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RESEARCH FOR SOYBEAN PRODUCERS

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AUTHORSHIP

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RECOMMENDED PRODUCTION PRACTICES

1. Lime and fertilize according to soil test recommendation. Fertilizer applied directly to soybeans should be either broadcast or applied 2 or 3 inches to the side of seed if drilled at planting. When soybeans follow crops that were fertilized according to soil test, fertilizer is not recommended for soybeans.

2. If soybeans have not been grown successfully on the land, inoculate seed with a commercial inoculant.

3. Recommended varieties, in order of maturity and planting dates, for Alabama are:

Area	*Variety*	*Planting date*
Northern counties	Hood and Lee	May 1-30
Central counties	Lee, Bragg, Jackson, and Hampton-266	May 1-June 15
Gulf Coast counties	Lee, Bragg, Jackson, Hampton-266, Bienville, and Hardee	May 15-June 15

4. Soybeans should be planted in rows as narrow as weed control will permit. Correct seeding rate is about 60 pounds of viable seed per acre regardless of row width.

5. For preemergence herbicides to be effective, soybeans should be planted flat. Amiben and PCP are recommended for preemergence weed control – amiben at rate of 3 pounds active material per acre and PCP at 13 to 18 pounds. Vernolate and trifluralin are the preplant herbicides recommended for weed control in soybeans. For control of johnsongrass apply dalapon at rate of 4 to 8 pounds of active material per acre. Three days after applying dalapon, johnsongrass should be plowed under and soybeans can be planted 18 days later.

6. Foliage feeding insects may cause considerable ragging of leaves without reducing bean yields. However, control measures are needed if insects appear to be reducing total leaf surface by as much as one-third between bloom and maturity.

7. Soybeans should not be harvested until moisture content of beans drops to 14 per cent. Maximum moisture level for safe storage is 11 per cent.

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RESEARCH FOR SOYBEAN PRODUCERS

SOYBEANS, though not a newcomer to Alabama, in recent years has caught the interest of farmers as a low-labor money crop.

The first commercial acreage in Alabama was harvested in 1924 —all of 3,000 acres. Acreage of harvested soybeans in the State did not increase much until 1940, Figure 1. By 1956 more than 100,000 acres were harvested. Since then the acreage has more than doubled (228,000 in 1966), with much of the increase coming in the last year.

Baldwin, Mobile, and Escambia counties still produce more soybeans than any other area in Alabama. Much of the 1966 increase in acreage occurred in the Black Belt counties of Dallas, Green, Sumter, Marengo, and Perry. Acreage in this western Alabama section increased from 7,500 in 1965 to 38,000 acres in 1966.

State average yield of more than 20 bushels per acre was first reached in 1948. Yields per acre up to 1945 were 12 bushels or less, much too low to be economical, Figure 1. In recent years average State yields have been 22 to 24 bushels per acre, which are not greatly different from United States average. In 1964, Alabama average yield was slightly above that of the United States.

The value of Alabama's 1966 soybean crop is estimated at more than $12.5 million. Exports of soybeans have increased as production has expanded. A large portion of the State's crop is exported through the Port of Mobile.

Marketings of soybeans in Alabama are heaviest in November. Buying points exist within or near the major producing areas. Presently 25 firms buy soybeans within the State and in some cases soybeans are sold across the State line. Storage, receiving points, and markets must develop as production is expanded. With expanding livestock and poultry industries in the State, the

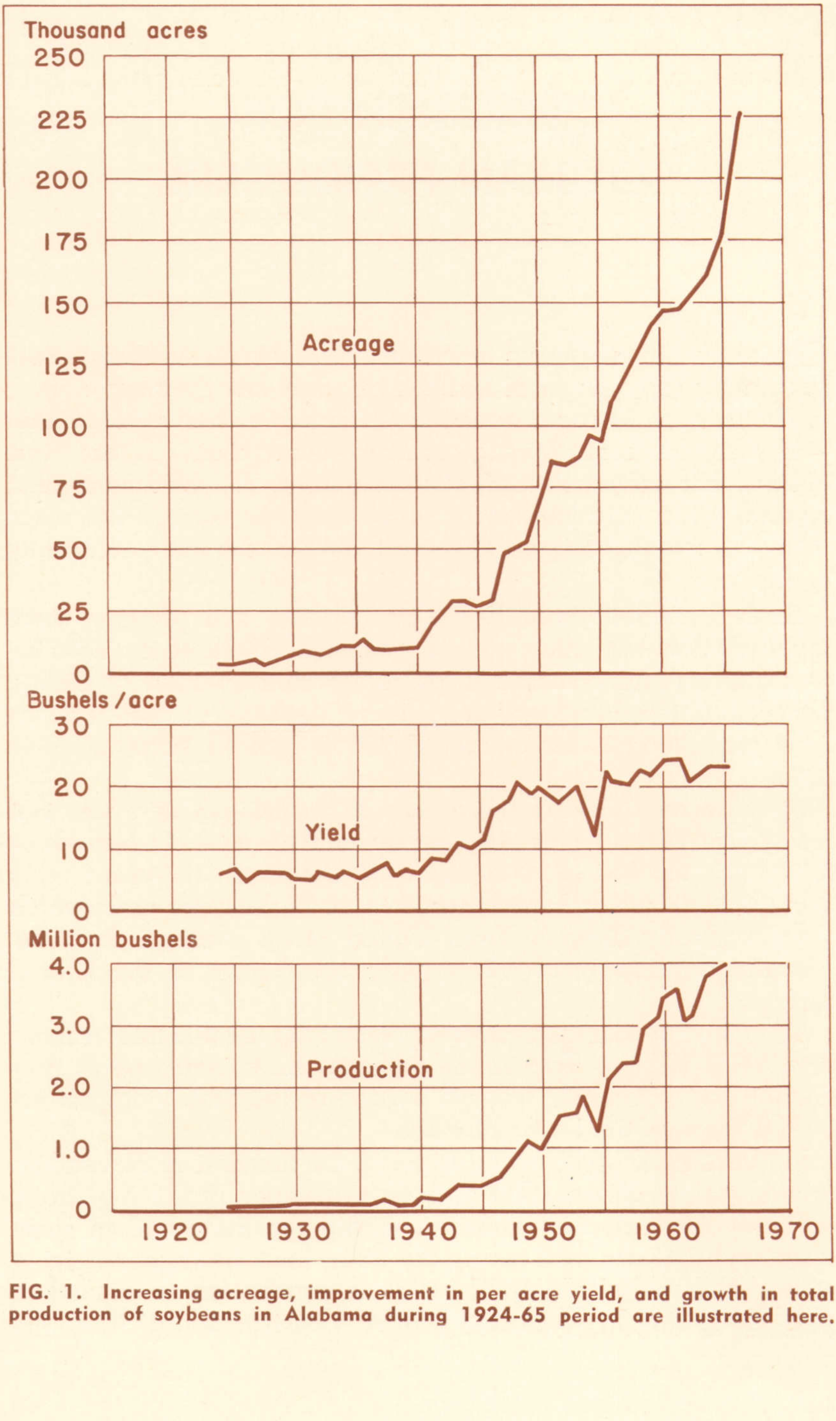

FIG. 1. Increasing acreage, improvement in per acre yield, and growth in total production of soybeans in Alabama during 1924-65 period are illustrated here.

market for soybean oil meal will continue to grow. To meet protein feed needs for broilers presently produced in Alabama, it is estimated that three times present soybean production would be needed.

Summarized in this bulletin are results of research by Auburn University Agricultural Experiment Station. Results from other State Experiment Stations have been taken into consideration in making recommendations for Alabama.

SOYBEAN COSTS and RETURNS

Soybeans as an enterprise fits well on farms that have mechanized production and harvest. A major reason for the rapid growth of soybeans in Alabama during recent years is that labor requirements are relatively low as compared with those of other row crops. Thus with reasonably good yields, returns per hour of labor are generally favorable.

Soybeans are produced with about 6.0 man hours per acre, as compared with 9.4 hours for corn. With custom combining, labor required by the farm operator is about 0.5 man hour less per acre. Because of higher wage rates and scarcity of farm labor, increased numbers of farmers have turned to soybeans as a cash crop. In addition, soybeans following early harvested crops provide for double cropping and fuller use of the land resource.

Net returns from soybeans to operator, labor, land, and management are estimated to be $35 per acre based on per acre yield of 28 bushels and assumed typical production situations, Table 1.

