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CROPPING SYSTEMS, TILLAGE AND SOIL FERTILITY EFFECTS ON COTTON YIELDS

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Introduction

Increased plant nutrient utilization, improved weed control and higher crop yields are usual benefits from crop rotation. Grower interest in use of conservation tillage has increased in the South. Such factors as conservation of soil, water and product output economics have influenced this change. Research evaluating crop rotations with feed grains and legumes which utilize biological nitrogen fixation under various conservation tillage systems in the Southwest is limited.

The objectives of our research included the development of crop rotation/tillage systems and nitrogen (N) fertility levels for profitable production of major crops of feed grain and cotton; and to investigate the contribution of a legume in rotation to the N fertilizer requirements of cotton.

Materials and Methods

This experiment was conducted at the Texas A&M University AREC Farm at Corpus Christi for five years (1997-2001). Corn (Zea Mays), cotton (Gossypium hirsutum L., variety CAB-CS) and soybean (Glycine max, variety NK 452) were grown on a Victoria clay soil (Udic Pellusterts). Seeding rates were 80,000, 96,000, and 18,000 seed/Ac for cotton, soybean and corn, respectively. The experiment was conducted in a randomized block design and replicated four times. Crop rotation systems were compared as main plots. These included cotton:corn, corn:cotton, soybean:cotton and continuous corn. Cotton was grown in alternate years with corn and soybean. Minimum tillage (MT, total 5 tillage operations and plow depth <3") was compared with conventional tillage (CT, 10 tillage operations) in a split-plot design. Fertilizer N rates used in the corn and cotton tillage system include 0, 30 and 60 lb/Ac while 0, 15, and 30 lb N/Ac were used on soybean. A RCB design with four replications was used. Phosphorus was blanketed at 20 lb P_2O_5/Ac. All fertilizer was preplant banded in a 5" x 4" relation to the seedfurrow. Glyphosate and gramoxine extra were used between tillage operations to control fall and winter weeds in the MT plots.

Results and Discussion

Data from an earlier rotation study using grain sorghum grown in alternate years with cotton rather than corn showed a stronger contribution from soybean as compared to sorghum. In an unfertilized system the soybean benefit reflected in 75% and 92% yield increases for CT and MT systems, respectively. As N rate was increased to 30 lb/Ac, 12% and 31% increases in lint yields were measured for the same tillage systems. Higher N rates in the CT system reduced benefits from the soybean, but in the MT system, the legume contribution still caused a 17% boost in lint yields over sorghum. In this study without fertilizer N in 1997, soybean boosted lint yields over the corn:cotton rotation by 23 percent (76 lb) in the CT system but only 3 percent (9 lb) with MT (Table 1). Due to delayed planting and a summer drought, yields in 1997 approached only 55 percent of those in previous seasons which apparently resulted in some suppression in treatment response.

At 30 lb N/Ac to corn and 15 lb N/Ac to soybeans, the corresponding yield changes were - 11% (46 lb) and + 0.01% (2 lb) for CT and MT respectively, due to soybean in the rotation. As N was increased to 60 lb N/Ac for corn and 30 lb N/Ac for soybean, cotton following soybean produced 12% less lint under CT and 4% less when grown with MT. Cotton grown under MT appeared to produce better yields when following soybeans as compared to corn (Table 1) especially with higher rates of N fertilizer (30 lb N/Ac vs. 0, 15 lb).

Although lint yields varied widely with seasons due to varied rainfall, average yields under MT compared closely with CT yields for 1997, 1998, and 2000 (Tables 1-2). However, in the fifth year (2001) cotton following soybean and grown under MT produced marked increase in lint especially at the medium and higher rates of N (Table 3). This may be partly attributable to soybean performance somewhat better in the MT system. With normal rainfall in 2001, average cotton yields were 74% higher than in the previous drier seasons. Cotton following corn yielded less lint under MT at all N rates with the largest yield reduction (- 117 lb/Ac) at 0 lb N/Ac. Benefits from MT on cotton yields showed only when cotton followed soybean and progressively increased with N rates as follows: + 84, + 91, + 135 lb lint/Ac.

Plant population data are presented in Table 4-5. Populations varied with years, the effect of tillage intensity and crop rotation on stand establishment appeared not to follow a consistent trend. Generally, very slight differences in stand density were measured due to tillage but slightly larger variation was evident due to crop rotation.

Summary

Results of an earlier study comparing grain sorghum with soybean grown in alternate years with cotton on the same soil indicated soybean to be superior to grain sorghum in increasing cotton lint yields. In this study, the lint yield advantage from soybean in rotation with cotton over corn was smaller than with grain sorghum and varied widely with season and precipitation. Cotton following soybean generally produced lower yields than when planted after corn mostly under the conventional tillage system. This cropping system produced equal or greater lint yields when grown under minimum tillage. At this time we do not offer a plausible explanation for cotton yield decreases with soybean in rotation only under conventional tillage. Perhaps, with the minimum tillage system more residue was accumulated over the past 6 years and moisture conservation through reduced evaporative losses may have been a factor.

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Table 1. Influence of crop rotation, N fertilization and tillage on lint yields, (T-5-97).

		Tillage	
	N Rate	Conventional	Minimum
Cropping System	lb/Ac	lb/Ac	
Corn:Cotton	0	335	348
Soybean:Cotton	0	411	357
Corn:Cotton	30	449	434
Soybean:Cotton	15	403	436
Corn:Cotton	60	428	473
Soybean:Cotton	30	378	455
	x	401	417
LSD 0.05		91	

Table 2. Influence of tillage and N fertilization on lint yields (T-5-98; T-5-00).

	Conventional Tillage		Minimum Tillage	
Nitrogen	lb/Ac			
Rate (lb/Ac)	1998	2000	1998	2000
0	475	421	491	391
30	543	441	579	418
60	632	471	580	424
x	550	444	550	411
LSD 0.05	66	90	66	90

Table 3. Influence of crop rotation, N fertilization and tillage on lint yields (T-5-01).

		Tillage			
		Conv.	Min.	Conv.	Min.
Cropping System	N Rate (lb N/Ac)	Lb/Ac		% change due to soybean	
Corn:Cotton	0	838	721		
Soybean:Cotton	0	621	705	- 26	- 2.2
Corn:Cotton	30	771	713		
Soybean:Cotton	15	651	742	- 16	4
Corn:Cotton	60	862	789		
Soybean:Cotton	30	694	829	- 19.5	5.1
	x	740	750		

Table 4. Influence of crop rotation, N fertilization and tillage on stand establishment (T-5-97).

		Tillage			
		Conv.	Min.	Conv.	Min.
Cropping System	N Rate (lb N/Ac)	Plants/Ac		% change due to soybean	
Corn:Cotton	0	67,070	64,777		
Soybean:Cotton	0	61,338	56,752	-8.5	-12.5
Corn:Cotton	30	62,484	57,898		
Soybean:Cotton	15	59,045	60,191	-5.5	+4.0
Corn:Cotton	60	59,245	59,045		
Soybean:Cotton	30	57,330	55,605	-3.0	-5.8
	x	61,085	59,045	-5.7	-4.8

Table 5. Influence of tillage and N fertilization on plant populations, cotton following corn (T-5-98; T-5-00).

	Tillage				% of Conventional	
Nitrogen Rate	Conventional		Minimum			
(lb N/A)	1998	2000	1998	2000	1998	2000
0	63,631	62,512	57,325	60,144	90	96
30	57,325	49,895	60,191	59,644	105	120
60	63,631	57,350	63,058	64,232	99	109
x	61,439	56,586	60,191	61,340	98	109