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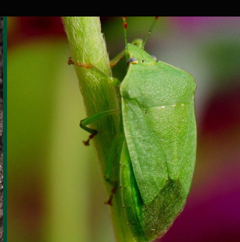
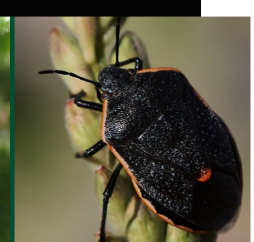
Managing Insect and Mite Pests of Texas Sorghum

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Sorghum production: An integrated approach

Sorghum is a leading crop commodity in Texas, with about 1.9 million acres planted annually. The crop's low production costs and high tolerance to heat and drought stress minimize the risks associated with crop production in Texas, making sorghum an attractive alternative to other row crops. Sorghum is also an important rotation crop, which helps control weeds, diseases, and insect pests. However, the low risk of growing sorghum is often offset by low commodity prices and limited yield potential on dryland or marginal production acres.

To meet production goals and maintain profits, growers need to adopt an integrated approach to managing insect and mite pests on sorghum. Integrated pest management (IPM) takes advantage of all appropriate pest management strategies, including the judicious use of pesticides. Well-implemented IPM programs include several cultural practices that reduce pest damage:

- Ensuring that the soil has enough nutrients
- Planting hybrids with resistance to pests
- Planting at the optimum time
- Rotating crops
- Destroying crop residues

The benefits of IPM include a healthier environment for people in rural and urban communities; reduced harm to nontarget organisms, many of which are important for pest management; and the achievement of yield goals while minimizing production costs.

This guide will explain insect pest biology, damage, and management options for grain sorghum production. Management of insect pests attacking sorghum grown for forage and hay is presented in the publication *Managing Insect Pests of Texas Forage Crops*, which is available from the Texas A&M AgriLife Bookstore at http://www.agrilifebookstore.org.

Sampling fields to make insect-control decisions

To determine how severe an infestation is and whether you need to apply insecticide, sample insects and mites in the field. Insect pest numbers can change rapidly. Inspect the sorghum at least once a week, especially during critical times when insect pests are likely to be present (Fig. 1). Record the information you collect during each field inspection to determine changes in insect abundance and plant damage.

The number of samples needed depends on the size of the sorghum field, the growth stage of the plant, and the uniformity and severity of the infestation. Because insect pests are seldom distributed evenly in a sorghum field, examine plants from all parts of the fields. Avoid checking only the borders.

Growers can estimate the abundance of most insects in sorghum by examining some of the plants and plant parts. Randomly select and carefully inspect plants to detect insect pests and associated damage. During the inspection, consider other factors such as predators, parasitized aphids, and plant growth stage and condition.

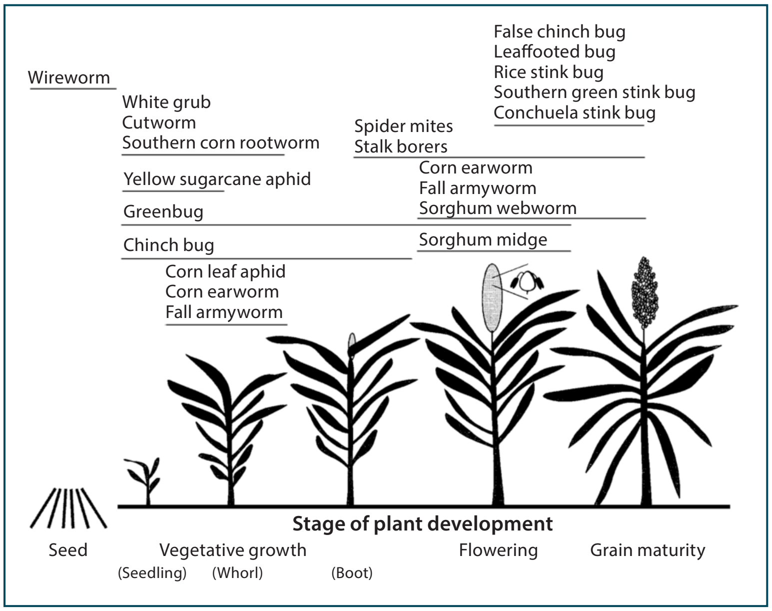

Figure 1. Sorghum insect pest occurrence

Some insects, especially those infesting sorghum grain heads, are effectively sampled by using the "beat-bucket" method:

1. Shake the grain sorghum heads vigorously into a 2½- to 5-gallon bucket, where you can see and count the bugs more easily.
2. Sample at least 30 plants from a field. In fields larger than 40 acres, take at least one sample per acre.
3. Because insect pests that live in the soil are hard to control once the crop has been planted, most need to be sampled before planting.

Economic injury level

The *economic injury level* is the abundance of an insect pest or the amount of plant damage that justifies applying insecticide. The economic injury level is used to develop the action level, or *economic threshold.* The economic threshold is always lower than the economic injury level. Acting early can help prevent the pest from causing economic loss and allow time to implement a management plan, such as an insecticide application or early harvest.

Although economic thresholds in this publication are based on research, consider them only guidelines because environmental and crop conditions can influence economic thresholds from year to year and region to region.

Insecticides

Applying insecticide is often the only practical way to control insect and mite pests that are at or near damaging levels. The key disadvantages of insecticides are their cost and broad toxicity to beneficial insects. Many of these chemicals can harm insects and spiders that feed on insect pests in and near the crop, leading to secondary pest outbreaks or pest resurgence. To minimize these problems, use the insecticide that is the least toxic to the pest's natural enemies. Other factors to consider when buying insecticide are its cost and effectiveness.

Apply insecticide only when necessary to prevent economic loss. Otherwise, the cost of control can exceed potential benefits. Use economic thresholds, if available, to consider the cost of control and market value of the crop.

Soil insecticide treatments

Insecticides for controlling some pests that live in the soil can be applied before the crop is planted, at planting, or as a side-dress application. Choose a formulation—granular or liquid—that is appropriate for the target insect and the equipment available.

Preplant row treatment requires special equipment to incorporate the insecticide to a depth of 2 to 4 inches. In fields planted on raised beds, make row treatments during or after bed formation. Further cultivation or bed shaping changes the position of the insecticide in the row. Follow the label directions for placement of the insecticide in the row.

To apply insecticide to the soil at planting, use row band or in-furrow applications:

1. Choose the technique according to the pest insect and the insecticide label.
2. Mount the granular applicator spout or spray nozzle just behind the opening plow or disc opener and in front of the covering shovels or press wheel.
3. Adjust the spouts or nozzles to make the treatment band 6 to 8 inches wide, treating the seed furrow as well as the covering soil.
4. Incorporate the insecticide with covering shovels, short parallel chains, loop chains, press wheels, finger tines, or other suitable devices.

Do not apply insecticides directly on seed unless the label clearly describes that use. Doing so usually reduces seed germination.

Insecticide seed treatments

Insecticides applied directly to seeds to control pre- and post-emergent insect pests are called *insecticide seed treatments*. Seed treated with any pesticide must be dyed an unnatural color to distinguish it from untreated grain. The color is added to prevent unintended use as oil, food for people, or feed for animals. The pigments may change the seed texture and movement in planters during planting operations. The seed bag will offer suggestions on talcs or other flowing agents to mix with the seed.

The container (such as the bag or a center flow container) must carry labels that include:

- A notice that the seeds have been treated
- The commonly accepted chemical name of the applied substance

- The application rate
- A caution statement if the treatment substance can harm humans or other vertebrates if it remains on the seed
- A statement with the words “Warning—poison treated. Do not use for food, feed, or oil purposes.”

Before handling seed treated with any pesticide, read and follow the directions on the label.

Some seed companies package seed treated with insecticide; others treat seed on request. Although you or another third party could apply a seed treatment, consult the seed dealer before treating purchased seed. Third-party application of a seed treatment may nullify any implied warranty for the seed.

Foliar application of insecticides

Some insecticides discolor the foliage of certain sorghum hybrids. If used on susceptible hybrids, the chemicals could damage the leaves extensively, reducing yields. Read the label carefully before using an insecticide. If you do not know whether the sorghum is susceptible to the insecticide, consult the insecticide manufacturer or seed company. Follow the instructions on the container label carefully to avoid hazards to the applicator, wildlife, and the environment.

Controlling some insect pests requires that you completely cover the plants with insecticide. Complete coverage can be challenging if dense canopies have formed because of hybrid leaf structure and narrow row spacing. To ensure good coverage, consider a high spray volume per acre—no less than 10 GPA and preferably 15 GPA for ground application—to move the insecticide through the canopy and onto the lowest leaves.

Other ways to increase insecticide penetration include selecting appropriate nozzles, lowering the boom to just above the crop surface, slowing the ground application equipment, and, when appropriate, increasing pump pressure. Calibrate the sprayer carefully to ensure that you apply the recommended amount of insecticide.

Protecting bees and other pollinators

Honeybees and other insect pollinators forage in sorghum fields for the pollen in flowering sorghum as well as flowering weeds in and around fields. Honeybees also collect the sugary honeydew deposited on sorghum leaves by aphids. When possible, use pesticides that are less toxic to bees. Most of the insecticides listed in this publication are highly toxic to bees. Exceptions include Sivanto Prime and Prevathon.

Some insecticides kill bees when they contact the chemical residues on or in plants. Adopt these practices to help prevent bee poisoning:

- Apply insecticides late in the evening or at night when bees are not foraging in the field.
- Avoid pesticide drift onto bee colonies. During hot evenings, bees often cluster on the front of their hives. Pesticide drift onto clustering bees can kill many bees.
- Avoid insecticide drift onto blooming plants around the field.
- Make sure that the producer, applicator, and beekeeper cooperate closely to minimize bee mortality.

For directions and restrictions on protecting bees and other insect pollinators, read the "Directions for Use" section of the product label. New labels include this information in a bee advisory box highlighted by the bee icon (Fig. 2).

Figure 2. Icon on pesticide labels identifying steps to protect bees and other pollinators

Inbred lines for hybrid seed production

Compared to hybrids, inbred lines used to produce sorghum hybrid seed have lower economic thresholds and greater risk of foliar insecticide sprays injuring the plants (being *phytotoxic*). The thresholds are lower in seed-production fields because of the crop's higher value, its increased susceptibility to damage by insecticides and insect pests, and the greater damage caused by insects that reduce seed quality and germination.

To minimize these problems, regularly monitor fields producing hybrid seed. Before applying an insecticide, check the label carefully, and consult the manufacturer and seed company about possible phytotoxicity.

Endangered Species Act

The Endangered Species Act is designed to protect and aid in the recovery of animals and plants that are in danger of becoming extinct. Because of this act, restrictions have been set on the use or application methods of many pesticides in designated biologically sensitive areas. These restrictions are subject to change. To learn what restrictions apply to your area, read the sections on environmental hazards and endangered species on product labels, and contact the local office of the U.S. Fish and Wildlife Service. Regardless of the law, pesticide users can be good neighbors by knowing how their actions may affect people and the natural environment.

Figure 3. False wireworms (top) and true wireworms

Insect pests of seeds and roots

Wireworms

True wireworms and false wireworms

True wireworms (Elateridae) and false wireworms (Tenebrionidae) are the immature stages of click and darkling beetles, respectively. Wireworms are usually shiny, slender, cylindrical, hard bodied, and yellow to brown (Fig. 3).

Wireworms feed on planted sorghum seed, preventing germination. To a lesser degree, they feed on seedling plant roots, reducing plant stands and vigor.

Several cultural practices can reduce wireworm abundance and damage in sorghum:

- Cultivating to reduce noncrop plant material
- Preparing good seedbeds
- Planting when soil moisture and temperature are adequate to promote rapid seed germination
- Planting in a field where a tap-rooted crop such as cotton was grown the previous year

Before planting, sample sorghum fields to determine whether you need to use insecticide-treated seed or to apply an insecticide at planting (Table 1). Sampling methods include soil examination and bait trap installation.

Examine the soil: Examine a 1-square-foot area of soil to 4 inches deep. Repeat at several locations in the field. If you find one or more wireworms per square-foot sample, treat either the seed or the soil with an insecticide at planting.

Set bait traps: Two or more weeks before planting, install one bait trap for each 10 to 20 acres, following these steps:

1. Place 6 to 12 ounces of sorghum seed (not treated with insecticide) in a hole 4 inches wide and 6 to 8 inches deep in the field.
2. Cover the hole with soil and mark the trap with a stake.
3. Cover the trap area with a 4- by 4-foot sheet of black plastic to warm the soil and make the trap more effective.
4. Install one trap for each 10 to 20 acres.
5. Two weeks later, examine the grain in the trap and count the wireworms. If the bait traps average two or more larvae each, consider treating either the seed or the soil with an insecticide at planting.

