# Crop Profile for Sesame in United States

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## General Production Information

**History and overview:**
Sesame is an integral part of ancient legends [2]. Sesame (*Sesamum indicum*) has early origins in East Africa and in India (Bedigian, 1985; Nayar and Mehra, 1970). It is perhaps one of the oldest crops cultivated by man, having been grown in the near east and Africa for over 5,000 years for cooking and medicinal needs. The ancients attributed near-mystical powers to sesame. The oil was used in barter since it would preserve and store in the desert for years.

**Production:**
Today, world production is estimated to be over 15 million acres (6.2 million hectares) and over 57% of the world production is in Asia (Table 1). Most of the Asian production is in India, China, and Burma (Myanmar). In Asia most sesame is consumed within 100 miles of where it is grown since farmers grow very small plots for their extended families. Africa grows 15% of the world's sesame, with Sudan, Uganda, and Nigeria being key producers. However, political unrest in that area limits exports to the U. S. Latin America grows 4% of the total world production in Mexico, Guatemala, and Venezuela. The United States usually imports about 40,000 metric tons annually, mostly from Guatemala, Mexico, and India.

For years the U.S. was totally dependent on imported sesame seed since harvesting was labor intensive. Similar to soybeans, sesame became commercially feasible in the U.S. after shatter-resistant genotypes were developed, which made combine harvesting practical. Genetic advances over the past ten years have produced superior lines with both single stemmed (uniculm) and branched stemmed shatter-resistant lines. Presently U.S. production is about 40,000 acres and is based primarily in Texas and Oklahoma; production practices have been described for the region (Anonymous, 1999).

**Uses:**
Sesame seed is processed and utilized in numerous ways. In most areas of the world, sesame is produced for its cooking oil and other direct food uses, with some direct consumption of the seed. In the U.S. sesame seed is primarily used as a confectionary topping, in baked goods, or as a condiment. Seed color is genetically controlled and light-colored seed is preferred for these confectionery uses. Sesame seed imparts unique taste and textural features when included with baked products. Sesame is rich in calcium and high in antioxidants and other healthful features. Imported seed is usually de-hulled before shipment where hand labor is involved in removing extraneous matter. Imported seed is brokered by firms for the processing firms who produce baked or confectionary products. Import brokers and warehouses are generally based on the east and west coasts of the U.S. Market demand in the U.S. for whole seed has

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been stable for over 20 years. The sesame ingredient market is expected to increase several-fold over the next decade.

**Processing:**
A U.S. firm (Sesaco, at Paris, Texas) uses several mechanical and wet processing methods to produce food-grade sesame for U.S. markets. (Table 3). Field-run, un-hulled seed is 70 to 95% pure. This seed is mechanically cleaned in a series of screening, de-stoning, and other processing steps to remove extraneous plant and foreign matter. About 10% of this "cleaned natural seed" moves directly into food use as whole seed to be blended into flour for baked goods. The remaining seed is cleaned further in either a washed or decortication/de-hulling wet processes. At least two growers and two firms produce and process sesame in Texas for organic food markets at premium prices.

"Washed-natural seed" is prepared by passing seed through an agitated wash, followed by a continuous-flow drier. This bright, dust free un-hulled seed makes up 30% of the domestic production and is 99.97% pure for the baked goods market. Immature or off-sized seed are removed and salvaged for oil production.

"De-hulled seed" is produced by a wet/chemical process to remove hulls. The hulls surrounding the seed are removed in a wet process using caustic soda (a sodium hydroxide solution) to loosen and remove hulls from the seed. The decorticated hulls are discarded. The bare seed is then washed and dried to produce a premium confectionary product. These de-hulled seed make up 50% of the U.S. market, for use in speciality baked goods or added as a topping after buns, rolls, or crackers are baked.

Currently less than 10% of the total U.S. production is processed into oil and flour. Traditionally, these products were produced from cracked, off-sized, or otherwise cull seed that were separated during the preparation of premium grade seed for other uses. Sesame contains 52 to 57% oil which is extracted in a multi-step press processes. In contrast to most other oilseeds, (such as cottonseed or soybean), sesame oil is not extracted with a solvent but rather with pressure in a mechanical expeller and is not heated. This pure, virgin oil is preferred by many food handlers. The oil is blended with other vegetable oils for salads and other food uses.

Another use for sesame oil in the U.S. is as a medical carrier in medical injections and in the cosmetics industry. This oil is extracted from number one quality seed. Oil for pharmaceutical uses is further refined. Many cosmetics include sesame oil because of its antioxidant properties.

After oil extraction, the resultant meal contains 50 to 55% protein and is blended with other flours for food use. The flour is an emerging market with significant growth potential. The antioxidants in sesame increase the shelf-life of the products baked with sesame flour.

