in central Arkansas. Stubble planting was found to both increase and decrease cotton yield relative to soil that was disked before planting depending upon cultivar and rainfall amount. They concluded that doublecropped cotton was limited by latitude and cultivar characteristics. They did not find differences in the quality of fiber or percentage lint. Baker (1987) investigated cotton doublecropped with wheat in southern Georgia under irrigated conditions and varying levels of tillage in two locations. At Tifton, GA, yield of doublecropped cotton was 54% of the full-season cotton for stubble planting and 71% for planting after stubble burning and bottom plowing. He concluded that yield of doublecropped cotton could be improved by development of earlier cultivars. In similar studies at Plains, GA, Baker (1987) did not make a full-season comparison, but he found that yield was 3% higher for the stubble-mulched planted cotton than the cotton planted after stubble burning and bottom plowing. The differences in cotton yield between Tifton and Plains may have been related to the more extensive fall tillage and rotation of plots at Plains. However, annual fall tillage along with residue burning prevented the evaluation of the effects of long-term conservation tillage on either of these Coastal Plain soils. Bruce et al. (1995) concluded that crop residue alone was not sufficient to maintain the soil C content of southern Piedmont soils once the soil had been placed in conventional tillage, and this would be particularly true if the crop residue was burned.

At Florence, SC, in 1988, a Coastal Plain site existed with 10 yr of continuous conservation vs. conventional tillage. Karlen et al. (1989) reported that the C content of the surface soil at this site had increased under long-term conservation tillage culture. Thus, the site provided a northern latitude site for evaluation of cotton cultivars in a wheat-cotton doublecropping system within tillage systems that had established differences in soil properties. In this study, our objectives were (i) to determine the influence of continuous conservation tillage on doublecropped wheat-cotton grown on a Coastal Plain soil and (ii) to determine the performance of specific cultivars to late planting and conservation tillage.

MATERIALS AND METHODS

The investigations were conducted on an experimental site that was initiated in 1979 to assess the impact of con-

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Abbreviations: DP, Deltapine; St, Stoneville.

Table 1. Cultural practices used during the study.

Year	Crop	Planting date	Seasonal rainfall	Dolomitic limestone	N	P	K
			in.		— lb/acre —		
			CS 1†				
1988	Corn	12 Apr	25.5	--	150	63	100
	Wheat	14 Nov	23.1	2000	105	45	45
1989	Cotton	15 Jun	23.6	--	75	--	--
1990	Corn	22 Mar	19.2	--	150	50	100
	Wheat	13 Nov	18.9	2000	105	45	45
1991	Cotton	7 Jun	21.2	--	75	--	--
1992	Corn	6 Apr	25.5	--	150	50	100
	Wheat	19 Nov	17.8	2000	105	45	45
1993	Cotton	‡	18.2	--	75	--	--
1994	Corn	4 April	30.2	--	150	50	100
			CS 2				
1988	Cotton	13 Jun	20.9	--	75	--	--
1989	Corn	30 Mar	31.1	--	150	50	100
	Wheat	6 Nov	17.2	2000	105	45	45
1990	Cotton	11 Jun	24.4	--	75	--	--
1991	Corn	3 Apr	19.9	--	150	50	100
	Wheat	27 Nov	17.1	2000	105	45	45
1992	Cotton	18 Jun	28.0	--	75	--	--
1993	Corn	4 April	10.9	--	150	50	100
	Wheat	19 Nov	22.1	2000	105	45	45
1994	Cotton	15 Jun	35.9	--	75	--	--

† CS = Cropping sequence

‡ Cotton did not germinate because of drought.

Table 2. Pest control practices used during the study.

Practices	Cotton: Conservation tillage	Cotton: Conventional tillage	Wheat: Conservation tillage	Wheat: Conventional tillage
Herbicides				
Bromoxynil (1 pt/acre)	--	--	1988–1994	1988–1994
Cyanazine (2 pt/acre)	1988–1989, 1994	--	--	--
DSMA (4 pt/acre)	1991	1991	--	--
Fluazifop (1.5 pt/acre)	1990	1990	--	--
Fluometuron (2 pt/acre)	1988–1994	1988–1994	--	--
Glyphosate (1.5 pt/acre)	1988–1994	--	1988–1994	--
MSMA (3 pt/acre)	1988–1989, 1994	--	--	--
Paraquat (2 pt/acre)	1992–1993	--	--	--
Sethoxydim (1.5 pt/acre)	1989–1990, 1992	1990, 1992	--	--
2,4-D (2 pt/acre)	--	--	1988–1994	1988–1994
Insecticides†				
Acephate (4 oz/acre)	1989–1994	1989–1994	--	--
Aldicarb (2 lbs/acre)	1989–1994	1989–1994	--	--
Cyhalothrin (4 oz/acre)	1989–1994	1989–1994	--	--
Disulfoton (1 pt/acre)	--	--	1988–1990, 1993	1988–1990, 1993
Thiodicarb (3 pt/acre)	1989–1994	1989–1994	--	--
Cultivation				
3 in-row cultivations	--	1989–1994	--	--
Preplant disking	--	1989–1994	--	1988–1994

