Texas A&M AgriLife Research and Extension Center at San Angelo

Sunflower–Production Guide

Sunflower Production Guide

for West Central Texas
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Description/Agronomic Characteristics:

Sunflowers are grown in Texas for four principal marketing objectives. Confectionary sunflower in the large seeded white stripe sunflower which is grown for human consumption and bird feed. The hybrid oil type sunflower is utilized as a source of high quality vegetable oil with the extracted meal utilized as a protein source in livestock feed. Hybrid oil types are also used in bird feed mixtures. Another popular use for sunflower plantings is a food plot for wild birds, mostly white winged and mourning doves. Properly managed sunflowers might yield 1000 to 1400 pounds per acre dryland, and perhaps 50% more under irrigation.

Specific Areas of Adaptation:

Sunflowers are adapted to a wide variety of soils and climatic conditions but perform best when grown on good land and provided sound management practices. Some soils consistently produce larger yields of sunflowers than other soils. The properties of soils that influence sunflower yields include (a) water holding capacity, (b) internal drainage, (c) seedbed condition, and (d) soil fertility.

Under dryland farming, medium and moderately fine textured soils that have moderate to good internal drainage are better suited for sunflowers than are the coarse or the many fine textured soils. Soils such as the loams; silt loams, clay loams, and silty clay loams usually have moderate to large water holding capacities and are not as drouthy as the sands; sandy loams, and loamy sands. The coarse textured soils, because of their lower water holding capacity, generally do not provide enough water for high yields, although good yields may be obtained when seasonal precipitation is adequate and the rains are uniformly distributed throughout the growing season. The fine textured soils, on the other hand, have higher water holding capacities, but the internal drainage of some of these soils is often restricted. Under wet conditions, these soils have water-logged or saturated conditions causing an oxygen deficiency which slows growth and promotes fungal seedling diseases. Wet, low lying fields also are slow to warm up in the spring, and usually cause seeding delays.

Length of growing season:

Most sunflower varieties mature in 85 to 95 days. As maturity progresses with heat units, it takes early planted sunflowers longer to mature than later planted acreage of the same variety. Maturity of the crop is also hastened by photoperiod in late plantings.

Varieties Suited for Use:

Sunflowers are presently grown from North Dakota and Minnesota south to Texas. In addition, sunflowers are grown in Indiana, Ohio, Michigan, Pennsylvania, and Georgia.

Most oil and confectionary cultivars presently available are the result of hybridization. Seed of these hybrids is more expensive than open pollinated sunflowers but the associated hybrid vigor generally results in higher yields. In sunflower planted for food plots, it is not necessary to seek hybrid seed. Experimental trials have not been recently conducted in West Central Texas to evaluate the best germplasm. Seek information from sunflower seed producers relative to hybrid selection.

Sunflowers are of either standard height or double dwarf. The dwarf sunflower seldom achieves more that 40 inches in height while standard height hybrids can exceed 6 feet if growing conditions are good. The primary advantage of dwarf hybrids is lodging resistance. Dwarf hybrids are often planted in narrow rows at higher populations, whereas standard height hybrids are best planted in conventional rows.

Key Production Requirements:

Planting Dates

Soil temperatures should be 50 degrees Fahrenheit or above when the seed is planted. This will probably occur in mid-March or early April. The seedling sunflower plant will tolerate lower temperatures but plant growth is very slow. Planting after July 1 may result in lower grain yields if climatic conditions are not ideal. Row direction has little effect on grain yield, however, prevailing winds may tend to lodge plants if rows are planted across the wind. The sunflower is phototropic (head faces east in morning and west in evening) in its vegetative growth while most heads face east after the flowers are open.

Seed will germinate at 42 degrees Fahrenheit but a 50 degree temperature is more satisfactory for uniform stands. Temperatures must be 26 degrees Fahrenheit or lower for several hours to kill mature plants. Climatic conditions during seed development affect fatty acid composition of the oil which determines its food value. Tolerance to cold and high temperatures contributes to sunflower adaptation in different environments.

The seedbed should be prepared so that it is moist and firm with the surface rough enough to minimize soil drifting. A firm seedbed is desirable so that seeds planted at shallow depths in cool soils obtain adequate moisture for rapid and even emergence. Soil compaction by excessive land preparation should be avoided because this promotes poor drainage and increases the probability of downy mildew in areas where this disease is prevalent.

Sunflowers are able to emerge from rather deep placement. The important consideration in planting is to place the seed into moisture, but in no case should the depth of seeding be more than three inches. Uniform stands should be a goal for most efficient use of water, nutrients and light.

Row Width and Plant Population

Sunflowers are a row crop, but the row width varies depending upon the equipment available. Performance has been better when the width of the row has been between 20 and 30 inches, however, widths as wide as 40 inches and as narrow as 14 inches have produced good yields. Row spacing with conventional height sunflower should correspond with harvest equipment. A difference of a few inches in row width would not justify the investment for a different set of equipment.

