

# Crop Profile for Sunflower in Kansas



**Prepared: April, 2001**

## General Production Information

- In 1998, Kansas ranked 3<sup>rd</sup> in U.S. sunflower production behind North Dakota and South Dakota. The State contributed 5% to the total U.S. production.
- The total production of sunflower in 1999 was 406 million pounds, up 52 percent from 1998 production (267.35 million).
- Over 91 percent of total sunflower production was oil-type sunflower while only 8 percent was non-oil type.
- Total acreage planted in 1999 was 280,000 acres up 56 percent from 1998. Eighty-nine percent of the planted acres were oil-type sunflower, while only 11 percent were non-oil sunflower.
- Total acreage harvested in 1999 was 267,000 acres, up 53 percent from 1998. Oil-type sunflowers were harvested from 240,000 acres for a total of 372 million pounds. Non-oil type sunflowers were harvested from 27,000 acres for a total of 33.75 million pounds.

- The State average yield of total sunflower was 1,520 pounds per acre, down 8 pounds from 1998 yield. In 1999, oil-type sunflower yield averaged 1,550 pounds per acre compared with 1,570 pounds in 1998 yield. Non-oil type sunflowers yield 50 pounds per acre more than that of 1998.

### Production Regions

- In 1999, the northwestern region (Figure 1) led the State in total sunflower production with 194.3 million pounds, followed by the north central then the west central region with 72.25 million and 56.55 million pounds, respectively. The above regions combined accounted for about 80% of Kansas's total sunflower production. The south central region was the lowest-production region with 11.05 million pounds.
- Northwestern region accounted for 43 and 46 percent of the State's planted acres and production of oil-type sunflower, respectively.
- Sherman, Cheyenne, and Thomas Counties in northwestern Kansas (Figure 2) led the State in total sunflower production with 88.0, 39.55, and 28.05 million pounds, respectively. The next highest County was Wallace in the west central region with 24.85 million pounds.

Figure 1. Kansas Agricultural Districts.

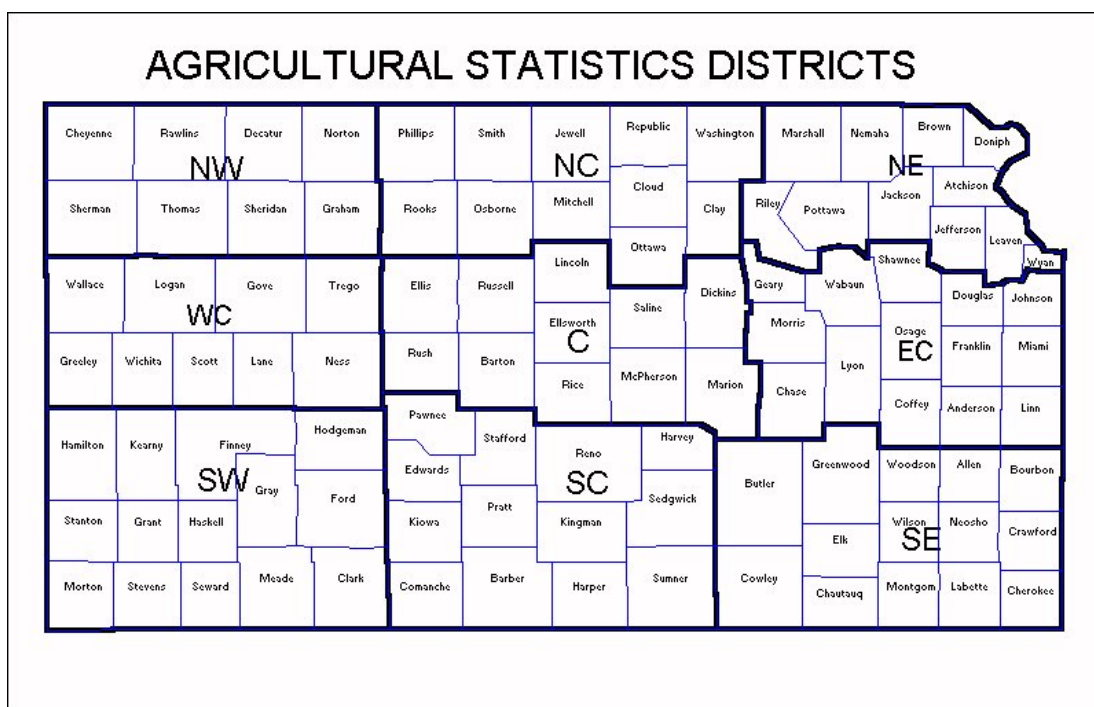
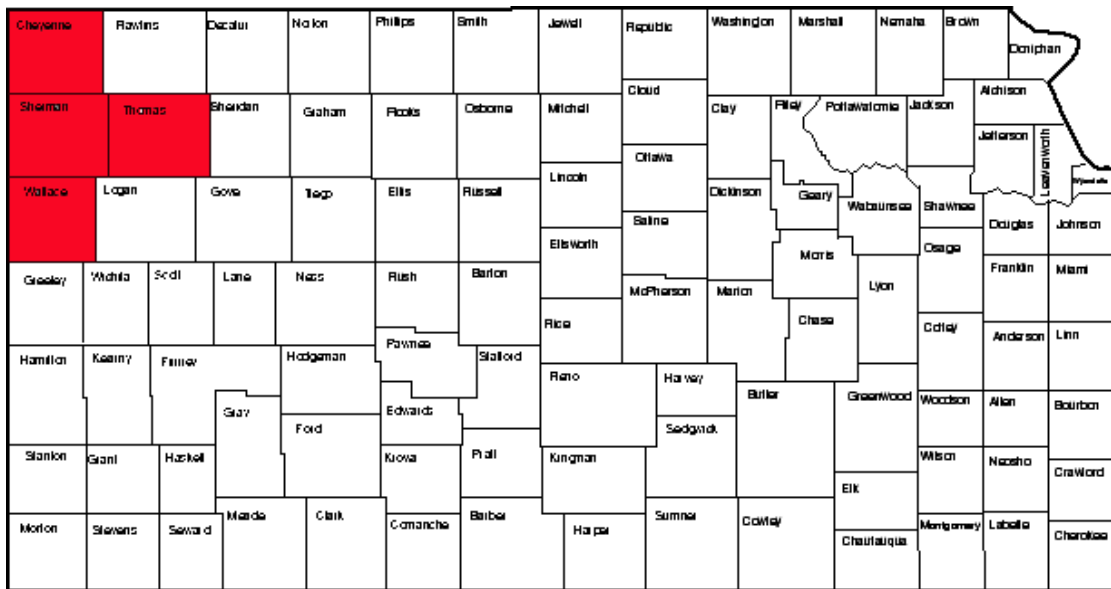


Figure 2. Top Four Counties in All Sunflower Production, 1999.



