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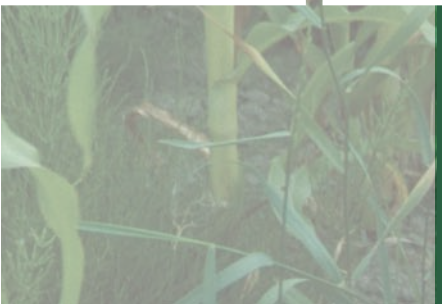
Managing Insect and Mite Pests of Texas Corn







Managing Insect *and* Mite Pests *of* Texas Corn

Patrick Porter
Associate Professor and Extension Entomologist

Gregory B. Cronholm
Extension Agent—Pest Management

Roy D. Parker
Professor and Extension Entomologist

Noel Troxclair
Assistant Professor and Extension Entomologist

Ed Bynum
Extension Entomologist

Carl D. Patrick
Professor and Extension Entomologist

Stephen P. Biles
Extension Agent—Pest Management

The Texas A&M System

This publication may be used in conjunction with B-6177, *Texas Corn Production Emphasizing Pest Management and Irrigation* (2005), which is available from Texas AgriLife Extension (*http://agrilifebookstore.org*). B-6177 provides details on each corn pest and discusses scouting and economic thresholds. As part of this new publication, there are instructional videos and pest identification guides at *http://lubbock.tamu.edu/cornIPM/*.

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Introduction

Corn is subject to insect attack throughout the growing season. Some insects may reach damaging levels in spite of natural predators and parasites and may require chemical control.

However, plant damage is not always directly related to insect numbers. Other factors such as plant vigor, growth stage, moisture conditions, time of year, parasite and predator abundance and crop rotation are equally important.

Therefore, chemical treatments should be based on careful evaluation of economic and natural control factors. Wise use of insecticides requires that producers inspect their crops frequently to determine if damaging numbers of insect or mite pests are present.

Methods of determining insect numbers and guides for determining the need for pesticides are provided in this publication. ***Seed corn production fields and sweet corn are more susceptible to insect damage than is field corn. Increased susceptibility to insect attack and higher value often require that certain pests be controlled at lower levels in seed production and sweet corn fields than in field corn.***

A few insect and mite pests attacking corn in Texas show some resistance to once-effective pesticides. Generally, the more extensively a pesticide is used, the more rapidly resistance develops. Therefore, pesticides should be used only when needed. The actual need can be determined only by frequent inspections of the crop to determine pest numbers. The present status of resistance in specific pests is discussed in this publication.

NOTE: This guide discusses insect and mite pests in the approximate seasonal order that they damage corn: pre-emergence, seedling to tassel and tassel to hard dough. Insect control suggestions in this bulletin primarily refer to insect and mite control on field corn.

Policy Statement for Making Pest Management Suggestions

This is not a complete listing of all products registered for corn, and does not list all uses of products mentioned. The insecticides and their suggested use patterns included in this publication reflect a consensus opinion of Extension and research entomologists based on field tests. The data from these field tests met the minimum requirements as outlined in the Guidelines for the Annual Entomology Research Review and Extension Guide Revision Conference. Products listed must conform to our performance standards and avoid undue environmental consequences.

Suggested insecticide use rates have exhibited sufficient efficacy in tests to provide adequate control in field situations. However, it is impossible to eliminate all risks. Conditions or circumstances that are unforeseen or unexpected may result in less than satisfactory results. Texas AgriLife Extension will not assume responsibility for such risks. Such responsibility shall be assumed by the user of this publication.

Suggested pesticides must be registered and labeled 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.

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. Always read and follow carefully the instructions on the container label. Pay particular attention to those practices that ensure worker safety.

For more information, contact your county Extension staff or write the Extension Entomologist, Department of Entomology, Texas A&M University, College Station, TX 77843-2475; or call 979.845.7026.

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 of product labels and/or call your county Extension office 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, the WPS applies to you.

The WPS requires you to protect your employees from pesticide exposure. It requires you to provide three types of protection. You must:

- Inform employees about exposure
- Protect employees from exposure
- Mitigate pesticide exposures that employees might receive

The WPS requirements will appear in the "Directions for Use" part of the pesticide label. For more information, consult the EPA Worker Protection Standard website at *http://www.epa.gov/pesticides/health/index.htm*. You may also call the Texas Department of Agriculture Pesticide Worker Protection Program at 512.463.7622 or 800.TELL.TDA (800.835.5832).

Biological Control

Biological control is the use of living organisms such as parasites, predators and disease-causing organisms to control pests. Important natural enemies in corn include minute pirate bugs, spiders, lady beetles, predatory mites and thrips, and a variety of tiny wasps that parasitize insect pests.

Insect and mite populations are often held below damaging levels by weather, inadequate food, and natural enemies (including disease, predators and parasites). It is important to recognize the impact of these natural control factors and, where possible, encourage their action.

Biological control includes the conservation, augmentation and importation of natural enemies. Existing populations of natural enemies can be conserved by minimizing insecticide applications and using insecticides that are more toxic to the target pest than to the natural enemy. Augmentation involves the purchase and release of natural enemies on a periodic basis. Classical biological control, the third type, is the importation of natural enemies from other countries.

Transgenic Corn

Terminology and Toxins

Transgenic corn is, by definition, a corn plant that contains at least one gene from a noncorn species. The first transgenic corn was registered for use in 1996, and because the "trans-gene" came from the soil-dwelling bacterium *Bacillus thuringiensis,* which creates an insecticidal protein, the first transgenic corn was called "Bt corn." However, newer types of transgenic corn contain toxins that are constructs of several sub-units of genes that code for toxin production. It is more proper to use the term "transgenic corn" than "Bt corn," especially since future hybrids will contain toxins not based on the *Bacillus* species, and current hybrids that have only herbicide resistance have no relation to Bt at all.

Broadly speaking, there are three types of transgenic corn: that which kills caterpillars, that which kills corn rootworms, and that which kills both. The latter type is just a combination (stack) of the first two types.

Bt corn that kills caterpillars has no effect on corn rootworm larvae. The Bt corn that kills corn rootworm larvae has no effect on caterpillars. This is because the toxins produced by each type of corn have a very narrow range of pests to which they are toxic.

The first generation of transgenic corn contained only a single toxin for caterpillars (Lepidoptera) or corn rootworm (Coleoptera), and some hybrids had stacks of these toxins with one toxin for each group of pests. These hybrids were also tolerant to one group of herbicides. The next generation of transgenic corn, such as YieldGard VT Pro, contains multiple toxins for caterpillars—a pyramid of toxins targeted at the same pest group. Genuity VT Triple Pro hybrids are stacked but contain only one suite of pyramided toxins for caterpillars plus a single toxin for corn rootworms. Agrisure Viptera contains two caterpillar toxins and one corn rootworm toxin.

The newest generation of transgenic corn contains toxin pyramids for both caterpillars and corn rootworms and can contain tolerance to as many as two herbicide groups. For example, Genuity SmartStax contains three toxins for caterpillars, two toxins for corn rootworms, and tolerance for two herbicides. Many seed companies are pursuing this stacked, multiple-toxin pyramid approach to insect-protected transgenic crops. In addition to better insect control, there are several reasons this approach is appealing. The pyramided toxins have, for the first time, made it scientifically possible to

reduce the proportion of refuge well below what is mandated for single-toxin corn, while also lengthening the number of years before resistance to the toxins is projected to develop. Growers should consult their seed dealers to make sure they are following the correct resistance management plan for the hybrids they are planting.

The following table lists current transgenic hybrids (April 2010), the toxins they possess, the genetic transformation that provided the toxin, and the target pests for each. The table allows an "at a glance" comparison of currently marketed transgenic hybrids for insect control. Genetic transformation events are listed in parentheses directly beneath the toxin they produce. Note that more recent events may express the same toxin as older events, but the later events generally result in higher levels and/or longer or more even expression of a toxin.

Table 1. Currently registered transgenic corn hybrids for insect control.

Corn hybrid [Bag tag]	Lepidoptera toxin (Event)	Target	Rootworm toxin (Event)	Target
YieldGard Corn Borer [YGCB]	Cry1Ab (MON810)	Stalk boring Lepidoptera	none	
YieldGard RW [YGRW]	none	none	Cry3Bb1 (MON863)	CRW
YieldGard Plus [YGPL]	Cry1Ab (MON810)	Stalk boring Lepidoptera	Cry3Bb1 (MON863)	Corn rootworms
Herculex I [HX1]	Cry1F (TC1507)	Stalk boring Lepidoptera, WBC, FAW	none	none
Herculex RW [HXRW]	none	none	Cry34Ab1 + Cry35Ab1 (DAS-59262-7)	CRW larval susceptibility: WCR > NCR > SCR
Herculex Xtra [HXX1]	Cry1F (TC1507)	Stalk boring Lepidoptera, WBC, FAW	Cry34Ab1 + Cry35Ab1 (DAS-59262-7)	CRW larval susceptibility: WCR > NCR > SCR
YieldGard VT RW [VTRW]	none	none	Cry3Bb1 (MON88017)	Corn rootworms
YieldGard VT Pro [VTP]	Cry1A.105 Cry2Ab (both MON89034)	Stalk boring Lepidoptera	none	none
Genuity VT Triple Pro (Monsanto) [VT3P] (RR2)	Cry2Ab2 Cry1A.105 (both MON89034)	CEW, FAW, BCW, stalk boring and other Lepidoptera	Cry3Bb1 (MON 88017)	Corn rootworms
Genuity SmartStax (Monsanto)	Cry2Ab2 Cry1A.105 (both MON89034) Cry 1F (Dow TC1507)	CEW + other leps FAW, BCW WBC, FAW, stalk boring Lepidoptera	Cry3Bb1 (MON 88017) Cry34Ab1 + Cry35Ab1 (DAS-59262-7)	Corn rootworms
Optimum AcreMax1	Cry1F (TC1507)	Stalk boring Lepidoptera, WBC, FAW	Cry34Ab1 + Cry35Ab1 (DAS-59262-7)	Corn rootworms
Agrisure CB	Cry1Ab (Bt11)	Stalk boring leps, CEW	none	none
Agrisure RW	none	none	Cry3A (MIR604)	Corn rootworms
Agrisure CB/RW	Cry1Ab (Bt11)	Stalk boring Lepidoptera	Cry3A (MIR604)	Corn rootworms
Agrisure 3000GT	Cry1Ab (Bt11)	Stalk boring Lepidoptera	Cry3A (MIR604)	Corn rootworms
Agrisure Viptera	Vip3A (MIR 162) +Cry1Ab (Bt 11)	Stalk boring Lepidoptera, CEW, FAW, WBC	Modified Cry3A (MIR604)	Corn rootworms

