

Best Management Practices for Colorado Corn

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Insect Pests

A number of insect pests cost Colorado corn producers millions of dollars each year in lost yields and control measures. Essential to sound management decisions is proper identification of the insect pest, field scouting to determine insect population density and growth stage, and knowledge of management options. Scout fields more efficiently by knowing insect life cycles, environmental conditions favoring pest outbreaks, areas of the farm most susceptible to insect pressures, and corn growth stages most susceptible to insect damage.

Table 4. Corn insect activity according to corn growth stage.

Attacks the seed

Seedcorn maggot
Wireworm

Seedcorn beetle*
White grub*

Attacks seedlings - germination to 4 leaf stage (V4)

Dingy cutworm
Seedcorn maggot
Wireworm

Alfalfa webworm*
Flea beetles*
Pale western cutworm*
Thrips*
Variegated cutworm*
White grub*

Attacks roots - 4 leaf (V4) to 12 leaf stage (V12)

Western corn rootworm larvae

Attacks 5 leaf (V5) to silk (R1)

leaf feeding

Banks grass mite
European corn borer
(1st generation)

stalk feeding

European corn borer
Southwestern corn borer

tassel/silk feeding

Corn blotch leafminer*
Corn earworm*
Corn leaf aphid*
Fall armyworm*
Grasshoppers*

Corn leaf aphid*
Northern corn rootworm*
Western bean cutworm *
Western corn rootworm beetles*

Attacks silking (R1) to maturity

leaf feeding

Banks grass mite
European corn borer
(2nd generation)
Two-spotted spider mites

stalk feeding

Southwestern corn borer
European corn borer
(2nd generation)

ear/silk feeding

Corn earworm
European corn borer
(2nd generation)
Southwestern corn borer
Western bean cutworm

Armyworm*
Corn blotch leafminer*
Corn leaf aphid*
Grasshoppers*
Northern corn rootworm beetles*
Western corn rootworm beetles*

Fall armyworm*
Grasshoppers*
Western corn rootworm beetles*

Dryland considerations

Three insect pests commonly cause economic damage to non-irrigated corn in Colorado. These are the corn earworm, the southwestern corn borer and the western bean cutworm (see pages 33, 37, 38).

Insect pests that can attack dryland corn, but rarely at levels justifying control, are Banks grass mite and pale western cutworm. Western corn rootworm can cause damage in dryland corn, but is effectively controlled through rotation.

Chemical control guidelines can be found in the High Plains IPM Guide - CSU Cooperative Extension Bulletin 564A or on the web at www.highplainsipm.org.

*Economic levels of damage occur sporadically or in isolated areas.

Insects



Seedcorn maggot symptoms: Damaged corn seeds, seedlings, or the surrounding soil may contain small (0.25 inch) yellow or white larvae of seedcorn maggots.

Photo Ken Gray Collection, Entomology Department, Oregon State University

BMP

Destroy alternate pest breeding sites and hosts during the off-season and at off-site locations to interrupt life cycle so that potential recurrences are reduced.



Wireworms cause poor stands by boring into seeds before or during germination, killing seedlings before they emerge. Yellow to reddish larvae may also tunnel into roots and stalks of corn plants.

Top photo F. B. Peairs
Bottom photo Ken Gray Collection, Entomology Department, Oregon State University

Seedcorn maggot (*Delia platura*)

Size:

Larvae: 0.25 inch long

Description:

Maggots are yellow white and tapered. Adults are small flies.

Life cycle:

Maggots feed on a corn seed kernel resulting in weak plants or no germination. Feeding occurs 2 to 3 weeks before pupating into one-fifth inch adult flies. In early spring, a large amount of organic matter and decaying vegetation attracts egg laying female flies. Cool and damp soils can delay germination and extend the seed's vulnerable period. Scout where there is poor emergence, gaps or skips. If there is extensive damage, consider options such as replanting.

Management:

Use insecticidal seed treatments if a soil insecticide is not used for other soil pest problems.