## Cultural Practices

The state of Kansas is divided into nine districts as shown in Figure 1. Soil types vary within a district. In general, northwestern and most of the west is deep, dark gray-brown silt loams, except the southwest counties are silt and sandy loams, and brown loamy fine sands. Moderately deep, dark gray-brown silt loams, and gray clays dominate the central and north central districts of Kansas. Northeastern Kansas has very dark brown silt, clay and silty clay loams soils whereas, the southeastern part has shallow, very dark gray-brown silt, clay, and silty clay loam soils. Average rainfall ranges from 16-18 inches in the western half of Cheyenne, Sherman, and Wallace Counties in the northwest to 42-44 inches in eastern half of Crawford and Cherokee Counties in the southeast region.

Sunflower is an alternative crop for Kansas growers. It is well adapted to irrigated and dryland crop rotations, and it is a viable "double crop" option.

Sunflower can be classified into two kinds: confection (non-oil) and oil types. The oil-type is more common in Kansas. Production of both types is similar except in the areas of insect pest control and plant population. Head moth is the most yield-limiting insect in Kansas sunflower. Stem weevil is the second most important insect in Kansas sunflowers. Seed weevil must be controlled in confectionery sunflower in order to meet market standards for human consumption. Generally, seed weevils do not reach economic thresholds in oil sunflower. Insect threshold for non-oil type is lower than that for oil type sunflower because insect-free confection seeds are necessary to meet market standards. Tillage, water, and fertilization requirements are similar.

Doublecropping is a practice of planting a second crop immediately after harvesting the first crop in

southern Kansas. Farmers can plant sunflower in a conventionally prepared seedbed or in a reduced or no-tillage seedbed. Seedbeds should be moist, firm, and free from weeds. Sunflower seeds are planted into moist soil about 2 inches deep. Semidwarf hybrids should not be planted more than 1.5 inches deep. More than 50 °F soil temperature is recommended for early germination of sunflower seeds. Thirty inches row spacing is most popular, and is considered to be standard. Plant population is important for highest possible seed yields. Non-oil type should be planted 2,000-4,000 fewer plants than oil-type sunflower in order to develop larger seeds. Final plant population of sunflower depends on moisture in the soil profile and expected in season rainfall.

Generally, plant populations for oil-type hybrids grown under dryland conditions should be between 14,000 and 20,000 final plants per acre. Under irrigated conditions, oil-type sunflower populations should be up to 24,000 plants per acre. In central and eastern Kansas, 26,000 plants per acre is recommended for irrigated sunflowers.

Confection type sunflower should be planted between 12,000 and 15,000 plants per acre in dryer areas and up to 18,000 under irrigated conditions. In central and eastern areas, confection population ranges from 15,000 to 18,000 plants per acre.

## **Insect Pests**

Although cultivated sunflower in Kansas hosts variety of insects, few may reduce sunflower yield due to damage from feeding on leaf, stem, root, or seed. Many insects overwinter in or near sunflower plant residues, thus crop rotation, modified planting dates, wild-sunflower control, or deep plowing may reduce the economical impact of insect infestations. Insecticide treatments are successfully used in Kansas. Scouting the field once a week would determine the need for insecticide treatment.

The listed insecticide and miticide in this section are classified as:

1. **Organophosphate**
2. **Biological**
3. **Carbamate**
4. **Organochlorine**
5. **Pyrethroid**
6. **other**

### **Insecticide Usage in 1999**

In 1999, fifty-six percent of the 280,000 acres in Kansas were treated with 67,000 pounds of insecticides. Methyl parathion and esfenvalerate were the most frequent insecticides used on forty-nine and thirty-two percent of the acres, respectively. Forty-six thousand pounds of methyl parathion were used at 0.34 pounds per acre for the season. Most of the insecticides were aerial broadcast (54 %) by custom applicators (55%). Eighty-eight percent of the fields were scouted for insects. Fifty-nine percent of the insecticide treatment was based on operator's determination of infestations, while only twenty percent was based on preventive schedule.

Sunflower producers reported using other methods, besides insecticides, for pest control. The following list the percentage of producers who practiced alternative methods to control insects\*:

- Crop rotation past three years (65%).
- Cultivated weed control (35%).
- Clean equipment and implements (34%).
- Adjust planting or harvesting dates (33%).
- Alternating pesticides (28%).
- Tilling, mowing, burning, or chopping field edges (24%).
- Treated seeds (22%).
- Pest-resistant seed variety (21%).
- Protection of beneficial organisms (16%).
- Adjust row spacing or plant density (7%).
- Use of beneficial organisms (5%).
- Use of water management practices (3%).

\*percentages exceed 100% because some producers reported using more than one method of pest control.

Several classes of insecticides were used on Kansas sunflowers during 1999. Data are extracted from the Kansas Agricultural Chemical Usage, 1999 Sunflower Pesticide Summary publication(MF-2500), in response to a survey conducted by the Kansas Agricultural Statistics (KAS) and the National Agricultural Statistics Service (NASS) of Kansas sunflower producers.