Table 1. Insecticides labeled for wireworms in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, NipsIt Inside	4A	5.1–6.4 fl oz/100 lb seed	—	12H	—
imidacloprid	Gaucho 600, generics	4A	6.4 fl oz/100 lb seed	Do not graze or harvest for forage within 45 days, and fodder or grain within 100 days of planting.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed	—	12H	45 days
At-planting treatment						
terbufos	Counter 20G Lock n' Load	1B	5.2 oz/1000 row ft, any row spacing	At planting time; banded or knifed in. Do not place granules in direct contact with seed, as they may injure the crop. Apply no more than 11.3 lb/A. Do not use banded applications for aphid control in West Texas. Restricted use	48H	Do not graze or harvest forage within 50 days, and fodder or grain within 100 days
	Counter 15G Lock n' Load		7 oz/1000 row ft, any row spacing		48H	
	Counter 15G Smartbox		7 oz/1000 row ft		48H or 72H where average rainfall < 25 in./yr	
	Counter 20G Smartbox		5.2 oz/1000 row ft	Can be applied at bedding, banded, or knifed in. If applied at planting, do not treat at postemergence or cultivation. Restricted use		

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Red imported fire ant

Under some conditions in East and South Texas, red imported fire ants (*Solenopsis invicta*) feed on planted sorghum seed. Worker ants chew through the thin seed coat and remove the embryo (germ). They rarely consume the endosperm (starch) of the seed. Although the ants prefer water-soaked or germinating seeds, they also damage dry seeds.

To reduce damage by red imported fire ants, use the cultural management practices recommended for wireworms. Use seed with good vigor, and plant it into a well-prepared seedbed when the soil temperature and moisture are adequate for rapid seed germination. Pack the covering soil firmly to prevent easy access of fire ants to the planted seed.

Table 2. Insecticides applied as seed treatments and labeled for fire ants in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
imidacloprid	Gaucho 600, generics	4A	6.4 fl oz/100 lb seed	Do not graze or harvest for forage within 45 days, and fodder or grain within 100 days.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed	—	12H	45 days

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Insecticide seed treatments labeled for red imported fire ants may protect seed from damage (Table 2). Applying a granular or liquid insecticide in-furrow at planting may also provide effective control.

Figure 4. White grubs

White grubs

White grubs (*Phyllophaga crinita* and others) are the larvae of May or June beetles. They are characteristically C-shaped with white bodies and tan to brown heads and legs (Fig. 4). Because the last abdominal segment is transparent, dark-colored digested material is visible in the larvae. Their size varies by age and species.

Grubs damage sorghum by feeding on the roots. They may kill small seedlings, causing stand loss. If the grubs severely prune the roots of larger plants, they may lodge, be stunted, or become more susceptible to drought and stalk rot organisms.

White grubs are rarely serious pests of sorghum. However, because they cannot be controlled once the crop has been planted, you must determine before planting whether they are present in the soil. Examine 1 square foot of soil in each 5 to 10 acres. If white grubs average one per square foot, consider applying turbos in a band at planting. Sorghum seed treated with clothianidin is labeled for control of white grubs (Table 3). Planting sorghum in a field where a nongrass crop (such as cotton or soybean) was grown the

Table 3. Insecticides labeled for white grubs in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, Nipsit Inside 5	4A	5.1–6.4 fl oz per 100 lb seed	—	12H	—
At-planting treatment						
terbufos	Counter 20G Lock n' Load	1B	5.2 oz/1000 row ft, any row spacing	At planting time; banded or knifed in. Do not place granules in direct contact with seed, as it might injure the crop; no more than 11.3 lb/A. Do not use banded applications for aphid control in West Texas. Restricted use	48H	Do not graze or harvest forage within 50 days, and fodder or grain within 100 days
	Counter 15G Lock n' Load		7 oz/1000 row ft, any row spacing			
	Counter 15G Smartbox		7 oz/1000 row ft		48H or 72H where average rainfall is less than 25 in./ year	
	Counter 20G Smartbox		5.2 oz/1000 row ft	Can be applied at bedding, banded or knifed in. If applied at planting, do not make postemergence or cultivation time treatments. Restricted use	48H	

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previous year is the most important cultural management practice for control of white grubs.

Southern corn rootworm

The adult southern corn rootworm (*Diabrotica undecimpunctata howardi*) is also called the spotted cucumber beetle. The adult overwinters in surface debris but may become active during warm weather. In early spring, the females deposit eggs in the soil around the base of plants. There are two generations per year.

The larvae are small, brown-headed worms with wrinkled, creamy white skin (Fig. 5). They chew into germinating seeds, roots, and crowns of sorghum plants. The symptoms of rootworm damage include reduced stands, lower plant vigor, and the occurrence of dead heart, or the death of the newest growth in the central whorl of young plants. Later in the season, maturity may be delayed, the plants may lodge, and weeds may multiply because the plant stand is not uniform. The shaded areas on the map (Fig. 6) indicate where the pest is most likely to damage sorghum in Texas.

Cultural management practices include keeping fields clean of grassy weeds, plowing or disking 30 days before planting, planting early, and planting at a slightly higher than normal seed rate.

Apply insecticides labeled for control of southern corn rootworm at planting time or postemergence (Table 4). Base the need for insecticide treatment on the field's history of damage by rootworms.

Figure 5. Southern corn rootworm larva (top) and adult

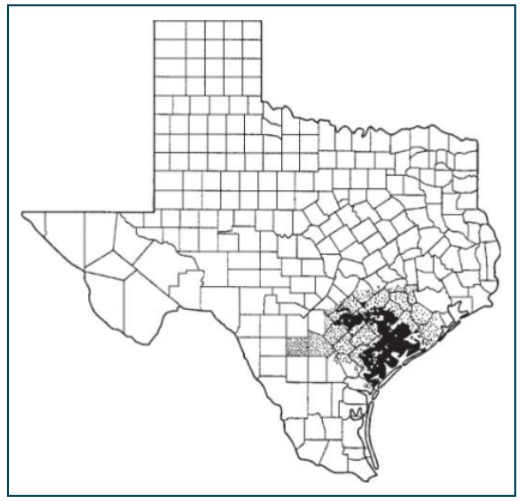

Figure 6. Areas in Texas where economically damaging infestations of southern corn rootworm could occur

Table 4. Insecticides labeled for controlling southern corn rootworm. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
At-planting treatment						
chlorpyrifos	Lorsban 15G	1B	8 oz/1000 row ft	At planting, T-banded applications	24H	—
terbufos	Counter 20G Lock n' Load	1B	5.2 oz/1000 row ft, any row spacing	At planting time; banded or knifed in. Do not place granules in direct contact with seed, as it may injure the crop; no more than 11.3 lb/A. Do not use banded applications for aphid control in West Texas. Restricted use	48H	Do not graze or harvest forage within 50 days, and fodder or grain within 100 days
	Counter 15G Lock n' Load		7 oz/1000 row ft, any row spacing			
	Counter 15G Smartbox		7 oz/1000 row ft			
	Counter 20G Smartbox		5.2 oz/1000 row ft	Can be applied at bedding, banded, or knifed in. If application is made at planting, do not treat at postemergence or cultivation. Restricted use	48H or 72H where average rainfall is < 25 in./year	

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2: PHI = Preharvest interval

Figure 7. Cutworm and damage

Stem- and leaf-feeding insects

Cutworms

Cutworms are the larval stages of moths that are active at night. Several species of cutworms (*Agrotis* and *Euxoa* spp.) can damage sorghum. The moths prefer to lay eggs in grassy and weedy fields. They lay the eggs in the soil or on stems or leaves of sorghum or grassy weeds. They hatch in 2 to 14 days.

The typical cutworm larva attacking sorghum is plump and curls into a C shape when disturbed (Fig. 7). The larvae vary from grayish white to grayish black or brown, depending on the species. Fully grown larvae are 1 to 2 inches long. Some species overwinter in the soil as pupae, others as adults, but most overwinter as small larvae in cells in clumps of grass or in the soil under trash. They begin feeding in the spring and grow until early summer, when they pupate in the soil. The larvae of most species stay underground during the day and feed at night.

The most common cutworms in sorghum feed on the soil surface. The feeding cuts plants off at, slightly below, or above the soil surface. Some cutworms (climbing or army cutworms) feed on the aboveground plant parts; others are subterranean and feed on underground plant parts, including seedling roots.

Cultural controls for cutworms include destroying weeds, preparing the seedbed thoroughly at least 4 to 6 weeks before planting, and plowing under or using herbicides to reduce weeds in late summer or early fall. Cutworms are more severe in weedy fields.

When scouting for cutworms in sorghum, look for severed, dead, and dying plants. For surface-feeding and subterranean cutworms, calculate the number of damaged plants per foot of row. Base your decision to apply insecticide on the degree to which an adequate stand is threatened. For cutworms that feed on aboveground plant parts, significant losses occur when the grubs have eaten more than 30 percent of the leaf tissue.

Insecticide sprayed as a broadcast treatment on the ground and plants usually protects against cutworms (Table 5). Because cutworms spend the day hidden in the soil, insecticides are sometimes more effective if they are applied in late afternoon.

Although insecticidal baits are effective against some cutworms, they are expensive. Insecticide applied at planting can control subterranean cutworms. Apply it in a 6- to 7-inch band and incorporate it into the top 1 to 2 inches of soil. See the product label for specific directions.

Aerial or ground applications of labeled insecticide can control cutworms in an established sorghum stand. However, foliar insecticides are more effective on climbing than on subterranean cutworms.

Table 5. Insecticides labeled for cutworms in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
At-planting treatment						
chlorpyrifos	Lorsban 15G	1B	8 oz/1000 row ft	Apply in T-band and cover lightly with soil. See label. Restricted use	24H	Not listed
esfenvalerate	Asana XL, generics	3A	5.8–9.6 fl oz	May be applied broadcast at or immediately before planting. Restricted use	12H	21 days
Post-emergence treatment						
alpha-cypermethrin	Fastac	3A	1.3–3.8 fl oz/A	Restricted use	—	14 days
beta-cyfluthrin	Baythroid XL	3A	1.0–1.3 fl oz/A	Application must be made before cutworms bore into plant. Restricted use	12H	14 days
chlorpyrifos	Lorsban 4E, Lorsban Advanced, Lorsban 75WG, Generics	1B	1–2 pt/A 1–2 pt/A 0.67–1.33 lb/A	Apply as a postemergence spray. To ensure complete coverage of plants, apply in at least 15 GPA for ground application and 2–5 GPA by aircraft. Restricted use	24H	30 days for 1 pint/A rate, 60 days for any rate above 1 pint/A
chlorpyrifos + *gamma*-cyhalothrin	Cobalt	1B, 3A	13–38 fl oz	Restricted use	24H	30 days for up to 26 oz/A and 60 days for more than 26 oz
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B, 3A	13–38 fl oz	Restricted use	24H	30 days for up to 26 oz/A and 60 days for more than 26 oz
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3A	3.75 –11.75 oz/A	Direct spray to the base of plants with sufficient spray volume to penetrate the soil/stem interface, leaf collars, and sheaths. Restricted use	24H	30 days
cyfluthrin	Tombstone	3A	1–1.3 fl oz/A	Restricted use	12H	14 days
deltamethrin	Delta Gold 1.5 EC	3A	1.0–1.5 fl oz/A	To ensure good spray coverage, apply in a minimum of 5 GPA by ground and 2 GPA by aircraft. Restricted use. **Danger–Poison**	12H	14 days
esfenvalerate	Asana XL	3A	5.8–9.6 fl oz	Restricted use	12H	21 days
gamma-*cyhalothrin*	Declare 1.25, Proaxis 0.5	3A	0.77–1.02 fl oz/A 1.92–2.56 fl oz/A	To ensure good spray coverage, apply at least 2 GPA by aircraft. Restricted use	24H	30 days
lambda-cyhalothrin	Warrior II with Zeon, Karate with Zeon, generics	3A	0.96–1.28 fl oz/A	To ensure good spray coverage, apply in a minimum of 2 GPA by aircraft. Restricted use	24H	30 days
lambda-cyhalotrhin + chlorantraniliprole	Besiege 1.25 SC	3A, 28	5–6 oz/A	Do not exceed total of 18 fl oz/A/yr. Restricted use	24H	30 days
zeta-cypermethrin	Mustang Max	3A	1.28–4.0 fl oz/A	Restricted use	12H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Figure 8. Yellow sugarcane aphid

Yellow sugarcane aphid

Yellow sugarcane aphids (*Sipha flava*) are usually lemon yellow (Fig. 8) but sometimes pale green. They are covered with small spines and have two double rows of dark spots on the back. There are winged and wingless forms.

This aphid feeds on many grasses, including johnsongrass and dallisgrass. The females give birth to living young for 28 days, averaging two nymphs a day for each female. The nymphs mature in 13 to 19 days; the adults live 25 to 30 days.

Yellow sugarcane aphids feed on sorghum and inject toxin into leaves of seedlings and older plants. Aphid feeding on seedlings turns the leaves purple (Fig. 8) and stunts their growth. By the time that the discoloration is visible, the aphids have injured the plants significantly (Tables 6 through 9). Damage often leads to delayed maturity and plant lodging, which may be increased by associated stalk rots. Many predators feed on yellow sugarcane aphids, but they are rarely parasitized.

Scout sorghum by inspecting plants beginning the first week of emergence and continuing twice weekly until they have at least five true leaves. Infestations of a week or less can significantly damage very small seedling sorghum plants (one to three true leaves). As the plants grow, they become more tolerant of aphid feeding.

The presence of purple seedlings can indicate an infestation of yellow sugarcane aphids. However, purple leaves can also develop in response to root injury, phosphorous deficiency, or cold, wet, or compacted soil. If aphids caused the discoloration, yield will decrease as damage increases (Table 6). Yellow sugarcane aphids can infest sorghum during later growth stages. The action thresholds for greenbug (Table 13) can serve as a guide for determining when to control yellow sugarcane on later growth stages of sorghum.

