Influence of Irrigation and Conservation Tillage on Corn and Soybean Yields

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Corn and soybean are sometimes grown in sequence in crop rotation systems for the purpose of maintaining higher yields as a result of reduced buildup of crop pests in comparison to monocropping systems. Corn consistently responds to irrigation, even with short intervals of hot dry conditions between rainfall events. Corn yield losses due to stress in excess of 2 bushels per acre per day of stress have been recorded (Rhoads, 1982). Conservation tillage has not been extensively evaluated under irrigation.

One advantage of conservation tillage is a lower fuel requirement for tillage operations, although, yields may not be different from those obtained with conventional tillage (Forbes et al., 1984). Corn yield in Kentucky with conservation tillage was superior to conventional tillage when planting data was delayed (Herbeck et al., 1984). Soybean varieties responded differently to conservation tillage in Alabama (Granade and Akridge, 1984). Some soybean varieties yielded higher with conservation tillage than with conventional tillage, while others gave the opposite response, and still others did not respond to tillage variables. Where soil compaction was a problem, subsoiling was necessary for soybeans to produce yields with conservation tillage equal to those with conventional tillage (Hovermale, 1984). Furthermore, subsoiling improved soybean yield in a conventional tillage system on a soil containing a traffic pan in North Florida (Rhoads, 1978).

Objectives of this experiment were to determine corn and soybean yields with different tillage systems for both irrigated and unirrigated cropping systems.

Materials and Methods

This experiment was conducted in 1986 and 1987 on an Orangeburg loamy fine sand on the North Florida Research and Education Center at Quincy.

Fertilizer rates were 500 pounds of 0-10-20 per acre each year for both corn and soybeans, irrigated and unirrigated. Irrigated corn received 600 pounds of ammonium nitrate per acre each year. Unirrigated corn received 400 pounds per acre of ammonium nitrate in 1986 and 600 pounds per acre in 1987. Nitrogen was not applied to soybeans. Row width was 30 inches each year for both corn and soybeans. Plant population was 30,000 plants per acre for irrigated corn and 20,000 plants per acre for unirrigated corn. Soybeans were planted about 2 inches apart in the drill.

Dekalb-Pfizer (DK-748) corn was planted in irrigated treatments and DK-689 corn was planted in unirrigated treatments on March 13, 1986. Dekalb-Pfizer (DK-689) corn was planted on March 17, 1987 in both irrigated and unirrigated treatments. Soybeans (Braxton cv.) were planted in both irrigated and unirrigated treatments May 27, 1987. Unirrigated soybeans were replanted June 30, 1987 because of poor germination due to lack of rainfall.

Irrigation was applied with a center pivot system in half-inch increments when soil-water suction at the 6-inch depth exceeded 20 centibars. Unirrigated plots were outside of the area irrigated with the center pivot and adjacent to the irrigated plots.

Tillage treatments are shown in Table 1. Conventional tillage (CT) included disking until weeds and crop residues were buried and using an S-tine cultivator with a crumbler attachment to level the seedbed before planting. Conservation tillage (MT) was accomplished with a subsoiler having fluted coulters to prepare a seedbed over the subsoiler slot. A two-row John Deere 71® planter was used to plant both conventional and conservation tillage systems. Three procedures were used to increase soil-water infiltration in 1986: (1) mid-

Table 1. Tillage treatments applied to corn in 1986 and to corn and soybean in 1987.

	1986		1987	
Nu.	Unirrigated	Irrigated	Unirrigated	Irrigated
1	CT*	CT	CT	CT
2	CT+IRSS	CT+IRSS	MT+IRSS	MT+IRSS
3	CT+IRMSS	—	—	—
4	CT = IRMSSDD	—	—	—
5	CT+RS	—	—	—
6	Same as No. 4 Fall and Spring	—	—	—
7	MT+IRSS	MT+IRSS	—	—
8	MT+IRMSSDD	—	—	—
9	Bottom Plow	—	—	—
10	CT+MB at layby	CT+MB at layby	—	—

* CT = conventional tillage, MT = conservation tillage, MB = middle buster, IRSS = in-row subsoil, IRMSS = in-row and middle subsoil, IRMSSDD = in-row and middle subsoil with Dammer Diker, RS = rain saver. The Dammer Dikef is made by Ag Engineering and Development Co., P.O. Box 2814, Tri-Cities, WA 93302. The Rain Saver® is made by Sam Stevens, Inc., Route B, Lamesa, TX 79331.

