Alternative
Field Crops Manual
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Guar

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I. History:

Guar, or clusterbean , (*Cyamopsis tetragonoloba* (L.) Taub) is a drought-tolerant annual legume that was introduced into the United States from India in 1903. Commercial production of guar in the United States began in the early 1950s and has been concentrated in northern Texas and southwestern Oklahoma. The major world suppliers are India, Pakistan and the United States, with smaller acreages in Australia and Africa. In the early 1980s, Texas growers were planting about 100,000 acres annually. They harvested about half of the planted acreage and plowed the rest under as green manure.

Unlike the seeds of other legumes, the guar bean has a large endosperm. This spherical-shaped endosperm contains significant amounts of galactomannan gum (19 to 43% of the whole seed), which forms a viscous gel in cold water. Guar gum is the primary marketable product of the plant. India and Pakistan export much of their guar crop to the United States and other countries in the form of partially processed endosperm material. World demand for guar has increased in recent years, leading to crop introductions in several countries.

Like other legumes, guar is an excellent soil-building crop with respect to available nitrogen. Root nodules contain nitrogen-fixing bacteria, and crop residues, when plowed under, improve yields of succeeding crops.

II. Uses:

In Asia, guar beans are used as a vegetable for human consumption, and the crop is also grown for cattle feed and as a green manure crop. In the United States, highly refined guar gum is used as a stiffener in soft ice cream, a stabilizer for cheeses, instant puddings and whipped cream substitutes, and as a meat binder. Most of the crop in the United States, however, is grown for a lower grade of guar gum, which is used in cloth and paper manufacture, oil well drilling muds , explosives, ore flotation, and a host of other industrial applications.

Guar gum consists of long branching polymers of mannose and galactose in a 2:1 ratio. After extraction of the gum, guar meal contains approximately 35% protein, which is about 95% digestible. The seed protein is low in methionine , like most legumes. Enough gum remains in the meal to make it an excellent feed pelleting material. Toasting improves its palatability to livestock and helps remove a trypsin inhibitor for non-ruminants.

III. Growth Habits:

Guar is an upright, coarse-growing summer annual legume known for its drought resistance. Its deep tap roots reach moisture deep below the soil surface. Most of the improved varieties of guar have glabrous (smooth, not hairy) leaves, stems and pods. Plants have single stems, fine branching or basal branching (depending on the variety) and grow to be 18 to 40 in. tall. Racemes are distributed on the main stem and lateral branches. Pods are generally 1 1/2 to 4 in. long and contain 5 to 12 seeds each. Seeds vary from dull-white to pink to light gray or black and range from 900 to 1,600 seeds/oz.

IV. Environment Requirements :

A. Climate:

Guar tolerates high temperatures and dry conditions and is adapted to arid and semi-arid climates. Optimum temperature for root development is 77 to 95°F. When moisture is limited, the plant stops growing but doesn't die. While intermittent growth helps the plant survive drought, it also delays maturity. Growing season ranges from 60-90 days (determinate varieties) to 120-150 days (indeterminate varieties). Guar responds to irrigation during dry periods. It is grown without irrigation in areas with 10 to 40 in. of annual rainfall. Excessive rain or humidity after maturity causes the beans to turn black and shrivel, reducing their quality and marketability. While profitable seed production in southern U.S. areas of high rainfall and humidity is likely to be limited, guar can be successfully grown as a green manure crop under these conditions. Guar varieties that require a particular daylength to flower or day-neutral have been described. Considering these high soil temperatures and long growing season, successful guar production in Wisconsin and Minnesota is very unlikely.

B. Soil:

Guar grows well under a wide range of soil conditions. It performs best on fertile, medium-textured and sandy loam soils with good structure and well-drained subsoils . Guar is susceptible to waterlogging . Guar is considered to be tolerant of both soil salinity and alkalinity.

Guar is an excellent soil-improving crop and fits well in a crop-rotation program with grain sorghum, small grains or vegetables. In Australia, guar was found to add 196 lb N/acre to the soil-plant system over three years. Increased yields can be expected from crops following guar because of increased soil nitrogen reserves. When used in rotation with cotton in Texas, researchers measured a 15% yield increase in cotton.

