Conservation Tillage in Soybean and Corn in the South Carolina Coastal Plain

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Abstract

Numerous variations of conservation tillage (CT) systems have been adopted for soybean, corn and double-crop wheat grown on Coastal Plain Ultisols. A systematic investigation of the effect of these variations in cultural practices on yields was needed. A long term tillage study was established in Florence, SC to study these variations in conservation tillage systems. Soybean yields were favored by CT but were reduced by drilling. Burning of double-crop residues showed no yield advantage. Corn yields were slightly reduced by conservation tillage systems in which residues were left standing at planting. Double-crop yields were greatly increased by deep primary tillage. Double-cropped wheal and reduced operations with CT in soybean increased cash returns. However, caution is still in order when considering CT for corn in the Coastal Plain.

Introduction

Conservation tillage (CT) is a broad term as applied to farming practices in the SC Coastal Plain. A range of farming practices and rotations are often combined to create production systems suitable to a farmer's particular needs or perception of needs. These combinations of practices are the result of various factors including changing market prices and their influence on rotational schemes, equipment flexibility, pest control considerations, and the need to manage excessive accumulation of surface residues. Because of dense root-restrictive subsoil horizons in most Coastal Plain Ultisols, nearly all CT systems imply in-row subsoiling in conjunction with planting (Sojka et al.. 1984; Busscher ct al., 1986).

In addition to rotation of corn *(Zea mays* L.) and soybean *(Glycine max* (L.) Merr.) common system components in South Carolina often include Fall cover crops or double-cropping with small grains, Fall disking. Fall fallow (no disking until Spring, but without a cover crop). Spring disking or spraying of cover crops two to three weeks prior to planting, Spring disking or spraying of cover crops immediately before planting and Fall or Spring burning of double-crop small grain stubble and residues. Small grains used in double-cropping and for cover cropping can include rye *(Secale cereale* L.), wheat *(Triticum aestivum* L.), and barley *Hordeum vulgare* L.). Drilling of soybean after double-crop small grains has gained acceptance in some areas, especially if soybean planting is delayed beyond early June. However, this eliminates in-row subsoiling.

In order to compare these kinds of variations, two large field experiments were conducted in adjacent fields. The studies were conducted simultaneously to allow observation of annual meteorological effects on related treatments of a corn and soybean rotation.

Methods and Materials

These studies were conducted from I982 to 1985 at the Coastal Plains Soil and Water Conservation Research Center near Florence, SC. Two fields were established. Field #I was the continuation of a long term tillage study (Campbell, et al.. 1984a,b) with corn and soybean rotation in the plots going back to 1980. Field #2 was established in the Fall of 1981 with the planting of the study area to barley. The barley crop was completely lost to a severe frost in Spring of 1982 at the time of flowering, and was managed subsequently as a cover crop. Prior to establishment of these studies the fields had been alternately "weed fallowed" and cropped to Tobacco (Nicotiana tabacum L.) for several decades. The soil in the study area was classified as Norfolk sandy loam (fine-loamy, siliceous, thermic Typic Paleudult).

The study was in a randomized split block design in four replications, with Tillage main plots sometimes split for cultivar or planter subplots as indicated in tables I and 2. Fertilizer was surface granular applied prior to each crop's operations according to South Carolina standard production recommendations. Liming was surface applied at a rate of 1000 lb/acre $CaC0_3$ equivalent applied each Spring prior to row-crop planting. Herbicides and pesticides follow SC Exp. Stn recommendations and were as reported for the early years of the study of the study (Campbell, et al., 1984a, b).

Planting for all tillage regimes was with a Brown-Harden Super Seeder', except for drilling operations, which were with a KMC Unidrill. Drilled soybean plots were subsoiled on 30 in. spacing in a separate operation immediately prior to planting. Plots were 135 ft by 45 ft. Row Crops were on 30 in. spacing. The Unidrill was 10 ft wide, with 7 in. drill spacing. When row planting vs drill comparisons were made th ree drill passes were planted alongside one six-row super-seeder pass to fill the plot area. Corn and Soybean were planted 19,000 and 80,000 plants per acre respectively; and wheat was planted at a rate of 60 lbs of seed per acre. A 125 ft pass through the center of each subplot with a 60 in. wide plot-combine constituted the harvest area for each subplot. In the fall of 1984 the corn in the field designated as field #2 was followed by wheat in treatments 3. 4, 5, and 6. using no-till planting with the KMC Unidrill, or field preparation by disking, moldboard plowing, or chisel plowing. respectively to establish the treatments.

