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Managing Insect and Mite Pests of Texas Small Grains

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Managing Insect and Mite Pests of Texas Small Grains

Integrated pest management (IPM) refers to the use of the most economical and ecologically sound pest suppression techniques to control insect and mite pests efficiently and effectively. It includes the following:

- cultural practices, such as crop rotation, fertilization, variety and planting date selection;
- biological control, including the use of pests' natural enemies; and
- chemical control, the judicious use of selected insecticides and rates to keep pest numbers below economically damaging levels.

Certain cultivars are resistant to such pests as the greenbug, Russian wheat aphid and Hessian fly. Plant damage does not always relate directly to pest numbers. Other factors, such as plant vigor, stage of growth, moisture conditions and crop rotation practices, influence crop damage.

The best pest control strategy is prevention. Use good agronomic practices and cultural methods, and use insecticides only wwhen pest populations reach levels that can cause crop losses greater than the cost of treatment. The potentially damaging population or plant damage level is called the **economic threshold**, or **action level**.

Pests are active at different times during the small grains growing season September through June. Figure 1 shows the probable seasonal occurrence of pests as related to plant development. Fields must be inspected regularly, twice weekly during critical periods, to make informed pest management decisions. This publication includes pest descriptions, methods of monitoring insects and mites, and various pest control methods.

Cultural Practices

Plant health

Factors that affect a small grains plant will also affect the insects and mites that feed upon the plant. The healthier, more vigorously growing and larger the plant, the more pests it can tolerate without significant loss. This has been demonstrated for the greenbug, bird cherry-oat aphid, winter grain mite and Hessian fly.

Varietal selection

In areas where the Hessian fly has been a problem, planting resistant varieties of wheat or barley is a major component of management. However, the Hessian fly has developed new biotypes that overcome the resistance genes. TAM-110 and TAM-112, primarily adapted to the Texas High Plains, were developed to provide resistance to greenbug.

Tillage and other management factors

Tillage has long been recognized as important for insect control. It not only destroys host plants, but also may bury some insects too deep for survival. Plowing under stubble reduces the Hessian fly and some other pests that remain on or in the stubble.

Reduced tillage leaves more crop residue on the soil surface, reduces soil temperatures and increases soil moisture. Some evidence shows that reduced tillage may encourage certain diseases and insects. The wheat curl mite, a vector of the wheat streak mosaic and High Plains viruses, is an example. This pest is a particular problem in the Texas Panhandle, where it survives between crops on volunteer wheat. Winter grain and brown wheat mites increase where there is crop residue. However, other research indicates that reduced tillage decreases aphid numbers. Intensified pest management may be needed to prevent crop losses in a reduced tillage program

Reducing small grains stubble and controlling volunteer plants and summer weeds will help in managing Hessian fly and wheat curl mite infestations.

Crop rotation

Crop rotation is particularly useful in managing pests with a limited dispersal range, such as the Hessian fly, white grubs, wireworms and winter grain mites. Rotation is often very effective.

Planting date

Planting date will be influenced by how the small grains will be utilized. Small grains are cool season plants and will not do well when daytime temperatures are in the upper 90's. When planting early for grazing, producers should understand that the field will be at greater risk for disease and arthropod problems. Some of the risk can be minimized by planting later in the season (varies within production regions, check with the local Texas AgriLife Extension Service office) and using resistant varieties. Producers can also plant another small grains crop. For example, oats and triticale are not a host of Hessian fly and can be used where Hessian fly is a threat. If the producer is interested only in grain production then the planting date can be delayed until after mid-October to the first of November in many regions. Delayed planting will allow wheat and barley to miss at least part of the first Hessian fly generation. Greenbugs, Russian wheat aphids and bird cherry-oat aphids will have less time to establish populations. Destroying volunteer small grains plants before the small grains crop is planted can reduce wheat curl mite infestation.

Grazing Management

Wheat is planted in Texas on more than 6 million acres each year. Approximately 40 percent of the wheat acreage is grazed to some extent, and approximately 30 percent is used only for forage. Oats, barley, rye and triticale also are used for livestock forage. Small grains pastures are usually seeded after there is adequate moisture in September or early October, and cattle are allowed to graze after the plants have established a good root system.

Grazing of small grains suppresses aphid and winter grain mite infestations. However, where aphid populations are above the economic threshold after small grains are well established, livestock may be placed on part of the pasture and the remainder treated. After the re-entry interval for grazing (specified on the insecticide label), the livestock can be turned into the treated portion of the pasture. The grazed area should then be inspected to determine if aphid control is still needed. Under heavy grazing, it is unlikely that the aphid infestation will still be above the economic threshold.

Seasonal Small Grains Pest Profile

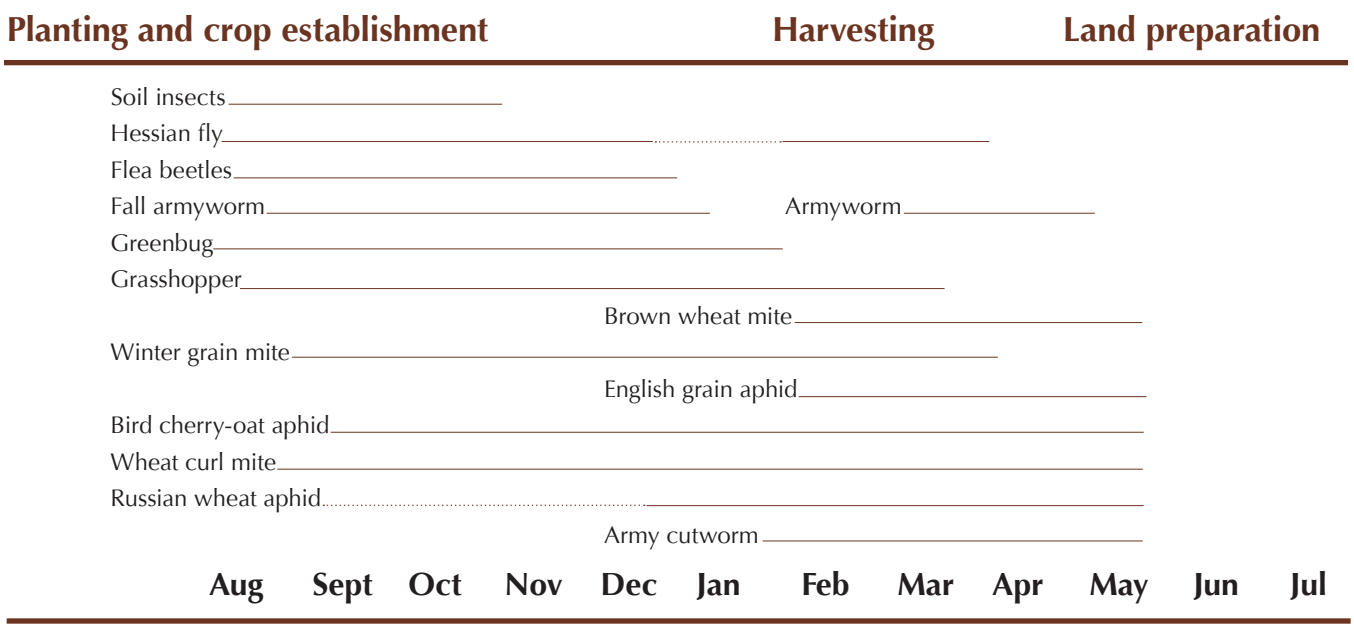

Figure 1. The occurrence and development of different small grains pests are usually related to plant development and various environmental factors. Although the severity of insect problems cannot be predicted, this pest occurrence profile indicates insect and mite pests that may attack small grains in various seasons and stages of development. Fields should be carefully inspected to determine the presence and damage potential of each pest.

