Influence of Cover Crop, Perennial Sod, and Crop Rotation on Soybean Growth and Yield

J.H. Edwards[1] D. L. Thurlow[2], J. L. Holliman[3] ,and M. D. Pegues[3]

Abstract

Continuous cropping of Braxton soybean *(Glycine max.* (L.) Merr.] was compared with cropping systems that included various sequences of annual and perennial grass species. The study was conducted on a Sumter clay (fine-silty, carbonatic, thermic, Rendollic Eutrochrepts) soil. The grasses in the rotation were wheat *(Triticum aestivum)* for winter cover, grain sorghum (*Sorghum bicolor)* for one year, and tall fescue *(Festuca arundinacea* Schreb.) sod for three years. The six-year average yields of continuous soybean were increased by 23% when wheat was included as a winter cover crop. When soybean was rotated with grain sorghum and wheat was included as a winter cover crop, soybean yields were increased by 52%. After three years of fescue sod, yields of soybean were increased 68%. The rotation effects on soybean yields appear to be related to the reduction in soybean cyst nematode *(Hererodera Glycine)* populations after 2 to 4 years of grasses. The differences in early-season growth of Braxton soybean as measured by plant height were similar to yield but lower in magnitude.

Introduction

Soybean production in the Black Belt region of Alabama is limited by foliar diseases and parasitic nematodes. These diseases and nematodes become acute after land has been in continuous soybean production for more than three years (Curl and Rodriguez-Kabana, 1971). Some of the most successful soybean producers are cattleman who rotate their declining pastures into soybean production.

Some success in controlling or reducing disease and nematode damage in soybean bas been achieved by planting resistant or tolerant cultivars (Rodriguez-Kabana and Thurlow, 1980; Rodriguez-Kabana and Weaver, 1984); in rotation with corn *(Zea mays* L.) (Kinloch, 1983; Kinloch, 1986); by using conservation tillage cropping systems (Edwards et al., 1988a; Edwards et al., 1988b); in rotation with grain sorghum (Rodriguez-Kabana et. al, in press); and in rotation with bahiagrass (Rodriguez-Kabana et al., 1990). These studies were conducted for 2 to 3 years, but the long-term cropping sequence best suited for controlling soybean diseases or damage induced by nematodes could not be determined. Thus, the purpose of this study was to: (i) compare growth and yield of continuous cropping soybean with those in a 2-year rotation with grain sorghum; (ii) compare the affect of winter cover crop on growth and yield of soybean; (iii) determine the residual effects of a perennial grass sod (tall fescue 'Kentucky 31') on the growth and yield of soybean.

Materials and Methods

A field experiment was established in the Black Belt region of west central Alabama on Sumter clay (fine-silty, carbonatic, thermic, Rendollic Eutrochrepts) soil. Initial soil test levels are given in Table 1. Soil samples were collected each spring before planting to determine the required P and K fertilization for grain sorghum and soybean. Phosphorus and K fertilizers were applied broadcast, according to Auburn University soil test recommendations, each spring prior to the chiseling and disking tillage operation. The experiment is a seven-year rotation which includes 3 years of perennial sod crop ('Kentucky 31' tall fescue) and 4 years of row crops. The rotation treatments were: (i) continuous soybeans-no wheat cover; (ii) continuous soybean-wheat cover; (iii) soybean-no wheat cover-grain sorghum; (iv) soybean-wheat cover-grain sorghum.

Table 1. Initial soil test values for Ihe experimental site.

	soil test Kg/ha		
Soil test	Sample depth (cm)		
values	0-20	20-33	33-39
pH	8.1	8.1	8.1
P	63	15	15
K	232	183	1%
Mg	146	119	124

[1]USDA-ARS, National Soil Dynamics Lab, Auburn, AL 36831-0792.
'Department of Agronomy and Soils.
'Superintendent and Assistant-Superintendent of Black Belt Substation; and Ala. Agric. Expt. Sta., Auburn University, AL 36849-5412.

The experimental design was a split-split plot in a randomized complete block with three replications. The main plot (22.9 m x 18.3m) included the rotation treatments; the split-split plot was for nitrogen levels on grain sorghum, wheat, and tall fescue in the rotations. Row spacing was 36 in. for both soybean and grain sorghum. Plant height measurement were made at maturity for both soybean and grain sorghum.

Soybean (Braxton) and grain sorghum (Savannah 5) were planted in mid-May and mid-April of each year, respectively. The center two rows of soybean and grain sorghum were harvested to determine yield. All soybean yields were adjusted to 13% moisture.

Results and Discussion

Grain sorghum and wheat yields were determined each year, however, only the soybean data will be presented. The early- growth of soybean was influenced most by perennial sod crop; plant height was 38% taller when following three years of fescue (Table 2). In general, the early-growth pattern was the same as the final soybean yield, but was not as dramatic in effect as the yield.

The rotation was established in 1983; therefore, 1986 was the first year that soybean yields were measured after the full three years of fescue sod (Table 3). The soybean yield in the early years of the rotation appeared to be influenced by one or two years of fescue that interrupted the continuous-cropping sequence. The rotation effect on soybean yields appears to be related to the reduction in soybean cyst nematode (*Heterodera glycines)* population after two to three years of continuous grass crops (Edwards et. al, 1989).

