Bulletin 919

SOYBEAN PRODUCTION *in Texas*

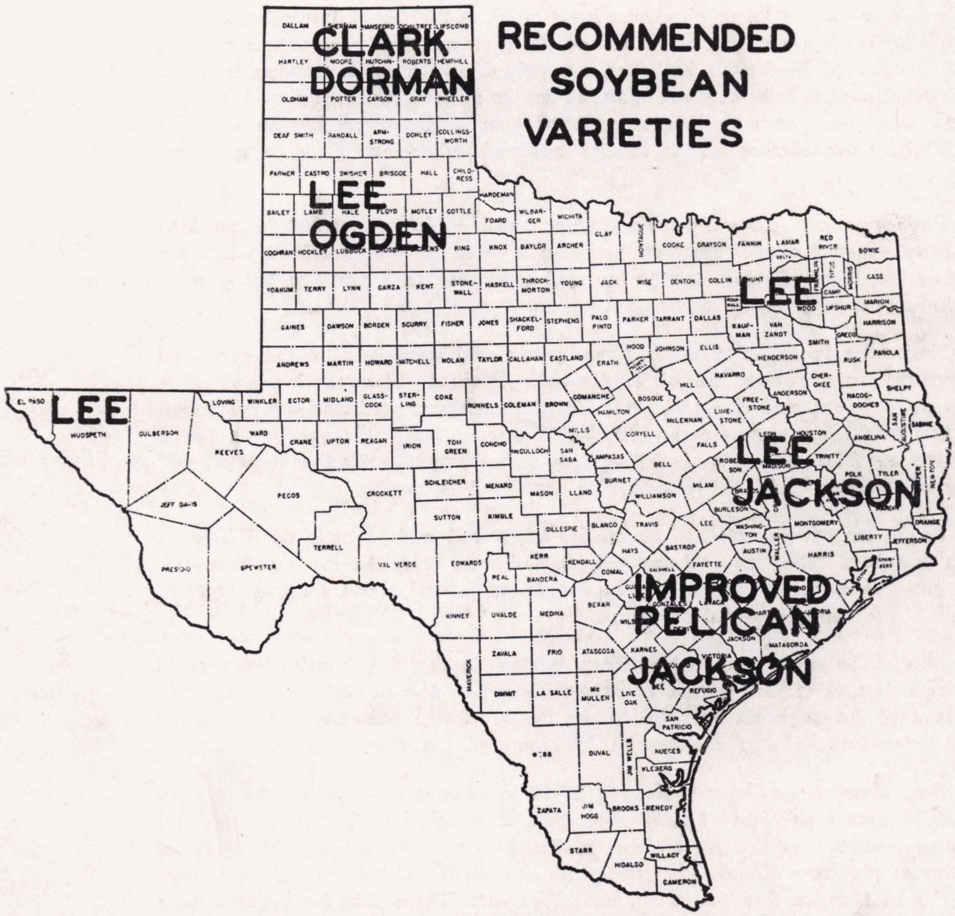

Figure 1. Varieties of soybeans recommended for the irrigated sections of Texas. Soybeans are not recommended in the Blackland area because of the cotton root-rot disease.

November 1958

TEXAS AGRICULTURAL EXPERIMENT STATION

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DIGEST

Soybeans have been grown in Texas for more than 40 years, but have not become an important crop although their potential value is recognized. The financial success or failure of soybean production in Texas depends on a good competitive relationship with other major field crops. This relationship may be improved greatly with the development of better adapted varieties, the use of better production methods and the development of adequate marketing facilities.

Soybeans can be grown in most irrigated sections of Texas. In areas of higher rainfall, such as East Texas, yields are inconsistent under dryland conditions, and the crop is not recommended unless irrigation facilities are available.

Average yields under irrigation are approximately 25 bushels per acre, but some relatively large plantings have produced 30 to 40 bushels per acre. At this level of production, soybeans do not give as much cash return as does grain sorghum. Soybeans, however, are valuable in a soil-improving rotation, and weed control following soybeans is not as serious a problem as following grain sorghum. Recent increasing interest in soybean production may be justified by considering all the factors involved rather than yield comparisons alone.

Soybeans are grown principally for seed, which are used to produce soybean oil and meal. Most of the meal is used in livestock feed while the oil is used in shortening, margarine and salad oil, with portions being used for industrial purposes.

Hydraulic press, expeller or screw press and solvent-extraction are used in processing soybeans for oil and meal. The solvent-extraction method is the most efficient, and about 95 percent of the soybeans produced are processed by this method. As soybean production becomes more widespread in Texas and the need for processing facilities increases, many oil mills that now process only cottonseed could be converted to handle both seed.

Soybeans are adapted to about the same soil and climatic conditions as corn or cotton. They do best on well drained, mellow, fertile and sandy loams, but good results can be obtained on most properly-drained soils, if water is available for supplemental irrigation.

Lee is the most important soybean variety in Texas, primarily because of its high degree of shatter and disease resistance. Lee occupies more than 90 percent of the soybean acreage in the State. Other varieties used for seed production include Ogden, Dorman, Jackson and Improved Pelican.

Soybeans generally are planted in 36 to 42-inch rows at a rate to give 10 to 12 plants per foot of row. The date of seeding soybeans is important because of the sensitivity of the plants to day length and temperature. Optimum planting dates occur when the minimum soil temperature is above 65° F. and after the day length reaches 14½ hours. These planting requirements are met between May 15 and June 15 in all areas of the State.

Soybeans should be harvested when fully mature, but before the first pods begin to shatter. As the plant approaches maturity, the leaves turn yellow and drop from the plant naturally. Defoliating soybeans with chemicals to hasten maturity reduces the yield and the quality of the bean.

Several leaf-eating insects may damage soybeans. These include the bean leaf beetle, legume caterpillar, corn earworm, green cloverworm and fall armyworm. Most insect damage occurs in August and September. Periodic checks for excessive damage should be made. When material loss from insects is suspected, the local county agricultural agent should be contacted for information on insect control.

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SOYBEAN PRODUCTION *in Texas*

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THE SOYBEAN, *Glycine max.*, is one of the oldest crops grown by man. It was cultivated extensively in China as early as 3,000 B.C. (11),[1] but was not introduced into the United States until 1804. Even though it was recognized as a plant adapted for cultivation, the soybean long was regarded more as a botanical curiosity than a plant of much economic importance. The U. S. Department of Agriculture in 1898 began introducing many soybean varieties from Asiatic countries. Increases of acreage and production in this country have been associated closely with the introduction of varieties and their improvement through selection and breeding.

Soybeans have found a permanent place as a seed and forage crop in many farming systems, especially in the eastern half of the United States (13). At first the acreage of soybeans harvested for hay was larger than the acreage harvested for beans. The reverse has been true since 1935 in the Corn Belt States and since 1941 in the United States as a whole. Soybean acreage for forage has continued to increase, but the acreage for commercial bean production has increased more rapidly. Ninety percent of the United States soybean acreage in 1948 was harvested for seed.

Soybeans have not become important in Texas, although the potential value of the crop is recognized. The financial success or failure of soybeans in this State depends on several factors. Soybean production should have a good competitive relationship with other major field crops. Better production methods and adapted varieties need to be developed before this relationship can be greatly improved. Soybean production is new to most farmers and, as with any new crop, a sound education and promotion program should be carried on so that the growers may benefit from the latest research information. In addition, suitable marketing facilities for soybean seed need to be developed simultaneously with production.

Experimental plantings of soybeans on various field research units in Texas have been grown for more than 40 years (1, 2). Results in the early years were generally disappointing. Varieties evaluated in early tests shattered easily, were highly susceptible to disease and, in many cases, were not adapted for use in the South. Soybean plants are relished by rabbits and small trial plantings frequently were destroyed.

Soybean breeding programs at various experiment stations in the South in recent years have developed varieties that are resistant to shattering and which produce beans that do not shrivel when subjected to the high temperatures of late summer. Some soybean varieties in use today are better adapted to Texas growing conditions than was true formerly.

The use of supplemental irrigation in crop production is increasing. Irrigated soybean production is in a more favorable competitive relationship with other crops than is dryland production. At present, two Texas oil mills (at Lubbock and Sherman) provide good markets for soybeans in the major areas of production. Interest in production, processing and marketing of soybeans is increasing in several other areas of the State.