Comparisons of aphid infestations in wheat that is grazed and not grazed have shown that grazing reduces aphid numbers three- to ten-fold. However, when aphid infestations are very light and many of the aphids are winged, there will be little difference in the numbers of aphids found in grazed and non-grazed wheat. In general, the heavier the grazing, the more an aphid infestation is reduced. When livestock are taken off the pastures, aphids will increase. Livestock are generally removed from wheat pasture just before the wheat begins jointing and rapidly growing. The chance that damaging numbers of aphids will develop then is greatly reduced because the plants are large and vigorously growing.

Biological Control

Insect and mite infestations are often held below damaging levels by weather, inadequate food and natural enemies, such as parasites, predators and pathogens. It is important to recognize the effect of these natural control factors and, where possible, to encourage them.

Biological control uses living organisms (parasites, predators and pathogens) to control pests. Important natural enemies of insect and mite pests attacking wheat include several kinds of parasitic wasps, lady beetles and lacewings. Other predators include syrphid flies, damsel bugs, big-eyed bugs and spiders. Pathogenic fungi also control aphids somewhat.

Biological control is most effective when used with other compatible pest control practices in an integrated pest management program. These practices include cultural control, host plant resistance and the selective use of insecticides when other practices fail to keep pest numbers below economic levels.

Methods of biological control are conservation, importation and augmentation of natural enemies. *Conservation* of existing populations of natural enemies avoids the use of insecticides until they are needed to prevent the development of economically damaging pest infestations. The effects of insecticides also can be minimized by using those more toxic to the target pest than to the natural enemy. Certain cultural practices can encourage natural enemies as well.

Importation is the release of natural enemies into areas where they do not occur naturally. This method has been effective where an exotic pest has entered Texas without the natural enemies that help control the pest in its native country. For example, several species of natural enemies have been imported into Texas to control the Russian wheat aphid.

Augmentation is the purchase and periodic release of natural enemies that do not occur naturally in sufficient numbers to provide pest control. Green lacewings and convergent lady beetles are sometimes sold for release in wheat. Because there is little definitive information on augmentation (e.g., when to apply and how many to release), Extension entomologists cannot provide guidelines for augmentation as a management tool in wheat.

The Texas A&M University System is committed to the development of pest management tactics that use biological control. Refer to B-5044, "Biological Control of Insect Pests of Wheat," for detailed information on natural enemies of insect pests of wheat and their use in biological control. The publication is available from your county Extension office.

Soil Pests of Small Grains

White grubs, wireworms, false wireworms and cutworms are the most common soil insect pests of Texas small grains. Weeds are important food sources for them. Key measures for reducing these soil pests include summer fallowing, tillage and/or the use of herbicides to reduce crop residues and kill weeds.

It is important to prepare the seedbed properly and inspect the soil for these pests before planting. There are no effective methods of treating soil pests with insecticides once the crop has been planted and seedlings have emerged. No insecticides are labeled for pre-plant soil application to small grains fields, but approved insecticides can be applied to the seed before planting if damaging numbers of soil pests are detected.

Wireworm and false wireworm

Sample fields for wireworms before planting. Wireworms, which are the immature stages of click beetles, are shiny, slender, cylindrical and usually hard-bodied. The larvae range in color from white to yellow to brown.

False wireworms, which are the immature stages of darkling beetles, are more common when there is little rainfall. Like the wireworm, this soil pest destroys planted seed and feeds on seedling roots, reducing stands and plant vigor.

Cultural controls for both of them include killing weeds in fields and rotating to warm-season crops.

Suggested Insecticides for Controlling Wireworms and False Wireworms

Insecticide	Amount per acre	Waiting period (days) to: Harvest	Grazing
Imidacloprid		See remarks	
Gaucho® 600	600 @ 0.13–0.26 fl oz per 100 lbs of seed — commercial seed treater only		45
Thiamethoxam		See remarks	
(Cruiser®)	5FS @ 0.75–1.33 oz per 100 lbs of seed — commercial seed treater only		

Remarks
Surplus treated seed must not be used for feed or food.

Rotating to crops that can be treated with a pre-plant soil insecticide also will reduce wireworm damage. Because certain species of wireworms are abundant only in poorly drained soils, proper drainage of such soils will help prevent damage.

Imported fire ant

Imported fire ants feed on wheat seeds along field margins where colonies are concentrated. Feeding may cause stand loss extending 10 to 15 feet into the field. Damage is most common during dry, warm weather that delays germination and gives ants more time to feed. Loose, dry soil gives ants easy access to the seed.

White grub

White grubs are the larval stage of May or June beetles. Larvae are "C-shaped" with white bodies and tan to brown heads. The last abdominal segment is transparent, allowing dark, digested material to be seen. Larvae, which vary in size according to age and species, feed on plant roots. They often kill small seedlings and cause stand loss. Larger plants with severely pruned roots may be stunted and more susceptible to drought.

As soil temperature decreases in the fall, white grub feeding decreases, and larvae migrate deeper into soil. Delayed planting may improve stand establishment. While there are no registered insecticides for white grub control in wheat, limited field tests suggest that Gaucho® and Cruiser® seed treatments are effective.

Cutworm

Cutworms are the immature stages of drab, brownish moths that are active at night. Several species can damage small grains. While moths like grassy, weedy fields for laying eggs, army cutworms will lay eggs even in bare soil. Newly hatched cutworms are brown to black and feed on small grain seedlings. Older larvae have a shiny, or "greasy," appearance. They clip the above-ground portion of the plant from the root system at or below the soil surface. Infested fields look like they have been closely grazed, and damage may be "clumped" as spots in the field.

The army cutworm is a true cutworm, but feeds much like an armyworm. During late summer and early fall, female moths will lay 1,000 to 2,000 eggs each as they migrate through an area. Eggs hatch in a few days, and larvae feed periodically through the fall and winter as temperature allows. By mid-to-late winter, larvae as large as ⅜ to 1½ inches can be found in small grains. Large populations can cause considerable damage by defoliating plants and reducing stands, especially in February and March as small grains begin to green up. Late, poorly tillered or thin stands are particularly vulnerable to the army cutworm.

In outbreak years, it is not uncommon to find 10 to 20 cutworms per square foot. On sunny days, they will be under debris or slightly below the soil surface. **An insecticide application should be considered when four to five cutworms per square foot can be found**. Larvae pupate in the soil in early spring and emerge as moths about 3 to 4 weeks later. These moths are attracted to lights and can become a real nuisance around homes and buildings. They migrate from the area and return in late summer and early fall to begin the cycle again. **Reduce weeds and crop residues in fallowed fields and delay planting until fields have been clean plowed to reduce cutworm numbers**.