Plant population per acre should remain the same regardless of row width. For example, the number of plants per acre should be the same in fields with 36-inch rows as in fields with 18-inch rows. The seed spacing must be proportionately increased with lower germinating seed and decreased with higher germinating seed.

Sunflowers compensate for differences in plant populations by producing large seeds and large heads at low populations. Oilseed varieties may be planted at a higher population than non-oil varieties. Seed size is unimportant in oilseed types but very important in non-oil varieties for human food markets. Plant populations for oilseed varieties should be between 15,000 and 22,000 plants per acre with adjustments made for soil type and for the production potential of the soil. Lower populations are used on the lighter soils, those with lower water holding capacity, and where rain patterns are inadequate. Confectionary varieties grown for the food contracts (non-oil) should be planted at a population between 12,000 and 18,000 plants per acre. Many of the confectionary contracts are based upon seed size. A large seed size is required, and a drastic price reduction may result with the delivery of small seed. Low plant population helps insure consistently large seed. Under dryland production, oil seed types do not have the same seed size requirements, and may pose less pricing risk. By planting dwarf sunflowers at the 25,000 to 30,000 seeding rate, lodging is greatly reduced, and the small plant uses less water.

Cultural Practices

Proper adjustment and operation of planting equipment is one of the most important operations in sunflower production. Yield potential of the field can be influenced greatly by the population distribution as well as the number of plants. Plateless and air-planters have been used effectively to get good seed distribution. However, conventional planters will provide good seed distribution by using correct planter plates, properly sized seed, and proper seed kickers. Several commercial seed companies supply properly sized plates for the seed they sell. The only other modification required for standard planters is sunflower seed kickers. Grain drills are used on some farms where row crop equipment is not available. The results are not particularly good because of seed damage and poor seed distribution, especially for large seeds.

Any conventional corn planter or precision drill can be used for planting. Use plastic plates with filler rings matching the seed size indicated on the bag for plate planters. Some farmers have experienced difficulty when the small seed sizes were too small for the drum being used on air planters. Sunflowers should be planted in rows to permit cultivation.

Seed should be planted 1 to 2 inches deep depending on soil moisture conditions. A sunflower may take longer to emerge than grain crops because of slow moisture penetration through the achene or seed coat.

Fertilizer Requirements

Many growers believe that sunflowers do not require as much applied fertilizer as cereals. Sunflowers have an extensive root system which may help them utilize residual soil nutrients. To achieve consistent yields, an adequate fertilizer program must be a part of sunflower production.

Fallowed soils frequently have adequate nitrogen for a sunflower crop, but not enough phosphorus and potassium.

Soil sampling and soil testing are recommended for determining the soil fertility level and for making fertilizer recommendations. Soil tests make it possible to classify the soil's ability to supply nutrients as very low (VL), low (L), medium (M), high (H) or very high (VH). Fertilizer recommendations are based on the level of available nutrients and a realistic yield goal. A realistic yield goal is estimated from the highest sunflower yield that has been produced on the field or farm. It is then adjusted up or down depending on stored soil water, on expected precipitation, and on changes in management practices.

Table 1. Soil nitrate and fertilizer nitrogen needed to produce projected yields of sunflowers.

Yield goal (pounds per acre)	Total nitrogen required (pounds per acre to a depth of 2

	feet)
1000	50
1200	60
1400	70
1600	80
1800	90
2000	100
2200	110
2400	120
2600	135
2800	150
3000	170

Because of the nature of phosphate and potash chemistry in the soil, these nutrients move very little with soil water. A 6 inch soil sample is usually adequate for these elements. The amounts of phosphate (P2O5) and potash (K20) which should be added as fertilizer will be indicated in the recommendation section of your soil sample analysis.

To date, use of micronutrients has not been shown to give profitable responses. If for some reason a micronutrient problem is suspected, it is suggested that a soil test be obtained to evaluate crop needs.

Sunflower seeds are sensitive to fertilizer salts. The nitrogen (N) plus potash (K20)or the phosphate (P2O5) should be limited to 5 pounds per acre when fertilizer is placed in contact with the seed. Where the fertilizer is banded 2 inches to the side and 2 inches below the seed, the entire recommended rate can be applied with the planter. Where soil tests indicate a need for a nutrient, it is advisable that some starter fertilizer be banded at planting to increase nutrient uptake.

Nitrogen can be broadcast either fall or spring on medium to moderately fine textured soils. To prevent loss of broadcast nitrogen, it should be incorporated within 2 days after broadcasting. For coarse textured and low lying fine textured soils, nitrogen may be broadcast in the spring and incorporated. A portion of the nitrogen also may be sidedressed when the sunflowers are less than one-foot tall; sidedressing at later stages may damage the lateral roots.