Insecticides can be applied as seed treatments or postemergence to control this aphid (Table 10). On plants at the 1, 2, or 3 true-leaf stage, apply a foliar insecticide when the percentage of plants infested with sugarcane aphids reaches or exceeds the economic injury levels in Tables 7 to 9. Do not count the two seed leaves that appear first.

Table 6. Estimated yield loss based on damage by yellow sugarcane aphids to 3-true-leaf-stage sorghum plants

Description	% Loss /plant
No discoloration	0
Localized discoloration	8
< 1 entire leaf discolored	11
1 entire leaf discolored	31
> 1 leaf discolored	54
> 2 leaves discolored	77
Dying/dead plant	100

Table 7. Economic injury levels for yellow sugarcane aphid based on percentage of seedling plants infested at the 1-true-leaf stage

Control cost ($) per acre	Crop market value ($) per acre							
	100	150	200	250	300	400	500	600
	Percent infested plants							
6	15	10	8	6	5	4	3	3
8	20	13	10	8	7	5	4	4
10	25	17	12	10	9	6	5	5
12	30	21	14	12	10	7	6	5

Table 8. Economic injury levels for yellow sugarcane aphid based on percentage of seedling plants infested at the 2-true-leaf stage

Control cost ($) per acre	Crop market value ($) per acre							
	100	150	200	250	300	400	500	600
	Percent infested plants							
6	26	18	13	11	10	7	6	5
8	35	24	17	14	13	9	7	7
10	43	29	22	17	16	11	9	8
12	51	35	26	20	18	13	10	9

Table 9. Economic injury levels for yellow sugarcane aphid based on percentage of seedling plants infested at the 3-true-leaf stage.

Control cost ($) per acre	Crop market value ($) per acre							
	100	150	200	250	300	400	500	600
	Percent infested plants							
6	67	44	33	27	24	17	14	12
8	89	60	44	36	32	22	18	16
10	*	76	55	44	39	28	22	20
12	*	92	66	53	44	33	27	22

* Do not treat.

Table 10. Insecticides labeled for control of yellow sugarcane aphid. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, NipsIt Inside	4A	5.1–6.4 fl oz/100 lb seed		12H	—
imidacloprid	Gaucho 600, generics	4A	6.4 fl oz/100 lb seed	Do not graze or harvest for forage within 45 days, and fodder or grain within 100 days of planting.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed		12H	45 days
Postemergence treatment						
chlorpyrifos	Lorsban 4E, Lorsban Advanced, Lorsban 75 WG, generics	1B	0.5–1.0 pt/A 0.5–1.0 pt/A 0.33–0.67 lb/A	Restricted use	24H	30 days at 1 pt, 60 days at 2 pt
chlorpyrifos + *gamma*-cyhalothrin	Cobalt	1B, 3A	6–13 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A; 60 days for > 26 oz
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B,3A	6–13 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A and 60 days for > 26 oz
dimethoate	Dimethoate 400, Dimethoate 4EC, Dimethoate 2.67	1B	0.5pt–1.0 pt/A 0.5pt-1.0pt/A 0.75-1.5 pt/A	Labeled for “aphids” Restricted use	48H	28 days
flupyradifurone	Sivanto Prime	4D	7.0–14.0 fl oz/A		4H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Figure 9. Winged and wingless sugarcane aphids

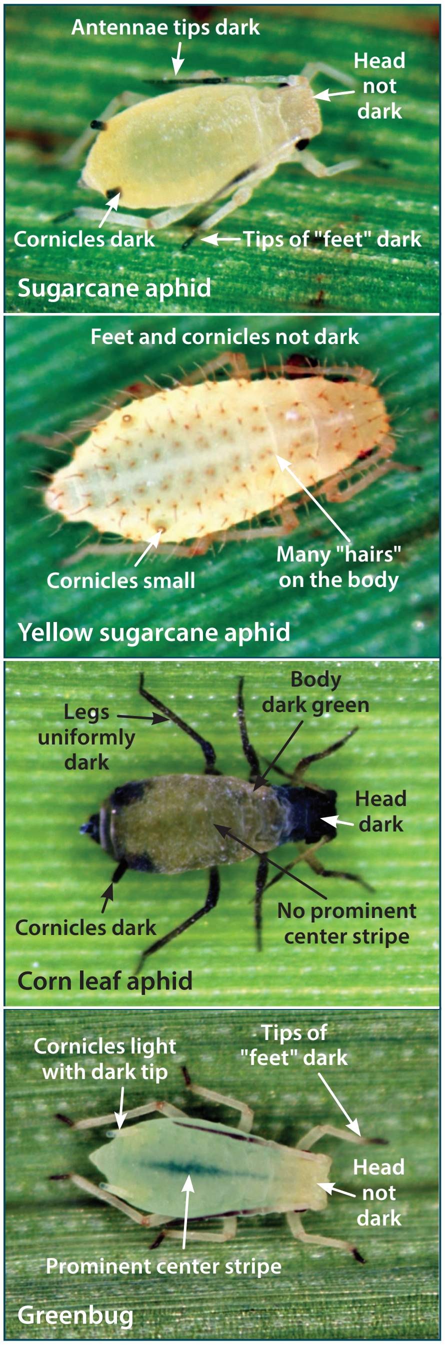

Figure 10. Key characteristics of aphid species that affect grain sorghum

Sugarcane aphid

Since the sugarcane aphid (*Melanaphis sacchari*) was first recorded feeding on sorghum in Texas in 2013, it has become one of the most damaging insect pests of grain and forage sorghum in much of the United States.

Sugarcane aphids are pale yellow, gray, or tan. The feet, antennae, and cornicles ("tailpipes") are black (Figs. 9 and 10). In contrast:

- Greenbugs are light green with a dark green stripe running down the back.
- Corn leaf aphids are dark green and typically feed in the whorl of the sorghum plant.
- Yellow sugarcane aphids are bright yellow with rows of dark spots and short cornicles (Fig. 9). They do not produce honeydew.

The sugarcane aphid feeds primarily on the underside of sorghum leaves. Although the initial colonies consist of just a few aphids, they can increase rapidly until they cover much of the lower leaf surface. The aphids produce large amounts of honeydew, which collects on the tops of leaves below, making them sticky and shiny. Sugarcane aphids can also move into the grain head (*panicle*).

All are females and give birth to live young. In about 5 days, the immature aphids develop into adults, which live for about 4 weeks. Because sugarcane aphid populations can increase rapidly, monitor them 1 to 2 times a week once you find them in a field to determine if the infestations have reached treatment thresholds.

Sugarcane aphids feed by sucking plant sap. Their feeding causes the leaves to turn yellow, purple, and then brown as the leaf tissue dies (Fig. 11). Infestations on preboot sorghum can cause significant grain loss and poor head emergence. During flowering and grain development, they can reduce yields greatly—even more so under drought conditions. Sorghum stressed by sugarcane aphid feeding is more susceptible to stalk rots and lodging. Infestations also produce honeydew, which can interfere with harvest. The sticky leaves and stalks clog combines at harvest and reduce separation of the grain from the plants. Clogged grain separators can cause as much as 50 percent grain loss. Honeydew can increase costs further when harvest must be interrupted to clean the combines.

Sugarcane aphids also feed and reproduce well on johnsongrass. They may increase on the johnsongrass early in the season and then move to the sorghum. The aphids survive the winter by feeding on johnsongrass and on volunteer and regrowth sorghum that survives the cold. Destroying johnsongrass in and around fields is a key practice in controlling sugarcane aphids.

Planting date and hybrids maturity

One of the most effective ways to manage sugarcane aphids is to plant early in the normal planting period. Although the aphids can reduce yields up to the hard dough stage, infestations during preboot, boot, and head emergence are the most damaging. Early planting reduces the risk that the infestations will reach high numbers during these most sensitive stages. Early planting can also shift the peak infestations closer to harvest and reduce or avoid the need for insecticide applications. Another means of reducing the window for sugarcane aphid infestation potential is to select an early-maturing hybrid. However, when considering early planting and hybrid maturity, factor in the effect on yield potential.

Planting sugarcane aphid-resistant hybrids

Many seed companies market hybrids with resistance or "tolerance" to sugarcane aphids. Compared to susceptible hybrids, sugarcane aphid populations on resistant hybrids increase more slowly, cause less leaf damage, and are less likely to require an insecticide treatment. However, no current hybrids are immune to sugarcane aphid infestation and damage. Thus, you still need to monitor resistant hybrids for the presence of sugarcane aphids, and apply insecticides if the infestations exceed action thresholds. Also, stay-green sorghum hybrids tolerate drought better than do other hybrids and have withstood sugarcane aphid injury better under droughty conditions.

In addition to sugarcane aphid resistance, consider yield and other agronomic qualities when selecting hybrids. Those that are high yielding and well adapted yet susceptible to the aphids may be more profitable. Protect these hybrids from sugarcane aphid damage by scouting often and, if infestations exceed the action threshold, timing insecticide applications appropriately.

Insecticide seed treatments

The insecticide seed treatments clothianidin (NipsIt Inside, Poncho), imidacloprid (Gaucho and others), and thiamethoxam (Cruiser) are labeled for control of sugarcane aphids and other seedling pests. These treatments protect seedlings from aphid damage for about 4 to 6 weeks after planting. The value of seed treatment to control sugarcane aphids depends on how soon after planting that the aphids infest the field. Insecticide seed treatments tend to be more valuable for sugarcane aphid management in more southern areas and for late plantings.

Managing johnsongrass and volunteer sorghum

Infestations of sugarcane aphids can sometimes be associated with nearby stands of johnsongrass or volunteer sorghum. Sugarcane aphid infestations in a sorghum field often begin on field edges bordering ditch banks or in fields with johnsongrass or volunteer sorghum. To reduce the risk of infestation, eliminate these potential sources of these aphids.

Figure 11. Sugarcane aphid colonies and damage

Scouting for sugarcane aphid

Sampling procedures differ slightly according to the action threshold you choose (see below). Regardless of the threshold, begin scouting for sugarcane aphids soon after plant emergence and make it a part of a weekly field-monitoring program for all sorghum pests. Once you find sugarcane aphids, begin scouting twice a week. A suggested sampling protocol:

1. Once a week, walk at least 25 feet into the field and examine the plants along 50 feet of row.
2. Inspect the *underside* of leaves from the upper and lower canopy. The presence of winged aphids on the upper surface of upper leaves indicates that adults have recently migrated into the field. Inspect 15 to 20 plants per location.
3. Sample each side of the field as well as sites near johnsongrass and tall grain-sorghum plants.
4. Check at least four locations for a total of 60 to 80 plants per field.
5. If you see honeydew on a leaf, look on the underside of the leaves above it to confirm that the cause is sugarcane aphids. However, do not rely solely on obvious honeydew to detect infestations. You could easily overlook colonies that are too small to produce noticeable honeydew. Instead, look closely for small colonies on the underside of lower and upper leaves.
6. If no sugarcane aphids are present or if only a few wingless or winged aphids are on the upper leaves, continue scouting once a week.
7. If you find sugarcane aphids on lower or mid-canopy leaves, scout twice a week. Base your decision to treat primarily on one of the established thresholds listed below.

Treatment or action thresholds

There are two sampling procedures and action thresholds for sugarcane aphids, one based on the percentage of infested plants at different growth stages and the second based on the number of aphids per leaf. The choice of one action threshold over another varies by geographic region, personal preference, and degree of desired thoroughness. Use action thresholds as guides, considering the weather and your ability to make timely, effective insecticide applications.

Sugarcane aphid populations can double every 4 to 8 days, depending on the hybrid, environmental conditions, and density of the aphids' natural enemies. Sample fields twice a week when the weather is warm and dry, which are the optimal conditions for aphid colony expansion. Yield loss is minimal once the grain reaches the hard dough stage. However, high infestations of sugarcane aphids may lead to lodging and harvest delays because of honeydew contamination. To determine if the infestation may impair harvest, scout sorghum 2 to 3 weeks before harvest. The best indicators that insecticide is needed to reduce honeydew contamination at harvest are the movement of aphids to the head late in the season and the presence of honeydew in the head.

1. Thresholds based on sorghum growth stages

The threshold based on sorghum growth stages, which is more conservative than that based on sugarcane aphids per leaf (see below), has been successful in parts of Texas and other states. The growth-stage threshold allows for nonuniform sugarcane infestations, problems caused by weather delaying insecticide treatment, the inability to scout the field more than once per week, and uncertainty about timing insecticide applications.

Field sampling protocol

Once you find sugarcane aphids in a field, use the following protocol to determine whether an insecticide treatment is needed:

1. Walk 25 feet into the field to look for aphids on the underside of green leaves from the lower canopy to the uppermost leaf. The presence of honeydew on top of a leaf will indicate that aphids are infesting the leaf above.
2. Record the numbers of plants that are not infested, plants infested with fewer than 50 aphids each, and plants with 50 or more aphids.
3. Check at least 10 plants at four locations across the field.
4. Calculate the percentage of plants infested with 50 or more aphids:

   (Number of plants with 50 or more aphids ÷ Total number of plants inspected) × 100

5. Use the action thresholds in Table 11 to determine whether you need to take action.

In Table 11, the term *localized area* refers to a single plant or group of adjacent plants with sugarcane aphid colonies. Finding several of these areas indicates that the sugarcane aphid infestation is well established and increasing in the field.

