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Texas Agricultural Extension Service

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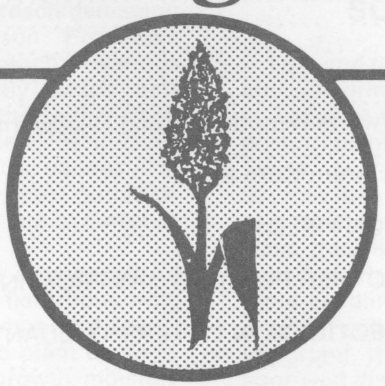
Managing Insect and Mite Pests of Sorghum



Texas Agricultural Extension Service • Zerle L. Carpenter, Director • The Texas A&M University System • College Station, Texas

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Managing Insect and Mite Pests of Texas Sorghum

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Five to six million acres of Texas farmland are utilized annually to produce sorghum. The potential economic value of sorghum, primarily as livestock and poultry feed, makes pest control an important factor in efficient and profitable production. Sorghum also is used extensively in rotation with cotton and soybeans and is important to weed and some disease control strategies.

Sorghum and other crops grown in a community share important insect relationships. Beneficial insects that reproduce in maturing sorghum often move to cotton and other crops and aid in the control of numerous pests. Therefore, control decisions carried out in sorghum may affect pests and beneficial insect numbers in neighboring crops.

Insect and mite pests of sorghum may reach damaging levels throughout the production season. Producers should be aware of the probable occurrence of various pests (Figure 3, page 16), be able to correctly identify pests and be aware of the various methods that aid in their suppression. Proper choice and careful use of insecticides are important. Indiscriminate insecticide use can result in pest resistance, resurgence or secondary pest outbreak. Selective insecticide use greatly reduces the occurrence of these problems.

Proper crop production planning and seedbed preparation, as well as periodic in-season field monitoring for the occurrence of pest problems, are important. Insect numbers do not always relate directly to plant damage. Factors such as plant vigor and stage of growth, moisture conditions, time of year, parasite and predator abundance, and crop rotation are equally important.

Descriptions of pests and their damage, methods for making insect and mite counts and various pest control methods are included in this publication.

POLICY STATEMENT FOR MAKING PEST MANAGEMENT SUGGESTIONS

The information and suggestions included in this publication reflect the opinions of Extension entomologists based on field tests and use experience. Our management suggestions are a product of research and are believed to be reliable. However, it is impossible to eliminate all risk. Conditions or circumstances which are unforseen or unexpected may result in less than satisfactory results even when these suggestions are used. The Texas Agricultural Extension Service will not assume responsibility for risks. Such risks shall be assumed by the user of this publication.

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Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate specialists are advised of changes as they occur.

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

SOIL PESTS OF SORGHUM

True and false wireworms, white grubs, corn rootworms and cutworms are the most common soil pests of sorghum in Texas. Additionally, fire ants are common soil insect pests of planting seed in the eastern and southern areas of Texas. Non-crop plant materials are important food sources for soil pests. Cultivation practices and/or the use of herbicides that reduce crop residues and provide for weed-free fields are important in reducing soil pest densities. Proper seedbed preparation that provides for rapid seedling emergence and stand establishment and preplant soil inspection for the presence of soil pests are important. If damaging levels of soil pests are detected, approved insecticides may be applied to the seed prior to planting or to the soil using the broadcast, rowband or in-furrow method of application. Preplant seed treatment or planter box seed treatment has proven effective in controlling wireworms and corn rootworms where low densities were present. High densities of these pests require broadcast or band application of approved insecticides. Effective control of white grubs at densities grater than 1 per square foot is usually obtained only with the broadcast, incorporated application technique.

Seed Treatment

Seed treatment in the past was done by the seed company; however, because of restrictions on chemicals used on seeds, many commercial seed companies are not treating seeds. Direct seed treatment or planter box treatments have been used by growers where commercially treated seeds are not available.

Wireworms, fire ants and other seed-feeding insects may be effectively controlled by treating seeds with lindane. When treating seeds, the insecticide should coat each seed evenly. Use a concrete mixer, commercial or homemade seed treater to treat seeds. Sprinkle 1 pint of water on each 100 pounds of seed and mix this to coat the seed with moisture. Slowly add the correct amount of

insecticide while mixing the seed, and mix thoroughly until the insecticide is evenly distributed on all seeds. Treated seeds should be planted within 20 days of treatment, since long exposure to the chemical will affect germination in some varieties. Do not use treated seed for human consumption or livestock feed.

Insecticides such as malathion or methoxychlor are often applied to seed to control stored grain pests. These insecticides are not effective for control of soil pests.

Certain precautions should be followed when lindane is used on planting seed since it can slow germination under cold, wet soil conditions. Do not use more than the labeled rate; in fact, it would be best to use less than the maximum allowed. Make sure to redistribute planter box applied materials once or twice per day or when adding seed. If the 7-day forecast is for a cold, wet period or the soil temperature is marginal for seed germination, it may be best not to use lindane. Do not apply lindane to sorghum seed already treated with heptachlor. Despite all these precautions, lindane seed treatment has been an effective, low-cost method of protecting planting seed from insect attack.

Soil Treatment

Insecticide for controlling some soil pests must be applied before the crop is planted or at planting time. Granular or liquid formulations may be used. The formulation used usually depends on the producer's equipment and the target insect. Granular forms of insecticide are generally safer and more convenient. With the soil method there are three application techniques: (1) the preplant broadcast, (2) row band, and (3) in-furrow at planting.

Preplant Insecticide Application. A broadcast application generally provides the best protection against soil insects and is the only means of controlling heavy infestations of white grubs. Unfortunately, broadcast applications require more insecticide and are more expensive than row band or in-furrow treatments and, therefore, are usually not recommended. However, when broadcast applications are necessary, the insecticide should be applied uniformly to the field and incorporated to a depth of 3 to 5 inches immediately after application.

When sorghum is planted on a bed, special equipment is required to incorporate the insecticide to a depth of 3 to 5 inches. This is called row treatment. Row treatments must be made after or during bed formation, since further cultivation or bed shaping will alter the position of the insecticide in the row. A treated band of soil 7 to 10 inches wide and 3 to 5 inches deep, with seed placed in the center of the treated band, is necessary to obtain the best control.

Insecticide Application at Planting. Insecticides may be applied to the soil at planting time by the row band or in-furrow techniques. The technique of choice will depend on pest insect and how a particular insecticide is labeled.

Mount granular application equipment on the planter with the spout just behind the opening plow or disc opener and in front of the covering shovels or press wheel. Adjust the spouts so that the treatment band is about 6 to 8 inches wide and so that the seed furrow, as well as covering soil, is treated. Incorporation of the insecticide by covering shovels is adequate. Insecticide can also be incorporated with short parallel chains, loop chains, press wheel, finger tines or other suitable devices. Some insecticides are labeled only for band application behind the seed covering devices. *Do not* apply insecticides directly on the seed unless it is specifically listed on the label, since doing so usually results in poor seed germination. Poor control usually results from in-furrow application where western corn rootworm or white grub populations are high.

Some insecticides (e.g., aldicarb, carbofuran, disulfoton, phorate, terbufos, etc.) have systemic activity and can be applied at planting. When these chemicals are applied to the soil, they are absorbed into the young growing sorghum plant and will suppress some early season insect pest species such as greenbug, corn leaf aphid, yellow sugarcane aphid and chinch bug on seedling plants. Certain of the chemicals, e.g. carbofuran, besides being systemic, are effective against some species of soil-inhabiting insect pests such as wireworms and corn rootworms. The duration of systemic activity varies with the insecticide, but generally insect pest suppression is provided for two to three weeks after application.

For specific pesticide control suggestions, limitations and rates of each insecticide labeled for use on sorghum, refer to the insecticide suggestion tables for each insect pest.

Wireworms, Fire Ants and Other Seed-Feeding Insects

True and false wireworms are the immature stages of click and darkling beetles. Wireworms are generally shiny, slender, cylindrical and hard-bodied. They range in color from yellow to brown.

Wireworms damage sorghum by destroying planted seed and, to a lesser degree, by feeding on seedling plant roots. Stand establishment and plant vigor are reduced. Sampling of fields for the presence of wireworms prior to planting is recommended. Soil samples 1 foot square by 4 inches deep should be examined thoroughly. *If two or more wireworm larvae per square foot are detected, control measures should be implemented.*

Cultural practices that reduce non-crop plant materials in fields or rotation to tap-rooted crops that are unfavorable for wireworm development are important non-chemical control methods.