Where all the phosphate is broadcast, the recommended rate for very low, low and medium testing soil should be doubled. It is recommended, however, that at least 10 pounds of P2O5 be reserved for band application at planting. When the application is split between banding and broadcast, the portion not banded should be increased by 1.5 times. When potash is broadcast, about 1.5 times more potash than recommended should be applied and incorporated.

Water-Irrigation Needs:

The sunflower plant is drought tolerant and has an extensive, heavily branched root system which permits it to extract more deep soil moisture than corn roots. For this reason, preplant irrigations can have a longer benefit to sunflower than other grain crops. Short periods of drought may not greatly reduce seed yield because crops are less stressed due to the large root volume. The critical yield period occurs 20 days before and after flowering. Make sure that adequate water is available to the crop at the time the sunflower bud reaches about 0.75 to 1 inch in diameter. If dry conditions persist, apply a second irrigation about 20 days following the first and in unusually dry weather, a third may be required in late grain fill.

Pest Management:

Major insect pests and their control

Experienced producers will watch their fields for insects and take appropriate action if they are found. Many insects are attracted to the field during flowering; therefore, insects should be properly identified before indiscriminately spraying

Insects

Insects are often a major limiting factor to the production of oil-seed type sunflowers in Texas. In experimental plantings carried out by entomologists in Texas, as many as 47 different insect species were recorded visiting sunflowers. Some 14 to 15 of these insects were considered potential major pests. Fortunately, chemicals are available and management practices are known that provide adequate control of some of the more serious insects. Recommended insecticides occasionally change as new chemicals are approved and some existing insecticides may be removed from the market. Therefore, when insect problems develop, growers are advised to contact their county extension agent or specialists for the recommended insecticides.

It is also important for growers to become familiar with the major pests of sunflowers as well as pollinators and beneficial insects associated with the crop.

Major pests of sunflowers are the sunflower moth and the carrot beetle. The sunflower moth can be successfully controlled with insecticides, but no effective control method has been found for the carrot beetle. In addition to these pests, a number of stem girdlers, leaf feeders, and stem borers may be capable of reducing sunflower seed yields if present in sufficient numbers.

Sunflower Moth

Homoeosoma electellum

The sunflower moth is the most common pest of sunflowers in Texas. The larvae of the insect overwinters in soil and the adult moth emerges in early spring. The first generation is maintained by wild host plants. The second and third generations by eggs on both wild and cultivated sunflowers and these constitute the major threat to commercial sunflower crops.

The adult is a light brown to buff colored moth. Female moths lay eggs in or between the individual flower tubes on the sunflower head during the bloom stage. The eggs hatch in 48 to 72 hours and the newly-hatched larva (about 1/8 inch large and yellowish in color) feed on the surface of the flower for about 2 days. They then tunnel into developing seed and the fleshy receptacle of the head where they feed for an additional 19 to 20 days. Each larva normally damage or destroy 9 to 10 seed.

Young larvae (worms) can be controlled with insecticides that are applied before the larvae tunnel into the seed or plant tissue. Methyl parathion and endosulfan are both cleared for up to three seasonal applications against these pests. Tests have shown that these materials give effective control when applied at 1 lb. a.i. rate per acre in a schedule of 2 to 3 applications, at a 5-day interval. The initial application should be made when 20% of the plants have begun to flower and moths and young larvae are present. Check at least 25 plants at different locations throughout the field to determine if treatment is warranted.

Carrot Beetle

Bothynus gibbosus

The carrot beetle must be considered an occasional threat to successful sunflower production in the southwestern United States. Sunflowers in the Texas rolling plains have sustained severe damage by this species. Light-trap catches of 10,000 beetles per night in May and August are not uncommon in this region. Carrot beetles feed on the roots of sunflowers, causing plants to wilt and die.

Adult carrot beetles are similar in appearance to the common “June bug” or “May beetle” except that they are darker (deep reddish-brown to black) in color. Carrot beetles occur throughout the High and Rolling Plains and damage sunflowers by burrowing into the soil and feeding on the roots. Due to this root pruning, damaged plants take on a drought-stressed appearance and may eventually die. Damage may occur at any stage of plant development.

The carrot beetle is not limited to the High and Rolling Plains and may become of economic importance in other areas with more extensive plantings. At this date, however, no serious damage has been reported in Central and South Texas.

Numerous insecticides have been tested for their effectiveness against this pest, but none of these adequately protected sunflowers from severe carrot beetle damage. No other control techniques have yet evolved that will reliably reduce this species to sub-economic levels.

Major disease pests and their control

Disease problems should be verified by the Plant Disease Clinic (take sample to your County Extension Agent) for proper identification and control recommendations.