† Acephate [O,S-dimethyl acetylphosphoramidothioate]
Aldicarb [2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl)oxime]
Cyhalothrin [α-cyano-3-phenoxybenzyl 3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate]
Disulfoton [O,O-diethyl S-[2-(ethylthio)ethyl] phosphorodithioate]
Thiodicarb {dimethyl N,N-[thiobis[(methylimino)carbonyloxy]-bis(ethanimidothioate)]}

servation tillage and residue management on a soil typical of the southeastern Coastal Plain. The site is a 6.55-acre plot of Norfolk loamy sand located on the Clemson University Pee Dee Research and Education Center near Florence, SC. The coordinates are latitude 34° 18′, longitude 79° 44′, and the elevation is 121 ft above mean sea level. Cultural and management practices from 1979 to 1986 were reported by Karlen et al. (1989).

The experimental area consisted of five blocks that were about 300 by 200 ft. Each block was split in half to allow each crop of a 2-yr rotation to be grown annually in each replicate. Since the crops rotated from one side of the split to the other with each passing year, the year component of the analysis of variance is expressed as site-year. Sub-blocks were then split in half to compare conservation and conventional tillage. A 2-yr rotation of corn (*Zea mays* L.) (data not reported in this manuscript) and doublecropped wheat-cotton was established in 1988 and continued until 1994 (Table 1). Fertilizer, lime, and pesticides were applied using Clemson University recommendations (Anonymous, 1982). Specific pesticides and rates are presented in Table 2. Aldicarb [2-methyl-2-(methylthio) propionaldehyde O-(methylcarbamoyl)oxime] was applied in cotton furrows at the rate of 0.27 lb a.i./acre for early season insect control. Other insecticides applied follow: Disulfoton [O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate], Thiodicarb {Dimethyl N,N-[thiobis[(methylimino)carbonyloxy]-bis (ethanimidothioate)]}, Acephate [O,S-Dimethyl acetylphosphoramidothioate], and Cyhalothrin [α-cyano-3-phenoxybenzyl 3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate]. Cotton received 25 lb/acre of N at planting and 50 lb/acre of N approximately 4 wk after planting. Wheat received 45 lb/acre of N at planting and 61 lb/acre of N 16 wk after planting. Liquid (30% UAN) and granular N were applied by use of Hardee[1] model MA-200-HC and Lilliston applicators, respectively.

Treatments were arrayed in a randomized complete block design with site-year as the main plot and tillage as a split plot. Conventional tillage consisted of multiple diskings to incorporate crop residues, fertilizers, and lime as well as cultivation to control weeds. Conservation tillage eliminated surface tillage, but both tillage treatments received in-row subsoiling at planting to fracture a root restrictive layer (E horizon) that reforms annually within these soils (Busscher et al., 1986).

Cotton cultivars were inserted as the split-split plot treatments. A Kelley conservation-till subsoiler (Kelley Manufacturing Co., Tifton, GA) and International 800 conservation tillage planters (Case-International Corp., Racine, WI) were used to plant cotton. Seeds were planted in June at 55 000 seeds/acre on 38-in.-wide rows. From 1988 to 1992, three full-season cultivars ['PD 1,' 'PD 3,' and 'DP 90'] and two short-season cultivars (DP 20 and 'DP 50') were evaluated. Due to lack of available seed, the PD cultivars were eliminated from the experiment in 1993 and 1994, and three other short-season cultivars ['Stoneville (St) 132,' 'St 453,' and 'St 907'] were added. This cultivar selection provided a range in relative maturity. DP 20 and 50 were early maturating cultivars and PD 1 and 3 along with DP 90 were full-season cultivars.

[1] Mention of a trademark, proprietary product, or vendor is for information only and does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

Table 3. Seed yield of wheat grown on a Norfolk loamy sand under conservation and conventional tillage.