Wireworm (several species)

Size:

Larvae: 0.5 to 1 inch long

Description:

Hard-shelled and yellow brown, however, early larvae are small and white. Adult beetles are brown to black, elongate and tapered at each end.

Life cycle:

Larvae can take from 2 to 5 years to mature. Wireworms pupate in the soil and emerged adults remain in soil until spring. Larvae feed on germinating corn seed and seedlings, and may eventually bore into stalk.

Management:

Insecticidal seed treatments are effective against moderate wireworm infestations. Conventional soil insecticide applications may be required to protect seedlings from heavy infestation.

Western corn rootworm (*Diabrotica virgifera virgifera*)

Size:

Larvae: 0.5 inch

Adult: 0.25 inch

Description and life cycle:

Slender, white larvae with brown heads and a dark plate on the top side at its end. Western corn rootworm eggs overwinter in the soil and hatch in late spring, moving to nearby corn root hairs and small roots to feed. By July, larvae pupate and emerge as beetles with black and yellow striped wings. Adults feed on silks.

Corn rootworms (a complex of four species in the genus *Diabrotica*) are among the most serious pests of corn in the U.S. In Colorado, the western corn rootworm is an important pest on medium to heavy textured soils throughout the state, whereas the northern corn rootworm and the southern corn rootworm occur less often. Root feeding by these insects weakens root systems, thereby reducing yield and making plants more likely to lodge. The national economic impact of corn rootworm is estimated at \$1 billion annually, which includes yield losses and the cost of control measures.

Management:

Corn growers currently use four strategies for limiting rootworm damage: crop rotation, application of soil insecticides at planting, post emergence larval insecticide treatments (granular, chemigation, aerial) and spraying insecticides midseason to control adult rootworm beetles to prevent egg laying, and thus reduce rootworm damage the following season. However, each approach has limitations. In some growing areas in the midwest U.S., northern and western rootworms have adapted to rotational practices, rendering that strategy less effective. Soil insecticides are estimated to be applied on 25% of the U.S. and the Colorado corn crop.

Corn growers may have another option for controlling rootworms in 2003: genetically engineered Bt corn targeted specifically to these pests. Like Bt corn for control of the European corn borer, which has been grown since the mid-1990's, the new hybrids incorporate genes from the soil bacterium *Bacillus thuringiensis* that produce insecticidal proteins. Rootworms are killed after feeding on roots of engineered plants, but before the insect causes significant damage.



The western corn rootworm is one of the most serious pests of corn in Colorado. Continuous corn fields that were not scouted for adults during the previous growing season should be protected with an at-planting or at-cultivation insecticide.

Top photo J.L. Capinera
Middle and bottom photo F.B. Peairs

BMP

Scout crop fields at least weekly after insect infestations are first predicted or observed. Be sure pests are properly identified before control measures are employed.

Insects



Dingy cutworms feed mostly below the ground and most often cause problems in no-till or reduced till situations.

Photos J.L. Capinera



The pale western cutworm is a subterranean cutworm that attacks corn from very early spring through the end of June.

Photos J.L. Capinera

BMP

Avoid repetitive use of the same pesticide or pesticides of similar chemistry, to reduce the potential for pesticide resistance development and pest spectrum shifts.

Dingy cutworm (*Feltia ducens*)

Size:

Larvae: 1 to 1.25 inches long

Description:

Larvae are brown and mottled with a broad gray stripe with lighter V-shapes at each segment. Adults are brown with bean-shaped markings.

Life cycle:

Dingy cutworms overwinter as larvae and begin feeding in spring on early leaves or may cut off plants at or below soil surface. Found in fields with residue.

Management:

Consider chemical control if 1 in 20 (5%) plants are damaged and cutworms are present.

Pale western cutworm (*Agrotis orthogonia*)

Size:

Larvae: 1 inch long

Description:

Larvae is grayish white with two brown bars on the front of the head.