Suggested Insecticides for Controlling Cutworms

Insecticide	Amount per acre	Waiting period (days) to:	
		Harvest	Grazing
β-Cyfluthrin	See remarks		
(Baythroid® XL)	1.0–1.8 fl oz	30	3
Gamma-cyhalothrin	See remarks		
(Proaxis®)	1.29–3.2 fl oz	30	30
(Declare®)	0.77–1.28 fl oz		
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	1.92–3.2 fl oz	30	7
(Karate wth Zeon Technology®)	0.96–1.60 fl oz	30	7
Methyl parathion	See remarks		
(4 lb)	12–16 fl oz	15	15
Zeta-cypermethrin	See remarks		
(Mustang Max)	1.28–4 fl oz	14	14

Remarks
Applying insecticide in late afternoon or evening may improve control.
β-Cyfluthrin. Do not apply more than 4.8 fluid ounces per acre per season.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

Aboveground Pests of Small Grains

Fall armyworm

In addition to small grains, fall armyworms are found on corn, grain sorghum, sorghum grass hybrids, peanuts, alfalfa, cowpeas and cotton. The larvae are usually shades of brown but may also be greenish to nearly black. Four distinct black spots are on top of the eighth abdominal segment, and a white inverted Y is on the front of the head. Mature larvae are 1½ inches long.

Early planting of small grains increases the risk of fall armyworm infestation. When large infestations occur on other hosts, fall armyworm moths may deposit egg masses in seedling small grains. Small larvae feed on the leaf tissue, creating tiny "window panes" in the leaves. Larger larvae consume entire leaves and are more difficult to control. **Control is suggested when there are four or more larvae 1 inch or longer per square foot and when their damage is threatening the stand. Delaying planting can reduce damage when there are large infestations in other host crops or when dry conditions limit the attractiveness of other hosts**.

Armyworm

Armyworms may attack small grains in large numbers, devouring all material in their path. Outbreaks are favored by cool, damp weather from late March through June. The larvae feed mostly at night and are 1½ inches long when fully grown. They are green to brown with light stripes on their sides and back, and the outer side of each proleg has a brown or dark band. The head, which has a pattern of narrow lines that looks like a net, lacks the white inverted Y of the fall armyworm. Armyworm larvae do not develop well once maximum temperatures average 88 degrees F, and their numbers dramatically decrease. Infestations often begin in areas of fields where small grains are the tallest and thickest or near the edge of fields where weeds provide a favorable environment.

Armyworms hide at the bases of the plants during the day and move up the plants to feed during cloudy weather, late in the afternoon and at night. They can cause extensive damage below the crop canopy before they are detected. Early armyworm detection is important because small larvae are easier to control. The larger the larvae, the more they will consume. Damage symptoms include defoliation, and beard and head clipping. **Control measures are sug-**

Suggested Insecticides for Controlling Fall Armyworms and Armyworms

Insecticide	Amount per acre	Waiting period (days) to:	
		Harvest	Grazing
β-Cyfluthrin	See remarks		
(Baythroid® XL)	1.8–2.4 fl oz	30	3
Gamma-cyhalothrin	See remarks		
(Proaxis®)	2.56–3.84 fl oz	30	30
(Declare®)	1.02–1.54 fl oz	–	–
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	3.84 fl oz	30	7
(Karate wth Zeon Technology®)	1.28–1.92 fl oz	30	7
Methomyl			
(Lannate® SP)	0.25–0.5 lb	7	10
(Lannate® LV	0.75–1.5 pt	7	10
Methyl parathion			
(4 lb)	1.5 pt	15	15
Methyl parathion encapsulated			
(Penncap-M®)	2–3 pt	15	15
Spinosad			
(Tracer®)	1–3 fl oz	21	14
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks
Applying insecticide in late afternoon or evening may improve control.
β-Cyfluthrin. Labeled for control of small 1st and 2nd instar larvae. Do not apply more than 4.8 fluid ounces per acre per season.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

gested when four to five larvae per square foot are found in combination with evidence of extensive feeding on lower leaves.

Greenbug

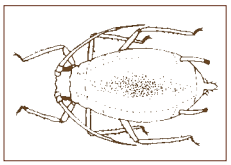

Figure 2. Greenbug

Greenbugs suck plant juices and inject toxins into plants. These aphids are pale green, approximately 1⁄16 inch long, with a dark green stripe on the back. Greenbugs develop in large numbers under favorable conditions and can cause economic losses. They reproduce rapidly at temperatures between 55 and 95 degrees F. Their natural enemies, however, reproduce slowly when temperatures are below 65 degrees F. Consequently, in cool weather the greenbug may increase to enormous numbers, while its natural enemies multiply slowly. The average temperature must be below 20 degrees F for at least a week to kill 99 percent of the greenbugs. The population also must be without protection from snow cover. During the winter, infested fields may turn yellow, and spots in fields or entire fields can be affected. Small grains may be killed by heavy, uncontrolled infestations.

Greenbugs, which are a vector of barley yellow dwarf virus, cause more damage when small grains suffer from lack of moisture during a mild winter and cool spring. This damage may be confused with moisture stress, nitrogen deficiency or dryland root rot (foot rot).

Sampling for greenbugs. While walking diagonally across the field, make at least five random counts per 20 acres of field area, with each count consisting of 1 linear foot of row. Greenbugs can be counted on small plants. On larger plants, slap the plants against the ground to jar greenbugs loose for counting. If

greenbugs are numerous, estimate the number present. Make counts during the warmest part of the day when greenbugs are most likely to be exposed on the aboveground parts of the plants. During cool, dry weather, greenbugs may congregate in loose soil at the bases of plants, making detection and chemical control difficult.

To help wheat producers, crop consultants and others involved in wheat insect pest management, a "Glance 'n Go" greenbug sampling system has been developed by an Oklahoma State University and USDA-ARS wheat research program at Stillwater, Oklahoma. It calculates a treatment threshold based on potential crop value, cost of control and time of year. The sampling system is quicker and more simple than counting the actual number of greenbugs. Glance 'n Go scouting forms and information can be obtained at *http://entoplp.okstate.edu* by selecting "Agriculture Models" and then "Cereal Aphids Pest Management."

Suggested Insecticides for Controlling Greenbugs

Insecticide	Amount per acre		Waiting period (days) to:	
			Harvest	Grazing
Chlorpyrifos		See remarks		
(Lorsban® 4E or 4E-SG)	0.5–1 pt		28	14
(Nufos® 4E)	0.5–1 pt		28	14
Dimethoate		See remarks		
(Dimethoate 2.67)	0.75–1 pt		35	14
(Dimethoate 4E)	0.5–0.75 pt		35	14
(Dimate 4EC)	0.5–0.75 pt		34	14
Gamma-cyhalothrin		See remarks		
(Proaxis®)	3.84 fl oz		30	30
(Declare®)	1.54 fl oz			
Imidacloprid		See remarks		
Gaucho® 600	600 @ 0.8–2.4 fl oz per 100 lbs of seed — commercial seed treater only			45
Lambda-cyhalothrin		See remarks		
(Warrior with Zeon Technology®)	3.84 fl oz		30	7
(Karate wth Zeon Technology®)	1.92 fl oz		30	7
Malathion		See remarks		
(5 lb)	1.5 pt		7	7
Methyl parathion		See remarks		
(4 lb)	0.5–1.5 pt		15	15
Methyl parathion encapsulated		See remarks		
(Penncap-M®)	2–3 pt		15	15
Thiamethoxam		See remarks		
Cruiser®	5FS @ 0.75–1.33 fl oz per 100 lbs of seed — commercial seed treater only			
Zeta-cypermethrin		See remarks		
(Mustang Max®)	3.2–4.0 fl oz		14	14

Remarks

Chlorpyrifos. Labeled for use on wheat only. Do not make more than two applications per crop.
Dimethoate. Labeled for wheat and triticale only.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Malathion. Not as effective as methyl parathion, but may be used where a less toxic material is preferred for ground applications.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

When to treat greenbugs. The need to apply insecticide depends on the number of greenbugs present, the size and vigor of plants, the temperature, time of year, moisture conditions, stage of plant growth, and effectiveness of parasites and predators. Irrigated small grains can withstand larger greenbug populations.

