RESEARCH UPDATE 1991

SOYBEANS

Crop Rotation and Conservation Tillage Increase Yields

Corn-soybean rotations and conservation tillage boosted yields of the Essex soybean variety in a 9-year study at the Sand Mountain Substation, Crossville. These increases probably reflect how the rotation and tillage treatments delayed build-up of soybean cyst nematode populations in the soil. Further yield increases resulted from use of the Forrest cultivar, which is resistant to soybean cyst nematode, in place of Essex. While all of these factors may be related, effects of each represent potential improvement in soybean production.

Conservation tillage systems used in planting soybeans following a wheat cover crop in the AAES test were:

Strip tillage—kill wheat with herbicide, till with a chisel to 12 inches under the row, pull soil over the chisel area, and plant.

No tillage—kill wheat with herbicide and plant in residue with a double-disk opener.

The conservation tillage system used for comparison consisted of plowing under the wheat cover in spring (using a moldboard plow), incorporating herbicide with a disk, and planting.

The same tillage treatments were also evaluated with a rotation in which the wheat was harvested for grain (identified as C-W-S to represent corn-wheat for grain-soybeans). This system produced yields equal to continuous soybeans, but made lower soybean yields than when wheat was used only as a cover crop and not harvested for grain.

With conventional tillage, there was a build-up of cyst nematodes to damaging levels in the first 60 days after planting during early years of the test. Conservation-tillage plots reached the same cyst nematode population levels, but the build-up was at a slower rate than with conventional tillage. By the sixth and seventh years, the conservation-tillage plots had even higher numbers of cyst nematodes, but soybean yields were less affected than with conventional tillage. Cyst nematode build-up declined over time where Essex soybeans were grown with conventional tillage, suggesting that factors other than nematode populations also affected yields.

The largest yield difference because of rotation was with the strip-tillage treatment, table 1. The greatest yield differences due to cultivar were observed in the soybean-wheat for grain-soybean rotation, table 2.

Table 1. Effect of Tillage System on Yield, 9-year Average

Cropping system	Yield/acre, by tillage system			
	Conventional	Strip	No-till	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*
Continuous	26	27	31	28
Soybean-corn	31	34	36	34
C-W-S	27	28	29	28
Tillage average	28	30	32	

Table 2. Effect of Cultivar on Yield, 5-year Average

Cropping system	Yield/acre, by variety		
	Essex	Forrest	Average
	Bu.	*Bu.*	*Bu.*
Continuous	25	32	29
Soybean-corn	32	38	35
C-W-S	22	33	27
Variety average	30	34	

J. H. Edwards and D. L. Thurlow

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
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Weed Competition for Water Measured in Soybeans

Sicklepod and common cocklebur can cause sizeable yield losses in soybeans by competing for light, soil moisture, and plant nutrients. Competition for water is especially important since lack of moisture is often a limiting factor in soybean production.

Extent of water competition has been unknown in the past because of the difficulty of measuring water use of individual plants when roots of both weeds and soybeans are growing together. Now there is a new method of measuring water use—a heat balance method that measures water flow in plants. A device measures heat movement from a small heater wrapped around a plant stem to points along the stem. Water uptake of a plant can then be calculated since water carries a specific amount of heat as it moves up a plant stem. This method was used with soybeans, sicklepod, and cocklebur in two 1990 AAES field competition experiments near Auburn.

One experiment compared water uptake of weed-free soybeans with that of soybeans having 6 common cocklebur or 30 sicklepod plants per 10 feet of row. Row spacing was 30 inches and soybeans were planted at a density of 6 plants per foot of row. Measurements of water uptake by soybean plants and weeds were made at soybean flowering and pod-fill, the time when soybeans are most sensitive to drought.

At flowering, water use by soybeans was as follows (per acre per day):

Weed-free soybeans—5,220 gallons

Soybeans growing with common cocklebur—4,280 gallons

Soybeans growing with sicklepod—2,400 gallons

Common cocklebur and sicklepod used 940 and 2,400 gallons per acre per day, respectively. Common cocklebur took up more water per plant than sicklepod, but per acre amount was less because of lower weed density.

At the pod-fill stage, soybean water uptake decreased to approximately 3,130 gallons per acre per day for all treatments. Use by common cocklebur and sicklepod, respectively, increased to 1,570 and 3,340 gallons per acre per day because of larger size of weeds.

Soybean pod numbers were decreased 29 and 22 percent, respectively, by sicklepod and common cocklebur. This translated into seed yield reductions of 54 and 37 percent, respectively. The results suggest that effects of competition were greatest at the flowering stage.