Table 2. The effect of annual and perennial grass crops in the rotation of early soybean growth as measured by plant height of Braxton soybeans at Black Belt Substation.

Cropping System	Crop Rotation	Plant Height of Braxton Soybean (Inches)							6 yr. Avg. (84-89)	4 yr. Avg. (86-89)	3 yr. Avg. (87-89)
		1983	1984	1985	1986	1987	1988	1989			
No Winter Cover											
Continuous Row Cropping	Continuous Sovbeans	29	31	26	10	22	27	20	23	20	23
	Grain Sorghum-Soybean	GS[1]	34	GS	17	GS	30	GS	26	23	25
		---	GS	31	GS	22	GS	24			
Winter Cover											
Continuous Row Cropping	Continuous Soybean	30	33	27	15	20	28	21	24	21	23
	Grain Sorghum-Soybean	GS	36	GS	24	GS	29	GS	28	25	26
		---	GS	30	GS	25	GS	23			
3 yr. Perennial Sod											
Continuous Row Cropping	Soybean	FES[2]	FES	FES	21	21	28	20	---	23	---
	Soybean	---	FES	FES	FES	29	32	24	---	---	28
	Soybean		---	FES	FES	FES	34	20	---	---	---
	Soybean		---	---	FES	FES	FES	25	---	---	27
	Grain Sorghum-Soybean	FES	FES	FES	GS	26	GS	26	---	---	---
					SB[3]	GS	28	GS			
	Grain Sorghum-Soybean		FES	FES	FES	GS	28	GS	---	---	---
						SB	GS	24			
	Grain Sorghum-Soybean	---	---	FES	FES	FES	GS	26	---	---	---

[1]GS = Grain Sorghum; [2]FES = Fescue; [3]SB = Soybean.

Table 3. The effect of annual and perennial grass crops in the rotation on Braxton soybean yields.

Cropping System	Crop Rotation	Yield of Braxton Soybean (Bu/A) 1983	1984	1985	1986	1987	1988	1989	6 yr. Avg. (84-89)	4 yr. Avg. (86-89)	3 yr. Avg. (87-89)
No Winter Cover											
Continuous Row Cropping	Continuous Soybeans	20.6	22.3	13.5	3.0	9.8	18.2	7.7	12.4	9.7	11.9
	Grain Sorghum-Soybean	GS	26.8	GS	11.4	GS	21.9	GS	16.5	15.0	14.5
			GS	17.4	GS	8.5	GS	13.0			
Winter Cover											
Continuous Row Cropping	Continuous Soybean	22.3	29.0	16.6	7.4	8.9	24.2	5.6	15.3	11.5	10.2
	Grain Sorghum-Soybean	GS[1]	30.5	GS	23.7	GS	21.7	GS	18.9	15.8	13.1
			GS	19.8	GS	10.1	GS	7.6			
3 yr. Perennial Sod											
Continuous Row Cropping	Soybean	FES[2]	FES	FES	19.6	12.1	28.2	2.3	---	15.6	---
	Soybean	---	FES	FES	FES	9.8	31.1	8.8	---	---	16.6
	Soybean	---	---	FES	FES	FES	29.2	4.4	---	---	---
	Soybean	---	---	---	FES	FES	FES	6.5	---	---	---
	Grain Sorghum-Soybean	FES	FES	FES	GS	11.8	GS	12.1	---	---	19.4
					SB[3]	GS	34.4	GS			
	Grain Sorghum-Soybean	---	FES	FES	FES	GS	34.4	GS	---	---	---
						SB	GS	12.1			
	Grain Sorghum-Soybean	---	---	FES	FES	FES	GS	9.0	---	---	---

[1]GS= Grain Sorghum; [2]FES= Fescue; [3]SB= Soybean

In comparison to continuous soybean cropping for six years (1984-1989), soybean yields were 33% higher when grown in a 2-year rotation with grain sorghum. This relative increase in yield appears to be increasing with the duration of the experiment. There was a 23% increase in soybean yield for this period by using a winter cover crop of wheat, which is a slight decrease from early data from the test, and a 52% increase when comparing soybean yields following grain sorghum in a two-year rotation along with wheat as a winter cover.

During the four-year period 1986-1989, first-year soybean yields were 68% higher when following three years of fescue sod versus continuous cropping soybean. This is also a larger relative yield increase from early data when only one or two years of sod was used. The effect of three years of fescue sod carried into the second year of soybean yields, but started to drop off by the third and fourth years. The highest soybean yields were obtained when soybean followed grain sorghum after three years of fescue sod. This response was observed in the second year soybean.

Summary

Soybean yields were increased by winter cover and rotation with annual grass row crop. An additional benefit was obtained by incorporation of a perennial grass sod crop into the rotation sequence. The rotation affects on soybean yields and plant height appears to be related to the reduction in soybean cyst nematode population following the grass crops in rotation as compared to continuous cropping soybean.

Related Literature

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