Approved insecticides, applied as seed treatments or planter box treatments, are effective in controlling wirewoms and fire ants. Pretreated commercial seed may sometimes be purchased for wireworm control. Check the label to see if such seed has been treated for soil insects. See seed treatment procedures on page 3 for specific treatment procedures.

Under certain conditions fire ants will feed on planting seed. In addition to treated seed, use seed with good vigor and plant into a well-prepared seed bed. Firm up the covering soil to reduce chances of fire ant damage.

White Grub

White grubs are the larval stages of May or June beetles. Larvae are characteristically "C-shaped" with a white body and tan to brown head. Larvae vary in size according to age and species. The last abdominal segment is transparent, and dark colored digested material can be seen in the larvae.

Damage to plants results from larvae feeding on the roots. Small seedlings often are killed, resulting in stand loss. Severely pruned roots of larger plants result in stunting, plant lodging and increased susceptibility to drought conditions and stalk rot organisms.

The need for white grub control, using a soil insecticide, can be determined by soil sampling. Examine one square-foot soil sample for each 5 to 10 acres before planting. *If white grub numbers exceed 2 per square foot, broadcast insecticide.* On the same day as treatment, incorporate the insecticide into the top 2 to 4 inches of soil using a disc, field cultivator or equivalent equipment. *If white grubs average approximately 1 per square foot, adequate suppression can be achieved with a planting time in-furrow or band treatment.*

SUGGESTED INSECTICIDES FOR CONTROLLING WHITE GRUBS

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Diazinon		See Remarks	
(14 G)	7-10 lbs	7	0
(4 lb)	1.5-2 qts	7	0
Fensulfothion			
(Dasanit®)		See Remarks	
(15 G)	6.5 lbs	0	0
(6 lb)	22 f oz	0	0

Remarks

Diazinon. Preplant broadcast applications are most effective though soil incorporation is necessary. Do not apply directly to seed. Make application where populations average one grub per square foot of soil.

Fensulfothion (Dasanit®). Apply granules in seed furrow at planting as a 2-inch band, ½ inch above seed. Do not apply directly to seed. Apply specified dosage in 20 gallons of water as a 3- to 4-inch band in the seed furrow at planting, ½ inch above seed. Do not apply directly to seed.

Southern Corn Rootworm

Southern corn rootworm is the larval stage of the twelve-spotted cucumber beetle. The southern corn rootworm is the most important sorghum pest of the rootworm complex. Rootworms are small, brown headed, creamy white larvae that burrow into the roots and crowns of sorghum plants. Reduced stands and plant vigor, and the occurrence of dead heart in young plants, are characteristic of rootworm damage. Delayed maturity, increased weed abundance and plant lodging may occur later in the season in corn rootworm-damaged stands.

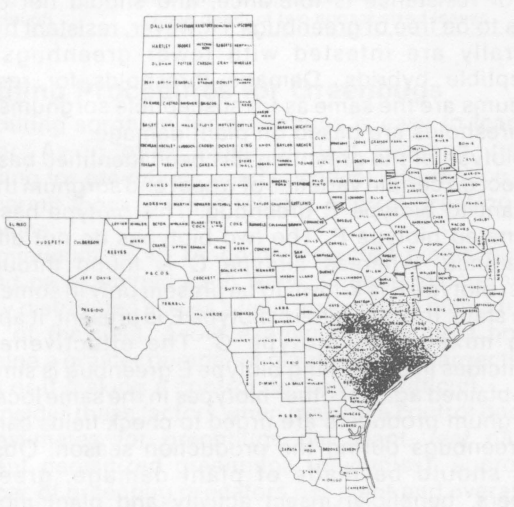


Figure 1. Areas of southern corn rootworm infestations in Texas.

Granular or liquid insecticides are labeled for in-furrow or pre-plant use for control of corn rootworm. These insecticides are recommended for corn rootworm control in the area of Texas shaded in the map below. Base treatments on field history of previous damage. It is recommended that chemicals be rotated to decrease the possibility of rootworms developing resistance. Seed treatment with lindane is effective in controlling light infestations of corn rootworms present at planting time.

SUGGESTED INSECTICIDES FOR CONTROLLING SOUTHERN CORN ROOTWORM

Insecticides (listed alphabetically)		
Toxicant per gallon or pound	Amount	
Carbofuran		See remarks
(Furadan® 4F)	1-2 pts/acre	
(Furadan® 10G)	6-12 oz/1000 ft row	
(Furadan® 15G)	4-8 oz/1000 ft row	
Chlorpyrifos		See remarks
(Lorsban® 15G)	4-8 oz/1000 ft row	
Terbufos		See remarks
(Counter® 15G)	4-8 oz/1000 ft row	

Remarks

Carbofuran. Apply in seed furrow or in a 7-inch band and incorporate.

Chlorpyrifos. Apply in a 6- to 7-inch band, one application per season. Apply behind planter shoe and in front of the press wheel.

Terbufos. Place granules in a 5- to 7-inch band directly behind the planter shoe in front of the press wheel. Do not place granules in direct contact with seed. Only one application per season may be used.

NOTE: The lower rates given above have been shown in numerous field experiments to provide the most favorable economic returns, in most fields; however, in fields where heavy infestations occur each year, it would be advisable to increase the insecticide rate.

Cutworms

A complex of cutworm species can damage sorghum. Cutworms are the immature stages of moths that are active at night. Grassy sod and weedy fields are attractive to moths for egg laying. Some subterranean cutworms feed on the seedling root system. These cutworms are often those which have overwintered in the field. Subterranean cutworms can be suppressed with soil insecticide applied at planting. Incorporation of insecticide into the top 1 to 2 inches of soil in a 6- to 7-inch band is best. Refer to labels of insecticides listed for southern corn rootworm on page 5 for their cutworm status.

Cultivation practices and/or the use of herbicides that reduce non-crop plants in season and in fallowed fields are important cutworm control methods.

Aerial or ground application of approved insecticides is effective in controlling cutworm damage to established sorghum stands.

Lesser Cornstalk Borer

Larvae of the lesser cornstalk borer attack the root system and lower stalk of sorghum plants. Larvae are light bluish-green with prominent transverse bands of brown. They feed in silken tunnels covered with soil particles. After completion of feeding, larvae pupate in silken cocoons under crop debris.

Cultural practices which increase moisture and crop residue, along with early planting and rotation to nonhost crops, will reduce damage from lesser cornstalk borer.

SUGGESTED INSECTICIDES FOR CONTROLLING LESSER CORNSTALK BORER

Insecticide		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Diazinon (14G)	7-8 lbs	See remarks	

Remarks

Diazinon. Apply granules in a band 10 inches wide over seed furrow or seedling plants. Apply simultaneously with planting, just after seed drop and seed press wheel and in front of covering shovels, press wheel or chain drag. Soil coverage is important. Do not apply directly to seed.

ABOVE GROUND PESTS OF SORGHUM

Sorghum is susceptible to above ground insect pests throughout its growth and development. Some insects attack sorghum over a broad range of developmental stages while others only attack the plant at a specific stage of growth (Figure 3).

Regular monitoring of pest populations in the field is important for making good management decisions. At least weekly field inspections should be made throughout the growing season, although a specific insect pest(s) may require more frequent monitoring.

Insecticide Application Methods And Precautions

Ground machines or aircraft may be used to apply most insecticides to sorghum. For best results with aerial applications, flag the swaths so that they meet or overlap.

Spray applications are most effective and hazards minimized when wind velocity does not exceed 15 miles per hour. Avoid spraying when plants are wet. For broadcast crops, number 3 cone nozzles set 20 inches apart on a rear-mounted boom of a tractor sprayer are satisfactory. A pump pressure of 60 pounds per square inch is recommended.

Nozzle size and number, ground speed and pressure influence the rate of output per acre; therefore, calibrate the sprayer carefully to ensure application of recommended insecticide amounts. One nozzle per row usually is adequate for young row crops, but two to three nozzles per row may be desirable on larger plants to obtain adequate coverage.

