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SESAME IN TEXAS

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Sesame, Sesamum indicum L., was one of the first oilseed crops cultivated by man. It formerly was grown mostly by small farmers in Asia and Africa, but fairly large-scale commercial production has been undertaken recently in Latin America. It may prove to be a valuable cash crop for Texas and other Southern States.

The genus Sesamum belongs to the small family, Pedaliaceae, which consists of 16 genera and 60 species found in tropical or subtropical regions. In addition to the cultivated S. indicum, there are at least 16 wild species of the genus Sesamum in Africa and 2 in India. Authorities disagree as to whether sesame originated in Africa or India.

Sesame is an erect annual plant of many types and varieties. Depending to some degree on the conditions under which they are grown, varieties range from less than 2 to over 10 feet tall and possess a growth cycle of from 70 days to more than 6 months. Some strains have many branches, while others are essentially unbranched.

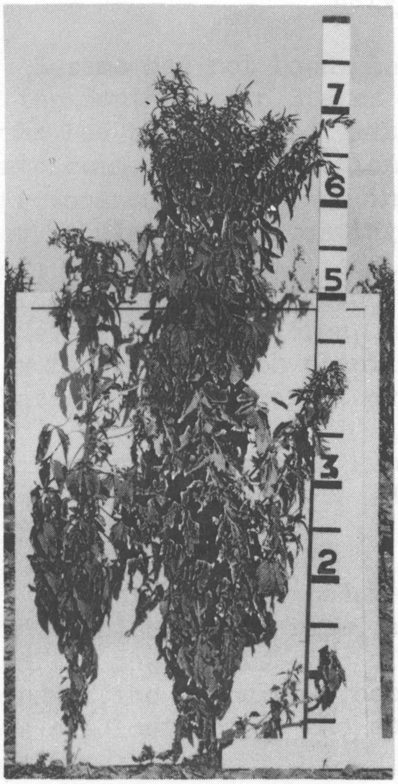
Sesame probably possesses as much genetic variability as any cultivated crop. One to three attractive flowers, which later develop into the seed capsules, are born in each leaf axil. Flowering begins as early as 6 weeks after sowing and continues until maturity. Thus, there may be mature seed capsules and flowers on a plant at the same time. Different varieties have a wide range of seed colors, varying from pure white to black. White and tan-seeded varieties are preferred.

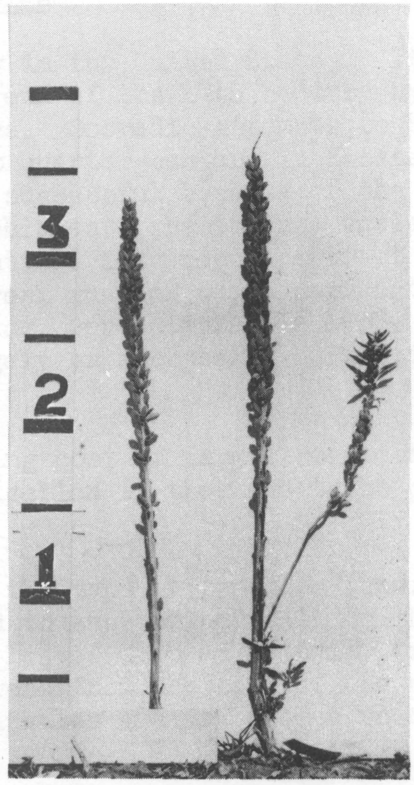
World Production

China, India and Burma produce most of the world's sesame, but the crop also is grown to a varying extent in Manchuria, the Anglo-Egyptian Sudan, Nigeria, Turkey, Greece, the Soviet Union and Latin America. Increased acreage in Mexico, Venezuela, Colombia and Nicaragua has largely offset the decline in production in the Orient, and recent world production has remained about constant.

Before World War II, the annual world acreage of sesame was roughly estimated at 11,500,000, with production at 3 billion pounds of seed. This low yield, 261 pounds per acre, was due to primitive cultural methods and to the fact that sesame is interplanted with other growing crops in some Oriental countries.

World trade in sesame, which formerly accounted for about 8 percent of the total production, has decreased in recent years. Imports of sesame seed by the United States have varied from 146 million pounds in 1934 to a little over 2 million pounds in the war year 1944. Formerly, most of our imports came from China; we now rely principally on Latin American countries for our requirements.