Benefits of Transgenic Technology

Transgenic corn produces some of the insecticidal endotoxins found in the bacterium *Bacillus thuringiensis* (Bt). These proteins are highly toxic to certain insect pests but have little or no effect on humans, livestock, most beneficial insects and other nontarget organisms.

The benefits of transgenic corn include the potential reduction in human exposure to pesticides, reduced incidence of some plant diseases, lower insecticide application costs and reduced environmental consequences from pesticide use. Transgenic crops also provide protection for most or all of the growing season, and this protection is relatively unaffected by weather.

What to Expect for Insect Control

Extensive field testing indicates that all currently marketed transgenic corn hybrids toxic to Lepidoptera provide excellent control of first- and second-generation European corn borers, southwestern corn borers and sugarcane borers. However, it should be noted that as of this writing in April 2010, scientists in Louisiana are publishing research data suggesting that sugarcane borer may have some resistance to Cry1Ab corn. The recent inclusion of multiple toxins for Lepidoptera has increased the effectiveness on other pest species such as corn earworm, fall armyworm and western bean cutworm.

It is a little more complicated to describe the efficacy against corn rootworms. Expect good control of Mexican, northern and western corn rootworms, but do not expect the same control of southern corn rootworms. With the exception of southern corn rootworm, both Cry3Bb1 and Cry34/35 hybrids have been shown to protect roots at least as well as the best conventional insecticides. This protection is not absolute, and the roots will sustain some corn rootworm damage if larvae are in the field.

The efficacy of conventional insecticides can vary widely, depending on rainfall, soil moisture and plant development in relation to rootworm egg hatch. Transgenic crops are much more consistent than are conventional insecticides in providing protection against economic damage.

This is not to say that they will kill all of the rootworms feeding on the roots. In fact, Cry3Bb1 is a "non-high dose" toxin, and it is common to find adult rootworm beetles emerging in transgenic corn fields. Cry34/35 corn expresses a bit higher dose of toxin, and there are fewer survivors than on Cry3Bb1 corn.

The bottom line is that both types of transgenic corn provide good corn rootworm control, but neither provides absolute protection. Also, in extremely weedy fields, rootworm larvae may be able to feed on weed roots until they are large and then move to corn roots and cause significant damage. In this case, control may not be as good as it should have been.

Also, it is common for a very small percentage of the seed in a bag to be "nonexpressing," which means that the plant that develops from the seed will contain a reduced amount or none of the Bt toxin. This is entirely normal. Nonexpressing plants will sustain damage because they have little or no protection except for the insecticide contained in the seed treatment.

Preventing Resistance to Transgenic Corn

Just as with conventional insecticides, insects can develop resistance to the toxins in transgenic corn. Texas Extension personnel are monitoring the development of resistance to corn that is active against caterpillars. Fortunately, this level is still relatively low.

Resistance management discussion is beyond the scope of this publication, but growers and consultants are strongly encouraged to read and follow the resistance management guidelines provided by seed dealers. The producers of transgenic corn have partnered with the National Corn Growers Association (*http://www.ncga.com/*) to provide up-to-date information and training on preventing resistance.

The Environmental Protection Agency is developing remote methods of determining compliance with resistance management regulations, and this monitoring may soon be done by airplane or satellite.

Pre-emergence Insect Control

Soil-Inhabiting Pests

White grubs, corn rootworms, cutworms, wireworms, sod webworms, seedcorn beetles and seedcorn maggots are the most common soil insects attacking corn in Texas. Cultural practices are very important in reducing damage by these soil pests.

The continued growth of corn on the same land year after year increases damage by certain soil insects. For example, losses from corn rootworms may be reduced or in some cases eliminated by a crop rotation scheme including soybeans or other crops that are not fed upon by rootworms.

In most areas of Texas, corn has been rotated successfully with sorghum without damage from the Mexican corn rootworm and western corn rootworm. However, corn following sorghum in parts of South Central Texas has been damaged by the Mexican corn rootworm, but this is a rare occurrence.

Another cultural practice that reduces soil insect pests is to maintain weed-free fields throughout the year, since weeds serve as host plants for certain soil insects.

Producers should sample their fields for white grubs, cutworms and wireworms before bed formation. If chemical treatment is necessary, soil treatment or seed treatment methods are available. One method may be more effective for a particular soil pest than another.

Seed Treatment

Some corn seed, especially that of transgenic hybrids, comes pretreated in the bag. Clothianidin (Poncho®) and Thiamethoxam (Cruiser®) are commonly used for this purpose. 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.

Light populations of wireworms, seedcorn maggots, seedcorn beetles and seed-feeding ants may be effectively controlled by treating seeds with planter box products. When treating the seeds, the insecticide should coat each seed evenly. Use a concrete mixer, commercial seed applicator or homemade seed applicator to treat seeds.

Sprinkle 1 pint of water on each 100 pounds of seed and mix 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, because long exposure to the chemical will affect germination in some hybrids.

Do not use treated seed for human consumption or livestock feed.

Some insecticides are made to be applied to seed in the planter box. This method is effective only against low populations of wireworms, seed-feeding ants, seedcorn beetles and seedworm maggots. Use this soil insect control technique as directed on the insecticide label.

Insecticides such as malathion, pirimophos-methyl (Actellic®) or methoxychlor are often applied to seed to control stored grain pests. These insecticides are not effective for control of soil pests.

Soil Treatment

Insecticide directed against 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.

With the soil treatment method there are three application techniques: the preplant broadcast, row band or T-band, and in-furrow at planting.

Preplant insecticide application: A broadcast application generally provides the best protection against soil insects and is the only way to control heavy white grub infestations. Unfortunately, the broadcast applications require more insecticide and are more expensive than row band or in-furrow treatments. Therefore, broadcast applications 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. Because of label changes in recent years, fewer products are labeled for preplant broadcast application.

When corn 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 during or after bed formation. 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, T-band, or in-furrow techniques. The technique of choice will depend on the pest insect and how a particular insecticide is labeled. Some insecticides applied at planting for corn rootworm control will suppress some early-season pests such as chinch bugs, fire ants and flea beetles on seed or seedling plants. These pests may be suppressed for 2 to 4 weeks depending upon the insecticide used.

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 and covering soil are treated.

Incorporation of the insecticide by covering shovels is adequate. Insecticide also can be incorporated with short parallel chains, loop chains, press wheels, finger tines or other suitable devices. Some insecticides are labeled only for band application behind the seed covering devices.

Do not apply insecticide directly on the seed unless this use is specifically listed on the label, because doing so can result in poor seed germination. Poor control usually results from in-furrow application where white grub populations are high.

White Grubs and Cutworms

White grubs

White grubs are the larval stage of May and June beetles. Damage results from larvae feeding on the plant roots. Small damaged plants often are killed and large plants are stunted and may lodge before harvest. To determine the need for white grub control before planting, *examine a 1-square-foot soil sample for each 5 to 10 acres. An average of one white grub per square foot is enough to cause significant stand loss.*

If white grub populations average approximately one per square foot, adequate suppression can often be achieved with a planting time in-furrow or band treatment. For surface cutworms, incorporating insecticide into the top 1 to 2 inches of soil is best. Refer to the table in this document for cutworm control on seedling corn.

Suggested Insecticides for Controlling White Grubs

Insecticides (listed alphabetically)	Amount per 1,000 feet of row	Amount per acre on 40-inch row spacing
Chlorpyrifos		
(Lorsban 15G)	8.0 oz	6.5 lb
(Nufos® 15G)	8.0 oz	6.5 lb
Tebupirimfos + cyfluthrin		
(Aztec® 2.1G)	6.7 oz	5.5 lb
Tefluthrin		
(Force® 3G)	4–5 oz	3.3–4.1 lb
Terbufos		
(Counter® 20G)	6.0 oz	4.9 lb
(Counter® 15G)	8.0 oz	6.5 lb

Remarks

Chlorpyrifos: Chlorpyrifos 15G is not labeled for band application. Must be in-furrow or T-band.

