Corn and Soybean Response to Conservation Tillage, Irrigation, and Short Term Crop Rotation

F.M. Rhoads[1]

Introduction

Crop rotation to increase yield has not been emphasized since adequate supplies of low cost nitrogen fertilizers became available. Recent research with crop rotation has been related mostly to soil erosion and water infiltration (Laflen and Moldenhauer, 1979) with yield response not reported in most cases.

There are several advantages and disadvantages of crop rotation listed by Kurtz et al. (1984). The most important advantages are: legumes provide a source of N for other crops, protection against soil erosion, improved aeration and drainage, increased water-holding capacity, better pest control, and elimination of autoallelopathy. Two main disadvantages are maximum land area is not available to highest value crop and more equipment is required that with a monocropping system.

Interest in crop rotation before low cost N fertilizer was mainly due to increased corn yields as a result of N supplied by a previous legume crop. However, corn yield increases of as much as 17% have been observed after soybean that could not be attributed to N from the legume (Welch, 1979 and Vandoren et al., 1976). Not much information is available on legume yields in response to rotation. However, soybean yields declined by 40% when grown continuously for three years in North Florida (Rhoads and Manning, 1989). Quantitative data showing yield response to crop rotation would be useful to crop producers in making management decisions of whether or not to rotate and how often to rotate.

Irrigation and conservation tillage practices have expanded quite rapidly during a period when crop rotation has not been widely practiced. Therefore, not much is known about yield response to crop rotation under irrigation or with conservation tillage.

The objective of this research is to determine yield re-

[1]Soil Scientist, Univ. of Florida, Institute of Food and Agricultural Sciences, North Florida Res. and Educ. Ctr., Quincy, Florida 32351. Florida Agric. Exp. Sta. Journal Series No. 10015.

sponse of corn and soybean to crop rotation and conservation tillage with and without irrigation.

Materials and Methods

This experiment was initiated in 1987 on a Dothan loamy fine sand on the North Florida Research and Education Center at Quincy.

Fertilizer rates were 500 lb of 0-10-20 per acre each year for both corn and soybean. Corn received 600 lb of ammonium nitrate per acre each year. Nitrogen was not applied to soybean.

Row width was 30 inches each year for both corn and soybean. Corn plant population was 30,000 plants per acre. Soybeans were planted about 2 inches apart in the drill.

DeKalb-Pfizer (DK689) corn was planted on March 17, 1987 and March 25, 1988 in both irrigated and unirrigated treatments. Soybean (Braxton cv.) was planted in both irrigated and unirrigated treatments May 27, 1987. Unirrigated soybean was replanted June 30, 1987 because of poor germination due to lack of rainfall. Soybean (Thomas cv.) was planted in irrigated plots June 14, 1988 and unirrigated plots were planted July 7, 1988.

Irrigation was applied with a center pivot system in 1/2 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.

Regular tillage (RT) included disking until weeds and crop residues were buried and using a S-tine cultivator with a crumbler attachment to level the seed bed before planting. Conservation tillage (CT) was accomplished with a subsoiler having fluted coulters to prepare a seed bed over the subsoiler slot. A two-row John Deer 71 planter was used to plant both regular and conservation tillage systems. The crop rotation plan is show in Table 1.

Table 1. A four-year rotation plan for determining quantitative effects of tillage and cropping system on yield of irrigated and unirrigated corn and soybean.

	Year			
Tillage	1987	1988	1989	1990
RT†	Corn	Corn	Corn	Corn
	Soybean	Soybean	Soybean	Soybean
	Corn	Soybean	Corn	Soybean
	Corn	Corn	Soybean (Wheat)‡	Soybean
	Soybean (Wheat)$	Soybean (Wheat)$	Soybean (Wheat)‡	Soybean
CT	Corn	Corn	Corn	Corn
	Soybean	Soybean	Soybean	Soybean
	Corn	Soybean	Corn	Soybean
	Corn	Corn	Soybean	Corn
	Soybean	Soybean	Corn	Soybean

†RT = Regular tillage CT = Conservation tillage.
‡Wheat grown during winter months.

Roundup was used to control weeds on conservation tillage plots before crop emergence. Lasso and altrazine were applied postemergence to corn plots at the 2-leaf stage. Lasso and treflan were used for weed control in soybean.

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

Results and Discussion

Irrigated corn yields ranged from 179 to 201 buiacre in 1987 and from 181 to 205 bu/acre in 1988. (Table 2). Unirrigated corn yields in 1987 were about twice those of 1988. Higher soybean yields in 1988 than in 1987 may be due to variety difference (Table 2).

Table 2. Yield of irrigated and unirrigated corn and soybean grown continuously and in rotation with regular tillage (RT) and conservation tillage (CT) in 1987 and 1988.

