Grain Sorghum and Soybean Rotations Evaluated in Conventional and No-Till Planting Systems

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Rotating soybeans with grain sorghum was a popular recommendation for North Mississippi in the early 1980's. Research agronomists of the North Mississippi Branch Experiment Station, however, lacked data to support this recommendation. Consequently, many assumptions were made about benefits of this rotation using data from other areas with different environments and soil types.

Alternate year rotation of soybeans and grain sorghum seemed justifiable on paper but did not always fit into a grower's schedule or take advantage of best yearly market prices. Moreover, growers in north Mississippi have a tendency to rotate only when they have to because of pests. Usually, growers will plant the crop that has the highest market price potential that year.

The lack of local research to justify how much annual benefit one could gain by crop rotation, coupled with which crop could be the most profitable that particular year, created a problem for some growers. Consequently, we felt that we should not only evaluate alternate year rotation, but also determine if soybean and grain sorghum rotations have any carryover effect for yield past the first year of rotation. Another objective was to determine if a rotational system provided any pest control. Since no-till farming was also a popular subject, these evaluations were made using both tilled and no-till farming practices.

Procedures

Two experiments were established on a Grenada silt loam soil with less than 2 percent slope. Soybeans had been grown on both sites in 1980-83 prior to the study. Rhizome johnsongrass had been a problem on both site areas in past years but was controlled 2 years prior to the study with Poast® herbicide applied over-the-top (OT) of soybeans. The identity of each plot was maintained throughout the study. The experimental design was a randomized complete block with four replications. Plots consisted of four rows on 36-inch spacing 50 feet long. The rotation plan used in Experiments 1 and 2 is shown in Table 1. All data for the 1984 season are omitted in order to establish an orderly rotation scheme.

Table 1. Cropping treatments for grain sorghum-soybean rotations North Mississippi Branch.

Trt. no.	Rotation	1984	1985	1986	1987
1.	Continuous GS	GS	GS	GS	GS
2.	Continuous SB	SB	SB	SB	SB
3.	1-year rotations	GS	SB	GS	SB
4.	I-year rotations	SB	GS	SB	GS
5.	2-year rotations	SB	SB	GS	GS
6.	2-year rotations	GS	GS	SB	SB
7.	3-year rotations	SB	SB	SB	GS
8.	3-vear rotations	GS	GS	GS	SB

GS = Grain sorghum; SB = Soybeans

Experiment 1

Grain Sorghum

Plots were disked and chiseled at least 2 weeks prior to planting, then redisked and do-alled immediately before planting each year using a John Deere 7000® planter. Seeding rate was 6 lb/acre using Funk's 522 DR® brand seed treated with Concep® herbicide safener. Fertilizer, at the rate of 65-65-65 (N-P-K), was applied at planting. Bicep® herbicide at 3.0 Ib ai/acre was sprayed broadcast over the plots immediately after planting. Plots were topdressed with 60 Ib N/acre in 4- or 5-leaf stage. Each year all plots were cultivated twice, soil samples for nematodes were taken in early August, and johnsongrass stem counts were made before harvest. Two center rows of each plot were harvested with a plot combine.

Soybeans

Preplant tillage and planting equipment was the same for soybeans as described above for grain sorghum. Seeding rates were adjusted each year to obtain 8-10 plants per foot of row. Essex, Centennial, Asgrow 5980® , and Essex varieties were planted in 1984, 1985, 1986, and 1987, respectively. Essex is susceptible to soybean cyst nematode (SCN) Races 3 and 4; Centennial is resistant to Race 3; and Asgrow is resistant to Races 3 and 4.

Fertilizer was applied at planting at the rate of 0-60-60 (N-P-K). Dual® herbicide was applied preemerge in 1984 and 1985 at the rate of 2.0 Ib ai/acre. Dual and Canopy@ were both applied preemergence in 1986 and 1987 at the rate of 2.0 Ib ai/acre and 1.0 ai/acre, respectively. An application of Basagran® at 0.75 ai/acre was made OT in early season to

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control escaped broadleaf weeds. Applications of Poast® were made OT in early and mid-season at the rate of 0.3 and 0.2 lb ai/acre, respectively, to control johnsongrass.

Plots were cultivated twice during the growing season. Soil samples for nematodes were taken in the row from the plots in early August each year. Two center rows of each plot were harvested with a plot combine.

