Performance of Corn, Wheat, and Cotton in a Two-year Rotation on a Norfolk Loamy Sand Soil after 10 Years of Conservation or Conventional Tillage

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Abstract

Conservation tillage offers the possibility of conserving natural resources and optimizing crop productivity through controlled soil erosion, reduced soil compaction, increased water use efficiencies, and reduced energy costs. Fulfillment of this possibility in a particular physiographicregion requires adaptation to the soils and cropping systems of that region. A rotational system of corn, small grain, and soybean has been studied rather extensively in the Eastern Coastal Plain. However, investigation of rotational systems that used cotton and conservation are limited. A two year rotation of corn, wheat, and cotton was grown on a Norfolk loamy sand with conservation and conventional tillage. Tillage systems were not significantly different for any of the crops, but cotton cultivars were significantly different. The rotation appears to be a viable production option, but research is continuing to asses the long term effects of tillage and the limitations of frost free days.

Conservation tillage has been viewed as a promising technology for conserving natural resources and optimizing crop productivity through controlled soil erosion, reduced soil compaction, increased water use efficiencies, and reduced energy costs since the early 1970's. Enthusiastic reports of success in hilly areas of the Southeast resulted in an 80% increase in conservation tillage usage in the southeastern USA between 1973 and 1983 (Christensen and Magleby, 1983). Corn (*Zea mays* L.), wheat (*Triticum aestivum* L.), and soybean [*Glycine max* (L.) Merr.] were the first crops evaluated using conservation tillage in the Coastal Plain (Campbell et al., 1984; Karlen et a1.,1984, 1985, 1987; Hunt et al., 1985, 1987).

Initial conservation tillage experiences on the sandy soils of southeastern Coastal Plain revealed soil fertility and plant establishment problems that resulted in reservations concerning the utility of these practices. Sojka et al. (1985) concluded that differences in soil physical and chemical properties could affect conservation tillage in this region. Reduced crop yields associated with non-uniform plant establishment was often a significant problem with conservation tillage on sandy coastal plain soils. Karlen and Sojka (1985) reported that corn yield differences between conservation and conventional tillage systems were initiated by early season differences in plant growth and development. They observed that only 27 to 43% of the plants had emerged during the first week after planting when conservation tillage was used, but 64 to 77% of the plants had emerged when conventional tillage was used. Lower yields and dry matter production of wheat with conservation tillage has also been attributed to non-uniform plant establishment (Karlen and Gooden, 1987). Early research was conducted with less advanced conservation tillage equipment, and poor seed-soil contact was a major factor contributing to non-uniform plant establishment.

More recently, an eight-year evaluation by Karlen et aL(1989) showed that Coastal Plain soil fertility levels could be maintained by using current soil-test procedures and recommendations for lime and fertilizer application. Several improvements in planters and in-row subsoiling equipment for conservation tillage have made it possible to establish more uniform plant stands with conservation tillage. Corn, wheat, and soybean systems have been investigated rather extensively. However, conservation tillage research with cotton [*Gossypium hirsumtum* (L)] in the southeastern Coastal Plain has been limited (Roach, 1981; Roach and Culp, 1984; Baker. 1987). The present study was initiated to evaluate the influence of conservation tillage on productivity of a two-year, corn-wheat-cotton rotation.

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Materials and Methods

Conventional and conservation tillage plots that were 75 feet wide and 200 feet long were established in 1979 on a Norfolk loamy sand soil (fine-loamy, silicious, thermic, Typic Paledult) at the Clemson University Pee Dee Research and Education Center near Florence, SC. Continuous corn was grown from 1979 through 1982. A two-year rotation consisting of a wheat-soybean double crop followed by corn was used between 1983 and 1986. The site was chemically fallowed in 1987 to control bermudagrass [*Cynodondactylon* (L.)] and Johnson grass [*Sorghum halepense* (L.)] infestations. In 1988, the two-year rotation was changed to acorn-wheat-cotton sequence. Sub-plots (10 feet wide by 7.5 feet long) were used for plant sampling to insure that sequential samples would be taken from the same area. Conventional tillage consisted of multiple diskings and cultivation. Surface tillage was eliminated for conservation tillage treatments. Corn and cotton were planted with Case-IH Series 800 Early-Riser planters, and in-row subsoiling was used with both tillage systems to fracture a root-restrictive E horizon. Wheat was planted with a Kelley Manufacturing (KMC) Uni-drill for conservation tillage and a John Deere Grain Drill for conventional tillage.