These and other recent developments have contributed to a renewed interest in this crop and a re-evaluation of its potential for profitable production in Texas. Active testing programs are in progress at College Station, Denton, Chillicothe, Lubbock and Plainview.

ECONOMICS OF PRODUCTION

Soybeans have been grown in Texas for hay, green manure and soil improvement, but at present, the crop is grown principally for seed. Some 25,000 to 30,000 acres of soybeans were planted in Texas in 1956, with most of the acreage on the High Plains. The soybean acreage in the State in 1957 was only about 20,000 because of poor planting conditions in May and June, but the acreage in 1958 was approximately 60,000. This rapid increase in acreage reflects the growing interest in the crop where irrigation facilities are available.

Average yields under irrigation are 22 to 25 bushels per acre, with some relatively large plantings averaging 30 to 40 bushels per acre (10). The price for soybeans during 1956 and 1957, was about $2.00 per bushel, compared with $1.50 per hundred pounds being paid for grain sorghum during the same period. On the basis of prices farmers received for their crops, a 25-bushel per acre yield of soybeans would be comparable to a 3,000-pound per acre yield of grain sorghum. Since irrigated grain sorghum generally produces more than 3,000 pounds per acre, yields alone would not establish the soybean crop economically in Texas. Several factors other than yield, however, favor soybean production.

Soybeans are a new crop to most Texas farmers, thus, their experiences with this crop have varied. Most farmers in 1956 made a higher cash income per acre from planting grain sorghum than from soybeans. A few made as much money or more from soybeans. Future yields from soybeans, however, are likely to increase with better varieties and as farmers gain experience in their production.

Soybeans are valuable in a soil-improving rotation. Several West Texas farmers, who have used soybeans in their cropping system for several years, generally have found that yields of cotton are increased one-fourth to half a bale per acre when cotton follows this legume instead of grain sorghum. Soybeans have an outstanding ability to loosen and mellow the surface soil. This favorable soil conditioning effect is due partially to root action and shading of the ground by the vegetative canopy of the bushy plants. Such tilth improvement is of particular value on heavy clay, clay loam and silty clay loam soils.

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[1]Numbers in parentheses refer to literature cited.

TABLE 1. YIELD OF SOYBEAN OIL AND SOYBEAN MEAL OBTAINED PER BUSHEL OF SOYBEANS BY THREE METHODS OF PROCESSING[1]

Year	Soybean oil, pounds			Soybean meal, pounds		
	Solvent	Expeller	Hydraulic	Solvent	Expeller	Hydraulic
1948	10.67	8.86	8.46	46.33	48.14	48.54
1949	10.94	9.16	8.67	46.06	47.84	48.33
1950	10.73	8.96	8.38	46.27	48.04	48.62
1952	10.52	8.57	8.39	46.48	48.43	48.61
1953	11.11	9.11	8.11	45.89	47.89	48.89
Average	10.79	8.93	8.40	46.21	48.07	48.60

[1]Yield figures represent national averages for all varieties.

Any harvested crop tends to deplete the soil of its mineral elements and organic matter. Soybeans are no exception. However, returning all the soybean crop residue left by the combine to the soil reduces the organic matter and mineral element losses to a minimum. This crop residue left on the land, in addition, effectively increases surface water intake and reduces soil erosion losses.

Leguminous plants, such as soybeans, add to the available nitrogen of the soil and are effective in restoring soils deficient in nitrogen. Vigorous soybean plants produce an abundance of nitrogen-bearing root nodules with about two-thirds of this nitrogen obtained from the air and the remainder from the soil. Well-inoculated soybean plants that are harvested for beans usually increase the total nitrogen content of the soil about 16 pounds per acre if all of the plant residue is left on the ground. The net gain in total nitrogen is not large, but much of the total soil nitrogen is in the nitrate form which is available readily to crops following soybeans in a rotation. Winter legumes usually are not successful in North and West Texas as soil-improving crops because of the short spring growing season before they must be turned under prior to cotton planting. Thus, for the first time, these areas of the State have the possibility of growing a good soil-improving legume crop that provides a source of cash income.

Volunteer sorghum plants and the annual weed problem in general increases the cost of production when cotton is planted after the grain crop. A rotation of grain sorghum, soybeans and then cotton places cotton (the major cash crop) in position to get the maximum benefit from following the legume crop. A dense growth of soybeans reduces the development of annual weeds and grasses that usually grow after sorghum has its last cultivation. The competitive nature of the soybean plant and the widespread use of the rotary hoe in early cultivations of soybeans practically eliminate volunteer sorghum plants.

PROCESSING AND UTILIZATION

Most soybeans in the United States are grown for seed, which are used in the production of oil and meal. Most of the meal is used for livestock feed, though its use in food and industrial products is increasing (12). The oil is used principally in shortenings, margarine and salad oils, with portions used for industrial purposes.

The value of soybeans as a high protein feed for livestock is indicated by extensive feeding trials in all parts of the United States. Soybeans can be used as a protein supplement to partially replace the more expensive commercial protein concentrates necessary for stock feeding and milk production. The soybean is the cheapest source of vegetable protein available to the farmer. It contains 35 to 45 percent protein, which compares favorably with the protein content of other concentrated feeds.

The beans can be fed whole to sheep and hogs, but it is better to grind them. Soybeans should be fed in mixtures with other feeds because of their high protein content. Practical experience shows it is advisable to mix the beans with corn, oats or other grain and then grind them into meal. The beans are difficult to grind alone because of their high oil content.

Soybean oil is highly important in the domestic and international vegetable-oil supply and economy, and the soybean now competes with other oil seed on the world market. Soybeans were first processed for oil about 1910 (12). Although many efforts had been made to interest cottonseed oil mills in the South in processing domestic-grown soybeans for oil and meal, no extensive work was done until 1915. Soybean processing became established as an industry in the early 1920's. Most processors operated on a small scale until about 1930. By 1936, about 50 percent of the U. S. soybean production was processed by oil mills. Processing has increased rapidly since 1936. Soybean processing mills in the U. S. in 1954 had a total capacity of more than 270 million bushels annually.

Hydraulic pressing, expeller or continuous pressing (screw press) and solvent extraction are used commonly in processing soybeans for oil and meal. Hydraulic pressing, the least economical method, is limited almost entirely to mills engaged in processing cottonseed or flaxseed. Screw presses handled about 74 percent of the soybeans processed and solvent extraction about 23 percent in 1940-41. By 1954, (17) it was estimated that 94 percent of the soybean production was processed by the solvent-extraction method, 5 percent by the expeller method and 1 percent by hydraulic processors.

Table 1 shows the average yield of oil and meal by the different processing methods as determined by the USDA and the Bureau of Census. The meal yields were obtained by subtracting oil yield from an arbitrary 57-pound per bushel combined yield. Presumably, because of economic reasons or obsolescence of the older plants, or both, the shift to the solvent extraction method will eventually come even nearer 100 percent.

Soybeans can be processed with the facilities ordinarily used for processing cottonseed, but the resulting soybean oil is "marginal," low-quality oil with certain restrictions placed on its use. The yield of soybean oil per bushel of beans is considerably less when mechanical presses are used. As soybean production becomes more widespread in Texas and the need for processing facilities increases, many oil mills in the State that now process only cottonseed could be converted easily to handle both soybeans and cottonseed efficiently.

"Soybean products" are a third result from the processing of soybeans. These products result from further refinement of the oil and meal. Table 2 presents some of the many products that result from the processing of soybeans.

ADAPTATION

Soybeans can be grown successfully in irrigated sections of Texas. Most of the commercial acreage harvested for seed is on the High Plains. Profitable yields of soybeans have been produced in the Red River Valley, in river valleys of the East Texas Timberlands and the eastern part of the Coast Prairie, under dryland conditions. Even in these areas, profitable yields under dryland conditions are inconsistent and have limited the crop to a minor role.