Figures 1 and 2. A comparison of the tall, late, non-productive type sesame (left) in which the indehiscent capsule character was first discovered, with a short, early, productive indehiscent selection (right) which had resulted from the breeding program by 1952. Both photographs were taken October 20, 1952.

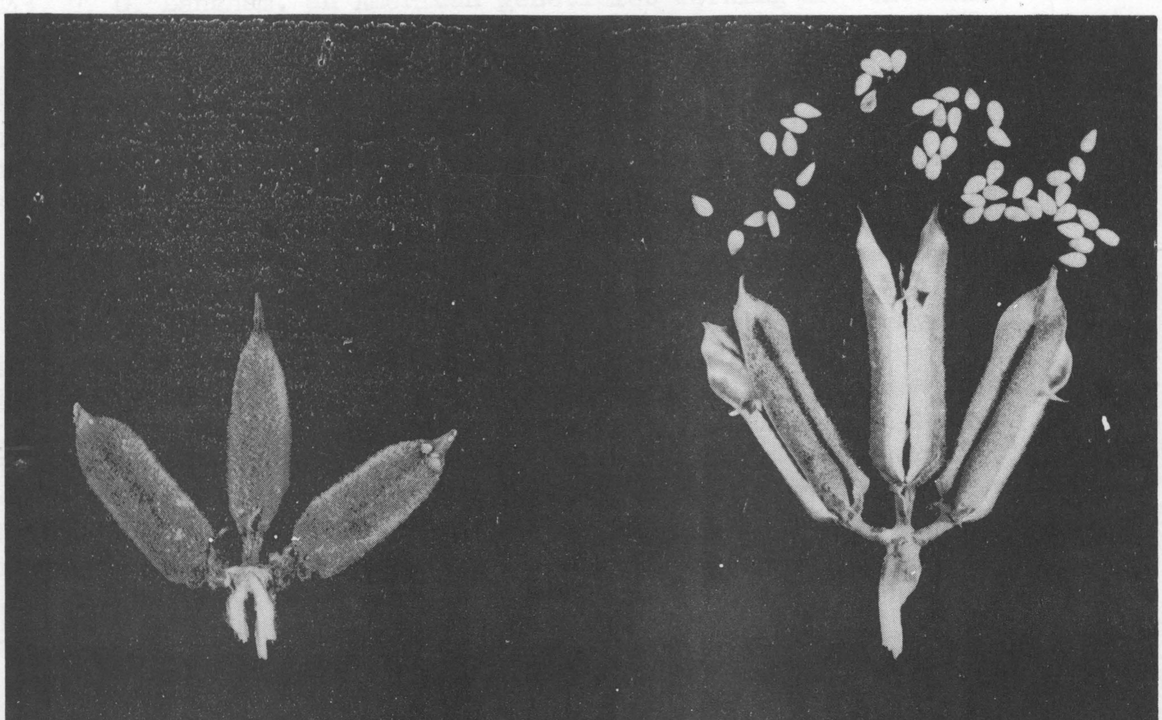


Figure 3. A comparison of indehiscent (left) and dehiscent (right) sesame capsules at dry maturity.

Harvesting Difficulties

Sesame has not been planted extensively in the United States. It was grown in the Southeastern States as early as the end of the 17th century by Negro slaves, who had brought seed with them from Africa. Sporadic attempts to bring sesame into commercial production during the past quarter-century in Kansas, California, Arizona and South Carolina have not been successful because of the excessive hand labor required in harvesting the existing dehiscent (shattering) varieties. In 1952, there were a few small semi-commercial plantings in various parts of the country; these probably totaled less than 100 acres, many of which were not harvested. Several hundred acres, most of it in Texas, were planted in 1953. The success or failure of such plantings depends largely on successful harvesting, weather hazards and the market price.

The ever-decreasing supply and increasing cost of farm labor means that both old and new crops must be adapted to mechanization if they are to be produced at a profit.