A number of insecticides discolor the foliage of certain sorghum hybrids. Yield losses have resulted from extensive leaf damage following the use of these chemicals on susceptible sorghum hybrids. Before application, check the insecticide label closely and consult the manufacturer and the seed company regarding possible phytotoxic effects. Insecticides which are known to cause extensive phytotoxicity have been eliminated from the recommendations in this publication. Always follow label instructions carefully to avoid hazards to the applicator, wildlife and the environment.

Cutworms

Cutworms are dingy, grayish-black, smooth "worms" that are the larval stage of several different moths. Cutworms are active at night and damage seedling sorghum by cutting the stalk just above ground level. Large numbers of cutworms may be found in fields where grass and weeds are a problem.

When cutworms are damaging plant stand, an application of insecticide applied by air or ground usually will give adequate control. Best results are obtained when insecticides are applied in the late afternoon. If the soil is dry, cloddy or crusty at the time of treatment, control may not be as effective as in moist soil.

SUGGESTED INSECTICIDES FOR CONTROLLING CUTWORMS

Insecticide		
Toxicant per gallon or pound	Concentrate per acre	
Chlorpyrifos (Lorsban® 4E)	1-2 pts	See remarks

Remarks

Chlorpyrifos. To minimize chemical injury, do not apply to drought stressed sorghum within 3 days following irrigation or rain except where the product is applied in irrigation water.

Greenbug

The greenbug is an aphid that sucks plant juices and injects a toxin into sorghum plants. The aphid is pale green, approximately 1/16-inch long with a characteristic dark green stripe down the back. Greenbugs often occur in damaging numbers under favorable conditions and may cause economic losses. The extent of greenbug damage in sorghum is dependent upon greenbug numbers, plant size, vigor and stage of growth, moisture conditions and effectiveness of parasites and predators. Producers are cautioned to observe plant conditions closely as well as greenbug numbers and damage. Damage at the seedling stage may result in stand loss. Greenbugs usually feed in colonies on the underside of leaves. Characteristic reddened spots on the upper leaf surface and the occurrence of honeydew are associated with greenbug feeding damage.

Producers in areas of the state where greenbugs occur should consider planting greenbug-resistant sorghum hybrids. These hybrids are helpful in reducing damage by the greenbug. Producers should be aware that the primary type of resistance is tolerance, and should not expect plants to be free of greenbugs. However, resistant hybrids generally are infested with fewer greenbugs than susceptible hybrids. Damage thresholds for resistant sorghums are the same as for susceptible sorghums since the thresholds are based on plant damage.

A biotype of the greenbug has been identified based on its effect on certain varieties of wheat and sorghum that are resistant to biotype C greenbug. This biotype has been designated biotype E. The two biotypes do not differ in appearance. Whereas biotype C is found throughout Texas, biotype E is known to be present only in some areas of the state. In areas where biotype E is present, it appears to be mixed with biotype C. The effectiveness of insecticides in controlling biotype E greenbug is similar to that obtained against other biotypes in the same localities.

Sorghum producers are urged to check fields carefully for greenbugs during the production season. Observations should be made of plant damage, greenbug numbers, beneficial insect activity and plant moisture stress. Guidelines for when to treat are given in the table

below. Sorghum hybrids resistant to biotype C and E are available.

Treat plants up to about 6 inches in height when visible yellowing and reddening of the plant and greenbug colonies are observed and stand loss is probable. Larger plants up to the boot stage will tolerate more greenbugs than seedling sorghum. Control greenbugs on this size plant before any entire leaves are killed.

Yield reductions during the boot, flowering and grain development stages are dependent on greenbug numbers, length of time that greenbugs have infested plants and plant condition. High numbers on booting and older plants can cause yield reduction and weakened plants that may *lodge at a later date. Greenbugs on boot to heading stage sorghum should be controlled when colonies are causing red spotting or yellowing of leaves and at the death of one functional leaf.*

In the Texas Blacklands, insecticide applications are suggested if greenbugs are colonizing on the upper leaves of booting sorghum and death of tissue is occurring. Plants can tolerate approximately 30 percent leaf loss before yield reduction occurs. *After sorghum heading, indications are that greenbug numbers which cause the death of more than two normal-sized leaves after flowering and before the hard-dough stage should be controlled.*

These general guides are based on the assumption that the greenbug density increase is occurring so rapidly that control by beneficial insects is not effective. However, if more than 20 percent of the greenbugs appear brown and swollen from being parasitized, then application of an insecticide is not generally necessary. Also, plants undergoing drought or other stress cannot support as many greenbugs without suffering yield reductions.

The following table will serve as a general guide in determining the need for treatment:

Greenbug Treatment Thresholds

Plant Size	When to Treat
Emergence to about 6 inches	Visible damage (plants beginning to yellow) with colonies of greenbugs on plants
Larger plant to boot	Greenbug colonies causing red spotting or yellowing of leaves and before any entire leaves are killed
Boot to heading	At the death of one functional leaf
Heading to hard-dough	When greenbug numbers are sufficient to cause death of two normal-sized leaves

Scouting Procedures for Greenbugs

Scouting sorghum for greenbugs is easy to learn and master. As in other types of field scouting, persons scouting for greenbugs need to collect information which will permit them to make reliable control (treat/no-treat) decisions.

A minimum of 40 randomly selected plants per field should be examined each week. Greenbugs are seldom evenly distributed across a field, so examine plants from all parts of the field. Avoid examining only field borders. Examine a greater number of plants in fields larger than 80 acres or if making a control decision is difficult.

Consider these factors when making a control decision: the estimates for greenbugs per plant, leaf damage, percent parasitized greenbugs (mummies), appropriate number of greenbug predators per plant and overall crop condition. When estimating the number of greenbugs absolute accuracy is not necessary because treatment decisions cannot be based on these numbers alone. However, it is important to know if these numbers are increasing or decreasing from week to week. For instance, if the recommended treatment level (based on leaf damage) has been reached but greenbug numbers have declined substantially from previous observations, chemical treatment would not be justified.

In seedling sorghum (up to about 6 inches tall), greenbugs may be found on any part of the plant including the whorl, or under some environmental conditions, in the soil at the base of the plant.

When scouting seedling sorghum, examine the entire plant and the soil around the base of the plant. Note the presence or absence of greenbugs and any damage to plants (yellowing, death of tissue).

When scouting fields with larger plants, whole plant and soil inspections are not necessary. Greenbug colonies generally originate on the undersides of lower leaves and move up the plant. Only the undersides of lower leaves need to be examined. A word of caution: the development of greenbug colonies does not always follow this pattern on some sorghum hybrids. In some cases, greenbug colonies may first be found on the undersides of upper leaves. Take care not to confuse the bluish-green corn leaf aphids often found in the plant whorls with greenbugs.

To make a correct control decision, record and consider the previously listed factors and consult the recommended treatment levels provided. When estimating leaf damage, consider any leaf which has more than 75 percent of its surface reddened or damaged to be a dead leaf. Take care not to mistake the natural senescence of the small bottom "seed" leaves for greenbug damage. Estimate an average leaf damage level for the entire field unless it is feasible to spot treat.

Some insecticides with systemic action applied at planting for soil pests will also suppress greenbug. (See page 4).

SUGGESTED INSECTICIDES FOR CONTROLLING GREENBUG

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Attention: Review all remarks thoroughly.			
Carbofuran (Furadan®) (4 lb)	0.5-1 pt	See remarks	
Chlorpyrifos (Lorsban®) (4 lb)	0.5-1 pt	See remarks 28	28
Diazinon (4 lb)	0.25-1 pt	7	0
Dimethoate (Cygon®) (4 lb)	0.5-1 pt	See remarks 28	28
(2.67 lb)	0.66-1.5 pts		
Disulfoton (Di-Syston®) (8 lb)	4-8 fl oz	See remarks 7	28
(15G)(whorl application)	3.5-6.7 lbs	30	14
Malathion (5 lb)	0.5-1.5 pts	7	7
Oxydemetonmethyl (Metasystox-R®) (2.0 lb)	1-2 pts	See remarks 45	21

(continued)

Parathion (ethyl)		See remarks	
(4 lb)	0.25-1 pt	12	12
(8 lb)	0.125-0.5 pt	12	12
Phorate		See remarks	
(Thimet®)			
(15G)	5-6.5 lbs	28	28
(20G)	4.9 lbs	28	28

Difficulty in controlling greenbugs has been encountered in some counties of Texas. Resistance exists to most registered materials in some localized areas and continued extensive use of certain insecticides is apt to expand the resistance problem. Where resistance exists in an area, the initial insecticide application should be made at the higher labeled dosage rate. *See remarks for use of lower rates.*

Remarks

See *Greenbug* on page 6 for details on timing applications, type of damage and need for control. It is important to be able to distinguish between the greenbug and other aphids (page 7) occurring in sorghum. Lower rates in the table have been effective in controlling economic infestations. In areas that do not have insecticide resistance, effective use of reduced rates is dependent on proper application timing. Reduced rates are designed to suppress greenbug densities below injurious levels while providing maximum protection of beneficial species. Using insecticides to achieve total elimination of greenbugs is not desirable. To conserve beneficial species, a sub-economic greenbug density must be maintained as a food source.