It is impractical to specify all conditions under which insecticides should be applied for greenbug control. The following table is a general guide for determining the need for treatment.

Plant height (inches)	Number of greenbugs per linear foot
3–6	100–300
4–8	200–400
6–16	300–800

Yellow or brown plants caused by greenbug feeding in spots in the field may indicate a need for treatment. **Occasionally, populations of 25 to 50 greenbugs per foot of drill row on very young plants may warrant treatment**.

Heavy, rapidly increasing greenbug infestations can cause excessive damage. However, under favorable weather conditions, lady beetles and parasitic wasps can reduce greenbug populations. **Where there are one to two lady beetles (adults and larvae) per foot of row, or 15 to 20 percent of the greenbugs have been parasitized, control measures should be delayed until you can determine whether the greenbug population is continuing to increase**. Other important predators include spiders, damsel bugs, lacewing larvae and syrphid fly larvae. When weather conditions remain favorable for predators and parasites, greenbug populations will be significantly reduced during the following week.

Insecticide resistant greenbugs. Greenbug resistance to registered insecticides causes problems for small grain producers in the Texas High Plains. Surveysin 1990 in High Plains sorghum found insecticide-resistant greenbugs in most counties north of Amarillo. Resistant greenbugs are known to overwinter in small grains and to develop after an insecticide treatment for Russian wheat aphids. Every effort should be made to apply insecticide only to fields where economic thresholds have been exceeded and, thus, reduce the rate of selection for insecticide-resistant greenbugs.

Host plant resistance. TAM-110 was the first wheat variety to carrwy resistance to all current greenbug biotypes (E, I and K). TAM-110 is basically TAM-107 with improved resistance to greenbug. More recently, TAM-112 was developed as a greenbug resistant wheat to replace TAM-110. In some years, wheat varieties with disease resistance may be more important than varieties with insect resistance.

Low temperatures slow the activity and effectiveness of most insecticides. It may take twice as long for an insecticide to kill at 45 degrees F as it would at 70 degrees F. For best results, apply insecticides when temperatures are above 50 degrees F. If an application must be made when the temperature is lower, use the highest rate recommended.

Russian wheat aphid

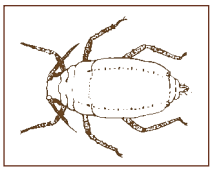

Figure 3. Russian wheat aphid.

The first appearance of the Russian wheat aphid in the United States was in March 1986 in the Texas High Plains. It has since extended its range throughout the Great Plains, into Canada and to the west coast. The Russian wheat aphid is up to 1⁄16 inch long, lime green and spindle-shaped. It has short antennae and no prominent cornicles, but a projection above the cauda (tail) gives it a "double tail" appearance (Fig. 4).

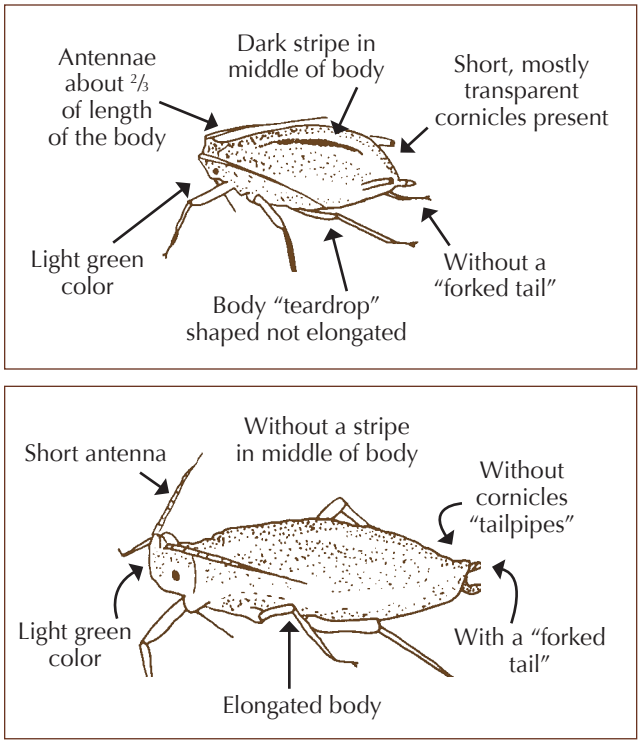

Figure 4. Comparison of greenbug (top) and Russian wheat aphid (bottom).

Russian wheat aphids inject a toxin while feeding, causing white and purple longitudinal streaks on leaves. Heavily infested plants appear flattened, and leaf edges roll inward, giving the entire leaf a tube-like appearance. Russian wheat aphids, which can be vectors of viral diseases, prefer feeding on the younger, uppermost leaves of a plant.

Because Russian wheat aphids cause the most damage in small grains that are stressed, use cultural practices that reduce crop stress. Destroying volunteer wheat and planting later will delay the initial aphid infestation.

Predators and parasites are important in suppressing the Russian wheat aphid. Many of the natural enemies that attack the greenbug also attack the Russian wheat aphid. Wheat should be managed to conserve these natural enemies.

The Russian wheat aphid prefers wheat and barley more than triticale, rye and oats as hosts. They are occasionally observed on corn and sorghum, but are not known to cause any damage. A new Russian wheat aphid biotype has been detected in Colorado. It appears to have overcome the Russian wheat aphid resistance developed in Ankor, Halt, Prairie Red, Prowers and Stanton wheat varieties, which are adapted to the Texas High Plains but used primarily in Colorado and Western Kansas.

Wild hosts of Russian wheat aphid include cool-season grasses, such as jointed goat grass, various brome grasses and several species of wheat grasses. The aphid is found in the greatest numbers and, consequently, causes the most damage in the High Plains. Although it is found in the Rolling Plains (Fig. 5), it is not now considered an important pest there because it is unable to oversummer. In the High Plains, the aphid can oversummer on warm-season grasses, such as green sprangletop, buffalo grass and several species of grama grass.

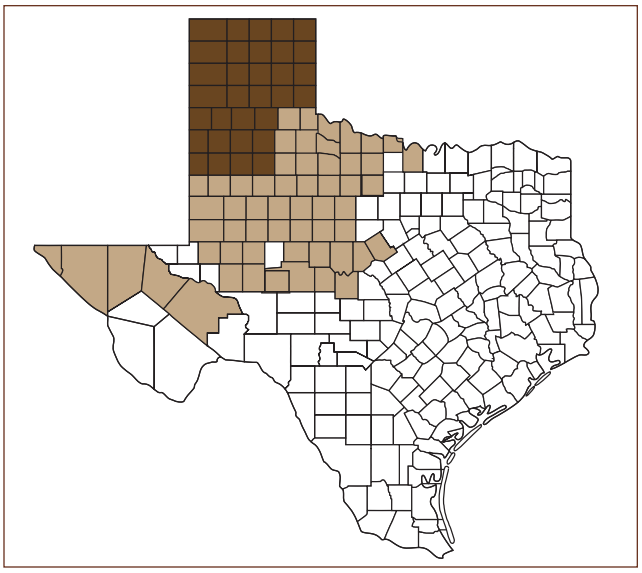

Figure 5. Texas counties where Russian wheat aphids have been found. (Dark brown indicates area where Russian wheat aphids are most damaging.)