### **(1) Methyl parathion**

- **Average use rate per crop year:** 0.34 Ib a.i./A.
- **Number of application:** 1.1.
- **Percent of acres treated:** 49%.
- **Amount applied per year:** 46,000 Ib.
- **Target pests:** sunflower moth, seed weevil, and moth/caterpillar.

### **(5) Esfenvalerate**

- **Trade name and formulation:** Asana ® \*.
- **Average use rate per crop year:** 0.03 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 32%.
- **Amount applied per year:** 3,000 Ib.
- **Target pests:** seed weevil, moth/caterpillar, and stem weevil.

### (5) Lambda-cyhalothrin

- **Trade name and formulation:** Warrior ® \*T.
- **Average use rate per crop year:** 0.02 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 5%.
- **Amount applied per year:** 300 Ib.
- **Target pests:** moth/caterpillar.

### (3) Carbofuran

- **Trade name and formulation:** Furadan ® \*4F.
- **Average use rate per crop year:** 0.2 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 2%.
- **Amount applied per year:** 1,000 Ib.
- **Target pests:** not reported.

### (5) Cyfluthrin

- **Trade name and formulation:** Baythroid.
- **Average use rate per crop year:** 0.04 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 2%.
- **Amount applied per year:** 200 Ib.
- **Target pests:** sunflower moth.

**The most important sunflower insects in Kansas and the recommended insecticides are:**

**Head Sunflower Moth** (*Homoeosoma electellum* Hulst.). The greatest loss from head moth is that the larvae predispose the sunflower for the Rhizopus Head Rot infection. The tan or gray adults (1 inch long with ¾ inch wingspread) migrate from the southern regions, and are found in sunflower fields from late June to July. Adults prefer early stages of bloom for egg laying purpose. The larvae have brown head capsules with alternate dark and light lines running longitudinally. Young larvae feed on pollen and florets for the first 4 to 5 days after hatching. Subsequently, larvae tunnel into sunflower seeds and other

head tissues from July to August. Early damage may result in floret death or unfilled seed hulls.

Since insecticide application may be ineffective to control moth larvae feeding within the head, most researchers recommend insecticide treatment when early morning or late evening scouting of sunflower at the R-3 stage results into two or more adults per five plants. Pheromone traps are used to pinpoint moth activity periods. Researchers have found that if more than 4-sunflower moths per head per day are captured then heads will usually contain many larvae and suffer extensive damage. First spray should be applied at the early bloom stage.

#### ***Non-chemical control:***

- Planting late, such as in early July, greatly reduced head moth infestations.

#### ***Chemical control:***

##### **(5) Esfenvalerate**

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

##### **(5) Cyfluthrin**

- **Trade name and formulation:** Baythroid® \* 2.
- **Recommended rate:** 0.031 to 0.044 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

##### **(1) Chlorpyrifos**

- **Trade name and formulation:** Lorsban® \* 4E.
- **Recommended rate:** ½ to ¾ Ib a.i./a.
- **Comments:** PHI 42 days. Two treatments are permitted at 7-day intervals. Do not graze or feed treated forage.

##### **(6) Endosulfan**

- **Trade name and formulation:** Thiodan® .
- **Recommended rate:** 1 Ib a.i./a
- **Comments:** up to three treatments are permitted. Multiple treatments may follow at 7-day intervals. Do not feed treated forage to livestock.

## **(5) Lambda-cyhalothrin**

- **Trade name and formulation:** Warrior® \* 1 EC.
- **Recommended rate:** 0.02 to 0.03 Ib a.i./a.
- **Comments:** do not apply more than 0.12 Ib a.i./a per season and do not apply more than 0.09 Ib a.i./a per season after bloom initiated. Do not apply within 45 days of harvest.

## **Ethyl parathion\***

- **Recommended rate:** 1 Ib a.i./a.
- **Comments:** PHI 30 days. Up to 3 applications at 5-day intervals are permitted. Control of moth with parathion has been erratic in Kansas research tests.

## **Methyl parathion\***

- **Recommended rate:** 1 Ib a.i./a.
- **Comments:** PHI 30 days. Up to 3 applications at 5-day intervals are permitted.

**Banded Sunflower Moth** (*Cochylis hospes* Walsingham). Adults are straw-colored with ½ inch wingspan. Young larvae are cream colored, whereas mature larvae are pink to reddish brown with a brown head. Adults begin to emerge in the field from June to early July and lay eggs during R-3 and R-4 (late bud growth) stages of sunflower development. Larvae feed on seeds and florets in the central portion of sunflower head through late September to early October. Treatment is justified if one moth adult is found per two plants.

### ***Chemical control:***

## **(5) Esfenvalerate**

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

## **(5) Cyfluthrin**

- **Trade name and formulation:** Baythroid® \* 2.
- **Recommended rate:** 0.031 to 0.044 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

**Sunflower Seed Weevils.** At least two types of seed weevils have caused yield reduction: the red

sunflower seed weevil (*Smicronyx fulvus* LeConte), which is 1/8 inch long, and the larger (1/4 inch) gray sunflower seed weevil (*Smicronyx sordidus* LeConte). Adults are found from June to September. They feed on stem, leaf petioles, area beneath the bracts on the buds, and pollen during anthesis, while larvae feed on the inner meat of the seeds. Usually, females insert an egg per developing seed. Mature larvae leave the seed and drop to the ground from August to early October to overwinter. Insecticide treatments are made to prevent adults from laying eggs.

Both oil and confection types sunflower should be treated for gray sunflower seed weevils when 10 -15 percent of the plants have reached the R-4 stage. Treatments for red seed weevils should be timed when 30 percent of the oil-type sunflower plants reach the R-5.1 stage. Confection type should be treated earlier when less than 10 to 15 percent of the plants have reached the R-5.1 stage, and one to two red sunflower seed weevils are found per head.

### ***Chemical control:***

#### **(5) Esfenvalerate**

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

#### **(5) Cyfluthrin**

- **Trade name and formulation:** Baythroid® \*2.
- **Recommended rate:** 0.031 to 0.044 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

#### **(5) Lambda-cyhalothrin**

- **Trade name and formulation:** Warrior® \* 1 EC.
- **Recommended rate:** 0.02 to 0.03 Ib a.i./a.
- **Comments:** do not apply more than 0.12 Ib a.i./a per season and do not apply more than 0.09 Ib a.i./a per season after bloom initiated. Do not apply within 45 days of harvest.