**Sesame Antioxidants:**
Sesame has traditionally been valued as a health food throughout Asia and the Middle East. It is described in the ancient medical texts of India and China for preserving health, preventing disease, and

promoting general well being. About 20 years ago, a research team in Japan scientifically verifyied many of these traits (Namiki,1995).

Sesame is rich in natural antioxidants or lignans, which are both oil and water-soluble. These antioxidative compounds preserve the stability of sesame seed and oil. Furthermore, they are biologically active and provide a variety of healthy benefits upon ingestion. These compounds are being researched as potential industrial antioxidants and nutraceutical and pharmaceutical ingredients. The biological functions of sesame lignans are being investigated in both animal studies and human clinical trials.

Antioxidant content in sesame may be enhanced through traditional crop breeding. Sesame breeding programs in the U.S., Korea, China, Thailand, and Japan consider antioxidants as one of the selection factors in the development of new varieties for the future.

## Cultural Practices

- **Crop establishment:**
  Stand establishment is the biggest challenge in profitable production of sesame. Seed are small (100,000 to 180,000 per pound of seed or 220/g) (Martin et al., 1976). Since seedlings lack the emergence vigor of larger-seeded agronomic crops, soil crusting can be a severe problem in stand establishment. Sesame is commonly planted after soils reach 70 F (20 C) or higher and can be planted in many areas of Texas until mid-July but early plantings usually yield best. The crop is planted at 2½ to 4 pounds of seed per acre with a modified grain drill or conventional planter in 12 to 40 inch rows to achieve a desirable stand of 4 to 8 plants per linear foot of row. Seed bed preparation and shallow seed placement are essential to enhance emergence. Seedlings are vulnerable to early-season weather adversities. Rainfall or irrigation right after planting usually causes soil crusting and hampers seedling emergence. Sesame is an excellent crop of its own standing or as "catch crop" (Smith, 1999).

- **Varieties and growth features:**
  Until 1985, sesame production in the U.S. centered around shattering-type varieties such as 'Baco' which produced lateral branches with numerous dehiscent pods which split open near maturity. These shattering types were the only practical lines for commercial production since seed yields were 50% higher than those of non-shattering experimental lines. These dehiscent lines were typically hand-cut or harvested with a binder and shocked for field drying before threshing. Labor requirements and weather uncertainties precluded practical commercial production in the U.S. until recently. Higher yielding shatter resistant varieties, such as 'S-17', 'S-

23', 'S-24', 'S-25', and others with unique agronomic features were developed after years of breeding and selection by Deral G. Langham and more recently by D. Ray Langham. These varieties produce superior yields and are well adapted for mechanized harvest. The crop may be cut with a swather, allowed to field dry for two to three weeks, and then picked up with a combine header for harvest or the crop may be harvested directly with a combine. The high oil content and fragile seed coat require careful combine settings to avoid damage.

This annually seeded crop grows 3 to 6 feet tall. In the southwestern U.S., plants mature in 95 to 110 days and may be planted well after the usual planting dates for cotton or after cotton stands have been damaged by adverse spring weather. The plant produces a deep tap root which improves soil properties and water penetration. Over 85% of U.S. sesame is rotated annually with cotton and other crops. In some years, sesame can be planted immediately after harvesting wheat and with some early harvests of sesame, wheat can be planted in the fall. Sesame varieties vary in determinate growth habit[(2)] but defoliate naturally well before a killing frost. Harvest aid chemicals are not essential for timely harvest. In subsequent rotational crops, volunteer sesame is easily controlled with mechanical, cultural, and herbicidal practices.

- **Production:**
  Domestic acreage of sesame in the late 1990's has varied from 20,000 to 40,000 acres, depending on prices of major agronomic crops, weather outlooks, early season weather damage to cotton, and contract prices for sesame (which are tied to world prices). The crop responds to 50 pounds of nitrogen per acre, which enhances seed production and capsule fill. After production, over 80% of the land is rotated to other crops to reduce potential weed problems and to extend the biological benefits from sesame production to other crops.

  Texas is the leading state in U.S. sesame production (Table 2), with substantial production in Oklahoma. Nominal acreage is planted in Arkansas and Missouri. Sesame has been commercially grown in Arizona and New Mexico in the past. Total domestic production in recent years has varied from 2,000 to 6,000 tons, with an average of 3,500 to 4,500 tons in most years. The majority of U.S. sesame is grown under natural rainfall; 10% or less receives supplemental irrigation.

  U.S. yields range from 400 to 1,200 pounds per acre, and are affected by length of growing season, rainfall, weather, and plant stand. Yields are substantially higher in other countries where sesame is a primary crop and the small hand-tended plots receive substantial rainfall and is hand harvested. The U.S. record for commercial yields was 2,500 pounds per acre in fields near Yuma, Arizona.