Table 11. Action thresholds based on sorghum growth stages (Source: revised from thresholds created by Louisiana State University)

Growth stage	Action threshold
Preboot	20% of plants infested with 50 or more aphids
Boot	20% of plants infested with 50 or more aphids
Flowering–milk	30% of plants infested with 50 or more aphids
Soft dough	30% of plants infested with established aphid colonies and localized areas1 with heavy honeydew
Dough	30% of plants infested with established aphid colonies and localized areas[1] with heavy honeydew
Black layer	Heavy honeydew and established aphid colonies. Treat only to prevent harvest problems. Observe preharvest intervals for insecticides.

1: A single plant or group of adjacent plants with sugarcane aphid colonies

2. Threshold based on sugarcane aphids per leaf

This threshold assumes that insecticide will be applied within 3 days of reaching or exceeding the action threshold. It applies to infestations during preboot through flowering and does not consider infestation during grain fill. This threshold is based on research conducted in the Texas Upper Gulf Coast, Louisiana, Arkansas, and Georgia.

Field sampling protocol

Once sugarcane aphids appear in a field, assess the infestation using the following steps:

1. Examine the underside of one completely green leaf from the lower canopy and one from the uppermost leaf (or the leaf below the flag leaf at boot to heading). Estimate and record the number of sugarcane aphids per leaf.
2. Examine two leaves (one upper and one lower) from each of five randomly selected plants for a total of 10 leaves per location.
3. Repeat at four locations for a total of 40 leaves per field.
4. Calculate the average number of aphids per leaf for the field:

    Total aphids counted ÷ total leaves inspected

Figure 12. Leaf with 50 aphids

Counting exact numbers of aphids per leaf is often impractical, and estimating aphid number can be more efficient. Texas A&M AgriLife offers a card (https://tinyurl.com/ycapgkbl), that illustrates how to estimate sugarcane aphid abundance per leaf.

Treatment threshold: If a field averages 50 or more aphids per leaf (Fig. 12), apply an insecticide within 1 to 3 days. Evaluate control after 3 to 4 days and follow insecticide reentry intervals. Continue to monitor sugarcane aphid infestations until harvest to determine if additional insecticide applications are necessary.

Insecticides and applications

Always read and follow insecticide label directions; they change often. Only Sivanto Prime is currently labeled (24c) specifically to control sugarcane aphids in grain sorghum after planting (Table 12).

Since 2014, a Section 18 Emergency Exemption has allowed Transform WG insecticide to be used to control sugarcane aphids in sorghum. Availability is uncertain because continuation of this registration must be approved every year. Check the label for current status.

Regardless of the insecticide used, good coverage of the crop canopy, including the lower leaves, is necessary for acceptable control. Adjust the spray volume according to anticipated spray coverage. Generally, spray volumes of 10 to 15 gallons per acre are recommended for ground applications and at least 5 gallons

Table 12. Insecticides labeled for controlling sugarcane aphid[1,2]. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, NipsIt Inside 5	4A	5.1–6.4 fl oz/100 lb seed	2 ee label for TX	12H	—
imidacloprid	Gaucho 600	4A	6.4 fl oz/100 lb seed	Label does not specify sugarcane aphid but lists "aphids" only.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed	2 ee label for TX	12H	45 days
Postemergence treatment						
flupyradifurone	Sivanto Prime	4D	4.0–7.0 oz/A (Section 2 ee)	Do not apply more than 28 oz/acre/season.	4H	14 days (Section 24(c))

1: Transform WG insecticide was approved under a Section 18 Emergency Exemption in 2018. This exemption expires Nov 30, 2018. Check label for current status.
2: Chlorpyrifos (Lorsban and generics) is not specifically labeled for sugarcane aphid but is labeled for "other aphids" in sorghum. University trials have shown that although chlorpyrifos can control sugarcane aphid short-term, it is not as effective as Sivanto Prime. Chlorpyrifos 4 at the rate of 1 pint per acre has a 30-day preharvest interval and higher rates have a 60-day preharvest interval.
3: REI = Restricted entry interval
4: PHI = Preharvest interval

per acre for aerial applications. Sivanto Prime can be applied by chemigation via overhead sprinkler irrigation systems. This application method is highly effective for managing sugarcane aphid infestations.

Adding a spray adjuvant usually does not increase sugarcane aphid control over the insecticide alone. Exceptions do occur, especially under hot, dry conditions such as those in the Texas High Plains, where much of the spray would evaporate before reaching the plants. Adjuvants may also be needed to adjust high-pH water.

Managing sugarcane aphids before harvest

Although sugarcane aphid infestations present after grain fill may have less effect on yield, they can continue to produce large amounts of honeydew, which can interfere with harvest. This risk increases when sugarcane aphids are present in the panicle. Rain can help wash honeydew from leaves. If it appears that aphids are likely to hinder harvest, consider applying an insecticide. Sivanto Prime can be applied up to 14 days before harvest. Harvest aid chemicals such as glyphosate and sodium chlorate have been used to kill sorghum leaves to reduce sugarcane aphid infestations before harvest. However, if the plants are slow to desiccate, the aphids may have time to move up into the sorghum panicle and continue to feed and produce honeydew. For this reason, you may need to use high rates of harvest aids that kill leaves quickly or include an effective insecticide with the harvest aid. An insecticide application is often more effective than harvest aids alone. Read and follow the label directions for the harvest aids, and observe preharvest intervals for both the harvest aids and the insecticides.

Managing sorghum midge, headworms, and stinkbugs when sugarcane aphid is present

Sivanto insecticide is effective against sugarcane aphids but is not labeled for midge, headworm, or stinkbug control in sorghum. Many insecticides labeled for these pests are toxic to beneficial insects, including lady beetles, syrphid flies, and parasitic wasps (Figs. 13 through 16), which help suppress sugarcane aphid infestations. Preserving these natural enemies whenever possible is an important goal in managing sugarcane aphids. All of the pyrethroid insecticides and methomyl and chlorpyrifos labeled for

Figure 13. Beneficial lady beetle larva (left) and adult

Figure 14. Beneficial syrphid fly (from left): larva, pupa and adult

Figure 15. Beneficial insects (from left): minute pirate bug feeding on whitefly nymphs, lacewing larva, and Scymnus lady beetle larva

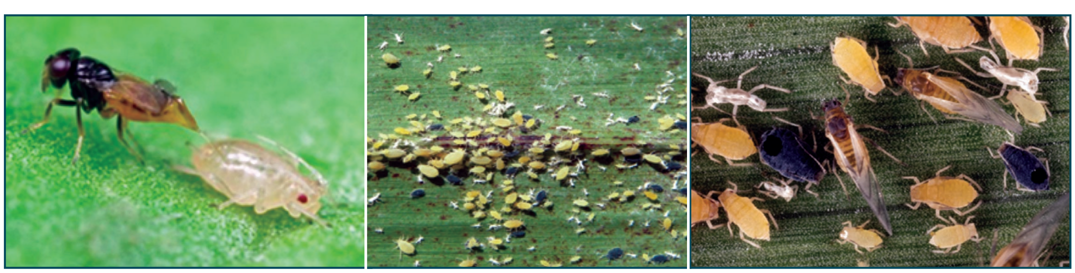

Figure 16. An *Aphelinus* wasp parasitizing an aphid (left); black or blue-black aphids, or mummies (center), that have been killed by the *Aphelinus* larva feeding inside the sugarcane aphid; aphid mummies (right) showing the round exit hole from which the adult wasp emerged from the dead sugarcane aphid

midge, headworms, and stinkbugs (Tables 18, 21, and 24) are broad-spectrum insecticides that are highly toxic to the natural enemies attacking sugarcane aphids. Thus, sugarcane aphid infestations can increase rapidly following their use, and treated fields should be closely monitored.

For control of midge, Blackhawk is less toxic to natural enemies than the other alternatives (Table 18). However, data for Blackhawk efficacy for midge control is limited; it is not recommended when midge pressure is high.

For corn earworm, fall armyworm, and sorghum webworm control, Prevathon and Blackhawk are less toxic to natural enemies than the alternatives while remaining effective on the headworm complex. Besiege is a premix of the same active ingredient as Prevathon plus a pyrethroid, and hence is not as safe for beneficial insects as Prevathon alone (Table 21). All of the insecticides labeled for stinkbugs are toxic to most aphid natural enemies.

Scout fields, and base insecticide applications on counts of midge, headworms, and stinkbugs. Do not treat based solely on crop growth stage; instead, use economic thresholds to make treatment decisions as described for each pest. Automatic insecticide applications for midge at bloom are not recommended. Midge, headworms, and stinkbugs at treatment thresholds present a certain threat to yield and profitability. While there is a risk of sugarcane aphid outbreaks after some insecticides have been applied, crop yield should not be jeopardized solely to spare the natural enemies.

Corn leaf aphid

Corn leaf aphids (*Rhopalosiphum maidis*) are oval and dark bluish-green and have black antennae, cornicles, and legs (Fig. 17). There are winged and wingless forms. These aphids are usually found deep in the whorl of preboot sorghum, but they also occur on the underside of leaves, on stems, or in grain heads. When abundant, corn leaf aphids within the whorl of sorghum plants are easy to see. To detect small aphid populations, pull the whorl leaf from the plant and unroll it.

Figure 17. Corn leaf aphid

When feeding, corn leaf aphids suck plant juices but do not inject toxin as do greenbugs and yellow sugarcane aphids. The most apparent feeding damage is yellow mottling of the leaves that unfold from the whorl.

Corn leaf aphids rarely cause economic loss to sorghum. In fact, they can be considered helpful. They attract beneficial insects such as lady beetles, which feed on the aphids. When corn leaf aphid numbers decline, the beneficial insects then can attack greenbug, sugarcane aphids, and other insect pests. Beneficials are also believed to move to adjacent crops, such as cotton, and feed on insect pests there.

Occasionally, corn leaf aphids will become so abundant on a few plants in a field that they hinder grain head exertion and development. These aphids are more likely to damage moisture-stressed than unstressed sorghum plants. Although very rare, infestations on seedling sorghum might cause stand loss, and grain head infestations might cause harvesting problems. The aphid also transmits the virus that causes maize dwarf mosaic.

Because corn leaf aphids prefer to live and feed in the whorl of sorghum plants, aphid numbers normally decline rapidly after the grain head emerges (*exerts*) from the boot.

Applying insecticide to control corn leaf aphids is rarely justified, but they can be suppressed with insecticides for greenbug control that are applied as seed treatments or postemergence as a foliar spray. Because it is rarely a pest, sampling procedures and damage assessment information for corn leaf aphid have not been developed.

Greenbug

Figure 18. Greenbug colony (top) and greenbugs

The greenbug (*Schizaphis graminum*) is an aphid that sucks plant juices and injects toxin into sorghum plants. The adult greenbug is light green and about 1⁄16 inch long. It has a characteristic dark green stripe down the back (Fig. 18). The tips of the cornicles and leg segments farthest from the body are usually black. A colony can have winged and wingless forms.

Females produce living young (*nymphs*) without mating. Because there are no males, populations can develop quickly. Under optimum conditions, the life cycle is completed in 7 days. Each female produces about 80 offspring during a 25-day period.

Greenbugs usually feed in colonies on the underside of leaves and produce much honeydew. The greenbug may be a pest during the seedling, boot, and heading stages. To detect an infestation, look for reddish leaf spots caused by the toxin greenbugs inject into the plant. The reddened areas enlarge with increases in the number of greenbugs and amount of injury. Damaged leaves begin to die, turning yellow and then brown. Damage at the seedling stage may result in stand loss.

Although larger sorghum plants tolerate more greenbugs, these plants can also be heavily damaged. Yield reductions during the boot, flowering, and grain development stages depend on the number of greenbugs, the general health of the plants, and the length of time that the insects have infested the plants. Large populations of greenbugs on booting and older plants can reduce yields and weaken plants, which may lodge later.

Greenbug colonies usually begin on the underside of lower leaves and move up the plant. On most sorghum hybrids, you will need to examine the underside of the lower leaves only. However, in some cases, colonies may appear first on the underside of upper leaves. Do not confuse greenbugs with the bluish-green corn leaf aphid, often found with greenbugs in the plant whorl.

Once a week, scout for greenbugs by examining at least 40 randomly selected plants per field. Because greenbugs are seldom distributed evenly in an area, examine plants from all parts of the field, not just on the borders. Check more than 40 plants if the fields are larger than 80 acres or if making a control decision is difficult.

When determining whether to control greenbugs, consider several factors:

- Amount of leaf damage
- Number of greenbugs per plant
- Percentage of parasitized greenbugs (mummies)
- Number of greenbug predators (such as lady beetles) per plant
- Moisture conditions
- Plant size
- Plant growth stage
- Overall crop condition

Knowing whether greenbug numbers are increasing or decreasing from week to week can help you determine whether insecticide treatment is justified. For example, it would not be justified if the populations had reached the recommended treatment level (based on leaf damage) but had declined substantially from previous observations.

In seedling sorghum (less than 6 inches tall), greenbugs may infest any part of the plant, including the whorl, as well as in the soil at the base of the plant. When scouting seedling sorghum, examine the entire plant and the soil around its base. Note the presence or absence of greenbugs and any damage to the plants, such as yellowing or dead tissue.