TABLE 1. ESTIMATED COSTS AND RETURNS PER ACRE OF SOYBEANS IN ALABAMA

Item	Quantity	Rate	Amount
Receipts from soybeans produced	28 bu.	$2.25/bu.	$63.00
Expenses			
Seed	1 bu.	3.50/bu.	3.50
Fertilizer, 0-20-20	2.5 cwt.	2.35/cwt.	5.88
Liming, custom application[1]		per acre	1.94
Insecticide		per acre	1.45
Tractor and equipment expense		per acre	7.41
Truck hauling expense		per acre	.70
Seasonal labor		per acre	.42
Custom combining		per acre	6.00
Interest on operating capital		per acre	.70
TOTAL EXPENSES			$28.00
Net return to land, labor, and management			$35.00

[1] Since it is assumed that 1 ton of lime is applied every 4 years, one-fourth of $7.75 cost per ton is charged.

Price per bushel used for these calculations was $2.25. During 1961-65, Alabama farmers received an average of $2.49 per bushel. Corn sold as a cash grain would be about equally profitable as soybean production, Table 1, if corn yield was 60 bushels per acre and price received was about $1.20 per bushel.

Based on prevailing average yields and prices for corn and soybeans in recent years, soybeans have been more profitable than corn on a per acre basis.

Prices Received

Prices received by producers have remained favorable even though production in Alabama and the United States has been expanded greatly in the past 10 years. In the late 1940's Alabama farmers in some months received more than $4 per bushel for soybeans. Prices during the 1965 season in Alabama averaged $2.50 per bushel.

Prices received follow a fairly consistent seasonal pattern. They are generally lowest in the fall (November lowest month) and highest in April and May, Figure 2. The seasonal soybean price change is normally greater than that of other storable grains.

Prices increased 11 per cent from November to May as an aver-

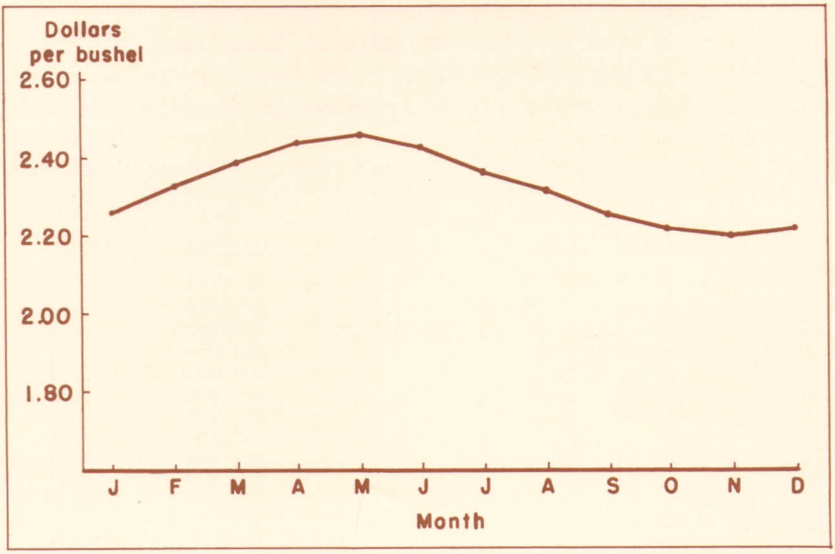

FIG. 2. Month-to-month fluctuations in soybean prices are shown here by the average monthly prices received by Alabama farmers during the 1956-65 period.

age for the 10-year period, 1956-65. This was 25 cents per bushel increase over the average November price of $2.21 per bushel.

Storing soybeans makes possible increased profits from the crop. However, expenses and possible losses in connection with storage should be considered along with potential price gains. (See section, "Drying and Storing of Soybeans," page 35.)

PRODUCTION of SOYBEANS

Suitable Soils

Soybeans can be grown successfully in most sections of the State and on a wide range of soil types. Usually soybeans start flowering in August when moisture is necessary for pod set and when drought is most likely to occur. Therefore, soybeans are best adapted to areas that usually have good rainfall in late summer and to soils that have good moisture relations. Because of low moisture, satisfactory yields cannot be expected on deep sands and eroded clays.

Land Preparation

A well prepared seedbed is necessary for good stands of soybeans. If soybeans follow small grain harvested for grain, proper seedbed preparation may be a problem, especially on fine textured soils. The best method of handling the stubble is the one that will most likely give a stand of beans at the earliest date. The following methods of planting after small grain are being used by growers: (1) turning stubble and disking, (2) disking stubble, (3) burning stubble and disking, and (4) mulch or trash planting in stubble with special equipment. Since burning destroys valuable organic matter, it should be used only as a last resort.

Lime and Fertilizer

Soybeans respond less to direct fertilizer applications than does cotton or small grains. Like most crops, however, soybeans require a fertile soil for maximum yields. The data in Table 2 show the response of soybeans to lime, phosphorus, and potassium when grown in a rotation of cotton-winter legume, corn, and oats-soybeans. Cotton received 200 pounds each of P_2O_5 and K_2O, but no phosphorus or potassium was applied to the other crops in the rotation. Plots receiving lime were treated with dolomite

TABLE 2. EFFECT OF LIME, PHOSPHORUS, AND POTASSIUM ON YIELDS OF SOYBEANS GROWN IN A ROTATION OF COTTON-WINTER LEGUME, CORN, OATS-SOYBEANS ON A LAKELAND LOAMY SAND[1], MAIN STATION, AUBURN, ALABAMA

Fertilizer and lime treatments[2]	Per acre yields, 1961-65 average
	Bushels
Lime	8.5
Lime and potassium	12.7
Lime and phosphorus	12.8
Lime, phosphorus, and potassium	29.7
Phosphorus and potassium	17.0

[1] Soil test—pH 4.8, phosphorus and potassium low.
[2] Lime applied as recommended by soil test and 200 pounds each of P_2O_5 and K_2O applied to cotton.

as recommended by soil test. The unlimed plots had a pH of 4.8 and the unfertilized plots tested low in phosphorus and potassium. The response to lime on the Lakeland loamy sand at Auburn was greater than that obtained at most other locations.

The results reported in Table 3 show that soybeans need little or no additional phosphorus and potassium when grown on soils high in available phosphorus and medium in potassium. The Kalmia fine sandy loam at the Brewton Experiment Field had a pH of 6.2 and, as would be expected, soybeans did not respond to lime. Although the Marlboro sandy loam at the Gulf Coast Substation had a pH of 4.8, response to lime was small—no lime 31

TABLE 3. EFFECT OF LIME PHOSPHORUS, AND POTASSIUM ON YIELDS OF SOYBEANS, TWO TEST LOCATIONS

Lime and fertilizer per acre			Yields per acre	
Lime	P_2O_5	K_2O	Marlboro fine sandy loam,[1] 1958-65 average	Kalmia sandy loam,[2] 1962-65 average
Lb.	*Lb.*	*Lb.*	*Bushels*	*Bushels*
2,000	0	0	----	31.3
2,000	0	100	33.8	32.9
2,000	25	100	33.7	33.7
2,000	50	100	33.4	33.4
2,000	100	0	34.4	31.4
2,000	100	25	34.1	34.2
2,000	100	50	34.9	33.5
2,000	100	100	34.9	34.8
2,000	100	100[3]	34.1	34.1
0	100	100	30.8	33.7

[1] Gulf Coast Substation, Fairhope, Alabama; soil test—pH 4.8, phosphorus high, and potassium medium.
[2] Brewton Experiment Field; soil test—pH 6.2, phosphorus very high, and potassium medium.
[3] Calcitic lime—all other limed plots received dolomitic lime.

bushels, limed 35 bushels. Results from earlier experiments in Alabama also showed less response of soybeans to lime than was expected *(7)*. Unless potatoes are grown in rotation with soybeans, lime is recommended for soybeans on soils with a pH below 5.7.

Even though lime and fertilizer needs are met, soybean yields may be low because of moisture shortage at a critical time. Several years ago an experiment was begun at several locations to determine maximum yields of soybeans and other crops when grown at an extremely high fertility level, Table 4. On the Alexandria Experiment Field, yields varied from a low of 10 bushels to a high of 40, with a 10-year average of 21 bushels. The experiment at that location was on an eroded phase of Decatur silt loam, which is considered a droughty soil. The 11-year average yield at Brewton on a Kalmia fine sandy loam was 33 bushels. Brewton is near enough to the Gulf Coast to have good summer rainfall during most years.