C. Seed Preparation and Germination:

Select seed that is uniform in color and size and is free from other crop and weed seed. New guar varieties have been released that have some resistance to diseases that once devastated fields of the crop. To prevent disease problems, select certified seed that does not contain seed of older varieties with less disease resistance.

Seed should be inoculated just before planting with a special guar inoculant or the cowpea (Group "E") inoculant . Exposure of inoculum to sunlight, heat and drying before planting can impair the effectiveness of the nitrogen-fixing bacteria. Seed should be planted in moist soil within 2 hours after inoculation. Fungicidal seed treatments may inhibit inoculation.

V. Cultural Practices:

A. Seedbed Preparation:

The seedbed should be firm and weed-free. Soil in the row should be ridged slightly to facilitate harvest of low-set beans.

B. Seeding Date:

Guar should be planted when soil temperature is above 70°F; the optimum soil temperature for germination is 86°F. A warm seedbed, adequate soil moisture and warm growing weather are essential for establishment of a stand. In Texas, June plantings of guar produce more reproductive buds than July plantings, resulting in substantially higher yields. Thus, production of this crop in the Upper Midwest is unlikely.

C. Method and Rate of Seeding:

1. Method of Planting: Guar is usually planted in 36 to 40 in. rows with a row crop planter. However, it can be broadcast seeded or planted in narrower rows with a grain drill if moisture is adequate. A planting depth of 1 to 1 1/2 in. is usually recommended. If guar seed is crushed, gumming or clogging of equipment may occur. To prevent clogging, holes on the bottom sides of the plates should be straight, rather than beveled or tapered. Adding graphite or a dry detergent to the seed box and reducing seed weight on the plates by filling the planter box only about one-third full may also help prevent gumming during planting.

2. Rate of Planting: Although some studies have found little effect on yield when seeding rates ranged from 5 to 44 lb seed/acre, other researchers have indicated an optimum seeding rate of 5 to 9 viable seeds/ft of row (30 in. rows). Current Texas recommendations are 5 lb/acre for 30 in. rows and 12 lb/acre for broadcast. Broadcasting should be practiced only where moisture is sufficient to support the higher plant population.

D. Fertility and Lime Requirements:

Nitrogen is not thought to be limiting in guar when the plants are well nodulated . Like most legumes, guar usually requires application of a rather high level of phosphorus (20 to 30 lb of P_2O_5/acre) and medium levels of potash (40 to 50 lb of K_2O/acre). For highest yield, fertilize according to soil test results. Apply fertilizer below the seed before planting or to the side and below the seed at planting. Sulfur fertilizers have been found to affect guar on some soils, and zinc deficiency is a common problem in India.

Moderately alkaline soils are considered desirable for guar crop production (pH 7.0 to 8.0).

E. Variety Selection:

There have been notable improvements in guar varieties developed in the last 30 years. The newer cultivars are much more disease resistant with higher yields. Pod set in improved varieties is higher, and pods are well distributed on the main stem and branches, increasing harvest efficiency. The multiple branching of these newer cultivars also produces more pods.

Only the earliest-maturing varieties are recommended for production in Wisconsin and Minnesota.

Brooks , released in 1964, was the first improved variety, replacing Texsel and Groehler . Brooks has been grown on most of the guar acreage since 1966, but is rapidly being replaced by two newer releases, Kinman and Esser . Brooks is high-yielding and resistant to the major guar diseases, Alternaria leaf spot and bacterial blight. It is medium to late in maturity. Plants have a fine-branching growth habit and small racemes of medium-sized pods. Leaves and stem are glabrous . The seed is of medium size.

Hall is a slightly later-maturing variety than Brooks, and therefore not recommended for production in the Upper Midwest. It is resistant to bacterial blight and Alternaria leaf spot. Plants are relatively tall, coarse, finely branched, and produce small racemes of medium-sized pods. Leaves and stems are glabrous . This variety is best adapted to heavier soil types and higher elevations.

Mills is an early-maturing variety which also is resistant to bacterial blight and Alternaria leaf spot. Plants are short and finely branched and produce small racemes with relatively large pods. Leaves and stems are pubescent (hairy). Seeds are larger than those of Brooks and Hall. In dry seasons, Mills does not grow tall enough for efficient harvest. Yields are generally lower than those of Brooks and Hall.