Carbofuran. Do not apply after heads emerge from the boot. Do not graze or harvest sorghum grown for forage or silage within 75 days of treatment. Do not apply to grain sorghum prior to rogueing. Workers should not enter fields within 14 days of application unless full protective equipment is used.

Chlorpyrifos. Do not exceed three applications.

Dimethoate. Do not apply more than three times per season.

Disulfoton. Do not apply foliar spray or granules more than three times per crop season. Granular formulation recommended as whorl application only. Post-harvest interval is 34 days for three foliar applications.

Oxydemetonmethyl. Apply with not less than 1 gallon of water per acre up to three applications per season. Do not use on sweet sorghum. Slight phytotoxicity may occur in some sorghum hybrids.

Parathion. Do not substitute with methyl parathion.

Phorate. Whorl application only; only one application per season. Do not enter field for 7 days after treatment.

Corn Leaf Aphid

High densities of this bluish-green aphid, characterized by black legs, cornicles and antennae, sometimes cause damage to seedling sorghum. Larger sorghum plants in the boot and later growth stages generally can tolerate large numbers of aphids without significant damage. After panicle exertion, corn leaf aphid numbers rapidly decline. Yield losses have occurred only where corn leaf aphids cause stand loss of seedling plants. Although rare, head infestations have caused harvesting problems. These aphids feed primarily in the whorl of pre-boot sorghum and do not inject a toxin. Corn leaf aphids are important hosts for development of beneficial insects which are helpful in the control of greenbugs and other pests of sorghum.

Yellow Sugarcane Aphid

This lemon-yellow aphid is covered with small spines and has two double rows of dark spots down the back. The yellow sugarcane aphid has a wide range of wild hosts and is often found on johnsongrass and dallisgrass in Central and South Texas. This aphid injects a toxin during feeding which causes purple-colored leaves in seedling plants, and stunting and yellowing of more mature leaves. It has caused death of plants in the pre-boot stage. Yellow sugarcane aphids typically infest sorghum soon after plants emerge from the soil. Consequently, fields should be scouted and plants inspected beginning the first week of plant emergence and twice weekly until plants have at least five true leaves. Yellow sugarcane aphid injury to sorghum is most severe when plants are small. As plants grow larger they become more tolerant to yellow sugarcane aphid feeding. Very small seedling sorghum plants (1 to 3 true leaves) are often significantly damaged after being infested for one week or less. The economic injury levels presented in the following tables are based on percent yellow sugarcane aphid infested plants when the infestation occurred at the 1, 2 or 3 true leaf stage. Do not count the two cotyledon leaves which first appear. To use the tables, determine the cost of control per acre (both the insecticide and cost of application per acre); then estimate, based on production experience, the expected per acre value of the crop. Match the appropriate columns in the table, reading down for crop value and across for control cost. The value found is the percent yellow sugarcane aphid infested plants that would cause economic damage sufficient to off-set the cost of control.

Yellow sugarcane aphid feeding on seedling sorghum causes a purple or yellow leaf discoloration. Apparently, by the time plant discoloration symptoms are readily visible, plants have already been significantly injured. However, discoloration symptoms may be useful in assessing yield loss that might be used in a decision to replant. Table 4 presents a description of plant damage and the corresponding percent yield loss associated with that level of damage. The yield loss of plants that suffered the described amount of damage can be adjusted for the condition of plants in a field by multiplying the number of plants having the amount of damage described by the appropriate percent yield loss, adding the total percent yield loss of the number of plants examined and dividing by the sampled number.

Systemic insecticides applied at planting for soil insect pests will also suppress the development of yellow sugarcane aphid (see page 4).

Table 1. Economic Injury Levels for Yellow Sugarcane Aphid Based on Percent Seedling Plants Infested at the One True-leaf Stage

Per acre control cost ($)	Crop market value ($) per acre								
	100	120	140	160	180	200	220	240	260
2	5	4	4	3	3	3	2	2	2
4	10	8	7	6	5	5	4	4	4
6	15	12	10	9	8	8	7	6	6
8	20	17	14	12	10	10	9	8	8
10	25	21	18	15	14	12	11	10	10

Table 2. Economic Injury Levels for Yellow Sugarcane Aphid Based on Percent Seedling Plants Infested at the Two True-leaf Stage

Per acre control cost ($)	Crop market value ($) per acre								
	100	120	140	160	180	200	220	240	260
2	9	7	6	5	4	4	4	3	3
4	17	14	12	11	10	9	8	7	6
6	26	22	19	16	14	13	12	11	10
8	35	29	25	22	19	17	16	14	13
10	43	36	31	27	24	22	20	18	16

Table 3. Economic Injury Levels for Yellow Sugarcane Aphid Based on Percent Seedling Plants Infested at the Three True-leaf Stage

Per acre control cost ($)	Crop market value ($) per acre								
	100	120	140	160	180	200	220	240	260
2	22	18	16	13	12	11	10	9	9
4	44	37	31	28	24	22	20	19	17
6	67	55	48	41	37	33	30	28	25
8	89	74	63	55	49	44	40	37	34
10	*	92	79	69	62	55	50	45	42

*do not treat

Table 4. Estimated Yield Loss Based on Damage Symptom Ratings*

Description	% Loss/plant
no discoloration	0
localized discoloration	8
less than one entire leaf discolored	11
one entire leaf discolored	31
more than one leaf discolored	54
more than two leaves discolored	77
dying-dead plant	100

*One to three true-leaf plants.

SUGGESTED INSECTICIDES FOR CONTROLLING YELLOW SUGARCANE APHID

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Disulfoton (Di-Syston®)		See remarks	
(8 lb)	4-8 fl oz	7	28
Parathion (ethyl)			
(4 lb)	1 pt	12	12
(8 lb)	0.5 pt	12	12

Remarks

Disulfoton. A maximum of three foliar applications may be made at rates of 8 fl oz or less per acre. Postharvest interval is 34 days for three foliar applications.

Chinch Bugs

Chinch bugs are sporadic pests of sorghum in Texas. The black bodied adult chinch bug has reddish-yellow legs and fully developed wings. The mostly white wings are marked with a triangular black spot at the middle of the outer wing margin. Immature chinch bugs resemble adults in shape but are reddish in color with a white band across the back.

Adult and immature chinch bugs suck plant juices and cause leaf reddening. Wilting and severe stunting of plants attacked by chinch bugs have been noted from the time of seedling emergence until plants are 18 inches high. Chinch bugs are favored by hot, dry weather, and large numbers of immature bugs often migrate from wild bunch grasses or small grains to congregate and feed behind the lower leaf sheaths of sorghum plants.

Apply insecticide treatments when two or more adult chinch bugs are found on 20 percent of the seedlings less than 6 inches high. Make at least five random checks per field. *On taller plants, initiate control when immature and adult bugs infest 75 percent of the plants.* When using ground application equipment, insecticide applications should be made through nozzles directed at the infested portion of the plants. Satisfactory control is seldom obtained on booting or larger plants.

Systemic insecticides applied at planting for soil insect pests will also suppress the development of chinch bugs (see page 4).

SUGGESTED INSECTICIDES FOR CONTROLLING CHINCH BUGS

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Carbaryl (Sevin®)		See remarks	
(80S)	1.25-2.5 lbs	21	0
(XLR® 4 lb)	1-2 qts	21	0
(Sevimol® 4 lb)	1-2 qts	21	0
Carbofuran (Furadan®)		See remarks	
(4 lb)	0.5-1 pt		
Chlorpyrifos		See remarks	
(Lorsban 4 E)	1-2 pts		
	1 pt	30	30
	2 pts	60	60
Parathion (ethyl)			
(4 lb)	0.5-0.625 pt	12	12
(8 lb)	0.25-0.60 pt	12	12

Remarks

Carbaryl. Use high gallonage ground application directed at base of plants.