Another experiment measured effects of height of sicklepod on soybean water use. This is important since many herbicide treatments damage sicklepod and reduce its height rather than killing the weeds. It is often cheaper to reduce the height of a weed than to kill it.

Soybeans and sicklepod were grown at the same densities as in the previous experiment. Sicklepod was (1) allowed to grow unrestricted, (2) clipped to the height of soybeans, and (3) clipped to half the height of the soybeans. These heights were maintained from 4 weeks after planting to harvest and results compared.

At flowering, there were no differences in soybean water use between treatments. By pod-fill, however, differences between treatments were apparent, as indicated by the following water use per acre per day of soybeans grown with:

Unrestricted sicklepod—2,530 gallons

Sicklepod clipped to height of soybeans—4,170 gallons

Sicklepod clipped to half height of soybeans—5,590 gallons

Sicklepod water use at this stage was 2,370, 1,720, and 520 gallons per acre per day, respectively, for the unrestricted sicklepod, that clipped to same height, and that clipped to half the height of soybean plants.

Clipping the sicklepod to half the height of soybeans increased soybean yields 53 percent, but clipping to the height of soybean plants did not improve yields. Reducing sicklepod height reduced the amount of water taken up by the weeds, thereby leaving more water for use by the crop.

R. E. Jones, Jr. and R. H. Walker

Deep Tillage and Reduced Traffic Boost Soybean Yields

Choosing the right tillage system is the first step in maximizing soybean yields. Based on cooperative AAES/USDA-ARS research, the "right" system is one that uses deep tillage and that minimizes soil-compacting tractor traffic.

The interaction of tractor traffic and tillage on yields was examined in an Alabama Agricultural Experiment Station study at the E. V. Smith Research Center, Shorter. Plots with varying tillage and tractor traffic treatments were planted on 30-inch rows following a legume winter cover crop (corn was grown the previous year). Treatments consisted of combinations of the following deep-tillage, surface-tillage, and tractor-traffic treatments:

- Deep tillage: no subsoiling, annual in-row subsoiling, or a one-time complete disruption of the hardpan.
- Surface tillage: leaving winter

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cover crop stubble on surface or harrowing and field cultivating before planting.

• Tractor traffic: normal traffic with the use of 4-row equipment or removal of all tractor traffic from plots (use of wide-frame research vehicle that spanned soybean rows for necessary tillage).

Soil moisture conditions were monitored throughout the growing season and soybean yields were measured at harvest. In addition, soil compaction measurements at different depths were made with a penetrometer.

Both test years (1989 and 1990) had extremely dry growing seasons, and yields were low (especially in 1990). Under these conditions, deep tillage increased yields and surface tillage reduced yields.

The biggest yields resulted when deep tillage, either annual subsoiling or complete disruption, was used without surface tillage. This is probably because the deep tillage allowed for deeper rooting of soybean plants and surface residues reduced surface water losses, thereby increasing water availability to the crop during the drought. Results are illustrated by data in the table.

Effect of Tillage Treatment and Tractor Traffic on Soybean Yields

Tillage treatment	Yield, per acre			
	No traffic		Traffic	
	1989	1990	1989	1990
	Bu.	*Bu.*	*Bu.*	*Bu.*
No deep tillage	23	13	23	13
Annual in-row subsoiling	31	16	36	16
Complete disruption	33	15	33	12
Surface tillage	28	14	29	12
No surface tillage	29	15	32	15

Surface tillage produced larger plants, but yield was lower. It is believed that surface tillage increased rooting in the surface soil early in the season, but when drought occurred later these shallow roots were not able to supply enough water for the large plants. Results may be different in years of good rainfall, when surface tillage may actually increase yields.

In these AAES tests, intensive tillage systems followed by tractor traffic resulted in greater recompaction of the soil, which restricted root growth. This was substantiated by penetrometer measurements and soil water measurements showing reduced water removal.

Tractor traffic generally reduced yields, and was especially detrimental following surface tillage. However, annual subsoiling resulted in a greater beneficial effect to soybeans when traffic was applied.

H. A. Torbert and D. W. Reeves

Weed Seed Level in Soil Not Increased by Non-damaging Threshold of Sicklepod and Morningglory

The concept of allowing a non-damaging weed threshold level (the maximum density level that does not affect crop yield and quality) before applying control treatment has been accepted. However, there is concern about what will happen over time as more and more weed seeds are returned to the soil seed bank as these non-damaging thresholds produce seed. Because of this concern, research on this subject was begun at the Alabama Agricultural Experiment Station's Wiregrass Substation, Headland. Sicklepod and pitted morningglory were the weed species studied.