Tebupirimfos + cyfluthrin: May not be used in counties adjacent to the Gulf Coast. For applications made within 20 yards of aquatic sites, apply as an in-furrow application only. See Special Local Needs Registration TX-00008. For optimum results, apply as a band or T-band. In-furrow application may provide less control.

Tefluthrin: Apply as an in-furrow treatment.

Terbufos: Read supplemental label for information on potential crop damage if used in combination with some herbicides. Banded or in-furrow application only.

Wireworms, Seedcorn Maggots and Seedcorn Beetles

Wireworm larva

Seed treatment with products containing lindane or other insecticides is generally effective in controlling these soil pests. See the section seed treatment procedures for more information. Where large populations of wireworms are present, follow the recommendations listed on appropriate insecticide labels. Producers should check their soil closely

Suggested Insecticides for Controlling Wireworms

Insecticides (listed alphabetically)	Amount per 1,000 feet of row	Amount per acre on 40-inch row spacing
Chlorpyrifos		
(Lorsban® 15G)	8.0 oz	6.5 lb
(Nufos® 15G)	8.0 oz	6.5 lb
Fipronil		
(Regent® 4SC)	Varies by row width	3.12 oz
Tebupirimfos + cyfluthrin		
(Aztec® 2.1G)	6.7 oz	5.5 lb
Tefluthrin		
(Force® 3G)	4–5 oz	3.3–4.1 lb
Terbufos		
(Counter® 20G)	6.0 oz	4.9 lb
(Counter® 15G)	8.0 oz	6.5 lb

Remarks

Chlorpyrifos: Chlorpyrifos 15G is not labeled for band application. Must be in-furrow or T-band. For best control of wireworms, apply as an in-furrow treatment. Consider using a hopper box insecticidal seed treatment with T-band applications

Fipronil: Do not apply on row spacing less than 30 inches. Do not harvest within 90 days of application. Do not plant small grains or other rotational crops within 12 months of application, or root crops within 5 months of application.

Tebupirimfos + cyfluthrin: May not be used in counties adjacent to the Gulf Coast. For applications made within 20 yards of aquatic sites, apply as an in-furrow application only. See Special Local Needs Registration TX-00008.

Tefluthrin: Apply as an in-furrow treatment.

Terbufos: Read supplemental label for information on potential crop damage if used in combination with some herbicides.

False wireworm

during land preparation to determine the need for seed treatment or soil applications to control these pests.

Mexican and Western Corn Rootworm

Mexican and western corn rootworm beetles lay eggs in the soil during the summer and fall, shortly after silking time. Eggs are usually laid within the corn field in the upper 2 to 8 inches of the soil, where they remain until they hatch the following year.

Mexican corn rootworm adult

Western corn rootworm adult

The time of hatching depends to some extent on soil temperature; however, eggs usually begin to hatch about mid-April in South Texas and about mid-May in the High Plains and continue to hatch for several weeks. If corn roots are not available for the newly hatched corn rootworms to feed on, they will die. There is only one generation per year; *therefore, the best method of controlling these two subspecies is to rotate corn with any other crop.*

Fields planted to corn year after year in Mexican and western corn rootworm problem areas (see map) generally require a soil insecticide at planting time. In continuous corn production fields, an average of one or more beetles per plant on any sampling date during the growing season indicates a need for a soil insecticide the following spring or a need to consider crop rotation.

Damage from corn rootworms usually occurs from mid-April through mid-May in South Texas and during June in the High Plains. Extensive damage to the brace roots and fibrous roots may cause plants to lodge. A "goose necking" appearance occurs when lodged plants continue to grow.

Suggested Seed Treatments for Controlling Mexican and Western Corn Rootworms

Seed treatment	Application rate
Clothianidin (Poncho 1250, the 1.25 mg rate of Poncho 600)	For Poncho 600, apply 1.25 mg ai/seed or 5.64 fl oz per 80,000 units of seed
Thiamethoxam (Cruiser 5FS)	Apply 1.25 mg of ai per kernel. Each fluid ounce contains 17.7 g of active ingredient.

Remarks for seed treatments

Seed treatments have been shown to provide adequate root protection under light and moderate infestations. However, granular insecticides provide better control of high rootworm infestations.

Clothianidin: For use in commercially available equipment designed for seed treatment only. Not for use in hopper-box, slurry box or similar seed treatment applications used at planting.

Thiamethoxam: Consult your Syngenta Seed Treatment representative for recommendations on slurry additives to use during applications of Cruiser 5FS. Follow planter manufacturer recommendations for use of talc, graphite or other hopper box additives at planting.

Suggested Granular and Liquid Insecticides for Controlling Mexican and Western Corn Rootworm Larvae

Insecticides (listed alphabetically)	Amount per 1,000 feet of row	Amount per acre on 40-inch row spacing
Chlorpyrifos		
(Lorsban® 15G)	8.0 oz	6.5 lb
(Nufos® 15G)	8.0 oz	6.5 lb
(Lorsban® 4E)		2 pt per acre
(Nufos 4E)		1.5–2.0 pt per acre
Tebupirimfos + cyfluthrin		
(Aztec® 2.1G)	6.7 oz	5.5 lb
Tefluthrin		
(Force® 3G)	4.0–5.0 oz	3.3–4.1 lb
Terbufos		
(Counter® 20G)	6.0 oz	4.9 lb
(Counter® 15G)	8.0 oz	6.5 lb

Remarks for granular and liquid insecticides

Chlorpyrifos: Chlorpyrifos is not effective on Mexican corn rootworm in high-pH soils in South Texas. Nufos® 15G and 4E do not list Mexican corn rootworm as a pest controlled. Granules are not labeled for band application. Must be in-furrow or T-band. Liquid formulation must be applied by T-band application only. Applications made using a band width less than 5 to 6 inches may result in phytotoxicity under certain environmental conditions (such as cool temperatures, wet conditions and light soils).

Tebupirimfos + cyfluthrin: May not be used in counties adjacent to the Gulf Coast. For applications made within 20 yards of aquatic sites, apply as an in-furrow application only.

Terbufos: Read supplemental label for information on potential crop damage if used in combination with some herbicides.

PRECAUTION: Certain sulfonylurea herbicides and organophosphate insecticides used in the same crop year on corn may result in severe crop injury. Please read pesticide labels carefully.

IMPORTANT: The use of the same soil insecticides year after year in the same field is not a good practice. Producers are encouraged to rotate organophosphate (chlorpyrifos, terbufos, tebupirimfos) with other (tefluthrin, cyfluthrin) soil insecticides each year for best results.

For all band applications, apply in a 6- to 8-inch band just behind seed drop and in front of covering shovels and press wheel or chain drag. Soil incorporation to a depth of about 1 inch is important.

Southern Corn Rootworm

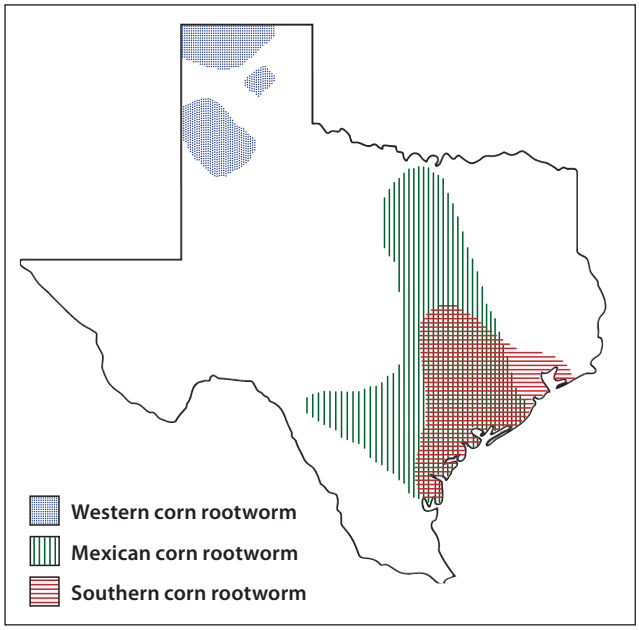
Corn rootworm larva

Southern corn rootworm adult

The southern corn rootworm deposits eggs in soil after the corn is in the seedling stage. Therefore, crop rotation will not provide adequate control of this insect. Unlike the Mexican and western corn rootworms, more than one generation of southern corn rootworm may occur per year. This species is considered a minor corn pest in most areas of Texas where corn is planted in fields that were not grassy or weedy the previous year.

In the Gulf Coast region (see map), however, the southern corn rootworm has been a significant pest. Where there is a history of infestations along with losses in plant stands in previous years, an in-furrow or band pesticide application should be considered.

With insecticides that can be applied in-furrow, field experiments show that in most fields one-half the maximum rate listed in the table provides the most favorable economic returns for control of southern corn rootworm. However, in fields where heavy infestations occur each year it would be advisable to use the higher rates.



Suggested Seed Treatments for Controlling Southern Corn Rootworms

Seed treatment	Application rate
Clothianidin (Poncho 1250, the 1.25 mg ai/seed rate of Poncho 600)	For Poncho 600, apply 1.25 mg ai/seed or 5.64 fl oz per 80,000 units of seed
Thiamethoxam (Cruiser 5FS)	Apply 1.25 mg ai per kernel. Each fluid ounce contains 17.7 g of active ingredient.

Remarks

Seed treatments have been shown to provide adequate root protection under light and moderate infestations. However, granular insecticides provide better control under high rootworm infestations.