Results and Discussion

Rhizome johnsongrass in grain sorghum became more abundant when rotation intervals were more than one year. Effective control of rhizome johnsongrass was achieved with one-year rotations with soybeans. Grain sorghum yields were not increased by rotating it with more than one consecutive year of soybeans (Table 2). Since johnsongrass culm counts were made at harvest, they represent both seedling and rhizome plants. Yields of grain sorghum were adversely affected after the second year of continuous grain sorghum following soybeans due to uncontrolled seedling johnsongrass becoming rhizome johnsongrass.

Soybean yields were always higher each year on a one-year rotation than with continuous soybeans. Soybeans in rotation with grain sorghum, however, did not produce significantly higher yields than continuous soybeans (Table 3).

Table 2. Annual yield for grain sorghum and number of johnsongrass culms per 15 feet of row grown in a rotational system with soybeans.

	Grain yield (JG culms/15 ft)		
Rotational system	**1985**	**1986**	**1987**
		lb/a	
Continuous GS	3,405 (12)	908 (88)	651 (124)
GS following SB previous year	4,599 (5)	3,056 (5)	1,694 (19)
GS following SB, 1984 and 85		3,113 (5)	1,869 (58)
GS following SB, 1984, 85, 86			1,676 (20)
LSD (0.05)	ns (ns)	315 (45)	362 (42)
C.V. (%)	34 (136)	8 (78)	15 (48)

GS = Grain sorghum; SB = Soybeans; JG = Johnsongrass.

Table 3. Annual yield for soybeans grown in a rotational system with grain sorghum.

	Grain yield		
Rotational system	**1985**	**1986**	**1987**
		bu/a	
Continuous SB	41	32	20
SB following GS previous year	42	35	21
SB following GS in 1984 and 1985		34	17
SB following GS in 1984, 1985, 1986			18
LSD (0.05)	ns	ns	ns
CV(%)	5	16	14

SB = Soybeans; GS = Grain sorghum

Table 4. Effects of crop rotations on the populations of three types of soil nematodes.

	1987	Nematodes (no./pt of soil)		
Treatment	**crop[1]**	**cyst[2]**	**Lesion**	**stunt**
Continuous GS	**GS**	**19**	**279**	**109**
Continuous SB	**SB**	**341**	**47**	**31**
I-year rotations	**GS**	**3**	**93**	**139**
I-year rotations	**SB**	**238**	**109**	**31**
2-year rotations	**GS**	0	***46***	**0**
2-year rotations	**SB**	**322**	**16**	***46***
3-year **rotations**	**GS**	**47**	**186**	**278**
3-vear rotations	**SB**	**46**	**108**	**78**

[1]Grain sorghum and soybeans are represented by GS and SB, respectively.
[2]Each number is a composite of the number of cyst nematodes in the free larvae hatched, and cyst stages.

Data from nematode analysis were extremely hard to interpret due to high variability. It appeared that the SCN populations were highest in the continuous soybean crop and the lesion nematode numbers were highest in the continuous grain sorghum crop (Table 4).

Conclusion

Johnsongrass in grain sorghum became a greater pest with succeeding years in a continuous till cropping system. A one-year rotation from soybeans to grain sorghum with effective johnsongrass control in soybeans was sufficient in reducing rhizome johnsongrass in grain sorghum. In this study, grain sorghum yields were significantly improved by alternate year rotations over continuous grain sorghum. In the soybean crop, johnsongrass was controlled and yields were not significantly improved in rotation with grain sorghum. In rotation schemes of greater than one year for this study, there appears to be no carryover effect for yield from crop rotations.

Experiment 2

Grain Sorghum

Plots were planted using a John Deere 7000 planter equipped with ripple coulters and cast iron press wheels. Funk's 522 DR brand seed treated with Concep herbicide safener was planted at the rate of 6.0 lb/acre. Fertilizer, at the rate of 65-65-65 (N-P-K) was applied at planting. Roundup@ at the rate of 0.75 lb ai/acre, mixed with Bicep at 3.00 lb ai/acre, was sprayed broadcast over the entire plot area immediately after planting. Plots were topdressed with 60 lb N/acre when plants were in the 4-or 5-leaf stage. Soil samples for nematodes were taken in early August and johnsongrass counts were made before harvest each year. Plots were harvested using a plot combine.