Sorghum plants can lose about 30 percent of the leaves to greenbug feeding before yield is reduced. Control greenbug infestations before they kill more than two normal-sized leaves on 20 percent of the plants after sorghum flowering and before the hard-dough stage. When estimating leaf damage, consider any leaf to be dead if more than 75 percent of its surface is red, yellow, or brown. Do not mistake for greenbug damage the natural aging and gradual deterioration (senescence) of the small bottom leaves. Unless it is feasible to spot-treat some areas of the field, estimate the average leaf damage level for the entire field.

Action thresholds (Table 13) can help you determine when an insecticide treatment is justified at different stages of plant growth.

Table 13. Action threshold levels for greenbug on sorghum at different plant growth stages

Growth stage	When to treat
Emergence to about 6 in.	20% of plants visibly damaged (beginning to yellow), with greenbugs on the plants
Larger plant to boot	Greenbug colonies causing red spotting or yellowing of leaves and before any entire leaves on 20% of plants are killed
Boot to heading	At death of 1 functional leaf on 20% of plants
Heading to hard dough	When greenbug numbers are sufficient to cause the death of 2 normal-size leaves on 20% of plants

These guidelines assume that the greenbugs are increasing so rapidly that beneficial insects cannot control them. However, an insecticide treatment is usually unnecessary when more than 20 percent of the greenbugs appear brown and swollen from being parasitized. Also, the action levels in Table 13 should be lower when the plants are under drought or other stress.

Table 14. Insecticides labeled for greenbug control. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, NipsIt Inside 5, NipsIt Inside 5 FS	4A	5.1–6.4 fl oz/100 lb seed	—	12H	—
imidacloprid	Gaucho 600, generics	4A	6.4 fl oz/100 lb seed	Do not graze or harvest for forage within 45 days, and fodder or grain within 100 days of planting.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed	—	12H	45 days
At-planting application						
terbufos	Counter 20G Lock n' Load	1B	5.2 oz/1000 row ft for any row spacing	At planting time; banded or knifed in. Do not place granules in direct contact with seed, as crop injury might occur; no more than 11.3 lb/A. Do not use banded applications for aphid control in West Texas. Restricted use	48H	Do not graze or harvest forage within 50 days, or fodder or grain within 10 days
	Counter 15G Lock n' Load		7 oz/1000 row ft for any row spacing			
	Counter 15G Smartbox		7 oz/1000 row ft	Can be applied at bedding, banded or knifed in. If application is made at planting, do not treat at post-emergence or cultivation time. Restricted use		
	Counter 20G Smartbox		5.2 oz/1000 row ft			
Postemergence application						
alpha-cypermethrin	Fastac	3A	3.2–3.9 fl oz/A	Restricted use. **Danger**	12H	14 days
chlorpyrifos	Lorsban4E, Lorsban Advanced, Lorsban 75WG, generics	1B	0.5–2 pt/A 0.33–1.33 lb/A 0.33–1.33 lb/A	Restricted use	24H	30 days at 1 pt, 60 days above 1pt/A
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Adv	1B, 3A	6–13 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A and 60 days for > 26 oz
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3	9.25–11.75 fl oz/A	Restricted use	24H	30 days
dimethoate	Dimethoate 4E, Dimethoate 2.67 E	1B	0.5 pt–1.0 pt/A 0.75–1.5 pt/A	Not all labels allow for application after head emergence. Restricted use	48H	28 days
flupyradifurone	Sivanto Prime	4D	7–14 fl oz/A	Labeled for "aphids"	4H	21 days
malathion	Malathion 57%, other brands	1B	1.5 pt/A	—	12H	7 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Scout the fields more often when the weather is warm and dry—the conditions that favor rapid greenbug reproduction. Early in the season, rain as well as lady beetles and other predators suppress aphid abundance. However, the increase of natural enemies has a lag time of 1 to 2 weeks. In the spring, a common parasitic wasp usually causes the aphids to decline rapidly.

Plant sorghum hybrids that are resistant to greenbug. Because thresholds are based on plant damage, the action thresholds for resistant sorghums are the same as for susceptible sorghums.

Although the greenbug is usually susceptible to labeled insecticides (Table 14), it has developed resistance to organophosphorous insecticides (Mode of Action Group 1B) in several counties in the Texas Panhandle. If growers continue to use these insecticides extensively, the resistance problem could worsen. In areas where greenbug resistance has developed, apply an effective insecticide with a different mode of action from that of the previous insecticide and increase the application volume to ensure complete plant coverage.

Chinch bug

Adult chinch bugs (*Blissus leucopterus*) are black with reddish-yellow legs and conspicuous, white, fully developed forewings, each with a black triangular spot at the middle of the outer edge (Fig. 19). Immature chinch bugs are shaped like the adults but lack wings.

Figure 19. Chinch bugs

Young nymphs are yellowish but later turn reddish with a white or pale yellow band across the front part of the abdomen. The older nymphs are black and gray with a conspicuous white spot on the back between the wing pads.

Chinch bugs are not a pest of sorghum in West Texas. However, false chinch bugs, discussed below, do occur there.

Chinch bugs lay eggs behind the lower leaf sheaths of sorghum plants, on roots or in the ground near the host plant. The life cycle is completed in 30 to 40 days, and there are at least two generations a year. Chinch bugs overwinter as adults in bunchgrass. They begin moving to sorghum when temperatures reach 70°F.

Cultural practices that stimulate dense, vigorous plant stands deter chinch bugs and usually reduce injury. Plant sorghum as early as practical.

Adult and immature chinch bugs suck juices from stems, leaves, and underground plant parts. Young plants are highly susceptible. Although older plants can better withstand attack, they too become reddened, weakened, and stunted. Chinch bugs proliferate in hot, dry weather, when many adult and immature bugs often migrate from wild bunchgrasses or small grains into sorghum.

To find chinch bugs, examine the lower leaves and stalks. Pull back the lower leaf sheaths to look for bugs on the stalk, and examine the surrounding soil at the plant base. Check at least five random areas per field.

Apply postemergent insecticide if you find two or more chinch bugs on 20 percent of seedlings less than 6 inches tall (Table 15). On taller plants, insecticide often is justified when chinch bugs infest 75 percent of the plants. Generally, one chinch bug per seedling sorghum plant reduces grain yield by 2 percent.

Apply postemergence insecticide with a ground rig using at least 20 gallons of water per acre through nozzles directed at the plant base. Control is seldom satisfactory on plants in the boot stage or later. Aerial application is seldom effective and not suggested.

Chinch bugs are sometimes difficult to control with foliar-applied insecticides. In fields with a history of economically damaging of chinch bug infestations, using insecticide seed treatments or applying insecticides applied at planting may be justified. Granular insecticides must receive about ½ inch of rainfall after application to effectively suppress early-season chinch bug infestations.

Table 15. Insecticide labeled for chinch bug control in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Seed treatment						
clothianidin	Poncho 600, NipsIt Inside 5 NipsIt Inside 5 F	4A	5.1–6.4 fl oz/100 lb seed		12H	—
imidacloprid	Gaucho 600, generics	4A	6.4 fl oz/100 lb seed	Early-season suppression. Do not graze or harvest for forage within 45 days, and fodder or grain within 100 days of planting.	12H	45 days grazing
thiamethoxam	Cruiser 5FS	4A	5.1–7.6 fl oz/100 lb seed	—	12H	45 days
In-furrow at planting						
chlorpyrifos	Lorsban 15G	1B	8 oz/1000 row ft	At planting; T-banded applications	24H	—
terbufos	Counter 20G Lock n' Load	1B	5.2 oz/1000 row ft for any row spacing	At planting; banded or knifed in. Do not place granules in direct contact with seed, as crop may be injured; no more than 11.3 lb/A. Restricted use	48H	Do not graze or harvest forage within 50 days, and fodder or grain within 100 days
	Counter 15G Lock n' Load		7 oz/1000 row ft for any row spacing			
	Counter 15G Smartbox		7 oz/1000 row ft	Can be applied at bedding, banded or knifed in. If applied at planting, do not make postemergence or cultivation time treatments. Restricted use	48H or 72H where average rainfall <25 in./yr	
	Counter 20G Smartbox		5.2 oz/1000 row ft			
Post-emergence treatment						
carbaryl	Carbaryl 4L Sevin XLR Plus	1A	1–2 qt/A	For best results use high gallonage ground application at the base of plants	12H	21 days harvest, 14 days grazing

continued on next page

Table 15 continued

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Post-emergence treatment						
chlorpyrifos	Lorsban 4 E, Lorsban Advanced, Lorsban 75WG, generics	1B	1–2 pt/A 1–2 pt/A 0.67–1.33 lb/A	Do not use on sweet sorghum varieties. Apply at base of seedling plants in 8–12-in. band with adequate water. Concentrate full rate in the treated band. Restricted use	24H	30 days at 1 pt, 60 days at 2 pt
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B, 3A	11–38 fl oz/A	Apply as a directed spray toward the base of the plant using power-operated ground spray equipment with enough water to cover an 8–12 in. band centered in the row. For plants < 6 in. tall, apply an 8–12-in. band centered over the row. Restricted use	24	30 days up to 26 fl oz/A 60 days over 26 fl oz/A
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3A	9.25–11.75 oz/A	Direct spray to the base of plants with sufficient spray volume to penetrate the soil/stem interface, leaf collars, and sheaths. Restricted use	24H	30 days
beta-cyfluthrin	Baythroid XL	3A	2.0–2.8 fl oz/A	Restricted use	12H	14 days
cyfluthrin	Tombstone	3A	2.0–2.8 fl oz/A	Use 20–30 gal water/A. Direct sprays toward infested areas. Restricted use	12H	14 days
deltamethrin	Delta Gold 1.5EC	3A	1.3–1.9 fl oz/A	Restricted use. **Danger—Poison**	12H	14 days
esfenvalerate	Asana XL, generics	3A	5.8–9.6 oz/A	Spray should be directed at base of plants. Restricted use	12H	21 days
gamma-cyhalothrin	Declare, Proaxis	3A	1.54 fl oz/A 3.84 fl oz/A	Restricted use	24H	30 days
lambda-cyhalothrin	Warrior II with Zeon, Karate with Zeon, generics	3A	1.92 fl oz/A	Begin applications when bugs migrate from small grains or grass weeds to small sorghum. Direct spray to the base of sorghum plants. Repeat applications at 3–5-day intervals if needed. Restricted use	24H	30 days
lambda-cyhalotrhin + chlorantraniliprole	Besiege 1.25 SC	3A, 28	10 oz/A	Direct spray to the base of sorghum plants. Do not exceed total of 18 fl oz/A per year. Restricted use	24H	30 days
zeta-cypermethrin	Mustang Maxx, generics	3A	3.2–4.0 fl oz/A	Begin applications when bugs migrate from small grains or grass weeds to small sorghum. Direct spray to the base of sorghum plants. Repeat applications at 3–5-day intervals if needed. Restricted use	12H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Corn earworm and fall armyworm (whorl worms)

(See later section for headworms)

Corn earworm (*Helicoverpa zea*) and fall armyworm (*Spodoptera frugiperda*) infest the whorls and grain heads of sorghum plants. If there are no grain heads, the insects lay eggs on the leaves. Young larvae feed on tender, folded leaves in the whorl.

To find larvae in a sorghum whorl, pull the whorl leaf from the plant and unfold it. Larval excrement (*frass*) is present where larvae feed within the whorl. Damaged leaves unfolding from the whorl are ragged with "shot holes." Although this may look dramatic, the damage usually does not significantly reduce yields, and controlling larvae during the whorl stage is seldom economically justified.

Insecticide application may be justified if:

- Larval feeding reduces leaf area by more than 30 percent, especially in drought-stressed fields
- Larvae are feeding on the developing grain head or growing point within the whorl or in high-value seed-production fields
- In seed production fields where the cost of the insecticide can often be justified due to the higher crop value

Once larvae are 1 to 1¼ inches long, they will complete feeding in 3 to 4 days and pupate. Treating these large larvae may provide little yield benefit. When considering treatment, check to see that larvae are still present in the whorls and less than 1 inch long. Control with insecticides is difficult because the larvae are protected deep within the whorl leaves. High volumes of spray applied by ground and directed into the whorl are needed to move insecticide into the whorl where larvae are feeding. Prevathon is labeled for corn earworm and fall armyworm. Pyrethroid insecticides are less effective on medium-size and large larvae and are toxic to beneficial insects. Also, chemigation (such as with Lorsban) can improve control by moving the insecticide into the whorl. See the section below for information on these insects as pests of sorghum grain heads.

Spider mites

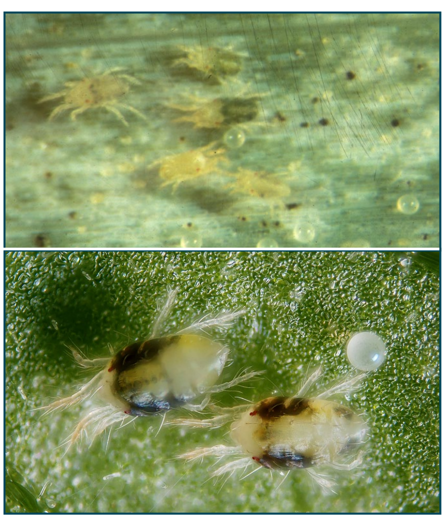

Figure 20. Banks grass mite adults and eggs (top) and two spotted spider mites

Banks grass mites (*Oligonychus pratensis*) and two spotted spider mites (*Tetranychus urticae,* Fig. 20) can infest sorghum, especially in drier areas of Texas. These mites are tiny, and females are larger than males. Each female lays about 50 eggs in webbing on the underside of sorghum leaves. The eggs are spherical, pearly white, and ¼ the size of the adults. They hatch in 2 to 3 days. Under favorable conditions, the life cycle takes about 5 to 7 days to complete.

