Texas A&M AgriLife Extension

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MANAGING INSECT AND MITE PESTS OF TEXAS CORN

PATRICK PORTER AND HOLLY DAVIS*

*Extension Entomologists, The Texas A&M University System





Images Courtesy of Christina DiFonzo (Michigan State University), Stephen P. Biles, Ed Bynum, Dalton Ludwick (University Of Missouri), Patrick Porter, Bob Glodt, Alton N. Sparks, Phil Sloderbeck (Kansas State University), John Norman, and Bart Drees.

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INTRODUCTION

Corn is subject to attack by insect and mite pests 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, soil moisture conditions, time of year, parasite and predator abundance, and cultural practices, such as crop rotation, are equally important. Therefore, insecticide treatments should be based on careful evaluation of economics 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. This publication provides guidelines for determining insect numbers and the need for pesticides. Seedcorn production fields and sweet corn are more susceptible to insect damage than field corn. Increased susceptibility to insect attacks and higher value often require that pests be controlled at lower levels in seed production and sweet cornfields than in field corn. Insect control recommendations in this bulletin primarily refer to insect and mite control in field corn.

INSECTICIDE RESISTANCE

A few insect and mite pests attacking corn in Texas show resistance to once-effective pesticides. Generally, the more extensively a pesticide is used, the faster resistance develops. Even when insecticides have different trade names, they may have the same active ingredients, and alternating between insecticides with the same active ingredients does no good in delaying resistance. The suggested insecticides tables contain a column called "IRAC Group." This is the formal mode of action group recognized by the International Resistance Action Committee (IRAC). It is important to rotate insecticides from different IRAC groups in order to delay the development of resistance; never sequentially apply insecticides from the same IRAC group. The present status of resistance in specific pests is discussed in this publication.

SEASONAL PROGRESSION OF PESTS

This guide discusses insect and mite pests in the approximate seasonal order that they damage corn: pre-emergence to seedling, whorl to tassel, tassel through silk stages, and grain filling. Many pest species cause economic damage for only a short time during the growing season. However, some pests remain a threat for much longer periods of time. The following table is a quick reference to the stages of corn and associated pests that may be of economic consequence at a particular growth stage.

Seasonal Progression of Insect and Mite Pests

Pest	Seed/ Seedling	Whorl to Pretassel	Tassel/ Silk	Grain filling
Wireworm	Yes			
White grub	Yes			
Sugarcane beetle	Yes			
Fire ant	Yes			
Seedcorn beetle	Yes			
Seedcorn maggot	Yes			
Lesser cornstalk borer	Yes	Yes		
Flea beetle	Yes			
Chinch bug	Yes	Yes		
Corn leaf aphid	Yes	Yes	Yes	
English grain aphid	Yes	Yes	Yes	
Cutworms	Yes			
Fall armyworm	Yes	Yes	Yes	Yes
Armyworm	Yes	Yes	Yes	Yes
Western corn rootworm	Yes	Yes	Yes	
Mexican corn rootworm	Yes	Yes	Yes	
Southern corn rootworm	Yes	Yes		
Spider mites	Yes	Yes	Yes	Yes
Southwestern corn borer		Yes	Yes	Yes
European corn borer		Yes	Yes	Yes
Mexican rice borer		Yes	Yes	Yes
Sugarcane borer		Yes	Yes	Yes
Neotropical borer		Yes	Yes	Yes
Western bean cutworm		Yes	Yes	Yes
Corn earworm		Yes	Yes	Yes
Grasshoppers		Yes	Yes	Yes

TRANSGENIC CORN FOR INSECT CONTROL

This version of *Managing Insect and Mite Pests of Texas Corn* is being written with the assumption that transgenic technology is now the most common form of insect control for major pests, and most other pest control decisions will be made in fields of transgenic corn. This is not to say that non-transgenic corn is being de-emphasized in this publication; it is not, and growers of non-transgenic corn will still find as much information for their insect management decisions as in past editions.

Insect-protected transgenic corn and seed treatments have fundamentally changed the way we practice insect pest management for many key pests. These technologies are deployed before the insects arrive rather than after they are present and threatening economic loss. In the end, these new technologies are no different from traditional insecticides, and prophylactic use of pesticides or Bt traits is not good integrated pest management. This is in part because the cost of control may not be justified by pest numbers, and also because it promotes insect resistance through widespread and continuous selection. That being said, these technologies do allow greater flexibility in designing pest management plans, due to the fact one can usually avoid using insecticides for key pests like caterpillars, which in turn will reduce the threat of causing secondary pest outbreaks that often result from pesticide use.

How Transgenic Corn Works

Modern insect-protected transgenic corn contains combinations of several toxins—all of which are derived from the bacterium *Bacillus thuringiensis* (Bt). This is where the term "Bt corn" originates. However, newer technology that does not rely on Bt is on the horizon.

The plants have had genes from the *Bacillus thuringiensis* bacterium placed into the DNA of the corn. These genes produce proteins present in the natural Bt bacteria that are toxic to certain groups of insects. When these proteins are eaten by target insects, they break down into smaller subunits—some of which bind on the wall of the insect gut. This binding eventually causes a small hole to form in the gut wall, and bacteria present in the gut then move into the body of the insect. Death is caused by bacterial septicemia from the natural bacteria that entered from the insect gut, not by the Bt protein crystals. There is a wide range of susceptibility to Bt toxins among broad insect groups, such as caterpillars, beetles, flies, etc., and among even closely related insects within a small group, such as caterpillars. The acidity of the insect gut is important, and the wrong acidity prevents the crystal subunits from forming. Additionally, the insects must have the right type of receptors on the gut wall in order for the protein subunits to bind, and many insect species lack the appropriate receptors for the Bt toxins they encounter when feeding on Bt plants. The following table provides a list of currently available Bt toxins that are registered against corn insects.

This differential activity by Bt proteins on different, even closely related, insect species explains why some Bt toxins work better on certain pests than on others. A good illustration of this phenomenon is that fall armyworms are relatively less affected by the toxin Cry1Ab than by the toxin Cry1F. However, the southwestern corn borer and European corn borer are extremely susceptible to both toxins, so much so that we have driven down the size of their populations just by planting Bt corn.

Currently registered Bt toxins active against insects

Target Pests	Toxin
Lepidoptera (caterpillars)	Cry1Ab, Cry1F, Cry1A.105, Cry2Ab2, Vip3a
Corn rootworm	mCry3a, eCry3.1Ab, Cry3Bb1, Cry34/35Ab1

Multiple Toxins in Modern Transgenic Corn

In order to understand modern insect protected Bt hybrids, it is important to know the meaning of the terms "stacked traits" and "pyramid traits." "Stacking" is where toxins that act against totally different groups of insects are put together in a single hybrid. An example of this is a corn hybrid that has one toxin, Cry1F, to kill caterpillar pests, and a different toxin, Cry34/35, to kill corn rootworm larvae. Cry1F has no effect on corn rootworms, and Cry34/35 has no effect on caterpillars, but the combination of the two provides protection against both types of pests. Similarly, herbicide-tolerant genes are also added to the mix of traits, which makes this a three-way stack of traits.

Pyramids are where two or more types of Bt toxins that act on the same group of pests are combined in a plant. A simple example is when Cry1F and Cry1Ab, both of which are targeted at caterpillars, are combined. This type of corn has no toxins for corn rootworm but is pyramided for toxins to protect against caterpillars.

Stacked pyramids are currently the highest evolution of Bt technology. These are both stacked for toxins active against very different types of insects and pyramided for two or more toxins active against a particular type of insect or pest group. An example is when a hybrid contains three different toxins targeted at caterpillars—Cry1F, Cry1A.105, and Cry2Ab2—and is, therefore, a pyramid toxin plant for caterpillars. Additionally, it has two toxins directed specifically at corn rootworm larvae, Cry3Bb1 and Cry34/35, so it is pyramided against rootworms as well. (Technically speaking, Cry34/35 is a binary toxin, but both components are always present, so it acts as a single toxin.) Also, the hybrid would have genes for tolerance to two different types of herbicides.

The seed and technology companies are cross-licensing Bt toxins from each other in order to build multi-toxin pyramids for caterpillar pests and corn rootworms. There are two very good reasons for this: improved efficacy against target pests and Insect Resistance Management (IRM). Improved efficacy is easy to understand; two toxins are better than one, and three toxins are better than one and possibly two. As a general statement, better insect control results from more toxins in the pyramid, although this can vary somewhat on the particular toxins being used. Pyramids are critical in delaying the development of resistance. We have insects that have the genes to survive some of the individual toxins in hybrids if they encounter these toxins one at a time. For example, fall armyworm is resistant to Cry1F in Puerto Rico and parts of the southern United States, and continuing to use only Cry1F corn will make a larger and larger percentage of the population resistant each year. One answer to the problem is to add a second or even a third toxin so that the insects with genes to live through Cry1F will most probably not have the genes to live through the second and third toxin. This effectively removes the Cry1F-resistant insects from the population, and resistance to Cry1F does not continue to develop.