Two areas were selected that were free of sicklepod and pitted morningglory. In separate experiments, sicklepod seeds and pitted morningglory seeds were sown at rates to establish soil infestation levels representing 0, 1, 3, and 5 years of a non-damaging threshold returning seeds to the soil reserve.

The non-damaging threshold used for sicklepod was one plant per 13 feet of 30-inch spaced rows. This level of infestation was calculated to return 400 pounds of seed per acre to the soil reserve each year. The non-damaging threshold treatments were the same for the morningglory experiment. However, this threshold level was calculated to return only 105 pounds of seeds per acre each year.

Prowl®, broadcast at 3/4 pound active per acre over both experiments during all 4 years and soil incorporated, was used to control grass weeds. Braxton soybean seeds were planted (mid-May all 4 years) in 30-inch rows. The sicklepod experiment had supplemental irrigation but the morningglory experiment did not.

Sixteen soil cores per plot (6 inches deep and 4 inches in diameter) were collected in spring (shortly after planting) and in fall (shortly after harvest) of each year. Sicklepod and morningglory seeds were removed and counted.

Total weed control inputs in 1986 were: **sicklepod experiment**—Prowl at 3/4, Lexone® at 3/8, and Lexone + Butyrac® at 1/4 + 1/4 pound active per acre applied preplant incorporated, preemergence, and postemergence directed, respectively; **morningglory experiment**—Prowl at 3/4, Blazer® at 1/2, and Butyrac at 1/4 pound active

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Weed Seed Level, continued

per acre applied preplant incorporated, postemergence over the top, and postemergence directed, respectively. Each treatment combination included one cultivation prior to the postemergence directed application.

Weed control inputs for 1987, 1988, and 1989 were the same as 1986 except all postemergence directed applications were eliminated. Weed escapes did not exceed the threshold level and therefore the postemergence directed applications were not justified after the first year. Number of weed seed in the soil and soybean yield are reported in figures 1 and 2 for the sicklepod experiment and figures 3 and 4 for the pitted morningglory test.

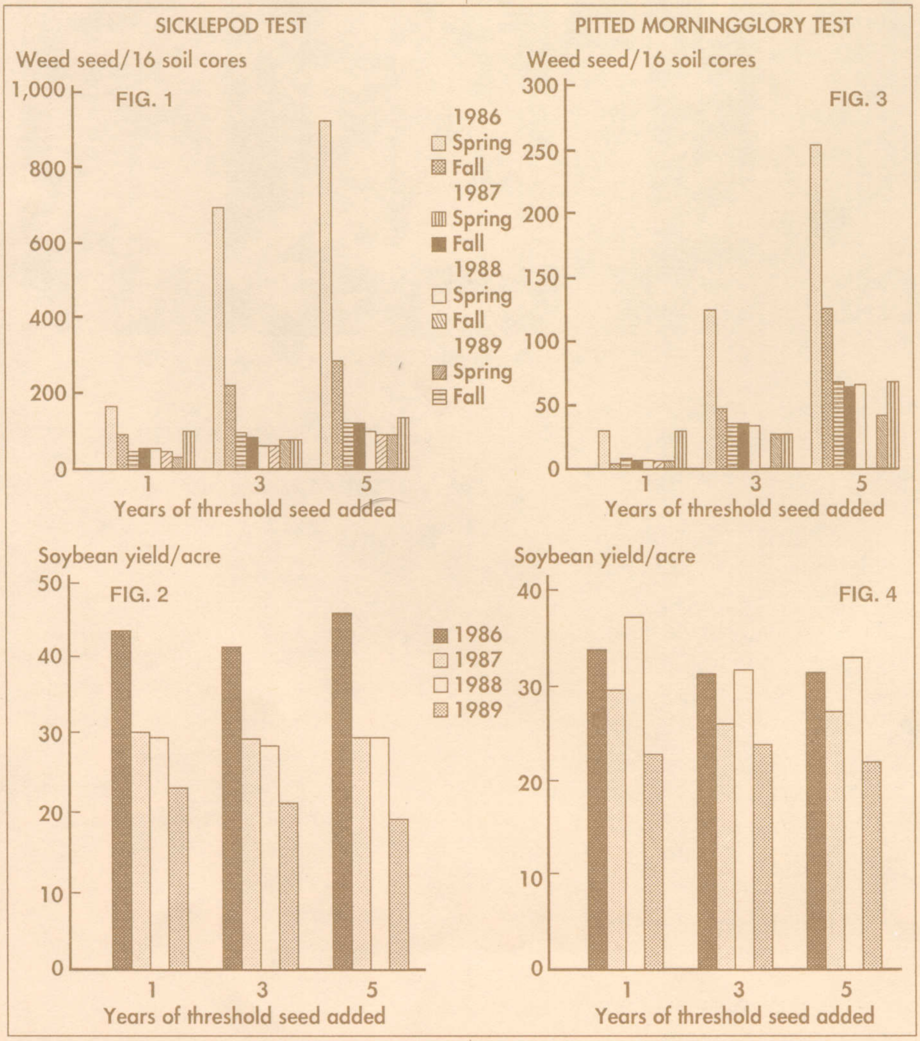
Sicklepod experiment. The majority of sicklepod seeds germinated during the 1986 growing season. There was a significant decrease in seed number from the 1986 fall sampling to the spring of 1987 sampling, but little change occurred from the spring sampling of 1987 through the spring of 1989. Slightly higher seed numbers were evident with the higher levels of initial infestations. However, two of the threshold levels (levels 1 and 5) showed an upward turn in seed numbers for the fall 1989 sampling. Soybean yields for 1986-89 were not affected by the number of sicklepod seeds in the soil. Trash content for 1986-88 ranged from 1.0 to 3.4 percent and was generally unaffected by the seed populations added initially. Trash content for 1989 was not taken.