Mite infestations begin along the midrib of the lower leaves. Spider mites suck juices from the underside of sorghum leaves, causing the infested areas to become pale yellow initially and reddish on the top later. The entire leaf may turn brown. As the mites become more abundant on the lower leaves, the infestation spreads upward through the plant. The undersides of heavily infested leaves have a dense deposit of fine webbing spun by the spider mites.

Spider mite abundance generally increases after the grain heads emerge. If many mites infest sorghum early in kernel development, the plants become less able to make and fill grain. Mites do not affect the grain after the kernels reach hard dough. However, if spider mites are very abundant, the sorghum plants may lodge, reducing yields.

Inspect the underside of the lower leaves carefully. Mite infestations usually begin along field borders and may spread quickly throughout the field. Hot, dry weather may favor a rapid increase in mites. They may also increase after an insecticide application for other pests such as greenbug or midge. If the increase occurs after such an application, the cause may be the tolerance of mites to some insecticides, the destruction of beneficial insects, or the dispersal of mites from colonies, which can increase their reproduction rate.

Natural enemies do not always control spider mites adequately. Because spider mites increase faster on moisture-stressed than nonstressed plants, time irrigation if possible to prevent plant stress. Rain can suppress spider mite population growth. Also, spider mites may move from small grains, especially wheat, to sorghum. To avoid this problem, plant sorghum away from small grains.

The use of miticides to control mites in sorghum has been erratic. Miticide application may be justified when damage appears on 30 percent of the leaf area of most sorghum plants in the field (Table 16). Thorough coverage is required; apply at least 3 to 5 gallons of spray mixture per acre by air and 10 to 20 gallons per acre by ground. Spider mites are often resistant to miticides.

Table 16. Miticides labeled for control of two-spotted and Banks grass mites. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
hexythiazox	Onager 1.0EC	10A	10–24 oz/A	Apply Onager before mites build up. Use higher rates on moderate to high mite infestations or for larger plants with a dense canopy. 15–20 GPA recommended for ground application, at least 5 GPA for aerial application. Chemigation is labeled. Do not apply it more than once a year.	12H	30 days
propargite	Comite II	12C	24–36 fl oz/A	Apply only to dry foliage. Do not tank-mix with other products or use oil-based surfactants. Use at least 20 GPA for ground applications and 5 GPA for aerial application. Treating a test plot is recommended to check for phytotoxicity before treating a large area. Restricted use	13 days	30 days for silage; 60 days for grain harvest

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Insects that feed on developing grain in the head

Sorghum midge

The sorghum midge, *Stenodiplosis* (*Contarinia*) *sorghicola,* is one of the most damaging insects of sorghum in Texas, especially in the southern half of the state. The adult sorghum midge is a small, fragile-looking orange-red fly with a yellow head, brown antennae and legs, and gray, membranous wings (Fig. 21).

During the single day of adult life, each female lays about 50 yellow-white eggs in the flowering spikelets of sorghum. The eggs hatch in 2 to 3 days.

At first, the larvae are colorless; fully grown larvae are dark orange. They complete development in 9 to 11 days and pupate between the spikelet glumes. Shortly before the adult emerges, the pupa moves toward the upper tip of the spikelet. After the adult emerges, it leaves a clear or white pupal skin at the tip of the spikelet—a sure sign of sorghum midge damage (Fig 21).

Under favorable conditions, a generation is completed in 14 to 16 days, and midge numbers increase during the season with each subsequent generation. Thus, late-planted sorghum is at risk to large infestation of adults moving in from fields planted earlier.

Sorghum midges overwinter in cocoons inside spikelets of sorghum or johnsongrass that fall to the ground and become covered with litter. Adult sorghum midges emerge in the spring before flowering sorghum is available, and these adults infest johnsongrass. Sorghum midges developing in johnsongrass disperse to sorghum when it flowers.

Early-season infestations in sorghum are usually below damaging levels. As the season progresses, sorghum midge populations increase, especially when late planting makes flowering sorghum available in the area. Numbers often drop late in the season.

The larva damages sorghum by feeding on a newly fertilized ovary, which prevents normal kernel development. Grain loss can be extremely high. The glumes of an infested spikelet fit tightly together because no kernel develops. Typically, a sorghum grain head infested by sorghum midges has normal kernels scattered among spikelets that do not bear kernels, depending on the degree of damage.

The most effective cultural management practice is planting sorghum early and uniformly so that flowering occurs before the sorghum midges reach damaging levels. It is critical to plant hybrids early enough to prevent grain heads from flowering late (Fig. 22).

Figure 21. Sorghum midge adult (top), midge adults on blooming head (middle) and pupal skins (bottom)

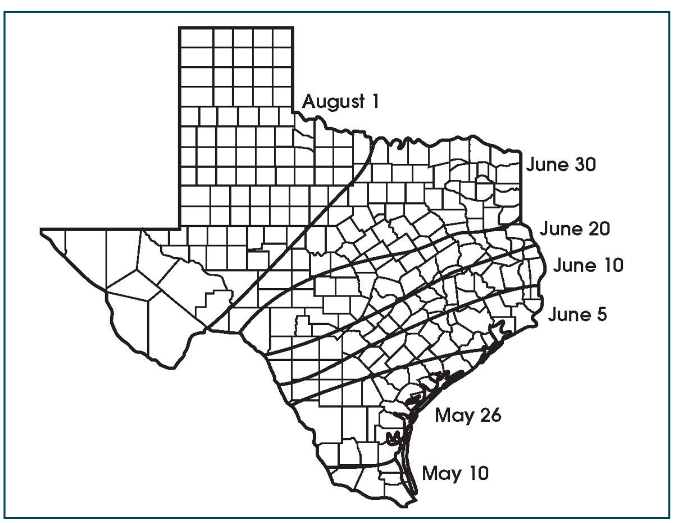

Figure 22. Estimated latest sorghum flowering dates most likely to escape significant damage by sorghum midge

Cultural practices that promote uniform heading and flowering in a field are also important for reducing sorghum midge infestations. Use cultivation and/or herbicides to eliminate johnsongrass inside and outside the field. Where practical, disk and deep-plow the previous year's sorghum crop to destroy overwintering midges. Late-planted and late-flowering sorghum are especially vulnerable to sorghum midge.

This midge lays eggs in spikelets when yellow anthers appear on the sorghum head. An individual grain head requires 7 to 9 days to complete flowering; it may take 2 to 3 weeks for all of the heads in a field to complete flowering. Thus, a field can remain susceptible to midge infestation for several weeks, depending on how uniformly the plants flower. Once the anthers turn reddish brown, they are no longer susceptible to midge infestation.

Begin scouting for sorghum midge soon after head emergence, when yellow blooms first appear in the field. Scout at midmorning when the temperature rises to about 85°F. The adult lives for 1 day, and each day a new brood of adults emerges. For this reason, you need to sample flowering fields almost daily.

Look for adults on the yellow blooms by inspecting carefully and at close range all sides of randomly selected flowering grain heads. The reddish, gnatlike adults crawl on or fly about the flowering heads. During inspection, handle the grain heads carefully to avoid disturbing the adult midges. Another sampling method is to gently but quickly slip a clear, 1-gallon plastic bag over the head. Tap the head to disturb the midges, which will fly up in the bag, where you can easily see and count them. A faster yet still efficient method is to turn the head downward into a white plastic bucket or pail and beat the head in the bucket to knock the midge from the head. Remove the head and count any sorghum midge in the pail or bucket. A 1-gallon milk jug with the bottom cut out also works well for this type of sampling.

Because they are relatively weak fliers and rely on wind currents to help them disperse, adult sorghum midges usually are most abundant along edges the of sorghum fields. For this reason, inspect plants along field borders first, particularly those downwind of earlier-flowering sorghum or johnsongrass. If the grain heads along the field edges have few or no sorghum midges, there should be little need to sample the entire field.

However, if you find more than one sorghum midge per flowering grain head in a field border area, inspect the rest of the field. Flowering heads are those with yellow blooms. Sample at least 20 flowering grain heads for every 20 acres in a field. For fields smaller than 20 acres, sample 40 flowering grain heads. Avoid plants within 150 feet of field borders. Record the number of sorghum midges for each flowering head sampled and then calculate the average number of midges per flowering head. Almost all of the sorghum midges seen on flowering sorghum heads are female.

Next, calculate the number of flowering heads (those with yellow blooms present) per acre. Record the number of flowering heads along a length of row equal to 1/1000 acre. As an example, for a row spacing of 40 inches, 13.1 row feet is equal to 1/1000 acre. Make counts in at least four areas of the field. If flowering (plant maturity) is highly variable across the field, sample additional sites. Average all counts and multiply by 1,000 to estimate the number of flowering heads per acre. If there is only one head per plant, the number of flowering heads per acre is the percentage of heads in bloom multiplied by the number of plants per acre.

Then calculate sorghum midge density per acre as the average number of midges per flowering head multiplied by the number of flowering heads per acre. For example, if there are 30,000 flowering heads per acre and scouting records show an average of 0.5 sorghum midge per flowering head, there are an estimated 15,000 sorghum midges per acre (0.5 sorghum midge per head × 30,000 flowering heads per acre). The percentage of flowering heads changes rapidly during bloom and should be calculated each time the field is sampled.

Studies have shown that the larvae from a single female sorghum midge will destroy an average of 45 grain sorghum kernels. The seed weight of sorghum hybrids averages 15,000 seeds (12,000 to 18,000, depending on the hybrid) per pound. A loss of 45 kernels per midge, therefore, represents 0.0030 pounds (1.364 grams) of grain.

Calculate the economic injury level for sorghum midge using the following equation:

$$\textbf{Number of sorghum midges/flowering head} = \frac{\textbf{Cost of control as \$/A} \times \textbf{33256}}{\textbf{Value of grain as \$/cwt} \times \textbf{Number of flowering heads}}$$

In the equation above, the control cost is the total cost of applying an insecticide for sorghum midge control; the grain value is the expected price at harvest as dollars per 100 pounds. The value 33256 is a constant and results from solving the economic injury equation. Determine the number of flower heads per acre as described above.

For example, assume that field scouting yields an average of 1.1 sorghum midges per flowering head and that field sampling shows the number of flowering heads is 18,000 per acre. (This is equal to a plant population of 90,000 with 20 percent of the heads flowering and one head per plant). If the value of the crop is estimated to be \$4.00 per 100 pounds and the cost of control is \$5.00 per acre, the equation yields the injury level as:

$$\frac{\$5.00 \times 33{,}256}{\$4.00 \times 18{,}000} = \textbf{2.3 sorghum midge per flowering head}$$

In this example, the field density of 1.1 sorghum midges per flowering head is below the injury level of 2.3 per head, and treatment would not be justified. If you scout the field 2 days later and the sorghum midge density is again 1.1 midges per flowering head, but the number of flowering heads has increased to 45,000 per acre (50 percent of the plants now have a flowering head in a plant density of 90,000 plants per acre), the economic injury level would be ($5.00 × 33256) ÷ ($4.00 × 45,000) = 0.9 sorghum midge per flowering head.

Now the average of 1.1 sorghum midges is above the economic injury level of 0.9 per flowering head, and treatment would be justified. These examples show the importance of considering the number of flowering heads (grain susceptible to midge damage) in estimating the economic injury level.

Table 17 lists the economic injury levels, as determined from the above equation, for a range of typical treatment costs per acre, market values per 100 pounds of grain, and numbers of flowering heads per acre. Use the equation to estimate injury levels for your control costs, crop value, and number of flowering heads per acre. These variables can be entered into an online calculator to determine the economic threshold for midge. The calculator is available at **http://entomology.tamu.edu/extension/apps/**.

Insecticide residues should kill the adults and prevent egg laying 1 to 2 days after treatment. However, if adults still are present 3 to 5 days after the first insecticide application, apply a second insecticide treatment immediately. Making several insecticide applications at 3-day intervals may be justified if the yield potential is high and sorghum midges exceed the economic injury level (Table 18).

Table 17. Estimated economic injury levels for sorghum midge for a range of factors. (This table is only a guide. Use the equation in the text to estimate the economic injury level in your field.)