Harvest year**	Cst.‡	Cvt.
	lb/acre	
1989	1626	1843
1990	1553	1536
1991	1915*	1464
1992	1178	1912*
1994†	3921	3529
Mean	2039	2057
LSD (0.05) year by tillage = 399*		

* Significantly different by LSD at the $P \leq 0.05$ level.
** Year by tillage was significant at a P value ≤ 0.01.
† Wheat was not harvested in 1993.
‡ Cst = conservation tillage and Cvt = conventional tillage.

Table 4. Planting date, heat units, precipitation, and frost-free growing days during cotton growing seasons.

Year	Planting date	Heat units, °F	Precipitation, in.	Frost-free days†
1988	13 June	2273	20.9	123
1989	15 June	2043	24.3	147
1990	11 June	2203	26.5	161
1991	7 June	2111	19.8	152
1992	18 June	1846	28.9	125
1994‡	14 June	1924	35.9	163

† Frost-free days are the number of days between planting and the first day with a minimum temperature of 32°F.
‡ Drought prevented the establishment of a cotton crop in 1993.

Wheat (cv Coker 9227) was planted in November at 90 lb/acre. Conservation tillage plots were planted with a Kelley conservation drill in 1988, a United Farm Tool conservation grain drill (United Farm Tool, Glasgow, KY) from 1990 to 1993, and a John Deere model 750 conservation grain drill (John Deere and Co., Moline, IL) in 1994. The conventional tillage plots were planted with a Case Model 5100 grain drill.

Wheat yields (9.8% moisture) were measured by harvesting an area of 1000 sq ft with an Almaco plot combine (Almaco, Nevada, IA). Seed cotton yields were measured from 635 sq ft of row with a two-row spindle picker. An estimate of cotton yield loss from late planting was obtained by comparison of seed cotton yields in this experiment from 1991 to 1994 to yields of full-season PD 3 under nonirrigated conditions in a contiguous field experiment (Camp et al., 1997). Heat units were obtained by summation of mean daily temperatures minus 60°F from planting until harvest. All data were subjected to analysis of variance (ANOVA), and least significant difference (LSD) was computed when F-test values from the ANOVA were significant at the 0.05 level (SAS, 1990).

RESULTS AND DISCUSSION

There was a significant site-year × tillage interaction ($P \leq 0.01$) for wheat yield. Conservation tillage yields were 31% larger and 62% smaller than conventional tillage yields in 1991 and 1992, respectively. However, the 5-yr means of 2039 and 2057 lb/acre for conservation and conventional tillage, respectively, were not significantly different (Table 3); and they were close to the South Carolina state average, 2400 lb/acre, for the study period. Yields may have been limited by lack of deep tillage. Frederick and Bauer (1996) recently demonstrated that conservation tillage yields for wheat on a Coastal Plain soil were optimal for conservation tillage when deep tillage was used to disrupt hardpans.

Table 5. Seed cotton yield of cultivars grown under conservation and conventional tillage in 1989–1992.

Year†	Tillage‡	PD 1	PD 3	DP 20	DP 50	DP 90	Mean§
		lb/acre					
1989	Cst	1236	989	1528	1432	921	1221
	Cvt	1127	1095	1321	1172	822	1107
1990	Cst	626	928	943	1140*	1303*	988
	Cvt	1269*	716	868	558	758	834
1991	Cst	1631	2132*	2190*	1962	1940*	1971
	Cvt	1804	1717	1632	1872	1504	1706
LSD (0.05) for comparing cultivar in tillage and year = 376							
LSD (0.05) for comparing tillage in year and cultivar = 379							
Mean‡	Cst	1164	1350	1554*	1511*	1388*	1393
	Cvt	1400*	1176	1274	1201	1028	1216
LSD 0.05 for tillage × cultivar = 219							

* Tillage comparisons are significantly different at the 0.05 level by the least significant difference test.
† Crop failures in 1988 and 1992 were due to early frost, and crop failure in 1993 was due to drought at planting time.
‡ Cst = conservation tillage and Cvt = conventional tillage.
§ P values for the F-test were tillage, 0.01; tillage × year, 0.38; tillage × cultivar, 0.01; year × cultivar, 0.01; year × tillage × cultivar, 0.01.

