

Vegetable Insects

Department of Entomology

MANAGING INSECTS IN COMMERCIALY GROWN SWEET CORN

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Sweet corn may be attacked by pest insects from the time of planting until harvest. Insects will attack seeds, seedlings, roots, stalks, leaves, tassels, silks, and ears. Managing insects is one of the most critical aspects of producing a marketable sweet corn crop. Learning to recognize the pests and their damage, and knowing something about the insects' biology will be valuable when making management decisions. Most of the insects discussed in this bulletin will frequently cause minor damage and will occasionally cause serious damage.

CORN ROOTWORM LARVAE

Northern and western corn rootworm larvae damage corn by tunneling into roots, often pruning the roots back to the crown. This root damage reduces water and nutrient uptake and can cause the plants to be stunted. Severe damage can also result in plants falling over or lodging.

If sweet corn were planted in a field and a normal spray program was followed during silking, there should be little or no danger of rootworm damage the following year. Rootworm damage can also be avoided by delayed planting. Corn fields planted more than 5 days after rootworm egg hatch will be safe from larval feeding. The time of egg hatch varies greatly depending on temperature, but based on data from the last 10 years, corn planted June 21 or later would be safe from rootworm damage.

You can estimate the potential for rootworm damage next year by counting adult beetles in this year's field corn (see beetle photos on page 3). During the second or third week of August, count the number of beetles on 2 consecutive plants at 25 locations in the field. This should take less than an hour. If you find an average of fewer than 0.5 beetles per plant,

then the potential for damage during the following year is not very great. If the field were planted later than most fields in the area, count the rootworms again in 1 to 2 weeks. Rootworm beetles are more attracted to corn with fresh, green silks. If you find more than 0.5 beetles per plant on either scouting effort, then you should consider planting some other crop in that field or if the corn is going to be planted before June 21 or using a soil insecticide at planting.

Historically, western corn rootworm adults laid their eggs almost exclusively in corn fields, so that corn planted after any other crop was unlikely to suffer damage from the larvae. In recent years, a variant of the western corn rootworm has developed that will lay eggs in other crops, including soybeans, alfalfa, and vine crops. This variant is most common in the northern two thirds of Indiana, so growers in that area may have the potential for damage even if they rotate crops.

SEEDCORN MAGGOT

The seedcorn maggot is a pale, yellowish-white, legless maggot that reaches a length of 1/4 inch. The maggot burrows into the seed, often destroying the germ. Damaged seeds may not germinate or may produce weakened or sickly plants. The adult is a fly slightly smaller than a housefly. The female flies prefer to lay their eggs in cool, wet soils with high organic matter. Therefore, the likelihood for seedcorn maggot damage is increased in fields that had large amounts of manure applied, a cover crop plowed down, or reduced tillage.

Once seedcorn maggot damage is detected, the only choices are to either live with the reduced stand or replant the field because there are no rescue treatments available.



Corn rootworm larva (Photo Credit: J. Obermeyer)



Seedcorn maggot (l-r) larva, pupa, and adult (Photo Credits: J. Obermeyer (larva, pupa) and B. Christine (adult))

Considering the price of sweet corn seed, a prudent management strategy is to use a seed protectant, which costs approximately \$4 per acre.

WIREWORM

Wireworms are slender, hard bodied, wirelike larvae that are yellow to brown and range from 1/2 to 1-1/2 inches long. Wireworms feed on the germ or hollow out corn seeds, or tunnel into roots and shoots of seedlings. Damaged seedlings will usually wilt, with the symptoms first showing up on the youngest leaves. Damage to either seeds or seedlings may result in the death of the plant.



Wireworm larva (Photo Credit: J. Obermeyer)

Wireworms typically are more serious in fields that were sod or fallow the previous year. If the field was alfalfa, sod, or fallow the previous year or if wireworms have been a problem in the past, the potential for wireworm problems can be assessed by putting 4 or 5 baits in the field 2 to 3 weeks prior to planting. A bait can be a handful of either untreated wheat or corn. Bury the entire handful of grain 6 inches deep in the soil, and mark the site with a flag. Dig the baits up in about 10 days, and look for wireworms. If you average one wireworm per bait, then you should use a seed treatment and may want to consider using a soil insecticide. None of the soil insecticides are extremely effective at controlling wireworms, but they will provide a limited amount of control. Like seedcorn maggots, there are no rescue treatments for wireworms. Once damage is noticed, the only management decision is whether to replant.