Clothianidin: For use in commercially available equipment designed for seed treatment only. Not for use in hopper box, slurry box, or similar seed treatment applications used at planting.

Thiamethoxam: Consult your Syngenta Seed Treatment representative for recommendations on slurry additives to use during applications of Cruiser 5FS. Follow planter manufacturer recommendations for use of talc, graphite, or other hopper box additives at planting.

Suggested Insecticides Applied at Planting for Controlling Southern Corn Rootworm

Insecticides (listed alphabetically)	Amount per 1,000 feet of row	Amount per acre on 40-inch row spacing
Chlorpyrifos		
(Lorsban® 15G)	8.0 oz	6.5 lb
(Nufos® 15G)	8.0 oz	6.5 lb
Tefluthrin		
(Force® 3G)	4–5 oz	3.3–4.1 lb
Terbufos		
(Counter® 20G)	6.0 oz	4.9 lb
(Counter® 15G)	8.0 oz	6.5 lb

Remarks

Chlorpyrifos: Lorsban 15G is not labeled for band application. Must be in-furrow or T-band. 8.0 oz per 1,000 feet of row is the maximum application rate for at-plant application.

Terbufos: Read supplemental label for information on potential crop damage if used in combination with some herbicides.

PRECAUTION: Certain sulfonylurea herbicides and organophosphate insecticides used in the same crop year on corn may result in severe crop injury. Please read pesticide labels carefully.

IMPORTANT: The use of the same soil insecticide year after year in the same field is not a good practice. Producers are encouraged to rotate organophosphate (chlorpyrifos, terbufos) with other (tefluthrin) soil insecticides each year.

For all band applications, apply in a 6- to 8-inch band just behind seed drop and in front of covering shovels and press wheel or chain drag. Soil incorporation to a depth of about 1 inch is important.

Seedling to Tassel Stage Insect Control

Corn Leaf Aphid

Fields in the seedling stage *rarely* require treatment for corn leaf aphid. Yield losses have occurred *only* where corn leaf aphids caused stand loss to seedling plants. Pre-tassel and later growth stages can tolerate large numbers of aphids without economic damage.

Aphid mummies

Corn leaf aphid

Soil Cutworms

Cutworms are smooth, dingy, grayish-black "worms" that are the larval stages of several different moths. Cutworms are active at night and damage seedling corn by cutting the stalk just above ground level. Large numbers of cutworms may be found in grassy or weedy areas. Most cutworm species hide in the soil during the day and are not visible on the plants.

Cutworm

When cutworms are damaging plant stands, an application of insecticide by ground will usually 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

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Chlorpyrifos			
(Lorsban® 4E or Advanced)	1–2 pt	21	0
(Nufos® 4E)	1–2 pt	21	0
Esfenvalerate			
(Asana® XL 0.66E)	5.8–9.6 oz	21	See label
Permethrin			
(Ambush® 2E)	6.4–12.8 oz	30	30
(Arctic® 3.2EC)	4.0–6.0 oz	30	0
(Pounce® 1.5G)	6.7–10.0 lb	30	0
Lambda-cyhalothrin			
(Warrior® CS)	1.92–3.20 oz	21	See label

Remarks

Chlorpyrifos: It is preferable to apply chlorpyrifos when soil is moist and cutworms are active on or near the soil surface. Do not feed treated corn fodder to meat or dairy animals within 35 days after last treatment.

Permethrin: Preemergent use—Apply in the time period from 5 days prior to planting up to emergence of the crop. Apply as a broadcast spray in a minimum of 20 gallons of finished spray/acre with ground equipment. Foliar use—Apply before ear formation by ground.

Southwestern Corn Borer

Southwestern corn borer larva

Southwestern corn borer adult

Southwestern corn borer girdle

Southwestern corn borers emerge from corn stubble in the spring to lay eggs on whorl-stage corn. Corn next to or near unplowed stubble typically experiences higher densities of southwestern corn borer larvae feeding in the whorl. Eggs are laid on the upper and lower surfaces of expanded leaves in the whorl. Freshly laid eggs are creamy white and after about 24 hours three red bands appear on each egg. Small larvae hatch from the eggs in about 5 days and begin feeding in the whorl.

The typical rows of holes across the leaf surface associated with whorl feeders become apparent as leaves unfold. Another leaf symptom commonly associated with southwestern corn borer feeding in the whorl is longitudinal, transparent areas on the leaf where young larvae feed only partially through the leaf tissue. After the larva has fed in the whorl, it crawls down the plant and bores into the stalk.

Corn borer larvae reach a length of 1 to 1½ inches. They have a regular pattern of raised black dots on a creamy white body.

First-generation eggs and larvae are difficult to detect because infestations seldom exceed 5 percent infested plants. However, if infestations are great enough to warrant treatment, applications should be made before borers leave the whorl and enter the stalk. For recommended insecticides, refer to the southwestern corn borer table in the "Tassel to Hard Dough Stage" of this guide.

European Corn Borer

European corn borer

European corn borer was first discovered in Texas High Plains corn in 1978. Economic infestations can be found in most corn growing areas of the Texas Panhandle. Borers overwinter as full-grown larvae in corn stalks, corn cobs, weed stems or other corn field debris. Pupation occurs in May and first generation moth emergence begins in late spring.

Moths are first attracted to dense vegetation around corn and remain there for a few days while they mate. Mated females return to the corn fields to lay eggs. They are attracted to the tallest fields (at least 22- to 35-inch extended leaf height).

The eggs, 15 to 30 in a mass, overlap like fish scales and are normally deposited near the midribs on the undersides of the leaves. Eggs hatch in 3 to 7 days. Larvae move to the whorl to feed before entering the stalk for pupation.

To determine the need for insecticide application to control first-generation European corn borers, examine five random samples of 20 consecutive plants each. An insecticide application is justified if 50 percent of the plants are found to be infested with an average of at least one live larva per plant. For recommended insecticides, refer to the European corn borer table in the "Tassel to Hard Dough Stage" of this guide.

Lesser Cornstalk Borer

Lesser cornstalk borer larva

The lesser cornstalk borer occasionally attacks seedling corn. The small, slender larva remains in the soil in a silken tube and injures plants by feeding on the crown area of the plant at the soil line.

These insects may occur in damaging numbers on sandy soils and can become more numerous under dry conditions. Rainfall and irrigation will kill many larvae, so irrigation timing and the amount of water applied at each irrigation will influence control. Insecticides applied at planting for corn rootworms may control other soil pests such as lesser cornstalk borer.

Applications of Terbufos (Counter® CR) for corn rootworms have provided suppression of lesser cornstalk borer. Careful inspection during the seedling stage is important in areas where this insect has been a problem. Base treatments on plant damage and the presence of larvae. Larger corn plants usually are not affected by this insect.

Suggested Insecticides for Controlling Lesser Cornstalk Borer

Insecticides (listed alphabetically)	Rate	Days from last application to: Harvest	Grazing
Chlorpyrifos			
(Lorsban® 15G)	8 oz/1,000 row ft	21	See label
(Nufos® 15G)	8 oz/1,000 row ft	21	See label
(Lorsban® 4E or Advanced)	2 pt/acre	21	0
(Nufos 4E)	2 pt/acre	21	0

Remarks

Chlorpyrifos: Chlorpyrifos 15G for lesser cornstalk borer control is labeled for T-band application only, not in-furrow.

Other Borers

Mexican rice borer larva

In recent years, most borer damage to corn in the Lower Rio Grande Valley and along the Gulf Coast has been caused by the Mexican rice borer, sugarcane borer and the neotropical borer (see map).

Sugarcane borer larva

These borers typically attack corn both before and after tassel. They feed on the leaves for a short time before boring into the stalks. Sugarcane borer can cause whorl damage, stalk tunnels, shank damage and grain-feeding injury. Yield losses are thought to be minor unless stalk lodging occurs, but Texas AgriLife Extension and AgriLife Research personnel are re-examining this concept and are working to develop economic thresholds.

Sugarcane borer adult

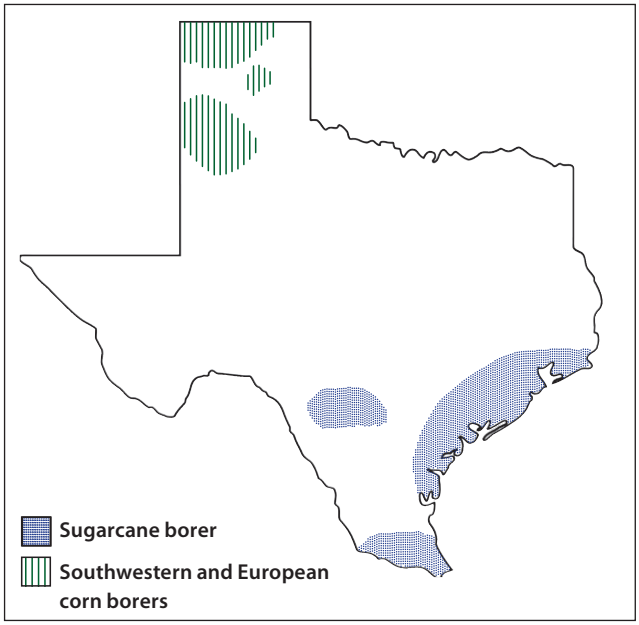
Sugarcane borer damage to kernels may cause a red coloration that makes the grain unmarketable for some purposes. Bored stalks most frequently fall during ear filling or ear maturation and lodging is often associ-

ated with high winds. The stalks may break at any point and usually do not break near the soil level as with southwestern corn borer infestations.