#### **Methyl parathion\***

- **Recommended rate:** 1 Ib a.i./a.
- **Comments:** PHI 30 days. Up to 3 applications at 5-day intervals are permitted. Do not feed seeds to birds.

## (1) Chlorpyrifos

- **Trade name and formulation:** Lorsban® \* 4E.
- **Recommended rate:** ½ to ¾ Ib a.i./a.
- **Comments:** PHI 42 days. Do not graze or feed treated forage.

**Sunflower Stem Weevils** (*Cylindrocopturus adspersus* LeConte). The most important stem weevil that may cause damage in Kansas is the mottled weevil (1/8 to 3/16 inches long) with varying shaped white spots on the wing covers and thorax. Adults only feed on the foliage and are found in June and July. The female adults insert up to 20 eggs per plant in the lower 1/3 of the stem. Larvae can cause economic damage to sunflower plants. The newly hatched larvae feed on leaf tissue, but the mature larvae move into and feed on the pith tissue of the stalks from July to late September to form a chamber near the base of the stalks where they overwinter. The presence of larval chambers can weaken the stalks. Significant damage to the sunflower from stem weevil is due to yield depression through physiological stress and lodging losses. Additionally, severe feeding damage can disrupt the flow of water and minerals, causing delaying development, dwarfed heads with low oil content per seed. Weak stalks are prone to severe lodging during drought stress or high winds. Foliar treatment is recommended in Kansas when 2 to 4 weevils per plant are detected.

### **Treatments:**

#### ***Non-chemical control:***

- Late planted or double crop sunflowers seldom develop severe stem weevil infestations.

#### ***Chemical control:***

## (5) Esfenvalerate

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

## (5) Cyfluthrin

- **Trade name and formulation:** Baythroid® \*2.
- **Recommended rate:** 0.025 to 0.0375 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

## (5) Lambda-cyhalothrin

- **Trade name and formulation:** Warrior® \* 1 EC.
- **Recommended rate:** 0.02 to 0.03 lb a.i./a.
- **Comments:** do not apply more than 0.12 lb a.i./a per season and do not apply more than 0.09 lb a.i./a per season after bloom initiated. Do not apply within 45 days of harvest.

## (1) Chlorpyrifos

- **Trade name and formulation:** Lorsban® \* 4E.
- **Recommended rate:** ½ to ¾ lb a.i./a.
- **Comments:** PHI 42 days. Do not graze or feed treated forage.

## (3) Carbofuran

- **Trade name and formulation:** Furadan® \* 4F.
- **Recommended rate:** 2.5 fl. Oz./1000 ft or row.
- **Comments:** PHI 26 days. At planting, apply directly into seed furrow. Do not reenter treated field within 14 days. Apply prior to bloom.

## Other Insects of Sunflowers

### I. *Seed and seedling pests:*

**Armyworms** (*Euxoa auxiliaris* Grote) and several species of cutworms: **Darkside Cutworm** (*Euxoa messoria*), **Sandhill Cutworm** (*Euxoa detersa* Walker), **Dingy Cutworm Complex** (*Feltia ducens* Walker), and **Pale Western Cutworm** (*Agrotis orthogonia* Morrison) can damage sunflower seedlings. Caterpillar-like larvae are cream color to gray-brown, often with dark mottling or strips. Mature larvae are between 1 to 1 ½ inches long. Early pesticide treatment is recommended when one cutworm per square foot is found or if plant losses are resulting in stands near the lower limits for optimum plant populations.

### *Chemical control:*

## (5) Esfenvalerate

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 lb a.i./a. Do not exceed 0.2 lb a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

## (5) Cyfluthrin

- **Trade name and formulation:** Baythroid® \*2.
- **Recommended rate:** 0.0125 to 0.025 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

### (5) Lambda-cyhalothrin

- **Trade name and formulation:** Warrior® \* 1 EC.
- **Recommended rate:** 0.01 to 0.02 Ib a.i./a.
- **Comments:** do not apply more than 0.12 Ib a.i./a per season and do not apply more than 0.09 Ib a.i./a per season after bloom initiated. Do not apply within 45 days of harvest.

### (1) Chlorpyrifos

- **Trade name and formulation:** Lorsban® \* 4E.
- **Recommended rate:** 1 to 1½ Ib a.i./a. Two treatments at 7- to 10-day intervals are permitted.
- **Comments:** PHI 42 days. Do not graze or feed treated forage.

**Wireworm.** Many wireworm species attack sunflower. The beetles are hard shelled, brownish, grayish, or black in color. The larvae are hard, dark brown, smooth, "wirelike" worms varying from ½ to 1 ½ inches in length when mature. The larvae stage is spent in the soil and lasts 2 to 6 years. Sunflowers planted in wheat stubble are most vulnerable to wireworm. Generally, wireworms are concentrated in the highest residue areas of the field. Larvae kill sunflower plants by feeding either on the sunflower seed before germination or after germination on the stem between the seed and the soil surface. Seed damage can be prevented with a seed treatment with Lindane.

#### I. *Head infesting pests:*

**Sunflower Bud Moth** (*Suleima helianthana* Riley) adults are gray-brown with two black transverse bands on the wing. The larvae are cream colored with yellow-brown head. First generation adults appear in sunflower field in May to mid-June, whereas the second-generation adult moths emerge in July or August.

Larvae from the first generation generally only damage terminals and stalks, while larvae from second generation feed in the pith area of the head. Symptoms of the infested plant consist of head and stalk deformation. Significant yield reduction by sunflower bud moth has not been reported. Insecticide treatments are considered not necessary under most conditions.