Carbofuran. Ground application only. Use 20-30 gallons of water per acre. Do not apply more than twice per season. Do not apply after heads emerge from the boot.

Chlorpyrifos. Apply with sufficient water to ensure a minimum spray volume of 20 to 40 gallons per acre. Apply as a directed spray toward the base of the plant using ground spray equipment. Do not treat sweet sorghum varieties. Do not apply more than 3 pints per acre per season.

Banks Grass Mite

High numbers of Banks grass mite have been observed on sorghum in the more arid areas of Texas. Newly hatched, light-colored mites become dark green after feeding on sorghum with sucking mouthparts that withdraw plant fluids. Mites also produce webbing that can cover the undersides of leaves and the sorghum head during periods of heavy infestation. Although mites can be observed early in the growing season, density increases generally occur after the boot stage of development. Mites normally become established on the undersides of lower plant leaves. Mites migrate upward and sometimes move into sorghum heads as mite density and plant damage increase. Extremely high densities produce extensive webbing on sorghum heads and may be associated with stalk rot and lodging. Periods of hot, dry weather favor rapid mite population increase. Plants will tolerate mite damage better if protected from water stress. Heavy irrigation after mites increase will not suppress mite densitites.

Mite density and plant growth stage will dictate the need for miticide applications. Research has shown that large numbers of mites can reduce the ability of sorghum plants to make grain only until the seed reaches hard dough

stage. However, yield losses may occur after hard dough stage due to mite-induced lodging and related harvest losses. Erratic control has been experienced with all recommended miticides in some areas (Trans-Pecos and areas of the High Plains) of Texas. Thorough coverage is required; apply at least 3 to 5 gallons of spray mix per acre.

SUGGESTED MITICIDES FOR CONTROLLING BANKS GRASS MITE

Miticides (listed alphabetically)		Days from last: application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Dimethoate		See remarks	
(Cygon®)			
(4 lb)	1 pt	28	28
2.67 lb)	1.5 pts	28	28
Disulfoton		See remarks	
(Di-Syston®)			
(8 lb)(excluding Trans-Pecos area)	8-16 fl oz	7	28
Ethion		See remarks	
(4 lb)	1 pt	30	30
Methidathion		See remarks	
(Supracide®)			
(2 lb)	2 pts	30	30
Oxydemetonmethyl		See remarks	
(Metasystox-R®)			
(2.0 lb)	1-2 pts	45	21
Phorate		See remarks	
(Thimet®)			
(15G)	5-6 lbs	28	28
(20G)	4.9 lbs	28	28
Propargite		See remarks	
(Comite®)			
(6.75 lb)	1.5-2 pts	30	0

Remarks

Dimethoate. Ground application: apply in 25 to 40 gallons of water. Do not apply more than three times per season.

Disulfoton. The 8 fluid ounce rate may be applied as directed above for aphids. Rates above 8 fluid ounces per acre should not be applied if any soil applications have been made. If rates above 8 fluid ounces per acre are used, do not apply more than twice per crop season nor within 7 days of harvest of grain or 28 days of use as forage or fodder.

Ethion. Do not apply more than three times per growing season. Slight phytotoxicity may occur in some sorghum hybrids. It has been effective only in South Texas and Gulf Coast areas.

Methidathion. Up to three applications per season at 10- to 14-day intervals. Slight temporary phytotoxicity may occur.

Oxydemetonmethyl. Do not apply more than three times per season. Do not use on sweet sorghum. Certain sorghums may be sensitive to Metasystox-R®.

Phorate. Whorl application only. Use only one application per season.

Propargite. Do not apply more than once per season. Slight phytotoxicity may occur on some sorghum hybrids.

Sorghum Midge

The sorghum midge is one of the most damaging insects to sorghum in Texas. The adult sorghum midge is a tiny, fragile-looking, orange-colored fly. Damage to sorghum results from larvae that hatch from eggs deposited by female midge in spikelets of flowering sorghum heads. Each female may deposit about 50 tiny, yellowish-white eggs during her short lifetime of less than 24 hours. An orange-colored maggot hatches from the egg and feeds on the newly fertilized ovary, thereby preventing kernel development.

Effective sorghum midge control requires the successful integration of several activities that adversely affect midge population density and their potential to cause crop damage. Planting hybrids of uniform maturity early enough to avoid late heading is strongly recommended. This practice allows sorghum to complete flowering prior to the buildup of damaging midge densities. Cultural practices that tend to provide for uniform heading and flowering in a field are also important in midge control and in making decisions concerning the need for insecticide applications. The elimination of johnsongrass inside and outside the field by cultivation and/or herbicide applications will also help suppress midge.

To determine the need for chemical control, an assessment of crop development, yield potential and midge density is required. Daily evaluation of these factors is encouraged during flowering.

Since midge lay eggs in flowering sorghum heads (yellow anthers exposed on individual spikelets), damage can occur until the entire head or field of sorghum has flowered. The period of midge susceptibility may last from 7 to 9 days (individual head) to several weeks (individual field) depending on the uniformity of flowering. The map on page 11 is provided as a guideline to midge damage associated with time of sorghum flowering.

To determine the presence of sorghum midge, fields should be inspected during mid-morning until shortly after noon when midge are most abundant on flowering heads. Each day a new midge brood appears; therefore, inspect fields daily. Midge adults can be detected crawling on or flying about flowering heads. Use of a clear plastic bag as a trapping device, quickly slipped over sorghum heads, is helpful in detecting and counting midge adults. Windy weather conditions make the midge more difficult to locate and sample accurately.

The need to apply insecticidal control is based on the number of adult midges during the flowering period. *To determine the need for insecticidal control use the economic injury levels for susceptible or resistant sorghum hybrids as presented in the following tables.* The density of adults per panicle that would justify chemical control can be determined by first estimating the per acre value of the crop, which is based on the condition of the crop at that time, and historical experience. Second, determine per acre cost of control, which includes both the cost of the insecticide and cost of application. Read down columns for cost of control. The density of adult midges at that point in the table would be the density that would cause damage sufficient to warrant the cost of control. If adults are still present 3 to 5 days later, immediately apply a second treatment. If midge numbers are present the day following treatment, it does not mean you do not have protection for the heads; the numbers could be because of reinfestation. Because midge frequently reinfest treated fields, several insecticide applications at 3-day intervals may be justified if the yield potential is high and midge are abundant. For additional information see L-842, *The Sorghum Midge and Its Control.*

Midge resistant sorghum hybrids are commercially available and, within limits, provide an additional management tool. At similar infestation levels of ovipositing midge females, resistant hybrids generally suffer one-third the damage that susceptible sorghum hybrids suffer. The resistant hybrids have economic injury levels five-fold higher than susceptible hybrids. When adult midge densities exceed the economic injury level

during flowering of resistant hybrids, insecticide applications at 5-day intervals are required.

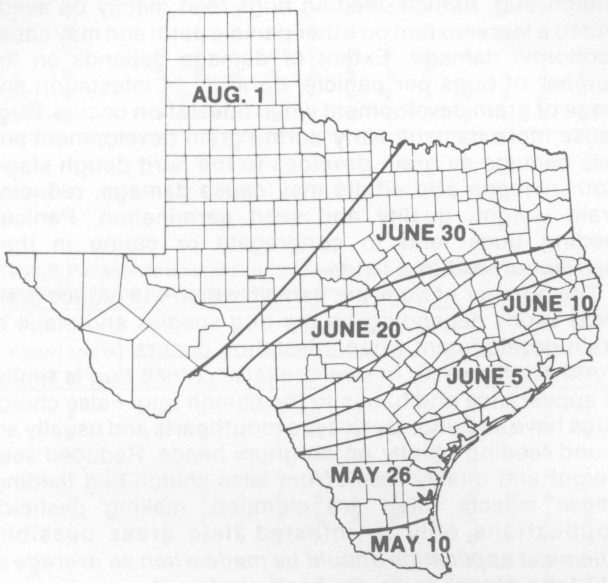


Figure 2. Estimated latest sorghum flowering dates most likely to escape significant sorghum midge damage.