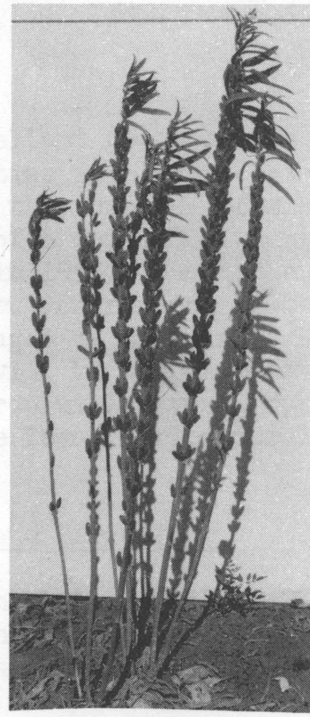
The varieties of sesame available have the type of capsules (pods) that "pop-open" (dehisce) when ripe, allowing the seed to shatter and fall to the ground. Usually, after the plants stop flowering and the leaves drop at maturity, ripening and opening of the capsules proceed gradually upward from the base of the plant and many seeds are lost before the stems and upper capsules are dry enough to be threshed with a combine.

The adaptation of sesame to mechanized harvest may well depend on a "quirk" of nature--a mutation, a rare change in the heredity make-up of the plant. This may make possible the transformation of sesame from a crop grown only in the economically-retarded areas of the world, where human labor is cheap, to a crop that may take its place in the highly mechanized agriculture of the United States. In 1943, D. G. Langham, an American geneticist working in Venezuela, discovered a single plant on which the capsules remained closed after the plant dried at maturity. Although this plant had this highly desired trait, it also had many undesirable characteristics and was worthless for commercial production. It would have remained a genetic curiosity had it not been for the foresight of a small group of plant scientists and some forward-thinking representatives of the oilseed processing industry.

Sesame Improvement by Breeding

Seed of the indehiscent type of sesame from Venezuela were brought to the United States in 1946-48 by the U. S. Department of Agriculture and the South Carolina and Nebraska Agricultural Experiment Stations. At the suggestion of Dr. Langham, J. A. Martin of South Carolina, beginning in 1948, made a series of multiple crosses (hybrids) involving as many as 32 parental strains with indehiscence introduced through some of the parents. Selections from these crosses gave us the breeding material for the intensive state-federal research program now underway, the goal of which is the breeding of indehiscent (non-shattering) varieties. Thus, the modern phase of the sesame breeding program is only 5 years old and is based on the material provided by Mr. Martin.

Regional headquarters for the joint state-federal sesame research program, was established at College Station in 1950 by the U. S. Department of Agriculture, in cooperation with the Department of Agronomy of the Texas Agricultural Experiment Station. There has been close cooperation in the sesame research programs, with the Texas and South Carolina Agricultural Experiment Stations and the U. S. Department of Agriculture functioning essentially as a unit.



Figures 4 and 5. Left-- A green plant of the K10 variety of sesame. This is the type grown commercially in Texas in 1953. It was selected by J. W. Zahnley of the Kansas Agricultural Experiment Station from a mixed strain from Syria which has been frown for over 30 years by S. F. Bayouth of Wichita, Kansas. This strain has many desirable features and is one of the best of dehiscent (shattering) types being used as parents in breeding indehiscent varieties. Right-- Plants of the K10 variety at physiologic maturity. This is the stage of growth at which the dehiscent (shattering) type must be cut and shocked to avoid excessive seed loss.

Figure 6. A Close-up of a row of indehiscent sesame, showing the luxuriant foliage and attractive flowers.

Considering the short time involved, excellent progress has been made toward the development of indehiscent sesame varieties adapted to Texas. However, these new strains must be tested thoroughly before they can be recommended for commercial production. Comprehensive yield tests of a few indehiscent selections are being conducted at several locations in Texas in 1953. Whether any of these strains are good enough to be increased for distribution remains to be seen. If not, better material is already in the advanced stages of breeding. When indehiscent varieties are released for farmer planting, there will be adequate advance notice so that growers interested in producing this new crop will have an opportunity to obtain seed through the foundation seed unit of the Texas Agricultural Experiment Station.

Adaptation, Cultural Requirements and Harvesting

Sesame appears well adapted to most of the better soils of Texas, with the possible exceptions of the northern part of the Panhandle where early frosts occur, and the high rainfall areas of East Texas where leaf diseases may hinder production.

The following discussion of cultural practices is intended only as a general guide in sesame production. Specific practices for any area or farm will depend greatly on local soil and climatic conditions, the growth habit of the variety grown and on the equipment available to the farm operator.

Sesame is not a poor-land crop; it grows best on fertile, well-drained soils. Soils with neutral reaction are preferred, but good results have been obtained on either slightly acid or slightly alkaline soils. Heavy applications of commercial fertilizers are required for satisfactory production on soils of low to moderate fertility.