Texas AgriLife Extension Service scientists have developed economic thresholds for Russian wheat aphids infesting wheat in late winter and spring. The thresholds are based upon the cost of control and the market value of wheat. **For every 1 percent of the tillers infested, there is a 0.5 percent yield loss**.

Russian Wheat Aphid Economic Threshold Using Percent Infested Wheat Tillers as the Sampling Unit

Control cost per acre $	Market value of crop ($) per acre					
	50	100	150	200	250	300
	Percent infested tillers					
4	16	8	5	4	3	3
5	20	10	7	5	4	3
6	24	12	8	6	5	4
7	28	14	9	7	6	5
8	32	16	11	8	6	5
9	36	18	12	9	7	6
10	40	20	13	10	8	7
11	44	22	15	11	9	7
12	48	24	16	12	10	8

Sampling and economic thresholds for Russian wheat aphid. While walking across a field, randomly select 100 tillers, each from a different site. To prevent bias, select tillers without looking at them. Carefully examine each tiller and record the number infested. Consider any tiller with one or more Russian wheat aphids as infested. Determine the percent of infested tillers and use the following table to decide whether treatment is justified. For example, if the market value of the crop is projected to be $50 per acre and control costs are $9 per acre, the treatment threshold is 36 percent infested tillers.

Bird cherry-oat aphid

This aphid feeds on various grains and grasses and is particularly abundant on small grains. Bird cherry-oat aphids are yellowish green to dark green to black with a reddish-orange area around the base of the cornicles. Unlike the greenbug, the bird cherry-oat aphid does not inject a toxin while feeding and therefore feeding by this aphid is less damaging. So, control of the bird cherry-oat aphid is only occasionally required to prevent feeding damage. However, like the greenbug, the bird cherry-oat aphid

Suggested Insecticides for Controlling Russian Wheat Aphids

Insecticide	Amount per acre	Waiting period (days) to: Harvest	Grazing
Chlorpyrifos	See remarks		
(Lorsban® 4E or 4E-SG)	0.5–1 pt	28	14
(Nufos® 4E)	0.5–1 pt	28	14
β-Cyfluthrin	See remarks		
(Baythroid® XL)	1.8–2.4 fl oz	30	3
Dimethoate	See remarks		
(Dimethoate 2.67)	0.75–1 pt	35	14
(Dimethoate 4E)	0.5–0.75 pt	35	14
(Dimate 4EC)	0.5–0.75 pt	35	14
Gamma-cyhalothrin	See remarks		
(Proaxis®)	2.56–3.84 fl oz	30	30
(Declare®)	1.02–1.54 fl oz	–	–
Imidacloprid			
Gaucho® 600	600 @ 0.8–2.4 fl oz per 100 lbs of seed — commercial seed treater only		45
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	2.56–3.84 fl oz	30	7
(Karate with Zeon Technology®)	1.28–1.92 fl oz	30	7
Methyl parathion			
(4 lb)	1–1.5 pt	15	15
Methyl parathion encapsulated			
(Penncap-M®)	2–3 pt	15	15
Thiamethoxam			
Cruiser®	5FS @ 0.75–1.33 fl oz per 100 lbs of seed — commercial seed treater only		
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks

Chlorpyrifos. Labeled for use on wheat only. Do not make more than two applications per crop.
β-Cyfluthrin. Do not apply more than 4.8 fluid ounces per acre per season.
Dimethoate. Labeled for wheat and triticale only.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

is an important vector of barley yellow dwarf virus. Seed treatments (Gaucho, Cruiser) can control early season infestations of bird cherry-oat aphid and greenbug and reduce the potential spread of barley yellow dwarf virus due to these aphid vectors.

English grain aphid

English grain aphids are usually green with black legs, cornicles and antennae. These pests are most abundant from late February through June. English grain aphids cluster on the developing heads of small grain plants, and their feeding may result in shrunken, shriveled grain. This aphid is normally controlled by many of the same predators and parasites that help control the greenbug and seldom causes yield losses. It is a vector of barley yellow dwarf virus.

Rice root aphid

The primary hosts of the rice root aphid are peaches and plums. Secondary host plants include rice, wheat and other small grains. The rice root aphid is a vector of barley yellow dwarf virus and is found on plant roots in spots within wheat fields. Stunted plants may be the first indication of its presence, with only a small percentage of plants infested. These aphids are up to approximately 1/10 inch long and are dark green or olive. They usually have a reddish area at the posterior between and around the base of the cornicles. Insecticidal control measures have not been developed.

Winter grain mite

The winter grain mite may damage oats, wheat and barley. Mites range from 1/32 to 1/16 inch long. The adult has four pairs of reddish-orange legs, and the body is dark brown to black. Mite damage is generally more severe when small grains were planted in previous years. Rotation with other kinds of crops reduces infestations.

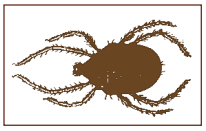

Figure 6. Winter grain mite.

This pest feeds primarily at night and remains around the base of the plant during the day. Mites are less active in hot, dry weather. The greatest damage occurs in winter and early spring. **Mites cause leaf tips to turn brown and plants to become stunted with a silvery-gray appearance. These symptoms and the presence of mites indicate the need for control.**

Brown wheat mite

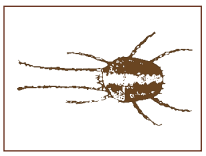

Figure 7. Brown wheat mite.

The brown wheat mite is about the size of the period at the end of this sentence and is considerably smaller than the winter grain mite. Its rounded body is metallic dark brown with a few short hairs on the back. The front legs are about twice as long as the other three pairs of legs. It is most prevalent in dry weather, and populations increase when wheat suffers from deficient moisture. The brown wheat mite occurs throughout the High Plains and Rolling Plains. Miticides may not economically control this pest if the crop is unable to respond because of dry conditions.

Wheat curl mite

The wheat curl mite is approximately 1/100 inch long, white, sausage-shaped and has four small legs on the front. It vectors wheat streak mosaic and wheat mosaic virus (formerly called High Plains virus), but causes very little damage otherwise. Mite feeding alone causes leaves to roll, taking on an onion-leaf appearance. If the virus is present, leaves become mottled and streaked with yellow.

Mites reproduce most rapidly at temperatures between 75 and 80 degrees F. They crawl very slowly and depend almost entirely on wind for dispersal.

Suggested Miticides for Controlling Winter Grain Mites

Miticide	Amount per acre	Waiting period (days) to:	
		Harvest	Grazing
Malathion			
(5 lb)	1.5–2pt	7	7
Methyl parathion			
(4 lb)	0.50–1.50 pt	15	15

Suggested Insecticides for Controlling Brown Wheat Mite

Insecticide	Amount per acre		Waiting period (days) to:	
			Harvest	Grazing
Chlorpyrifos		See remarks		
(Lorsban® 4E or 4E-SG)	0.5–1 pt		28	14
(Nufos® 4E)	0.5–1 pt		28	14
Dimethoate		See remarks		
(Dimethoate 2.67)	0.75–1 pt		35	14
(Dimethoate 4E)	0.33–0.5 pt		35	14
(Dimate 4EC)	0.33–0.5 pt		35	14
Gamma-cyhalothrin		See remarks		
(Proaxis®)	3.84 fl oz		30	30
(Declare®)	1.54 fl oz		–	–
Lambda-cyhalothrin		See remarks		
(Warrior with Zeon Technology®)	3.84 fl oz		30	7
(Karate wth Zeon Technology®)	1.92 fl oz		30	7
Methyl parathion				
(4 lb)	0.5–1.5 pt		15	15

Remarks
Chlorpyrifos. Labeled for use on wheat only. Do not make more than two applications per crop.
Dimethoate. Labeled for wheat and triticale only.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z for ground applications.