Applying lime and fertilizer for soybeans according to soil test gives best results. Soybeans grown in rotation with crops that have been fertilized and limed according to soil test usually do not need additional fertilizer. For example, if beans are to follow wheat, the soil test recommendations for wheat would be as follows:

Soil test		*Fertilizer recommended*		
P	*K*	*N*	*P_2O_5*	*K_2O*
			Lb. per acre	
Low	Low	100	90	90
Medium	Medium	100	60	60
High	High	100	40	40

If the foregoing recommendations are followed, it would not be necessary to fertilize the soybean crop following wheat.

Where soybeans do not follow a well fertilized crop, the following rates of phosphorus and potassium are recommended based on soil test:

Soil test		*Fertilizer recommended*	
P	*K*	*P_2O_5*	*K_2O*
		Lb. per acre	
Low	Low	80	80
Medium	Medium	40	40
High	High	0	0

TABLE 4. YIELDS OF SOYBEANS GROWN AT A HIGH FERTILITY LEVEL, EIGHT ALABAMA LOCATIONS[1]

Location and soil type	Yields per acre, bushels											
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	Av.
Alexandria Experiment Field, Decatur silt loam	----	10	17	10	31	40	20	16	10	22	34	21
Auburn, Chesterfield fine sandy loam	----	----	----	----	----	----	----	26	21	37	17	25
Brewton Experiment Field, Kalmia fine sandy loam	19	15	38	46	21	44	30	27	40	46	41	33
Monroeville Experiment Field, Magnolia fine sandy loam	15	7	23	24	15	36	35	10	17	31	26	22
Prattville Experiment Field, Greenville fine sandy loam	14	30	12	38	16	36	37	33	14	27	27	26
Sand Mountain Substation, Hartsells fine sandy loam	----	----	----	----	----	----	----	28	25	21	23	24
Wiregrass Substation, Norfolk fine sandy loam	----	----	----	----	----	----	----	11	21	34	----	22
Tallassee Plant Breeding Unit, Cahaba loamy fine sand	----	----	----	----	----	----	----	----	36	53	41	43

[1]Sufficient lime and fertilizer were applied to remove fertility as a limiting factor for production.

Placement of Fertilizer

Soybean seed are easily injured by fertilizer salts, as illustrated by Figure 3. Thus, any fertilizer applied directly to soybeans should be broadcast or placed in the drill 2 to 3 inches to the side and below the seed. In no case should fertilizer be placed in the drill with the seed.

FIG. 3. Effect of fertilizer placement on soybean stands is shown by these research plots. Fertilizer was drilled too near seed in the plot at left, whereas the plot at right had all fertilizer broadcast. Rate of fertilization was 400 pounds of 0-14-14 per acre to each plot, applied at planting.

Inoculation

Inoculation is probably not necessary if soybeans have been grown successfully on the area to be planted in the last 3 or 4 years. However, on new land or where the previous crop of soybeans was not satisfactory, seed should be inoculated with a commercial inoculant prepared specifically for soybeans. When properly inoculated, soybeans start fixing nitrogen 3 or 4 weeks after emergence. This means that on fertile soils inoculated soybeans do not need commercial nitrogen. Sandy soils of low fertility may require an application of about 20 pounds of commercial nitrogen per acre to take care of the plant's requirements until nitrogen fixation begins.

Researchers in Georgia and Mississippi have reported some response to molybdenum when applied to seed at planting time. An experiment was conducted in Alabama at seven locations in 1964 to determine response of soybeans to seed-applied molybdenum. The pH of the soils ranged from 5.0 to 5.9. Since no response was obtained, it is apparent that additional molybdenum is not required for proper nodulation of soybeans in Alabama soils.

SOYBEAN VARIETIES

Variety tests have been conducted by the Alabama Station in cooperation with the USDA Southeastern Regional Soybean Laboratory, Stoneville, Mississippi. Much of this research has had to do with evaluating new breeding lines. However, only varieties released and named are included in this report, Table 5. There are numerous available varieties that are not included in the regional test, and these have been evaluated in another variety test series.

Varietal recommendations are based not only on yield but also on resistance to disease, nematodes, shattering, and lodging. All varieties recommended are similar in oil content, ranging from

TABLE 5. YIELD OF SOYBEAN VARIETIES AT SIX LOCATIONS

Variety	Average maturity date[1]	Per acre yield by location						
		Belle Mina, Ala.	Experiment, Ga.	State College, Miss.	Tallassee, Ala.	Fairhope, Ala.	Walnut Hill, Fla.	Av. all locations
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Very early								
Dorman	9-28	22.3	25.5	28.8	----	----	----	25.5
Hill	9-28	23.0	25.6	29.0	----	----	----	25.9
Early								
Lee	10-13	17.5	----	34.4	37.4	35.6	44.2	33.8
Hood	9-29	18.8	----	34.1	34.4	36.3	42.0	33.1
Midseason								
Bragg	10-21	----	44.1	26.1	43.4	35.7	----	37.3
Jackson	10-25	----	37.5	28.8	34.3	32.7	----	33.3
Late								
Bienville	11-1	----	----	----	37.8	34.9	----	36.4
Hampton	10-27	----	----	----	38.6	39.9	----	39.3
Hardee	11-4	----	----	----	36.7	38.8	----	37.8

[1] Average maturity date for very early varieties at Belle Mina, Alabama; all others at Tallassee, Alabama.

21 to 22 per cent. The currently recommended varieties are described by maturity groups.

Very Early Varieties

Dorman and Hill are considered too early for extensive planting in Alabama. However, there may be situations where a 10 to 30 per cent reduction in yield may be justified for early harvest. Under no circumstances should these varieties be planted before May 1 or after June 1 in northern Alabama or after June 15 in the southern part of the State.

Early Varieties

The early varieties mature in mid-October. Lee and Hood are recommended in this maturity group and both are adapted throughout the State. However, since Hood is 10 to 12 days earlier than Lee, it is better suited for use in northern Alabama and Lee for use in the southern area.

Midseason Varieties

The midseason varieties are adapted to the southern two-thirds of Alabama. Frequently they mature before frost in northern Alabama, but the risk of frost damage to soybeans of this maturity is too great for recommendation of their general use. Recommended varieties are Bragg and Jackson.

Late Varieties

Late varieties are of greatest value in southern Alabama. The recommended varieties in this maturity group are Bienville, Hampton-266, and Hardee. Of these three, Hampton-266 is the earliest; it is also recommended for use in central Alabama, especially when planting is late.

Date of Planting

Studies to determine optimum planting dates were conducted at 11 locations in Alabama during 1953-57. Data from these experiments *(5,7)* indicate that May is generally the best month for planting in most of the State. However, planting in Baldwin and Mobile counties should be 2 weeks later, May 15 to June 15.

By May soil temperature is usually high enough for good germination. Regardless of date, however, soybeans should not be planted unless there is sufficient soil moisture for immediate germination.

A delay in planting will reduce the yield of all soybean varieties. The reduction is not the same for all varieties, however, as shown by results of a 3-year experiment at the Gulf Coast Substation, Fairhope, Alabama, Table 6. In this test, four adapted varieties representing a range in maturity from very early to very late were each planted at approximately 2-week intervals from May 1 to July 15. The varieties are listed in the table in order of maturity, with Hood being approximately 4 weeks earlier than Bienville. No variety was significantly influenced by planting date prior to mid-June. After this date, however, there was a marked decline in yield and also a reduction in plant height and bean placement. The drop in yield was at the rate of approximately ½ bushel per day for each day's delay in planting after June 15. The reduction was most severe on the early variety,

TABLE 6. PERFORMANCE OF SOYBEAN VARIETIES PLANTED AT VARIOUS DATES, GULF COAST SUBSTATION, 1960-62

Variety and planting date	Per acre yield, 1960-62	Plant height, 1960	Height of lowest bean, 1960
	Bushels	*Inches*	*Inches*
Hood			
May 1	45	23	4
May 15	45	18	3
June 1	48	24	5
June 15	41	22	4
July 1	30	16	3
July 15	15	16	3
Jackson			
May 1	41	34	7
May 15	45	37	8
June 1	44	34	6
June 15	45	21	6
July 1	43	26	4
July 15	32	24	4
Yelnanda			
May 1	38	42	12
May 15	44	42	12
June 1	46	40	9
June 15	41	35	9
July 1	42	35	8
July 15	29	29	8
Bienville			
May 1	42	39	7
May 15	45	39	7
June 1	46	36	6
June 15	42	31	6
July 1	39	25	5
July 15	29	24	4

Hood. Latest planting dates for reasonable chance of success are July 15 in southern and central Alabama and June 20 in northern Alabama.