Prior to planting the corn, dolomitic lime and fertilizer (0-10-20) were applied at the rate of 2000 and 500 lbs/acre, respectively. Corn (Pioneer 3165) was planted on 30-inch rows at the rate of 25000 seeds/acre in April 1988. Liquid nitrogen (30% UAN) and 'Furadan' (carbofuran) were applied at the rate of 30 and 13.3 Ibs/acre, respectively, at planting. Immediately after planting, 'Atrazine' and 'Lasso' were applied to the conventional tillage plots; 'Atrazine', 'Lasso', and 'Gramoxone' were applied to the conservation tillage plots at recommended rates. Forty days after planting, additional liquid nitrogen (120 lbs/acre as 30% UAN) was applied to both tillage systems.

Following corn grain harvest, wheat (Coker 9227) was planted in November, 1988. Prior to planting, corn stover was disked into the the soil surface. for conventional tillage; it was chopped but left on the soil surface for conservation tillage. Fertilizer (10-10-10) was applied at the rate of 450 Ibs/acre. Wheat was planted at the rate of 90 Ibs/acre. Immediately after planting, 'Roundup' was applied to the conservation tillage plots. In March, 1989, wheat was sidedressed with 60 Ibs/acre of nitrogen (30% UAN).

Following wheat grain harvest, cotton was planted in June, 1989. Six cotton cultivars (Delta Pine 20, Delta Pine 41, Delta Pine 50, Delta Pine 90, PD1, and PD3) were planted in 38-inch rows at the rate of 55000 seeds/acre. Nitrogen was applied at the rate of 25 Ibs/acre at planting and at 50 lbs/acre four weeks after planting. 'Temik' was applied at the rate of 2 Ibs/acre; 'Meturon' was applied to the conventional tillage plots; and 'Meturon' and 'Roundup' were applied to the conservation tillage plots immediately after planting. Seed cotton was harvested in November, 1989.

Yields for corn, soybean, and all six cultivars of cotton were taken from 200 feet of row in each main plot with a mechanical harvester. Corn, wheat, and seed cotton ('PD1') yield, number, and dry matter samples were obtained from the sub-plots prior to the main plot harvest. Analysis of variance. and least significant differences were calculated using a randomized complete block design with five replicates.

Results and Discussion

Tillage practices did not significantly affect corn or wheat or 'PD1' cotton yields (Table 1). Plant stand and dry matter were similar for both tillage systems. The equivalent yields with the two tillage systems were possible because of adequate plant stands. The improved yields with conservation tillage in this study relative to yields with conservation tillage in earlier studies may be partially due to the increased organic matter and nitrogen in the surface layer over the ten year period.

Table 1. Yield, plant populalion, and biomass of corn, wheal, and cotton plants in sub-plots at harvest as influenced by conservation and conventional tillage in a two-year rotation

			-----------Plant-----------	
Crop	**Tillage**	**Yield**	**Number**	**Weight**
		-bu/ac-	-No./ac-	-tons/ac-
Corn	**Conservation**	**91.8**	**18005**	**6.49**
	Conventional	**89.8**	**18179**	**5.84**
	LSD $_{0.05}$	**NS+**	**NS**	**NS**
Wheat	**Conservation**	**29.5**	**-----**	**1.97**
	Conventional	**30.7**	**-----**	**2.00**
	LSD $_{0.05}$	**NS**		**NS**
Cotton	**Conservation**	**1983++**	**26543**	**2.25**
	Conventional	**2027**	**26020**	**2.38**
	LSD $_{0.05}$	**NS**	**NS**	**NS**

+The term 'NS' indicates that data between tillage systems were not statistically different.
++Seed cotton yields are reported in lbs/acre.

Seed cotton yields were significantly different among cultivars ($p < 0.01$) (Table 2). Cotton cultivars 'Delta Pine 50 and 20' had the highest yields with either tillage practices, and they both had significantly higher yields with conservation tillage. The cotton yields of the hand sampled subplots of 'PD1' cotton were higher than those of the main plots (Table 1 vs Table 2). However, the differences between tillage methods were small and nonsignificant in both cases. Thus, the data from the first cycle of the rotation system show conservation tillage to be equal to conventional tillage for yield.

Table 2. Seed cotton yields as influenced by cultivar and tillage.

	Cotton Cultivar					
Tillage	**DP2O**	**DP41**	**DP50**	**DP90**	**PD1**	**PD3**
	------------------------lbs/ac-----------------------					
Conservation	**1529**	**1061**	**1404**	**921**	**1235**	**1032**
Conventional	**1275**	**1095**	**1168**	**822**	**1126**	**1094**
Mean	**1402**	**1078**	**1286**	**872**	**1181**	**1063**
LSD $_{0.05}$	**235**					

Conclusions

These studies indicate that cotton grown in a two-year rotation with corn and wheat is a viable conservation tillage rotation for the southeastern Coastal Plain. However, selection of early maturing cultivars will be important for this crop rotation with any tillage system. Further studies are being conducted to better understand the long term effects of conservation tillage.

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