- **Pest Problems:**
  Several pests attack sesame, with potential to limit economic production. Some of these pests[(3)] cause moderate to severe yield losses now while others have been noted in the U.S. but are not severe problems. However, some review of these pests may help circumvent problems later as

sesame production expands in the U.S. Historically, crop pests cause only nominal damage in the early years of production but become more serious since pest populations tend to increase as crop acreage expands.

No pesticides are labeled for sesame production in the U.S. Sesame is a minor crop in U.S. agriculture and agricultural chemical companies cannot justify developing new pesticides for small acreage crops. However, a special program known as "IR-4 Minor Crops Pesticide Clearance Project" works with land grant universities, commodity groups, chemical registrants, US EPA, USDA, and others to obtain pesticide tolerances and labels. Pesticide residue and labeling implications for sesame in the U.S. have been summarized by Markle et al. (1998). Potential pests, scientific names, and impacts on sesame are summarized in Table 4.

## Insect Pests

**Overview:**
Insect pests threaten most crops and cause economic losses as a result of foliar feeding or damage to seed or other harvestable portions of the plant. In sesame, two pests have caused economic problems and two others have been observed feeding on sesame. It should be noted that sesame acreage in the U.S. has been relatively low and massive insect problems have not yet developed into re-occurring problems. However, awareness of insect pests should be noted to reduce potential losses. Bt (*Bacillus thuringiensis*) and neem (Azadirachtin) are cleared for use on sesame: Aluminium phosphide, HCN, and Diatect (pyrethrins and diatomaceous earth) have post harvest tolerance for insect control in storage.

**Foliar insect pests:**
Aphids are more severe in sesame where pyrethroid insecticides have been applied in other crops and have reduced the natural enemies of aphids in sesame. Aphids feed on new foliage near the top of the plant and can attack sesame nearly anytime and reduce plant growth. Damage is caused by the loss of plant sap and reduced plant vigor. Sesame has produced good yields in research plots when aphids were sprayed once (however the seed could not be sold since the chemical was not cleared).

Silverleaf whitefly can be a problem in sesame, especially when populations migrate from winter crops into sesame fields. Whiteflies feed on the lower parts of the plant. Populations build rapidly and cause plant death. Whiteflies are most severe after mild winters and when winter crops are near sesame fields. Whiteflies have been observed in sesame since 1978 but were not a severe problem until 1991, with the appearance of the silverleaf white fly in southern areas of Texas. The whitefly has not been a problem north of Uvalde, Texas. Some sesame varieties have shown tolerant to the silverleaf whitefly.

Researchers have noted two "occasional pests" in sesame plots. Garden webworm is a general foliage feeder and can be a problem in several crops. Larva of this pest were noted in sesame plots at Uvalde and were considered to be a potential production problem.

Bollworms are voracious foliar feeders on many plant species and were a serious threat to sesame production in southwest Texas in 1980. While Bt may offer some control, no trials have been reported. Some farmers have reported massive populations of worms moving out of sorghum after harvest and into the sesame, only to have the migration reverse tide several hours later.

Problems with cabbage loopers have been noted in some locales in past years. Grasshoppers cause damage at the edges of sesame fields located near pastures.

**Stored insect pests:**
Larva of several common stored product insects invade sesame seed. Commonly recognized sanitation measures are practiced around storage facilities to reduce insect harborage. As seed is placed into storage, inert diatomacious earth is added. As larva feed on seed, silica from the finely ground diatoms destroys the gut and causes death. Aluminum phosphide is not commonly used in sesame storage facilities or warehouses.

**Vertebrate feeders:**
At research stations, deer frequently feed on peanuts, forage plants, and other crops. However, deer and other wildlife have not been attracted to sesame foliage. In severe drought deer may nibble sesame, but do not like the mucilage on the leaves and will do little damage. Cows, horses, and sheep will not eat sesame, but goats will feed on the foliage. Field mice sometimes come out of a pasture into sesame but have not caused economic damage.

## Diseases

**Overview:**
Several pathogens attack sesame and can impose severe economic losses. Plant diseases are not a significant problem since sesame is a relatively new crop on limited acreage in the U.S. However, as acreage and production increases, disease problems will become more prevalent and will need to be considered in future production and research programs. There are no fungicides cleared for use in sesame. The American Phytopathological Society maintains an inventory of plant diseases (Farr et al., 1989) and includes records of pathogens observed on sesame. Diseases of sesame include several fungal leaf spots, bacterial leaf blight, Fusarium wilt, stem and crown rots, and incidence of Phytophthora root rot. The disease implications of each of these pathogens is briefly discussed below.

**Soil-borne pathogens:**
Genetically pure seed is produced, screened, and maintained for planting purposes but is not treated with

a protective fungicide since treated seed cannot be used for other purposes. Presently seedling diseases are minor since sesame is usually planted in warm soils. Breeders are developing sesame that will germinate at lower temperatures, but early planting may increase seedling diseases.