	1987			1988		
Tillage	Rotation	Irrig.	Unirrig.	Rotation	Irrig.	Unirrig.
		bu/acre			bu/acre	
RT	Corn	201	94	Corn	197	50
	Soybean	36	36	Soybean	46	37
	Corn	180	107	Soybean	57	45
	Corn	194	119	Corn	205	41
	Soybean?	42	35	Soybean?	56	35
CT	Corn	183	107	Corn	192	30
	Soybean	42	38	Soybean	45	39
	Corn	182	118	Soybean	54	45
	Corn	179	107	Corn	181	32
	Soybean	37	40	Soybean	42	40

†This rotation includes wheat during winter months.

Tillage did not influence ($P > 0.10$) irrigated corn yields in either 1987 or 1988. (Table 3). Unirrigated corn yields were not influenced by tillage in 1987 but conservation tillage reduced ($P < 0.01$) unirrigated corn yields in 1988. The yield difference is attributed to reduced runoff in RT plots because of inter-row cultivation prior to a significant amount of rainfall.

Table 3. Statistical analysis of tillage effects on irrigated and unirrigated corn yield in 1987 and 1988.

			Average yieldt		F test††	
Source of Variation	Year	Irrigated	Unirrigated	Irrigated	Unirrigated
		bu/acre			
Tillage	RT‡	1987	192	107	P>0.10	N.S.
	CT	1987	181	111	2 29	0 35
	RT	1988	201	46	P>0 10	P<0.01
	CT	1988	187	31	13X	11 71

†Irrigation effects cannot be determined statistically because irrigation was not replicated.

††F values arc for comparing means within years. The probability of a greater F value is shown above eachF value.N.S. = not significant ($F < 1.0$).
SRT = regular tillage CT = conservation tillage.

Soybean yields were not influenced by tillage in 1987 nor were unirrigated yields in 1988 (Table 4). Irrigated soybean yield in 1988 was significantly ($P<0.05$) higher in RT plots than in CT plots. However, this was not a response to tillage but rather a response to rotation because the CT plots did not contain a wheat-soybean (WS) rotation. The WS treatment in 1988 irrigated soybean yielded about 20% greater than con-

tinuous soybean. Lack of response to the WS rotation in unirrigated soybean may be due to soil water depletion by the preceding wheat crop. Whereas, the soil was recharged by irrigation in the irrigation WS rotation. Yield of continuous soybean was about 20% less that corn-soybean with irrigation and about 13% less without irrigation.

Table 4. Statistical analysis of tillage and rotation effects on irrigated and unirrigated soybean yield in 1987 and 1988.

Source of Variation	Year	Average yield† Irrigated	Unirrigated	F testtt Irrigated	Unirrigated
		------bu/acre------			
Tillage RT	1987	39	35	N.S.	P<0.10
CT	1987	39	39	0.001	4.98
RT	1988	53	39	P<0.05	P>0.10
CT	1988	47	42	7.60	2.66
Rotation SS§	1988	44	39	P< 0.01	P<0.01
CS	1988	55	45	18.34	11.71
SS (RT)	1988	46	37	P<0.05	N.S.
WS (RT)	1988	56	35	6.37	0.42

†Irrigation effects cannot be determined statistically because irrigation was not replicated. †† F values are for comparing means within years. The probability of a greater F value is shown above each F value. NS = not significant (F<1.0).
§RT = regular tillage, CT = conservation tillage, SS = continuous soybean, CS = soybean following corn SS (RT) = continuous soybean and regular tillage, WS (RT) = wheat in winter and soybean in bummer with regular tillage.

The rotation plan does not allow measurement of corn response to rotation until the third and fourth years of the experiment. However, continuous corn yields were about the same in 1988 as in 1987. Soybean response to rotation can be measured each year with the exception of year one when it was not possible to measure rotation effects in either crop.

References

Kurtz, L.T., L.V. Boone, T.R. Peck, and R.G. Hoeft. 1984. Crop rotations for efficient nitrogen use. p. 295-305. *In* R.D. Hauck (ed.) Nitrogen in crop production ASA, CSSA, and SSSA, Madison, WI.

Laflen, J.M. and W.C. Moldenhauer. 1979. Soil and water losses from corn-soybean rotations. Soil Sci. Soc. AM. J. 43:1213-1215.

Rhoads, F.M. and A. Manning. 1989. Soybean, com, and wheat yields with variable soil pH on Plinthic Acrisols. Fertilizer Research (In Press).

Steel, R.G.D. and J.H. Tome. 1960. Principles and procedures of statistics. New York: McGraw-Hill.

VanDoren, D.M. Jr., G.B. Triplett, Jr. and J.E. Henry. 1976. Influence of long term tillage, crop rotation, and soil type combinations on corn yield. Soil Sci. Soc. Am. J. 40:100-105.

Welch, L.F. 1979. Nitrogen use and behavior in crop production. Ill. Agric. Exp. Stn. Bull. 761, Univ. of Illinois, Urhana-Champaign.