The mite is most active during warm weather and moves mostly on warm, southwesterly winds. Consequently, most wheat streak mosaic virus symptoms develop from southwest to northeast across a field. Mites survive the summer on volunteer wheat and grass. Volunteer wheat is the most important host for the mite as well as for the wheat mosaic virus and the wheat streak mosaic virus. The potential for wheat curl mite is highest in the following conditions:

- Early volunteer wheat as a result of hail damage to wheat nearing maturity,
- Good stands of volunteer wheat as a result of July rains,
- Volunteer wheat that is not destroyed, or not destroyed until after planted wheat is up,
- Early planted wheat,
- Cool summers, and
- Warm, dry fall for optimum mite reproduction and movement.

There are no remedial control options after a wheat plant is infected with the wheat streak mosaic virus or wheat mosaic virus. Therefore, host resistance and avoiding infection are the most important control strategies. Breaking the "green bridge" from one wheat crop to the next will prevent transmission of the viruses by the wheat curl mite. This can be achieved by eliminating grass weeds and volunteer wheat around your fields and neighboring properties. Delaying plantings near CRP or native stands of grasses until the grasses have senesced also helps. **Grass weeds and volunteer wheat should be destroyed by tillage or a burn-down herbicide at least 21 days before planting wheat**.

Some wheat varieties are more susceptible to wheat streak mosaic virus than others, but none is totally resistant. TAM-107 and other varieties with the Amigo gene confer resistance to the mite and the virus. There currently is no resistance to wheat mosaic virus and chemical control of mites has not been effective.

Hessian fly

The Hessian fly infests wheat in Central Texas and west into the Central Rolling Plains (Fig. 8).

Injury to wheat is caused by larval feeding on stem tissue at the crown of young plants or just above the nodes on jointed wheat. The extent of injury is generally greater in newly emerged and younger

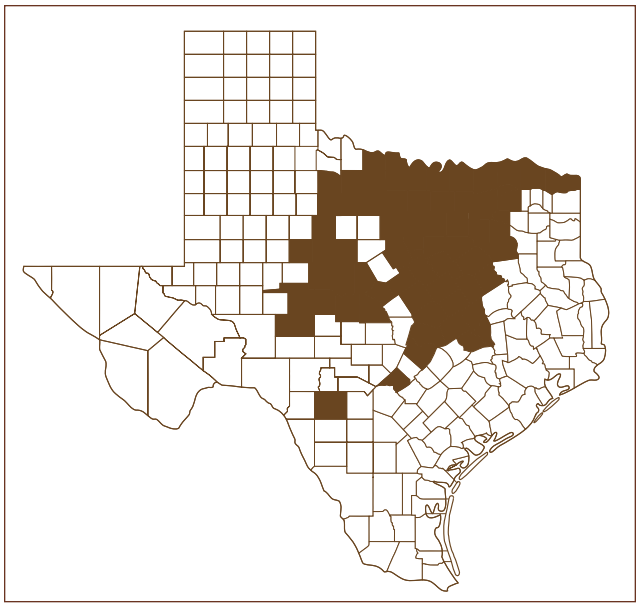

Figure 8. Counties in which the Hessian fly has been recorded.

seedlings than in older, established plants. **Larval feeding stunts infested tillers, and the leaves become somewhat broader and darker green**. Stunted tillers, particularly in younger plants, usually wither and die. This can result in thin stands in the fall, reduced forage production and greater winter kill. If infested tillers survive, their growth and yield will be reduced. **Significant grain losses can be expected when fall infestations exceed 5 to 8 percent or spring infestations exceed 20 percent infested stems.**

Serious infestations may lead to thin wheat stands that yield poorly and are likely to have more weed problems than healthy stands. Hessian fly feeding also weakens the stem at the site of feeding and **may cause significant lodging** or stem breakage and make harvesting the crop difficult. Feeding also can interfere with nutrient flow to the head during kernel formation, reducing grain quantity and quality.

Wheat is the **preferred** host, but infestations have been found on barley, rye, spelt and emmer. **Oats are not a host for the Hessian fly**. Occasionally, it has been found on wild grasses, such as quackgrass, western wheatgrass, little barley, goatgrass and timothy. There are likely other grass hosts in Texas.

The mosquito-like Hessian fly adult is ⅒ inch long and has dark wings, a black thorax and a dark-red abdomen. Adult flies live no more than 3 days. Females deposit an average of 200 eggs in clusters of 5 to 12 eggs, preferring younger plants and leaves for egg laying. The glossy, red eggs are deposited in the grooves on the upper leaf surface. Maggots move down the grooves of the leaf and under the leaf sheath, coming to rest right above the plant crown or just above a node. Larvae suck plant juices and form a shallow depression in the stem as they develop. Newly hatched larvae are red, but turn lighter in a few days. Fully developed larvae are white with a translucent green stripe down the middle of the back. As a dormant, fully developed larva, the Hessian fly survives summer and very cold winter conditions in a tiny, dark brown puparium. This is known as the "flaxseed stage" because it resembles a seed of flax.

Management strategies. Cultural management practices that can reduce economic losses include the following techniques:

- Growing genetically adapted resistant wheat varieties (information for your area available from your county Extension agent),
- Planting wheat later in the fall to reduce the potential for the fall generation,
- Deeply burying crop residue to reduce Hessian fly numbers,

Suggested Insecticides for Controlling Hessian Fly

Insecticide	Amount per acre	Waiting period (days) to: Harvest	Grazing
Imidacloprid			
Gaucho® 600	600 @ 0.8–2.4 fl oz per 100 lbs of seed — commercial seed treater only		45
Thiamethoxam		See remarks	
Cruiser®	5FS @ 0.75–1.33 oz per 100 lbs of seed — commercial seed treater only		

Remarks
Seed treatments may not provide protection against spring broods.

Table 1. Wheat varieties expected to be moderately resistant (MR) and resistant (R) to the Hessian fly in north central and west central Texas.

Wheat Class	Seed source	Variety	Resistance rating (biotype)
Hard Red	Agri-Pro	Coronado	MR
	Pioneer	2158	MR
	Oklahoma State University	Duster	R
	Kansas State University	Everest	R
Soft red winter	Agri-Pro	Crawford	MR
	TAMU	TAMsoft	R

- Rotating to crops other than wheat or barley to suppress the fly population, and
- Not moving infested straw from an infested area to an non-infested area.

Some wheat varieties are resistant to certain populations of the Hessian fly and are susceptible to other populations of this pest. These unique populations, or races, of Hessian flies are called biotypes. They result from genetic changes that allow the flies to feed and survive on different varieties of wheat. Some biotypes cannot successfully infest wheat varieties that have specific genes for resistance. This is why planting Hessian fly-resistant varieties works well to prevent losses.

However, widespread planting of one or two resistant varieties over time can favor biotypes that survive on the resistant varieties. This virulent biotype eventually can become so common that the formerly resistant varieties begin to suffer damage. Thus, Hessian flies can overcome resistance in wheat just as rust fungi develop new races.