There is so much complexity involved in choosing Bt corn active against insects that consultation with seed dealers is recommended. It should be noted that Bt corn offers no protection against spider mites, and mites can threaten any type of corn in Texas.

Insect Resistance Management and Transgenic Corn

All of the registrants of hybrid corn with plant-incorporated protectants are required by the United States Environmental Protection Agency (EPA) to have a resistance management plan. These plans are based on our scientific understanding of the pests, their survival on a particular toxin, their movements both before and after mating, and several other factors. The plans are designed with the goal of preventing resistance from developing for a certain number of years; they are not meant to prevent resistance forever, as that is not a practical goal.

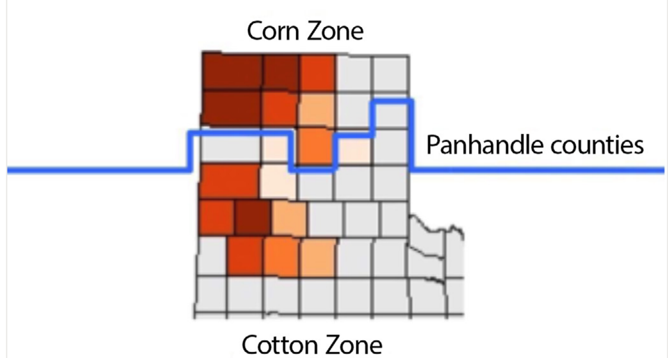
The EPA will not grant permission for a company to sell Bt corn without a resistance management plan in place. The seed companies, therefore, require growers to sign a Stewardship Agreement each year. The agreement is based on the resistance management plan the EPA has in place for the particular set of Bt toxins present in the hybrids. The Stewardship Agreement is very important because, when implemented, it will delay the development of resistance to the toxins in the corn. All current resistance management plans in corn rely on a "refuge," or a certain percentage of the corn seed that does not contain the Bt toxins. The idea is to let some of the insects develop on non-Bt corn where they are not selected for resistance, and these will then mate with selected insects and dilute the resistance genes in the next generation.

Seed companies must report "compliance data" to the EPA each year. Compliance is the number of growers who are following the stewardship guidelines and the number who are not. The EPA has noted a drastic reduction in compliance in recent years, especially in the South, or the cotton zone, and has turned up the heat on companies to increase compliance. The seed companies know that a lack of compliance means it is more likely that resistance will develop to their Bt toxins. Taken together, this is why corn growers can expect visits from seed company representatives to ensure they are in compliance with the stewardship agreement. The big stick, and the thing that we worry about the most, is that if resistance develops, then the EPA can force the removal of certain Bt technologies from the market. This has already happened in Puerto Rico. Of course, the other big stick is that resistance means that the Bt hybrids stop working and growers once again lose money to the pests that have developed resistance. Growers in the Midwest with resistant corn rootworms are now paying the technology fee for rootworm Bt corn with the highest levels of seed treatment available. On top of that, they are paying for soil-applied insecticides and also paying again to spray adult rootworm beetles in the summer, all while losing yield to corn rootworm. Resistance means vastly increased costs and lower farm profits.

Across the United States, there are two "zones" for different refuge requirements in Bt corn. The "corn zone" includes the northern Panhandle of Texas and all of the traditional corn belt. The "cotton zone" is comprised of the areas where cotton is traditionally a significant crop. Bt corn has larger required refuges in the cotton zone than in the corn zone.

Texas is split into two zones, and counties north of the line in the map below follow the refuge requirements for the corn belt. Counties south of the line have larger required refuges because of the dominance of Bt cotton, which contains Bt toxins similar to those found in Bt corn. All corn in Texas grown south of the line (in the following map) have a 20 percent or 50 percent mandated caterpillar refuge. This is dependant on whether the corn has pyramid toxins, 20 percent, or a single toxin, 50 percent, and whether it is active against corn rootworms, caterpillar pests, or both. Regardless of the complexities involved in the sentence above, and there are many, all of the refuge in the counties south of the line in the map below—the cotton zone—must be a "structured refuge," except for corn active only against corn rootworm. This means that the non-Bt refuge corn must be in either a four-row minimum or wider strip or a block planting in part of the field or in an adjacent field, with restrictions depending on the Bt traits. Seed blend refuges, sometimes referred to as "refuge in the bag," are where the seed company blends non-Bt seeds with Bt seeds at the right ratio to give the minimum refuge stated in the stewardship agreement. It is illegal for growers to blend their own seeds. Seed blend refuges are legal to sell in the corn zone and may be planted in the cotton zone. In the cotton zone, all seed blends must have an additional block or strip refuge planted. None of the refuge seed in the bag counts toward the block or strip refuge that must be planted in the cotton zone.

Texas corn refuge requirements



Texas Panhandle and the line dividing the two different refuge zones.

It can be difficult to keep up with the proper stewardship practices required for the many types of Bt corn. As a response to this problem, the seed companies have partnered with the National Corn Growers Association to make it easy to learn the stewardship practices for any type of Bt corn grown anywhere in the country. There is a web-based tool here: *https://www.ncga.com/for-farmers/best-practices/bt-stewardship*. Additionally, Michigan State University produces "The Handy Bt Trait Table" annually, and this excellent two-page publication is a concise summary of the toxins in Bt corn, pests controlled, and refuge requirements. The publications for both field corn and sweet corn can be found at *https://www.texasinsects.org/bt-corn-trait-table.html*.

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-dwelling insects attacking corn before emergence. 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 most cases, eliminated by a crop rotation scheme, including cotton 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, as 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, insecticide soil treatment or seed treatment methods are available. One method may be more effective for a particular soil pest than another.

Seed Treatment

Almost all hybrid seedcorn comes pretreated in the bag. Companies are making rapid advances in seed treatments, so consult your seed dealer to determine the package you want on your seed.

Seed can also be treated on-farm with Clothianidin (Poncho), Imidacloprid (Gaucho, Latitude, and Concur), Permethrin (Kernel Guard Supreme) and Thiamethoxam (Cruiser). Light populations of wireworms, seedcorn maggots, seedcorn beetles, and seed-feeding ants may be effectively controlled by treating seeds with planter box products. Be sure to check the label, as not all products control all of these insects. When treating the seeds, follow the label instructions carefully, as the insecticide should coat each seed evenly. Treated seeds should be planted within 20 days of treatment, as 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 seedcorn maggots. Use this soil insect control technique as directed on the insecticide label.

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 to handle. With the soil treatment method, there are three application techniques: (1) the preplant broadcast, (2) row band or T-band, and (3) in-furrow at planting.

Preplant Insecticide Application: A broadcast application generally provides the best protection against soil insects and is the only means of controlling heavy 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.

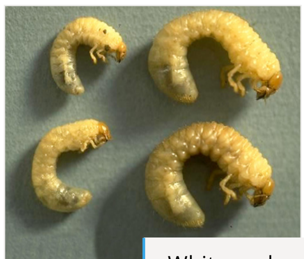
When corn is planted on a bed, special equipment is required to incorporate the insecticide to a depth of 3 to 5 inches. This is called "row treatment." Row treatments must be made during or after bed formation. Further cultivation or bed shaping will alter the position of the insecticide in the row. 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 and growing conditions.

- 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.
- Incorporate the insecticide by covering shovels, short parallel chains, loop chains, press wheels, finger tines, or other suitable devices.
- Do not apply insecticide directly on the seed unless this use is specifically listed on the label; doing so can result in poor seed germination. Some insecticides are labeled only for band application behind the seed-covering devices. Poor control usually results from in-furrow application where populations of white grubs are large.

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 are often killed, and large plants are stunted and may lodge prior to harvest. To determine the need for white grub control before planting, examine a 1-square-foot soil sample for every 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 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.

Wireworms, Seedcorn Maggots, and Seedcorn Beetles

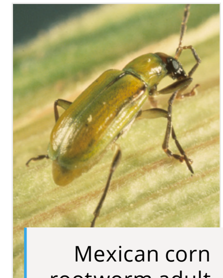

False wireworm

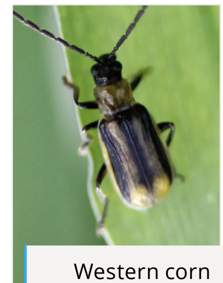

Wireworm larva

These insects are often controlled with insecticidal seed treatments. Where large populations of wireworms are present, follow the recommendations listed on appropriate insecticide labels. Producers should check their soil closely during land preparation to determine the need for seed treatments or soil insecticide applications to control these pests.