**Sunflower Head Clipping Weevil** (*Haplorhynchites aeneus* Boheman). The adults are black and ¼ inch long, while larvae are cream colored, somewhat C-shaped and grub-like in appearance. Adults may

appear on sunflower plants in mid-July for 2-to 3-week period. Adult females feed on the stalk just below the heads making a circle of feeding punctures that cause sunflower head to drop to the ground. Insecticide treatment is recommended when more than half of the examined plants have weevils and the head clipping damage exceeds 5 percent on average across the field.

**Sunflower Seed Maggot** (*Neotephritis finalis* Loew) adults are 1/3 of an inch long, with wingspan of about 1/4 inch. Mature larvae are 1/5 inch long. Adults can be found in sunflower fields during early July. The female lay eggs on the corolla of incompletely opened sunflower inflorescence. The first generation larvae pupate in the head, whereas the second generation overwinter in the soil as pupae. Damages to sunflower heads depend on the state of larvae and seed development. The young larvae tunnel into the corolla of young blooms and can destroy up to 15 ovaries, whereas mature larvae can destroy up to three seeds during development. A significant yield reduction due to this insect has not been reported thus insecticide treatments are not necessary under most conditions.

**Sunflower Receptacle Maggot** (*Gymnocarena diffusa* Snow). The adult fly emerges in late June to early July. It is about 1/2 inch long with a wingspan of about 3/4 inch. The immature larvae that hatch from eggs laid on bracts of developing sunflower heads feed on and tunnel into the spongy tissue of the head and upper stem. Thirty days later matured larvae cut a small hole on the underside of the receptacle and drop to the ground to pupate in late August or early September.

#### ***Chemical control of sunflower maggots:***

##### **(5) Esfenvalerate**

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.03 to 0.05 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

##### **Methyl parathion\***

- **Recommended rate:** 1 Ib a.i./a.
- **Comments:** PHI 30 days. Up to 3 applications at 5-day intervals are permitted. Do not feed seeds to birds.

#### **III. *Foliage feeders:***

**Painted Lady** (*Vanessa cardui* L.), also known as the Thistle Caterpillar, is a butterfly with a wingspread of 2 inches. Larvae are light brown to black, spiny, with pale yellow stripe on each side. Adults are found in sunflower field in mid May and June, while larvae appear shortly thereafter. The larvae feed on leaves, and the webbing on the leaves is a sign of larvae presence. Treatment is recommended if leaf defoliation on selected plants reaches 25 percent during bloom and larvae have not yet begun to pupate.

**Sunflower Beetle** (*Zygogramma exclamationis* F.). Adult is ¼ to ½ inch long and has a reddish-brown head, cream colored back with 3 dark, reddish-brown stripes on each wing cover. Larvae are yellowish-green color with a humped back. The adults appear in June and July to mate and lay eggs on stems and leaves. Both adults and larvae chew holes in the leaves. This insect rarely causes significant yield reduction to sunflower in Kansas. Insecticide treatments are recommended if one adult is found per seedling or 10 to 15 larvae are found per plant on upper leaves or 25 percent defoliation occurs.

***Chemical control:***

**(5) Esfenvalerate**

- **Trade name and formulation:** Asana® \* XL.
- **Recommended rate:** 0.015 to 0.03 Ib a.i./a. Do not exceed 0.2 Ib a.i./a per season.
- **Comments:** PHI 28 days. Repeat as needed to maintain control.

**(5) Cyfluthrin**

- **Trade name and formulation:** Baythroid® \*2.
- **Recommended rate:** 0.0125 to 0.025 Ib a.i./a. A total of 0.132 Ib a.i./a may be applied per season.
- **Comments:** PHI 30 days. Not applied directly on water. Highly toxic to bees, fish, and aquatic organisms.

**(5) Lambda-cyhalothrin**

- **Trade name and formulation:** Warrior® \* 1 EC.
- **Recommended rate:** 0.01 to 0.02 Ib a.i./a.
- **Comments:** do not apply more than 0.12 Ib a.i./a per season and do not apply more than 0.09 Ib a.i./a per season after bloom initiated. Do not apply within 45 days of harvest.

**(3) Carbofuran**

- **Trade name and formulation:** Furadan® \* 4F.
- **Recommended rate:** 1/8 to ¼ Ib a.i./a.
- **Comments:** PHI 26 days. At planting, apply directly into seed furrow. Do not reenter treated field within 14 days. Apply prior to bloom.

**(3) Carbaryl**

- **Trade name and formulation:** Sevin® XLR, 80S.

- **Recommended rate:** 1 to 2 lb a.i./a.
- **Comments:** PHI 60 days. Do not graze treated areas.

#### IV. *Root feeders:*

**Sunflower Root Weevil** (*Baris strenua* LeConte) adults are black with oval shape body, and about ¼ inch long. They aggregate around the root zone at the soil surface during June, and larvae can be found in sunflower stalks in mid July. By September and early October, larvae form "soil cocoon" around roots at 2-5 inches below the soil surface to overwinter. Adults can be vectors of charcoal rot and Phoma black stem diseases, while the presence of large number of larvae in the stalk will cause serious stalk breakage. No significant losses have been reported in Kansas. Insecticide treatments are not necessary under most conditions.

**Carrot Beetle** (*Ligyrus gibbosus* DeGeer) adult is ½ to ¾ inch long, stout, reddish-brown beetles that resemble May Beetle. Second-brood adults feed on roots 1 to 5 inches below the soil surface usually in late July or early August. Infested plants show stunting, wilting and lodging symptoms. There is no known insecticide control method.

## Weeds

Sunflower frequently is rotated with other crops, thus good weed management in the previous crop benefits sunflower. Sunflower can compete with weeds that emerge 3 or more weeks after sunflower planting, but are not very competitive during the first 3 weeks after planting. Therefore, maintaining sunflower weed free for the first 3 to 4 weeks after planting will minimize yield reduction.

Sunflowers are susceptible to herbicide carryover when planted in wheat stubble that was treated with Glean, Ally, Peak, Amber, Finesse, Rave, Maverick, or Tordon herbicides.

Preplant weed control is achieved with tillage, herbicides, or combination of both.