Table 1 lists wheat varieties that are adapted to Texas conditions and showed some level of resistance to the Hessian fly in 2005. This rating may change as biotypes change and as new varieties with resistance to the fly may be introduced to the market.

A date in late fall after which fly emergence will not occur is called the fly-free date. In central Oklahoma and farther north in the wheat belt, planting after this date has effectively reduced or totally prevented Hessian fly infestations and damage. This practice of planting after adult activity has ceased because of cold weather has proved to be of limited value in Texas, where intermittent periods of warm fall weather allow adults to emerge, mate and lay eggs. These environmental conditions can occur well into December and damage larval populations. However, delayed planting does minimize damage from the Hessian fly and decreases the number of fall generations. **If grazing livestock is important in early fall, producers should plant oats or a Hessian fly-resistant wheat variety or consider an insecticide seed treatment in fields with a history of Hessian fly damage**.

Destroying volunteer wheat is an important management tool for many wheat pests, including the Hessian fly, wheat curl mite and aphids. **Destroying volunteer wheat deprives first-generation adults of a place to deposit their eggs**. Plowing under old wheat stubble 4 to 6 inches deep in August greatly reduces adult emergence from buried plant residue. However, soil erosion and moisture retention problems in some areas can dictate that residue burial be limited to conform to conservation practices.

While crop rotation helps reduce Hessian flies within a given field, these pests can migrate a mile or more from adjacent fields. Burning the straw will kill exposed pupae and larvae in stems, but will **not** kill pupae located at the soil surface or below the soil line. You should **not** burn infested straw and **avoid baling and moving infested straw or hay to a non-infested area**. When buying or selling hay or straw, look for the brown pupae behind leaf sheaths at nodes to make sure the material is not infested with the Hessian fly.

Insecticide seed treatments with Gaucho® or Cruiser® are labeled for use on the Hessian fly and can suppress light infestation of Hessian fly in seedling wheat in the fall. These seed treatments may fail to protect seedling wheat from damage when large numbers of Hessian fly infest the crop.

Occasional Pests of Small Grains

Beet armyworm

Fully developed beet armyworms are 1¼ inches long. They are light green with a conspicuous black spot on each side of the thorax above the second pair of thoracic legs. Damaging populations are most likely to occur in late summer or early fall when hot, dry conditions inhibit the growth of preferred hosts and force moths to deposit egg masses on young, small grains.

Few insecticides control beet armyworms, and replanting may be more cost effective. **Fields planted after mid-October usually escape beet armyworm infestation**.

Chinch bug and false chinch bug

Adult chinch bugs are about ⅛ inch long. The body is black, but the wings are mostly white with black triangular spots at the middle of the outer margin. Young chinch bugs are shaped like the adults. They are red at first, but turn darker as they mature, and have a white band across the abdomen.

In early spring, chinch bugs move into small grains from bunch grass, where they overwintered. Young and adult chinch bugs feed on small grains, and very heavily infested plants may be stunted or killed. Infestations are usually confined to small, well defined spots. When a damaging infestation occurs on the field border, prompt treatment may prevent infestation of the entire field.

Adult false chinch bugs are ⅛ inch long, narrow and dull yellowish gray. The wing tips are transparent and extend beyond the end of the abdomen. Small grains are not preferred hosts to these bugs, which often migrate in large numbers. False chinch bugs suck sap from the stems and heads of small grains. This may cause poorly filled heads and shriveled grain, but the extent of their damage is not well documented. Before applying insecticides, consider the percentage of the field infested and make sure that these bugs are feeding on the small grains and are not just migrating through.

Grasshopper

Grasshoppers are an occasional problem in Texas small grains. Most damage occurs in the fall when these pests migrate into fields. **Check areas around wheat fields before planting to locate and treat heavy infestations before planted wheat emerges.**

Suggested Insecticides for Controlling Beet Armyworms

Insecticide	Amount per acre	Waiting period (days) to: Harvest	Grazing
Gamma-cyhalothrin	See remarks		
(Proaxis®)	2.56–3.84 fl oz	30	30
(Declare®)	1.02–1.54 fl oz	–	–
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	2.56–3.84 fl oz	30	7
(Karate wth Zeon Technology®)	1.28–1.92 fl oz	30	7
Methomyl			
(Lannate® SP)	0.25–0.5 lb	7	10
(Lannate® LV	0.75–1.5 pt	7	10
Methyl parathion			
(4 lb)	1.5 pt	15	15
Spinosad			
(Tracer®)	1–3 fl oz	21	14
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks

Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.

Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.

Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

Suggested Insecticides for Controlling Chinch Bugs and False Chinch Bugs

Insecticide	Amount per acre	Waiting period (days) to:	
		Harvest	Grazing
Gamma-cyhalothrin	See remarks		
(Proaxis®)	3.84 fl oz	30	30
(Declare®)	1.54 fl oz	–	–
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	3.84 fl oz	30	7
(Karate wth Zeon Technology®)	1.92 fl oz	30	7
Methyl parathion			
(4 lb)	1.5 pt	15	15
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

Suggested Insecticides for Controlling Grasshoppers

Insecticide	Amount per acre	Waiting period (days) to:	
		Harvest	Grazing
Chlorpyrifos	See remarks		
(Lorsban® 4E or 4E-SG)	0.5–1 pt	28	14
(Nufos® 4E)	0.5–1 pt	28	14
β-Cyfluthrin	See remarks		
(Baythroid® XL)	1.8–2.4 fl oz	30	3
Gamma-cyhalothrin	See remarks		
(Proaxis®)	3.84 fl oz	30	30
(Declare®)	1.02–1.54 fl oz	–	–
Imidacloprid			
Gaucho® 600	600 @ 1.2–2.4 fl oz per 100 lbs of seed — commercial seed treater only		45
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	2.56–3.84 fl oz	30	7
(Karate wth Zeon Technology®)	1.28–1.92 fl oz	30	7
Malathion	See remarks		
(5 lb)	1.5–2 pt	7	7
(Fyfanon® ULV)	8 fl oz	7	7
Methyl parathion			
(4 lb)	1.5 pt	15	15
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks
Chlorpyrifos. Labeled for use on wheat only. Do not make more than two applications per crop.
β-Cyfluthrin. Do not apply more than 4.8 fluid ounces per acre per season.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Imidacloprid. Reduce early-season damage with use as a 50- to 60-foot border treatment.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

Suggested Insecticides for Controlling Flea Beetles

Insecticide	Amount per acre	Waiting period (days) to: Harvest	Grazing
β-Cyfluthrin	See remarks		
(Baythroid® XL)	1.8–2.4 fl oz	30	3
Gamma-cyhalothrin	See remarks		
(Proaxis®)	3.84 fl oz	30	30
(Declare®)	1.02–1.54 fl oz	–	–
Lambda-cyhalothrin	See remarks		
(Warrior with Zeon Technology®)	2.56–3.84 fl oz	30	7
(Karate wth Zeon Technology®)	1.28–1.92 fl oz	30	7
Zeta-cypermethrin	See remarks		
(Mustang Max®)	3.2–4.0 fl oz	14	14

Remarks
β-Cyfluthrin. Do not apply more than 4.8 fluid ounces per acre per season.
Gamma-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season.
Lambda-cyhalothrin. Labeled for wheat, wheat hay and triticale. Do not apply more than 0.48 pints per acre per season for Warrior Z or 0.24 pints per season for Karate Z.
Zeta-cypermethrin. Labeled for wheat and triticale. Do not apply more than 20 ounces per acre per season.