Soybeans are adapted to about the same general soil and climatic conditions in Texas as corn or cotton. They do best on well-drained, mellow, fertile loams and sandy loams, but good results can be obtained on most of the Texas soils that are properly drained and that have water available for supplemental irrigation. After the plants are well started, their growth is not retarded seriously by a wet season. During the early part of the growing cycle (from emergence to flowering), the soybean is more tolerant of prolonged periods of drouth than cotton. During the flowering and fruit development period, however, a shortage of moisture may seriously decrease the yield of beans.

Several investigators have found temperature to be second only to moisture as an environmental factor affecting the growth and development of the soybean plant and the composition of the seed. Howell and Weiss *et al* (8, 15), using growth chambers with constant controlled day and night temperatures, found that day temperatures during the pod-filling period exerted a marked effect on the oil content of the seed. Increasing day temperatures from 70 to 85°F. increased the oil content of the seed, but had little effect on the protein or nitrogen content. Extremely high temperatures of 98 to 100°F. for 2 weeks caused a reduction in the growth rate of the plant. Optimum temperature for seed set in these experiments was 80 to 90°F., with a rapid decline in the number of pods set and a rapid increase in the number of flowers aborted as the temperature rose to 105°F. In these studies, moisture was adequate at all times and the temperatures constant during day and night. High temperatures in soybean fields during periods of drouth may give different results.

Studies at College Station (14) indicate that pod set was increased during periods of relatively cool temperatures and relatively high humidity. Only two favorable pod setting periods occurred during the flowering period in 1955. The first period lasted for 4 days and the second period for only 1 day. Except for these two periods, almost all the flowers that opened, aborted and fell to the ground within 24 to 48 hours. The percentage pod set in 1957 was increased by erecting an artificial shade over certain plots to reduce the daytime temperatures 5 to 10°F. These studies appear to confirm the growth chamber experiments with temperature.

Soybeans are sensitive to photoperiod, or day length, and it has been necessary to classify varieties and strains into broad maturity groups for testing and evaluation. The varieties grown in the United States are divided into nine maturity groups, O through VIII. Groups O and I contain varieties that will mature under the relatively long days encountered during the summer in the Northern States, while group VIII is best adapted in the Gulf Coast States. Varieties grown in Texas and the other Southern States are included in groups IV, V, VI, VII and VIII. Promising breeder lines and commercial varieties of all maturity groups are made available to cooperating states for evaluation through the regional testing program of the USDA and certain other state agricultural experiment stations.

SELECTING A VARIETY

Several factors should be considered when selecting a variety. The most important are adaptation to local climatic and soil conditions and the purpose for which the crop is grown. Though the yield of forage or seed may be the most important single consideration, date of maturity, habit of growth, resistance to seed shattering and shriveling, disease resistance, seed color and size of seed are important factors. When the production is primarily for oil, meal or other food

TABLE 2. PRODUCTS RESULTING FROM PROCESSING SOYBEANS

Crude soybean oil	Soybean meal
Refined Soybean Oil (Non-edible)	**Animal Feed**
Calking compound	Soybean flakes
Candles	Soybean pellets
Disinfectants	Fish food
Electrical insulation	Pet food
Insecticides	Dairy feed
Lighting oil	Vitamin carriers
Linoleum	Poultry feed
Oil cloth	Hog feed
Paints	**Human Consumption**
Putty	Soy flakes
Resins	Soy flour
Soaps	Soy grits
Varnishes	Soy meats
Wallboard	Macaroni
Waterproof cement	Pancakes
Printing ink	Sausages
Refined Soybean Oil (Edible)	Diabetic food
Cooking oil	Frozen dessert
Mayonnaise	Infant foods
Oleomargarine	Spice base
Hormones	Spaghetti
Sterols	Puddings
Salad dressing	Soups
Sandwich spread	**Others**
Lard compounds	Beta protein
Vegetable oils and shortening	Alpha protein
Pharmaceuticals	Bonding adhesive
Others	Amino acids
Cosmetics	Paper coatings
Candy	Textile sizing
Bakery products	Board coatings
Anti-knock gasoline	Water emulsion paints
Greases	Food flavoring
Munitions	Fire extinguishers
Adhesive tape	Fountain marshmallow
Shaving compounds	Fertilizer
Emulsifiers	Wallpaper paste
Carbon paper	Linoleum backing
	Medicines

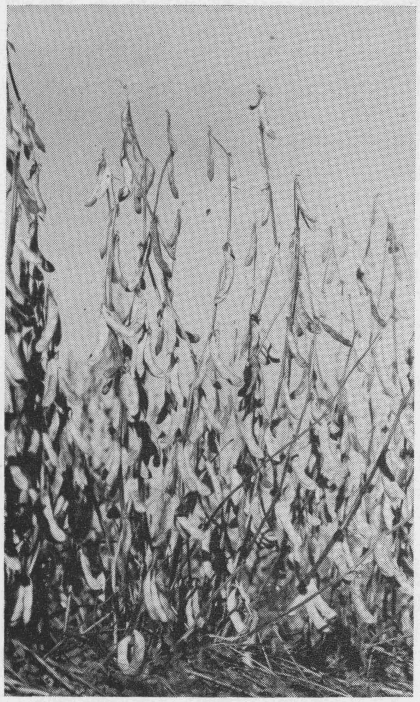

Figure 2. Characteristic growth of Lee soybeans. The variety is medium tall, somewhat bushy and has good seed-holding ability, resulting in high seed production.

products, the percentage of oil and protein and the color of seed become increasingly important.

Many varieties have been developed and several thousand introductions have been tested since the USDA started work on soybeans about 1898. The organization of the Regional Soybean Laboratory in 1936 stimulated the development and testing of new varieties. The primary objective in this development work has been to obtain high seed-yielding strains and varieties with a high oil and protein content. Yellow-seeded varieties are desired for commercial seed production. Color of seed is not important when soybeans are used for forage purposes.

A summary of the plant characteristics of the major soybean varieties grown in variety trials in Texas is given in Table 3. These descriptions are based on those given in recent USDA publications (6, 16) and recent information obtained from cooperating experiment stations. Figure 1 gives the varieties recommended for the various areas of the State.

VARIETY TESTS

Average seed yields of varieties tested in Texas during 1943-54 are given in Tables 4 and 5. Tests at College Station, Denton and Chillicothe were conducted under dryland conditions, the test at Lubbock was irrigated. All varieties were not grown each year; therefore, one check variety in each maturity group was selected to obtain a more accurate basis for comparisons.

In general, the average yields per acre of soybeans have been so low, regardless of the variety used, that the crop cannot be considered a profitable one in Texas under dryland conditions, Table 4. Yields during this period at Chillicothe were below 15 bushels and some years yields as low as 2 bushels were obtained. Yields at Denton were below 15 bushels and complete crop failures were frequent. The range of yields at College Station was 4 to 27 bushels, with considerable year-to-year variation. The higher yields, 20 to 30 bushels, obtained at College Station compare favorably with those in regions where the crop