CUTWORMS

There are a number of species of cutworms that feed on corn, but the most common is the black cutworm. The black cutworm reaches a length of 2 inches, varies in color from light gray to almost black, and has coarse granules visible on the skin. Small larvae eat irregular holes on leaves of seedlings, but larger larvae may cut plants off either above or below ground level. Plants that are cut off above the growing point will regrow, but those cut off below the growing point are dead. As a result, larger plants generally are more seriously damaged by cutworms than small plants, because the growing point is more likely to be above the location of the feeding. Cutworms tend to be more serious in fields with reduced tillage, fields that have winter annual weeds present prior to spring tillage, and fields that have a previous history of cutworm problems.

To scout for cutworms, check 20 consecutive plants in 5 areas of the field. Count the number of cut plants, and try to find the cutworm by digging in the soil around any damaged plant. Generally, a rescue treatment is justified if 5 or more of 100 plants are cut. Remember that the smaller the cutworms, the more feeding they will do in the future. If the cutworms are large, they may be nearing completion of the larval stage and may only do a little more feeding. Do not use a preventive soil insecticide for cutworm control, because the chances of having a problem are relatively low.



Black cutworm (l) curled with cut plant and (r) open (Photo Credit: B. Christine)

CORN FLEA BEETLE

Flea beetles are tiny (about 1/16 inch long) black beetles with enlarged hind legs that allow them to jump long distances. They feed by stripping the green top layer from the leaves, resulting in irregular brown or grey lines. Heavy feeding damage can stunt or kill young plants. More important, corn flea beetles can transmit a bacterium that causes a disease named Stewart's wilt. Sweet corn varieties vary greatly in their susceptibility to Stewart's wilt.

See the Midwestern Vegetable Variety Trial Report for 2007 <http://www.hort.purdue.edu/fruitveg/rep_pres/2007-8/CD/Start.pdf> for information regarding other varieties. Overwintering flea beetles suffer significant mortality during cold winters. To determine the potential for wilt problems in your area, add the average monthly temperatures (°F) for December, January, and February. If the sum of those 3 numbers is less than 90, then the disease can be expected to be mild. If

Table 1. Sweet corn hybrids with high levels of resistance to Stewart's wilt		
Sugary Enhancer Hybrids		
Yellow	White	Bicolor
El Toro	Denali HMX 7367	Ambrosia Synergy
Shrunken-2 Hybrids		
Yellow	White	Bicolor
Garrison Shogun		Mirai 334 BSS 1693 Holiday BC503



Corn flea beetle
(Photo Credit: J. Obermeyer)

the sum is between 90 and 100, then epidemics of moderate severity are expected. If the sum is greater than 100, then the disease can be expected to be severe and destructive. In those fields where a susceptible variety is being grown and moderate or severe disease pressure is expected, monitor the field on a regular basis. When beetles are first noticed, apply a foliar insecticide. No economic thresholds are available, but populations greater than 10 beetles per plant will usually cause economic losses, even when a Stewart's wilt resistant variety is grown.

STALK BORER

Stalk borers have prominent stripes running lengthwise on the body that are interrupted in the middle by a dark purple "saddle." Stalk borers bore through the unopened leaves so that as the plants develop the leaves have a series of holes across them. The top or "flag" leaf droops, and the whole plant may wilt. If the larva bores into the stem, the plant may die or not produce an ear.

Stalk borers are difficult to monitor, but usually confine their damage to field margins or near fence lines or waterways. Excessively grassy fields may have damage throughout.

If stalk borers have not yet bored into the plant, they may be controlled with foliar insecticides. Treat an area of a field if 15-20% of plants in that area show leaf feeding. If the larvae have bored into the plants, then no control is possible.