Mexican and Western Corn Rootworm

Corn rootworms can be a significant pest anywhere in Texas, and the best defense against corn rootworms is crop rotation. The exception is in the Coastal Bend and South Texas, where the southern corn rootworm is common—crop rotation does not always work for this insect. However, many growers cannot rotate out of corn and grow corn year after year in the same field. Laboratory studies have shown that corn rootworms can develop resistance to any of our current rootworm Bt toxins in as little as four years of continuous use. Western corn rootworms have become resistant to Cry3Bb1, eCry3.1Ab, and mCry3A in parts of the Midwest, and the first confirmed cases of resistance were in fields that were in continuous corn planted to Cry3Bb1 for 4 or more years. Unlike our caterpillar toxins that are relatively toxic to their target pests, corn rootworm toxins are relatively less toxic overall, and we know that the natural populations of corn rootworms have the genes to survive current toxins Cry3Bb1, Cry34/35, mCry3A, and eCry3.1Ab. There is some level of cross-resistance between Cry3Bb1 and mCry3A so that insects that become resistant to one of these toxins will have partial resistance to the other.


Mexican corn rootworm adult


Western corn rootworm adult

The key to preventing resistance to corn rootworm toxins is to practice crop rotation where possible and rotate corn rootworm toxins where crop rotation is not possible. Never plant the same rootworm technology in the same field for more than 3 years—fewer than 3 is even better. This might mean buying seed from a different company, but it is vital that this 3-year limit is observed if resistance is going to be delayed on a particular farm. Corn rootworm adults tend to stay in the same field where they fed on roots as larvae, and most corn rootworm resistance can be traced back to a specific field where toxins were not rotated.

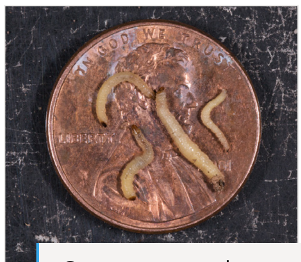
In the Coastal Bend and southern part of the state, even rotated corn may need protection from the southern corn rootworm. All Bt corn comes with an insecticidal and fungicidal seed treatment. However, even the best seed treatments are not able to control corn rootworms when they are at moderate and high infestation levels.

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 cornfield in the upper 2 to 8 inches of the soil, where they remain until they hatch the following year. 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, continuing to hatch for several weeks. If corn roots are not available for the newly hatched corn rootworms to feed on, they will die. Mexican and western corn rootworms have only one generation per year; therefore, the best method of controlling these two subspecies is to rotate corn with any other crop.

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 or transgenic Bt hybrid 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 "goosenecking" appearance occurs when lodged plants continue to grow.

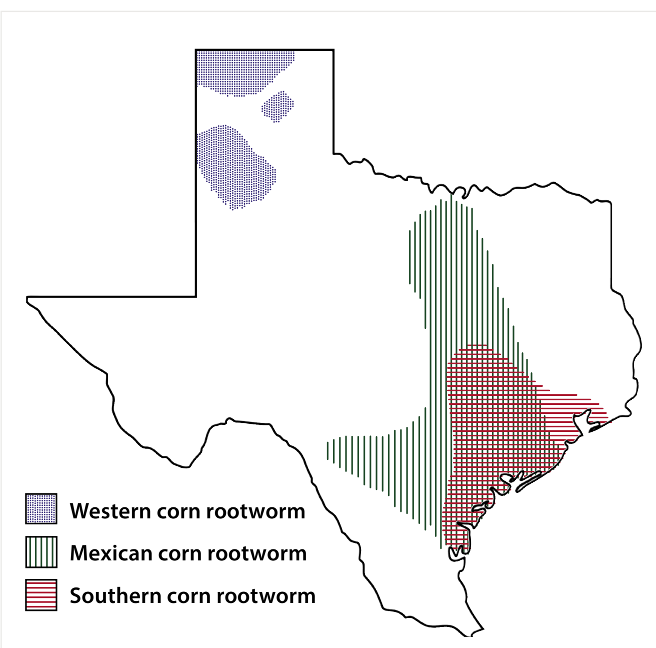
Southern Corn Rootworm

Because the southern corn rootworm lays eggs in the soil after the corn is in the seedling stage, rotating crops will not control this insect adequately. Unlike the Mexican and western corn rootworms, southern corn rootworms can have more than one generation 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.


Corn rootworm larvae


Southern corn rootworm adult

In the Gulf Coast region (see map), however, the southern corn rootworm has been a pest of economic significance. Where there is a history of infestations along with losses in plant stands in previous years, seed treatments or an in-furrow or band pesticide application should be considered. Seed treatments provide good control with increasing effectiveness as rates increase. The Bt hybrids are relatively ineffective at controlling southern corn rootworms.



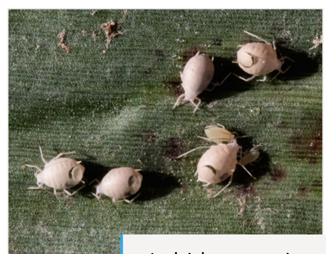
Areas where rootworms have damaged corn.

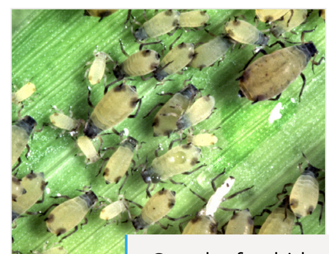
With insecticides that can be applied in-furrow, field experiments show that in most fields, one-half the maximum rate listed in the table below provides the most favorable economic returns for control of southern corn rootworms. However, in fields where heavy infestations occur each year, it would be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

SEEDLING TO TASSEL STAGE

Corn Leaf Aphid

Fields in the seedling stage rarely require treatment for corn leaf aphid. Economic yield losses occur only when corn leaf aphids threaten stand loss to seedling plants. Pre-tassel and later growth stages can tolerate large numbers of aphids without economic damage.


Aphid mummies


Corn leaf aphids

Sugarcane Beetle

The sugarcane beetle is a sporadic but serious pest of corn in some areas of Texas. Damage to young plants by overwintered adults can result in plant death or stunting, and losses due to yield reduction or replanting can be as much as 30 percent. There are currently no action thresholds established. Adults are good fliers and can readily move to corn from pasture and grassland areas.


Sugarcane beetle

Overwintering adults damage corn in the seedling stage, but plants as tall as 4 feet can be damaged. Damage is most commonly observed in the V3 to V5 growth stages. Beetles burrow beneath the soil and dig into and feed on the main stem of the plant at a depth of 0.5 to 1.0 inch. Symptoms of feeding depend on the severity of damage and include slight stunting and leaf streaking, plant lodging, goosenecking, suckering, dead heart, or plant death. Light trap studies in

Louisiana found peak flights of the overwintering generation in April and May, and early planting may allow corn to miss the peak flights, at least while it is in a very early growth stage.

Monitoring is difficult because the beetles migrate into the field and cause the injury overnight. The first sign of their presence is usually plant damage. A replant decision should be made based on the severity of infestation and plant damage. In fields or areas where sugarcane beetles are consistent problems, preventative insecticide treatments should be considered. The range of insecticides labeled for sugarcane beetles is limited, but a table near the end of this document presents a list of at-planting insecticides with efficacy. Most universities do not recommend a curative—or rescue—treatment, in part because the beetles are below the surface and will not come in contact with the insecticide. However, Georgia and Tennessee Extension guides suggest that a pyrethroid insecticide can be applied as a directed spray after plant emergence when stand loss is 5 to 10 percent, but these same guides acknowledge that such treatments are generally ineffective.

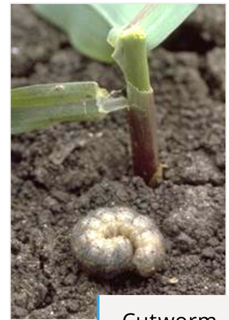
There is one generation per year, and adults emerge from the soil in the spring and late summer to early fall. They typically stay below the soil surface but may come to the surface to feed. As soil temperatures decline below 50 degrees in fall and winter, they burrow deeper into the soil and enter a state of dormancy. They become active in the spring as soil temperatures rise. Egg-laying begins shortly thereafter. Eggs are laid near or in contact with host plants, and the eggs hatch within 8 to 10 days. Larval development occurs below the soil surface over the course of the summer, and during this time, the larvae feed on decaying plant matter.

Females can lay about 100 eggs, and grass pastures and sod are preferred egg-laying locations. Corn is relatively unattractive as an egg-laying site. Larvae are the typical "white grubs," a plump insect that assumes a "C-shape" when disturbed. Small larvae have a patch of red on their heads. There are three larval instars, and development can take anywhere from 50 to 60 days. Fully developed larvae have a red head capsule and are approximately 1.25 inches long and 0.25 inch in diameter. While initially white, the pupae quickly turn brown. The pupal stage lasts about 16 days before adults emerge.

Newly emerged adults are glossy and may have a blackish-red color before they turn dull black. They look like black, heavily armored versions of a typical June beetle and range in size from 0.59 to 0.75 inch.

Soil Cutworms

Cutworms are dingy, grayish-black, smooth "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 the 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. The 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.

Southwestern Corn Borer

Southwestern corn borer eggs

Southwestern corn borer larva

Southwestern corn borer adult

Southwestern corn borer girdle

The southwestern corn borer is effectively controlled by all types of Bt corn with toxins targeted at caterpillars, and these types of Bt corn will not require an insecticide for southwestern corn borer control. Southwestern corn borer moths emerge from corn stubble in the spring to lay eggs on whorl-stage corn. Corn adjacent 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, 3 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 the windowpane effect, which creates 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 1.5 inches. They have a regular pattern of raised black dots on a creamy white body.