TABLE 3. CHARACTERISTICS OF THE SOYBEAN VARIETIES FOR OIL INCLUDED IN THE TRIALS

Maturity group and variety	Origin	Color characteristics				Seed per pod	Protein, %	Oil, %	Seed per pound	Year released
		Flower	Pubescense	Seed coat	Hilum					
IV										
Gibson	Midwest x Dunfield	White	Gray	Yellow	Buff	2-3	41.9	20.4	3900	
Wabash	Dunfield x Mansey	White	Gray	Yellow	Light-brown	2-3	40.3	21.0	3200	1948
Perry	Patoka x L7-1355	Purple	Gray	Yellow	Gray to black	2-3	41.5	21.7	3000	1951
Clark	Lincoln (2) x Richland	Purple	Brown	Yellow	Black	2-3	40.0	21.7	3100	1953
V										
S-100	Rogue from plot of Illini	White	Gray	Yellow	Light-brown	2-3	42.2	19.0	3400	1948
Dortchsoy 67	Macoupin x Ogden	White	Gray	Yellow	Buff	2-3	39.4	20.7	3900	1951
Dorman	Dunfield x Arksoy 2913	White	Gray	Yellow	Light-brown	2-3	40.1	21.4	3700	1952
D53-526	D632-15 x D49-2525	White	Brown	Yellow	Brown	2-3	40.0	21.8	3300	1958
VI										
Arksoy 2913	PI 37335 (Korea 1914)	White	Gray	Yellow	Brown	2-3	44.6	19.6	3700	
Ogden	Tokyo x PI 54610	Purple	Gray	Green	Light-brown	2-3	43.4	20.5	3200	1940
Lee	S-100 x CNS	Purple	Tawny	Yellow	Gray to black	2-3	41.9	20.8	3500	1954
Hood	Roanoke x N45-745	Purple	Gray	Yellow	Buff	2-3	40.0	21.8	3300	1958
VII										
Volstate	Tokyo x PI 54610	White	Gray	Yellow	Light-brown	2-3	40.7	20.9	3400	
Roanoke	Sel. from mixed seed lot	White	Gray	Yellow	Light-brown	2-3	40.1	21.8	3000	1945
Jackson	Volstate (2) x Palmetto	White	Gray	Yellow	Brown	2-3	40.4	21.7	3000	1953
VIII										
Yelnanda 53-116	Nanda x Yelredo	Purple	Gray	Yellow	Brown	2-3	43.5	18.8	2800	1946
J.E.W. 45	Sel. from mixed seed lot	Purple	Brown	Yellow	Brown	2	43.2	19.5	3000	1947
Majos 52-87	Tokyo x Yelredo	White	Gray	Yellow	Brown	2	42.1	19.7	2900	1949
Imp. Pelican	Tanloxi x PI 60406	Purple	Tawny	Yellow	Brown	2-3	44.2	18.9	4400	1950

is grown profitably, but low yields occur so frequently that dryland production in Texas is discouraged. Even under more favorable moisture conditions at Beaumont and Angleton, soybean yields are extremely low in some years.

Profitable yields of soybeans are obtained much more frequently when the natural rainfall is supplemented with irrigation, Table 5. Several varieties produced average yields of 20 bushels per acre and yields of 30 bushels per acre were not uncommon at Lubbock during 1943-54. Soybean yields can be affected adversely by improper timing of irrigation water and this may account for the relatively low yields of the early tests.

Data on soybean production in Texas during 1955-57, reported in Tables 6 and 7, further substantiates earlier work. Extremely hot and dry conditions prevailed during 1955-56, while above normal rainfall was obtained at all locations in 1957. The 1957 rainfall, however, was poorly distributed with little effective rainfall in July, August and September. Dryland bean production at Denton and Chillicothe again was low and could not be considered profitable even during an above-normal moisture year such as 1957. Profitable yields were obtained at College Station in only 1 of the 3 years. The crop was a complete failure at College Station and Denton in 1956.

Irrigated studies were expanded during 1955-57 and production practices were improved. Somewhat better yields were obtained. Irrigated soybean tests were initiated at College Station and Plainview, and the Lubbock work was continued. Average yields on the High Plains—Lubbock and Plainview—were 20 to 35 bushels for the best adapted varieties (9). Yields in this range can be considered profitable and competitive with those obtained from grain sorghum. Yields of soybeans at College Station were 15 to 55 bushels, with the high yield in 1957 being the highest recorded in Texas. The irrigated beans in 1955-56 were surrounded by dryland fields which may have reduced the response that supplemental irrigation normally produces.

DISCUSSION OF VARIETIES

Ogden was the most widely grown variety in the South until recent years, and is well adapted to North and Central Texas. Ogden gives high yields of seed and a good oil content. Its moderate height makes it easy to combine. Its heavy foliage helps keep down late season weeds and grasses. However, the seed of Ogden tend to shatter after maturity, making timely combining essential. The green color of the seedcoat also is objectionable on the commercial market. Ogden is classed in Group VI. It matures about October 22 at Lubbock and a few days earlier at College Station.

Lee, a new, superior group VI variety, averages 5 days later than Ogden and is superior to it in seed holding, disease resistance and yield, Figure 2. It is adapted to much of the

TABLE 4. AVERAGE AND COMPARABLE YIELDS PER ACRE OF SOYBEAN VARIETIES GROWN UNDER DRYLAND CONDITIONS AT COLLEGE STATION, DENTON AND CHILLICOTHE, 1943-54

Maturity group and variety	College Station		Chillicothe		Denton	
	Average yield, bushels	Years tested	Average yield, bushels	Years tested	Average yield, bushels	Years tested
IV						
Gibson	23.5	1	6.2	3	8.2	5
Wabash	15.2	4	11.1	1	7.2	4
Perry	23.3	2	13.3	1	8.8	3
V[1]						
Dorman	12.6 (8.5)	3	7.8 (6.5)	2	9.1 (11.0)	2
S-100	12.7	5	8.6	4	9.0	6
Dortchsoy 67			14.3 (11.8)	1	6.0 (7.2)	1
VI[2]						
Lee	17.7 (14.4)	2	11.1 (8.5)	2	6.6 (5.9)	1
Ogden	10.1	5	8.6	7	7.0	3
Arksoy 2913	8.5 (12.7)	2	7.6 (8.7)	5	5.8 (7.6)	2
VII[3]						
Roanoke	13.1	5	7.6	7		
Volstate	9.8 (8.3)	2	9.3 (8.3)	5		
Jackson			9.4 (9.1)	3		

[1]Numbers in parentheses are yields for S-100 when grown during same years.
[2]Numbers in parentheses are yields for Ogden when grown during same years.
[3]Numbers in parentheses are yields for Roanoke when grown during same years.

TABLE 5. AVERAGE AND COMPARABLE YIELDS PER ACRE AND OTHER AGRONOMIC DATA FOR SOYBEAN VARIETIES GROWN UNDER IRRIGATED CONDITIONS AT LUBBOCK, 1943-54

Maturity group and variety	Average yield, bushels	Height, inches	Grams per 100 seed	Maturity date	Percent[1]		Years tested
					Protein	Oil	
IV[2]							
Gibson	18.7	26	14	9/16	40.6	21.2	6
Wabash	19.5 (21.5)	25 (23.3)	16 (15.5)	9/25 (9/22)	40.0 (39.5)	22.9 (21.9)	3
Perry	20.5 (21.5)	22 (23.3)	17 (15.5)	9/26 (9/22)	40.8 (39.5)	23.0 (21.9)	3
V[3]							
Dorman	15.8 (15.0)	18 (24.2)	14 (14.5)	10/8 (10/7)	39.5 (42.3)	21.8 (19.8)	5
S-100	17.0	23	15	10/6	43.0	19.4	11
Dortchsoy 67	14.4 (12.5)	18 (24.5)	15 (14.4)	10/5 (10/7)	38.9 (42.1)	21.8 (19.7)	4
VI[4]							
Lee	16.6 (16.5)	26 (24.7)	14 (15.4)	10/27 (10/22)	40.9 (41.1)	21.4 (21.1)	4
Ogden	20.6	25	16	10/22	41.1	21.1	11
Arksoy 2913	17.5 (22.9)	25 (25.0)	15 (16.9)	10/16 (10/21)	43.4 (41.1)	20.1 (21.1)	7
VII[5]							
Roanoke	15.1	30	15	11/5	39.9	21.9	5
Volstate	7.3 (9.0)	23 (29.0)	14 (15.0)	11/5 (11/14)	40.2 (39.9)	21.4 (21.8)	1
Jackson	15.3 (16.6)	32 (30.8)	15 (15.3)	10/29 (10/29)	40.3 (39.9)	21.5 (21.9)	4

[1]Regional averages for percent protein and soil.
[2]Numbers in parentheses are values for Gibson when grown during same years.
[3]Numbers in parentheses are values for S-100 when grown during same years.
[4]Numbers in parentheses are values for Ogden when grown during same years.
[5]Numbers in parentheses are values for Roanoke when grown during same years.

