Influence of Tillage and Crop Rotation on Soybean Yields and Cyst Nematode Population

D. L. Thurlow, J. H. Edwards, W. Gazaway, and J. T. Eason

Alabama Agricultural Experiment Station, U S Department of Agriculture, Agricultural Research Service, Alabama Cooperative Extension Service, and Sand Mountain Substation. Auburn University, AL 36849

ABSTRACT

Strip-tillage (in-row chiseling), no-tillage, and conventional tillage (turnplow) systems were evaluated for 4 years together with cropping sequences of continuous corn (Zea mays L.), continuous soybeans (Glycine max [L.] Merr.), and corn-wheat (Triticum aestivum sp.)-soybeans. The field experiment was conducted on a Hartsells fine sandy loam (fine-loamy, siliceous, thermic, Typic Hapludults). Soybean cyst (Heterodera glycine Ichinohe) nematode (SCN) population was determined before and 58 days a ter planting soybeans. Corn yields in 1984 were not affected by cropping sequences or tillage systems. Soybean yields in 1984 were highly correlated with SCN population, were 39% higher with strip- and no-tillage than with conventional tillage, and were 28% higher when rotated with corn. SCN population 58 days after planting soybeans was highest with continuous soybeans and lowest with a combination of crop rotation and no-tillage.

Introduction

In a conservation tillage study conducted for 4 years on a Hartsells fine sandy loam (fine-loamy, siliceous, thermic, Typic Hapludults) conservation tillage resulted in 16 to 39% higher yields than conventional tillage in 3 of 4 years (1,2,3,4). In 1983, soybean yields with conventional tillage yielded only 690 kg/ha compared to 1660 and 1930 kg/ha with strip-till or no-till. With conventional tillage, the soybean plants were severely stunted in late August and began to defoliate 4 weeks before plants on other tillage treatments matured. Observation of the soybean roots suggested a nematode infestation.

The appearance of the soybean plants in mid-August 1983, and results of soil samples collected for nematode determination in late August suggested that the reduction of soybean yield under continuous soybeans may be caused by a buildup of a high soybean cyst nematode (SCN) population after 3 years of conventional tillage and continuous cropping. Thus, the objective of this study was to determine the rate of increase of SCN in 1984 in cropping and tillage systems started in 1980.

Materials and Methods

Minimum-tillage treatment consisted of planting soybeans over 20- to 22-cm deep chisel slots. No-tillage treatments were planted with a double-disk opener

planter directly into the untilled soil surface. Conventional tillage consisted of turning the wheat cover in spring, disking in herbicides, and planting. Cropping sequences were continuous soybeans; continuous corn; corn-soybean; and corn-wheat for grain-soybean. Wheat was planted in the fall on all plots as a winter cover, including those plots not used for grain crop. The wheat was killed on the winter cover plots 10 days before planting corn or soybeans. The experiment was located on a Hartsells fine sandy loam soil on the Sand Mountain Substation at Crossville, Alabama, which is in the Appalachian Plateau area of Alabama. The experiment was a split plot design in a randomized complete block with four replications. The corn treatment was planted in six 90-cm rows 16 m long, and the soybean treatment was planted in eight 68-cm rows 16 m long. 'Essex' soybeans have been used since the experiment was started in 1980.

Soil samples were taken in the last week of August 1983, and cyst nematode counts were determined by the flotation method on 50 cc of soil. These samples were taken 12 to 14 cm deep under the rows of each plot. Soil sample were collected in March, July, and August for nematode analysis. The July and August samples were taken 58 and 59 days after planting full-season and double-cropped soybeans. The full-season soybeans were planted on 24 May and double-cropped soybeans were planted on 20 June after wheat was harvested for grain. All plots were uniformly fertilized according to soil test recommendations.

Results and Discussion

Soybean yields in 1983 followed trends established in previous years: lower yields with continuous soybean than soybean in rotation with corn, and lower yields with conventional tillage than conservation tillage (Table 1). The lowest yields were from continuous soybeans grown in the conventional tillage system. Low yields with this system were probably due to high nematode population in spring, which caused stunting and low vigor of soybean plants (Table 2).