First-generation eggs and larvae are difficult to detect since infestations are small, and rarely more than 5 percent of plants become infested. However, if infestations are great enough to warrant treatment, insecticide applications should be made before borers leave the whorl and enter the stalk. For information on how the second generation affects corn, refer to the southwestern corn borer section in the "Tassel to Hard Dough Stage" of this guide.

European Corn Borer


European corn borer

The European corn borer was first discovered in Texas High Plains corn in 1978, but populations have declined drastically due to the widespread planting of Bt corn. The European corn borer is effectively controlled with all types of Bt corn. Economic infestations in non-Bt corn can be found in most corn-growing areas of the Texas Panhandle. Borers overwinter as fully grown larvae in corn stalks, corn cobs, weed stems, or other cornfield 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 cornfields 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 to continue feeding.

To determine the need for insecticide application to control first-generation European corn borers, examine 5 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 1 live larva per plant. For information on how the second generation affects corn, refer to the European corn borer section 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 prevalent 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.

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.

Other Borers

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.


Mexican rice 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 borers can cause whorl damage, stalk tunnels, shank damage, and grain feeding injury. Yield losses are thought to be minor unless stalk lodging occurs. 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 associated 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.

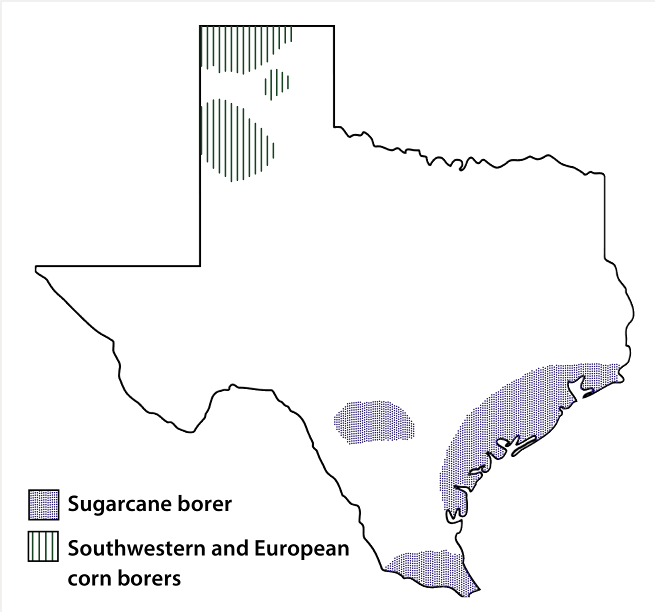
Transgenic Bt corn hybrids provide a high level of control. Conventional insecticidal control is most successful when fields are scouted closely and treated before larvae bore into stalks.


Sugarcane borer larva


Sugarcane borer adult


Neotropical borer larva


Neotropical borer adult



Areas where borers have damaged corn.

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 of whorl-stage corn are seldom recommended, and economic control is seldom achieved.

Corn earworm larva

Corn earworm adult

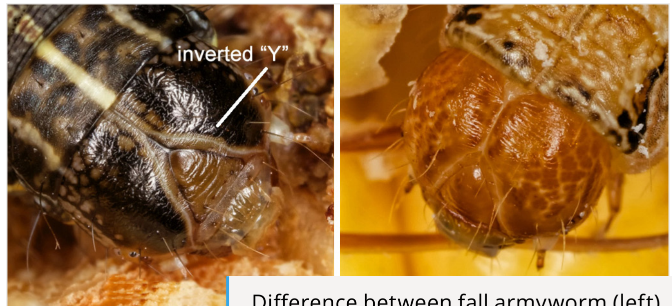
Fall armyworm egg mass

Fall armyworms hatching

Fall armyworm larva

Fall armyworm adult

Difference between fall armyworm (top) and corn earworm (bottom). Upper front view at left; side view at right



Difference between fall armyworm (left) and corn earworm (right)

Flea Beetles

Flea beetles are very 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 feeding on the leaves. Damaged leaves have a whitened, bleached appearance. Plant growth is retarded as the leaves wilt and hang limp. Later-maturing corn is more likely to be damaged by flea beetles.

Flea beetle

Flea beetles and damage

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.

Chinch Bug

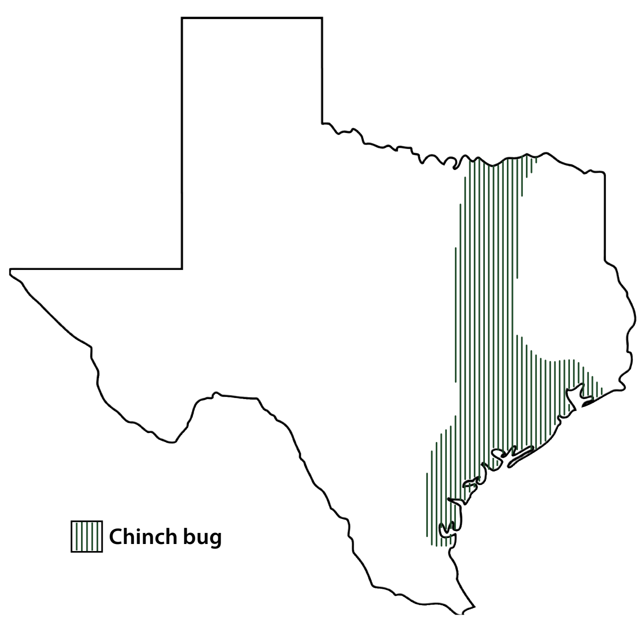
Adult chinch bugs are about 1/6 inch long with black bodies and reddish-yellow legs. When fully developed, the white wings are marked with a triangular black spot near the middle of the back on the outer wing margin. The insect appears to have a white “X” or white hourglass on its back when viewed from above.

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 and below the ground line on plant roots and crowns.

Chinch bugs

In fields with a history of early-season, economically damaging chinch bug populations—see the map for typical locations—the use of seed treatments or 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 of the granules. Young plants should be closely monitored for chinch bugs and feeding damage after germination and particularly during dry periods, even when seed treatments or 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.



Areas where chinch bugs have damaged corn.

TASSEL TO HARD DOUGH STAGE INSECT CONTROL

Corn Earworm

Corn earworm moths begin laying eggs singly on leaves and silks soon after tassel emergence. Eggs are laid on emerging silks prior to pollination. After hatching, the larvae tunnel into the silk channel to feed. The silks that the larvae feed on 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 since egg-laying is extended through the silking period and continues after the brown silk stage, when pollination is completed. Insecticides used for control have to be applied frequently because untreated silks are exposed daily as silks elongate. Control efforts are usually costly and inconsistent. Currently, control strategies are not suggested in commercial field corn.

Southwestern Corn Borer

The southwestern corn borer has been a major corn pest on the High Plains (see map), but population sizes have been reduced due to the widespread planting of Bt corn. The southwestern corn borer also appears in far West Texas and Northeast Texas but is not economically important in these regions. Damage is caused by larvae tunneling into 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, the two leaves above the ear leaf, and the four leaves below it. 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 1.5 inches in length. They are dull white and have a regular pattern of raised black dots over the body. As plant maturity is reached, 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 the yields are reduced.

Southwestern corn borer larvae overwinter in the stalk base or root crown. They are insulated by a frass—insect excrement—plug in the stalk and by the surrounding soil. One of the most effective borer control methods is the 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. 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 area-wide.

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, help 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. All of the Bt hybrids with toxins targeted at caterpillars provide excellent control of southwestern corn borers.

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.

European Corn Borer

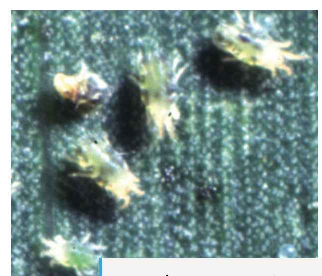
All of the Bt hybrids with toxins targeted at caterpillars provide excellent control of the European corn borer. In non-Bt corn, yield losses from second-generation European corn borers are usually higher than yield losses from the first generation. Second-generation moths that emerge in mid-summer are attracted to dense vegetation around cornfields, 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, approximately 75 percent of the small larvae move to the leaf axils, and the remaining 25 percent move 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 in non-Bt corn, examine a minimum of 5 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 the European corn borer.