Fusarium wilt has been noted in Georgia and Texas. *Rhizoctonia* spp. was observed on sesame in North Carolina. Both of these pathogens can attack seedlings, cause damping off, reduce crop stands in cool, wet soils, and may attack the crop later in the growing season. Sesame seedlings may emerge but seedling diseases may reduce stands 70% to 90%. Some varieties are very susceptible to Fusarium but breeding lines have shown some resistance. Fusarium may cause 80% yield loss with susceptible varieties.

After sesame seedlings are established, root damage can occur from *Helminthosporium sesami* and *Thielaviopsis basicola*. These pathogens infect the vascular system and can reduce stands and cause premature death. Aerial stem rot is present in Texas and probably persists in other southwestern states as well.

Verticillium wilt is a major plant pest and has occurred on sesame in New Mexico and at higher elevations in Texas. This pathogen is commonly present in slightly acid to alkaline cotton fields. In some years Verticillium wilt resulted in plant losses in sesame variety trials at Lubbock but did not appreciably affect yields (Brigham and Young, 1983). In western or semi-arid areas, verticillium wilt could be a severe disease in future years. Crop rotations and sanitation are important control strategies.

Charcoal rot was observed on sesame in Texas and California on young seedlings and in mid-season. Charcoal rot attacks roots, crowns, and lower stems when sesame is planted after other susceptible crops. The stem rots just above the soil line and results in severe stand reductions. Early sesame breeders in Texas (Kinman) and Arizona (Yermanos) worked on resistance to charcoal rot and it is rarely a problem now.

Phytophtora root and crown rot can be a serious disease problem in sesame. Infestations start in the root, spread to the crown area, and move into the lower stem. The fungus is soil-borne and moves with surface water. Phytophtora root rot is common in pepper and tomato fields and could become a significant problem when sesame is grown in rotation.

Phytophtora root rot was studied in sesame over several years at the Texas Agricultural Experiment Station research farm near College Station (McBee and Lyda, 2000). Several hundred lines from the sesame germplasm collection were screened in field and greenhouse studies in a search for some source of genetic resistence. Over 90% of the varieties and lines died. Only scattered plants escaped damage and there was no optimism for finding genetic resistence in sesame for root and crown rot tolerance. Phytophtora root rot was far more severe when sesame was planted two or more years in the same field but was lower when plots were continually rotated to new land each year. Trials with numerous fungicides and fumigants did not suppress Phytophtora root rot in sesame, which can result in a 10% yield loss with susceptible varieties.

Fusarium wilt became the major problem in sesame in the Winter Garden area of Texas in the early 1990's, when sesame could be grown on set-aside ground. Repeated plantings resulted in a build up of fungal spores. Fusarium shows up in earlier stages and kills the plant before seed is produced and reducing yields by 90% or more. In contrast, Phytophytora root rot normally attacks the plant later and reduces the yields by 10% or less. Some lines, such as S-23, S-24, and S-25 show some resistance to both of these soil pathogens.

Cotton root rot is one of the most pervasive plant pathogens in agriculture and infests the roots and vascular systems of over 2,000 plant species. However, cotton root rot has not been observed on sesame and Texas studies from the 1930's indicate that sesame is resistant to this broad-spectrum disease.

**Foliar diseases:**
Several leafspot pathogens, including *Alternaria sesame, Cercoseptoria sesame,* and *Cercospora sesami*, have been reported on sesame in Florida, Georgia, Mississippi, North Carolina, and South Carolina. Bacterial leaf spot did not cause yield loss but could be a problem in periods of high rainfall. Leafspot organisms cause spotting on leaves and progresses to destroy leaf tissue.

Leaf blight was noted on sesame plants in Mississippi. Leaf blight appears as a scorched blotch on the leaf surface and appear very quickly. Bacterial leaf blight may occur after rain or irrigation splashes soil onto leaves and leaf surfaces are wet for two hours or longer. If leaf blight is a potential problem, the management of irrigation water or scheduling may be advisable as alternative means to reduce the fungus.

Powdery mildew was noted in the Winter Garden area late in the season on the more determinate types but did not severely limit yields.

**Nematodes:**
Sesame has a deep tap root, which produces a natural biocide that suppresses most nematodes. Growers have noted a suppression of nematode populations in rotational crops such as cotton, peanuts and other crops. Researchers have documented the suppression of several genera of root-knot nematodes in soil where sesame was grown (Starr and Black, 1995). Most sesame varieties are resistant to root knot nematodes.

There have been no reports of nematodes reducing yields in commercial sesame fields in the U.S. but problems have occurred in India. Sesame exerts a biocidal control for nematodes and one way to suppress nematodes is alternate sesame with other crops. This natural suppression may offer some practical biological control of nematodes in other crops. Encapsulation or pelletization of sesame stalks, capsules, and seed are being researched as a potential nematicide. Sesame pellets might be formulated and applied to soil to suppress nematodes in other fields. Sesame residues probably suppress nematode reproduction but may not kill existing nematodes. Sesamin and sesamolin, the same antioxicants found in sesame seed, are also present in other parts of the plant.