ECONOMIC INJURY LEVELS FOR SORGHUM MIDGE-SUSCEPTIBLE HYBRIDS

Control cost ($) per acre	Market value ($) per acre										
	100	120	140	160	180	200	220	240	260	280	300
3.00	1.2*	1.0	.9	.8	.7	.6	.6	.5	.5	.4	.4
4.00	1.6	1.3	1.1	1.0	.9	.8	.7	.7	.6	.6	.5
5.00	2.0	1.7	1.4	1.3	1.1	1.0	.9	.8	.8	.7	.7
6.00	2.4	2.0	1.8	1.5	1.3	1.2	1.1	1.0	.9	.9	.8
7.00	2.7	2.3	2.0	1.8	1.6	1.4	1.3	1.2	1.1	1.0	.9
8.00	3.0	2.7	2.3	2.0	1.8	1.6	1.5	1.3	1.2	1.1	1.1

*Number of midge per panicle.

ECONOMIC INJURY LEVELS FOR SORGHUM MIDGE-RESISTANT HYBRIDS

Control cost ($) per acre	Market value ($) per acre										
	100	120	140	160	180	200	220	240	260	280	300
3.00	6*	5	5	4	4	3	3	3	3	2	2
4.00	8	7	6	5	5	4	4	4	3	3	3
5.00	10	9	7	7	6	5	5	4	4	4	4
6.00	12	10	9	8	7	6	6	5	5	5	4
7.00	14	12	10	9	8	7	7	6	6	5	5
8.00	15	14	12	10	9	8	8	7	6	6	6

*Number of midge per panicle.

SUGGESTED INSECTICIDES FOR CONTROLLING SORGHUM MIDGE

Insecticides (listed alphabetically) Toxicant per gallon or pound	Concentrate per acre	Days from last application to: Harvest	Grazing
Chlorpyrifos (Lorsban®)		See remarks	
(4 lb)	0.5 pt	28	28
Diazinon			
(4 lb)	0.5 pt	7	0
(50 WP)	0.5-1 lb	7	0
Ethion		See remarks	
(4 lb)	0.5-1 pt	30	30
Malathion ULV			
(95%)	8 oz	7	7
Methomyl (Lannate® or Nudrin®)			
(1.8 lb)	1-2 pts	14	14
(90% SP)	0.25-0.5 pt	14	14
(2.4 lb LV)	0.75-1.5 pts	14	14
Parathion (ethyl)			
(4 lb)	1 pt	12	12
(8 lb)	0.5 pt	12	12

Remarks

Chlorpyrifos. Do not apply more than three pints per season.

Ethion. Do not apply more than three times per growing season. Slight phytotoxicity may occur in some sorghum hybrids.

Sorghum Webworm

The sorghum webworm occurs primarily in the more humid eastern half of the state.

Webworm larvae are reddish to yellowish-brown, somewhat flattened and marked with four longitudinal reddish-to-black stripes. Larvae are approximately 1/2 inch long when mature and are densely covered with spines and hair.

Large numbers of webworms, especially in late planted sorghum, can occur in heads where they gnaw circular holes in maturing grain and feed on the starchy contents.

Plowing under crop residues to destroy overwintering larvae and early planting are important cultual control practices.

Make frequent head inspections when sorghum is beginning to flower and continue at 5-day intervals until hard dough. To examine heads for sorghum webworm, beat heads on a piece of paper or white handkerchief. Small larvae (less than 1/8 inch long) commonly overlooked during head inspections will be detected with this method. *Application of an approved insecticide is suggested when five or more small larvae are found per head.*

SUGGESTED INSECTICIDES FOR CONTROLLING SORGHUM WEBWORM

Insecticides (listed alphabetically) Toxicant per gallon or pound	Concentrate per acre	Days from last application to: Harvest	Grazing
Carbaryl (Sevin®)			
(80S)	1.5-2.5 lbs	21	0
(Sevimol® 4 lb)	1-2 qts	21	0
(XLR® 4 lb)	1-2 qts	21	0
Parathion (ethyl)			
(4 lb)	0.5-0.625 pt	12	12
(8 lb)	0.25-0.375 pt	12	12

Fall Armyworm—Corn Earworm (Whorlworm and Headworm)

Fall armyworm and corn earworm moths often deposit eggs on the leaves or heads of sorghum. Larvae of these moths vary in color from pale green to almost black, with longitudinal stripes running along the back.

On pre-headed sorghum, corn earworm and fall armyworm often feed in the plant whorl. As leaves emerge from the whorl, "ragged shot hole" damage is evident. Although this damage may be dramatic, control of "worms" in the whorl stage seldom is economically justified.

Chemical control may be necessary if examination of larval feeding indicates damage to the developing head or growing point. Larvae may also attack developing sorghum heads. Corn earworms are cannibalistic, therefore influencing the number of larvae usually occurring per head.

Early planting and practices that encourage the development of beneficial insect populations aid in the control of armyworms and earworms. Planting "open-headed" sorghum hybrids also tends to reduce the occurrence of larvae in sorghum heads. Begin inspection of sorghum heads soon after flowering and continue until the soft dough stage is reached. To determine the economic injury level see the chart below.

ECONOMIC INJURY LEVEL FOR CORN EARWORM IN SORGHUM BASED ON NUMBER OF LARVAE PER PANICLE

	Crop value ($) per acre								
Control cost($) per acre	100	120	140	160	180	200	220	240	260
2	.5	.4	.3	.3	.3	.2	.2	.2	.2
3	.8	.6	.5	.5	.4	.4	.3	.3	.3
4	1.0	.8	.7	.6	.6	.5	.4	.4	.4
5	1.2	1.0	.9	.8	.7	.6	.6	.5	.5
6	1.5	1.2	1.1	.9	.8	.8	.7	.6	.6
7	1.7	1.4	1.2	1.1	1.0	.9	.8	.7	.7
8	2.0	1.7	1.4	1.2	1.1	1.0	.9	.8	.8
9	2.2	1.9	1.6	1.4	1.2	1.1	1.0	.9	.9
10	2.5	2.1	1.8	1.6	1.4	1.2	1.1	1.0	1.0

SUGGESTED INSECTICIDES FOR CONTROLLING FALL ARMYWORM AND CORN EARWORM

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Carbaryl (Sevin®)			
(80S)	1.25-1.8 lb	21	0
(Sevimol® 4 lb)	1-2 qts	21	0
(XLR® 4 lb)	1-2 qts	21	0
Methomyl (Lannate® or Nudrin®)			
(1.8 lb SL)	1-2 pts	14	14
(2.4 lb LV)	0.75-1.5 pts	14	14
(90% SP)	0.25-0.5 lb	14	14
Parathion (ethyl)			
(4 lb)	0.5-1 pt	12	12
(8 lb)	0.25-0.5 pt	12	12

Panicle-Feeding Bugs

Several species of true bugs, primarily stink bugs, may move from alternate host plants into sorghum in relatively large numbers during grain development. Bugs infesting sorghum in Texas include the rice stink bug, southern green stink bug, conchuela stink bug, brown stink bug, red-shouldered stink bug, leaf-footed bug and false chinch bug. Panicle-feeding bugs feed mainly on seeds and to a lesser extent on other panicle parts and may cause economic damage. Extent of damage depends on the number of bugs per panicle, duration of infestation and stage of grain development when infestation occurs. Bugs cause more damage early during grain development and less damage as grain develops to the hard dough stage. Both nymphs and adults may cause damage, reducing grain weight, quality and seed germination. Panicle-feeding bugs tend to congregate or clump in their distribution within a field.

The number of bugs per panicle which will reduce grain yield varies depending on the bug species and stage of grain development when infestation occurs.

Although smaller in size, the false chinch bug is similar in appearance and habits to the chinch bug. False chinch bugs have sucking, stylet-type mouthparts and usually are found feeding chiefly on sorghum heads. Reduced seed weight and quality result from false chinch bug feeding. These insects often are clumped, making pesticide applications only to infested field areas possible. *Chemical application should be made when an average of 140 false chinch bugs per head are found.*

For additional information on panicle-feeding insects refer to B-1421, *Suggested Guide for Controlling Panicle-Feeding Bugs in Texas Sorghums.*

Not all stink bug species found in sorghum are economic pests. Several species are predacious in their feeding habits and thus are beneficial in nature.