Control is most successful when fields are scouted closely and treated before larvae bore into stalks.

Neotropical borer larva

Neotropical borer adult



Corn Earworm and Fall Armyworm

Corn earworm and fall armyworm moths deposit eggs on leaves. Newly hatched larvae begin to feed in the whorl. Larval feeding will cause the leaves to appear ragged, but *insecticide treatments are seldom recommended and economical control is seldom achieved.*

Corn earworm larva

Corn earworm adult

Fall armyworm larva

Fall armyworm adult

Flea Beetles

Flea beetle

Flea beetles are tiny, shiny black or greenish-black insects that will jump when disturbed. They range in size from a little smaller than a pinhead to several times as large. They damage corn plants up to 18 inches tall primarily by feeding on the leaves. Damaged leaves have a whitened, bleached appearance. Plant growth is retarded as the leaves wilt and hang limp.

Fields kept clean of weeds the previous season seldom suffer significant flea beetle injury. When sufficient numbers of flea beetles are damaging corn, an application of insecticide may be necessary.

Suggested Insecticides for Controlling Flea Beetles

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Carbaryl			
(Sevin® 80WSP)	1.25–2.5 lb	48	14
(Sevin® XLR Plus 4 lb)	1.0–2.0 qt	48	14
Esfenvalerate			
(Asana® XL 0.66EC)	5.8–9.6 oz	21	See label

Chinch Bug

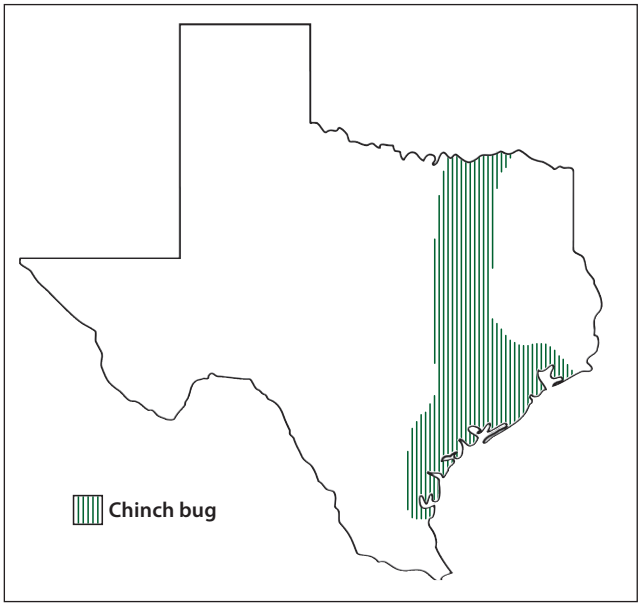
Adult chinch bugs are about ⅛ inch long with black bodies and reddish-yellow legs. When fully developed, the white wings are marked with a triangular black spot near the middle of the back on the outer wing margin. The insect appears to have a white "X" or white hourglass on the back when viewed from above.

Chinch bug

Adult and immature chinch bugs suck plant juices and cause reddening of the leaves. Damage by chinch bugs normally occurs from seedling emergence until the plants are 18 inches tall. Large numbers of chinch bugs can move into a cornfield by crawling or flying from wild bunch grasses or small grains. Once in the field they congregate and feed behind the leaf sheaths of the corn plant and below the ground line on plant roots and crowns.

In fields with a history of early-season, economically damaging chinch bug populations (see map for typical locations), the use of at-plant soil-incorporated insecticides can suppress the development of chinch bug populations. Granular formulations may provide 2 to 3 weeks of protection, provided sufficient rainfall is received following application to wash the insecticide off the granules. Young plants should be closely monitored for chinch bugs and feeding damage after germination and particularly during dry periods, even when at-plant insecticides are used.

Make at least five random checks in the field. *Insecticide should be applied when two or more adult chinch bugs are found on 20 percent of the seedlings less than 6 inches high. On taller plants apply insecticides when immature and adult bugs are found on 75 percent of the plants.*



Suggested Insecticides for Controlling Chinch Bugs

Seed treatments	Seed treatment rate
Clothianidin (Poncho® 250, the 0.25 mg rate of Poncho 600)	For Poncho® 600, apply 0.25–0.50 mg ai/seed or 1.13 fl oz per 80,000 units of seed
Thiamethoxam (Cruiser 5FS)	Apply 0.25 to 0.80 mg ai per kernel. Each fluid ounce contains 17.7 g of active ingredient.

Remarks for Seed Treatments

Clothianidin: This is a commercial seed treatment and growers cannot currently purchase clothianidin to treat their own seed. For use in commercially available equipment designed for seed treatment only. Not for use in hopper-box, slurry box, or similar seed treatment applications used at planting.

Thiamethoxam: This is a commercial seed treatment and growers cannot currently purchase thiamethoxam to treat their own seed. Consult your Syngenta Seed Treatment representative for recommendations on slurry additives to use during applications of Cruiser 5FS. Follow planter manufacturer recommendations for use of talc, graphite, or other hopper box additives at planting.

Liquid or granular insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
At-Plant			
Chlorpyrifos (Lorsban® 15G)	8 oz/1,000 row ft	21	See label
(Nufos® 15G)	8 oz/1,000 row ft	21	See label
Terbufos (Counter® 20G)	4.9 lb	30	30
(Counter® 15G)	8 oz/1,000 row ft	30	30
Post-Plant			
Carbaryl (Sevin® XLR Plus 4 lb)	1.0–2.0 qt	48	14
(Sevin® 80WSP)	1.25–2.5 lb	48	14
Chlorpyrifos (Lorsban® 4E or Advanced)	1–2 pt	21	0
(Nufos® 4E)	1–2 pt	21	0
Lambda-cyhalothrin (Warrior® 1CS)	1.92 oz	21	1

Remarks for Liquid or Granular Insecticides

For post-plant application, use only ground application equipment and direct spray nozzles at the infested portions of the plants. Control is difficult on larger plants.

Carbaryl: For optimum control, apply 20 gallons of water per acre by ground and direct spray towards bases of stalks to provide thorough coverage.

Chlorpyrifos: For Chlorpryfos 15G, a T-band is more effective than an in-furrow application. In-furrow applications should be considered as suppression only. Apply the 4E formulation with sufficient water to ensure a minimum spray volume of 20 to 40 gallons per acre and 40 psi using ground equipment.

Terbufos: Apply at planting time in-furrow, placing granules directly in the seed furrow behind the planting shoe. Terbufos is for early-season control of light to moderate infestations.

Tassel to Hard Dough Stage Insect Control

Corn Earworm

Corn earworm moths begin laying eggs on leaves and silks soon after tassel emergence. Eggs are laid on emerging silks before pollination.

After hatching, larvae tunnel into the silk channel to feed. The silks that are fed upon have usually completed pollination; therefore, a loss of pollination is generally not a problem. Later instar larvae can be found feeding on kernels at the tip of the ear. Ear damage is usually minor, although an occasional field may have excessive damage.

Corn earworm control is difficult because egg laying is extended through the silking period and continues after the completion of pollination (brown silk stage). Insecticides used for control must be applied often because untreated silks are exposed daily as they elongate. Control efforts are usually costly and inconsistent. Currently, control strategies are not suggested in commercial field corn.

Fall Armyworm

The fall armyworm is a sporadic pest of corn. It migrates north during the growing season from overwintering sites in South Texas and northern Mexico. Infestations occurring from tassel to dough stage can be very damaging. Larvae feed on ears and ear shanks and behind leaf collars. Heavy infestations may result in substantial yield losses because larvae feed directly on the ear. Additional losses can occur when shank feeding causes ears to drop and when stalks lodge as a result of feeding damage to the nodes.

Fall armyworm larvae range from a light tan to a dark green or black. Light and dark stripes run lengthwise on the body. Dark spots or bumps occur in a pattern over the body, especially when viewed from the top. The head of a larva has a prominent inverted Y, in a light color that contrasts with the dark head capsule.

Scouting for fall armyworms can be difficult. Check corn leaves and grasses in the furrow for egg masses. There may be 50 to 100 eggs per mass. Also check for small larvae behind leaf collars and at the bases of primary and secondary ears.

Small larvae differ from late instar larvae in that they are pale tan in color and have a small black spot on each side toward the head. This will help distinguish them from corn earworm and southwestern corn borer larvae.

Texas does not have an established economic threshold for this pest now. If control is deemed necessary, it should be targeted at small larvae before they have entered the primary ear.

Southwestern Corn Borer

The southwestern corn borer is a major corn pest on the High Plains (see map on page 14). It also occurs in far West Texas and Northeast Texas but is not economically important in these regions. Damage is caused by larvae tunneling in the stalk and later girdling the plant, which results in lodging. Moths emerge from corn stubble and weed hosts in the spring to lay first-generation eggs on whorl stage corn. First-generation larvae mature and pupate in the stalk in July on the High Plains. Moths begin emerging about mid-July and lay eggs of the second generation (see map for distribution).

Second-generation eggs are usually laid after tasseling has occurred. About three-fourths of these eggs are laid on the upper surfaces of the middle seven leaves. These leaves are the ear leaf, two leaves above and four leaves below the ear leaf.