Morningglory experiment. Pitted morningglory produced the same 4-year trends for seed numbers and soybean yields as sicklepod. Trash content for 1986-88 ranged from 1.4 to 6.4 percent and was not affected by the seed populations added initially. Trash content for 1989 was not taken.

It can be concluded that allowing a non-damaging threshold of sicklepod or pitted morningglory to return seeds to the soil reserve did not increase the level of weed seeds in the soil. However, adding all the seeds the first year and using a seed lot that had a high percentage of germination (few dormant seeds) may have masked some responses.

Soybean yield data for the two experiments verify that soybean yield declines rather rapidly when grown in monoculture. Therefore, rotations are needed for successful soybean production, and such rotations will also help alleviate weed problems.

R. H. Walker



Crop Rotation, Resistant Cultivars Best for Nematode Control in Soybeans

The best management strategy for nematode control in soils infested with root-knot and cyst nematodes is to rotate crops and use the most nematode-resistant cultivar available. This was clear from results of the 1990 continuation of soybean rotation experiments in nematode-infested soils in Baldwin County.

Tropical corn and grain sorghum were included in the rotation crops in 1990. They were compared with continuous soybeans for effect on yield and soil nematode numbers. Seven cultivars with various combinations of genetic nematode resistance (Braxton, Brim, Bryan, Kirby, Leflore, Stonewall, and Thomas) were compared with and without at-plant applications of aldicarb (Temik®).

As expected, pre-plant nematode

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Crop Rotation, continued

numbers were high in the monoculture soybean system. Tropical corn effectively suppressed cyst nematode numbers, and grain sorghum suppressed numbers of both species of nematodes.

All cultivars responded to the rotation, but the magnitude of response was dependent on resistance level of the cultivar. Those that had the least nematode resistance (Braxton, Brim, and Stonewall) had yield increases from rotations in the range of 143 to 209 percent. Cultivars with greater nematode resistance (Bryan, Kirby, and Leflore) benefited less from rotations, having increases ranging from 20 to 62 percent. However, these resistant varieties had greater total production than the less resistant varieties. Thus, planting nematode-resistant cultivars and using an effective rotation is the best management strategy.

Use of aldicarb was not economically effective in increasing yields.

In another phase of the Baldwin County tests, value of bahiagrass as a rotation crop was assessed in the third year of continuous soybeans following the rotation. Bahiagrass and soybeans were planted in 1986 and 1987, and soybeans grown continuously in 1988, 1989, and 1990. Although soybeans that were planted in the area previously in bahiagrass yielded more than the monoculture soybeans, yield levels in both systems were below those considered necessary for profitable production.