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. Mites first appear on the lower leaves but may move upward until all the leaves—and in extreme cases, the entire plant—are killed. Yield losses from mite feeding occur during the grain-filling growth stages, such as tassel to soft dough. Once corn reaches the full dent growth stage, mite feeding does not directly cause yield loss. Heavy infestations cause extensive webbing on the leaves and may be associated with stalk rot and lodging. 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. Broad-spectrum insecticides may kill beneficial arthropods that usually keep spider mite numbers low. Mite numbers 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. Some fields, however, will have high numbers of twospotted spider mites or mixed populations of Banks grass mite and twospotted spider mites. The most useful characteristic for distinguishing between these two species is the pattern of pigmentation spots on the body. (See diagram). 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



Banks grass mites

Banks grass mite colony

Twospotted spider mite

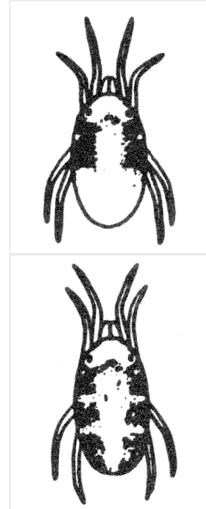
body. Additionally, twospotted spider mites produce more webbing than Banks grass mites.

All of the modern miticides take from a few to several days to begin controlling spider mite populations, and the action thresholds have changed from in the past when we had fast-acting miticides. Therefore, control decisions should be based on earlier spider mite feeding damage levels than in the past. Fields should still be scouted at least once a week to know the dynamics of the mite and predator population and subsequent changes in damage. When predators are keeping mite populations under control, both the mite densities and damage will not be increasing from week to week. The following table provides a rating scale with corresponding descriptions of mite damage that can be used to estimate when to initiate applications for spider mite control. The mite damage rating scale can be used to estimate damage to individual plants and to estimate the average damage to several plants in an area.

Mite damage rating scale used to estimate spider mite feeding damage on corn.

Rating	% leaf area damage per plant	Description of Damage
1	1–10	A few small mite colonies and associated damage (chlorotic spots) can be seen along the midrib of the lowest leaves.
2	11–20	Mite colonies and damage spread along the midribs on the lowest leaves on a plant.
3	**21–30**	**Mite colonies and damage are spreading out from the midrib on the lowest leaves, and small colonies may occur on leaves up to the ear. Action threshold.**
4	31–40	Mites and damage cover most of the leaf area on the one to two lowest leaves, and mite colonies and damage extend along the midrib to the ear leaf.
5	41–50	Mites have killed one leaf, the bottom two to three green leaves are heavily infested and damaged, and mite colonies are present on one to two leaves above the ear.
6	51–60	Mites have killed or nearly killed the bottom two leaves, and colonies and damage extend beyond the midribs on two leaves above the ear.
7	61–70	Mites have killed or nearly killed the bottom three leaves. All leaves up to the ear are significantly damaged, and mite colonies and damage are found on most to all leaves on the plant.
8	71–80	Mites have killed or nearly killed all leaves up to the ear, and mites and damage occur on most to all leaves on the plant.
9	81–90	Most leaves on the plant have been killed by mite feeding, and only leaves in upper third of the plant are alive.
10	91–100	Very little green area is left on plant, or the plant is dead.

The average damage to plants from several locations should be used when making control decisions. Field efficacy trials with the modern miticides have shown mite control is best achieved on tasseled corn before mite populations become aggressively active, rapidly moving up the plant and causing damage to the ear leaf—a damage rating of 5. When mites have caused damage ratings of 6 and above, significant yield losses have already occurred, and miticides will not effectively control the infestations. An action threshold for initiating miticides at a damage rating of 3 should provide sufficient time for the field to be sprayed and determining whether mite populations are becoming increasingly active.



Twospotted spider mite (top) and Banks grass mite (bottom).

Adult Corn Rootworm Beetle (Mexican and Western Corn Rootworm)

Adult rootworm beetles feed on leaves, pollen, and tassels, but prefer silks. When adults are numerous—8 to 10 per plant—during the green silk stage and the silks are chewed back to within 0.5 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, and it is for this reason that we do not recommend using a synthetic pyrethroid for control of adult corn rootworm beetles. Insecticide treatments for adult beetle control should only be used 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 present less risk of outbreaks of spider mites following application relative to many other conventional insecticides. Steward insecticide does not promote spider mite outbreaks.

Fall Armyworm

The fall armyworm is a sporadic pest of corn but has become a more consistent pest in recent years. It migrates north during the growing season from overwintering sites in South Texas and northern Mexico. Recent data from Mississippi indicate that significant whorl damage can result in yield loss, but as of this writing, the final scientific paper has not been published. Infestations occurring from tassel to dough stage can be very damaging. Larvae feed on ears, ear shanks, and behind leaf collars. Recent research on the High Plains has shown that one fall armyworm larva, when boring through the side of an ear, causes an average of 0.20 pounds of yield loss through direct kernel injury and damage by associated fungi. Mycotoxin levels in grain may also increase due to fall armyworm damage. Heavy infestations may result in substantial yield losses due to larvae feeding 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 in color from a light tan to a dark green or black. Light and dark stripes run longitudinally 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 light-colored inverted Y 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.

Currently, Texas does not have an established economic threshold for this pest. If control is deemed necessary, it should be targeted at small larvae before they have entered the primary ear. Recent research has shown that insecticides targeted at ear protection should be applied in a window from 2 days before pollen shed to 4 days after pollen shed. Later applications will be less effective in ear protection. The newer multiple toxin Bt corn hybrids provide good to excellent control of fall armyworms.

True Armyworm

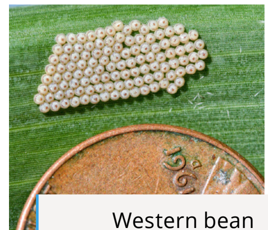
True armyworms occasionally cause heavy damage to corn. Activity is usually heaviest in fields with junglerice (watergrass) and Johnsongrass in the furrows or fields that have hail-damaged leaves. True armyworms may go unnoticed as populations build up on the weeds in the furrows. Then, when the weeds are consumed and larvae increase in size, 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.


Yellowstriped armyworm

Western Bean Cutworm

Economic damage from western bean cutworms 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 color at egg lay to a bluish-black color at hatching time. At hatching, the young cutworms will feed on the eggshell and then move to one of two sites on the corn plant, 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. The only types of Bt corn that are still effective against western bean cutworm are those that contain the Vip3a toxin in combination with other toxins.


Western bean cutworm larva


Western bean cutworm egg mass


Pale western cutworm

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 grasshoppers per square yard in crop margins warrant control measures.

Sap Beetles

Corn sap beetles, or picnic beetles, are attracted to decaying vegetable matter and often invade corn ears damaged by insects. These are small, 1/3-inch-long, 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 micro-organisms.


Sap beetle

Appendix

Pesticides listed in the following tables may not be all those labeled for any particular pest. Always read and follow the latest pesticide label, as these change frequently.

Transgenic corn for control of CATERPILLAR PESTS and CORN ROOTWORM. Single-trait hybrids for lepidoptera are not shown; they are being removed from the market because they pose a significant resistance risk compared to pyramids.

Trait packages in alphabetical order (acronym that may be used)	# Toxins for Lepidoptera, # for rootworm	Corn borers	Cutworm	Fall armyworm	Western bean cutworm	Western/ Mexican corn rootworm	Known resistance in[1]
AcreMax (AM)	2, 0	EX	G	VG	P	None	CEW FAW WBC
AcreMax CRW (AMRW)	0, 1	None	None	None	None	G	WCR
AcreMax Leptra (AML)	3, 0	EX	VG	EX	EX	None	
AcreMax Xtra (AMX)	2, 1	EX	G	VG	P	G	CEW FAW WBC WCR
AcreMax Xtreme (AMXT)	2, 2	EX	G	VG	P	G	CEW FAW WBC WCR
Agrisure Viptera 3110 (VR)	2, 0	EX	VG	EX	EX	None	
Agrisure 3120 E-Z Refuge (BZ)	2, 0	EX	G	VG	P	None	CEW FAW WBC
Agrisure 3122 E-Z Refuge	2, 2	EX	G	VG	P	G	CEW FAW WBC WCR
Agrisure Duracade 5122 EZ (D1)	2, 1[2]	EX	G	VG	P	G	CEW FAW WBC
Agrisure Duracade 5222 EZ (D2)	3, 1[2]	EX	VG	EX	EX	G	WCR
Agrisure Viptera 3220 E-Z (VZ)	3, 0	EX	VG	EX	EX	None	
Agrisure Viptera 3330 E-Z	3, 0	EX	VG	EX	EX	None	
Herculex RW (HXRW)	0, 1	None	None	None	None	G	WCR
Intrasect (YHR)	2, 0	EX	G	VG	P	None	CEW FAW WBC
Intrasect TRIsect (CYHR)	2, 1	EX	G	VG	P	G	CEW FAW WBC
Intrasect Xtra (YXR)	2, 1	EX	G	VG	P	G	WCR
Intrasect Xtreme (CYXR)	2, 2	EX	G	VG	P	G	CEW FAW WBC WCR
Leptra (VYHR)	3, 0	EX	VG	EX	EX	None	CEW FAW WBC WCR
Powercore (PW), PW Refuge Advanced (PWRA)	3, 0	EX	G	VG	P	None	
Powercore Enlist (PWE)	3, 0	EX	G	VG	P	None	CEW WBC
QRome (Q)	2, 2	EX	G	VG	P	G	CEW WBC
Smartstax (SX, STX or SS), STX Refuge Advanced (SXRA), or STX RIB Complete (STXRIB)	3, 2	EX	G	VG	P	G	CEW FAW WBC WCR
SmartStax Enlist (SXE)	3, 2	EX	G	VG	P	G	CEW WBC WCR
Smartstax PRO	3, 2 + RNAi	EX	G	VG	P	E	CEW WBC WCR
Trecepta (TRE) or Trecepta RIB Complete (TRERIB)	3, 0	EX	VG	EX	EX	None	CEW WBC WCR
VT Double Pro (VT2P) or VT2P RIB Complete (VT2PRIB)	2, 0	EX	G	VG	P	None	CEW

[1] "Known resistance" refers to scientific research that demonstrates resistance somewhere in the United States, not necessarily Texas. Because insects are mobile, resistance can spread quickly. For a full list of Bt corn hybrids, including those with single toxins (non-pyramids), and documentation of resistance visit *https://www.texasinsects.org/bt-corn-trait-table.html*. CEW = corn earworm, FAW = fall armyworm, WBC = western bean cutworm, WCR = western corn rootworm.