Life cycle:

Larvae live under the soil surface and prefer loose, dry soils. Outbreaks usually occur after several consecutive dry springs – ones that receive less than 10 days of at least 0.25 inch of rain. More rain and wetter soils drive the cutworms to the surface, exposing them to predators and parasitism. Mature larvae burrow into pupal chambers in the soil and emerge as moths in late July. Cutworm larvae feed on small seedlings below ground or enter older plants causing death at the growing point. Infestation in corn is most common following sod, alfalfa or small grains.

Management:

Because outbreaks are sporadic, treatment is limited to pesticides, making early detection critical. Consider chemical control if 1 in 20 (5%) plants are damaged and cutworms are present. Soil crusting can reduce treatment effectiveness.

Variegated cutworm (*Peridroma saucia*)

Size:

Larvae: 1.5 to 1.75 inches long

Description:

Larvae are gray to dark brown with a row of yellow spots along the back and a broad orange stripe along each side. Most have a dark W-shape on abdomen's tip. Adult moths have light tan forewings with black marks and two, pale eye-like markings on the middle of each forewing. Hind wings are silver-white.

Life cycle:

Pupae over winter to emerge as adults in spring. Moths lay eggs in clusters on dead twigs, plant stems and leaves. Eggs hatch in four to nine days and larvae feed up to 40 days. Once mature, larvae pupate and overwinter in soil. Cutworms feed on leaves at night and may feed on ear silk and tips. Defoliation indicates its presence.

Management:

The variegated cutworm is seldom a serious pest in field corn in Colorado.

Corn earworm (*Helicoverpa zea*)

Size:

Larvae: 1.5 to 2 inches long

Description:

Larvae varies from yellow, pink, green or black. Covered with micro spines, the body is marked with alternating light to dark stripes. Always a yellow-brown head capsule. Adults are a buff to grayish brown one and a half-inch moth.

Life cycle:

Single, off white eggs are laid in spring. First generation larvae feed on corn whorls in early summer, giving a ragged appearance. Serious early season infestations are rare. Corn earworms are migratory, causing infestation timing and generation numbers to vary. However, most problems in field corn occur after silking when moths deposit eggs on silk, which larvae feed on. Older larvae bore through to the ear and feed on the tip. Feeding on tip causes loss not only by earworms, but opens a channel for birds and pathogens.

Management:

Non-chemical control includes predacious insects including lady bird beetles and parasitic wasps and diseases such as *Bacillus thuringiensis* bacteria and *Heliothis polyhedrosis* virus.

Chemical treatment is rarely economically practical in field corn, but Bt (*Bacillus thuringiensis*) hybrids offer some control.



Variegated cutworms feed at night on the foliage of young corn and may eat the center of the stem down to 2-3 inches below the soil surface.

Photo J.L. Capinera

BMP

Protect naturally occurring pest control organisms by using insecticides that are less toxic to beneficial insects and pollinators.



Chemical treatment for earworm is rarely economical in field corn but sweet corn growers must control this pest to satisfy consumer demands.

Photo J.L. Capinera

Insects



Insecticides directed against other corn pests can cause spider mite outbreaks, especially during hot, dry years. In fields where economic levels of mite infestations are anticipated, preventative miticide application is often the only reliable control strategy. See the High Plains IPM Guide for chemical specific recommendations.

Photo F.B. Peairs

Banks grass mite (*Oligonychus pratensis*)

Size:

Barely visible, approximately 0.02 inch.

Description:

Banks grass mites (BGM) have a greenish round body with eight legs and overwintering females are bright orange.

Life cycle:

Fertilized females overwinter in winter wheat and other grasses, and either walk or get windblown into corn. Mites feed and damage plants by piercing plant cells with mouthparts to draw out juices.

Management:

First indication of infestation is discolored leaves with webbing from the bottom of the plant upwards. Preserving naturally occurring spider mite predators by avoiding broad spectrum pesticides is critical to proper management of spider mite problems in corn. The simple guideline for reactive chemical treatment is to treat if damage is visible in the lower one-third of the plant and mite colonies are present on the lower two-thirds of the plant.

Table 5. Banks grass mite economic threshold for reactive treatments.