Eggs are laid singly or in masses of two to three or more. Eggs overlap like fish scales or shingles. Freshly laid eggs are creamy white. One day later, three red bands appear across each egg. Eggs hatch in about 5 days.

Small larvae feed behind leaf collars and ears and beneath the shucks of the primary ear. Older larvae bore into the stalk and continue feeding.

Mature corn borer larvae reach 1 to 1½ inches long. They are dull white and have a regular pattern of raised black dots over the body.

As plant maturity is reached, the larvae prepare for overwintering in the base of the stalk by girdling the plant from 1 to 6 inches above the ground. Wind can easily lodge girdled plants. Lodged plants are difficult to harvest, and yields are reduced.

Southwestern corn borer larvae overwinter in the stalk base or root crown. They are insulated by a frass (excrement) plug in the stalk and by the surrounding soil. One of the most effective borer control methods is destruction of this winter habitat to reduce spring moth emergence. A single tandem disc cultivation or shredding will expose larvae to cold and dry winter conditions while leaving sufficient residue to prevent soil erosion. The shredder must be set to cut stalks at the soil surface to remove the protective frass plug.

Suggested Insecticides for Controlling Southwestern Corn Borer

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Bifenthrin			
(Brigade® 2EC)	2.1–6.4 oz	30	30
Bifenthrin + Zeta-cypermethrin			
(Hero)	4.0–10.3 oz	30	30
Carbaryl			
(Sevin® 80WSP)	1.25–2.5 lb	48	14
(Sevin® XLR Plus 4 lb)	1.0–2.0 qt	48	14
Chlorpyrifos			
(Lorsban® 4E or Advanced)	1.5–2.0 pt	21	14
(Nufos® 4E)	1.5–2.0 pt	21	14
(Lorsban® 15G)	3.5–8.0 oz, See remarks	21	14
(Nufos® 15G)	3.5–8.0 oz, See remarks	21	14
Esfenvalerate			
(Asana XL® 0.66E)	5.8–9.6 oz	21	See label
Lambda-cyhalothrin			
(Warrior® II)	1.28–1.92 oz	21	1
Methoxyfenozide			
(Intrepid 2F)	4.0–8.0 oz	21	See label
Permethrin			
(Ambush® 2E)	6.4–12.8 oz	30	0
(Arctic® 3.2EC)	4.0–6.0 oz	30	0
(Pounce® 1.5G)	6.7–10.0 lb	30	0
Spinosad			
(Tracer® 4EC)	2.0–3.0 oz	1	See label

Remarks

Research data demonstrate that use of cabaryl, chlorpyrifos, and certain pyrethroid (esfenvalerate, lambda-cyhalothrin, permethrin) insecticides can cause increases in spider mite densities on corn. See the Banks grass mite table footnotes for information about mite resistance to bifenthrin.

Bifenthrin + Zeta-cypermethrin: Do not apply more than 0.4 lb active ingredient per acre per season for foliar application.

Chlorpyrifos: The 15G formulation is labeled as a post-plant application only for corn borers. The rate is 3.5 – 8.0 oz per acre for first generation and 6.0 to 8.0 oz per acre for second generation.

Methoxyfenozide: Texas research trials have shown the 4.0 oz rate to be effective on low to moderate populations, but 6.0 to 8.0 oz rates are recommended at populations that significantly exceed the economic threshold. Do not apply through irrigation systems.

Permethrin: Do not apply after silks begin to turn brown.

Spinosad: Applications should be timed to coincide with peak egg hatch. High populations should be treated with the high rate.

Shredding is particularly compatible with grazing and minimum tillage operations because it does not bury plant materials, but it does expose corn borer larvae. Also, stalk shredding can be performed even when soil is frozen. Double disking and deep plowing are effective methods if soil erosion is not a problem.

High larval mortality is obtained when cultivation or shredding is performed before mid-January. Timely stubble destruction will reduce local infestations of first-generation larvae. However, every producer must cooperate by destroying stubble to effectively reduce southwestern corn borer populations areawide.

Early-planted corn is less susceptible to corn borer plant lodging. A plant population that promotes large, healthy stalks, combined with proper fertilization and adequate irrigation, helps prevent lodging of corn borer-infested stalks. Crop rotation, use of early-maturing varieties and an early harvest with equipment designed to pick up lodged stalks aid in reducing yield losses.

Insecticide treatments usually are directed toward second-generation larvae. *Insecticide should be applied when 20 to 25 percent of the plants are infested with eggs or newly hatched larvae.* Check for egg masses to determine the potential infestation and the correct timing of insecticide application.

Computer prediction of second-generation moth flight and egg lay can be used to plan field scouting to detect infestations. Contact your county Extension office for egg-laying predictions in your area.

European Corn Borer

Yield losses from second-generation European corn borer are usually higher than yield losses from the first generation. Second-generation moths that emerge in mid-summer are attracted to dense vegetation around corn fields, primarily for mating. Mated females return to recently tasseled corn to lay eggs.

Most of the egg masses will be laid on the undersides of leaves nearest to and including the ear leaf. Eggs are white and a black dot (the head of the young larva) can be seen just before hatching. Eggs will hatch in 3 to 5 days.

After hatching, about 75 percent of the small larvae move to the leaf axils and the remaining 25 percent to the ear sheath and collar tissue. Yield losses result from damage caused by larval tunneling, ear droppage and direct kernel feeding.

To determine the need for an insecticide application, examine a minimum of five random samples of 20 consecutive plants each. *An insecticide application is justified if an average of 10 to 20 hatched and unhatched egg masses can be found per 100 plants.* Two applications may be necessary to satisfactorily control European corn borer.

Suggested Insecticides for Controlling European Corn Borer

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Bacillus thuringiensis (Dipel® ES)	1.5–2.5 pt	0	0
Bifenthrin (Brigade® 2EC)	2.1–6.4 oz	30	30
Bifenthrin + Zeta-cypermethrin (Hero® add Formulation)	4.0–10.3 oz	30	30
Chlorpyrifos (Lorsban® 4E or Advanced)	1.0–2.0 pt	21	0
(Nufos® 4E)	1.0–2.0 pt	21	0
(Lorsban® 15G)	3.5–8.0 oz, See remarks	21	See label
(Nufos® 15G)	3.5–8.0 oz, See remarks	21	See label
Esfenvalerate (Asana® XL 0.66E)	7.8–9.6 oz	21	See label
Lambda-cyhalothrin (Warrior® II)	1.28–1.92 oz	21	1
Methoxyfenozide* (Intrepid® 2F)	6.0 – 8.0 oz	21	See label
Permethrin (Ambush® 2E)	6.4–12.8 oz	30	0
(Arctic® 3.2EC)	4.0–6.0 oz	30	0
(Pounce® 1.5G)	6.7–10.0 lb	30	0
Spinosad (Tracer® 4SC)	2.0–3.0 oz	1	See label

*We anticipate that Intrepid 2F will effectively control European corn borer, but populations have been too low in the recent past to allow us to conduct the necessary research trials.

Remarks

Research data demonstrate that use of cabaryl, chlorpyrifos, and pyrethroid (esfenvalerate, lambda-cyhalothrin, permethrin) insecticides can cause increases in mite densities on corn.

Bifenthrin + Zeta-cypermethrin: Do not apply more than 0.4 lb active ingredient per acre per season for foliar application.

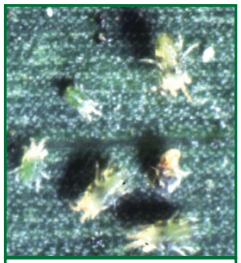
Chlorpyrifos: The 15G formulation is labeled as a post-plant application only for corn borers. The rate is 3.5 – 8.0 oz per acre for first generation and 6.0 to 8.0 oz per acre for second generation. For chlorpyrifos 4E the lowest rate for aerial or ground application is 1.5 pt per acre. The 1.0 pt rate is for chemigation only.

Permethrin: Apply before the brown silk stage.

Spinosad: Suggested for first generation only. Applications should be timed to coincide with peak egg hatch.

Spider Mites

Economic infestations of spider mites primarily occur on corn in the Texas High Plains, but they occasionally occur in the Winter Garden region and the Rio Grande Valley. High numbers of spider mites may occur on corn after tassels appear.



Banks grass mites

Mites first appear on the lower leaves, but may move upward until all the leaves (and in extreme cases the entire plant) are killed. Heavy infestations cause extensive webbing on the leaves and may be associated with stalk rot and lodging.

Banks grass mite colony

Periods of hot, dry weather favor rapid mite population increase. An important factor triggering mite increases is the use of insecticide to control other pests. Insecticides may kill beneficial insects that usually keep spider mite numbers low.

Mite numbers also may increase when excessive amounts of fertilizer are used; therefore, it is important to test soil and apply only the amount of fertilizer needed.

Proper irrigation timing will help plants withstand mite feeding damage. The most important time to prevent water stress is during tassel and early grain filling.

Both the Banks grass mite and twospotted spider mite can occur on corn in Texas. The Banks grass mite is the predominant species in early and mid-season, and is more widely distributed than the twospotted spider mite. A few fields, however, will have high numbers of twospotted spider mites.

Twospotted spider mite

Banks grass mite

It is important to be able to distinguish between these two species because presently registered miticides generally will not control twospotted spider mites in tassel-stage corn.