Although these results are from southern Alabama tests, the same trends have been observed throughout the State. Actually, time of planting affects varieties more in northern Alabama because of the shorter season and the greater change in daylength. Daylength is significant because it largely determines the time a given variety will start flowering and therefore will mature.

It may be desirable to plant varieties of different maturity to extend the harvest season. Also, preceeding crops or adverse weather may delay planting. In any case, variety selection is important. When planting in May or early June, either early or late maturing varieties are suitable, but only late maturing varieties are satisfactory for late planting.

Extremely early planting should also be avoided. Soybeans planted before May 1 will often make short plants with beans placed close to the ground. Not only is yield reduced but many beans are left in the field because they are set too close to the ground to be harvested. Furthermore, extremely early plantings are more subject to reduced quality by increased purple stain and rotting in the pods. These effects are most serious on the early varieties.

Rate of Seeding and Row Width

A survey conducted by the National Soybean Crop Improvement Council in 1955 showed that most oil varieties of soybeans are planted in 36- to 42-inch rows. However, results of New York studies *(10)* showed that decreasing row width from 32 to 8 inches increased yields 20 to 30 per cent. Data from four Corn Belt States *(9)* show rows spaced 21 inches apart gave slightly higher yields than 7-, 14-, 28-, 35-, or 42-inch rows. In contrast, studies in the Southeastern States have not shown an advantage from row-spacing less than about 36 inches *(4)*. Most of these studies have been conducted with plantings made at the optimum date. Since late-planted beans, such as those planted after small grains when weather did not permit planting in early June, seldom reached sufficient size to completely cover the ground, indications were that an advantage might be found from using closer row spacings. This theory was investigated in studies by the Agricultural Experiment Station.

Results given in Table 7 are from a 3-year study at the Plant

TABLE 7. EFFECT OF ROW WIDTH, SEEDING RATE, AND VARIETY ON YIELD OF LATE-PLANTED SOYBEANS, KALMIA SANDY LOAM, PLANT BREEDING UNIT, TALLASSEE, ALABAMA, 1954-56

Row width	Seeding rate per acre	Variety	Stand at harvest				Yield per acre				Av. for seeding rate	Av. for row width
			1954	1955	1956	Av.	1954	1955	1956	Av.		
In.	*Lb.*		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
June 1 planting												
30	30	Lee	83	99	96	93	19	40	47	35		
30	30	Jackson	45	89	82	72	17	44	44	35	35	
30	60	Lee	87	99	100	95	18	31	40	30		
30	60	Jackson	76	95	90	87	23	29	55	35	32	34
40	30	Lee	86	99	97	94	13	36	40	33		
40	30	Jackson	57	95	88	80	10	27	42	26	29	
40	60	Lee	97	100	100	99	16	29	34	26		
40	60	Jackson	82	100	98	93	15	32	39	29	27	28
July 1 planting												
30	30	Lee	81	91	97	90	15	34	36	28		
30	30	Jackson	75	76	87	79	13	32	35	27	27	
30	60	Lee	92	99	99	97	14	32	38	28		
30	60	Jackson	88	88	97	91	18	31	38	29	28	28
40	30	Lee	94	96	98	96	13	28	38	26		
40	30	Jackson	85	82	93	87	13	28	32	24	25	
40	60	Lee	97	99	98	98	14	27	34	25		
40	60	Jackson	98	91	100	97	15	24	35	25	25	25

TABLE 8. EFFECT OF ROW WIDTH, SEEDING RATE, AND VARIETY ON YIELD OF LATE-PLANTED (JULY 1) SOYBEANS, KALMIA SANDY LOAM, PLANT BREEDING UNIT, TALLASSEE, ALABAMA, 1955-56 AND 1958

Row width	Seeding rate per acre	Variety	Stand at harvest				Yield per acre				Av. for seeding rate	Av. for row width
			1955	1956	1958	Av.	1955	1956	1958	Av.		
In.	*Lb.*		*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
10	240	Lee	99	100	100	100	26	53	38	39		
10	240	Jackson	95	97	100	97	27	56	40	41	40	
10	60	Lee	84	97	100	94	50	57	56	54		
10	60	Jackson	72	85	100	86	42	59	71	57	55	48
20	120	Lee	100	100	100	100	29	45	37	37		
20	120	Jackson	90	97	100	96	29	40	40	36	36	
20	60	Lee	96	97	100	98	29	50	42	40		
20	60	Jackson	87	97	100	95	30	42	50	41	40	38
30	90	Lee	99	100	100	100	24	40	37	34		
30	90	Jackson	94	97	100	97	33	44	45	41	37	
30	60	Lee	99	100	100	100	24	38	35	32		
30	60	Jackson	91	100	100	97	32	40	43	38	35	36
40	60	Lee	100	100	100	100	27	36	37	33		
40	60	Jackson	94	97	100	97	26	39	44	36	34	34

Breeding Unit, Tallassee, comparing early and late-planted beans (about June 1 and July 1) in 30- and 40-inch rows at 30- and 60-pound seeding rates for Lee and Jackson varieties *(7)*. These data show a 3- to 5-bushel advantage for 30-inch rows over 40-inch rows. The same advantage prevailed for June 1 plantings over July 1 plantings. There was no difference between 30- and 60-pound seeding rates or between varieties.

Data in Table 8 are those of a study comparing 10-, 20-, 30-, and 40-inch rows seeded at 60 pounds per acre, and 240-, 120-, and 90-pound seeding rates on 10-, 20-, and 30-inch rows, respectively. This study showed a marked increase in yield from decreasing row width. Yields during the 3 years were highest when the seeding rate was 60 pounds per acre, averaging 34 bushels per acre in 40-inch rows and 55-bushels in 10-inch rows. These studies show that on land not heavily infested with weeds or where weeds are controlled, beans planted in narrow rows produce higher yields.

Based on these results, it is recommended that soybeans be planted in rows as narrow as weed control will permit. This is especially important for late planting. Seeding rate should be about 60 pounds of viable seed per acre regardless of row width.

WEED CONTROL in SOYBEANS

Top yields of good quality soybeans are not possible unless annual weeds and grasses are controlled. Not only do dense stands of weeds compete for available nutrients and moisture, they also interfere with harvesting. In addition, the presence of some weed seeds may lower the price of soybeans or necessitate recleaning, which would further reduce profits.

Mechanical weed control is an effective method of controlling weeds in soybeans. Because soybeans are fast-growing plants that rapidly shade the soil (in 3 to 5 weeks), early season weed control is most important. The rotary hoe is an efficient tool for early season weed control. Cultivation with rotary hoes should begin just before emergence of weeds and continue until soybeans are 4 to 6 inches tall, or until it would cause excessive injury to the soybeans. Injury can be reduced by working during the middle of the day when soybeans are slightly wilted. The rotary hoe is usually more effective after light rains, which form a light crust on the soil surface. One to two cultivations with sweeps is usually required to complete the weed control.

TABLE 9. RELATIVE EFFECTIVENESS OF RECOMMENDED HERBICIDES FOR CONTROL OF ANNUAL GRASSES AND BROADLEAF WEEDS IN SOYBEANS, 1963-66

Herbicide rate/acre	Percentage control							
	Annual grasses				Broadleaf weeds			
	1963	1964	1965	1966	1963	1964	1965	1966
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Vernolate, 2 lb.	----	----	92	56	----	----	93	86
Vernolate, 3 lb.	97	100	100	90	69	80	96	83
Vernolate, 4.5 lb.	95	100	----	100	92	60	----	87
Amiben, 2 lb.	18	----	56	----	65	----	87	----
Amiben, 3 lb.	----	----	88	95	----	----	73	81
Amiben, 6 lb.	----	77	----	100	----	40	----	80
PCP, 13 lb.	----	----	68	----	----	----	90	----
PCP, 16 lb.	52	----	----	----	85	----	----	----
Trifluralin, 0.50 lb.	----	----	93	61	----	----	83	90
Trifluralin, 0.75 lb.	----	----	98	91	----	----	89	85
Trifluralin, 1 lb.	90	61	----	91	69	20	----	80

Although mechanical control of weeds in soybeans is often successful, it is not foolproof. Early summer rains that favor germination and growth of weeds may also prohibit or delay mechanical cultivation. Conditions such as these demand other means of weed control, and many farmers are fulfilling this demand with herbicides.