Control Cost \$/A	----- Market Value - \$/A -----				
	350	400	450	500	550
	-----%infested leaves/%leaf area damaged-----				
\$10	17/9	15/8	13/7	12/6	11/6
\$15	25/13	22/12	20/10	18/9	16/9
\$20	34/18	29/16	26/14	24/13/	21/11
\$25	42/22	37/20	33/17	29/16	27/14

Source: Archer, T., Bynum, E., Texas A&M

An alternative method for determining the need for control of BGM in grain corn is based on total infested leaves and a total percentage of damaged leaf area. After calculating the percentage of infested leaves, look at the position in the Table 5 corresponding to the expected control cost and crop market value per acre. If the percent infested leaves is greater than the value given in Table 5 determine the percent leaf surface showing mite feeding damage. If this value exceeds the second value in the table, then a miticide treatment should be cost-effective. If the mites build up early and hot, dry weather persists, a second application may be necessary.



Two-spotted spider mite infestation

Photo F.B. Peairs

Two-spotted spider mite (*Tetranychus urticae*)

Size:

Barely visible, less than 0.02 inches.

Description:

Eight-legged, greenish with two darker regions on either side of abdomen.

Life cycle:

Life cycle from egg to adult as short as six days in temperatures greater than 80°F and less than 50% relative humidity.

Management:

Identify by webbing on plant and early damage of yellow spots on top of leaves. Advanced damage includes drying up of leaf tips, margins and leaves. Mites prefer hot, dry weather, so properly irrigate to avoid drought stress. Predatory insects include the predatory mite *Amblyseius fallacies* and the black lady bird *Stethorus*. Use similar treatment guidelines as for BGM.

Corn leaf aphid (*Rhopalosiphum maidis*)

Size:

From 0.06 - 0.10 inch

Description:

Aphids are bluish green and wingless, with short antennae and purple patches on the base of prominent cornicles. Aphids begin feeding in whorls, spread to upper leaves and tassel.

Management:

Usually cause little physical damage but are vectors for barley yellow dwarf and maize dwarf mosaic virus. Aphid's excreted honeydew can cause mold growth.

Non-chemical control includes predacious insects like lady bird beetles and parasitic wasps. Chemical treatment is rarely needed due to the effectiveness of predator control, however heavy infestations on tassels have been reported to affect pollination and some research data have indicated reduced yields.

Fall armyworm (*Spodoptera frugiperda*)

Size:

Larvae: 1.5 inches long

Description:

Larvae can vary from light tan or green to almost black with a white inverted Y on the front of the head. They have three cream-colored stripes running down back with a wider dark stripe and wavy yellow-red stripe on each side. Adults have dark and light gray forewings mottled with light and dark spots. Hind wings are grayish to pinkish-white.

Feeding:

While fall armyworms feed on corn in all growth stages, they mainly feed late season in ears. They feed during the day and night, but are most active in the morning or late afternoon.

Management:

Several insecticides are available to treat heavy infestations of fall armyworm. A new Bt event has shown effectiveness against fall armyworm.

BMP

Follow all label directions for storing and mixing agricultural chemicals and for disposing of empty containers.

Purchase the correct amount of product needed and return unopened containers for credit. Whenever available, use mini-bulks or small-volume refillable containers to avoid container waste.

Provide worker safety features such as gloves, showers, protective clothing, fire extinguishers and spill cleanup kits.



Corn leaf aphids can complete 10 generations per year and may build up to heavy populations on tassels and leaves. Other aphids seen on corn include bird cherry-oat aphid, greenbug, and corn root aphid.

Photos F.B. Peairs



Fall armyworms are dark, irregularly striped caterpillars that migrate from the south into Colorado every year and usually are not a problem until the latter part of the growing season.

Photo F.B. Peairs



ECB egg mass



European corn borer is a significant pest in eastern Colorado, mostly in sprinkler irrigated corn in the northeast. Treatment for ECB should be considered when 25% of plants are infested with egg masses or larvae. After pollination, this percentage should be raised to at least 50% infestation to justify chemical treatment.