To determine the profitability of controlling an infestation of rice, southern green or conchuela stink bugs or leaf-footed bugs, calculate the per acre control cost (insecticide and application) and the expected per acre market value of the grain (yield x price). Next, determine the approximate grain development stage when the infestation occurred. If the estimated stage of development is hard dough and the infestation level per panicle is 16 bugs or fewer, do not control bugs. For bug infestations beginning at the milk or soft dough stages, consult the economic injury level tables. Economic injury levels for infestation (rice stink bugs per panicle) at which control is justified are indicated for given control costs and market values. The economic threshold level for false chinch bug is 140 bugs per panicle when infestations begin at the milk stage of grain development. Economic thresholds for the rice stink bug, southern green stink bug, conchuela stink bug and leaf-footed plant bug are given in Tables 5, 6 and 7, 8 and 9, 10 and 11, and 12 and 13, respectively.

A method that can be used to establish the average number of bugs per head is the "beat-bucket" technique. Use the bottom 10 inches of a 5-gallon plastic bucket and shake the heads into the bucket with a sharp strike. The bugs from each head can then be counted. Also look for bugs on plant leaves and weeds within the field.

Table 5. Per panicle economic injury levels for an infestation of *rice stink bug* during the *anthesis stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	3	3	3	3	3	3	3	2	2	2	2	2	2
3	4	4	4	4	3	3	3	3	3	3	3	3	3
4	5	4	4	4	4	4	4	3	3	3	3	3	3
5	5	5	5	4	4	4	4	4	4	4	4	4	3
6	6	5	5	5	5	5	4	4	4	4	4	4	4
7	6	6	5	5	5	5	5	5	4	4	4	4	5
8	6	6	6	6	5	5	5	5	5	5	5	4	4
9	7	6	6	6	6	6	5	5	5	5	5	5	5
10	7	7	7	6	6	6	6	5	5	5	5	5	5

Table 6. Per panicle economic injury levels for an infestation of *rice stink bug* beginning at the *milk stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	4	4	4	4	3	3	3	3	3	3	3	3	3
3	5	5	4	4	4	4	4	4	4	4	4	3	3
4	5	5	5	5	5	5	4	4	4	4	4	4	4
5	6	6	6	5	5	5	5	5	5	5	4	4	4
6	7	6	6	6	6	6	5	5	5	5	5	5	5
7	7	7	7	6	6	6	6	6	5	5	5	5	5
8	8	7	7	7	6	6	6	6	6	6	5	5	5
9	8	8	7	7	7	7	6	6	6	6	6	5	5
10	8	8	8	7	7	7	7	7	6	6	6	6	6

Table 7. Per panicle economic injury levels for an infestation of *rice stink bug* beginning at the *soft dough stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	5	5	5	5	5	5	4	4	4	4	4	4	4
3	7	6	6	6	6	5	5	5	5	5	5	5	5
4	8	7	7	7	6	6	6	6	6	6	6	5	5
5	8	8	8	7	7	7	7	7	6	6	6	6	6
6	9	9	8	8	8	8	7	7	7	7	7	6	6
7	10	9	9	9	8	8	8	8	7	7	7	7	7
8	10	10	9	9	9	9	8	8	8	8	8	7	7
9	11	11	10	9	9	9	9	9	8	8	8	8	8
10	12	11	10	10	10	10	9	9	9	9	8	8	8

Table 8. Per panicle economic injury levels for an infestation of *adult southern green stink bugs* beginning at the *milk stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	3	3	3	3	3	3	2	2	2	2	2	2	2
3	4	3	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	3	3	3	3	3	3	3	3	3
5	4	4	4	4	4	4	4	4	3	3	3	3	3
6	5	5	4	4	4	4	4	4	4	4	4	3	3
7	5	5	5	5	5	4	4	4	4	4	4	4	4
8	5	5	5	5	5	5	4	4	4	4	4	4	4
9	6	6	5	5	5	5	5	5	4	4	4	4	4
10	6	6	6	5	5	5	5	5	5	5	4	4	4

Table 9. Per panicle economic injury levels for an infestation of *adult southern green stink bugs* beginning at the *soft dough stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	4	4	4	4	4	4	4	4	3	3	3	3	3
3	5	5	5	5	5	4	4	4	4	4	4	4	4
4	6	6	6	5	5	5	5	5	5	5	4	4	4
5	7	6	6	6	6	6	5	5	5	5	5	5	5
6	7	7	7	6	6	6	6	6	6	5	5	5	5
7	8	7	7	7	7	6	6	6	6	6	6	6	5
8	8	8	8	7	7	7	7	7	6	6	6	6	6
9	9	8	8	8	8	7	7	7	7	7	6	6	6
10	9	9	8	8	8	8	7	7	7	7	7	7	6

Table 10. Per panicle economic injury levels for an infestation of *adult conchuela stink bugs* beginning at the *milk stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	3	3	3	3	3	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	3	2	3	3	2
4	4	4	4	3	3	3	3	3	3	3	3	3	3
5	4	4	4	4	4	4	3	3	3	3	3	3	3
6	5	4	4	4	4	4	4	4	4	4	3	3	3
7	5	5	5	4	4	4	4	4	4	4	4	4	4
8	5	5	5	5	5	4	4	4	4	4	4	4	4
9	6	5	5	5	5	5	5	4	4	4	4	4	4
10	6	6	5	5	5	5	5	5	4	4	4	4	4

Table 11. Per panicle economic injury levels for an infestation of *adult conchuela stink bugs* beginning at the *soft dough stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	5	5	4	4	4	4	4	4	4	4	4	3	3
3	6	5	5	5	5	5	5	5	4	4	4	4	4
4	7	6	6	6	6	5	5	5	5	5	5	5	5
5	7	7	7	6	6	6	6	6	6	5	5	5	5
6	8	8	7	7	7	7	6	6	6	6	6	6	5
7	8	8	8	7	7	7	7	7	6	6	6	6	6
8	9	9	8	8	8	7	7	7	7	7	7	6	6
9	10	9	9	8	8	8	8	7	7	7	7	7	7
10	10	10	9	9	9	8	8	8	8	7	7	7	7

Table 12. Per panicle economic injury levels for an infestation of *adult leaf-footed bugs* beginning at the *milk stage* of grain development.

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	3	3	3	3	3	3	3	2	2	2	2	2	2
3	4	4	3	3	3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	3	3	3	3	3	3	3	3
5	5	4	4	4	4	4	4	4	4	3	3	3	3
6	5	5	5	4	4	4	4	4	4	4	3	4	4
7	5	5	5	5	5	4	4	4	4	4	4	4	4
8	6	5	5	5	5	5	5	4	4	4	4	4	4
9	6	6	5	5	5	5	5	5	5	4	4	4	4
10	6	6	6	6	5	5	5	5	5	5	5	4	4

Table 13. Per panicle economic injury levels for an infestation of *leaf-footed bugs* beginning at the *soft dough stage of grain development.*

Control cost ($) per acre	Market value ($) per acre												
	100	110	120	130	140	150	160	170	180	190	200	210	220
2	5	5	4	4	4	4	4	4	4	4	4	3	3
3	6	5	5	5	5	5	5	5	4	4	4	4	4
4	7	6	6	6	6	5	5	5	5	5	5	5	5
5	7	7	7	6	6	6	6	6	6	5	5	5	5
6	8	8	7	7	7	7	6	6	6	6	6	6	5
7	8	8	8	7	7	7	7	7	6	6	6	6	6
8	9	9	8	8	8	7	7	7	7	7	7	6	6
9	10	9	9	8	8	8	8	7	7	7	7	7	7
10	10	10	9	9	9	8	8	8	8	7	7	7	7

SUGGESTED INSECTICIDES FOR CONTROLLING PANICLE-FEEDING BUGS

Insecticides (listed alphabetically)		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Carbaryl (Sevin®)		See remarks	
(80S)	1.25-2.5 lbs	21	0
(XLR® 4 lb)	1-2 qts	21	0
(Sevimol® 4 lb)	1-2 qts	21	0
Parathion (ethyl)			
(4 lb)	0.5-0.625 pt	12	12
(8 lb)	0.25-0.375 pt	12	12

Remarks

Carbaryl. Direct spray into heads for optimum control.