Stalk borer
(Photo Credit: J. Obermeyer)

ARMYWORM

Armyworm larvae reach a length of 1-1/2 inches and are dull green to brown with alternating light and dark stripes running the length of their backs. They feed on the leaves of corn, giving it a ragged appearance, or, under heavy pressure, eat everything except the midrib. Typically, armyworm

problems occur when the larvae have developed on small grains or grassy weeds and then move to corn when the host plants dry down.



Armyworm larva
(Photo Credit: Purdue University)

Watch for larvae crawling toward corn at these times, and look for damage first in those areas of the field near a small grain field or next to a fence row or waterway. Grassy fields tend to have greater armyworm infestations. Foliar insecticides can be applied for armyworm control to those areas of the field where more than 5 percent of the plants show feeding damage, larvae are less than 3/4 inch long, and corn is less than 6 inches tall.

CORN ROOTWORM BEETLES

In addition to the larval damage described previously, adult rootworms can damage sweet corn by feeding on silks, which can interfere with pollination. When silks are green, inspect silks on 50 plants per field. If beetles are present and are clipping silks back to the tip of the husk, then treatment may be justified. You may be treating your corn at silking for another insect such as corn earworm or European corn borer. If you are using an insecticide other than the *Bacillus thuringiensis* based materials (Dipel, Javelin, etc.) or Spintor or Entrust. You can expect it to kill rootworm beetles as well, and no additional treatment is necessary.

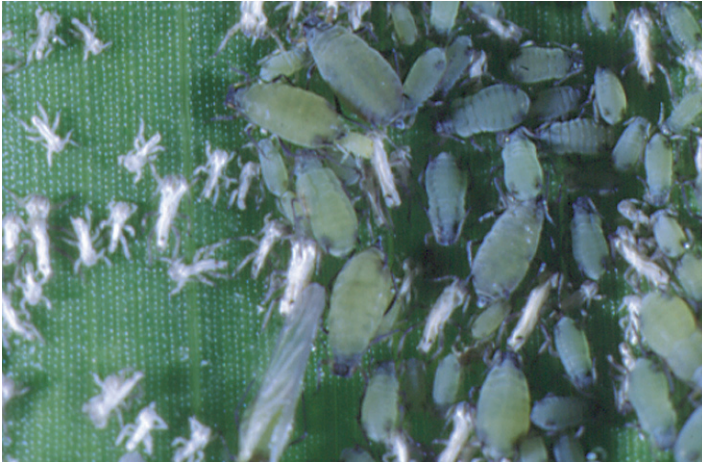


Northern corn rootworm beetle (l) and western male and female beetles (r) (Photo Credit: B. Christine)

CORN LEAF APHID

Corn leaf aphids can occur in large numbers on tassels of sweet corn plants. The feeding they do with their sucking mouthparts is usually not important. However, they secrete a sticky substance known as "honeydew" that can coat the an-

thers and reduce the amount of pollen that is dispersed. Treat fields if they are less than 50 percent pollinated and at least 50 percent of the plants are infested with at least 50 aphids per plant (“The Rule of 50’s”). The normal spray program for corn borers and earworms often will clean up the infestation. Lannate, which controls corn borers but not earworms, will provide good aphid control.



Corn leaf aphids
(Photo Credit: B. Christine)

FALL ARMYWORM

The fall armyworm does not overwinter in Indiana. Moths begin migrating northward from southern Florida or Texas or from Mexico or Central America in early spring. They may go through a generation at one or more intermediate locations before reaching Indiana. Infestations usually are not noticed until mid-to late summer. The larvae are smooth-skinned caterpillars varying from light green to nearly black with stripes of various colors that run the length of their bodies. The head has a prominent, white, inverted, Y-shaped line visible from the front. There are also four black spots arranged in a rectangle on the back of the last body segment.

Fall armyworms may feed on sweet corn at any stage of development. Damage during the early- to mid-whorl stage must be heavy before yield or quality of the crop will be affected. However, feeding during the late-whorl to tasseling stage can severely affect yield. Populations as low as 0.2 - 0.5 larvae per plant can significantly reduce yield of marketable sweet



Fall armyworm larva
(Photo Credit: J. Obermeyer)

corn ears. Those larvae present during those stages also may migrate to the ear region and damage the ear. Fall armyworm larvae will enter the ear at the tip or in the side. When they enter the side of the ear, they make a rather large hole.