The most useful characteristic for distinguishing between these two species is the pattern of pigmentation spots on the body (see drawings). The adult twospotted spider mite has a well-defined spot on each side of the front half of the abdomen. The spots on the adult Banks grass mite extend all the way down both sides of the body, sometimes almost touching at the rear of the body. Also, twospotted spider mites produce more webbing than Banks grass mites.

To decide whether or not Banks grass mites and/or twospotted spider mites should be controlled,

Economic Injury Level for the Banks Grass Mite and/or Twospotted Spider Mite on Corn, Based on the Percentage of Infested Leaves per Plant/Percentage of Leaf Area Damaged

Control cost ($) per acre	Market value ($) per acre										
	200	250	300	350	400	450	500	550	600	650	700
5	15/8	12/6	10/5	8/5	7/4	7/3	6/3	5/6	5/3	5/2	4/2
10	29/16	24/13	20/10	17/9	15/8	13/7	12/6	11/6	10/5	9/5	8/4
15	44/23	35/19	29/16	25/13	22/12	20/10	18/9	16/9	15/8	14/7	13/7
20	59/31	47/25	39/21	34/18	29/16	26/14	24/13	21/11	20/10	18/10	17/9
25	74/39	59/31	49/26	42/22	37/20	33/17	29/16	27/14	25/13	23/12	21/11

For market values that exceed $700 per acre use the following formulas to determine an economic injury level.
1. For percent infested leaves the formula is (cost of control x 600) ÷ (price per bushel x bushel yield).
2. For percent of leaf area damaged the formula is (cost of control x 312) ÷ (price per bushel x bushel yield).

the per acre control cost (miticide plus application costs) and the expected value of the crop (yield x value) should be estimated.

A two-step sampling process is necessary. The field can be quickly checked to determine the percent of the plant infested by mites. This is accomplished by dividing the number of mite-infested green leaves (a leaf is infested if a mite colony of any size is on the leaf) by the number of green leaves per plant. If the plant equals or exceeds the percentage of infested leaves needed to cause yield loss, based on the table below, then determine the percentage of the leaf area on the plant that is damaged by mite feeding.

Mite damage is any light-colored (chlorotic) areas on the plant that result from mite feeding. Remember to look at all leaves on the plant to estimate how much of the total leaf area is damaged by mite feeding. Do not base the damage estimate on infested leaves only, or the damage rating will be overestimated. Dead leaves equal 100 percent damage for that leaf.

Now, calculate the average percentage of the leaf area damaged. If both the percentage of the leaves infested and the percentage of the leaf area damaged equal or exceed the values for the crop on the table below, it is time to spray.

If the miticide to be applied provides rapid control (less than 3 days after application) you can wait up to 1 week before spraying the corn. However, if the miticide will not provide rapid control, spray the field immediately.

This economic injury level may be used to make control decisions on field or food corn before the full dent growth stage. Mite feeding after full dent will not cause yield loss, but may contribute to premature plant lodging if mite feeding damage is severe and the crop is stressed. Mite feeding will not slow dry-down of the grain. Research has shown that canopy penetration of miticides is increased with the addition of oil.

Suggested Miticides for Controlling Twospotted Spider Mites

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Hexythiazox (Onager® 1E)	10.0–24.0 oz	45	45
Propargite (Comite® II 6 lb)	2.25–3.38 pt	See remarks, 30	See label remarks
Spiromesifen (Oberon® 4SC)	4.0–8.0 oz	30	
Sulfur (6 lb flowable)	4 qt	0	0

Note: Hexythiazox (Onager® 1E) and spiromesifen (Oberon® 4SC) have activity on twospotted spider mites, but efficacy trials have not been conducted in Texas.

Remarks

Hexythiazox: Apply at the first sign of mites before the population begins to build. Do not make more than one application per year or apply more than 24 oz per year. Application after the VT (tassel) growth stage is prohibited. A Special Local Needs (Sec. 24 (c) label was issued in April, 2010, for use in western Texas counties not covered under the Sec. 3 label. Use is now permitted in counties east of Rt. 283 and southeast of Rt. 377.

Propargite: Ground application must use a minimum of 20 gallons of water per acre. A minimum of 5 gallons of water per acre are required for aerial application. Only one application can be made per year. Do not plant small grains in rotation within 82 days after application.

Spiromesifen: The addition of Baythroid may be advisable if mite populations are high. Do not use more than 8.5 oz per acre per season or exceed two applications per crop per season. The pre-harvest interval (PHI) is 5 days for green forage and silage and 30 days for grain or stover. Use a minimum application volume of 10.0 gallons per acre if applied by ground and 5.0 gallons per acre if applied by air. Follow label instructions for chemigation.

Sulfur: Thorough plant coverage is required.

Suggested Miticides for Controlling Banks Grass Mites

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Bifenthrin (Brigade® 2EC) See footnotes for resistance caution statement	5.12–6.4 oz	30	30
Bifenthrin + Zeta cypermethrin (Hero®)	10.3 oz	30	30
Dimethoate (Dimethoate 4 E)	0.67–1 pt	See label	14
(Dimethoate 5 lb)	8.4–12.8 oz	14	14
(Dimethoate 400)	0.67–1 pt	28	14
Hexythiazox (Onager® 1E)	10.0–24.0 oz	45	45
Propargite (Comite® II 6 lb)	2.25–3.38 pt	30	See label
Spiromesifen (Oberon® 4SC)	4.0–8.0 oz	30	See label
Sulfur (6 lb flowable)	4 qt	0	0

Remarks

Bifenthrin: Research results have indicated that spider mites in some areas of Texas are resistant to bifenthrin, especially in the High Plains. Bifenthrin will not control resistant populations. ULV applications are prohibited. Bifenthrin is often used in combination with dimethoate.

Bifenthrin + Zeta-cypermethrin: Apply for Banks grass mite control when colonies first form before leaf damage or discoloration and before dispersal above the bottom third of the plant. Research results have indicated that spider mites in some areas of Texas are resistant to bifenthrin, especially in the High Plains. Bifenthrin will not control resistant populations.

Dimethoate: It is not labeled for the Trans-Pecos area of Texas. This product has often been used in combination with pyrethroids for control of mites. There is no demonstrated advantage to mixing dimethoate with Propargite®. Heavy infestations may require an alternate chemical.

Hexythiazox: Apply at the first sign of mites before the populations begin to build. Do not make more than one application per year or apply more than 24 oz per year. Application after the VT (tassel) growth stage is prohibited. A Special Local Needs (Sec. 24 (c) label was issued in April, 2010, for use in western Texas counties not covered under the Sec. 3 label. Use is now permitted in counties east of Rt. 283 and southeast of Rt. 377.

Propargite: Ground application must use a minimum of 20 gallons of water per acre. A minimum of 5 gallons of water per acre are required for aerial application. Only one application can be made per year. Do not plant small grains in rotation within 82 days after application.

Spiromesifen: Do not use more than 8.5 oz per acre per season or exceed two applications per crop per season. The pre-harvest interval (PHI) is 5 days for green forage and silage and 30 days for grain or stover. Use a minimum application volume of 10.0 gallons per acre if applied by ground and 5.0 gallons per acre if applied by air. Follow label instructions for chemigation. The addition of dimethoate may be advisable with high populations.

Sulfur: This is the only material that has been partially effective in the Trans-Pecos area of Texas. Thorough plant coverage is required.

Adult Corn Rootworm Beetle

Adult rootworm beetles feed on leaves, pollen and tassels, but they prefer silks. When adults are numerous (8 to 10 per plant) during the green silk stage and *the silks are chewed back to within ½ inch of the shuck, poorly filled ears may result from poor pollination. When this amount of feeding occurs, or if excessive leaf damage occurs, it is profitable to control the beetles.*

Controlling adult beetles usually will reduce the number of eggs laid in the field. However, insecticides can cause an outbreak of spider mites by destroying predators. Spider mites can be very damaging to corn and are difficult to control. Insecticide treatments for adult beetle control should be used only when necessary.

Insecticide baits consisting of carbaryl and a feeding attractant from cucurbits are labeled for control of adult corn rootworms. These baits are fed upon by corn rootworm beetles and do not destroy as many beneficial insects and predatory mites. Therefore, these baits are less apt to cause outbreaks of spider mites following application than many other conventional insecticides.

These baits have been most effective when all the corn producers in an area cooperate to treat their fields and thus reduce rootworm numbers across a large area. An effective program requires an organized field scouting program, accurate timing of treatments, and proper application of the baits. For more information on an areawide pest management program for corn rootworms, contact the USDA-ARS Areawide Pest Management Research Laboratory at College Station.

Suggested Insecticides for Controlling Mexican and Western Corn Rootworm Beetles

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Carbaryl (Sevin® 80WSP)	1.25–2.5 lb	48	14
(Sevin® XLR Plus 4 lb)	1.0–2.0 qt	48	14
Malathion (Fyfanon® ULV 9.9 lb)	4.0 oz	5	no
Methyl parathion (Penncap-M® 2F)	1.0–2.0 pt	12	12
(Methyl parathion 4.0E)	0.5 pt	12	See label

Remarks

Research data demonstrate that use of cabaryl, chlorpyrifos, and pyrethroid (esfenvalerate, lambda-cyhalothrin, bifenthrin, permethrin) insecticides can cause increases in mite densities on corn. Other insecticides associated with mite increase on corn are ethyl and methyl parathion.

NOTE: Application of the insecticides listed above during pollen shed will destroy foraging honey bees.