TABLE 6. AVERAGE YIELD PER ACRE OF SOYBEANS PRODUCED UNDER DRYLAND CONDITIONS AT COLLEGE STATION, DENTON AND CHILLICOTHE, 1955-57

Maturity group and variety	College Station		Denton		Chillicothe		
	1955	1957	1955	1957	1955	1956	1957
IV							
Perry	7.5		11.9		5.8	6.0	
Clark				10.7	8.0	5.2	
V							
Dorman	9.1	13.1	13.6	8.7	9.4	4.5	
S-100					9.5	4.0	
Dortchsoy 67			11.2		13.2	4.8	
D53-526				8.6	12.9	6.1	
VI							
Ogden			7.3		14.8	2.4	5.3
Lee	8.9	21.0	7.2	8.6	16.8	4.8	7.5
Hood					16.1	2.7	4.7
VII							
Jackson		28.1			12.2	2.4	3.5
Roanoke	2.3				12.3	3.2	4.1
VIII							
Imp. Pelican		25.0					

same area as Ogden. Its superiority in seed holding will eliminate losses frequently experienced from shattering. Lee is resistant to the most common leaf disease found in the South (bacterial pustule) to which all other major varieties are susceptible. Lee occupied 80 percent of the soybean acreage in Texas in 1956 and is rapidly replacing Ogden throughout the South. On the High Plains, Lee may be damaged by frost when early freezes occur. Hood, a new soybean variety known previously as strain D51-4888, is comparable with Lee in most respects and matures about 1 week earlier.

Dorman was released in 1952 as an earlier variety (group V) to be grown along with Ogden or Lee. It is approximately 2 weeks earlier than Ogden and produces comparable yields where adapted. Dorman gave good results at Plainview and Lubbock and fair results at College Station. It is best adapted to the Panhandle region, but is satisfactory further south when one wishes to stagger his harvest season. Dorman produces good quality seed with high oil content and does not shatter as readily as Ogden. Its heavy foliage is comparable with Ogden, which helps control late season weeds (Figure 3).

Dortchsoy 67 and *S-100* are group V varieties that mature about the same time as Dorman. These varieties produced yields comparable with Dorman, but they are more subject to shattering. A new strain of this same maturity group, D53-526, has been superior to other group V varieties in yield and shatter resistance. Strain D53-526 has been tested for 3 years and will be increased and released in 1959 for the High Plains.

Clark, Wabash and *Perry* are group IV varieties primarily adapted to Indiana, Illinois and Missouri. They can be grown on the northern High Plains of Texas, but generally produce about 20 percent less than Ogden. They are erect varieties, give less ground cover and late-season weeds may become a problem before harvest. When grown too far south, these varieties produce poor seed quality. Perry, Clark and Wabash mature about 10 to 14 days earlier than Dorman, or about September 25 to October 1.

Roanoke is classified in group VII and is approximately 2 weeks later than Ogden. Generally it is not ready for harvest until the first week in November, and may be damaged prematurely by frost in North Texas. Roanoke is 6 to 8 inches taller than Ogden and produces good seed yields. It has the highest oil content of any variety in the United States. Roanoke produces yields comparable with Ogden, but considerably less than Lee at College Station.

Jackson was released in 1953 and is similar to Roanoke in maturity. Jackson is slightly taller than Roanoke, stands better and has given slightly higher seed yields. Its added height may be an advantage in areas where shorter varieties tend to produce their pods near the ground, Figure 4.

Figure 3. Characteristic growth of Dorman soybeans. The variety is short and bushy (left) and plants generally lap in the middles during the growing season. Pods hold their seed fairly well but are set low on the plant, (right).

TABLE 7. AVERAGE YIELDS PER ACRE OF SOYBEANS PRODUCED UNDER IRRIGATED CONDITIONS AT COLLEGE STATION, LUBBOCK AND PLAINVIEW, 1955-57

Maturity group and variety	College Station			Lubbock			Plainview	
	1955	1956	1957	1955	1956	1957	1956	1957
IV								
Perry	16.0				10.6		27.1	35.9
Clark		19.7			12.6		24.4	36.3
V								
Dorman	17.9	16.0	26.1	23.0	15.2		31.1	37.5
S-100				23.8	13.4		29.3	
Dortchsoy 67				33.1	15.8		33.4	32.7
D53-526				21.1	14.5		33.3	40.7
VI								
Ogden			49.4	31.1	17.0	18.9	26.1	37.2
Lee	19.6	20.0	54.2	28.1	19.4	21.3	26.0	33.2
Hood			55.4	28.1	17.8	23.0	32.0	36.5
VII								
Jackson		9.8	44.7	30.8	17.1	19.4		18.2
Roanoke	9.3		40.7	22.8	17.8	20.7		16.0
VIII								
Improved Pelican			36.0					
J.E.W. 45			33.4					
Majos 52-87			39.6					
Yelnanda 53-116			36.0					

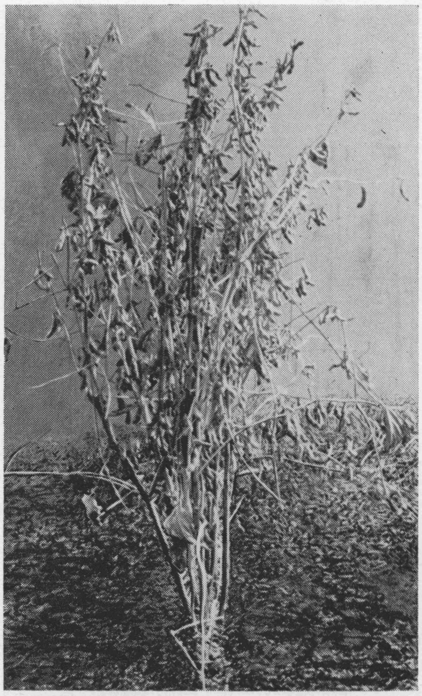

Figure 4. Individual plant of Jackson soybeans, showing good height, relatively small stems and the placement of pods well above the ground level.

Late varieties of group VIII maturity, such as *Improved Pelican, J. E. W. 45, Majos 52-87* and *Yelnanda 53-116,* are well adapted to the lower Coast Prairie and South Texas, but their seed quality and oil percentage are somewhat inferior to the earlier-maturing varieties. These varieties also are subject to considerable lodging and shattering. Interest in soybeans as a cash crop in South Texas should increase as better varieties of this maturity group are developed.

In any area, a combination of two or three varieties will lengthen the harvest period and permit harvesting of a greater acreage per combine. For example: A farmer on the High Plains may be limited to 250 acres per 12-foot combine if he were growing only Ogden. If he would distribute his acreage among Dorman, Ogden and Lee, for which the average maturity dates are October 5, October 20 and October 27, he could increase his acreage per combine to about 600. Weather hazards also are distributed by planting varieties differing in maturity.

PRODUCTION METHODS

Preparing the Seedbed

Seedbed preparation for soybeans is similar to that used for grain sorghum or cotton, and best results are obtained on a well-prepared seedbed. The land generally is prepared by bedding in 36 to 42-inch rows in the fall or early spring. When beds become weedy, they are disked or rebedded prior to planting. The land should be free of weeds at the time of planting since the young soybean plants start slowly and do not compete well with weeds.

The seedbed should be firm and the surface of the rows should be level or slightly above the general ground level to facilitate irrigating and harvesting. This can be done by breaking the well-settled beds down to a nearly level surface and drilling the beans in moist soil. In this manner, any weeds that may be growing in the beds are destroyed or thrown to the middles at planting time where they can be destroyed with the first cultivation after emergence. If soybeans are to follow a winter cover crop, the cover crop should be destroyed at least a month prior to planting.

Seed and Seeding Practices

Planting Seed. Good seed are important for successful soybean production. The seed loses its vitality more rapidly than most other legumes, because of its high oil content, and it is not advisable to plant seed more than 1 year old. Cracked, chipped or broken seed also are unsafe for planting. It is good practice to adjust the seeding rate according to germination tests.

Method of Seeding. Soybeans for seed production should be planted in rows and be given sufficient cultivation to keep down weeds. They may be planted with a corn or cotton planter equipped with a bean plate. In general, soybeans are planted in 36 to 42-inch rows, but recent tests under irrigation at College Station showed a slight advantage in bean

TABLE 8. SOYBEAN DATE-OF-PLANTING TEST, PERIOD-OF-YEARS SUMMARY, CHILLICOTHE

Planting date	Yields in bushels per acre										Comparable average
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
April			.7	4.0	10.5		.8	6.3	.9		5.6
May	8.2	7.4	3.6		18.6	14.4	3.8	5.2	3.2	13.2	8.2
June	12.4	10.8	3.7	5.6	16.5	13.2	16.7	12.5	1.7	9.6	10.3

TABLE 9. AVERAGE YIELDS PER ACRE OF SOYBEAN VARIETIES FROM FOUR MATURITY GROUPS, A&M PLANTATION, COLLEGE STATION, 1951-54[1]

Date of planting	Maturity classification[2]				Average
	Group IV	Group V	Group VI	Group VII	
May 1	9.5	8.5	9.5	13.6	10.3
May 15	11.8	9.1	14.3	17.1	13.1
June 1	9.2	6.9	15.8	13.4	11.3
June 15	8.5	9.1	14.5	14.6	11.7
Group average	9.8	8.4	13.5	14.6	

[1]Soybeans were produced under dryland conditions. Each growing season received below normal rainfall.