# Weeds

**Overview:**
Annual and perennial weeds are the most troublesome of all pests in U.S. production. Weed control is essential to obtain good stands, reduce competition, and avoid quality/contamination problems. Cultural controls are utilized to the maximum extent. Since sesame is grown in rotation, chemical weed control in other crops helps reduce weed problems in sesame. For example, "yellow" herbicides, such as trifluralin/Treflan and pendimethalin/Prowl, and postemergence herbicides such as glyphosate/Roundup in cotton help reduce troublesome weeds when sesame is planted the following year. Another cultural practice is to prepare land for planting, let weeds germinate after a rain, and then harrow lightly or apply glyphosate to kill weeds that may emerge before planting sesame.

Presently there are no herbicides labeled for use in domestically produced sesame. However, weeds cause two problems in sesame: (1) weeds adversely impact sesame yields and (2) at harvest, weed seeds contaminate sesame and are difficult to remove when processing the crop.

**Competitive weeds:**
Early-season weeds significantly reduce sesame yields. After planting, sesame is not highly competitive with weeds. Annual weeds create a shade canopy and intercept sunlight above the crop. Weeds have extensive root systems and extract moisture at the sacrifice of sesame seed production. Even moderate infestations of annual weeds reduce sesame seed yields of sesame by 20 to 60%. As much as 10,000 acres of sesame have been disced and discarded in some years because of weed infestations. The availability of a soil-applied herbicide is extremely important in reducing weed seedlings when the crop is getting established. Sesame typically grows 3 to 6 feet tall which creates a shade canopy and, due to its height advantage, suppresses late-season weeds.

Annual grasses, such as Texas panicum, southern crabgrass, and broadleaf signalgrass grow faster than sesame under the warm, moist conditions commonly found at planting time. This increased competition for moisture and nutrients can result in a substantial reduction in sesame growth and yield.

Broadleaf weeds can also be competitive early in the season due to their fast growth. Some weeds, such as Palmer amaranth and other pigweed species, may grow as tall or taller than sesame. This early-season height advantage of some broadleaf weeds seriously reduces crop yields and interferes with mechanical harvesting. The most competitive annual weeds that cause the greatest yield losses in sesame include pigweed or 'careless weed', cocklebur, annual sunflower, morningglory, and others. The presence of weeds at harvest increases the moisture content in seed and causes storage problems.

Perennial weeds create unique problems in sesame since these weeds have established root systems and are more competitive than the annual crops. Perennial weeds commonly found in sesame are similar to those that are most prevalent in cotton, peanuts, and sorghum. With the use of glyphosate for perennial weed control in Roundup-Ready cotton, these weeds commonly occur in isolated areas within fields rather than field-wide infestations. Tillage is not particularly effective due to the root system and growth habits of perennial grasses and broadleaf weeds. The most serious perennial weeds in sesame include johnsongrass, silverleaf nightshade or 'whiteweed', and bermudagrass. Sesame is drought tolerant and continues to grown under dry conditions. Farmers have reported pigweed, devil's claw, and silverleaf nightshade have died while sesame has survived. Some farmers have reported that sesame has suppressed silverleaf nightshade.

**Crop contamination by weed seeds:**
While weeds cause yield reductions in nearly all crops, an additional problem is created in sesame by cross contamination from weed seed at harvest. One of the desirable features of sesame is the attractiveness of the seed on consumer products. The presence of weed seed creates a contamination problem that is not acceptable in the baking and consumer product industry. For example, a single johnsongrass seed or any black object mixed with sesame seed is quickly mistaken for rat excreta. Pigweed seed are also small, dark and mistaken as undesirable foreign matter. Historically, sesame from foreign countries has had problems with rat and insect excreta. Food processors continually inspect for any signs of excreta-like materials on baked goods and other products.

Sesame seed contaminated with weed seed is purchased at a discount price, based on the type and the level of contamination. In some years, 20% of the field-run sesame samples must be discounted to off-set the extra expense and losses incurred by weed seed contamination.

When weed seeds are similar in size and density to sesame seed, extra processing is required to remove the contaminants. Most weed seed and other foreign matter can be removed by mechanical screening and gravity/density and air separation. When weed seed is similar to the crop seed, these separation processes are less effective or may require additional steps or slower processing for removal. Quality standards for whole sesame seed are higher than for seeds of other crops which are ground or milled to produce flour. Some of the most common weed contaminates of sesame include johnsongrass, kochia, wild cucumber, and sunflower, plus nightshades.