		Economic injury level—mean number of midges/flowering head		
Control cost, $/A	Crop value, $100 lb	Flowering heads = 18,000/A	Flowering heads = 45,000/A	Flowering heads = 67,500/A
5	6	1.6	0.6	0.4
5	7	1.3	0.5	0.34
5	8	1.2	0.5	0.3
6	6	1.9	0.8	0.5
6	7	1.6	0.7	0.4
6	8	1.4	0.6	0.35
7	6	2.2	0.85	0.6
7	7	1.9	0.75	0.5
7	8	1.6	0.65	0.45

Table 18. Insecticides labeled for sorghum midge control in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Post-emergence treatment						
alpha-cypermethrin	Fastac	3A	1.3–3.8 fl oz/A	Restricted use. **Danger**	12H	14 days
beta-cyfluthrin	Baythroid XL	3A	1.0–1.3 fl oz/A	Restricted use	12H	14 days
chlorpyrifos	Lorsban 4, Lorsban Advanced, Lorsban 75WG, generics	1B	0.5 pt/A 0.5 pt/A 0.33 lb/A	Do not use on sweet sorghum varieties. Restricted use	24H	30 days (1 pt) 60 days (> 1 pt)
chlorpyrifos + *gamma*-cyhalothrin	Cobalt	1B, 3A	7–13 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A and 60 days for > 26 oz
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B, 3A	6–13 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A and 60 days for > 26 oz
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3A	3.75–11.75 oz/A	Restricted use	24H	30 days
cyfluthrin	Tombstone	3A	1.0–1.3 fl oz/A	Restricted use	12H	14 days
deltamethrin	Delta Gold 1.5EC	3A	1.3–1.9 fl oz/A	Restricted use. **Danger–Poison**	12H	14 days
esfenvalerate	Asana XL, generics	3A	2.9–5.8 fl oz/A	Restricted use	12H	21 days
gamma-cyhalothrin	Declare 1.25, Proaxis 0.5	3A	0.77–1.02 fl oz/A 1.92–2.56 fl oz/A	Restricted use	24H	30 days
lambda-cyhalothrin	Warrior II Zeon, Karate with Zeon, generics	3A	0.96–1.28 fl oz/A	Restricted use	24H	30 days
lambda-cyhalothrin + chlorantraniliprole	Besiege	3A, 28	5–6 oz/A	Do not exceed total of 18 fl oz/A per year. Restricted use	24H	30 days
spinosad	Blackhawk (2ee)	5	1.5–3.3 oz/A	For low to moderate midge infestations	4H	21 days
methomyl	Lannate LV, Lannate SP, generics	1A	0.75–1.0 pt/A 0.25–0.5 lb/A	Do not use methomyl on sweet sorghum varieties. For SP, use a minimum of 10 gallons per acre by ground or 2 gallons per acre by air. Restricted use. **Danger**	48H	14 days
zeta-cypermethrin	Mustang Maxx Respect	3A	1.28–4.0 fl oz/A	Restricted use	12H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Corn earworm and fall armyworm: Headworms

Figure 23. Corn earworm larvae

Figure 24. Corn earworm (left) and fall armyworm with characteristic inverted Y marking

Corn earworm (*Helicoverpa zea*) and fall armyworm (*Spodoptera frugiperda*) moths lay eggs on leaves or grain heads of sorghum. Newly hatched corn earworm larvae are pale and only 1⁄16 inch long. They grow rapidly, and older larvae range from pink, green, or yellow to almost black (Figs. 23 through 25). Each segment has several long bristles or hairs. Many larvae are conspicuously striped. Along the side is a pale stripe edged above with a dark stripe. Down the middle of the back is a dark stripe divided by a narrow white line that makes the dark stripe appear doubled. Fully grown larvae are robust and 1½ to 2 inches long.

Young fall armyworm larvae are greenish, have black heads, and lack bristles. Mature larvae vary from greenish to grayish brown and have a light-colored, inverted, Y-shaped suture on the front of the head (Figs. 24 through 26) and dorsal lines running lengthwise on the body. The tail end has four large black spots.

Figure 25. Fall armyworm (top) and corn earworm

Corn earworm and fall armyworm larvae feed on the flowers and then on the developing grain and hollow out the kernels. The last two larval stages cause about 80 percent of the damage. Frass and fragments of grain kernels accumulate on top of the upper leaves and on the ground under plants where the larvae are feeding.

Many small corn earworm and fall armyworm larvae normally die because of predators, parasites, pathogens, and cannibalism. Infestations are less common in early-planted sorghum and in sorghum hybrids with loose (open) grain heads.

Figure 26. Fall armyworm larva

Begin sampling for headworms soon after the field finishes flowering and continue at 5-day intervals until the hard dough stage. To sample headworms, grasp the stalk just below the sorghum head, bend the head into a clean, white, 2- to 3-gallon bucket, and vigorously beat the head against the side of the bucket. Headworms will fall into the bucket, where you can see and count them. Sample at least 30 heads randomly selected across the field. In fields larger than 40 acres, sample at least one head per acre.

Record the number of small (less than ¼ inch long), medium (¼ to ½ inch long) and large (longer than ½ inch) headworms found in the samples. Divide the total number of medium or large headworms by the number of heads sampled to get the average number of headworms per head. Then multiply the average number of headworms per head by the number of heads per acre to calculate the number of headworms per acre. To estimate the number of plants or heads per acre, see the discussion on sorghum midges.

Studies have shown that a corn earworm larva will consume about 0.010252 pound (4.65 grams) of grain while developing in the sorghum head. However, estimating the economic injury level for headworms is complicated because the potential yield loss varies with the size of the larvae. That is why you need to record the number of small, medium-size, and large headworms.

Small larvae (up to ¼ inch) consume very little grain (about 10 percent of the total consumption), and about 80 percent of them die in this stage. Therefore, do not consider small larvae when determining the economic injury level. If most headworms are this size, sample the field again in 3 to 4 days. If at the later time, most of the larvae are longer than ¼ inch, determine which size (medium or large) is the most common and use the corresponding equation below to calculate the economic injury level.

$$\textbf{Number of large larvae/head} = \frac{\textbf{Cost of control as \$/A} \times \textbf{9754}}{\textbf{Grain value as \$/cwt} \times \textbf{heads/A}}$$

$$\textbf{Number of medium-size larvae/head} = \frac{\textbf{Cost of control as \$/A} \times \textbf{9754}}{\textbf{Grain value as \$/cwt} \times \textbf{heads/A} \times \textbf{0.19}}$$

As an example, if the cost of control is $8/acre and the grain value is $8/cwt, and if there are 50,000 grain heads per acre, the economic injury level equals an average of 0.2 large worm per head or 1.0 medium worm per head. In this example, an insecticide treatment should be considered if field scouting found an average of more than 0.2 large worm per head or 1 medium worm per head.

If the infestation consists of about equal numbers of medium-size and large headworms, use this equation:

$$\textbf{Potential loss as lb/A} = (\textbf{Number of large larvae/A} \times \textbf{0.010252}) + (\textbf{Number of medium-size larvae/A} \times \textbf{0.19} \times \textbf{0.010252})$$

Treatment is economically justified if the value of the economic loss (loss in pounds per acre multiplied by the dollars per pound of grain) exceeds the treatment cost per acre.

Most corn earworm larvae larger than ½ inch will survive to complete development. These large larvae account for 83 percent of the total grain consumed during larval development. About 19 percent of medium-size larvae (¼ to ½ inch long) survive beyond this stage. Thus, the potential grain loss from medium size larvae is only 19 percent of the potential loss from large larvae.

The above equations present the economic injury level as the number of larvae per head. The economic thresholds can also be calculated as the number of larvae per acre as shown in Tables 19 and 20. As an example, if the cost of control is $8 per acre and the grain value is $8 per 100 pounds, the economic injury level in the table below is 9,750 large larvae per acre. If there are 50,000 heads per acre, the economic injury level is 9750 ÷ 50,000 = 0.2 larvae per sorghum head.

These variables can be entered into a calculator available online to determine the economic injury levels given variable treatment costs and grain values. This calculator is available at http://entomology.tamu.edu/extension/apps/.

Table 19. Economic injury level for large (longer than ½ inch) corn earworm larvae shown as the number of larvae per acre. When the number of larvae per acre exceeds the number in the table at a given cost of control and value of grain per cwt, the value of the protected grain exceeds the cost of control.[1]

Control cost, $/A	Grain value $/100 lb			
	6.00	7.00	8.00	10.00
6	9,750	8,500	7,250	5,750
8	13,000	11,000	9,750	7,750
10	16,250	14,000	12,250	9,750
12	19,500	16,750	14,750	11,750

1: This threshold table assumes all larvae will survive and complete development.

Table 20. Economic injury level for medium-size (¼–½-inch) corn earworm larvae shown as the number of larvae per acre. When the number of larvae per acre exceeds the number in the table at a given cost of control and value of grain per cwt, the value of the protected grain exceeds the cost of control.[1]

Control cost, $/A	Grain value $/100 lb			
	6.00	7.00	8.00	10.00
6	51,500	44,750	38,250	31,250
8	68,500	58,000	51,500	41,750
10	87,750	73,750	64,500	51,500
12	102,750	88,250	77,750	62,000

1: This table assumes that 81% of the medium-size larvae will die in that stage and not contribute to additional yield loss.

Table 21. Suggested insecticides for controlling corn earworm and fall armyworm in grain sorghum. Resistance to pyrethroids (products with only mode of action 3A) in corn earworm has been reported from some areas. If resistance is present, applying pyrethroids can result in poor control of corn earworm, especially when the larvae are larger than ¼ inch (2nd instar). Also, pyrethroids are not recommended for fall armyworm larger than ¼ inch (2nd instar).

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2] for grain harvest
Postemergence treatment						
alpha-cypermethrin	Fastac	3A	1.3–3.8 fl oz/A	Restricted use. **Danger**	12H	14 days
beta-cyfluthrin	Baythroid XL	3A	1.3–2.8 fl oz/A	1st and 2nd instar (< ¼ in. long). Restricted use	12H	14 days
carbaryl	Sevin XLR Plus	1A	1–2 qt/A	Bee caution: Do not apply this product to target crops or weeds in bloom.	12H	21 days
chlorantraniliprole	Prevathon	28	14–20 fl oz/A	—	4H	1 day
chlorpyrifos	Lorsban 4E, Lorsban Advanced, generics	1B	1–2 pt/A (armyworm) 2 pt/A (corn earworm)	Do not use on sweet sorghum varieties. Restricted use	24H	30 days at 1 pt, 60 days at 2 pt

continued on next page

Table 21 continued

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2] for grain harvest
Postemergence treatment						
chlorpyrifos + *gamma*-cyhalothrin	Cobalt	1B, 3A	19–38 oz/A	See label	24H	Preharvest interval is 30 days for up to 26 oz/A and 60 days for > 26 oz
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B, 3A	16–38 fl oz/A	See label	24H	Preharvest interval is 30 days for up to 26 oz/A and 60 days for > 26 oz/A
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3A	9.25–11.75 fl oz/A	See label	24H	30 days to harvest
deltamethrin	Delta Gold 1.5EC	3A	1.0–1.5 fl oz/A	Apply at least 2 GPA by aircraft or 5 GPA by ground. Restricted use. **Danger—Poison**	12H	14 days
esfenvalerate	Asana XL, generics	3A	5.8–9.6 fl oz/A	Used for earworms on heads only. Restricted use	12H	21 days
gamma-cyhalothrin	Declare 1.25, Proaxis 0.5	3A	1.02–1.54 fl oz/A 2.56–3.84 fl oz/A	Use higher rates for large larvae. Restricted use	24H	30 days
lambda-cyhalothrin	Warrior II Zeon, Karate with Zeon, generics	3A	1.28–1.92 fl oz/A	Restricted use	24H	30 days
lambda-cyhalothrin+ chlorantraniliprole	Besiege 1.25 SC	3A, 28	6–10oz/A	Use higher rate range for large larvae. Do not exceed total of 18 fl oz/A per year. Restricted use	24H	30 days
methomyl	Lannate LV, Lannate SP	1A	0.75–1.5 pt/A 0.25–0.05 lb/A	Do not use on sweet sorghum varieties. Restricted use. **Danger**	48H	14 days
novaluron	Diamond	15	6–12 fl oz/A	Fall armyworm only. See label	12H	7 days for forage, 14 days for grain and stover
spinosad	Blackhawk	5	1.7–3.3 oz/A	Apply to coincide with peak egg hatch or small larvae. Use a higher rate range for heavy infestations, advanced growth stages of target pests, or difficult spray coverage situations.	4H	21 days
zeta-cypermethrin	Mustang Maxx, generics	3A	1.76–4.0 fl oz/A	Restricted use	12H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Sorghum webworm

Sorghum webworms (*Nola sorghiella*) occasionally infest grain heads of sorghum planted 2 to 3 weeks later than normal. This insect occurs primarily in the more humid eastern half of Texas.

The adults are small white moths that are active at night. They lay about 100 eggs singly on flowering parts or kernels of sorghum. The eggs are round to broadly oval and are flattened from top to bottom.

Webworm larvae are somewhat flattened, yellowish or greenish brown, and marked with four lengthwise reddish to black dorsal stripes (Fig. 27). When mature, the larvae are about ½ inch long and covered with many spines and hairs. A silk cocoon encloses the reddish-brown pupal stage. A generation requires 1 month; as many as six generations may develop in a year. The larva overwinters in a cocoon on the host plant.

Young larvae feed on developing flower parts. Older larvae gnaw circular holes in and feed on the starchy contents of maturing kernels. Each larva may eat more than 12 kernels in 24 hours. The larvae do not spin webs (as the name might imply) over the sorghum grain head but, when disturbed, they often suspend themselves by spinning a thin silken thread.

Look for sorghum webworms when grain heads begin to flower and continue at 5-day intervals until the kernels are in the hard-dough stage. To examine grain heads for sorghum webworms, shake the grain heads vigorously into a 2- to 5-gallon white plastic bucket, where you can easily see and count even small larvae.

Inspect at least 30 plants from several areas of a field. In fields larger than 40 acres, sample at least one grain head per acre.

Insecticide application is economically justified when an average of five or more small larvae are found per grain head (Table 22).