[2] Technically two toxins, but both in the Cry3 group and there is cross resistance between them in western corn rootworm.

PLANTER BOX SEED TREATMENT PRODUCTS. Consult your seed dealer for seed treatment packages that are applied prior to purchase.		
Product	**Active Ingredients/Rate**	**Labeled Pests**
Concur	Imidacloprid/1.5 oz/42 lb of seed	Seedcorn beetle, seedcorn maggot, wireworms, white grub, flea beetle *(up to first true leaf)*, imported fire ants
Cruiser 5FS	Thiamethoxam, 0.25–0.8 mg ai/kernel or 1.25 mg ai/kernel for corn rootworms	Sugarcane beetle, seedcorn beetle, wireworms, seedcorn maggot, southern corn leaf beetle, chinch bug, corn flea beetle, white grubs, black cutworm, southern green stink bug, corn leaf aphid, corn rootworms
Gaucho 600	Imidacloprid, 0.16, 0.60, or 1.34 mg ai/seed. Rate varies by pest, see label.	Seedcorn maggot, wireworm, flea beetle, white grubs, imported fire ants, chinch bug, black cutworm, southern corn leaf beetle, southern green stink bug, corn rootworms
Kernel Guard Supreme	Permethrin, 1.5 oz/42 lb of seed	Seedcorn beetle, seedcorn maggot, wireworms
Latitude	Imidacloprid, 1.5 oz canister/42 lb of seed	Seedcorn beetle, seedcorn maggot, wireworms
Poncho 600	Clothianidin, 0.25–0.5 or 1.25 mg ai per seed. Rate varies by pest, see label.	Sugarcane beetle, seedcorn maggot, wireworms, white grubs, southern corn leaf beetle, black cutworm, flea beetle, chinch bug, southern corn billbug, corn rootworms

PREMIXED INSECTICIDE PRODUCTS			
Trade Name (Insecticides)	**Amount of Product per Acre**	**IRAC Class**	**Comments and Primary Target Pests (see label for other pests that may be controlled)**
Besiege (Lambda-cyhalothrin + Chlorantraniliprole)	5.0–10.0 oz	3A, 28	Cutworms, chinch bug, corn rootworm adults, corn earworm, European corn borer, fall armyworm, flea beetles, grasshoppers, lesser cornstalk borer, southwestern corn borer, sugarcane borer, true armyworm, western bean cutworm
Consero (Gamma-cyhalothrin + Spinosad)	2.0–3.05 oz	3A, 5	Chinch bug, corn earworm, corn rootworm adults, cutworms, European corn borer, fall armyworm, flea beetles, grasshoppers, lesser cornstalk borer, southwestern corn borer, stalk borer, true armyworm, western bean cutworm
Elevest (Chlorantraniliprole + Bifenthrin)	4.8–9.6 oz	3A, 28	Chinch bug, corn rootworm adults, cutworms, flea beetle, Banks grass mite and twospotted spider mite, corn earworm, fall armyworm, European corn borer, southwestern corn borer, sugarcane borer adults, armyworm species, true armyworm, western bean cutworm, grasshoppers
Hero (Bifenthrin + Zeta-cypermethrin)	2.6–10.3 oz	3A	Chinch bug, corn earworm, corn rootworm adults, cutworms, Banks grass mite, European corn borer, fall armyworm, flea beetles, grasshoppers, southwestern corn borer, true armyworm, twospotted spider mite, western bean cutworm, white grubs, wireworms
Intrepid Edge (Methoxyfenozide + spinetoram)	4.0–12.0 oz	18, 5	European corn borer, southwestern corn borer, true armyworm, western bean cutworm
Index (Chlorethoxyfos + Bifenthrin)	0.44–0.72 oz/1000 row ft	1B, 3A	Cutworm, corn rootworms, sugarcane beetle, white grub, wireworm
SmartChoice 5G and HC (Chlorethoxyfos + Bifenthrin)	3.0–5.0 (5G) or 1.0–1.76 (HC) oz/1000 row ft	1B, 3A	Corn rootworm larvae, cutworms, white grubs, wireworms

WHITE GRUBS: Insecticides for Chemical Control (Product mixes in separate table, seed treatments in separate table)				
Insecticide (Trade Names)	**Amount per 1000 Feet of Row[1]**	**PHI – Grain (Days)**	**IRAC Class**	**Liquid Fertilizer Approved[2]**
Bifenthrin				
(Brigade 2EC and others)	0.15–0.30 fl. oz	30	3A	Y
(Capture LFR)	0.20–0.78 fl. oz	30	3A	Y
(Capture 3RIVE 3D)	0.23–0.92 fl. oz		3A	SL
(Ethos XB)	0.2–0.98 fl. oz		3A	Y
Chlorethoxyfos			1B	
(Fortress 2.5G)	6.0–7.5 oz			NM
(Fortress 5G)	3.0–3.75 oz			NM
Gamma cyhalothrin (Proaxis, Declare)[3]	0.082–0.66 oz[3]	21	3A	SL
Lambda cyhalothrin (Warrior II)	0.33 oz	21	3A	SL
Tefluthrin			3A	
(Force 3G)	4.0–5.0 oz		3A	NM
(Force 6.5G)	1.8–2.3 oz		3A	NM
(Force EVO)	0.46–0.57 oz		3A	Y
Terbufos				
(Counter 15G)	6.0–8.0 oz		1B	NM
(Counter 20G)	4.5–6.0 oz		1B	NM

[1]Rates may vary with row spacing

[2]Y = Yes, SL = See label; some products allowed, NM = No mention of fertilizer addition on label.

[3]Rates vary by product

WIREWORMS: Insecticides for Chemical Control (Product mixes in separate table, seed treatments in separate table)				
Insecticide (Trade Names)	Amount per 1000 Feet of Row[1]	PHI – Grain (Days)	IRAC Class	Liquid Fertilizer Approved[2]
Beta cyfluthrin (Baythroid XL and others)	2.0–2.8 fl. oz	21	3A	Y
Bifenthrin				
(Brigade 2EC and others)	0.15–0.30 fl. oz	30	3A	Y
(Capture LFR)	0.20–0.78 fl. oz	30	3A	Y
(Capture 3RIVE 3D)	0.23–0.92 fl. oz		3A	SL
(Ethos XB)	0.2–0.98 fl. oz		3A	Y
Chlorethoxyfos			1B	
(Fortress 2.5G)	6.0–7.5 oz			NM
(Fortress 5G)	3.0–3.75 oz			NM
Permethrin				
(Pounce 1.5G)	8.0 oz		3A	NM
(Pounce 3.2 EC)	0.30 fl. oz	See label	3A	SL
Gamma cyhalothrin (Proaxis, Declare)[3]	0.041–0.66 oz[3]	21	3A	SL
Lambda cyhalothrin (Warrior II)	0.33 oz	21	3A	SL
Phorate (Thimet 20G)	4.5–6.0 oz		1B	NM
Tefluthrin				
(Force 3G)	4.0–5.0 oz		3A	NM
(Force 6.5G)	1.8–2.3 oz		3A	NM
(Force EVO)	0.46–0.57 oz		3A	Y
Terbufos				
(Counter 15G)	6.0–8.0 oz		1B	NM
(Counter 20G)	4.5–6.0 oz		1B	NM

[1]Rates may vary with row spacing

[2]Y = Yes, SL = See label; some products allowed, NM = No mention of fertilizer addition on label.