The advent of preemergence herbicides has necessitated changes in methods of planting soybeans. Before preemergence herbicides, soybeans were commonly planted in a furrow, with sides of the furrow used to cover weeds during plowing. For preemergence herbicides to be used effectively, soybeans must be planted flat. This reduces leaching of herbicides into the area around the soybean seed when heavy rains occur shortly after application of the herbicides. Planting on the level also reduces the possibility of treated soil being washed from sides of the furrow, thereby exposing untreated soil from which weeds can germinate and grow. Because of the greater possibility of leaching, this is more important in sandy soils than in fine textured soils.

Effective control of weeds with herbicides permits greater freedom in planting patterns. If the requirement for mechanical cultivation were completely eliminated, soybeans could be planted at row spacings conducive to maximum yields.

At present, amiben and PCP are recommended for preemergence weed control in soybeans in Alabama, Table 9. Amiben is applied at 3 pounds active material per acre and the sodium salt of PCP at 13 to 18 pounds per acre. Each of these materials has given satisfactory results when moisture was adequate. However, excessive rainfall can decrease the effectiveness by causing leaching of the herbicide. These herbicides are applied either broadcast or in a band over the drill in enough water to ensure adequate coverage of the soil surface.

Two pre-plant herbicides that require incorporation, vernolate and trifluralin (Treflan), are also recommended for weed control in soybeans. Vernolate (Vernam) has given excellent control of most annual grasses. In some years it has caused considerable early temporary injury and stand reduction, and in one of the three experiments in 1966 vernolate caused a reduction in yield. Vernolate application rate is 2 to 3 pounds per acre of active material (higher rate for finer textured soils), incorporated prior to planting.

Trifluralin has consistently given exceptionally good grass control in soybeans when applied at rates of 0.5 to 1.0 pound of active material per acre. For satisfactory results, trifluralin should be incorporated immediately after application. Although trifluralin has caused stand reductions in some areas of the Southeast, none has been noted in Alabama.

A major weakness of both vernolate and trifluralin is that neither gives adequate control of many of the more troublesome broadleaf weeds. Sicklepod, cocklebur, Florida beggarweed, prickly sida (ironweed), and morning-glory are some broadleaf weeds that are either not controlled or are poorly controlled with vernolate or trifluralin. However, some broadleaf weeds, such as carpetweed, pigweed, and Florida pusley (purslane), are fairly well controlled with either of these herbicides. Both herbicides offer excellent control of most annual grasses, such as goosegrass, crabgrass, crowfootgrass, and barnyardgrass. Trifluralin also controls Texas millet, which is not controlled with vernolate; however, vernolate gives some control of nutsedge. Consequently, a combination of these herbicides might be appropriate if the major weed problem were Texas millet and nutsedge.

There are several methods of preplant incorporation, but one or two diskings with a double section disk harrow has given good results with both trifluralin and vernolate. If a second disking is used, it should be perpendicular to the direction of the first. Disk should be set to incorporate the herbicide 1 to 2 inches deep. Other satisfactory means of incorporation include power takeoff driven rotary tillers, hoes, and cultivators. Regardless of incorporation method, care should be exercised to ensure that planting equipment does not bring untreated soil to the surface.

Relative effectiveness of several herbicide combinations for weed control in soybeans is recorded in Table 10. There are two major advantages of a combination over a single herbicide: (1) a broader spectrum of weeds is controlled, and (2) the required amount of any single herbicide is reduced, thereby decreasing the possibility of herbicide residues accumulating in the soil. Judicious selection of herbicides could possibly reduce the cost for chemical weed control. The combination of CIPC and amiben has consistently given excellent grass control and good broadleaf weed control, Figure 4. CIPC and DCPA have given excellent

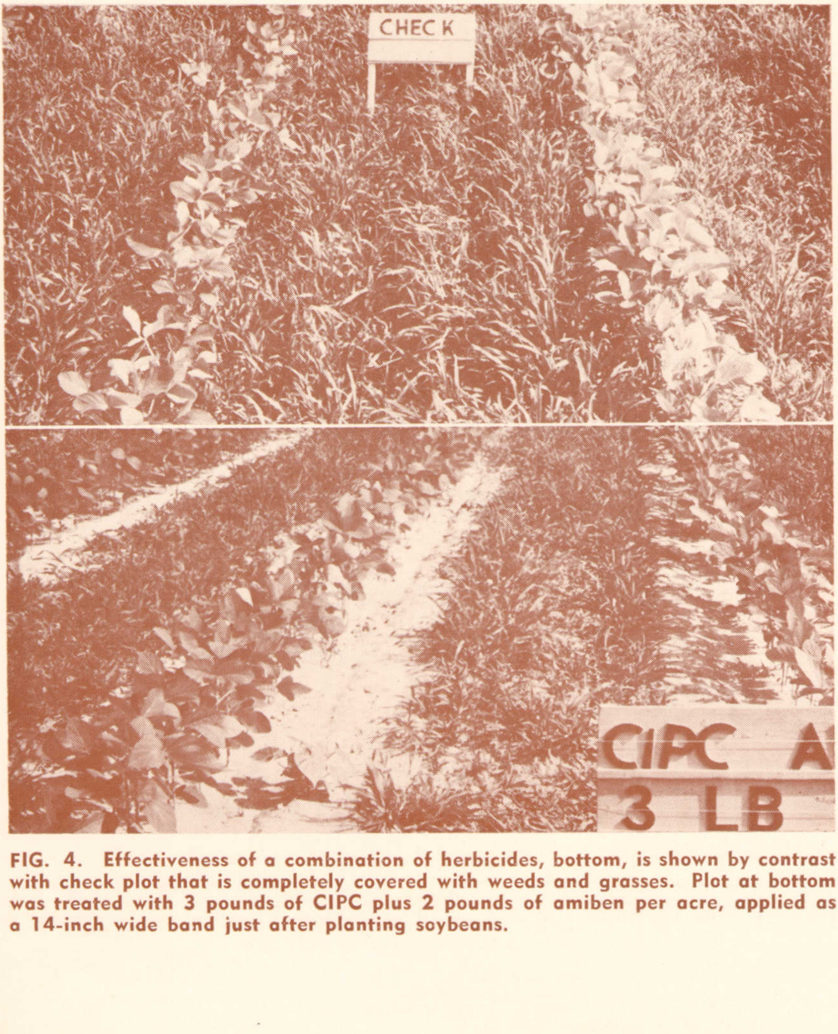

FIG. 4. Effectiveness of a combination of herbicides, bottom, is shown by contrast with check plot that is completely covered with weeds and grasses. Plot at bottom was treated with 3 pounds of CIPC plus 2 pounds of amiben per acre, applied as a 14-inch wide band just after planting soybeans.

TABLE 10. RELATIVE EFFECTIVENESS OF HERBICIDE COMBINATION FOR WEED CONTROL IN SOYBEANS, 1965-66

Herbicide rate/acre	Percentage control			
	Annual grass		Broadleaf weeds	
	1965	1966	1965	1966
	Pct.	Pct.	Pct.	Pct.
CIPC, 3 lb. + amiben, 1.5 lb.	----	91	----	61
CIPC, 3 lb. + amiben, 2 lb.	97	95	85	82
CIPC, 1 lb. + DCPA, 3 lb.	----	66	----	0
CIPC, 1.5 lb. + DCPA, 4.5 lb.	----	96	----	53
CIPC, 2 lb. + DCPA, 6 lb.	----	99	----	86
CIPC, 3 lb. + DNBP, 3 lb.	86	75	62	76
CIPC, 4.5 lb. + DNBP, 4.5 lb.	----	93	----	94
CIPC, 3 lb. + NPA, 2 lb.	----	58	----	59
CIPC, 3 lb. + NPA, 4 lb.	----	85	----	87
CIPC, 3 lb. + diphenamid, 3 lb.	92	93	66	80
CIPC, 3 lb. + linuron, 2 lb.	----	93	----	93
Trifluralin, 0.5 lb. + vernolate, 1.5 lb.	----	85	----	88
Trifluralin, 1 lb. + vernolate, 3 lb.	----	98	----	92

grass and broadleaf weed control when applied at 2 and 6 pounds per acre, respectively. Weed control effectiveness with other herbicide combinations is summarized in Table 10.