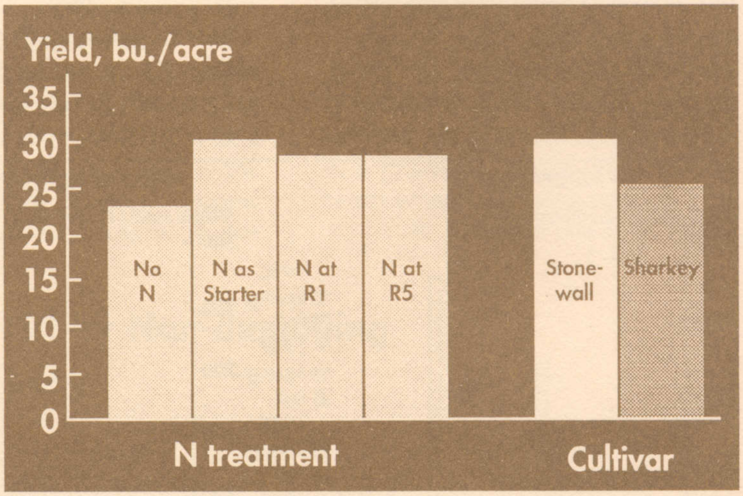
D. B. Weaver and R. Rodriguez-Kabana

N Application May Boost Soybean Yields

Past research concerning soybean response to nitrogen fertilization has produced conflicting results. Several studies have shown no yield benefit, or even detrimental effects, when soybeans were fertilized with N. However, in some studies adding N boosted soybean yields—especially on acid, low organic matter soils. Recent data from another state indicate that applying N to soybeans at early pod fill (R5) growth stage may result in increased yield and profit for producers.

Field studies during the 1990 growing season at three AAES locations investigated the response of soybeans to N fertilization at different stages of growth. Stonewall and Sharkey cultivars were evaluated at the Wiregrass Substation, Headland, Sand Mountain Substation, Crossville, and the E.V. Smith Research Center, Shorter. Nitrogen treatments included (1) no N, (2) 30 pounds N per are at planting (starter), (3) 50 pounds N per acre at first bloom (N at R1), and (4) 50 pounds N per acre at early pod fill (N at R5). All N treatments were applied as ammonium nitrate in a band 2 to 4 inches from the seed row. Row spacing was 36 inches at all locations. Irrigation water (1 inch) was applied after N application to move N into the rooting zone.

Grain yields were greater with than without N fertilizer at Shorter and Headland but not at Crossville. Data from Shorter and Headland are presented in the graphs.



Effect of N treatment and cultivar on soybean yield.

Soybean yields were low in 1990 because of drought conditions. However, even under adverse growing conditions, grain yield was increased by N fertilization. Nitrogen fertilizer increased yields by as much as 7 bushels per acre. Starter fertilizer at 30 pounds N per acre appeared to be more effective than 50 pounds applied later in the growing season. The Stonewall variety outyielded the Sharkey variety by 5 bushels per acre. Seed protein and oil were also evaluated, but N additions had little effect on these properties. Based on one drought year's results, it appears that N applications to soybeans may be beneficial in Alabama.

C.W. Wood and D.B. Weaver

Specialty Soybean Variety Development Begins at AAES

Japanese and other foreign buyers of U. S. soybeans are often interested in buying beans for specific purposes, other than just for the oil and protein they contain. Beans needed for these special purposes must have certain seed characteristics that are not often available in commercial cultivars.

Even though the demand for soybeans to be used for these special purposes may be small compared to the

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Specialty Soybean, continued

protein/oil market, the possibility exists for Alabama farmers to be able to take advantage of these so-called "niche" markets, provided cultivars are available that have the desired characteristics. Usually, these types will be grown on a contract basis, at premium price above the normal market price.

One soybean specialty product produced in Japan is natto, a fermented whole bean product eaten as a breakfast food in some areas. A comparable product in the United States is grits. Beans used to produce natto must be small-seeded, approximately half the size of normal soybeans produced in Alabama. Indications are that it is easier to produce beans of this size in the South than in the Corn Belt.

A program was begun at the Alabama Agricultural Experiment Station in 1988 to develop a soybean cultivar that has the needed seed size characteristics, and which can be produced by Alabama growers. Goals are to produce a cultivar with small seeds and maintain the yield level at or near that of currently grown cultivars. Crosses were made between adapted lines that had smaller than average seeds and plant introductions that had extremely small seeds. Advanced lines will be grown in rows for the first time in 1991, and yield tests will begin in 1992. Hopefully, a natto-purpose cultivar will be ready for release by the mid-1990's.

D.B. Weaver

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Large Larvae, Hot Weather Accelerate Leaf Damage by Soybean Looper

The amount of food eaten by most insects is affected by temperature. This is also true of such economically important insects as the soybean looper. An AAES laboratory study evaluated the effect of temperature and larval size and weight on the amount of soybean leaves eaten each day by the soybean looper. Seven weight and size classes of looper and four constant temperatures (60, 70, 80, and 90°F) were used in the study.

Consumption by large larvae made up about 96 percent of the total leaf area consumed. The average amount of leaf area eaten per insect increased with temperature and larval weight. Results also indicate that larval feeding rate does not peak within the temperature range studied; therefore, soybean looper larvae could be expected to consume more leaf area in hot weather. It is important to use a management practice for the soybean looper before its larvae become large-sized, since 96 percent of the insect's feeding occurs at that time.

P.J. Trichilo and T.P. Mack

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