Since the growing season is shortened, doublecropped cotton production is even more affected than full-season cotton by growing conditions, particularly at planting and harvest. Delays in planting because of drought or excess rainfall can cause loss of growing days or stand failure, and early frost can reduce or eliminate yields. Planting date, heat units, precipitation, and frost-free growing days for six cotton growing seasons are presented in Table 4. During the cotton growing seasons, rainfall ranged from 20 to 36 in. Frost-free days ranged from 123 to 163, and heat units ranged from 1846 to 2273°F. Early season freezes (123 to 125 frost-free days) ruined the late-planted cotton crops in 1988 and 1992 because the cotton bolls had not opened prior to the freezes. A June drought caused crop establishment failure in 1993. However, the remainder of the 1993 growing season was good. In a nearby experiment that was planted on 11 June with sufficient water for germination, more than 1340 and 2260 lb/acre of seed cotton were produced in the nonirrigated and irrigated treatments, respectively. This underlines the importance of sufficient water to insure stand establishment and reduce risk when short-season cotton is planted immediately after wheat harvest. When drought is not so extensive that it depletes all of the water in the soil surface, the moisture saved from reduced tillage and surface mulch may be critical in stand establishment. In addition to temperature and water, N is often affected by conservation tillage, but Karlen et al. (1996) found that fertilizer N uptake from microplots on this site was not consistently different between the tillage treatments.

From 1989 to 1991, there were more than 147 frost-free days and more than 2012°F heat units per season, and the overall seed cotton yield ranged from 558 to 2190 lb/acre (Table 5). The best site-year was 1991 when the conservation tillage mean was 1971 lb/acre. The means for conservation and conventional tillage during these three site-years were 1393 and 1216 lb/acre, respectively ($P \leq 0.01$). The F-test for tillage × cultivar was highly significant ($P \leq 0.01$).

Table 6. Seed cotton yield of cultivars under conservation and conventional tillage in 1994.

Tillage†	Cultivars						
	St 132	St 453	St 907	DP 20	DP 50	DP 90	Mean*
	lb/acre						
Cst	591	625	664	1109	798	867	776
Cvt	419	314	464	667	772	499	523
Mean	505	470	564	888	785	683	
LSD 0.05 for cultivar = 200							

* Tillage and cultivar were both significantly different at the $P \leq 0.01$ level by the F-test.

† Cst = conservation tillage and Cvt = conventional tillage.

The ranking of yields for the DP cultivars corresponded to their order of earliness with DP 20 highest and DP 90 lowest. All three DP cultivars consistently yielded higher with conservation tillage than with conventional tillage. The PD cultivars were less consistent in their yield response to conservation tillage. When averaged across years, PD 1 yielded better under conventional than conservation tillage, and it was the highest yielding cultivar under conventional tillage. The early DP cultivars (20 and 50) were superior to the PD cultivars for production under conservation tillage at the latitude of this investigation, but PD cultivars were similar to the later-maturing cultivar, DP 90. The site-year × tillage × cultivar interaction was also significant ($P \leq 0.01$). This was related to variation with tillage and year for PD 1 and PD 3 and to the cultivar ranking among years with DP. However, the DP cultivars were always higher for conservation tillage.

In 1994, the DP cultivars yielded better than the early cultivars of St under both tillages (Table 6). Cultivars were significantly different ($P \leq 0.01$); DP 20 again yielded the highest. The planting date of 15 June was late, but the first freeze was also late, which resulted in 163 frost-free days. However, a cool September lowered the accumulation of heat units to 1924°F, and the seed cotton yields were less than 900 lb/acre with the exception of DP 20, which yielded 1109 lb/acre under conservation tillage. The average seed cotton yields for 1994 were 776 and 523 lb/acre, respectively, for conservation and conventional tillage; and tillages were significantly different ($P \leq 0.01$). The tillage × cultivar interaction was not significant ($P \leq 0.14$); all cultivars yielded better under conservation tillage.

A major question concerning doublecropped cotton is the potential yield reduction. Cotton yield loss from the shortened season was estimated by comparison of seed cotton yields of full-season PD 3 obtained in this experiment in 1991 to those obtained in a contiguous field experiment grown under nonirrigated and irrigated conditions (Camp et al., 1997). The mean yield of doublecropped PD 3 was 60 and 48% of the full-season PD 3, respectively, under conservation and conventional tillage.

The performance of DP 20 indicates that there are possibilities for the development of doublecropped cotton and wheat in the northern latitudes of the cotton-producing portion of the eastern Coastal Plain. Frequent crop failures associated with the short growing season indicate that earlier-maturing cultivars for both cotton and wheat have to be developed. The most encouraging result of this investigation was the consistently better production of doublecropped cotton under conservation tillage. This indicates that the soil improvements associated with continuous conservation tillage are having positive effects on yields (Hunt et al., 1996). In addition, in an actual production system, the conservation tillage cotton could be planted immediately after harvesting rather than after field preparation; and the wheat could be harvested at a higher moisture content with a commercial combine than with our plot combine. These two factors could make a critical difference in days before frost for some years. Thus, cotton producers may benefit significantly from the improved production capacity of continuous conservation tillage even on Coastal Plain soils.

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