Although preemergence weed control combined with mechanical cultivation is usually satisfactory, there is often a need for postemergence weed control. Chloroxuron (Tenoran) has given control of many broadleaf weeds, such as pigweed, sicklepod, cocklebur, and morning-glory, when applied postemergence as a directed spray, Table 11. To effectively control broadleaf weeds, chloroxuron should be applied when weeds are small, 1

TABLE 11. RELATIVE EFFECTIVENESS OF NON-RECOMMENDED HERBICIDES FOR WEED CONTROL IN SOYBEANS, 1965-66

Herbicide rate/acre	Percentage control			
	Annual grass		Broadleaf weeds	
	1965	1966	1965	1966
	Pct.	Pct.	Pct.	Pct.
Applied postemergence				
Chloroxuron, 2 lb.	----	0	----	85
Chloroxuron, 3 lb.	----	0	----	95
Applied preemergence				
Sindone, 2 lb.	65	85	45	38
Sindone, 4 lb.	89	86	62	56
Rowmate, 6 lb.		99	----	68
Rowmate, 10 lb.	87	100	93	76
Planavin, 1 lb.	----	92	----	25
Planavin, 2 lb.		93	----	20

to 2 inches in height. Chloroxuron is ineffecive against most annual grasses.

Johnsongrass is also a major soybean weed problem in some areas of Alabama. The johnsongrass problem is aggravated because this grass is often cultivated as a hay crop in areas where soybeans are grown. There is no herbicide that can be used preemergence to control established johnsongrass rhizomes. Dalapon is the most effective postemergence herbicide. It is applied at 4 to 8 pounds per acre of active material to young actively growing johnsongrass when it is 8 to 12 inches tall. Often an early mowing will increase the number of rhizomes that have initiated regrowth, thereby increasing the number of plants receiving herbicide. An early mowing will also further deplete food reserves in the rhizomes and increase the kill. Three days after herbicide application, johnsongrass should be plowed under and soybeans can be planted 18 days after plowing.

Since dalapon has no preemergence activity, a herbicide such as trifluralin, vernolate, amiben, or PCP should be used routinely to control seedling johnsongrass. Although this procedure is not 100 per cent effective, it will permit soybean production in johnsongrass infested areas.

SOYBEAN DISEASES

There are about 50 diseases known to affect soybeans in this country, caused by bacteria, fungi, viruses, and nematodes. Annual losses from these diseases have been estimated at 12 per cent of the total crop. Disease-free soybean fields are rather rare, and it is not uncommon to find fields with several diseases present. Intensity of disease and amount of crop loss are dependent on such conditions as temperature and humidity. Yield reductions are not usually large enough to be observed directly by the grower.

Some soybean diseases are now controlled effectively by use of adapted, resistant varieties. Others can be controlled by crop rotation, fall plowing, use of disease-free seed, and seed treatment.

Bacterial Diseases

Bacterial blight is one of the most widespread diseases of soybeans. It is most common and conspicuous on leaves, although it may appear on stems and pods. Heavy infection may cause defoliation. It is likely to be most serious during periods of cool weather and frequent rain.

The bacteria that cause blight are seed-borne, but they can also survive in dead leaves from one growing season to another. By planting seed from severely diseased plants or replanting seed in infested fields, this disease becomes established. Thus, the use of disease-free seed and crop rotation are good disease control practices. Susceptibility to the disease varies with soybean varieties.

Bacterial pustule is present to some degree in most soybean-growing areas. In the South it is more uniformly severe when susceptible varieties are grown. The pods may become infected, but the disease is usually confined to the leaves. The pustule on leaf and the absence of a wet appearance before the spot turns yellow distinguish this disease from bacterial blight. Bacterial pustule has caused losses as high as 12 per cent. The disease-producing bacteria are seed-borne and overwinter in diseased leaves. Varieties like Hardee, Hill, Hood, and Lee are resistant.

Wildfire occurs only where bacterial pustule is found since the wildfire bacteria invade only leaves infected by the pustule bacteria. The bacteria are seed-borne, and may live for 3 to 4 months in dead leaves at the soil surface; however, they are killed in a few weeks when covered with soil. This disease can be controlled readily by planting varieties resistant to bacterial pustule.

Bacterial wilt, long recognized as an important disease of garden beans, has been found in recent years to be widely distributed in soybean fields in the United States. Most commercial seed are contaminated, and seed of some varieties appear more severely contaminated than others. No resistant varieties are known, but there is a considerable range in susceptibility. The Lee variety seems less susceptible than others. **Soybeans from severely diseased fields should never be used for seed.** Low temperatures, poor soil conditions, and heavy rains soon after planting increase infection severity. There is no effective method for controlling wilt.

Fungus Diseases

Downy mildew is one of the most common diseases in America. Severely infected leaves fall prematurely. A gray fungus growth, sometimes called mildew, develops on the lower side of these diseased areas. The fungus grows within the plant, invades the pods, and covers some seeds with a white crust.

Recent research has shown that 26 races of the mildew fungus exist. These are widely distributed throughout the country; however, normally only one or two occur in any field. Soybean plants resistant to all known races of the fungus have been found, and from these, resistant varieties are being developed.

Brown spot has increased greatly in severity and occurrence in recent years. It may cause serious defoliation and reduction in yield. It is seed-borne, and the disease occurs early in the season on both leaf surfaces as small, reddish-brown, more or less angular spots.

Seed from heavily diseased fields should not be used for planting because seed treatment does not give satisfactory control. Greatest damage occurs where soybeans are planted every year in the same field. Soybean varieties vary greatly in amount of damage from this disease.

Pod and stem blight is primarily a disease of stems and pods at maturity. It is identified by the many small, black fruiting bodies appearing on these plant parts. Seedlings developing from infected seed die before emergence, or soon after. The disease is seed-borne, and the fungus can overwinter on diseased stems in the field. Thus, using disease-free seed, plowing under crop refuse completely, and rotating crops are recommended as control measures.

Target spot affects leaves, stems, and pods, particularly during prolonged periods of wet weather. The varieties Bragg, Hampton-266, Hardee, and Jackson have a high degree of resistance. In addition, the use of disease-free seed and crop rotation are recommended as control measures.

Frogeye leafspot causes circular, gray spots with dark brown borders on leaves and stems and dark spots on pods. Heavily spotted leaves fall prematurely. The fungus survives on crop refuse and on seed. Recommended control measures include planting good quality, disease-free seed of varieties with some resistance, such as Bienville, Hampton-266, Hardee, and Jackson, and growing in rotation with grains, grasses, or cotton.

Southern stem blight (sclerotial blight) is characterized by a rot at base of the plant where usually a dense white mold appears. The disease seldom causes heavy losses but it is almost always present, particularly during hot weather, and kills plants at random throughout a field. Since the fungus attacks a wide variety of crops, rotation is of slight help in controlling the disease. Deep turning to provide a 4-inch cover of soil over crop debris may prove helpful in disease control.

Charcoal rot is a disease of roots and stems. When the bark is peeled from diseased areas, small black structures (sclerotia) may be seen. This disease occurs only when plant growth is retarded by hot, dry weather, poor soil, or other unfavorable conditions.

Seed decay and seedling root rots affect seed of poor quality, particularly if the soil is too cool or too wet for rapid germination. There are numerous soil-borne fungi that can adversely affect seedlings by causing a watery rot of roots and lower stems or a dry, reddish-brown rot of the same tissues. High quality seed with high germination potential markedly reduce seed decay and seedling diseases. For seed that germinate below 85 per cent, a seed protectant chemical such as Brasan 50, captan (Orthocide), or Panogen PX should be used.

Virus Diseases

To reduce virus disease problems, high quality seed should be used. Also, insects and weeds should be controlled around bean fields since insects can transmit viruses and weeds are host plant carriers.

Soybean mosaic occurs to some extent in all soybean-producing areas. Virus-infected plants are stunted and leaves are narrower and deeper green than normal. Leaf symptoms resembling mosaic often are caused by 2,4-D and related herbicides.

Bud blight may cause some damage to soybeans in this State. The terminal buds of young plants brown and crook sharply downward becoming dry and brittle. The leaf just below the damaged bud usually is rusty and bronzed. Plants affected near flowering are dwarfed and develop few seed. The pods will become purple-blotched and frequently drop. There is no effective control of bud blight.

Yellow mosaic is caused by the same virus-inducing yellow mosaic of garden beans. Younger leaves of infected plants usually show a yellow mottling. As the leaves mature, rusty dead spots develop in the yellow areas. Infected plants are not noticeably stunted. The virus is not seed-borne, and usually does not greatly reduce yield.