Johnsongrass is the leading source of contamination since the seed are similar in shape and size to sesame and shatter easily at harvest. Until recently, this perennial grass was difficult to control in crop land. However, several soil-applied herbicides used in other crops will control johnsongrass seedlings. The widespread use of glyphosate in Roundup Ready cotton has helped to reduce johnsongrass when sesame is grown the following year. Johnsongrass is a greater problem when sesame is planted after corn or sorghum, since this grassy weed is more prevalent in these crops. Mature seed usually can be separated in the screening processes and gravity tables. Additional johnsongrass seed may be separated in the washing or dehulling process. Dark seed that escapes all the above cleaning processes can be removed with color sorters. However, the presence dark weed seed in field-run sesame adds to cost, slows down processing, and creates quality concerns.

Kochia is a robust, annual broadleaf which grows 4 to 6 feet tall and is commonly found throughout the Great Plains states. Kochia is highly competitive, interferes with mechanical harvesting, and produces bodacious quantities of seed which can contaminate sesame. Kochia is prevalent in untilled or waste areas around fields but can be controlled by several herbicides cleared for use in other crops. Weed control by sanitation, crop rotation, or avoidance strategies are commonly practiced to reduce kochia infestations in cropland.

**Tillage:**
Tillage is practiced in 50% or more of the crop. Most growers cultivate one or two times and a portion of the acreage is hand hoed. Sweep cultivators, rotary hoes, and other implements break crushed soil and kill weeds between the rows. However, early-season summer annual weeds (such as pigweed) must be controlled in the crop row to reduce crop losses. Once sesame is established, cultivators can be used to throw soil into the row to cover small weeds. Cultivation can also control early flushes of weeds after irrigation or rains but crop height limits tillage later. Tillage cannot be practiced when sesame is drill-seeded in 12-inch rows.

**Herbicide Development:**
Several herbicides have been evaluated in sesame but there are no federally-registered herbicides for sesame in the U.S. Clearance of glyphosate is expected in 2000. Herbicide trials have been conducted at Yoakum, Texas, to identify possible chemicals that could be labeled with U.S. EPA. Some history and background on herbicide studies is appropriate. In test plots, reduced rates of DNA or "yellow herbicides", such as trifluralin (Treflan) or pendimethalin (Prowl) have controlled weeds when incorporated lightly at planting. However, when trifluralin or pendimethalin have been incorporated to normal depths in soil for peanut or cotton production, severe stand reductions have been noted in sesame.

A federally-approved herbicide is important for the expansion of sesame in the U.S. Field and lab residue studies were initiated in 2000 through the IR-4 program to establish a tolerance for metolachor (Dual) and clethodim (Select). However these chemicals are not registered and should not be applied in sesame until cleared by the US EPA. Residue trials are under way, which involve field work (at Weslaco), sample preparation (at College Station), chemical analysis, and fulfillment of regulatory provisions. This work is conducted on complex Good Laboratory Practice standards defined by the US EPA to assure quality and confidence in the data in the multi-step process. This work with metolachlor and clethodim is coordinated with the registrants and US EPA to gain a federal label for use in sesame in the U.S.

Metolachor was selected as the soil-applied herbicide since it has controlled small-seeded annual grasses and broadleaf weeds in research plots at 1.5 to 2.0 pounds (ai) per acre without damaging the shallow-seeded crop. Since additional weed problems occur after the crop is planted, a post emergence herbicide would be extremely useful for growers. Clethodim (Select) has been labeled for use in cotton and peanut and is very effective on several annual and perennial grasses (such as johnsongrass). Clethodim is more effective at lower rates than fluaziprop-butyl (Fusilade) or sethoxydim (Poast) and therefore was selected for the IR-4 program. None of these herbicides are currently labeled for use in sesame and should not be used until federal approvals are granted.

# Contacts

**Authors:**
Dudley T. Smith, W. James Grichar, and Amanda A. McCallum
Texas Agricultural Experiment Station, College Station and Yoakum prepared April 12, 2000

**Contacts:**

Mark Black
Diseases
Tx Ag Extension Serv., Uvalde
mblack@tamu.edu

Brian Collard
Processing Sesaco Corp., Paris, TX
bc3@1starnet.com

Tedrowe Coulter
Production Tonkawa, OK
Coulters@kskc.net

James Grichar
Production
Tx Ag Experiment Stat., Yoakum
taes@viptx.net

Ray Langham
Breeding
Sesaco Corp., San Antonio, Texas.
Yuma@texas.net

Sammy Nauert
Production
Stamford, Texas.
AgCrop@SWConnect.net

Ron Scholar

Agronomy
Okla. State Univ., Stillwater

Glenn Smith
Marketing
Sesaco Corp., Paris, Texas.
smith@sesmark.com

Nathan Smith
Antioxidants
Sesaco Corp., Paris, Texas.
Ngs13@aol.com

Carlyle Thompson
Production Kansas State Univ., Hays

1. [1] Technical Report 00-xx, Department of Soil and Crop Sciences, Texas Agricultural Experiment Station, College Station, TX 77843-2474. Mention of a practice or a product does not imply an endorsement, suggested use, or a label clearance of a pesticide in the production of sesame.