[3]Rates vary by product

Insecticides for control of WESTERN, MEXICAN, and SOUTHERN CORN ROOTWORM Suggested on-farm seed treatments for control of MEXICAN and WESTERN CORN ROOTWORM. These are products that can be added on-farm. Most commercial hybrid seed is pre-treated, perhaps with products not listed here.		
Product	Application Rate	IRAC Group
Clothianidin (Poncho 600)	For Poncho 600, apply 1.25 mg ai/seed or 5.64 fl. oz per 80,000 unit of seed.	4A
Imidacloprid (Gaucho 600)	For Gaucho 600 apply 1.34 mg ai/seed or 6.0 oz per 80,000 unit of seed.	4A
Thiamethoxam (Cruiser 5FS)	Apply 1.25 mg of active ingredient per kernel. Each fluid ounce contains 17.7 grams of active ingredient.	4A

Note that seed treatments are insufficient to control heavy rootworm populations.

Suggested granular and liquid insecticides for control of MEXICAN CORN ROOTWORM (MCR), WESTERN CORN ROOTWORM (WCR), and SOUTHERN CORN ROOTWORM (SCR) larvae				
Rootworm Species[1]	**Insecticide (Trade Names)**	**Amount per 1000 Feet of Row[2]**	**IRAC Class**	**Liquid Fertilizer Approved[3]**
WCR, SCR	Bifenthrin	0.30 fl. oz	3A	
	(Brigade 2EC and others)	0.30 fl. oz	3A	Y
WCR, SCR	(Capture LFR)	0.39–0.98 fl. oz	3A	Y
WCR, SCR	(Capture 3RIVE 3D)	0.46–0.92 oz	3A	SL
WCR, SCR	(Ethos XB)	See label	3A	Y
	Chlorethoxyfos		1B	
WCR, SCR	(Fortress 2.5G)	7.5–9.0 oz		NM
WCR, SCR	(Fortress 5G)	3.0–4.5 oz		NM
MCR, WCR, SCR	Gamma-cyhalothrin (Proaxis, Declare)[4]	0.26–0.66 fl. oz	3A	SL
MCR, WCR, SCR	Lambda-cyhalothrin (Warrior II)	0.33 fl. oz	3A	SL
MCR, WCR, SCR	Phorate (or Thimet 20G)	4.5–6.0 oz	1B	NM
	Tefluthrin		3A	
MCR, WCR, SCR	(Force 3G)	4.0–5.0 oz	3A	NM
MCR, WCR, SCR	(Force 6.5G)	1.8–2.3 oz	3A	NM
MCR, WCR, SCR	(Force EVO)	0.46–0.57 oz	3A	Y
	Terbufos			
MCR, WCR, SCR	(Counter 15G)	6.0–8.0 oz	1B	NM
MCR, WCR, SCR	(Counter 20G)	4.5–6.0 oz	1B	NM

[1]MCR = Mexican corn rootworm, WCR = western corn rootworm, SCR = southern corn rootworm

[2]Rates may vary with row spacing

[3]Y = Yes, SL = See label; some products allowed, NM = No mention of fertilizer addition on label

[4]Rates vary by product

Insecticides for management of SUGARCANE BEETLE in corn			
Product	**Application technique**	**Rate**	**Effectiveness**
Clothianidin (Poncho 600)	 Seed treatment Seed treatment Seed treatment	 0.25 mg ai/seed 0.50 mg ai/seed 1.25 mg ai/seed	 Poor Fair Good
Thiamethoxam (Cruiser 5FS)	Seed treatment Seed treatment Seed treatment	0.25 mg ai/seed 0.50 mg ai/seed 1.25 mg ai/seed	Poor Poor Poor/Fair
Bifenthrin (Ethos XB) (Capture 3RIVE)	In-furrow spray In-furrow or T-band In-furrow foam	70 g ai/ha 13.4–17 oz/acre 4. 0–16.0 oz/acre	Good Good Good
Bifenthrin + Poncho 600	In-furrow spray + seed treatment	70 g ai/ha + 0.25–1.25 mg ai/seed	Excellent
Bifenthrin + Cruiser 5FS	In-furrow spray + seed treatment	70 g ai/ha + 1.25 mg ai/seed	Good/Excellent

Other soil-applied corn insecticides that enhance control of seed treatments Clothianidin seed treatment at 0.50–1.25 mg-ai/seed with:			
Product	**Application technique**	**Rate**	**Effectiveness**
Terbufos (Counter 15G or 20G)	In-furrow/T-band granule	15G: 6.0–8.0 oz 20G: 4.5–6.0 oz	Fair

Literature cited:
Smith, T.P, J.M. Beuzelin, A.L. Catchot, A.C. Murillo, and D.L. Kerns. 2015. Biology, ecology, and management of the sugarcane beetle (Coleoptera: Scarabaeidae) in sweetpotato and corn. Journal of Integrated Pest Management 6 (1): 13.

CUTWORMS: Insecticides for Chemical Control (Product mixes in separate table, seed treatments in separate table)				
Insecticide (Trade Name)	Product Rate/Acre	PHI – Grain (Days)	IRAC Class	Liquid Fertilizer APPROVED[1]
Alpha-cypermethrin (Fastac EC)	1.3–2.8 oz	30	3A	SL
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A	Y
Bifenthrin (Brigade 2EC and others)	2.1–6.4 oz	30	3A	Y
Chlorantraniliprole (Vantacor)	1.7–2.5 oz	14	28	SL
Chlorethoxyfos			1B	
(Fortress 2.5G)	6.0–7.5 oz/1000 row ft	See label		NM
(Fortress 5G)	3.0–3.75 oz/1000 row ft	See label		NM
Deltamethrin (Delta Gold)	1.0–1.5 oz	21	3	NM
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A	SL
Gamma-cyhalothrin (Proaxis, Declare)[2]	0.77–3.2 oz[2]	21	3A	SL
Lambda-cyhalothrin (Warrior II)	0.96–1.60 oz	21	3A	SL
Permethrin				
(Ambush)	6.4–12.8 oz	30	3A	
(Pounce 3.2EC and others)	4.0–6.0 oz	30	3A	SL
(Pounce 1.5G)	6.7–10.0 lb	30	3A	NM
(Pounce 25 WP)	6.4–9.6 oz	30	3A	NM
Tefluthrin			3A	
(Force 3G)	4–5 oz/1000 row ft	NA		NM
(Force EVO)	0.46–0.57 oz/1000 row ft	NA		Y
Zeta-cypermethrin (Mustang Maxx and others)	1.28–2.8 oz	7	3A	SL

[1]Y = Yes, SL = See label; some products allowed, NM = No mention of fertilizer addition on label.

[2]Rates vary by product

LESSER CORNSTALK BORER: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Alpha-cypermethrin (Fastac EC)	2.7–3.8 oz	30	3A
Gamma cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Tefluthrin	0.46–0.57 oz/1000 row ft		3A
(Force Evo)	0.46–0.57 oz/1000 row ft		3A
(Force 3G)	4–5 oz/1000 row ft		3A
(Force 6.5G)	1.8–2.3 oz/1000 row ft		3A
Lambda-cyhalothrin (Warrior II and others)	1.28–1.92 oz	21	3A
Permethrin			
(Pounce 3.2EC and others)	4.0–8.0 oz	30	3A
(Pounce 25 WP)	6.4–9.6 oz	30	3A

[1]Rates vary by product

FLEA BEETLES: Insecticides for Chemical Control (Product mixes in separate table, seed treatments in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Alpha-cypermethrin (Fastac EC)	2.7–3.8 oz	30	3A
Beta-cyfluthrin (Baythroid XL and others)	0.8–1.6 oz	21	3A
Bifenthrin (Brigade 2EC and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Deltamethrin (Delta Gold)	1.0–1.5 oz	21	3
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Methomyl (Lannate LV)	0.75–1.5 pt	21	1A
Permethrin			
(Ambush)	6.4–12.8 oz	30	3A
(Arctic 3.2EC)	4.0–6.0 oz	30	3A
Zeta-cypermethrin (Mustang Maxx and others)	2.72–4.0 oz	7	3A

[1]Rates vary by product

CHINCH BUGS: Insecticides for Chemical Control (Product mixes in separate table, seed treatments in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin 2EC (Brigade and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Deltamethrin (Delta Gold)	1.5–1.9 oz	21	3
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.54–3.84 oz[1]	21	3A
Lambda-cyhalothrin (Warrior II)	1.92 oz	21	3A
Zeta-cypermethrin (Mustang Maxx and others)	3.2–4.0 oz	7	3A

[1]Rates vary by product

SOUTHWESTERN CORN BORER: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	Product Rate/Acre (Unless Specified)	PHI – Grain (Days)	IRAC Class
Alpha-cypermethrin (Fastac EC)	2.7–3.8 oz	30	3A
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin (Brigade 2EC and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Chlorantraniliprole (Vantacor)	1.2–2.5 oz	14	28
Deltamethrin (Delta Gold)	1.5–1.9 oz	21	3
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Methoxyfenozide (Intrepid 2F)	4.0–16.0 oz	21	18
Permethrin (Ambush) (Arctic 3.2EC and others) (Pounce 1.5G) (Pounce 3.2EC and others) (Pounce 25 WP)	 6.4–12.8 oz 4.0–6.0 oz 6.7–10.0 lb 4.0–8.0 oz 6.4–9.6 oz	 30 30 30 30 30	 3A 3A 3A 3A 3A
Spinosad (Blackhawk)	2.2–3.3 oz	28	5
Spinetoram (Radiant SC)	3.0–6.0 oz	28	5
Zeta-cypermethrin (Mustang Maxx and others)	2.72–4.0 oz	7	3A
[1]Rates vary by product			