Sesame is highly resistant to drouth. It has been grown for centuries in the Middle East without rainfall during the growing season, depending solely on stored moisture from winter rains. Areas receiving adequate rainfall for the production of dryland sorghum or cotton usually should have enough moisture for sesame production. The highest yields of sesame reported in the United States have been from experiments grown under irrigation in desert areas, with somewhat less irrigation water than is required for maximum yields of cotton.

One pound of sesame seed averages about 160,000 seed. This is enough to plant an acre. Small-seeded varieties may have as many as 190,000 seed per pound and large-seeded varieties as few as 130,000 seed per pound. Stand tolerance is high, under some conditions at least, and a uniform stand of about 40,000 plants per acre (plants 4 inches apart in 40-inch rows) may produce as great a yield as approximately 300,000 plants per acre (plants one inch apart in 20-inch rows). The seed should be planted not more than one inch deep in a well-prepared, mellow, moist seedbed.

Sesame should not be planted until all danger of cool weather is past. Planting dates may be as early as March 15 in the Lower Rio Grande Valley and as late as early June in the Panhandle. In general, sesame should be planted somewhat later than cotton or grain sorghum. In areas with long growing seasons and adequate summer rainfall or irrigation water, sesame may be planted in June or July. August or early September plantings sometimes have been successful in the Lower Rio Grande Valley.

In the humid part of Texas or in irrigated sections, satisfactory results have been obtained by planting on low beds. In drier areas, planting on the level

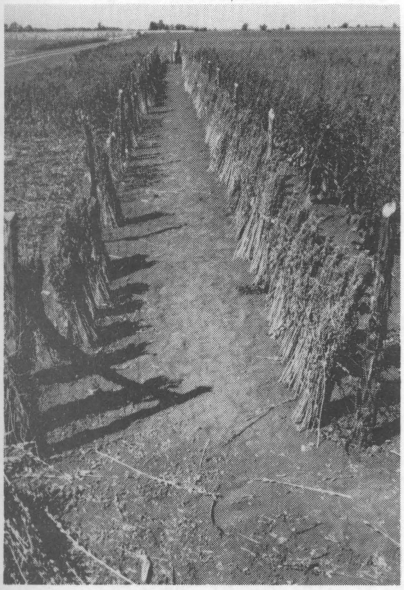


Figure 7. Bundles of sesame plants harvested from experimental plantings drying in the field. Each bundle contains the plants selected from a single progeny row or yield test plot.

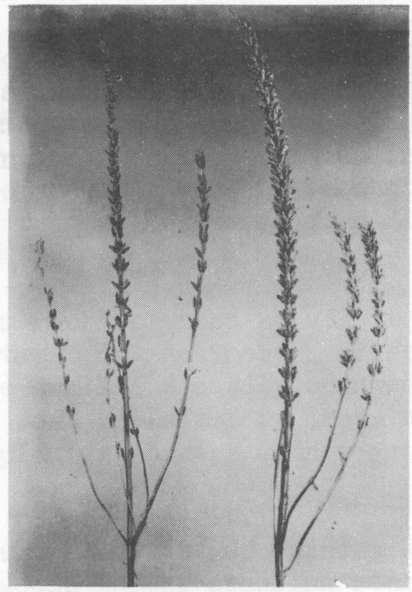


Figure 8. A comparison of dry plants of indehiscent (left) and dehiscent (right) sesame.

Figure 9. One of the sesame breeding nurseries at the Brazos River Valley Laboratory, College Station. Here, hundreds of introductions from all parts of the world--hybrids involving indehiscence and disease and insect resistance, and new indehiscent strains in all stages of development--are grown and evaluated. In the left background are J. A. Martin, associate horticulturist, South Carolina Agricultural Experiment Station and agent, BPISAE, U. S. Department of Agriculture; and Murray L. Kinman, author of the accompanying report.

or in shallow furrows has been satisfactory. Cultivated rows may vary from 18 to 42 inches apart, depending on the type of planting and cultivating equipment available. Double rows 12 to 16 inches apart on 36 to 40-inch vegetable beds are satisfactory under irrigation. In some parts of the world, sesame is sown broadcast or in narrow drill rows and is not cultivated. It is doubtful that this practice has any merit in Texas since weeds usually would become a serious problem. In an experiment grown at the Brazos River Field Laboratory near College Station in 1951, a dry year, rows 20 inches apart produced an average of 978 pounds of seed per acre, a significant increase of 90 pounds per acre more than was produced from 40-inch rows.