[2]Varieties represented in the four maturity groups are: group IV, Wabash, Perry and Clark; group V, S-100 and Dorman; group VI, Ogden and Lee; and group VII, Roanoke and Dortchsoy.

yield by using a more narrow-row spacing. Further studies need to be conducted since consistent yield advantages have not been obtained in large-scale plantings. Narrow-row plantings tend to lodge more than wide-row plantings. If standard corn, cotton or grain sorghum implements are used for seedbed preparation and planting, the crop can be cultivated with a rotary hoe and regular cultivating equipment.

For hay or green manure, soybeans may be planted in close drills if sufficient fertility and moisture are available to support the growth of plants in a thick stand. Thickly planted soybeans produce a finer quality forage that cures more quickly, but yields may be reduced during drouth years. Where satisfactory growth can be obtained only with irrigation, a row spacing of 18 to 24 inches may be preferred to wider or more narrow rows. The main objection to hay crops planted in rows is that the forage accumulates dirt when it is raked over the bare cultivated middles into windrows.

Date of Seeding. Soybeans may be planted in Texas over a relatively long period, but, regardless of variety, there is an optimum time for seeding soybeans to obtain the best results. In general, there is a tendency to plant too early. June plantings at Chillicothe, for example, gave higher yields than April or May plantings, Table 8. The beans produced from June planting usually were of good quality even when yields were low. Shriveled and poor-quality beans were produced from April and May plantings. Recent date-of-planting studies for irrigated soybeans at Plainview also indicate that planting soybeans in North Texas from May 25 to June 10 was superior to earlier or later plantings.

Date of planting studies at the A&M Plantation near College Station, Table 9, indicate that May 15 to June 1 is the optimum planting date for soybeans. Good vegetative growth was obtained in most years, but seed yields fluctuated widely and no significant differences could be shown. Plants bloomed normally each year, but frequently the small pods were shed as rapidly as they were formed, which undoubtedly accounted for yield fluctuations. Pod shedding was reduced with supplemental irrigation and yields were more consistent.

Research by Hartwig and others (5) indicates that optimum planting dates occur when the minimum soil temperatures reach 65°F. and after the length of the effective daylight period reaches 14½ hours. The effective daylight period includes about half an hour before sunrise and after sunset. Soybeans grown in nutrient solution with a soil temperature of 45°F. made only 23 percent as much growth in a 27-day period as plants with a root temperature of 63°F. They also showed that with 12 hours of daylight, all varieties began flowering 21 to 28 days after emergence.

Length of day may directly affect the rate of growth of soybeans as well as indirectly affecting it by forcing flower initiation, Figure 5. Short day plants, such as soybeans, make good vegetative growth with long days, but growth decreases or ceases altogether with short days. This is

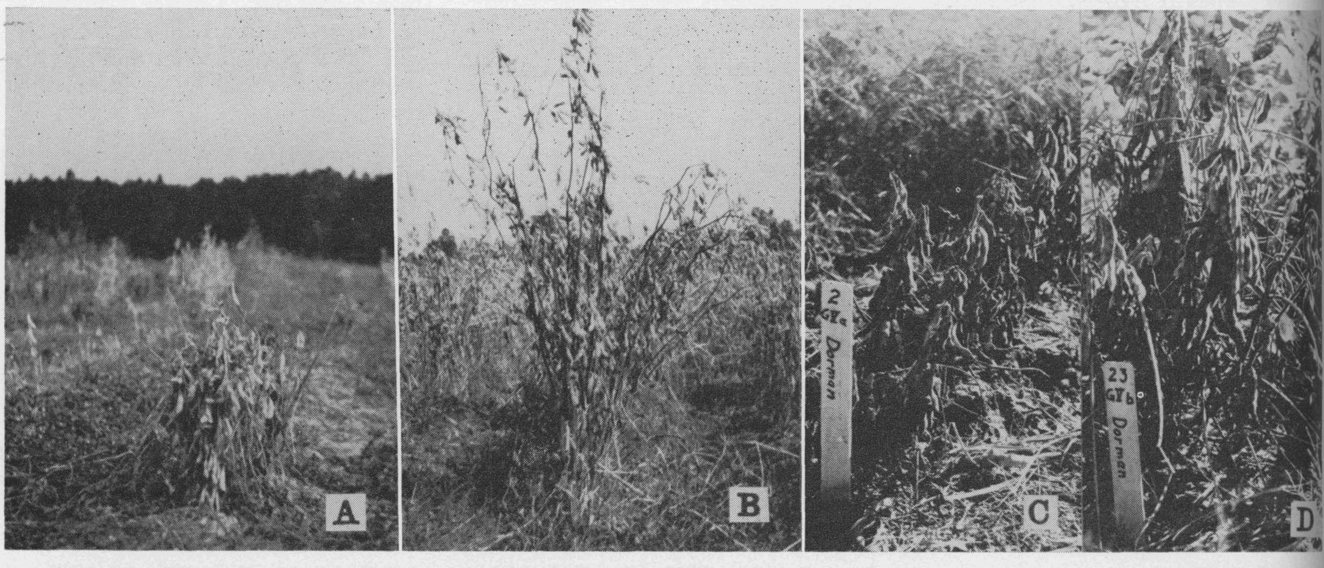

Figure 5. Effect of date of planting or length of day at planting time on plant growth. The Roanoke variety planted in April, A, and May, B, at Stoneville, Mississippi. Dorman variety planted May 1, C, and May 27, D, at College Station. The shorter growth of the early planting date is due to a short day length during early growth and subsequent early flower initiation.

due in part to the initiation of flowering and in part to insufficient photosynthetic food production to compensate for food loss from respiration during each 24-hour period. The short days and somewhat lower light intensities may provide for enough food synthesis to keep plants alive and allow for some increase in vegetative growth, but are not sufficient for maximum vegetative growth. Most varieties adapted to Texas have a critical day length of 14 to 14½ hours, and they flower too early, especially when planted in April, to make maximum vegetative growth. By delaying planting until the days are at least 14½ hours long, the length of the vegetative growth period in most of Texas is lengthened and the seed production potential is increased.

The approximate day length on various planting dates at several locations in Texas and the approximate date at which the day length reaches 14½ hours at each location are given in Tables 10 and 11. Table 12 gives the mean daily air temperatures which occur at these various locations during April, May and June. Average daily soil temperatures in the upper foot of soil do not differ appreciably from the average daily air temperatures during April, May and June in Central Texas (4), thus the air temperatures give a fair indication of soil temperature on different planting dates. At College Station, for example, 14½ hours of daylight are reached about May 15. At this time, both the average daily and minimum air temperatures are 65°F. or above. Both the temperature and day length become suitable for planting soybeans at about the same time. When planted earlier than this date, soybean plant growth is slow because of cooler temperatures and the premature initiation of flowers in the relatively short periods of daylight. At Amarillo, a 14½ hour day is reached about May 3, which is about 7 days after the average date of the last killing frost and temperatures are much below 65°F. Thus, on the northern High Plains of Texas, soybean planting dates are delayed by temperatures even though the day length is suitable for planting.

Day lengths of more than 14½ hours are not reached at Weslaco until early June, although minimum temperatures have been above 65°F. for some time. In fact, the longest day of the year barely exceeds the 14½ hour critical level of most of our present day varieties. Thus, in South Texas, most soybean varieties will begin flowering within 30 days after emergence regardless of planting date. One month is a short period for vegetative development before reproduction processes are initiated. The resulting plant growth frequently may be stunted and subsequent yields may be low.