Emerged seedling broadleaf weeds and grasses in sunflower field can be controlled by nonselective herbicides such as glyphosate (Roundup Ultra or Roundup RT) or paraquat (Gramoxone Extra) as an alternative to preplant tillage weed control.

Another alternative to tillage for weed control in double-crop sunflower is to burn the small-grain stubble before planting sunflower. Burning kills some existing weeds, reduces the potential for volunteer wheat problems, and eliminates interference of stubble with planting and cultivation equipment.

However, burning residue will cause the soil to be more susceptible to erosion from wind and water, and can reduce soil moisture. Burning also can reduce stored moisture in the profile during the growing season because it leaves the soil surface more exposed to wind and sunlight.

Late planting of sunflower sometimes is used to allow weeds and volunteer wheat to germinate however, it may reduce sunflower yield potential and oil content of the seed.

Grassy weeds such as crabgrass, foxtail, fall panicum, longspine sandbur, witchgrass, and barnyardgrass can be controlled with the following preplant incorporated herbicides: EPTC (Eptam), ethalfluralin (Sonalan), pendimethalin (Prowl), and trifluralin (Treflan and others). These herbicides also can control pigweeds and lambsquarters, and at higher rates can control kochia and Russian thistle.

Volunteer wheat can be a major problem for sunflower planted in wheat fields where wheat has been shattered by hail or wheat stubble has been disked. Sethoxydim is effective as a postemergence herbicide to control wheat that is less than 4 inches tall and is actively growing.

Mechanical weed control may be required to control broadleaf weeds in sunflower since herbicides labeled for many broadleaf weeds in sunflower are limited. Also, between-row cultivation should be practiced as a backup weed control method in sunflower.

## **Primary Weeds in Kansas Sunflower Fields**

### **Broadleaf weeds**

- **Kochia** (*Kochia scoparia* L.) (**summer cypress, fireweed, belvedere, mock cypress, Mexican firebush**) is an early germinating summer annual weed, native of Eurasia. Flowering season is from July to October. Seeds are the only source of reproduction. Found on rangeland, pastures, fields and disturbed sites. Confirmed resistance to triazine and ALS inhibiting herbicides.
- **Russian thistle** (*Salsola iberica*) (**tumbleweed, tumbling thistle**) is a native of Europe. Flowering season is from July to October. Seeds are the only source of reproduction. Found on small grain fields, cultivated dryland fields, and waste areas. Confirmed resistance to triazine and ALS inhibiting herbicides.
- **Common Lambsquarters** (*Chenopodium album* L.) (**lambsquarters goosefoot, white goosefoot**) is a native of Europe. Flowering season is from June to September. Seeds are the only source of reproduction. Found in cultivated crop fields, gardens, pastures, vacant lots, waste ground, and other disturbed areas.

### **Pigweed Family**

- **Palmer amaranth** (*Amaranthus palmeri*) is a native weed. Flowering season is from June to October. Seeds are the only source of reproduction. Found in cultivated and fallow fields, gardens, waste ground, and roadsides. Palmer amaranth leaf and stem surfaces are smooth with

few or no hairs. Confirmed resistance to triazine and ALS inhibiting herbicides.

- **Waterhemp** (*Amaranthus rudis*) (**common waterhemp**) is a native weed. Flowering season is from June to October. Seeds are the only source of reproduction. Found in cultivated fields, roadsides, marshes, sandbars, riverbanks, and waste places. Waterhemp stems and leaves are hairless with narrower leaves than Redroot pigweed or Palmer amaranth. Confirmed resistance to triazine and ALS inhibiting herbicides.
- **Redroot pigweed** (*Amaranthus retroflexus* L.) (**rough pigweed, careless weed**) is a native weed. Flowering season from July to October. Seeds are the only source of reproduction. Redroot pigweed stems and leaves are covered with fine pubescence. Confirmed resistance to triazine herbicides. Found in cultivated and fallow fields, gardens, waste ground, and roadsides.

## Grasses

- **Foxtails, including giant** (*Setaria faberi*) (**giant bristlegrass, Chinese foxtail, Chinese millet, nodding foxtail**) native of Asia; **green** (*Setaria viridis* L.) (**green bristlegrass, pigeongrass, wild millet**) native of Eurasia; **yellow** (*Setaria glauca* L.) (**yellow bristlegrass, pigeongrass, wild millet**); and **bristly foxtail** (*Setaria verticillata*) are native of Europe. Seeds are the only source of reproduction. Common on cultivated grounds, waste places, roadsides and degraded rangeland and pastures.
- **Large crabgrass** (*Digitaria sanguinalis*) (**hairy crabgrass, purple crabgrass**) is a warm season grass, native of Europe. Seeds are the only source of reproduction. Found in cropland, gardens, roadsides, pastures, and waste places.
- **Fall panicum** (*Panicum dichotomiflorum*) is a native weed. Seeds are the only source of reproduction. It flourishes in warm conditions. Common in cropland, waste areas. Roadsides, over grazed pastures, and disturbed areas.
- **Witchgrass** (*Panicum capillare* L.) (**ticklegrass, panicgrass, tumbleweed grass**) is a native weed. Seeds are the only source of reproduction. It flourishes in warm conditions. Common on cropland, roadsides, waste places, and rangeland in poor condition. It is abundant where the soil is somewhat sandy.
- **Barnyardgrass** (*Echinochloa crusgalli* L.) (**cockspur, watergrass**) originally from Europe. Seeds are the only source of reproduction. It flourishes in warm conditions. Common particularly in moist areas high in fertility, such as irrigated fields and old feedlots.
- **Longspine sandbur** (*Cenchrus longispinus*) (**field sandbur, burgrass**) is a native weed. Seeds are the only source of reproduction. Flourishes in warm conditions. Common in roadsides, waste places, cultivated fields, lawns, and a grazed rangeland. Grows well on sandy soils, but also found on heavier soils.
- **Volunteer wheat** (*Triticum aestivum* L.)