With certain adjustments, available farm machinery can be adapted to planting and cultivating sesame. The major adjustment in machinery used for planting sesame is in the planter box. Sesame seed are small and easily crushed. Crushed seeds will clog the planter plates. Probably the most satisfactory means of overcoming this difficulty is to replace the regular planter hoppers with vegetable planter hoppers, such as "Planet Junior" hoppers.

Sesame seedlings are small and grow slowly at first, especially during cool weather. Sesame does not compete well with weeds in the seedling stage. Planting in a weed-free seedbed and early cultivation close to the plants are recommended. Early cultivation seems to cause the seedlings to grow faster, possibly due to improved soil aeration. After the seedlings become well established and reach a height of three or four inches, they grow rapidly and little further cultivation is required to control weeds.

Under primitive agricultural conditions, the plants are cut by hand when they stop flowering and most of the leaves have dropped. At this stage, the stem and seed capsules are still green and contain considerable moisture. The plants are tied in bundles and shocked until dry. The seed are separated from the open capsules by inverting the plants over a canvas or other receptacle, and shaking. The seed fall readily from the capsules.

With improved dehiscent varieties which ripen more uniformly, and with modern machinery, much of the hand labor in harvesting can be eliminated. A row binder, such as is commonly used in harvesting corn or forage sorghum, may be used for cutting and binding the tall types of sesame. A small grain binder, such as is used for harvesting wheat and oats, will serve the same purpose for the shorter varieties.

Plants are cut and bound in small bundles. No loss in either yield or oil content of the seed is apparent when plants are cut at the proper stage, even though they may look quite green to the inexperienced grower. The bundles are shocked in small shocks. A string is tied around the top of the shock to prevent it blowing over. In about 2 weeks the bundles become dry enough to thresh. Light rains during the drying period do not appear to seriously damage seed quality. The plants may be threshed by tipping them over canvas or by threshing machinery. A grain combine is preferred to the stationary thresher since the only handling required of the bundles is to pick them up and throw them into the combine. The combine is pulled from shock to shock. With careful handling, 95 percent or more of the seed may be saved.

A screen with small perforations similar to the lespedeza screen is used in the cleaning mechanism of the combine. The air blast is much reduced and the cylinder is set wide from the concaves. The experienced combine operator will quickly determine the proper settings for his particular machine. Thorough cleaning should not be attempted with the combine since the seed are light and may be lost. The seed can be cleaned later with standard seed-cleaning equipment.

Under certain conditions, some of the semi-dehiscent varieties may be combined directly from the standing plants. Rapid drying may occur when the soil moisture supply is cut off rapidly, and when the plants are killed by frost or by certain chemicals. If high winds do not cause shattering during the drying period when the capsules are open, a high percentage of the seed may be obtained by direct combining. Neither dry soil conditions nor timely frosts can be depended on, and chemical killing techniques have not been completely mastered; therefore, direct combining of the normal shattering types of sesame is seldom successful.

When indehiscent varieties are commercially available, all hand labor can be eliminated from the harvest of sesame and direct combining will be possible. Costs of production then should be comparable with those for producing combine-type grain sorghum.

Even with indehiscent varieties which do not shatter, some means, such as windrowing or chemical killing of the plants, will be required to promote uniform drying. Water loss from physiologically mature plants is retarded by mucilaginous materials on the stems and capsules and, under field conditions, the plants may remain too green for combining for a long time. Preliminary work on preharvest drying with chemicals shows some promise, but uneconomical amounts of water have been required for adequate coverage. Frost will cause uniform field drying, but germination of the seed and quality of its oil appear to be adversely affected.

Sesame should fit the cropping system in most of its area of adaptation since it is a late-planted crop, and the types in which we are most interested would mature early enough to allow planting of fall-seeded cover crops.

Sesame Yield Tests in Texas

Sesame yield tests and observation plantings have been grown at several experimental substations during the past decade. Organized variety tests have been conducted since 1950 at College Station and Chillicothe and since 1951 on the High Plains. These tests have been intended primarily to provide information on the performance of dehiscent varieties being used as parents in the development of indehiscent varieties. Considerable information on the adaptation, yield and chemical composition of sesame is being obtained from these yield trials. How nearly the results of these tests represent the potential performance of indehiscent varieties in Texas remains to be determined.