   [2]"Open Sesame" may have originated decades ago. Children of all ages may recall "Ali Babba and the Forty Thieves" (www.paganlibrary.com/etext/arabian/Ali_Baba_And_The_Forty_Thieves.html) and the command of "open sesame" to enter the cave full of riches. A more scientific explanation of "open sesame" may be attributed to the biological nature of the plant, since seeds scatter as capsules open. Economically, "open sesame" infers the commercial interest in opening up sesame as an alternative crop for farmers.

2. Some plants exhibit indeterminate vegetative growth at temperate latitudes while others are more sensitive to day length and cease growing, as maturity approaches.
3. The term "pests" includes all weeds, diseases, and nematodes, and insects.

## References

1. Anonymous . 1999. Sesame seed production. Sesaco Corp., San Antonio, Tx. 23 p.

2. Bedigian D. 1985. Sesamin, sesamolin and the origin of sesame biochem systematics. Ecol. 13: *p133-9.*

3. Brigham, R. D. and J. K. Young. 1983. Sesame performance tests at Lubbock. Tx. Agri. Exp. Sta.

Progress Rept. 4131. 6p.

4. Farr, D. F., G. F. Bills, G. P. Chamuris, and A. Y. Rossman. 1989. Fungi on plants and plant products in the United States. Amer. Phytopathological Society, APS Press, St. Paul, MN. p 325.

5. Markle, G. M., J. J. Baron, and B. A. Schneider. 1998. Food and feed crops of the United States. Monograph 543. Sesame. Meister Publications. Willoughby, Ohio. p 235.

6. Martin, J. H., W. H. Leonard, and D. L. Stamp. 1976. Chapter 39. Miscellaneous industrial crops/ sesame. In Principles of field crop production. Prentice-Hall, Upper Saddle River, NJ. p 974-977.

7. McBee, G. G. and S. Lyda. 2000. Sesame assessments and screening genotypes for disease resistence. Unpublished data from 1986-1989 trials. Texas Agricultural Experiment Station, College Station, Texas.

8. Namiki, M. 1995. The chemistry and physiological functions of sesame. Food Reviews International 11(2):281-329. Marcel Dekker, Inc.

9. Nayar, N. M. and K. L. Mehra. 1970. Sesame: it's uses, botany, cytogenetic, and origin. Econ. Bot. 24(1):20-31.

10. Smith, J. T. 1999. Sesame saved the day: planting sesame increased cotton yields. Texas Farmer-Stockman. Aug. 1999. p 8-9.

11. Starr, J. L. and M. C. Black. 1995. Reproduction of Meloidogyne arenaria, M. incognita, and M. javanica on sesame. Suppl. J. Nematology 27(4S):624-627.

# Appendices

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**Table 1. World sesame production and imports to the U.S. in 1999**.

| **Region/Country** | **Production[1]** | | **Imported to U.S.[2]** |
|---|---|---|---|
| | **(Hectares)** | **(Metric Tons)** | **(Metric Tons)** |
| **Asia** | | | |
| India | 2,000,000 | 650,000 | 7,200 |
| China | 675,700 | 550,400 | 350 |
| Burma (Myanmar) | 500,000 | 186,300 | 100 |
| **% of total** | **51%** | **57%** | **20%** |
| **Africa** | | | |
| Sudan | 1,450,000 | 220,000 | 1,000 |
| Uganda | 186,000 | 93,000 | nil |
| Nigeria | 155,000 | 60,000 | 140 |
| **% of total** | **29%** | **15%** | **3%** |
| **Latin America** | | | |
| Mexico | 58,000 | 32,700 | 7,100 |
| Guatemala | 50,000 | 34,200 | 11,590 |
| Venezuela | 46,000 | 23,500 | 4,800 |
| **% of total** | **2%** | **4%** | **61%** |
| **World** | | | |
| 50 other countries | 1,107,000 | 282,6000 | 5,810 |

| Totals | 6,228,000 | 2,427,000 | 38,000 (1.5%) |
|---|---|---|---|

[1] Source: FAO Data Base Statistics

[2] Source: USDA Economic Research Service Trade & Marketing Division

**Table 2. Sesame production in the U.S. in 1999**[1]

| State | Acreage | % of total |
|---|---|---|
| Texas | 20,000 | 50% |
| Oklahoma | 18,000 | 45 |
| Kansas | 1,000 | 3 |
| Arkansas | 500 | 1 |
| Missouri | 500 | 1 |
| Totals | 40,000 | 100 |

[1] Source: Sesaco, Paris, Texas.