Diseases

Sunflowers in North America are exposed to more diseases at a greater intensity than they are in most other parts of the world. If the grower uses certain disease preventive practices, he can hold yield and quality losses to tolerable levels.

There are 30 or more known diseases of sunflowers, but only 10 are commonly seen. Of these, only six (downy mildew, rust, Sclerotinia stalk and head rot, Verticillium wilt, Phoma black stem, and Alternaria leaf and stem spot) threatens sunflower yields. Septoria leaf spot, powdery mildew, Rhizopus head rot, and charcoal stem rot are diseases which, although occasionally observed, seldom reach severe proportions.

Fungicidal protection against diseases in sunflowers is not normally economical. Therefore, growing resistant varieties, if available, and using pest management practices affords the best opportunity to minimize losses.

Downy Mildew

Downy mildew, caused by the seed-borne, soil-borne and wind-borne fungus, Plasrnopara halstedii, occurs in all areas of intensive production and is the most serious disease in the relatively flat areas.

Plants may be infected from the time of seed germination until flower, however, they are more prone to total (systemic) infection during or immediately following emergence. Typical symptoms include dwarfing and discoloration of the leaves, appearance of white cottony masses on the lower leaf surfaces during periods of high humidity, and little if any seed set in erect platform heads. Plants infected early in their development normally do not produce seed. Plants infected later seldom show systemic symptoms. They may carry the fungus and produce infected seed which can, if used for seed purposes, carry the disease to other fields the following year. Plants infected after the 4-leaf stage may exhibit root damage and are more susceptible to drought and lodging.

Dwarfing, stunting and distortion of plants exposed to herbicide drift, especially 2,4-D and related compounds, may cause symptoms which sometimes are mistaken for downy mildew.

Planting mildew-infected seeds seldom results in systemically infected seedlings. However, plants grown from infected seeds often harbor the disease in their tissue. This allows the fungus to become established in the soil. The next time sunflowers are grown on the field, systemically infected plants may occur. The fungus can persist in the soil for 5 to 10 years after introduction. Thus, control of the disease by short-term rotations is not possible.

Sunflowers planted on land with no previous sunflower history have occasionally shown considerable downy mildew, resulting in a great deal of puzzlement among growers concerning the source of the disease and causing many to suspect seed transmission. Spores of the fungus occurring on volunteer or wild annual sunflower plants in neighboring fields or on neighboring farms can blow to newly-planted fields and can cause heavy infection under favorable weather conditions. These wind-borne spores probably are responsible for downy mildew in fields with no sunflower history. Spores can blow several miles under favorable conditions and still remain infectious.

Control

The disease cycle of downy mildew prevents complete control strictly by management practices. Although crop rotation, early season destruction of volunteer sunflowers, field selection and delayed planting until soil temperature supports rapid germination can minimize losses from downy mildew, planting resistant varieties affords the best way to eliminate losses.

Rust

Rust occurs in all areas of production and can be a limiting factor in growing susceptible varieties. Fortunately, all Russian oilseed varieties and American oilseed hybrid varieties have good to excellent resistance and can normally be grown without significant yield loss. Rust not only reduces yield but also reduces seed size, test weight and nutmeat-to-hull ratios.

Rust, incited by the fungus Puccinia helianth, is characterized by cinnamon-colored spots which occur primarily on the leaves, which under severe infestations, also occur on the stems, petioles, bracts, and the back of the head. Rust usually is not observed until flowering, but under some conditions it may appear earlier. As the season progresses, the spots turn black as the summer spores are replaced by black overwintering spores.

The fungus overwinters on plant debris as heavily walled resting spores. These spores germinate in the spring and cause infection of young seedlings (primarily volunteer seedlings), since sunflowers are not normally seeded until later in the spring. The rust spreads by wind-borne spores from volunteer fields to volunteer plants along roadways, to wild sunflowers and to sunflowers seeded for the current year’s crop. Under favorable conditions, rust multiplies rapidly. Thus it is not surprising that an apparent light infection in June can result in severe rust in August.

Control

Normally, late planted fields are more severely damaged by rust than earlier planted ones. Early planting does not assure a rust-free crop. The only effective way to avoid loss from rust is by planting rust-resistant varieties. Management practices can be used to minimize the risk of large-scale losses. Destroy volunteer plants as early in the spring as possible. Control wild annual sunflowers occurring in the vicinity of commercial fields. If a severe rust problem develops in an area, susceptible varieties should not be grown in that area the next season. Large concentrations of susceptible varieties should not be centered in one locality.

Sclerotinia Stalk and Head Rot

Sclerotinia stalk and head rot occurs in all areas of sunflower production. The inciting fungus, Sclerotinia sclerotiorum, has an extremely wide host range and attacks many vegetable and field crops, including dry beans, rapeseed, flax, sugarbeets, potatoes, soybeans, and clover. It does not attack the cereal and grain crops. Sunflowers are extremely susceptible and may show severe loss while other host crops are only lightly damaged.