Top two photos F.B. Peairs
Bottom photo S.D. Pilcher

European corn borer (*Ostrinia nubilalis*)

Size:

Larvae: 1 inch long

Description:

Larvae are cream to pinkish with small round brown spots. Adults have buff-colored forewings with darker, wavy lines running across wings. Males are noticeably darker and less yellow than females.

Life cycle:

European corn borers (ECB) have two generations each year.

First generation: Overwintering larvae emerge as moths in late May to early June. These moths lay masses of 15 to 30 eggs on corn leaf undersides, near the midrib. This generation emerges as moths in mid-July to early August and lay eggs for the second generation.

Second generation: Larvae feed on leaves near hatching site and move on to whorls and leaf sheaths - giving the shot hole appearance. Mature larvae bore into stalk and second generation larvae will feed on the ear. Look for dropped ears, broken shanks, corn stalk breakage, castings appearing like sawdust (frass) and holes in the stalks.

European corn borer tunneling and feeding causes physiological stresses to corn plants, reducing ear size, grain quality and yield. Other consequences of ECB damage include stalk breakage, ear drop and poor harvestability.

Management:

Research has also shown a close association between ECB damage and stalk rots such as fusarium and gibberella. If an insecticide is needed, treatment timing is critical and can be difficult. The insecticide should be applied after hatch, but before the larvae reach the stalk. That is not always easy to determine, since egg laying may last 3 to 4 weeks. Growers should begin scouting their fields after experts in the surrounding area predict that egg laying is 25% complete. Growers should repeat scouting every 3 to 5 days. Overall, it's a good idea to scout early and periodically for these problems to avoid surprises at harvest. Treatment for ECB is considered economical when 25% of plants have feeding damage or live larvae are present in whorls.

Non-chemical control: Early planted corn is more attractive to first generation egg-laying females, while second generation females are more attracted to late planted corn. Bt corn is effective against ECB in Colorado, see page 6 for guidelines. Fields with significant levels of stalk damage should be scheduled for early harvest.

Naturally occurring predators and parasites like lacewing larvae, wasps, lady bird beetle larvae and adults, feed on eggs and just hatched larvae. Pathogens include the fungus *Beauveria bassinia* and the protozoan *Nosema pyraustae*.

Grasshoppers

Pest species:

Melanoplus differentialis - differential grasshopper

Melanoplus sanguinipes - migratory grasshopper

Melanoplus bivittatus - two- striped grasshopper

Melanoplus femurrubrum - redlegged grasshopper

Camnula pellucida – clearwinged grasshopper

Life cycle:

Grasshopper eggs overwinter and hatch into nymphs in late May and early June. By August, nymphs are adults.

Management:

Chemical treatment may be justified if there are more than 20 nymphs per square yard in the field margins. Foliar applied insecticides are effective if corn is infested at economically damaging levels.

Southwestern corn borer (*Diatraea grandiosella*)

Size:

Larvae: 1 to 1.25 inches long

Description:

Larvae is dull white with dark spots in a regular pattern along the body. Spots are not found on overwintering southwestern corn borers. Adult moths are about .75 inches long and are pale yellow.

Life cycle:

There are two to three generations a year. In spring, overwintering larvae pupate and emerge in about 10 days. The new moth lays eggs for the first generation. The first generation of larvae feeds on the growing point of a new plant causing “dead heart”, the second generation burrows into the stalk, girdling the inside a few inches above soil. The girdling causes lodging. The overwintering larvae then burrows in the stalk below ground.

Management:

Early maturing varieties, crop rotation and early planting may reduce second generation damage. Stalk destruction by chopping or tillage in fall and winter helps to mitigate first generation damage, but only if practiced area wide. Chemical control is economically justified when 25% of plants have egg masses or new larvae. Bt corn hybrids can be effective in managing SWCB.