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dles were subsoiled after corn was planted; (2) a paddle wheel type implement (Dammer Diker®) was attached behind the subsoiler as it was pulled through the middles to dig about 12,000 gallon-sized holes per acre to catch rainfall and reduce runoff; and (3) a second paddle wheel implement (Rain Saver®) was attached behind cultivator sweeps to build dikes in middles to reduce runoff. The Dammer Diker was used in the fall on one treatment to reduce runoff during winter rains and also after planting to reduce runoff during summer thunderstorms.

Roundup® was used to control weeds on conservation tillage plots before crop emergence. Lasso@ and atrazine were applied postemergence to corn plots at the two-leaf stage and Lasso was applied premerge to soybean.

Yield data are reported at 15.5 percent moisture for corn and 12 percent moisture for soybeans. Orthogonal contrasts were used for statistical comparison of treatment means (Steel and Tome, 1960). The experimental design was a randomized complete block with four replications.

Results and Discussion

Irrigated corn did not respond to tillage methods in 1986 (Table 2). Subsoiling in-row and middle was superior to subsoiling in-row only for unirrigated corn with conventional tillage. However, subsoiling in-row and middle was no better than subsoiling in-row only with conservation tillage. Subsoiling in the middle between rows obviously increases water movement into the soil from rainfall. Mulch from crop residue increases water infiltration into the soil and reduces evaporation from the soil surface in conservation tillage systems in

Table 2. Influence of tillage and irrigation on grain yield of eorn in 1986.

Tillage treatments	Yield (bulac) Unirrieated	Irrieated
CT[1]	14a[2]	190a
CT + IRSS	22a	187a
CT + IRMSS	38b	—[3]
CT + IRMSSDD	41b	—
CT + RS	28ab	—
CT + IRMSSDD Fall and Spring	36b	—
MT + IRSS	37b	186a
MT + IRMSSDD	37b	—
Bottom Plow	37b	—
CT + MB layby	27ab	199a

'See Table 1 for treatment description.

[2]Treatment not included under irrigation.

'Means within columns followed by same letter are not significantly different (P>0.05).

Table 3. Influence of tillage and irrigation on grain yield of corn and soybean in 1987.

Tillage	Corn		Soybean	
treatment	Unirrigated	Irrigated	Unirrigated	Irrigated
		bu/acre		
CT'	107a[2]	192a	35a	3Ya
MT+ IRSS	111a	181a	3Yb	39a

[1] See Table 1 for treatment description.

[2] Means within columns followed by the same letter are not significantly different (P>0. 10).

comparison to conventional tillage systems. Therefore, increased water movement into the soil as a result of subsoiling in middles is not as important in conservation tillage systems as in conventional tillage systems. In-row subsoiling only did not increase yield with conventional tillage. The Dammer Diker did not increase yield over subsoiling in middles alone in either tillage system. A 14 bu/acre yield increase occurred from use of the Rain Saver in the conventional tillage system. Power requirement is less for the Rain Saver than for a subsoiler. Yield difference between conservation tillage and conventional tillage was not significant (P >0.10) with in-row and middle subsoiling.

Tillage practices that increase rooting depth and/or total water infiltration result in yield improvement only if soil conditions and rainfall distribution complement each other. For example, if rainfall events are spaced close enough to prevent water stress without such tillage practices or if they are spaced far enough apart to severely stress the crop with these tillage practices, then no response is likely to occur. A yield response is expected when rainfall events are spaced such that plants with restricted rooting depth or restricted water infiltration become stressed while plants treated with tillage practices to relieve these problems are not stressed. Rainfall intervals that favor a yield response to tillage are greater for soils with high water holding capacity than for soils with a low water holding capacity.

Irrigation improved corn yields with both conventional and conservation tillage systems in 1987 (Table 3). The yield increase was 79 percent for conventional tillage and 63 percent for conservation tillage. However, there was no corn yield response to tillage with either irrigated or unirrigated treatments. Soybeans did not respond to irrigation, although, planting date was delayed about 30 days for the unirrigated plots due to lack of rainfall. Irrigated plots produced larger plants, but rainfall was adequate after unirrigated plots were planted the second time. There was, however, a slight response to tillage in the unirrigated plots of about 5 bu/acre (P > 0.10).

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