True Armyworm

Yellowstriped armyworm

True armyworms occasionally cause heavy damage to corn in the High Plains, and they also may occur in other areas of Texas. True armyworm activity is usually heaviest in fields with junglerice (watergrass) and johnsongrass in the furrows or fields that have hail-damaged leaves. True armyworms may go unnoticed as populations build up on the weeds in the furrows. Then, when the weeds are consumed and larvae grow, they begin feeding on corn leaves. Large larvae can defoliate corn plants rapidly. When defoliation is excessive, yield reductions will occur, and premature drying of the stalk may lead to lodging problems. *Chemical treatments should be applied when an average of three leaves per plant are destroyed by larval feeding.*

Suggested Insecticides for Controlling True Armyworm

Insecticides (listed alphabetically)	Amount per acre	Days from last application to Harvest	Grazing
Carbaryl			
(Sevin® 80WSP)	1.25–2.5 lb	48	14
(Sevin® XLR Plus 4 lb)	1.0–2.0 qt	48	14
Chlorpyrifos			
(Lorsban® 4E or Advanced)	1.0–2.0 pt	21	0
(Nufos® 4E)	1.0–2.0 pt	21	0
Esfenvalerate			
(Asana® XL 0.66E)	5.8–9.6 oz	21	See label
Methomyl			
(Lannate® 90SP)	0.25–0.5 lb	21	See label
(Lannate® 2.4LV)	0.75–1.5 pt	21	See label
Methyl parathion			
(Penncap-M® 2F)	2.0–3.0 pt	12	12
(Methyl parathion 4E)	0.5 pt	12	See label
Malathion			
(Fyfanon® 9.9 lb)	4.0 oz	5	no
Permethrin			
(Ambush® 2E)	6.4–12.8 oz	30	0
(Arctic® 3.2EC)	4.0–6.0 oz	30	0

Remarks

Research data demonstrate that use of carbaryl, chlorpyrifos, and pyrethroid (esfenvalerate and permethrin) insecticides can cause increases in mite densities on corn. Other insecticides associated with mite increase on corn are ethyl parathion and methyl parathion.

NOTE: Application of the insecticides listed above during pollen shed will destroy foraging honey bees.

Chlorpyrifos: Do not feed treated corn fodder to meat or dairy animals within 35 days after last treatment.

Methyl parathion: Do not apply during pollen shed.

Western Bean Cutworm

Western bean cutworm larva

Western bean cutworm egg mass

Economic damage from western bean cutworm is restricted to the extreme northwest corner of the Texas Panhandle.

Moth activity begins in early July, with egg lay following shortly thereafter. Eggs are laid on the upper surfaces of the corn leaves in masses of 5 to 200. They turn from a pearly white at egg lay to bluish black at hatching time.

At hatching time, the young cutworms will feed on the egg shell and then move to one of two sites on the corn, depending on the stage of corn development. If the corn has not tasseled, young cutworms will feed in the whorl on the developing tassel. If the corn has tasseled, young cutworms will move to the developing ear and feed on the silk. As the larvae mature, they begin feeding on developing grain.

Insecticide treatments should be made when 14 percent of the plants are infested with eggs or larvae and corn is 95 percent tasseled.

Suggested Insecticides for Controlling Western Bean Cutworm

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Bifenthrin			
(Brigade® 2EC)	2.1–6.4 oz	30	30
Bifenthrin + Zeta-cypermethrin			
(Hero®)	2.6–6.1 oz	30	30
Carbaryl			
(Sevin® 80WSP)	2.5 lb	48	14
(Sevin® XLR Plus 4 lb)	2.0 qt	48	14
Esfenvalerate			
(Asana® XL 0.66E)	2.9–5.8 oz	21	See label
Methyl parathion			
(Penncap-M® 2F)	3.0–4.0 pt	12	12

Remarks

Methyl parathion: Do not apply during pollen shed if bees are foraging in the area.

Grasshoppers

Grasshoppers occasionally cause damage to corn. Damaging infestations need to be controlled early while grasshoppers are small and still in crop border areas. *Ten or more nymphs per square yard in crop margins warrant control measures.*

Suggested Insecticides for Controlling Grasshoppers

Insecticides (listed alphabetically)	Amount per acre	Days from last application to: Harvest	Grazing
Bifenthrin (Brigade® 2EC)	2.1–6.4 oz	30	30
Bifenthrin + Zeta-cypermethrin (Hero® add Formulation)	2.6–6.1 oz	30	30
Carbofuran (Furadan® 4F) Sec. 24C	0.25–0.5 pt	30	30
Chlorpyrifos (Lorsban® 4E or Advanced)	0.5–1.0 pt	21	0
(Nufos® 4E)	0.5–1.0 pt	21	0
Esfenvalerate (Asana® XL 0.66E)	5.8–9.6 oz	21	See label
Lambda-cyhalothrin (Warrior® II)	1.28–1.92 oz	21	1

Remarks

Chlorpyrifos: Do not feed treated corn fodder to meat or dairy animals within 35 days after last treatment.

Sap Beetles

Sap beetle

Corn sap beetles or picnic beetles are attracted to decaying vegetable matter and often invade corn ears damaged by insects. These are small (⅓-inch) black or brown beetles, which may have orange to yellow spots on their wing covers. These secondary invaders are not attracted to healthy ears, but feed on decaying plant tissue and the associated microorganisms.

Insecticide Application Methods

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

Spray applications are more effective and drift is reduced when wind velocity does not exceed 10 miles per hour. Avoid spraying when plants are wet.

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

Certain insecticides and miticides applied with irrigation water through center pivot and stationary irrigation systems effectively control some corn pests. Chemigation can reduce application costs and, in some cases, requires less insecticide because of improved crop coverage as compared to conventional application methods. Chemigation requires an initial investment in chemical injection equipment and additional management time.

Certain safety features and practices are necessary for safe and effective chemigation. Prevention of groundwater contamination is of key importance. *Chemigation of some insecticides is prohibited* because of their high mammalian toxicity or lack of effectiveness when applied in irrigation water.

Refer to the pesticide label to determine if chemigation is prohibited or if it is an approved application method. Currently, bifenthrin (Capture®), carbaryl (Sevin®), chlorpyrifos (Lorsban®), dimethoate, permethrin (Ambush® and Pounce®), esfenvalerate (Asana XL®), lambda-cyhalothrin (Warrior®), methyl parathion (Penncap-M®), and spinosad (Tracer®) are registered for chemigation in corn in Texas. If approved for chemigation, the label will identify specific safety equipment and procedures that are required by federal law if the product is applied in this way. Refer to the product label for specific instructions and restrictions regarding chemigation.

The label also may provide instructions for mixing, diluting and agitating the product, and state the quantity of irrigation water to be applied during chemigation. Certain adjuvants may be recommended to increase pesticide efficacy by reducing washoff. Irrigation systems with nozzles positioned above the crop canopy should not be used for chemigation during windy weather because of the danger of pesticide drift from the treated field. Also, end-guns should be shut off during chemigation.

Personal safety equipment should be worn during mixing and loading of the insecticide. Avoid contamination of the site with spilled pesticide and properly dispose of pesticide containers.

The pesticide injection pump unit must be carefully maintained and calibrated to uniformly apply the insecticide at the desired rate in the irrigation water. Inaccurate calibration can result in underapplication, which reduces insecticide effectiveness, or in overapplication, which increases costs and crop and environmental contamination.

Protecting Bees and Other Pollinators from Insecticides

Pollination is extremely 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 insect pollinators. Where pollen-collecting insects are required for flower fertilization, the producer, insecticide applicator and beekeeper should cooperate closely to minimize bee losses. The following guidelines will reduce bee losses.

- If practical, apply insecticides before bees are moved into fields for pollination.
- Where insecticides are needed, use materials least toxic to bees.
- Make all applications when bees are away from the field. Evening or early morning treatments between the hours of 7 p.m. and 6 a.m. generally are most satisfactory. Evening applications after bees have left the field are less hazardous than early morning applications.
- Use spray or granular formulations rather than dusts.
- When possible, use an insecticide in groups 1 or 2 in the following list. Notify the beekeeper so that he can make necessary arrangements to protect his bees.
- Avoid drifting or spraying any insecticide directly on colonies. Heavy losses generally occur in these situations. On hot evenings, bees often cluster on the fronts of the hives. Pesticide drift or direct spray at this time results in heavy bee kill.

Honey Bee Hazards

Insecticides	Remarks
Group 1. Highly toxic Carbaryl (Sevin®) Chlorpyrifos (Lorsban®) Dimethoate Esfenvalerate (Asana® XL) Lambda-cyhalothrin (Warrior II®) Malathion Methomyl (Lannate®) Methyl parathion (EC, Penncap-M®) Permethrin Spinosad (Tracer®)	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. Apply malathion in the evening after all the bees have completed foraging. Avoid ultra-low-volume malathion after blooms appear.
Group 2. Moderately toxic Bifenthrin Malathion (EC) Spiromesifen (Oberon®)	Apply in late evening.
Group 3. Relatively nontoxic Dipel® Hexythiazox (Onager®) Methoxyfenozide (Intrepid® 2F) Sulfur Propargite (Comite®)	Apply in late evening or early morning when bees are not foraging.

Beneficial Arthropods


Bigeyed bug


Green lacewing egg


Green lacewing larva


Lady beetle adult


Lady beetle larva


Lady beetle pupa


Orius adult


Orius nymph


Crab spider


Syrphid fly larva

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Revision