Table 1. Yield of six dehiscent (shattering) strains of sesame tested in Texas

Variety	College Station			Chillicothe			High Plains 1/	
	1950	1951	1952	1950	1951	1952	1951	1952
	Pounds of seed per acre							
N57-2	1136	903	878	665	505	350	1119	1005
N119-3	1577	887	964	669	371	312	957	882
SC4520	1325	937	952	646	432	257	961	892
K10	1208	791	1064	645	477	321	913	848
Venezuela 51	1393	659	1072	273	371	367	903	874
Y 6	834	805	1112	587	548	313	807	685
Average	1246	830	1007	581	451	320	943	864

1/ Grown with supplemental irrigation at Plainview in 1951 and at Lubbock in 1952.

Diseases and Insects

Some enthusiasts have said that sesame is remarkably free of disease and insect pests. This has been the case with many crops new to a given region, but whenever large acreages of almost any crop are grown diseases and insects eventually become troublesome. Degrees of disease and insect damage, from insignificant to complete destruction of experimental plantings, have been observed in the United States. Indiscriminate and premature promotion of sesame culture in Texas before research has shown the way to control these diseases and insects may prove disappointing. Some strains of sesame are resistant to one or more of the diseases and insects that attack sesame, and an attempt is being made to incorporate this resistance into indehiscent varieties.

At least two fungi, Cercospora sesami and an Alternaria species, and one bacterium, Pseudomonas sesami, are known to cause leaf spot diseases. The development of these leaf troubles is favored by excessive rainfall and high humidity. The causal organisms can be seed-borne. It may be possible to control the leaf spots by the use of disease-free seed or by appropriate seed treatment. The Alternaria leaf spot may not be subject to complete control by these methods, since it appears to have other hosts. Disease-free seed can be grown in the desert under irrigation and the hot water seed treatment appears usable.

Fusarium wilt, Fusarium oxysporium f. sesami, has attacked sesame at a few locations in the United States, and this species is apparently specific to sesame. Southern blight, Pellicularia rolfsii, is known to attack sesame. Charcoal rot, Macrophomina phaseoli, will cause a stem rot of sesame; this disease is favored by drouthy conditions. Cotton root rot, Phymatotrichum omnivorum, attacks sesame, but usually occurs too late in the season to cause much loss in yield.

The most common and severe insect damage to sesame is caused by aphids. Several other chewing and sucking insects have been reported to attack the leaves and stems. The cotton bollworm will damage the green capsules. Sesame is believed to be highly resistant or immune to the root knot nematode. Stored grain insects will attack unprotected sesame seed in storage.

Several other diseases and insect pests are known in countries where sesame is grown. Those mentioned above are probably not the only ones which may cause trouble in this country.

Uses

Sesame products considered marketable in this country are the whole seed and the oil and meal from the seed. Although sesame stalks have little value for feeding, they are ground and sold as a livestock roughage in Venezuela. The best use of the stalks in Texas would be to plow them under as a source of organic matter. Sesame may be of value as a honey crop since bees work the flowers during the summer when other flowers are scarce. Sesame is sometimes planted as a source of food for game birds or as an ornamental because of its attractive flowers.

Sesame seeds are small, sweet and oily; they are free-flowing and will keep almost indefinitely, even in the tropics. In the Orient and Africa, the whole seed is relished in a wide variety of human foods. Dietary deficiencies among the native populations of those countries would undoubtedly be much greater if it were not for the high protein and mineral content of sesame seed. Benne (sesame) seed cakes are traditional in the Southeastern States. Some sesame seed are used in several types of confections and candies. The principal market for whole sesame seed in the United States, however, is in the baking industry. One to two-thirds of the whole sesame seed used in this country is as a topping for bread and rolls; this is the form in which the seed is most familiar to the American public. The seed are usually hulled before being used.

Table 2. Oil content of seed of six dehiscent (shattering) strains of sesame grown in Texas

Variety	College Station 1950	College Station 1951	College Station 1952	Chillicothe 1951	Chillicothe 1952	High Plains[1/] 1951	High Plains[1/] 1952
	Percent						
Y 6	60.7	52.1	51.7	52.2	51.6	51.7	50.5
N57-2	54.2	53.6	53.5	50.5	51.4	51.6	53.2
K 10	58.6	51.3	52.8	49.4	51.1	51.4	49.5
SC4520	57.5	51.8	51.0	47.9	49.9	50.8	51.7
Venezuela 51	52.6	48.0	53.1	47.5	48.2	49.6	49.2
M119-3	52.6	50.8	49.2	47.2	49.7	48.5	49.6
Average	56.0	51.3	52.0	49.0	50.3	50.6	50.6

1/ Grown with supplemental irrigation at Plainview in 1951 and at Lubbock in 1952.