EUROPEAN CORN BORER: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre**	**PHI – Grain (Days)**	**IRAC Class**
Alpha-cypermethrin (Fastac EC)	2.7–3.8 oz	30	3A
Bacillus thuringiensis (Dipel ES)	1.5–2.5 pt	0	11A
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin (Brigade 2EC and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.5–2.0 qt	48	1A
Chlorantraniliprole (Vantacor)	1.2–2.5 oz	14	28
Deltamethrin (Delta Gold)	1.5–1.9 oz	21	3
Esfenvalerate (Asana XL 0.66E)	7.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Methomyl (Lannate LV)	0.75–1.5 pt	21	1A
Methoxyfenozide (Intrepid 2F)	4.0–16.0 oz	21	18
Permethrin (Ambush) (Arctic 3.2EC and others) (Pounce 1.5G) (Pounce 3.2EC and others) (Pounce 25 WP)	 6.4–12.8 oz 4.0–6.0 oz 6.7–10.0 lb 4.0–8.0 oz 6.4–9.6 oz	 30 30 30 30 30	 3A 3A 3A 3A 3A
Spinosad (Blackhawk)	1.67–3.3 oz	28	5
Spinetoram (Radiant SC)	3.0–6.0 oz	28	5
Zeta-cypermethrin (Mustang Maxx and others)	2.72–4.0 oz	7	3A

[1]Rates vary by product

Miticides for Control of TWOSPOTTED SPIDER MITE			
Miticides (listed alphabetically)	Amount per Acre	PHI Harvest	IRAC Class
Dimethoate (Not labeled for Trans-Pecos area)			
(Dimethoate 4E and others)	0.66–1.0 pt	28	1B
(Dimethoate 5 lb)	8.4–12.8 oz	28	1B
(Dimethoate 400 EC)	0.6–1.0 pt	28	1B
Etoxazole (Zeal)	1.5–3.0 oz	21	10B
Fenpyroximate			
(Portal)	1.5–2.0 pt	14	21A
(Portal XLO)	2.0 pt	14	21A
Hexythiazox (Onager 1E)	12–24 oz	30	10A
Propargite (Comite II 6 lb)	Early: 18.0 oz Later: 36–54 oz	30	12C
Spiromesifen (Oberon 4SC)	2.85–8.0 oz	20	23
Sulfur (6.0 lb. flowable)	6.0 qt	0	none

Miticides for Control of BANKS GRASS MITE			
Miticides (listed alphabetically)	Amount per Acre	PHI Harvest	IRAC Class
Dimethoate (Not labeled for Trans-Pecos area)			
(Dimethoate 4E and others)	0.66–1.0 pt	28	1B
(Dimethoate 5 lb)	8.4–12.8 oz	28	1B
(Dimethoate 400 EC)	0.6–1.0 pt	28	1B
Etoxazole (Zeal)	1.5–3.0 oz	21	10B
Fenpyroximate			
(Portal)	2.0 pt	14	21A
(Portal XLO)	2.0 pt	14	21A
Hexythiazox (Onager 1E)	12.0–16.0 oz	30	10A
Propargite (Comite II 6 lb)	Early: 18.0 oz Later: 36–54 oz	30	12C
Spiromesifen (Oberon 4SC)	2.85–8.0 oz	20	23
Sulfur (6.0 lb flowable)	6.0 qt	0	none

ADULT CORN ROOTWORM BEETLES: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Malathion (Fyfanon ULV 9.9 lb)	4.0–8.0 oz	5	1B
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin 2EC (Brigade and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Deltamethrin (Delta Gold)	1.5–1.9 oz	21	3
Dimethoate 4E and others	0.66–1.0 pt	28 grain	1B
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Methomyl (Lannate LV)	0.75–1.5 pt	21	1A
Permethrin (Ambush) (Arctic 3.2EC and others) (Pounce 3.2EC) (Pounce 25 WP)	 6.4–12.8 oz 4.0–6.0 oz 4.0–8.0 oz 6.4–9.6 oz	 30 30 30 30	 3A 3A 3A 3A
Zeta-cypermethrin (Mustang Maxx and others)	2.72–4.0 oz	7	3A
[1]Rates vary by product			

CORN EARWORM and FALL ARMYWORM: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Chlorantraniliprole (Vantacor)	1.2–2.5 oz	14	28
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Spinosad (Blackhawk 36% WDG)	1.67–3.3 oz	28	5
Spinetoram (Radiant SC)	3.0–6.0 oz	28	5
[1]Rates vary by product			

TRUE ARMYWORM: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Alpha-cypermethrin (Fastac EC)	3.2–3.8 oz	30	3A
Bacillus thuringiensis (Dipel ES)	1.5–2.5 pt	0	—
Beta cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin 2EC (Brigade 2 EC and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Chlorantraniliprole (Vantacor)	1.2–2.5 oz	14	28
Deltamethrin (Delta Gold)	1.5–1.9 oz	21	3
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Methomyl (Lannate LV)	0.75–1.5 pt	Varies	1A
Methoxyfenozide (Intrepid 2F)	4.0–16.0 oz	21	18
Permethrin			
(Ambush)	6.4–12.8 oz	30	3A
(Arctic 3.2EC and others)	4.0–6.0 oz	30	3A
(Pounce 3.2EC and others)	4.0–8.0 oz	30	3A
(Pounce 1.5G)	6.7–10.0 lb	30	3A
(Pounce 25 WP)	6.4–9.6 oz	30	3A
Spinosad (Blackhawk)	1.67–3.3 oz	28	5
Spinetoram (Radiant SC)	3.0–6.0 oz	28	5
Zeta-cypermethrin (Mustang Maxx and others)	3.2–4.0 oz	7	3A

[1]Rates vary by product

WESTERN BEAN CUTWORM: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	Product Rate/Acre	PHI – Grain (Days)	IRAC Class
Alpha-cypermethrin (Fastac EC)	1.8–3.8 oz	30	3A
Beta-cyfluthrin (Baythroid XL and others)	1.6–2.8 oz	21	3A
Bifenthrin 2EC (Brigade and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	2.0 qt	48	1A
Chlorantraniliprole (Vantacor)	0.87 oz	14	28
Deltamethrin (Delta Gold)	1.0–1.5 oz	21	3
Esfenvalerate (Asana XL 0.66E)	2.90–5.8 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	0.77[1]–3.2 oz	21	3A
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Lambda-cyhalothrin (Warrior II)	0.96–1.6 oz	21	3A
Methoxyfenozide (Intrepid 2F)	4.0–16.0 oz	21	18
Permethrin			
(Ambush)	3.2–6.4 oz	30	3
(Arctic 3.2EC and others)	2.0–4.0 oz	30	3
(Pounce 3.2EC and others)	2.0–4.0 oz	30	3A
(Pounce 25 WP)	3.2–6.4 oz	30	3A
Spinosad (Blackhawk)	2.2–3.3 oz	28	5
Spinetoram (Radiant SC)	3.0–6.0 oz	28	5
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Zeta-cypermethrin (Mustang Maxx and others)	1.76–4.0 oz	7	3A

[1]Rates vary by product

GRASSHOPPERS: Insecticides for Chemical Control (Product mixes in separate table)			
Insecticide (Trade Names)	**Product Rate/Acre (Unless Specified)**	**PHI – Grain (Days)**	**IRAC Class**
Alpha-cypermethrin (Fastac EC)	2.7–3.8 oz	30	3A
Beta-cyfluthrin (Baythroid XL and others)	2.1–2.8 oz	21	3A
Bifenthrin 2EC (Brigade and others)	2.1–6.4 oz	30	3A
Carbaryl (Sevin XLR Plus 4 lb)	1.0–2.0 qt	48	1A
Chlorantraniliprole (Vantacor)	0.7–1.7 oz	14	28
Deltamethrin (Delta Gold)	1.0–1.5 oz	21	3
Dimethoate (Not labeled for Trans-Pecos area)			
(Dimethoate 4E)	1.0 pt	28	1B
(Dimethoate 5 lb)	12.8 oz	28	1B
(Dimethoate 400 EC)	1.0 pt	28	1B
Esfenvalerate (Asana XL 0.66E)	5.8–9.6 oz	21	3A
Gamma-cyhalothrin (Proaxis, Declare)[1]	1.02–3.84 oz[1]	21	3A
Indoxacarb (Steward EC)	6.0–11.3 oz	14	22
Lambda-cyhalothrin (Warrior II)	1.28–1.92 oz	21	3A
Malathion (Fyfanon ULV 9.9 lb)	4.0–8.0 oz	5	1B
Zeta-cypermethrin (Mustang Maxx and others)	2.72–4.0 oz	7	3A

[1]Rates vary by product

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Texas A&M AgriLife Extension Service is implied.

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