Sugarcane Borer—Southwestern Corn Borer

These closely related pests of sorghum, corn and other crops damage plant stalks by their tunneling activity. Buff-colored adult moths lay eggs in shingle-like arrangement on the leaves and stalks of host plants. Young larvae of the sugarcane and southwestern corn borer are characteristically creamy white and marked with brown to black spots. Spots of the more mature overwintering larval stage are less distinctive or absent. Larvae overwinter in the stalks or root crowns of sorghum plants and other crop debris.

Borer infested stalks are reduced in diameter and plant lodging often results. Dead heart or dying of the whorl of the plant and an increased susceptibility to stalk rotting diseases are also associated with borer damage.

Cultivation practices that destroy stalks, expose larvae and bury crop residues greatly reduce borer populations. Rotation with non-host crops and early planting of sorghum also aid in control of the sugarcane and southwestern corn borer.

SUGGESTED INSECTICIDES FOR CONTROLLING SOUTHWESTERN CORN BORER

Insecticide		Days from last application to:	
Toxicant per gallon or pound	Concentrate per acre	Harvest	Grazing
Carbaryl (Sevin®)			
(80S)	1.78	21	0
(Sevimol® 4 lb)	1.5 qts	21	0
(XLR® 4 lb)	1.5 qts	21	0

HYBRID SEED PRODUCTION FIELDS

Inbred lines used in sorghum hybrid seed production often are more susceptible to insect pest damage and insecticide phytotoxicity than hybrids. The increased susceptibility to chemicals and higher crop value generally demands lower economic threshold levels for insect pests. Also, insect pests which influence seed quality and germination have increased in importance in hybrid seed production. Hybrid seed production fields should be monitored regularly and consideration given to the increased susceptibility to insect damage and insecticide phytotoxicity. Before insecticide application, check the insecticide label closely and consult the manufacturer and the seed company regarding possible phytotoxic effects.

PROTECTING BEES AND OTHER POLLINATORS FROM INSECTICIDES

Pollination is important in producing many seed crops. This is particularly true for legumes such as alfalfa, clovers and vetch. Most grass-type plants are wind- or self-pollinated and do not require the assistance of insect pollinators. Where pollen-collecting insects are required for flower fertilization, the producer, insecticide applicator and beekeeper should cooperate closely to minimize losses of bees. Sorghum is an important source of pollen for honey bees in many locations in Texas. The following guidelines will reduce bee losses:

1. Apply insecticides, if practical, before bees are moved into fields for pollination.
2. Where insecticides are needed, use materials least toxic to bees.
3. Make all applications when bees are not foraging in the field. Evening or early morning treatments between the hours of 7 p.m. and 6 a.m. generally are more

satisfactory. Evening applications, after bees have left the field, are less hazardous than early morning applications.

4. Use spray or granular formulations.
5. Where it is necessary to use an insecticide from groups 1 or 2 in the following list, notify beekeepers so they can make necessary arrangements to protect their bees.
6. To prevent heavy losses of bees, avoid drifting or spraying any insecticide directly on colonies. Bees cluster on the fronts of their hives on hot evenings. Pesticide drift or direct spray at this time generally results in high mortality.

INSECTICIDES GROUPED ACCORDING TO THEIR RELATIVE HAZARDS TO HONEY BEES

Insecticides	Remarks
Group 1 - Highly Toxic Carbaryl (Sevin®) Carbofuran (Furadan®) Chlorpyrifos (Lorsban®) Diazinon Dimethoate (Cygon®) Malathion (wettable powder or ULV) Methidathion (Supracide®) Parathion (ethyl)	This group includes materials that kill bees on contact during application or for several days following application. Remove bees from the area if these are used on plants being visited by the bees, with some exceptions. Malathion occasionally causes heavy bee losses, particularly during periods of extremely high temperatures. Make malathion applications in the evening after all bees have completed foraging. Avoid ultra-low volume malathion after blooms appear.
Group 2 - Moderately Toxic Disulfoton (Di-Syston®) Ethion Malathion (EC) Methomyl (Lannate®, Nudrin®) Oxydemetonmethyl (Metasystox-R®) Phorate (Thimet®)	Do not apply when bees are working in field. Apply in late evening.
Group 3 - Relatively Non-Toxic Demeton (Systox®) Propargite (Comite®)	Make applications in late evening or early morning when bees are not foraging.

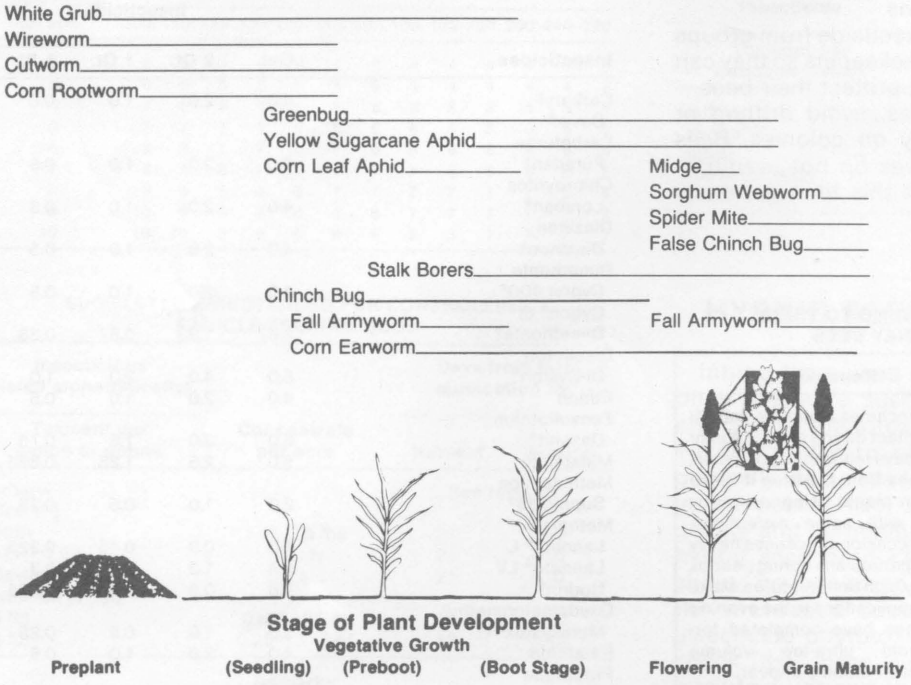
POUNDS OF ACTUAL INSECTICIDE IN DIFFERENT QUANTITIES OF CONCENTRATE

	Pounds of active insecticide			
Insecticides	**Gal.**	**2 Qt.**	**1 Qt.**	**1 Pt.**
Carbaryl Sevin®	4.0	2.0	1.0	0.5
Carbofuran Furadan®	4.0	2.0	1.0	0.5
Chlorpyrifos Lorsban®	4.0	2.0	1.0	0.5
Diazinon Diazinon®	4.0	2.0	1.0	0.5
Dimethoate Cygon 400®	4.0	2.0	1.0	0.5
Cygon® or Dimethoate®	2.67	1.33	0.67	0.33
Disulfoton Di-Syston®	8.0	4.0	2.0	1.0
Ethion	4.0	2.0	1.0	0.5
Fensulfothion Dasanit®	6.0	3.0	1.5	0.75
Malathion	5.0	2.5	1.25	0.625
Methidathion Supracide®	2.0	1.0	0.5	0.25
Methomyl Lannate® L	1.8	0.9	0.45	0.225
Lannate® LV	2.4	1.2	0.6	0.3
Nudrin®	1.8	0.9	0.45	0.225
Oxydemetonmethyl Metasystox-R®	2.0	1.0	0.5	0.25
Parathion	4.0	2.0	1.0	0.5
Propargite Comite®	6.55	3.3	1.6	0.8

POUNDS ACTUAL TRICHLOROFON, CARBARYL OR METHOMYL PER ACRE

	Pounds of active insecticide				
	3.0	**2.0**	**1.0**	**0.5**	**0.25**
80% Wettable Powder	3.75	2.5	1.25	0.625	0.312
80S Soluble Powder	3.75	2.5	1.25	0.625	0.312
90% Soluble Powder	3.34	2.22	1.11	0.55	0.277

Figure 3. SORGHUM PEST OCCURRENCE PROFILE*



*The occurrence and development of various sorghum pests are usually closely related to plant development and various environmental factors. Although the severity of insect problems cannot be predicted, this pest occurrence profile indicates insect and mite pests that *may* attack sorghum in various stages of development. Careful field inspection to determine the presence and damage potential of of each pest is strongly advised.

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