In 1984 soil samples for nematode determination were taken in March, in July, (58 days after planting full season soybeans), and in August, (59 days after planting double-cropped soybeans). The number of cyst nematodes where soybeans had been continuously cropped for the past 4 years was very high in July and August, but SCN count in double-cropped soybeans, no-till, dropped in August. This reduced SCN count in the conventional tillage was similar to that in 1983, and was probably due to plants and roots dying in these plots (Table 2).

The SCN count increased throughout the growing season with full season soybeans in the strip-tillage and no-tillage treatments when rotated with corn. However, the rate of SCN increase in the no-tillage system appears to be 1 to 2 years behind strip-tillage with full season planting. However, when planting was delayed each year due to double-cropping soybeans behind wheat, SCN number was lower than when compared to full season soybeans. The no-tillage system with double-cropped soybeans had the lowest SCN numbers, and SCN did not affect soybean yields.

Soybeans yields in 1984 were lowest with the conventional tillage treatment across all cropping sequences (Table 1). The highest soybean yields occurred with full season soybeans grown in rotation with corn and with strip-tillage. The double-cropped soybean yields were approximately 300 kg/ha lower than the full season soybeans, however, wheat yield ahead of the double-cropped soybeans was 3670 kg/ha. Soybean seed size was also affected by SCN. The largest soybean

seeds were from the tillage and crop rotation systems that gave the the highest yields. The double-cropped soybean seed size was affected by reduced rainfall in late August and September (Table 3). Late season rainfall was only 0.4 cm for September, and 2 cm or less the last 10 days of August and the first 10 days of October.

In summary, SCN populations built more slowly with conservation tillage than with conventional turning and disking; yields were higher when soybeans were in a 2-year rotation with corn than under continuous soybeans; and increased yield of soybeans in rotation with corn was even more evident when grown with conservation tillage than with conventional tillage systems.

Literature Cited

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Table 1. Soybean yields as affected by tillage and crop rotation systems at Crossville, Alabama, for 1983 and 1984.

Tillage treatments	Yield					
	1983	Rotation mean	1984	Rotation mean	Tillage mean	
					1984	1985
	kg/ha					
Continuous soybean						
Conventional	690		1818			
Strip-tillage	1569		1980			
No-till	2210		2360			
		1490		2070	1430	1900
Soybean-corn rotation						
Conventional	1660		1870			
Strip-tillage	2230		3070			
No-tillage	2380		2970			
		2090		2640	1890	2590
Wheat-soybean-corn						
Conventional	1930		1960			
Strip-tillage	1880		2720			
No-Tillage	1840		2450			
		1880		2380	2140	2590

Table 2. Soybean cyst nematode counts found in soybeans grown in 1983 and 1984 at Crossville, Alabama, under different tillage and crop rotation systems.

Tillage treatments	August 1983	March 1984	July[x] 1984	August[x] 1984
	SCN counts[2] by sampling dates			
		Continuous soybeans		
Conventional	460	13	590	122
Strip-tillage	806	72	741	693
No-tillage	498	97	785	599
Rotation mean	588	57	705	471
		Soybean-corn rotation		
Conventional	100	57	741	297
Strip-tillage	23	16	497	742
No-tillage	4	1	59	130
Rotation mean	42	25	432	356
		Wheat-soybean-corn		
Conventional	54	21	150	521
Strip-tillage	29	8	130	187
No-tillage	3	0	32	39
Rotation	29	9	107	249

[2]SCN counts in 50 cc sample of soil
[x]July and August samples were taken 58 and 59 days after planting full season and double-cropped soybeans.

Table 3. Soybean seed size at harvest as affected by tillage and cropping systems at Crossville, Alabama, for 1984.

Tillage treatments	Continuous soybeans	Soybeans-corn	Wheat-soybeans	Avg.
		g/100 seeds		
Conventional	9.8	11.8	10.5	10.7
Strip-tillage	11.0	14.8	11.8	12.5
No-tillage	12.8	14.8	11.3	12.9