Kinman , released by the Texas Agricultural Experiment Station, the USDA-ARS and the Oklahoma Agricultural Experiment Station in 1975, is derived from Brooks and Mills. Kinman is about 7 days earlier in maturity than Hall and of the same maturity as Brooks. It is highly resistant to bacterial leaf blight and Alternaria leaf spot. Kinman is slightly taller and coarser-stemmed than Brooks, but less so than Hall. It is fine branched and produces small-to-medium sized racemes. Seed pods are medium in length and generally contain from 7 to 9 seeds each. Seed of Kinman is slightly larger than Brooks. In 41 yield trials at eight locations in Texas and Oklahoma from 1971 to 1976, Kinman produced 17% more seed than Brooks.

Esser , released with Kinman in 1975, is a selection from progeny of the same Brooks × Mills cross. It is medium to late in maturity and therefore is probably not a good cultivar for Wisconsin and Minnesota. It has high resistance to Alternaria leaf spot and bacterial leaf blight. Esser has shown superior disease tolerance to Brooks and Kinman under severe bacterial blight conditions.

Esser plants have Brooks' fine branching growth habit, but Esser has stronger main stems and fewer lateral branches. Esser produces small racemes with medium-sized pods.

Lewis , released by the Texas Agricultural Station and the USDA- ARS in 1986, is a selection from a cross of a glabrous parent with a pubescent (hairy) parent. Lewis is a medium-to-late maturing variety that is highly resistant to Alternaria leaf spot and bacterial leaf blight. Leaves, stems and pods are glabrous . Plants have a basal branching growth habit. The main stem and the basal branches possess short internodes with racemes initiated at each node over the entire plant. Plants are of average height, and racemes and pods are of medium length. Pods generally contain 5 to 9 seeds of average size. In 10 yield tests at five Texas locations during 1980-1983, Lewis produced mean seed yields approximately 25% higher than Kinman and 21% higher than Esser (Table 1).

Table 1. Yields of five guar varieties in Texas from 1980 to 1983.

Year/location	Variety				
	Lewis	Kinman	Esser	Brooks	Hall
	lb/a				
1980					
Chillicothe 1	1,474	1,149	1,135	1,087	876
1981					
Chillicothe	844	781	666	617	458
Iowa Park	1,052	941	1,116	969	932
Stephenville 1	1,415	1,011	1,168	1,022	922
1982					
Chillicothe	1,631	1,275	1,450	1,319	1,186
Corpus Christi	935	718	653	676	467
Munday	1,022	756	733	689	436
Stephenville 1	1,197	1,042	875	1,240	1,009
1983					
Chillicothe 2	454	354	428	239	310
Munday 2	997	794	900	727	676
Mean	1,102	882	912	858	727

1 Test received supplemental irrigation.
2 Disease was present in the test.
Source: Stafford, R.E. 1986. Lewis: A New Guar Variety. Texas Agricultural Experiment Station Bulletin L-2177, February 1986. Texas A&M University System, College Station, Texas.

F. Weed Control:

Young guar plants grow slowly and are particularly susceptible to weed problems. Weeds can reduce yields and create harvesting problems.

1. Mechanical control: Guar should not be seeded in fields heavily infested with Johnsongrass (Sorghum halepense) and other perennial weeds. Early preparation of land and mechanical cultivations during the growing season will help minimize weed problems. Covering the lower branches during cultivation may promote development of disease and increase harvest difficulties.

2. Chemical: Treflan (trifluralin) is registered for use on guar as a preplant incorporated treatment to control most annual grass and several annual broadleaf weeds. Follow label instructions carefully for different soil types.

G. Diseases and Their Control:

Selecting disease-resistant varieties and high-quality certified seed is the best defense against disease problems. There are two major diseases of guar worldwide:

1. Alternaria leaf or target spot (*Alternaria cucumerina* var. *cyamopsidis*): This fungal disease may become severe during periods of heavy dew and high humidity. It causes a brown target-like lesion on the leaf between bloom and pod set. As the disease progresses, lesions enlarge, join and cause leaf drop.