Sunflowers can be attacked any time from the seedling stage to maturity. The first symptoms typically are a sudden wilting of the leaves. Wilted plants, when removed from the soil, show a prominent canker completely encircling the stem and extending 3 to 10 inches up the stem. These cankers have a soft consistency, gray to brown color, and a water-soaked appearance. Dense, white mold which usually appears on the surface of the canker, produces fuzzy white bunches that soon harden and turn black. These black bodies (sclerotia) are irregular in shape and are produced on the surface of the canker or partially embedded in it. In some cases, the fungus invades the pith of the growing plant without producing the white cottony masses on the surface, but it grows profusely, producing sclerotia on the inside of the stem. Cankers sometimes appear in sunflower stems 2 to 4 feet above ground and the stems normally break over at the point of infection.

When frequent rains and extended periods of high humidity occur after flowering, the disease may appear in the heads and partially or entirely rot them, leaving only the vascular bundles and the fibers and causing the head to appear shredded and brush-like. The hull of the seed from rotted heads may be badly discolored and scurfy in appearance. The external layers of the hull may be sloughed off, leaving a drab colored seed which is not preferred by the consumer. Large black sclerotia develop below the seed layer while others form around the seeds. The sclerotia are about the size and density of the seed, are difficult to remove in the threshing and cleaning process, and are a common fungal contaminant in seed stocks.

The fungus survives from one favorable crop to another as sclerotia in the soil. The sclerotia are distributed by farm implements, animals, and seed. Lower stem infection occurs directly from over-wintering sclerotia. Head infection occurs from air-borne spores produced from fruiting sclerotia in the soil and from bits of the fungus carried from the soil to the back of heads by birds.

Control

Resistant varieties are unknown and the chances of developing such are not likely. Fungicides which will control the disease are not yet approved for sunflowers. Consequently, losses must be minimized by managerial practices. The disease is one of the most difficult to control in the field. Rotation in an intensive sunflower producing area may not be effective because of the long persistence of the sclerotia in the soil and the presence of wind-borne spores. Nevertheless, losses can be minimized by following these recommendations: (1) plant seed free of sclerotia; (2) use at least a four-year crop rotation including fallow or non-host crops; (3) avoid growing very susceptible host crops, such as dry beans, safflower, rapeseed, and mustard in a sunflower rotation; and (4) do not exceed the recommended fertilization program.

Verticillium Wilt

Verticillium wilt may be a serious disease on lighter soils in areas where sunflowers have been grown for several years and on land with a history of Verticillium wilt.

Verticillium wilt shows as a mottling of the leaves, beginning on the lower leaves and progressing slowly upward. Leaves showing mottling soon dry completely. Symptoms usually are not observed until flowering, however, under severe conditions they may occur as early as the 6-leaf stage.

Verticillium wilt is a persistent soil-borne and seed-borne disease that will remain in the soil for several years and when once established cause some yield loss each time a susceptible crop is planted.

Verticillium dahliae, the fungus inciting wilt of sunflowers, has a wide host range and causes wilt of several other cultivated plants and weeds. In the principal sunflower producing area of the U.S., potatoes are the other important prime host of Verticillium. Consequently, sunflowers and potatoes should not be grown in the same rotation, especially if wilt has been previously observed in either crop in the rotation.

Control

Many of the newer hybrid varieties possess resistance to Verticillium wilt. When growing susceptible varieties, avoid or prevent Verticillium wilt through managerial practices. To minimize the introduction and buildup of Verticillium in the soil, growers should (1) plant only high quality, disease-free certified seed, (2) use a 3 to 4 year crop rotation which includes non-host crops, and (3) avoid growing sunflowers on land known to have a history of Verticillium wilt.

Phoma Black Stem

Phoma black stem is characterized by large brown to black lesions generally on the stem, but occasionally on the leaf petioles, leaves and the back of the head. The spots usually begin on the stem at the base of the leaf petiole and spread, under favorable conditions, to form large black patches with more or less definite margins. Small circular fruiting bodies often are produced on the surface of the darkened area. These are usually inconspicuous and may require a hand lens to see.

Although Phoma black stem may occur at any time during the season, it is more pronounced after flowering. Infested plants often are weakened, producing small heads with poorly filled seed. The stem is severely weakened at the point of attack and subject to lodging. Splashing water is the primary means of spreading the disease. Consequently, the occurrence of Phoma black stem at economically important levels has been sporadic in nature and closely associated with heavy precipitation during or immediately after flowering.

Control

No control measures are known. Field sanitation and crop rotation probably would be effective.