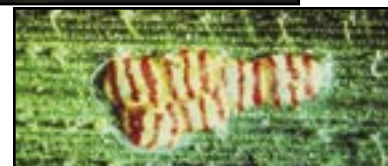
Dryland considerations

Southwestern corn borer problems can be controlled by Bt hybrids.



A number of different grasshopper species may attack corn in Colorado when warm, dry weather favors rapid development.

Top four photos J.L. Capinera
Bottom photo W.S. Cranshaw



SWCB egg mass

The southwestern corn borer is found in southeast Colorado, rarely occurring as far north as Burlington. White larvae with distinct black spots girdles lower stalk in fall causing lodging at harvest.

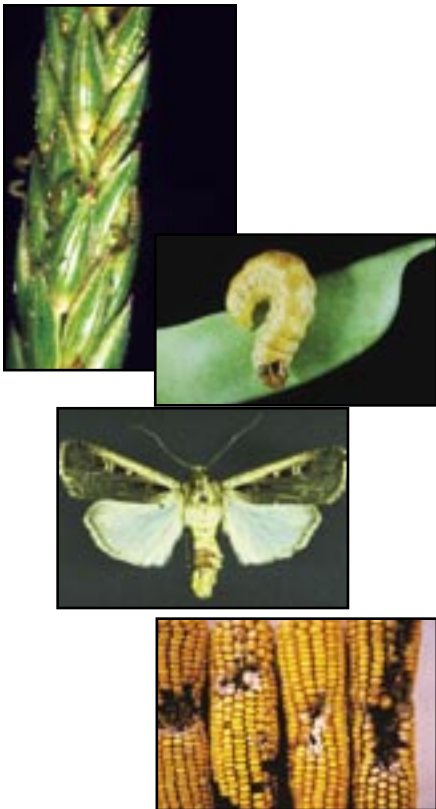
Top photo J.L. Capinera
Middle photo F.B. Peairs
Bottom photo W.M. Hantsbarger

Insects



Armyworm outbreaks occur only occasionally because they have many natural enemies that usually prevent the development of economically significant infestations.

Photo J.L. Capinera



Western bean cutworm prefers ear tips in corn and may tunnel through husks to reach the ear. It has become a serious pest of dryland and irrigated field corn in northeastern Colorado.

Top photo F.B. Peairs
Second photo J.L. Capinera
Third photo J.L. Capinera
Bottom photo R.L. Croissant

Armyworm (*Pseudaletia unipuncta*)

Size:

Larvae: 1 to 1.5 inches long

Description:

Larvae is smooth, dark gray to greenish black with five, length-wise stripes. Head has net-like markings.

Life cycle:

Adult moths lay eggs on lower leaves of grass crops and may have one or more generations per year. Armyworms hide from sunlight so feeding is at night or during cloud cover and feed mostly on lower leaves of grasses. Most damage occurs late into the season.

Management:

If the lower third of the plant is damaged before dent stage, consider chemical control.

Western bean cutworm (*Richia albicosta*)

Size:

Larvae: 1.5 inches long

Description:

Dark brown with faint diamond shape on back. Mature larvae have three dark stripes on the first segment behind head. Adult moths are approximately 0.75 inches long, brown with creamy white stripes on the leading edge of the wings. Hind wings are a light color.

Life cycle:

Mature larvae over winter in soil, pupate in spring and moths emerge in late June to mid-July. Eggs are in cluster of 4 to 200 on the tops of the upper corn leaves. Eggs start as white thinly-ringed in red, change to brown and then to purple-black just before hatching. This process takes about five to seven days. If corn is not tasseled, western bean cutworm feeds on pollen in the developing tassel. If corn is tasseled, the cutworm feeds on silk. Feeding on developed ears causes the most yield loss, up to 30% to 40%.

Management:

If more than 8% of the plants have egg masses and the crop is 95% tasseled, chemical control may be necessary. Spider mite outbreaks often follow chemical treatment.

Dryland considerations

Western bean cutworm is a silk feeding insect that can cause yield reductions up to 30 to 40%. Control is limited to insecticides. The number of plants infested to justify control has not been determined, but is probably about twice that of irrigated.