Nematode Diseases

The plant parasitic nematodes of importance to soybeans are the same tiny soil worms that are damaging to other crop, garden, and nursery plants. These nematodes attack only plants and are usually in localized areas, but they are distributed widely in the United States and other countries.

Life cycle of these tiny worms is in several stages: the egg, four larval stages, and adult male and female. The life cycle from egg to adulthood is about 4 weeks. Large numbers of eggs can be produced by nematodes, and the parasite population can flare up within a growing season. The nematodes can overwinter in the soil or within the roots.

Nematode damage to soybeans is mainly by injury to tissues of the roots, usually resulting in fewer roots and plants and reducing capacity to take up water and soil nutrients. This in turn can result in stunting, foliage yellowing, and a greater susceptibility to wilting during dry periods. Damage to plant tissues is caused by feeding activities of nematodes, particularly at the developing root-tips which are the sites for feeding and initial entry.

Not all important nematodes species enter the roots; some feed only at the root's surface, but root tip damage can stop the root's growth.

Nematode detection begins with observation in the field of round spots or of a portion of a row where plants are not growing normally. They may be stunted, off-color, or more prone to show wilting. These particular areas may be noted to expand in successive years. Weakened plants may be more susceptible to other disease agents or pests. The nematode as an initial cause is easily overlooked unless a soil and root examination is made. Unfortunately, the only nematode that produces easily determined symptoms is the root-knot nematode. Although quite important in Alabama, it alone of several important types produces the readily seen root-knot, or root-gall symptom.

Spread of nematodes by movement through the soil is limited to a few inches per year. However, nematodes are widely spread in soil and infected plant parts that become inadvertently distributed. Nematodes of soybeans are not seed-borne.

Control of nematodes of soybeans is possible in various ways. Using nematocidal chemicals may be too expensive as a general practice for entire soybean fields, but it is the best solution for treating known infested spots in a field to prevent increase and spread of the nematodes.

Soybean varieties are now available that are resistant to certain nematodes, and development of additional resistant and better suited varieties can be expected. Exact identification of kinds of nematodes present is a requirement for effective use of resistant varieties because resistance to one nematode species does not mean resistance to all the others.

Some cultural practices reduce nematode populations by planting in time to allow the soybean plants to get their root systems well established. Established soybeans generally are tolerant to moderate amounts of nematode infection. Therefore, any practice that can reduce populations in early season can be helpful.

Dry fallow, particularly with repeated turning of soil to expose infected roots and nematodes, is effective against all nematodes. Several months of bare fallow prior to planting can help, but all plants including weeds should be kept to a minimum.

Root-knot nematodes probably are the most important nematode pest on soybeans in Alabama. The galls produced by these nematodes are easily distinguished from the beneficial nitrogen-fixing bacterial nodules that appear as attachments to the roots and are easily broken off. The nematode knots or galls are root swellings and cannot be removed without breaking the root. Some of the small roots may end in a gall and appear club-shaped.

Nematode damage to soybeans varies depending on tolerance of the variety, the degree of nematode infestation, and the supply of soil nutrients and water available to the plants. Reduced yield of seed can sometimes be considerable, along with reduced stem and foliage quantity.

Sting nematode is known elsewhere in the South as an important pest of soybeans, but it is limited to sandy soils. This nematode is found in some Alabama locations with sandy soil, and soybean problems are anticipated wherever this nematode exists.

Soybean cyst nematode has not yet been found in Alabama but may eventually appear. It is now found in localized areas in Arkansas, Illinois, Kentucky, Mississippi, Missouri, North Carolina, Tennessee, and Virginia. Fields infested with this nematode are placed under quarantine.

Resistant soybean lines have been found and transfer of the resistance to commercially suitable varieties is in progress. A successful crop rotation that includes nonsusceptible plants requires 2 to 4 years. Cotton is a satisfactory rotation crop. Legumes are likely to be hosts for this nematode and should be avoided. Soybean growers in Alabama should abide by quarantine regulations of infested areas to help assure continued absence of this pest in the State. Any suspicious diseased site, if soon enough found and reported, can be treated by the quarantine authorities to obtain complete eradication of this unwanted pest.

Other nematode pests of potential concern as soybeans become more commonly grown in Alabama are species of the reniform nematode, the spiral nematodes, and the root-lesion nematodes. These have been found in association with soybean plantings in the State.

The reniform nematode is known in a few places in Alabama where it causes severe damage to cotton. Spiral nematodes have been found in 74 per cent of soil samples from soybean plantings in Alabama, Georgia, and northern Florida. The root-lesion nematode has a wide host range and distribution, and is likely to be present in corn plantings. Investigations on the economic importance of the reniform and spiral nematodes to soybeans are underway at Auburn.

SOYBEAN INSECTS

Insects that damage soybeans in Alabama may be grouped as follows: (1) insects that damage soybean stands, (2) insects that feed on foliage, and (3) insects that damage beans in the pod. Seven of the most important ones are shown in Figure 5.

Insects That Damage Soybean Stands

Cutworms are the larvae of small moths that fly at night. When fully grown the larvae are nearly 2 inches long. Several species

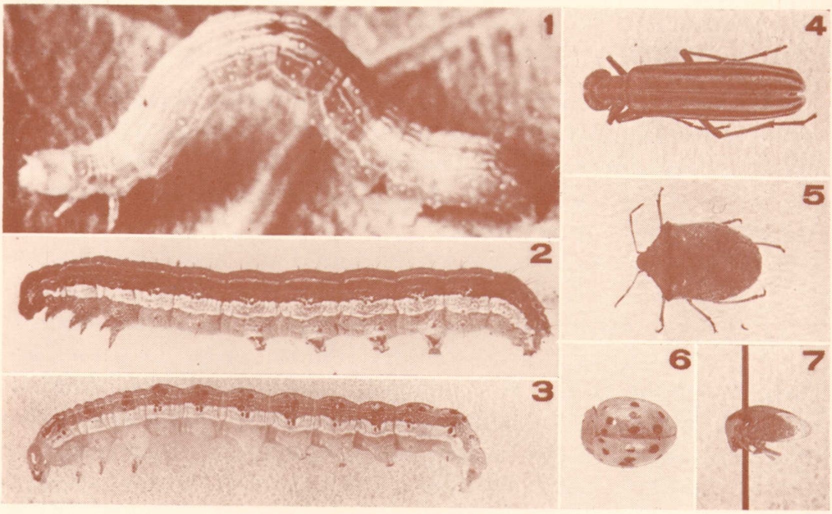

FIG. 5. Here are seven of the most important soybean insect pests in Alabama: (1) cabbage looper, (2) fall armyworm, (3) corn earworm, or podworm, (4) blister beetle, (5) stinkbug, (6) Mexican bean beetle, and (7) 3-cornered alfalfa hopper.

attack soybeans, but all are fat, dark-colored, and greasy looking. They hide beneath the soil surface during the day and emerge at night to feed. Cutworms usually feed on portions of the stem rather than foliage, which results in leaves being clipped or plants being cut.

The three-cornered alfalfa hopper is a green, triangular shaped treehopper that jumps and then takes flight when disturbed. Both nymphs and adults suck juice from a number of plants. They frequently occur in damaging numbers on soybeans. The nymphs are particularly damaging because they gradually work their way around the stems as they feed. This girdles the plant and either kills it outright, or weakens it so that it later falls over and dies. The girdling takes place near ground level.

Insects That Feed on Soybean Foliage

Blister beetles are elongate, soft-winged beetles that are about 2/5 inch long. They are usually black and yellow striped, but may be black or gray. They occur fairly frequently and large populations may occur in isolated parts of a soybean field. This general foliage feeder is easily seen and can be collected by hand or with a sweep net.

The fall armyworm is similar in appearance to the corn earworm and is the larva of a small, night-flying moth. It has a prominent, white, inverted Y on its head. Fall armyworms are general foliage feeders, and are easily seen and collected. Their occurrence is sporadic.

The false cabbage looper, usually referred to as the cabbage looper, is probably the most serious pest of soybeans in Alabama. It is the larva of a small, dark gray, night-flying moth. This larva is a fat "cabbage green" worm that forms loops or humps as it crawls and when fully grown is 1 to 1½ inches long. It feeds on foliage and is most often a pest from late August through September.