Flea beetles

Flea beetles are shiny, black, and about the size of a pin head. They readily jump when approached. During the fall, flea beetles may infest the borders of a field and gradually move across the field, feeding on and killing plants as they go. Leaves are skeletonized, giving injured plants a bleached appearance before they wilt and die. **Fields and field borders that have been kept clean of weeds the previous season are less subject to flea beetle damage.**

Wheat stem maggot

Adult flies of the second generation wheat stem maggot emerge in the spring and lay eggs on the leaves of wheat and other grass hosts. The developing larvae, or maggots, feed on the stem just above the last stem joint, cutting the moisture and nutrient flow to the head. The head loses its green color, turning tan to white, but the leaf sheath remains green. Infested tillers seldom exceed 1 percent, and you should not chemically control this insect.

Leafhopper

Large numbers of leafhoppers, including the aster leafhopper and other species, sometimes migrate into fields of small grains during dry weather in late fall. These pests apparently increase on wild hosts and move into small grains to feed on succulent plants. They suck sap from leaves, and, when there are many leafhoppers, infested fields can look silver. Infestations often decline following freezing temperatures.

Insecticide recommendations have not been developed for leafhoppers infesting wheat.

Insecticide Application Methods

Ground machines or aircraft can be used to apply most insecticides. For best results with aerial applications, swaths should meet or slightly overlap.

Spray applications are most effective when wind velocity does not exceed 15 miles per hour. Avoid spraying when plants are wet from dew or rain. For broadcast applications, use No. 3 cone nozzles set 20 inches apart on a rear mounted boom of a tractor sprayer. Pump pressure should be 60 pounds per square inch.

Nozzle size, nozzle number, ground speed and pressure influence the rate of output per acre. Therefore, calibrate the sprayer carefully to ensure that recommended rates are applied.

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 experience. Recommendations are a product of research and are believed to be reliable. However, it is impossible to eliminate all risk. Conditions or circumstances which are unforeseen or unexpected may result in less than satisfactory results even when these suggestions are used. The Texas AgriLife Extension Service will not assume responsibility for risks. Such risks shall be assumed by the user of this publication.

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 produced. 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 for 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.

Endangered Species Regulations

The Endangered Species Act is designed to protect and to assist in the recovery of animals and plants that are in danger of becoming extinct. In response to the Endangered Species Act, many pesticide labels now carry restrictions limiting the use of products or application methods in designated biologically sensitive areas. These restrictions are subject to change. Refer to the Environmental Hazards or Endangered Species discussion sections on product labels and/or call your

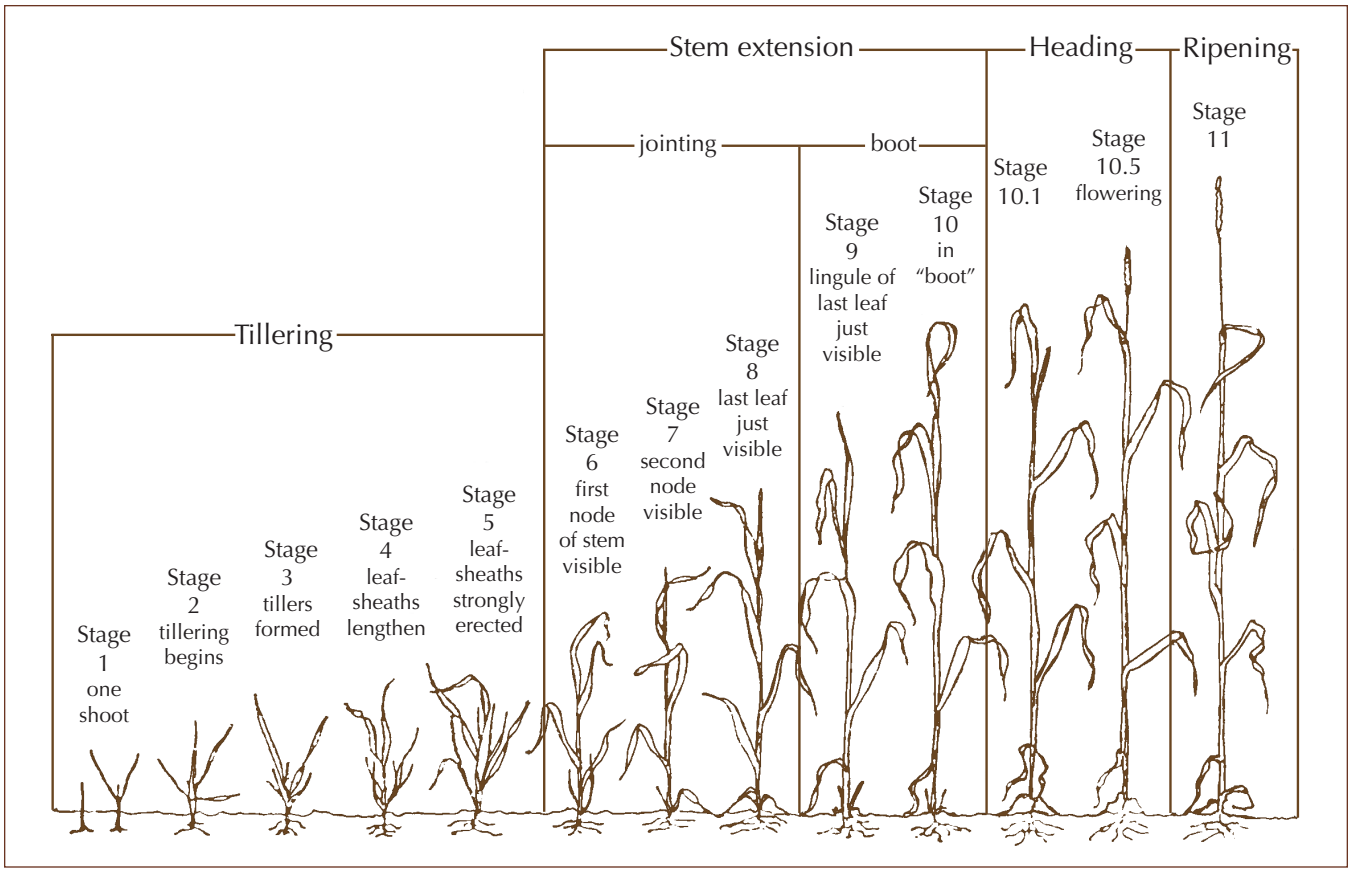

Figure 9. Feekes scale of small grain development.

county Extension agent or Fish and Wildlife Service personnel to determine what restrictions apply to your area. Regardless of the law, pesticide users can be good neighbors by being aware of how their actions may affect people and the natural environment.

Worker Protection Standard

The Worker Protection Standard (WPS) is a set of federal regulations that applies to all pesticides used in agricultural plant production. If you employ any person to produce a plant or plant product for sale and apply any type of pesticide to that crop, WPS applies to you. The regulations require you to protect your employees from pesticide exposure.

You must inform employees about exposure, protect them from exposure and mitigate pesticide exposures that they may receive. WPS requirements will appear in the "Directions for Use" part of the pesticide label. For more detailed information, consult Worker Protection Standard, 40 CFR part 170, or call the Texas Department of Agriculture, Pesticide Worker Protection Program, (512) 463-7622.

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