## Herbicide usage, 1999

In 1999, a total of 221,000 pounds of herbicides were applied to eighty-two percent of sunflower acres. Herbicides were custom applied to sixty-three percent. Herbicides were broadcast applied, with or without incorporation, to sixty-five percent of the acres. Aerial application accounted for fifteen percent. Fifty-five percent of the acres were treated with herbicides before planting, while twenty-seven percent were treated after planting.

Pendimethalin was the most frequently used herbicide. Thirty-eight percent of the acres were treated at 1.09 pound per acre per season for a total of 116,000 pounds.

Following are the active ingredients of herbicides applied to Kansas sunflower during 1999. Data are extracted from the Kansas Agricultural Chemical usage, 1999 Sunflower Pesticide Summary publication (MF-2500) in response to survey provided by the Kansas Agricultural Statistics (KAS) and the National Agricultural Statistics Service (NASS) to Kansas producers. Herbicides are classified according to the primary mode of action:

### **Seedling root (tubulin protein) inhibitors:**

#### **Pendimethalin**

- **Trade name and formulation:** Prowl® ; Pendimax® .
- **Average use rate per year:** 1.07 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 38%.
- **Amount applied per year:** 116,000 Ib.
- **Application time:** preplant up to 60 days before planting; preplant and incorporated before planting and within 7 days of application.
- **Target plants:** annual and perennial grasses, annual broadleaves, foxtail, and pigweeds.

#### **Trifluralin**

- **Trade name and formulation:** Treflan® and others.
- **Average use rate per year:** 0.79 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 14%.
- **Amount applied per year:** 31,000 Ib.
- **Application time:** preplant and incorporated within 24 hours.
- **Target plants:** annual broadleaves.

#### **Ethalfluralin**

- **Trade name and formulation:** Sonalan®

- **Average use rate per year:** 0.91 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 1%.
- **Amount applied per year:** 1,600 Ib.
- **Application time:** preplant and incorporate within 48 hours.
- **Target plants:** not reported.

**Amino acid synthesis (EPSP synthase enzyme) inhibitor:**

### Glyphosate

- **Trade name and formulation:** Glyphomax Plus; Roundup Ultraä.
- **Average use rate per year:** 0.76 Ib a.i./A.
- **Number of applications:** 1.3.
- **Percent of acres treated:** 21%.
- **Amount applied per year:** 45,000 Ib.
- **Application time:** preplant burndown.
- **Target plants:** kochia, pigweed, annual broadleaves, and annual grasses.

**Lipid synthesis (Acetyl-CoA carboxylase enzyme) inhibitor:**

### Sethoxydim

- **Trade name and formulation:** Poastâ
- **Average use rate per year:** 0.37 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 12%.
- **Amount applied per year:** 12,000 Ib.
- **Application time:** postemergence for annual grasses up to 8 inches, volunteer corn up to 20 inches, shattercane 6 to 18 inches, volunteer wheat before tillering, and rhizome johnsongrass 15 to 25 inches tall.
- **Target plants:** not reported.

**Protoporphyrinogen oxidase (PPO) inhibitor:**

### Sulfentrazone

- **Trade name and formulation:** Spartanâ ,
- **Average use rate per year:** 0.19 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 4%.
- **Amount applied per year:** 2,200 Ib.

- **Application time: preemergence.**
- **Target plants: not reported.**

â **Registered name**

\***Restricted-Use Pesticide (RUP)**

ä **Trade name**

## Diseases

### I. Root and Stalk Diseases:

**Seedling Blight and Seed Rot** are most often caused by *Pythium* sp. Affected seeds may rot before emergence or seedlings may be killed within a week or two after emergence. The primary symptom of seedling blight is damping-off, which is a collapsing of the stem at or below the soil surface that results in the death of the plant. Additionally, roots may become dark and rotted and stems are sometimes discolored.

#### **Management:**

- Good soil-seed contact at planting.
- Soil temperatures above 50 F.
- Sufficient moisture for rapid germination and growth.
- Use of a metalaxyl containing seed treatment when conditions are less than ideal.

**Downy Mildew** is caused by *Plasmopara halstedii*, a soilborne fungus that systemically infects the plant through the roots within the first few weeks after germination. The disease is favored by poorly drained, clay soils. Symptoms consist of dwarfing of the plant and a chlorosis in the leaves that starts near the midrib and expands outward. A white, cottony growth develops on the underside the leaf during periods of high humidity. As plants continue to grow, leaves become wrinkled and distorted having an appearance similar to 2,4-D injury. Infected plants produce upright "platform" heads that contain little or no seed.

#### **Management:**

- Rotate crops.
- Destroy volunteer sunflowers.
- Avoid poorly drained fields.
- Use resistant hybrids.
- Use metalaxyl treated seed.
- Delay planting until soil temperatures favor rapid seedling growth

**Verticillium Wilt** is caused by the soilborne fungus, *Verticillium dahliae*. Symptoms appear at flowering when infected plants may occur singly or in groups. The leaves turn yellow and eventually brown between the veins, beginning with the oldest leaves and moving upward. The veins remain green, giving the leaf a mottled appearance. Black lesions may occur on the stem near the soil line. The vascular bundles in the stem turns will be brown to black. Plants become stunted and may ripen early or die before flowering.

**Management:**

- Rotate sunflowers every 3 or 4 years with small grains or other non-host crops.
- Do not plant sunflowers in fields with a history of Verticillium wilt.

**Phoma Black Stem** is caused by the fungus, *Phoma macdonaldii*. High moisture during and after flowering favors the disease. Symptoms consist of large black lesions on the stem at the point where the leaf petioles attach. Leaves eventually wilt and dry up, and the stalk often turns dark brown to black. Infected plants become weak and produce small heads with low test-weights and oil content. When Phoma girdles the stem base, lodging can be severe. Phoma, combined with stem weevil damage, causes a condition known as premature dying that can significantly reduce yields.

**Management:**

- Rotate crops.
- Plant resistant hybrids.
- Control insects, especially the stem weevil, to limit disease spread.
- Harvest early, before lodging becomes severe.