TABLE 10. APPROXIMATE LENGTH OF THE EFFECTIVE DAILY PERIOD OF LIGHT AT SEVERAL LOCATIONS IN TEXAS ON CERTAIN DATES OF PLANTING

Planting date	Effective daily period of light[1]									
	Amarillo		Chillicothe		Lubbock		College Station		Weslaco	
	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.	Hrs.	Mins.
April 5	13	30	13	30	13	29	13	27	13	17
April 20	14	06	14	02	14	00	13	50	13	39
May 5	14	34	14	30	14	26	14	17	14	02
May 20	15	02	15	00	14	57	14	53	14	20
June 5	15	15	15	13	15	10	14	52	14	28
June 20	15	30	15	25	15	20	15	00	14	35

[1]Includes twilight period.

Planting in late May or early June when temperatures are above 65°F. and the daily period of light exceeds 14½ hours will give more rapid emergence, more rapid growth, higher yields of seed and better quality than either earlier or later plantings. Early plantings are affected adversely by cool temperatures or short day lengths, or both, and late June plantings are less productive because of frequent temperatures above 100°F. during July and August. Thus, planting dates for soybeans in all areas of the State range from May 15 to June 15.

Rate of Seeding. A stand of 10 to 12 plants per foot of row is optimum. A thinner stand may give about the same yields, but weeds will be more troublesome during the seedling stage. A thicker stand will be more subject to lodging if good growing conditions exist. When planted in 36 to 40-inch rows, 40 to 60 pounds of seed per acre are required, depending on the seed size. Close-drill or broadcast plantings for forage purposes will require 75 to 100 pounds of seed per acre.

Good stands reduce weeds and produce higher yields that are easier to harvest. Thin stands produce short, bushy plants with the pods set close to the ground, making combine harvest difficult and increasing harvest losses. The germination percentage should be determined and the planting equipment adjusted to drop 10 to 12 viable seed per foot of row.

TABLE 11. APPROXIMATE DATES IN THE SPRING AT WHICH THE DAY LENGTH REACHES 14½ HOURS AT SEVERAL LOCATIONS IN TEXAS

Location	Latitude	Date
Amarillo	35° 15′	May 3
Chillicothe	34° 15′	May 5
Plainview	34° 10′	May 5
Lubbock	33° 40′	May 7
Ysleta	31° 50′	May 11
College Station	30° 35′	May 14
Beaumont	30° 05′	May 15
Weslaco	26° 00′	June 10

Depth of Seeding. Poor stands result frequently from planting too deep, especially with the large seeded varieties of soybeans. The most favorable depth is governed by the character of the soil, amount of moisture present and the size of the seed. In clay or heavy soil, seed should be covered about 1 inch; in sandy or light soil,

TABLE 12. AVERAGE DAILY AIR TEMPERATURES AND AVERAGE DATES OF LAST KILLING FROST DURING 1953-57 AT SEVERAL LOCATIONS IN TEXAS

Location	Main daily temperature			Minimum daily temperature			Date of last killing frost
	April	May	June	April	May	June	
College Station	67	75	81	56	63	69	Mar. 18
Amarillo	57	65	76	40	49	60	Apr. 25
Chillicothe	65	72	83	50	59	69	Apr. 11
Lubbock	61	68	78	45	55	64	Apr. 11
Ysleta	62	70	79	44	52	61	Apr. 6
College Station	67	75	81	56	63	69	Mar. 18
Beaumont	69	76	80	59	66	70	Mar. 9
Weslaco	77	80	83	67	70	73	Jan. 30

seed should be placed 1½ to 2 inches deep. In irrigated areas, a preplanting irrigation is common practice when the soil is dry. Rain after planting may form a hard crust on the soil surface and prevent good seedling emergence. A spike tooth harrow or rotary hoe may be used to break such crusts.

Seed Treatment. Soybean planting seed may be treated with 2 ounces of Arasan, Arasan SF-X, Spergon or other non-mercuric fungicides per bushel prior to planting. These chemicals have given significant increases in stands, especially when the seed germination is less than 85 percent. Fungicides containing mercury reduce germination and are not recommended. When an inoculant is applied to the seed that have been treated with a fungicide, the seed should be planted immediately after inoculation, within 2 hours if possible.

Inoculation

Soybeans, like other legumes, are able to obtain nitrogen from the soil air through the action of bacteria that live on the roots (3). The proper kind of bacteria must be provided, however, to benefit from this source of nitrogen. Bacteria required by the soybean are seldom present in Texas soils because the crop has not been grown widely in the State and the bacteria usually do not survive from one season to the next. Thus, inoculation is necessary each time soybeans are planted.

Inoculation is done easily by purchasing prepared bacteria cultures from seed dealers or direct from commercial companies and following the directions on the package. Even though soybeans have been grown on the land before, it costs so little that it is good insurance to inoculate each year. Some growers apply a double amount of inoculum to the seed before planting. Others inoculate the seed and also apply inoculum to an inert carrier, such as moist sand, which is worked into the soil during seedbed preparation. Both methods insure well nodulated plants and increased production.

Poor inoculation may be indicated by a yellowish color of the leaves in the early growing season and poor growth in general. Adequate inoculation will enable the plant to function as a soil builder and will increase the protein level of the seed or hay. Studies at College Station indicate that the value of inoculation is equivalent to about 25 pounds of nitrogen per acre.

Fertilization

Very little experimental work on fertilizing soybeans has been done in most of the soybean-producing states. Soybeans are a relatively new crop and generally they have not given as dramatic returns from the usual applications of fertilizers as have other crops, particularly on fields of high fertility. However, considerable experimental work has been conducted in four or five of the leading soybean states in the South (7), and general recommendations are based on the results of tests in these states.

Experimental work in North Carolina, Georgia, Florida, Louisiana and Arkansas shows that soybeans grown on the Coastal Plain soils respond profitably to direct fertilizer applications. This is not surprising since these soils are of light texture, have been farmed for a long time and usually are low in nutrients. Soybeans grown on the Delta soils along the Mississippi River have shown no response to fertilizers. Cotton and corn on the same soils, however, respond only to nitrogen. There are cases in the Mississippi Delta, however, where soils were low in lime and minerals and applications of lime, phosphorus and potash have doubled the yield of soybeans. This indicates that the soil should be tested to determine the fertilizer needs.

Applications of nitrogen to soybeans may be profitable where the fertility is low. Where soybean yields are low because of poor fertility, a complete fertilizer, like 3-12-12 or 5-10-10, may be advantageous at planting time. Most tests indicate that sidedressed applications of nitrogen barely pay for themselves. If the level of fertility is medium or high and the soybeans are well inoculated, little or no response can be expected from nitrogen fertilizers.

To fertilize soybeans, start with a good soil test, apply needed elements as directed by a soil test and do not put potash or nitrogen fertilizer in direct contact with the seed.

Proper fertilization is essential. On fertile land or where the preceding crops have been fertilized heavily, it may not be necessary to fertilize all the crops in the rotation to maintain productivity. If other crops in a farming system give greater returns to direct applications of fertilizer than soybeans, apply the fertilizer to these other crops. A bushel of soybeans contains approximately 3 pounds of nitrogen, ¾ pound of phosphoric acid (P_2O_5) and 1½ pounds of potash (K_2O). Most of the nitrogen originates in the air, but the other elements are taken directly from the soil. This emphasizes the importance of having sufficient available phosphoric acid and potash in the soil for the soybean plants. In general, on soils where cotton yields are increased by phosphate or potash fertilizers, soybeans yields also are increased by these fertilizers.

Cultivation

Care should be given to the cultivation of soybeans during early growth. As many weeds as possible should be destroyed before planting. If weed seed germinate, or if a crust forms before the young plants emerge, the crop should be cultivated with a rotary hoe or spike-tooth harrow. This type of cultivation may be used when the plants are 4 to 6 inches high. Such implements may destroy many plants if used immediately following emergence, since the plants are brittle and tender at this stage.

Succeeding cultivation may be made with the equipment used for cotton or grain sorghum. Cultivation should be shallow and frequent enough to control grass and weeds until the plants begin to bloom or until the plants lap in the middles. The soil in the drill row should be left as flat as possible at the last cultivation so that the cutter bar of the combine may operate below the lowest beans on the plants.