Alternaria Leaf and Stem Spot

Alternaria leaf and stem spot is characterized by roughly circular uniformly dark colored spots on the leaves and as flecks, streaks and elliptical lesions on the stem, petioles, and back of the head. The stem lesions are not normally associated with the attachment point of the petiole but are scattered. Under favorable conditions of high humidity and warm temperatures, the lesions enlarge rapidly, merge and frequently blacken the complete stem. Alternaria usually does not become prevalent in a field until after flowering. Heavy leaf infection results in defoliation and heavy stem infection weakens the plant causing lodging.

Although differences in varietal response exist, the prevalence of the disease in the United States does not yet warrant efforts to develop resistant varieties. Little is known about the causal fungus and no control measures can be suggested.

Minor Diseases

A disease is considered of only minor importance if it has not previously inflicted serious yield losses on the crop. Symptoms may be very pronounced, but yield losses are only minimal as a result of the pathology of the disease. Some of these minor diseases may, under some unusual conditions, cause significant yield losses.

Septoria Leaf Spot

Leaf spot, caused by Septoria helianthi, is normally restricted to the leaves. Septorial leaf spot is characterized by numerous water-soaked spots that soon become roughly circular with gray centers and darker margins. Spots frequently merge, producing irregular shaped dead areas on the leaves. Septoria leaf spot may occur on plants at any age, but in fields it develops more rapidly on plants that have flowered. If temperatures are moderately high and rains frequent, there is a progressive loss of leaves from the lower leaves upward until only a few upper leaves are left. When that occurs, yields can be reduced. In the northern plains, however, conditions during and after flowering are not normally conducive for the rapid spread of Septoria leaf spot. Infection usually is light and yield loss negligible.

Powdery Mildew

Powdery mildew, incited by the fungus Erysiphe cichoracearum, can be found in most fields after full bloom, but is rarely found earlier. Powdery mildew occurs with greater intensity on the southern fringes of the principal sunflower producing area.

The disease appears in the form of white (later gray-tan), mildewy areas primarily on the leaves, but on all aerial parts of the plant under heavy infestations. These areas may enlarge and merge until most of the plant surface is involved. As the season progresses, the mildewy areas take on a dusty, powdery appearance. This powder may be removed by shaking. Later in the season, small black dots appear scattered within the mildewy areas. Severely infected leaves become permanently yellow and may dry up. Normally, the lower leaves are more heavily infected than the upper leaves.

Charcoal Rot

Charcoal rot, caused by the fungus Macrophomina phaseoil (Sclerotium bataticola), is the most destructive stalk rot of sunflowers under high temperatures and drouth conditions. It is unpredictable and more or less sporadic in appearance, occurring only rarely in the northern production areas. It is more common in the southern areas.

Usually, symptoms are not apparent until after flowering, when poorly filled heads are evident and premature ripening and drying of the stalks occur. The diseased stalks normally are discolored at the base; the pith is disintegrated, and the vascular fibers have a shredded appearance. After a period of hot and dry weather, the fibers become covered with small black sclerotia. Charcoal rot can be distinguished from Sclerotinia stalk rot in that the sclerotia are very small, seldom exceeding the size of pepper grains, and the white cottony growth on the surface of the root and stem base is lacking.

Charcoal rot has a wide host range, attacking many other crops, but its sporadic occurrence and low intensity suggests that no specific effort should be expended in the northern areas to control it. In more southern areas, crop rotation, and sanitation may be necessary.

Rhizopus Head Rot

Head rot, caused by one or more species of Rhizopus, occurs sporadically, causing rotting and shredding of the head similar to Sclerotinia head rot. Wet weather following flowering is conducive to Rhizopus head rot. The disease is common on heads that have been damaged by birds, hail and insects. When infected heads are closely examined, white threads with conspicuous small black dots can be observed. Large black sclerotia, present in heads infected with Sclerotinia, are absent in heads infected with Rhizopus, otherwise, the two diseases appear similar. Varieties with more upright heads appear to be more prone to infection by Rhizopus than the more nodding varieties.

Major weeds and their control

Early weed control is important. Use light tillage to destroy germinated and emerged weeds prior to planting. Consider applying a herbicide such as Treflan, Amiben, or Tolban. Sunflower seedlings are strongly rooted, consequently they can be harrowed during the 4 to 6 leaf stage. Postemergence harrowing should be done across the rows on a warm, sunny day to get best weed kill and little crop injury because the sunflower plants are less turgid. Cultivate, if needed, when plants are 8 to 12 inches tall. Cultivation should not be closer to the row than plant leaf spread. Deep cultivation when plants are 12 to 18 inches tall may drastically reduce yields.

Harvesting Requirements:
Preparation for harvest (i.e. harvest aid chemicals)

Gramoxone Super, a harvest aid desiccant, should be considered to remove moisture from the plants and make maturity more uniform. This harvest aid should be applied when the bottom of heads and bracts become lemon yellow in color.