**Table 3.** Sesame processing and uses in the domestic food market in the U.S.

| Products | Processing | Seed & end uses | % of U.S. production |
|---|---|---|---|
| Field-run seed | Combine harvest | 70 to 95% pure seed | 100% |
| Cleaned natural seed (hulls remaining). | Seed is mechanically processed to remove extraneous plant & foreign matter | 99.9% pure.<br>Whole & cracked seed used in flour mixes and for baked goods. | 10% |
| Washed natural seed (hulls remaining). | Cleaned natural seed is wetted, agitated, & then dried. | 99.97% pure.<br>Bright seed used for baked goods. | 30% |
| De-hulled seed (hulls removed) | Cleaned natural seed treated to remove hulls color. Sorter removes dark seed. | 99.99% pure seed.<br>Confectionary & toppings for baked goods. | 50% |

| | | | |
|---|---|---|---|
| Oil & flour | Cull and off-color seed are pressed for oil. | Oil for salad dressing.<br><br>Meal for specialty flour | 10% |

**Table 4.** Summary of weeds, diseases, and insects and other potential pests, with implications for sesame production in the southwestern U.S.[1]

| Pest | Scientific Name | Impact/Comments |
|---|---|---|
| **Weeds - annual broadleaf** | | |
| annual sunflower | *Helianthus* spp. | early-season competition, mechanical harvest |
| kochia | *Kochia scoparia* | yield reduction, mechanical harvest, seed contamination |
| morningglory | *Ipomoea* spp. | early-season competition, mechanical harvest |
| pigweed (careless weed) | *Amaranthus* spp. | yield reduction, mechanical harvest, seed contamination |
| wild cucumber | *Enchiocystis lobata* | seed contamination |
| **Weeds - annual grasses** | | |
| broadleaf signalgrass | *Brachiaria platyphylla* | early-season competition |
| southern crabgrass | *Digitaria ciliaris* | early-season competition |
| Texas panicum | *Panicum texanum* | early-season competition |
| **Weeds - perennial** | | |
| bermudagrass | *Cynodon dactylon* | yield reduction |
| johnsongrass | *Sorghum halepense* | yield reduction, severe seed contamination |
| silverleaf nightshade | *Solanum elaeagnifolium* | yield reduction |
| **Diseases - seedling** | | |
| fusarium wilt | *Fusarium* spp. | damping off, stand loss |
| seedling wilt | *Rhizoctonia* spp. | damping off, stand loss |
| aerial stem rot | *Helminthosporium sesami* | root damage, stand loss |
| root rot | *Thielaviopsis basicola* | root damage, stand loss |
| **Pest** | **Scientific Name** | **Impact/Comments** |

| | | |
|---|---|---|
| **Diseases - soil-borne** | | |
| charcoal rot | *Macrophomina phaseolina* | stand reduction |
| cotton root rot | *Phymatotrichum omnivorum* | little impact noted |
| phytophtora root & crown rot | *Phytophtora nicotianae* | stand destruction |
| verticillium wilt | *Verticillium albo-atrum* | could be severe in future |
| **Diseases - foliar** | | |
| leafspot | *Alternaria, Cercoseptoria, Cercospora, Pseudomonas* | loss of leaf tissue |
| leaf blight | *Cornespora cassiicola* | loss of leaf tissue |
| powdery mildew | *Leveillula taurica* | late season loss of foliage |
| **Insects** | | |
| aphids | *Myzus* spp. | attacks new foliage, reduces vigor |
| silverleaf whitefly | *Bemisia argentifolii* | destroys lower foliage |
| garden webworm | *Achyra rantalis* | larva feed on foliage |
| bollworm | *Heliocoverpa zea* | larva feed on foliage |
| cabbage looper | *Acrididae* (several) | larva feed on foliage |
| grasshopper | *Trichoplusia ni* | destroys foliage |

[1]This list of pest problems was prepared from reviews of numerous publications, field notes, and numerous personal accounts on sesame production in Texas but should not be considered as a comprehensive listing of all pest problems that may occur in the southwestern U.S.

## Executive Summary

Sesame is a warm season annual crop with growing conditions similar to cotton. Approximately 40,000 tons of sesame seed is imported into the U.S. annually from Africa, southeast Asia, and Latin America for use in baked and other goods in the U.S. About 38,000 acres are grown in the southwestern U.S., with 50% of that acreage located in Texas. Sesame also does particularly well as a re-plant crop and is responsive to rainfall. Stand establishment, weed control, contamination by weed seed, and potential disease and insect pest problems pose challenges for U.S. production. Presently there are no pesticides registered on sesame in the U.S. The two main hindrances for sesame expansion now in the U.S. are (1) a lack of registered herbicides for chemical weed control and (2) a lack of a safety net in crop disaster insurance. Several diseases and insect pests occur on sesame but have not yet become an economic

problem in most areas where sesame has been commercially produced. Currently IR-4 field residue trials are underway to gain labels for some herbicides.

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