Soybeans

Plots were planted using a John Deere 7OOO planter equipped with ripple coulters and cast iron press wheels. The seeding rate was adjusted each year to obtain 8 to 10 plants

perfoot of row. Essex, Centennial, Asgrow 5980, and Essex varieties were planted in 1984, 1985, 1986, and 1987, respectively. Roundup at the rate of 0.75 lb ai/acre mixed with Dual at 2.0 lb ai/acre was sprayed in 1984 and 1985. Roundup at 0.75 lb ai/acre and Canopy at 3.0 lb ai/acre were sprayed in 1986 and 1987 immediately after planting. An application of Basagran at 0.75 ai/acre was made OT in early season to control escaped broadleaf weeds. An application of Poast was made OT in early and in midseason at the rate of 0.3 and 0.2 lb ai/a, respectively to control johnsongrass. Soil samples for nematodes were taken in early August each year. Plots were harvested with a plot combine.

Results and Discussion

Cyst nematode counts were the highest in continuous soybean plots but non-existent in the alternate year rotation at the end of the study. This indicates that alternate year crop rotation with soybeans and grain sorghum, and switching from susceptible to resistant soybean varieties, may be beneficial in no-till farming to control SCN (Table 5). The continuous grain sorghum plots became so heavily infested with rhizome johnsongrass after the second year that visual observation indicated this was an unacceptable practice. In this study, when grain sorghum was grown for more than 2 consecutive years following soybeans, the grain sorghum became severely infested with johnsongrass and yields were greatly reduced (Table 6).

There did not appear to be any yield advantage for soybeans following grain sorghum in a 1, 2, or 3-year rotation system (Table 7). Even though SCN count increased in continuous soybeans the cyst nematodes never reached a level whereby yield was reduced. Grain sorghum, however, did benefit from rotation because the rhizome johnsongrass pest problem was kept under control in alternate years.

Grain sorghum yields were highest the first year following soybeans in a rotation and then dropped the second year due to competition of johnsongrass.

Table 5. Effects of crop rotations on the populations of three types of soil nematodes from no-tilled planting.

Treatment	1987 crop[1]	Nematodes found (no./pt of soil)		
		Cyst[2]	Lesion	Stunt
Continuous GS	GS	0	325	0
Continuous SB	SB	143	171	31
I-year rotations	GS	0	170	16
1-year rotations	SB	0	46	309
2-year rotations	GS	0	279	341
2-year rotations	SB	15	93	109
3-year rotations	GS	0	46	46
3-year rotations	SB	0	186	16

'Grain sorghum and soybeans are represented by GS and SB, respectively.
2Each number is a composite of the number of cyst nematodes in the free larvae hatched, and cyst stages.

Table 6. Annual yields for grain sorghum and number of johnsongrass culms per 15 ft of row when grown in a rotational system with soybeans from no-till planting.

Rotational system	Grain yield (JG culms/l5 ft)		
	1985	1986	1987
	lb/a		
Continuous GS	2,383 (22)	136 (195)	235 (197)
GS following SB previous year	2,717 (18)	1,494 (52)	1,051 (166)
GS following SB, 1984, 1985		1,354 (40)	305 (234)
GS following SB, 1984, 1985, 1986			1,150 (132)
LSD (0.05)	ns (ns)	614 (86)	ns (94)
C.V. (%)	48 (119)	36 (53)	84 (32)

GS = Grain sorghum; SB = Soybeans; JG = Johnsongrass.

Table 7. Annual yield for soybeans grown in a rotational system with grain sorghum from no-till planting.

Rotational system	Grain yield		
	1985	1986	1987
	bu/a		
Continuous SB	31	20	12
SB following GS previous year	29	20	10
SB following GS, 1984, 1985		20	13
SB following GS, 1984, 1985, 1986			12
LSD (0.05)	ns	ns	ns
C.V. (%)	27	12	22

SB = Soybeans; GS = Grain sorghum

Conclusion

Grain sorghum yields were severely reduced after 2 consecutive years due to rhizome johnsongrass. Soybean yields using no-till practices were not increased by rotation with grain sorghum using no-till practices over the continuous no-tilled soybeans. Soybean cyst nematodes increased in the continuous no-till soybean plots, but not to a level to cause yield reduction. Plots with alternate year rotation of no-till soybeans and no-till grain sorghum were free of cyst nematodes at the end of this study.