2. Bacterial blight (*Xanthomonas cyamopsidis*): This seed-borne disease can cause loss of plants from the seedling stage until maturity. Symptoms include large angular necrotic lesions at the tips of leaves, which cause defoliation and black streaking of the stems. This is potentially the greatest disease hazard to guar.

H. Insects and Other Predators and Their Control:

The guar midge (*Contarinia texana*) is the primary guar insect pest in the Southwest. Heavy midge infestations have caused up to 30% loss in seed production. Guar midge infestations are generally heavier in fields with sandy or sandy loam soils.

Damage to guar is caused by the larvae, which develop in the guar buds. Infested buds eventually dry up and fall from the plant. The adult female midge deposits her eggs in developing buds. After larvae complete their development, they drop from the buds to the ground to pupate. There are several generations each year.

Rainfall or sprinkler irrigation can reduce midge populations drastically. However, field inspection should continue because midge infestation problems may increase again as a result of improved growing conditions. Control midges while guar is producing buds -- primarily between 45 and 90 days after emergence.

Other guar insect pests include the gall midge (*Asphondylia* sp.), three-cornered alfalfa hoppers, pea aphids, white grubs, thrips , and whiteflies. Storage pests have not been a problem with guar.

I. Harvesting:

Since guar beans generally do not shatter, the crop can be direct-combined as soon after maturity as possible. Harvest does not generally take place until after frost in northern regions. At maturity, the seed pods are brown and dry, and seed moisture content is less than 14%. Gramoxone (paraquat) can be used as a harvest aid to speed up drying and to kill weeds prior to frost. Apply when pods are fully mature. Preharvest interval is 4 days. Do not graze treated areas or use the treated forage for animal feed.

Guar beans can be harvested with an ordinary grain combine. The cylinder should be slowed and the combine speed reduced to a rate that will permit proper threshing of the beans. A high fan speed can be used to clean out foreign material. Reel speed should be slightly greater than combine ground speed. Improper reel speed can shatter seed pods. Reels should be set just deep enough in the guar to control the stalks, and should be about 6 to 12 in. ahead of the cutterbar . Some operators replace the wooden reel bats with 1/2 in. steel rods to reduce shattering. When harvested for hay, guar leaves drop readily unless extreme care is taken during the curing process. For hay, the crop should be cut when the first lower pods turn brown.

Guar can be harvested for seed and then plowed under or used as a mulch. If seed is not harvested, guar used for green manure should be turned under when the lower pods begin to turn brown.

J. Drying, Storage and Seed Quality:

Following harvest, the seed is graded for size and cleaned to remove shrunken seed and crop residue. Little information is available on optimum storage conditions for guar, but this has not been identified as a problem in most production guides. Following cleaning, milling for gum extraction may proceed.

The principal factors that decrease seed quality in guar are seed blackening and the production of small and shrunken seed. White seed is preferred for many food applications, and black seed is often discounted. Darkening tends to follow patterns of increasing rainfall, especially when it occurs during the period of seed maturation.

Small seed contains less endosperm and therefore is less desirable for milling. Late flowering, diseases, insects and low moisture can cause small seed (preferred size is 4 mm).

VI. Yield Potential and Performance Results:

Production practices and rainfall during the growing season cause seed yields to vary from about 300 to 2,000 lb/acre. Yields of several varieties in Texas are shown in Table 1. Experimental plantings of guar at Rosemont, Minnesota, have resulted in plants that bloomed but produced very little seed.

VII. Economics of Production and Markets:

Income and production costs for guar vary from year to year and according to soil types. Production costs often vary by $20 to $40/acre between farms because of different fertilizer usage and other production practices.

Demand for guar is increasing because of the wide use of the gum in more products and efforts of dealers to obtain a larger percentage of the gum from domestic sources. Growth in the early 1980s was estimated at 10% annually. Grade factors considered by the purchaser are the moisture, foreign material and test weight. Identify a market and secure a contract, if possible, before growing guar for bean production.

The value of guar as a soil builder to increase yields of succeeding crops should not be overlooked when considering guar as an alternative crop.

VIII. Information Sources:

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