**Phomopsis Stem Canker** is caused by the fungus, *Phomopsis helianthi*. Symptoms of Phomopsis stem canker are similar to Phoma black stem except *Phomopsis* lesions are much larger and are a tan-to-brown color. In addition, *Phomopsis* causes more degradation of the stem pith than does Phoma, such that the stalk is easily crushed when pressure is applied to the lesion with the thumb and fingers. *Phomopsis* infected plants ripen prematurely and have seeds with low oil content.

**Management:**

- Rotate crops.

- Eliminate infested crop debris.
- Use resistant hybrids.

**Charcoal Rot** is caused by the soilborne fungus, *Macrophomina phaseolina*. Soil temperatures higher than 90° F and low soil moisture favor this disease. Symptoms appear after flowering and consist of a general wilting of the plant during the midday heat followed by a recovery in the evenings. Eventually the wilt becomes permanent and plants die. The infected stalks turn gray to brown at the base. The pith tissue decays leaving only the water conducting vascular bundles, which gives the internal stem a shredded appearance. In the final stage of disease development, the vascular bundles, roots and outer stem may become covered with small, black fruiting structures known as microsclerotia. These microsclerotia are usually so numerous, that they give the tissue the appearance of being covered with fine charcoal dust, hence the disease name. Microsclerotia can survive in the residue for several years. Charcoal rot has a wide host range, making the effect of rotation minimal. Wheat is the best rotation crop in Kansas.

### **Management:**

- Select planting dates to avoid flowering and seed filling in the hottest part of the summer.
- Use cultural practices that conserve soil moisture such as irrigation, weed control, reduced plant populations, and reduced tillage or no-till.

## **II. Foliar Diseases**

**Alternaria** is caused by either *Alternaria helianthi* or *A. zinniae*. These two pathogens can cause leaf spots, stem lesions, and a head rot. Both pathogens can be seed borne and overwinter in crop residue on or near the soil surface. Alternaria is favored by warm, humid conditions. Early-planted fields are often more severely infected than later-planted ones. Plants are more susceptible at flowering and seed-fill stages. When early infection does occur, yield loss can be significant. Dark-brown, oval, necrotic spots can occur on the heads, leaves, petals, petioles, and stems. Stem lesions start as black flecks or streaks that later enlarge to cover large areas of the stem, which may be girdled. Infected plants may be defoliated and die prematurely. Yield is reduced due to small head diameter, less seeds per head, and low oil content.

### **Management:**

- Rotate crops.
- Manage infested crop residues.

**Red Rust** is caused by *Puccinia helianthi* and is one of the most common diseases on sunflower. Losses are limited when it occurs late in the season, but in recent years, development has begun early in the season and significant losses have occurred, particularly in the confectionary type of sunflowers. The first noticeable symptom are pale yellow spots on the upper surface of the leaf. As spots develop,

cinnamon-colored pustules will form on the underside of the leaf, opposite the chlorotic spots on the upper leaf surface. These pustules turn black as the fungus completes its life cycle and leaves dry up and die.

### **Management:**

- Plant resistant hybrids.
- A section 18 emergency use permit was issued by the Kansas Department of Agriculture for the use of tebuconazole (Folicur 3.6F) for 1997-2000. Full registration is expected in 2001.
- Control volunteer and wild sunflowers.
- Avoid high nitrogen rates and high plant populations.

**White Rust** or **White Blister** is caused by *Albugo tragopogonis*. Warm temperatures, high rainfall and saturated soils favor the development of white rust. The fungus survives as oospores in crop residue in the soil, or as mycelium or sporangia on weeds, and wild and volunteer sunflower in milder climates. The first noticeable symptom is a raised, yellowish-green spot on the upper leaf surface. A creamy white, blister-like pustule forms below this spot on the underside of the leaf. No yield reduction has been reported in Kansas due to this disease, but significant losses have been observed in Southern Africa.

### **Management:**

- Extended rotations and weed management should reduce inoculum levels.
- Resistant hybrids.

## **III. Head Diseases**

**White Mold (*Sclerotinia* Diseases)** is caused by the fungus *Sclerotinia sclerotiorum*, and is the most destructive disease of sunflower in the northern growing areas. Cool nights, frequent rain and irrigation favor this disease. Symptoms include sudden wilting of leaves, middle stalk rot, and head rot. Wilt symptom is most common because the fungus survives in the soil and first attacks the roots. A dark canker forms at the base of the plant and eventually girdles the stem. Also, hard, black resting structures of the fungus, known as sclerotia, form at or near the stem base. After canopying and during periods of high moisture, the fungus also produces mushroom-like structures on the soil surface known as apothecia. Apothecia release ascospores that can colonize dead tissues on the stalk, leaves, or heads. Middle stalk rot and head rot usually begin as gray, water-soaked lesions on the upper stem and the fleshy tissue of the head, respectively. During wet weather, the stalk produces a dense snowy white fungal growth and sclerotia. On the head, the entire seed layer falls away leaving a bleached, shredded skeleton interspersed with large sclerotia. Neither resistant hybrids nor fungicides are available. Exclusion is the best way to control this disease.

### **Management:**

- Plant in noninfested fields.
- Use rotations of at least four years using non-host crops such as wheat, corn, or sorghum.
- Sunflowers should not be rotated with dry beans, soybeans, or canola.
- Control weeds that may serve as hosts of *Sclerotinia*.
- Avoid excessive nitrogen rates.
- Plant clean seed.

**Rhizopus Head Rot** can be caused by two species of *Rhizopus*, *R. arrhizus*, and *R. stolonifer*. The disease is associated with damage from sunflower head moth and has resulted in total loss of some fields where head moth has gone uncontrolled. During wet weather, the internal hollow part of the flower head will contain threadlike strands of fungal mycelium. Small, black fruiting structures develop later, giving the mycelium a grayish appearance. In later stages, the head will prematurely dry down and the back of the head will begin to shred. Seeds are generally light in weight and oil content is reduced.

### **Management:**

- Control damage by the sunflower head moth.

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