A schematic summary of cultural operations for the duration of the study is presented in table I and 2. Treatment I is a conventional tillage treatment, treatment 2 is a reduced tillage treatment, and treatments 3 through 6 are conservation tillage treatments. Analysis of variance and paired treatment comparisons of yields were accomplished using appropriate

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Table 1. Schematic of field surface-residue/tillageopera-tions for FIELD #1 for 1983, 84, and 85.

Trtmt	barley soybean (1983)	wheat	soybean (1984)	corn (1985)
1	disk/H disk/M PPI plant	disk/H disk/M	disk/H disk/M PPI plant	disk/H disk/M plant spray/PE
2	disk/H disk/L plant spray	disk/H	disk/H disk/L plant spray/PE	disk/H disk/L plant spray/PE
3	stubble plant spray/PE	stubble plant spray/E harvest/E	stubble plant spray/PE	stubble spray/L plant spray/PE
4	stubble burn/L plant spray/PE	disk/H plant spray/E harvest/E	stubble burn/L plant spray/PE	stubble spray/E plant spray/PE
5	stubble burn/L disk/L plant spray/PE	stubble plant	stubble burn/L disk/L plant spray/PE	stubble disk/E plant spray/PE
6	stubble disk/L plant spray/PE	disk/H plant	stubble disk/L plant spray/PE	stubble disk/L plant spray/PE

The Letters H, M, E, and L following operations refer to immediately post-harvest, multiple, early, or late operations in the periods between crops. PPI indicates preplant incorporation of soil-applied herbicides. PE indicates pre-emergence spray of soil surface-applied herbicides. The term "spray" indicates application of either paraquat or glyphosate and "spray/PE" indicates tank mixing of both herbicide systems.

models within SAS for each segment of the study (SAS Institute, Cary, North Carolina).

Results and Discussion

The yields from fields #1, and #2 over the course of the study are presented in tables 3 and 4. Treatments 3, 5,and 6 in field #1 and treatments 2, 4, 5, and 6 in field #2 were statistically indistinguishable from the highest yield for all crops and all years of the study (excluding wheat response to primary tillage in treatment 4 in 1985). Treatments 3, 4, 5, and 6 were all variations of conservation tillage. Treatment 2 utilized no double cropping or planted cover crop but limited tillage to a single disking immediately after harvest and a single disking immediately prior to planting.

Treatment 1, which was the most intensive form of conventional tillage produced the significantly lowest soybean yields in field 1 in 1983 and 1984, and in field 2 in 1985. Though not significantly different treatment 1 also produced among the numerically lowest soybean yields in field 2 in 1982 and 1983 as well. Although the highest yielding soybean treatment varied with field and year, there was a trend for increased yield with one form or another of conservation tillage. These results agreed with earlier findings (Campbell et al., 1984b). Drilling reduced soybean yields in field #2 in 1983 in all but treatment 5, which is consistent with observations of yield reduction in drilled soybean where available soil water was limited (Sojka, et al., 1988). Paired treatment analysis showed no significant effect of burning residues but a significant yield advantage of reduced tillage over conventional.

Corn yields were significantly lowest in treatment 4 in field # I in 19885 and numerically lowest in treatment in field #2 in 1984. In field #2 in 1983 treatment 3 produced only 1 bushel more corn than treatment 4. Treatments 3 and 4 represent no-till planting of corn into standing residues. The highest corn yields produced in field #1 were from treatments 1 and 6. Although none of these high yield trends were significantly greater than the other treatments, they all originated from treaments in which corn was planted in disked ground. Paired treatment comparisons showed a significant

Table 2. Schematic of field surface-residue/tillage operations or FIELD 2 for 1982,83,84 and 85.