Irrigation

Total water requirements for the production of soybeans do not differ materially from the water required to produce cotton. However, the proper timing of supplemental irrigations on soybeans is important and considerably different than for cotton. In the irrigated High Plains area, for example, a crop of cotton is not irrigated after September 1, and moisture stress during early and mid-season growth results in decreased yields of cotton. Soybeans, however, can withstand considerable moisture stress from the early season growth period to the flowering stage, but moisture stress should be avoided from the flowering stage to maturity. Thus, even though cotton and soybeans have similar water requirements, they do not compete seriously for available irrigation water.

In areas where full irrigation is required, a preplanting irrigation should be applied to wet the soil to a depth of 5 to 6 feet. Four irrigations generally are required after planting, with three of them in late August and September. The timing and number of mid-season irrigations will depend on the amount and distribution of natural rainfall, but sufficient moisture should be available to assure continued growth without serious wilting of the plants. Insufficient water from the fruiting period to maturity may reduce bean yields considerably.

Soybeans may be produced in areas of East Texas and the Coast Prairie without irrigation in certain years, but rainfall distribution patterns fluctuate greatly from year to year and bean production is erratic. If sufficient irrigation water is available to supplement the natural rainfall during low rainfall periods, good soybean yields are possibe with a minimum of expense for irrigation.

Harvesting

For seed production, soybeans should be combined when fully mature and before the first pods begin to shatter. As the beans approach maturity, the leaves turn yellow and drop from the plant. Defoliating soybeans with chemicals to hasten maturity reduces the yield and bean quality. The beans should dry naturally on the plant until the moisture content is about 14 percent. Harvesting before the pods are fully mature will cause the seed to wrinkle on drying and will increase storage problems. Delay in harvesting will result in serious losses from shattering, even when using varieties with a high degree of shatter resistance.

Direct combining is the most efficient method of harvesting soybeans for seed. The operator's manual for a particular combine should be followed as to proper combine adjustments. Soybeans should be combined at a slow ground speed with the cutter bar set close to the ground. Cylinder speed of the combine should be reduced and the concaves adjusted to prevent cracking the beans.

High grade soybeans are dry, clean, plump, pure as to variety and have a low percentage of cracked or split beans. Careful combining will avoid mechanical damage to the harvested beans. Mechanical damage will reduce the sales value of a crop and field losses from improper combining may take all the profits. Five to 6 bushels of beans per acre may be lost through delaying the harvest, letting the cutter bar ride too high and cutting through the lowest cluster of pods, and by improper threshing and screening adjustments.

Storage

Soybeans should not be stored in bins until they are thoroughly dry unless the bins are equipped with artificial drying equipment. When first harvested, the seed often contain too much moisture for safe storage. For storage, soybean seed should not contain more than 12 percent moisture. If artificial drying equipment is not available, spread the beans on a clean, dry floor immediately after harvesting and turn them over from time to time until they are thoroughly dry. They may be stored in sacks or bins if the storage room is well ventilated and dry. Soybean seed are rarely damaged by weevils or other grain insects, but they lose their vitality or germination power rapidly.

SOYBEANS FOR HAY

Good vegetative growth of soybeans usually is obtained in most of Texas under dryland conditions, and they are used in some areas as a hay crop. For hay production, late-maturing varieties, such as Improved Pelican, Red Tanner, Laredo and Ototan, are recommended. Jackson and Lee also are acceptable for forage production and will produce more beans than the four forage varieties mentioned.

Figure 6. Mature field of Lee soybeans at Plainview showing naturally defoliated plants and the heavy leaf mulch covering the ground. This heavy litter adds organic matter to the soil, makes the soil surface more permeable and prevents excessive water run-off and soil erosion.

Tests show that soybean hay has a high feeding value for cattle, if harvested when the seed are almost mature, but before the leaves are lost. The hay obtained by cutting at this stage is both a roughage and a concentrate. Better quality hay can be made by harvesting the crop when the seed are less than half developed. Hay cut at this stage, or when the seed are almost mature, cures quickly. It is difficult to make mold-free soybean hay unless it is shocked and cured in the field for a month to 6 weeks and allowed to pass through the sweating process before baling. Curing can be completed in the windrow, but it is much better to cure in small shocks. The weight of the crop and total protein content increase until the pods are well filled with seed, and the leaves are yellowing from maturity, but before they have begun to shed.

SOYBEANS IN ROTATIONS

Soybeans will fit into most crop rotations, and they may be used in the farming system as a full-season crop or as a part-season crop. One of the most popular soybean rotations used at the present time is: first year—grain sorghum; second year—soybeans; and third year—cotton. Farmers on the irrigated High Plains prefer this rotation over a sorghum-cotton rotation since weeds and volunteer sorghum are not as troublesome when cotton follows soybeans. By returning all soybean plant residue to the soil after harvest, the soil surface is loose and mellow and in excellent tilth for the following crop, Figure 6. Farmers in that area report their cotton comes up better and grows off faster when it follows soybeans instead of following grain sorghum in a rotation.

INSECTS AND DISEASES

Several leaf-eating insects may cause trouble in soybean production. Some of these are the bean leaf beetle, legume caterpillar, corn earworm, green cloverworm and fall armyworm. Several insects also may attack the young pods and cause damaged and poor-quality seed. Most of these insects appear during August and September. Farmers should check their crop for insects periodically, and, when economic loss is suspected, contact the local county agricultural agent for the latest information on insect control.

Approximately 50 diseases are known to occur on soybeans, but so far diseases have not been a problem to soybean producers in the areas of Texas where the crop is now concentrated.

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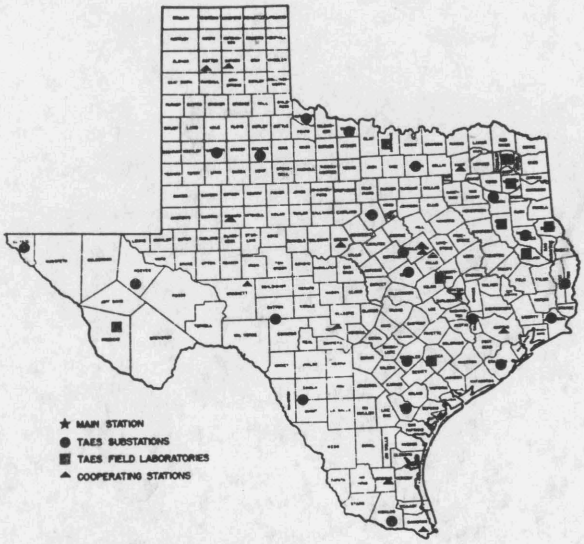

Location of field research units of the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of ten parts of the Texas A&M College System

ORGANIZATION

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies. Cooperating agencies include the Texas Forest Service, Game and Fish Commission of Texas, Texas Prison System, U. S. Department of Agriculture, University of Texas, Texas Technological College, Texas College of Arts and Industries and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

OPERATION

THE TEXAS STATION is conducting about 400 active research projects, grouped in 25 programs, which include all phases of agriculture in Texas. Among these are:

Conservation and improvement of soil	Beef cattle
Conservation and use of water	Dairy cattle
Grasses and legumes	Sheep and goats
Grain crops	Swine
Cotton and other fiber crops	Chickens and turkeys
Vegetable crops	Animal diseases and parasites
Citrus and other subtropical fruits	Fish and game
Fruits and nuts	Farm and ranch engineering
Oil seed crops	Farm and ranch business
Ornamental plants	Marketing agricultural products
Brush and weeds	Rural home economics
Insects	Rural agricultural economics

Plant diseases

Two additional programs are maintenance and upkeep, and central services.

Research results are carried to Texas farmers, ranchmen and homemakers by county agents and specialists of the Texas Agricultural Extension Service

AGRICULTURAL RESEARCH seeks the WHATS, the WHYS, the WHENS, the WHERES and the HOWS of hundreds of problems which confront operators of farms and ranches, and the many industries depending on or serving agriculture. Workers of the Main Station and the field units of the Texas Agricultural Experiment Station seek diligently to find solutions to these problems.

Today's Research Is Tomorrow's Progress