Figure 27. Sorghum webworm

Table 22. Insecticides labeled for sorghum webworm control in sorghum

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Postemergence treatment						
carbaryl	Carbaryl 4L, Sevin XLR Plus	1A	1–2 qt/A	Bee caution: Do not apply this product to target crops or weeds in bloom.	12H	21 days
methomyl	Lannate LV, Lannate SP	1A	1.5 pt/A 0.25-0.5 lb/A	**Danger–Poison**	48H	14 days
spinosad	Blackhawk	5	1.7–3.3 oz/A	Apply to coincide with peak egg hatch or the presence of small larvae. Use a higher rate range for heavy infestations, advanced growth stages of target pests, or difficult spray coverage situations.	4H	21 days
chlorantraniliprole	Prevathon	28	14–20 fl oz/A	—	4H	1 day
lambda-cyhalothrin + chlorantraniliprole	Besiege 1.25 SC	3A, 28	6–10oz/A	Use higher rate range for large larvae. Do not exceed total of 18 fl oz/A per year. Restricted use	24H	30 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Cultural practices to reduce sorghum webworm abundance include plowing sorghum residues after harvest to destroy overwintering pupae, planting as early as practical, and using sorghum hybrids with loose (open) grain heads.

Grain head-feeding bugs

During grain development, stink bugs, leaffooted bugs, false chinch bugs, and Lygus bugs can move from alternate host plants into sorghum. These bugs have piercing-sucking mouthparts and feed on developing grain kernels. Feeding can reduce grain weight, grain size, and seed germination. The bugs cause more damage during early kernel development and less as the grain develops to the hard-dough stage. Fungi often infect damaged kernels, causing them to turn black and further deteriorate in quality. Damaged kernels rarely develop fully and may be lost during harvest. The extent of damage depends on the species of bug, the number of bugs per grain head, and the stage of kernel development when the infestation occurs.

Grain head-feeding bugs tend to congregate on grain sorghum heads and sometimes within areas of a field. Use the beat-bucket technique to estimate abundance:

1. Shake grain sorghum heads vigorously into a 2.5- to 5-gallon bucket, where you can easily see and count the bugs.
2. Sample at least 30 plants from a field. In fields larger than 40 acres, take at least one sample per acre.
3. Calculate the average number of bugs per sorghum head.

Treatment thresholds vary according to species as discussed below.

Rice stink bug

The rice stink bug (*Oebalus pugnax*) is straw colored, shield shaped and ½ inch long (Fig. 28). The female lays about 10 to 40 short, cylindrical, light-green eggs in a cluster of two rows. The eggs hatch after 5 days. The nymphs require 15 to 28 days to become adults.

Figure 28. Rice stink bug

Sample for rice stink bugs using the beat bucket method as described above. Determine the average number of bugs per sorghum head, and use Table 23 to determine the treatment threshold based on the cost of control and grain value. For example, if the cost of control is $8 per acre and grain value is $8/cwt, the economic threshold is 30,500 rice stink bugs per acre. To determine the threshold as the number of rice stinkbugs per head, divide the threshold by the number of plants per acre with a grain head. As an example, if the plant population is 50,000 plants, each with 1 grain head, the threshold is 30,500 ÷ 50,000 = 0.6 rice stinkbug per head.

Table 23. Economic injury level, shown as the number of rice stink bugs per acre of sorghum at the milk stage

Control cost, $/A	Grain value, $/100 lb			
	6.00	7.00	8.00	10.00
6	30,500	27,000	23,000	18,500
8	40,500	35,000	30,500	24,500
10	51,000	43,500	38,000	30,500
12	62,000	52,500	46,000	36,500

In this example, an insecticide treatment should be made if field scouting finds an average of 0.6 or more rice stinkbugs per head (Table 24).

Growers can also enter these variables into an online calculator to determine the economic threshold for rice stinkbugs (http://entomology.tamu.edu/extension/apps/).

False chinch bug

The false chinch bug (*Nysius raphanus*) resembles the chinch bug but is uniformly gray to brown (Fig. 29). False chinch bugs are 1⁄10 inch long. Large numbers of these bugs occasionally migrate from wild hosts, such as wild mustard, to sorghum. However, these insects usually concentrate in small areas of a field. Sample for false chinch bugs using the beat bucket method described above. The action level for false chinch bug is 140 bugs per grain head when infestation begins at the milk stage of grain development (Table 24).

Figure 29. False chinch bugs

Stink bugs, leaffooted bug, and Lygus bug

Like the rice stinkbug, other species of true bugs have piercing-sucking mouthparts and feed on developing grain in sorghum heads:

- **Southern green stink bugs** (*Nezara viridula*) are bright green, shield shaped, and slightly larger than ½ inch long.
- **Conchuela stink bugs** (*Chlorochroa ligata*) vary from dull olive or ash gray to green, purplish pink, or reddish brown. The most characteristic markings are orange-red bands along the lateral margins of the thorax and wings and a spot of the same color on the back at the base of the wings.
- **Leaffooted bugs** (*Leptoglossus phyllopus*) are brown, oblong, and just longer than ¾ inch. A white band extends across the front wings. The lower part of each hind leg is dilated or leaflike.
- **Lygus bugs** (*Lygus* spp.) are oval, greenish insects that run and fly quickly when disturbed. The adults can fly into sorghum fields during grain fill and feed on the developing kernels, potentially reducing grain yield and quality.

Figure 30. From left: Brown, conchuela, rice, and southern green stink bugs

Figure 31. Leaffooted bug

Figure 32. Lygus bug

Figure 33. Lesser cornstalk borer

The treatment threshold for the southern green stink bug and conchuela stink bug is an average of four or more bugs per grain head during the during the flowering, milk, or soft dough stages (Table 24, Fig. 30). Once the grain is in the hard dough stage, the threshold for these stink bugs and leaffooted bugs increases to an average of 16 or more per grain head. The threshold for leaffooted bugs is an average of six or more bugs per grain head during flowering, milk, or soft dough stages (Fig. 31).

No treatment threshold has been developed for Lygus bugs in grain sorghum (Fig. 32). Results of one experiment in the High Plains suggested a treatment threshold of 12 lygus bugs per head during the soft dough stage.

Stalk-boring insect pests

Lesser cornstalk borer

The larvae of lesser cornstalk borers (*Elasmopalpus lignosellus*) attack roots and bore into the stems of young plants of peanuts, corn, sorghum, and other crops. Damaging infestations of this insect rarely occur in sorghum. The larvae are light bluish green with prominent transverse reddish-brown bands (Fig. 33). They feed in silken tunnels covered with soil particles. The larvae pupate in silken cocoons under crop debris.

Infestations of lesser cornstalk borers usually are more severe during dry periods and in sandy soils. To discourage the insect, adopt cultural practices that preserve moisture and increase organic matter in the soil. Early planting and rotation with nonhost crops help avoid damage from lesser cornstalk borer. Insecticidal control rarely is justified, although formulations of *lambda*-cyhalothrin, *gamma*-cyhalothrin, deltamethrin and chlorpyrifos are labeled for control of lesser cornstalk borer in grain sorghum.

Other borers

The sugarcane borer (*Diatraea saccharalis*), southwestern corn borer (*Diatraea grandiosella*), European corn borer, (*Ostrina nubilalis*), Mexican rice borer (*Eoreuma loftini*), and neotropical borer (*Diatraea lineolata*) are closely related insects that tunnel in the stalks of sorghum, corn, and other crops.

The biology of these four species is similar. The moths are white to buff colored, and the females deposit clusters of flattened, elliptical to oval eggs that overlap like fish scales in a shingle-like arrangement on the host plant leaves. The eggs hatch in 3 to 7 days.

The larval stage lasts about 25 days and the pupal stage about 10. There are two to three generations a year. The larvae are creamy white and about 1 inch long when fully grown. Most of the body segments have conspicuous round brown or black spots (Fig. 34). The spots on mature overwintering larvae are lighter or absent. Most of these borers pass the winter as fully grown larvae in cells inside the stalks that remain after the crop is harvested.

Table 24. Insecticides labeled for stink bugs and false chinch bugs in grain sorghum. Follow label directions.

Active ingredient	Insecticide	Mode of action	Rate	Remarks	REI[1]	PHI[2]
Postemergence treatment						
alpha-cypermethrin	Fastac	3A	1.3–3.8 fl oz/A	Restricted use. **Danger**	12H	14 days
beta-cyfluthrin	Baythroid XL	3A	1.3–2.8 fl oz/A	Restricted use	12H	14 days
chlorpyrifos + *gamma*-cyhalothrin	Cobalt	1B, 3A	19–38 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A; 60 days for > 26 oz/A
chlorpyrifos + *lambda*-cyhalothrin	Cobalt Advanced	1B, 3A	16–38 fl oz/A	See label. Restricted use	24H	30 days for up to 26 oz/A and 60 days for > 26 oz/A
chlorpyrifos + *zeta*-cypermethrin	Stallion	1B, 3A	5.0–11.75 oz/A	Restricted use	24H	30 days
cyfluthrin	Tombstone 2	3A	1.3–2.8 fl oz/A	Restricted use	12H	14 days
deltamethrin	Delta Gold	3A	1.5–1.9 fl oz/A	Not labeled for false chinch bug. Restricted use. Danger—Poison	12H	14 days
gamma-cyhalothrin	Proaxis Declare	3A	2.56–3.84 oz/A 1.02–1.54 oz/A	Not labeled for false chinch bug. Restricted use	24H	30 days
lambda-cyhalothrin	Warrior II with Zeon, Karate with Zeon, generics	3A	1.28–1.92 oz/A	Apply no more than 6 oz of *lambda*-cyhalothrin-containing products once the crop has reached soft dough stage. Not labeled for false chinch bug. Restricted use	24H	30 days
lambda-cyhalotrhin + chlorantraniliprole	Besiege 1.25 SC	3A, 28	6–10 oz/A	Do not exceed total of 18 fl oz/A per year. Apply no more than 6 oz of *lambda*-cyhalothrin-containing products once the crop has reached soft dough stage. Not labeled for false chinch bug. Restricted use	24H	30 days
zeta-cypermethrin	Mustang Maxx, generics	3A	1.76–4.0 oz/A	Restricted use	12H	14 days

1: REI = Restricted entry interval
2: PHI = Preharvest interval

Figure 34. Borers that attack sorghum include (from top): Mexican rice borer, southern cornstalk borer, neotropical cornstalk borer, and European corn borer

Figure 35. Sugarcane rootstock weevil

Young larvae feed for a few days on the leaves or leaf axes. Older larvae tunnel into the sorghum stalks; larvae bore up and down the pith of the stalk. Borer-infested stalks may be reduced in diameter and yield less. Larval tunneling just below the grain head can cause it to break and the grain head to fall. Injury by borers increases sorghum susceptibility to stalk rot diseases and lodging.

Plant sorghum early because borers are typically more abundant in late-planted sorghum. In northern Texas regions, shredding stalks very close to the ground or plowing and disking stubble destroys overwintering larvae of the southwestern corn borer by exposing them to cold temperatures. This practice reduces borer abundance the next year.

Check the plants carefully for stem borers. Look for small holes near the leaf axis, which indicate that a larva has entered the stalk. Once the larvae have entered the stalk, it must be split to see them. Inspect the leaves carefully—the eggs are hard to find. Clusters containing 10 to 20 individual eggs may be on the top or underside of leaves, depending on the borer species. Assess the abundance of eggs and small larvae before the larvae bore into stalks. Insecticidal control is effective only if applied before larvae bore into stalks.

Sugarcane rootstock weevil

The sugarcane rootstock weevil, *Apinocis* (*Anacentrinus*) *deplanatus,* infests sorghum sporadically, especially during dry years and in fields where johnsongrass is abundant. The adult weevil is dark brown or black, about 1/8 inch long and 1/16 inch wide (Fig. 35). It overwinters beneath plant residues on the ground. In early spring, the weevils infest wild grasses, such as johnsongrass, and later move to sorghum. The female uses its mouthparts to make a small puncture at the base of the plant, where the egg is deposited and concealed. It lays about 16 eggs, which hatch in 6 days. When fully grown, the larvae are white, legless grubs about 1/5 inch long. A generation is completed in about 40 days.

Adult weevils feed on young sorghum plants and create pinpoint holes in the leaves. The larvae cause the most damage as they tunnel into the sorghum stalk just above or below the soil surface. The larvae are often found at nodes and near the outer surfaces of the stalk. As a result of larval feeding, the plants appear drought stressed and may lodge. Pathogens can invade the plant through feeding tunnels. Although locally damaging populations may occur, economic thresholds for this pest have not been established, and control has usually not been required.

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The information and suggestions in this publication reflect the opinions of Extension entomologists based on research and experience. However, it is impossible to eliminate all risk. Conditions or circumstances that are unforeseen or unexpected may result in less than satisfactory results even when these suggestions are used. Texas AgriLife Extension Service will not assume responsibility of risks. The user of this publication shall assume such risks.

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The users are always responsible for the effects of pesticide residues on their livestock and crops, as well as for problems that could arise from drift or movement of the pesticide from their property to that of others. Always read and carefully follow the instructions on the container label.

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You must inform employees about exposure, protect them from exposure, and mitigate pesticide exposures that they may receive. WPS requirements appear in the "Directions for Use" part of the pesticide label. For more information, see the online Worker Protections Standard, 40 CFR part 170, or visit the website of the Texas Department of Agriculture's Pesticide Worker Protection Program or contact the department at (512) 463-7622 or pesticides@TexasAgriculture.gov.

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