Harvesting may start when grain moisture reaches 18-20 percent. Some moisture testers will not check sunflower moisture.

Harvest equipment

Any conventional grain combine can be used for harvesting with the addition of a sunflower head attachment. Long gathering pans extending ahead of the cutter bar are used to salvage shattered seed. Ten seeds per square foot equals a harvest loss of 100 pounds per acre. The price of these attachments vary depending upon the size of combine head and manufacturer. Harvesting may start when grain moisture reaches 18-20 percent. Some moisture testers will not check sunflower moisture, however, Dickey-John and Farmi offer a special chart and adapters for their machines.

Combine cylinder speed should be as slow as possible and still thresh seed from the head (300 to 400 RPM). Concaves are usually set wide open and fan air flow reduced approximately 50 percent. Some drying or air movement will probably be required during storage. Natural air with no added heat should be sufficient under most Ohio conditions. Grain should be 12 percent moisture for temporary storage and 9 percent for long time storage. Harvesting at a high moisture content (18 to 20%) normally results in higher yields, less bird damage, and less shattering or dropping of heads than when seeds are harvested at a lower moisture content.

Grades and Standards

Table 2 lists the U.S. grade requirements for sunflower according to the Federal Grain and Inspection Service. These requirements became effective September 1,1984. The table lists the minimum limit for test weight and the maximum for damaged and dehulled seed. U. S. grades for both oilseed and nonoilseed classes of sunflower are determined with the requirements listed below.

Table 2. Grade and grade requirements for sunflower.

Grade	Minimum test weight per bushel	Maximum limits of damaged sunflower seed		
		Heat damage	Total	Dehulled seed
U.S. No. 1	25.0 lbs.	0.5%	5.0%	5.0%
U.S. No. 2	25.0 lbs.	1.0%	10.0%	5.0%

U.S. Sample grade	**U.S. sample grade shall be sunflower seed which:** (1) Does not meet the requirements for the grades U.S. No. 1 or U.S. No. 2; or(2) In a 600 gram sample, contain * 8 or more stones which have aggregate weight in excess of 0.20 percent of the sample weight, * 2 or more pieces of glass, 3 or more crotalaria seeds (Crotalaria spp.), * 2 or more castor beans (Ricinus Communis), * 4 or more particles of an unknown substance(s), * 10 or more rodent pellets, bird droppings, or an equivalent quantity of other animal filth; or (3) Has a musty, sour, or commercialy objectionable foreign odor; or (4) Is heating or otherwise of distinctly low quality.

Drying and Storage

Guidelines for drying sunflower are:

- The area around the dryer and the plenum chamber should be thoroughly cleaned.
- The fan must be fed clean air without seed hairs.
- Overdrying sunflower must be avoided.
- A continuous flow for all sections of recirculating batch and continuous-flow dryers should be maintained. Uneven flow will cause overdried spots and increase fire hazard.
- Drying equipment must not be left unattended day or night.
- The dried sunflower should be cooled to air temperature before storing.

Low temperature bin drying is energy efficient if designed properly and permits rapid harvest since bins can be filled at the harvest rate. Drying will take three to six weeks depending on the initial moisture content and airflow rate. Required airflow rates and drying time for drying oil sunflower at various moisture contents using air at 47 degrees Fahrenheit and 65 percent relative humidity are shown in Table 3.

Table 3. Drying oilseed sunflower using 47 degrees Fahrenheit air with a relative humidity of 65 percent.

Moisture Content	Airflow (cfm/bu.)	Drying Time Required
17%	1.00	648 hours (27 days)
15%	1.00	480 hours (20 days)
	0.75	720 hours (30 days)
	0.50	960 hours (40 days)
13%	1.00	336 hours (14 days)
	0.75	504 hours (21 days)

	0.50	672 hours (28 days)

Add enough heat when needed to dry the sunflower to the safe storage moisture content. Generally enough heat to warm this air 10 degrees is the maximum amount required. As a rule of thumb, about 2 kw of heater will be required per fan motor horsepower.A perforated floor is recommended. Since air does the drying, it is imperative that air reaches all the sunflower. The uniform airflow distribution required for drying is more difficult to achieve with ducts than with perforated floors. However, drying can be done successfully with proper duct spacing and careful attention to detail. Provide one square foot of perforated surface area for each 25 cubic feet per minute (cfm) of airflow. One square foot of bin exhaust opening should be provided for each 1,000 cfm of airflow.

Drying temperatures up to 220 Fahrenheitdo not appear to have an adverse effect on oil percentage or fatty acid composition. High drying temperatures for the nonoil varieties may cause the kernels to be steamed, wrinkled, or even scorched.