Sesame oil is used as a salad or cooking oil, in shortening, in margarine and in the manufacture of soap. Minor uses are as a fixative in the perfume industry and as a carrier for fat-soluble substances in pharmaceuticals such as penicillin. One of the minor constituents of sesame oil, sesamin, is used for its synergistic effect in pyrethrin insecticides; the addition of a small quantity of this substance markedly increases the effectiveness of fly sprays.

Sesame oil possesses a bland, pleasant flavor and is easily processed and refined. In Latin America, it is considered the "Queen" of the vegetable oils. Perhaps the outstanding characteristic of sesame oil is its stability or keeping quality, which is a result of its resistance to oxidative rancidity. One of the minor constituents of sesame oil, sesamolin (which on hydrolysis yields sesamol, a powerful antioxidant) is responsible for this remarkable stability.

Sesame oilseed meal is, like the whole seed, a rich source of protein, calcium, phosphorus and of the vitamin niacin, Table 3. Sesame protein is especially high in the amino acid methionine. The trypsin inhibitor is not present in sesame protein, therefore, digestibility is high without heating.

Table 3. Chemical composition of sesame seed[1/]

Composition	Range	Average
Moisture content, %	4.19 to 5.97	
Oil, % (moisture free basis)	45.15 to 63.38	53.53
Crude protein, % (moisture free basis)	16.69 to 31.56	26.25
Total ash, %	5.01 to 6.14	
Calcium oxide, %	1.32 to 1.76	
Phosphorus (as P_2O_5), %	1.42 to 1.78	
Carbohydrates, %	0.00 to 12.76	
Crude fiber, %	2.88 to 15.70	
Niacin (milligrams per pound)	38.17 to 57.77	
Riboflavin (milligrams per pound)	0.22 to 0.33	
Iodine value of oil	101.4 to 116.5	110.0
Crude protein content of oil free meal	41.55 to 70.32	57.28

1/ From results of experimental tests in Texas and from the literature.

Market Outlets

The specialty uses, to which sesame seed are essential in the United States, would probably not absorb much more than the amount now being imported. This amount of seed could be produced in this country on less than 25,000 acres. If a large acreage of sesame is to be grown in Texas, the seed must enter the oilseed processing trade. Sesame seed promise to be well received by the oilseed processing industry, and industrial acceptance of the oil is assured whenever worthwhile quantities are regularly available at prices comparable with competing vegetable oils.

Definite markets for sesame seed have not been established in Texas. Imported seed, intended for the bakery and confectionery trade, have sold for 13 to 18 cents per pound on the New York market during the past few years. This market is for a relatively limited amount of seed and could easily be glutted. While definite information is not available, it seems likely that the Texas oilseed crushing industry could afford to pay only about half as much for sesame seed as the bakery and confectionery trade has been accustomed to paying, since sesame oil and protein feed would have to compete directly with cottonseed and soybean products on a price basis.

Until a regular marketing system for sesame seed develops, anyone contemplating the production of this crop should have his market definitely established before planting. Cotton oil mills and other concerns interested in processing sesame seed may find it to their advantage to contract for the desired acreage before the planting season.

Cautions

Sesame is not a wonder crop. It has its weaknesses as well as its strong points as a potential cash crop for Texas. Sesame requires good soil and good care to produce a satisfactory crop. Under certain conditions, it is difficult to establish a stand and early-season weed control sometimes may prove to be a problem. Under conditions favorable for their development, leaf diseases or insects may seriously damage or destroy the planting. When produced and sold in competition with other oilseeds, sesame will not have an extremely high value per acre, and markets are not well established or stabilized. Timeliness in harvest and an adequate labor supply are important, especially when attempting to produce the dehiscent types now available.

The Texas Agricultural Experiment Station is not recommending sesame as a general farm crop for Texas at this time and probably will not do so until acceptable indehiscent varieties are commercially available, or unless a national emergency should require an additional source of vegetable oil. Growers should consider any plantings of the dehiscent types as experimental; the major value to be obtained from such plantings may well be experience in handling the crop, looking forward to the time when indehiscent varieties are available.

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