The Mexican bean beetle is frequently a pest of soybeans in the Gulf Coast Area of Alabama. This beetle is a destructive insect of the lady beetle family and resembles the other lady beetles in shape. The adult is hemispherical, yellow, and has 16 black spots on its back. Both adults and larvae are foliage feeders and are serious pests where they occur.

The velvetbean caterpillar is the larva of a small night-flying moth that overwinters in the tropics and southern Florida. Adults migrate into Alabama in June or July and begin laying eggs on soybeans. The worms (larvae) are slender, green, and have faint white stripes. They are sometimes serious foliage feeders.

Insects That Damage Beans in Pods

The corn earworm, sometimes called the podworm in soybeans, is the larva of a small brownish-yellow moth that flies at dusk. The larvae vary in color from light green to brown and have light and dark stripes running lengthwise on the body. They are about 1½ inches long when fully grown. These caterpillars enter pods and eat the beans.

Stinkbugs include several shield shaped bugs that may be brown or green depending on the species. Both nymphs and adults suck juice from soybean pods causing discoloration of the beans and subsequent reduction in grade. Heavy populations of stinkbugs may occur in isolated parts of a soybean field and, unless fields are closely examined, such infestations may go unnoticed. Beans are susceptible to stinkbug damage up to maturity.

Other pests that may attack soybeans are: (1) banded cucumber beetle, (2) bean leaf beetles, (3) garden webworm, (4) grape colaspis, (5) green cloverworm, (6) grasshoppers, (7) lesser cornstalk borer, (8) spider mites, (9) 12-spotted cucumber beetle, (10) thrips, and (11) yellow-striped armyworm.

Soybean Insect Control

Insects that affect soybean stands are usually a problem only early in the season. They should be controlled any time they are present in large numbers. Cutworms are difficult to control in soybeans, but toxaphene at 4 pounds per acre or TDE at 2 pounds per acre is usually effective. The three-cornered alfalfa hopper can be controlled with malathion, 1 pound per acre, or almost any of the other insecticides recommended for soybean insect control.

Foliage feeding insects can cause considerable ragging of leaves without actually reducing bean yield, particularly if the feeding occurs before bloom or after bean maturity. If foliage feeding insects appear to be reducing total leaf surface in the field by as much as one-third between bloom and bean maturity, control measures are justified. Blister beetles can be controlled with 2 pounds DDT, 1 pound malathion, 2 pounds methoxychlor, 1 pound carbaryl, or 3.5 pounds toxaphene per acre. Fall armyworm can be controlled with 1 pound carbaryl, 2 pounds DDT, 2 pounds TDE, or 2 pounds methoxychlor per acre. The false cabbage looper is best controlled with ½ to 1 pound per acre of methyl parathion or parathion. Excellent control of the Mexican bean beetle is obtained with 1 pound carbaryl per acre. Other materials that are effective against this beetle, at specified per acre rates, include 1 pound malathion, 2 pounds methoxychlor, and 2 pounds TDE. The velvetbean caterpillar can be controlled with the materials listed for use against the fall armyworm.

Pod-feeding insects are generally more damaging than foliage feeders since they feed directly on the marketable product. When one podworm is found per 3 row-feet control measures should be undertaken. Treating with 1 pound carbaryl, 2 pounds TDE, or 2 pounds DDT per acre has proved effective. When large numbers of stinkbugs appear control can be obtained with one of the following: 2 pounds carbaryl, 1¼ pounds malathion, ½ pound methyl parathion, or ½ pound parathion per acre.

The following restrictions should be observed with insecticides used on soybeans: Do not feed forage treated with toxaphene, DDT, or TDE to dairy animals or animals being finished for slaughter. Do not apply the following insecticides within the indicated days of harvest: carbaryl, 0; malathion, 1; methyl parathion, 20; parathion, 15; methoxychlor, 7; DDT, 21; TDE, 28; and toxaphene, 21.

HARVESTING

Proper land preparation is the first step in making sure that harvesting will not be a problem. Terraces should be designed with combine operations in mind.

Harvest should start as soon as beans reach a moisture content of 14 per cent. If beans are too dry, excessive shattering may result. The cutter bar should be run as low as possible to get bean pods that set low on the stalk. Speed and height of the reel should be adjusted to prevent beans from being knocked to the ground.

Combine damage of soybeans is a source of loss to growers. Broken beans and splits reduce market grade and price. The amount of splits can be reduced by harvesting beans at the proper moisture content and by reducing cylinder speed or increasing space between cylinder and concaves. Variation in moisture condition during the day may require combine adjustments to correct for moisture changes.

DRYING and STORING of SOYBEANS

Normally, soybeans are harvested at a moisture content too high for safe storage and must be dried before farm storage is possible. Present U.S. standards specify a moisture content no higher than 14 per cent for grade No. 2 soybeans, and no higher than 13 per cent for grade No. 1.

In storage tests *(2)*, soybeans with moisture contents of 13 per cent were invaded by Aspergillus *halophilicus*, A. *restrictus*, and A. *repens*, with accompanying increases in fat acidity value (FAV). Invasion by storage fungi and FAV increased as moisture contents went from 13 to 14 per cent. The effect of these increases on quality of soybeans was not determined, but increasing FAV could be expected to be accompanied by some reduction in quality.

Much of the annual storage losses can be attributed to storing beans with a moisture content of no more than 1 per cent above the safe level *(1)*. The maximum moisture level recommended by USDA for safe storage of soybeans is 11 per cent or less.

Storing beans at 11 per cent moisture does not assure that it will remain at this desired level. Increases of moisture levels in stored soybeans are caused by temperature differentials within the storage bin, which cause warm and moist air to migrate and form damp spots in the stored beans. Another cause of increased moisture content is absorption of moisture from the air. Beans stored at 11 per cent moisture in an atmospheric condition of 75 per cent relative humidity and 77° F. will absorb enough moisture from the air to raise the moisture level to 13.08 per cent.

Reports of other experiments *(6)* show that dried soybeans will reach a maximum moisture level of 10 per cent in about 74 days if stored in still air of 62 per cent relative humidity. When stored at 93 per cent relative humidity, the beans will reach 17.1 per cent moisture in 74 days and continue up to 22 per cent in 150 days.

If moist air of 90 per cent relative humidity is blown through beans, a moisture content of 20 per cent will be reached in 49 days. It is apparent, therefore, that forced air at 90 per cent relative humidity raises the moisture content of stored beans to about 22 per cent 3 times as fast as still air at 93 per cent relative humidity.

It is assumed that soybeans harvested in Alabama are usually above the recommended safe storage level of 11 per cent moisture; therefore, the beans should be dried before storing *(8)*.

There are several factors to consider in the drying operations: Initial moisture content, final moisture content, volume to be dried, use to be made of beans, and length of storage period.

The initial moisture content will affect length of drying time, drying temperature, and length of time the beans can be held before drying is started. For higher moisture contents, a longer drying period is needed and drying must be started early to prevent heat from building up in the beans. If beans are to be used for seed, the following is a good guide *(3)*.

Seed moisture	*Drying temperature*
Above 18 per cent	90° F.
18 to 10 per cent	100° F.

The maximum air temperature for drying beans to be used for milling purposes is 140° to 150° F.

Volume of beans to be dried at one time will determine the size of drying bin and size of fan and heater. The bin should be large enough to permit a drying depth of not over 10 feet, with 3 feet being preferable. If the batch is not dried within a 24-hour period, mold may develop in the top layer. The fan should be large enough to deliver at least 3 cubic feet per minute (CFM) per bushel of beans to be dried. The heater should be large enough to raise the drying air temperature approximately 40° F.

Each storage and drying installation should be designed to meet the capacity required by a particular operation.

Soybeans must be cooled after drying by forcing dry cool air through them or by conveying them from one bin to another until they have reached the outside temperature.

However carefully it is done, drying is of little value unless beans are stored properly. Proper storage means keeping them as dry and as cool as possible throughout the storage period.

The most practical method to prevent moisture migration within storage bins is to aerate them during cool dry weather. Since beans at 11 per cent moisture will absorb moisture from the air when relative humidity is above 68 per cent, it is not advisable to aerate stored beans when the humidity is above 68 per cent unless hot spots (95° to 100° F.) develop in beans. Beans aerated under these conditions should be checked frequently to make sure no deterioration is taking place. A humidistat may be used to keep the fan from operating when humidities are too high or during periods of rain.

Aeration to equalize the temperature in stored beans may be started when outside air temperature is 10° to 15° F. below that of the warmest portion of the stored beans. This aeration should continue as long as weather is favorable or until the temperature is uniform.

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