Column batch and bin batch dryers should be operated at 140 and 110 F, respectively. Continuous flow dryers may be operated at temperatures up to about 200 F. Temperatures over 110 Fahrenheitshould not be used to dry sunflower seed for seeding purposes.

Operators accustomed to drying corn or small grains may tend to overdry sunflower. About half as much water per bushel of sunflower needs to be removed per percentage point of moisture content as compared to corn or wheat. For example, drying corn from 25 percent to 15 percent moisture will remove 6.6 pounds of moisture per bushel. Drying sunflower from 20 percent to 10 percent removes only about three pounds of moisture per bushel.

Fire hazards exist in dryers used for sunflower. Very fine hairs or fibers from the seed are rubbed loose during handling and are commonly found floating in the air around the dryer. These hairs or fibers ignite when drawn through the drying fan and open burner. A fire hazard is present unless these ignited particles burn themselves out before contacting the sunflower seed.

The fire hazard is decreased if the fans are turned into the wind to draw clean air that does not contain fine hair or fibers, although this adjustment becomes a constant problem on days with frequently changing wind direction. A stationary dryer should be faced into the prevailing wind. Long snorkel tubes are available for attachment to the drying fan of some dryers or can be constructed for other dryers. Restricting the airflow will reduce the drying rate.

Overdrying causes the sunflower or debris in the sunflower to become very combustible. Obstruction to the flow of sunflower seed in the dryer leads to overdrying.

Frequent cleaning reduces the collection of debris in the plenum, in the column or around the dryer. Cleaning the dryer daily is the best fire prevention activity.

Early detected fires are relatively easy to extinguish so the dryer should be monitored constantly. If a fire is detected, the air flow should be shut off first. Water can be applied directly to the area where the fire is occurring, or the dryer can be unloaded onto the ground and the fire extinguished outside the dryer. A sunflower fire should be handled as an oil fire. A fire extinguisher could be used to put out the fire but care must be exercised to avoid contaminating the sunflower.

Measuring moisture content.

Measuring the moisture content of sunflower immediately after removal from the dryer is only an estimation. As moisture is removed from the sunflower seed the hull dries first and the kernels dry last. Moisture testers used by local grain elevators and farm operators generally result in a reading that is lower than the actual moisture percentage. The amount of error is influenced by the initial moisture content of the sunflower and the temperature of the drying air. A number of operators have reported that sunflower removed from the dryer at 8 to 9 percent moisture (according to the moisture tester) would be up to 12 percent moisture by the next morning. The moisture rebound can be estimated by placing a sample from the dryer in a covered jar and rechecking the moisture after 12 hours.

Storage

Farm structures that are structurally adequate to store small grains are adequate for storing sunflower due to sunflower's light test weight.

Seed should be cleaned for storage. Fines tend to concentrate in the center of the bin. This area tends to be wetter and is more prone to storage problems. Airflow will also be restricted by the fines, limiting cooling by aeration. Large pieces of head, stalk, and corolla tubes, which frequently adhere to the seed, should be removed because they are higher in moisture than the seed.

Oil sunflower should not be stored above 10 percent moisture during the winter and 8 percent during the summer. Nonoilseed sunflower should not be stored above 11 percent moisture during the winter and 10 percent during the summer. Sunflower can be stored for short periods at 12 percent with adequate airflow to keep the seeds cool. Resistance of oilseed sunflower to fungal infection during storage at 10 percent moisture is equal to wheat resistance at 17 percent stored moisture.

Aeration is essential, especially in the larger bins now available. Aeration may be accomplished with floor-mounted ducts or portable aerators. Sunflower should be rotated between bins when aeration is not available.

An air space should be left in the top of the bin to facilitate checking the condition of stored seed. Bins should be checked initially every two weeks for moisture condensation on the roof, crusting, and for changes in temperatures within the pile. Any of these conditions could indicate the presence of mold or insects. If the pile has started to heat, the pile should be cooled immediately because spontaneous combustion is a real danger. The sunflower should be checked at least monthly after the seeds have been cooled to about 25 Fahrenheitfor winter storage and a history of temperature and moisture content has been developed.

Sunflower can be stored more than one season under proper conditions (dry, clean, aerated, and in tight bins), but processors of nonoilseed sunflower for human consumption prefer not to use seed that has been stored more than one season.

Main Limitations to Adoption and Acceptance in District:

Since some country elevators will not purchase sunflower grain, arrange for a market before the crop is planted. Your seed supplier may be able to suggest some markets available to you.

Birds can be a problem if sunflower fields are planted near a flyway or roost. Scaring devices such as gas guns and shooting can be used to protect production fields.

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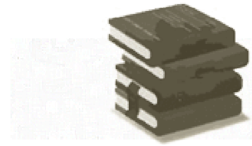

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