Trtmt barley	soybean 1982	wheat	soybean 1983	corn 1984	wheat	soybean 1985
I	disk/H disk/M PPI plant	disk/H disk/M	disk/H disk/M PPI plant	disk/H disk/M plant spray/PE	disk/H disk/M	disk/H disk/M PPI plant
2	disk/H disk/L plant spray/PE	disk/H	disk/H disk/L plant spray/PE	disk/H disk/L plant spray/PE	disk/H	disk/H disk/L plant spray/PE
3	stubble spray/L plant apray/PE	stubble plant spray/E harvest/E	stubble plant spray/PE	stubble spray/L plant spray/PE	stubble plant	stubble plant spray/PE
4	stubble spray/E plant spray/PE	disk/H plant spray/E harvest/E	stubble burn/L plant spray/PE	stubble spray/E plant spray/PE	disk/H disk/M plant	stubble burn/L plant spray/PE
5	stubble disk/E plant spray/PE	stubble plant	stubble burn/L disk/L plant spray/PE	stubble disk/E plant spray/PE	plow/L plant spray/PE	stubble burn/L disk/L plant
6	stubble disk/L plant spray/PE	disk/H plant	stubble disk/L plant spray/PE	stubble disk/L plant spray/PE	Chisel/L plant	stubble disk/L plant spray/PE

The Letters H, M, E, and L following operations refer to immediately post-harvest, multiple, early, or late operations in the periods between crops. PPI indicates preplant incorporation of soil-applied herbicides. PE indicates pre-ermegence spray of soil surface-applied herbicides. The term "spray" indicates application of either paraquat or glyphosate and "spray/PE" indicates tank mixing of both herbicide systems.

Table 3. Yields for soybean, wheat, and corn for treatment in field 1.

Year	Crop	Variety	Treatment 1	2	3	4	5	6
			----	----	----	bu/a	----	----
1983	Soybean	Braxton	24.7	27.6	32.6	36.6	25.8	28.2
		C 488	27.4	29.8	36.5	35.4	33.0	30.8
		C 237	30.2	31.6	38.0	36.2	33.6	33.6
		Mean	27.4b	29.7b	35.7a	36.1a	30.8ab	30.9ab
1984	Wheat	C 797	--	--	49.9a	49.2	50.7a	50.7a
1984	Soybean	C488	19.8b	22.8ab	22.7ab	26.3a	22.3ab	20.2ab
1985	Corn	P 3572	101ab	106a	103ab	97b	106a	100ab

Numbers in the same row followed by the same letter indicate no difference as determined by LSD comparison at the 5% level of probability.

Table 4. Yields for soybean, wheat, and corn for treatment in field 2.

Year	Crop	Variety	Treatment 1	2	3	4	5	6
			----	----	----	bu/a	----	----
I982	Soybean	C237	34.5a	39.0a	34.2a	33.7a	35.2a	35.7a
1983	Wheat	C 797	--	--	24.7a	21.2a	21.[illegible]a	20.7a
1983	Soybean	C 488	36.1	37.1	35.4	37.7	35.8	41.1
		C 488*	33.8	32.7	30.8	36.2	38.0	35.8
		Mean	35.3ab	34.9ab	33.1b	37.0ab	36.9ab	38.4a
1984	Corn	P 3572	139a	131a	129a	128a	135a	138a
I985	Wheat	C 916	--	--	19.2	26.4	45.7	28.8
		C983	--	--	29.1	36.9	47.1	41.7
		HX 3021	--	--	39.1	46.3	58.7	48.8
		HX 3022	--	--	34.7	42.4	50.0	42.2
		Mean	--	--	30.5c	38.0b	50.4a	40.4b
1985	Soybean	C368	35.3c	46.3a	40.2bc	42.8ab	41.9ab	43.9ab

*Drilled.

Numbers in the same row followed by the same letter indicate no difference as determined by LSD comparison at the 5% level of probability.

positive yield effect of conventional tillage and disking over planting directly into residue for corn. These results coincide with earlier observations from related work (Campbell et al.. 1984a; Karlen and Sojka, 1985).

Wheat did not produce clear responses to the four reduced tillage regimes compared in field #1 in 1984 and field #2 in 1983. This prompted a comparison of primary tillage operations to prepare for this double-crop between row-crop sequences. The results from field #2 in 1985 clearly indicated a positive response to deep primary tillage for double-crop wheat, with yield increasing significantly with tillage intensity, in the order plow x chisel x disk x no-till.

Conclusion

Various CT systems have been adapted for soybean, corn and double-crop wheat grown on Coastal Plain Ultisols. Burning of double-crop residues showed no yield advantage. Soybean yields were favored by CT but were reduced by drilling. Corn yields were slightly reduced by conservation tillage systems in which residues were left standing al planting. Double-crop yields were increased by deep primary tillage. Double-cropped wheat and reduced operations with CT in soybean have the potential to increased cash returns. Caution is still in order when considering CT for corn in the Coastal Plain.

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