The key to fall armyworm management is control during the late whorl or tasseling stage. If they are not controlled before silking, it is very difficult to protect the ears, even with frequent sprays. Fortunately, fall armyworms are not often present in large numbers in Indiana. Monitor late-planted sweet corn for fall armyworms during the mid- to late-whorl stages to determine the necessity for treatment.

EUROPEAN CORN BORER

European corn borers have diminished in importance in the last 10 years since the introduction and widespread adoption of Bt field corn. However, since the tolerance level for damage to sweet corn is so low, corn borer must still be managed.

European corn borers overwinter as larvae and pupate in May. Moths emerge in late May and begin flying and laying eggs in early June. The adult female is a creamy, yellowish-



European corn borer egg mass and larva
(Photo Credits: J. Obermeyer and B. Hutchson)



European corn borer adult and black light trap
(Photo Credit: R. Foster)

brown moth approximately 3/4 inch long. It has a stout body and a wing span of a little more than 1 inch. Two dark serrated lines run across the outer one third of the forewings. The moths from this first generation look for the oldest corn available on which to lay their eggs. (Moth flights can be monitored effectively with blacklight traps to better time scouting efforts and insecticide applications.) The eggs are laid in masses of 15 to 30 eggs usually on the underside of the leaves. The eggs in a mass overlap like fish scales. The larvae that emerge from these eggs will feed on leaves in the whorl while they are young and later will bore into the stalk or into the ear, if one is present. The larvae are flesh-colored with small, round, dark spots on each of the body segments. Mature larvae are about 1 inch long.

Sweet corn can tolerate a fairly large amount of injury when the plants are in the early- to mid-whorl stage. **Treatment is justified during the mid to late-whorl stage if 15 percent or more of the plants show larval feeding and borers are still present.** If you use a slower acting *Bacillus thuringiensis* based insecticide, lower the threshold to 10 percent.

Second generation moths begin flying in mid July, and larvae are present beginning in late July. This generation is usually more important on sweet corn. In this generation, the moths look for the youngest fields available for egg laying. Eggs, again, will be laid on the underside of leaves, usually near the ear. When the plant starts to tassel, a larva feeding in the whorl is pushed out and must either hide behind a leaf sheath or bore into the ear. It is during this movement that a corn borer is most vulnerable to insecticides. Larvae will bore a fairly small, nearly inconspicuous entrance hole into the ear through the tip, side, or shank, unlike fall armyworm larvae.

Unless corn borer populations are extremely high, sprays applied every 5 days from the late-whorl stage until 10 days before harvest should provide adequate control. Acceptable control has been achieved with Warrior, Baythroid, Capture/Bridgade, Intrepid, Lannate, Larvin, Mustang Max, SpinTor, Entrust (organic), PennCap-M, Pounce, and Ambush. *Bacillus thuringiensis* based insecticides do not provide control suitable for commercial sweet corn production.

In some years, there will be a third generation in Indiana. When a third generation occurs, expect the infestations in late planted sweet corn to be heavy.

Corn borer moth activity should be monitored with blacklight traps. Treat according to the following decision guide. Treatment is not necessary later than 10 days before harvest, because the larvae will not have time to infest the ear.

CORN EARWORM

The adult corn earworm is a yellowish-brown moth with a wingspan of 1-1/2 inches. The wings are light tannish brown with a prominent, dark, “comma” shaped mark on the forewing that is more prominent on the male. Infestations in Indiana develop from pupae that overwinter in some parts of Indiana and moths from southern regions. Moths prefer to lay eggs singly on fresh, green silks. When the eggs hatch 2 to 6 days later, the young larvae follow the silk channel to the tip of the developing ear, where they feed, consuming kernels and fouling the ear with excrement. Frequently, the damage will be confined to the terminal inch or so of the ear. Thus,

European Corn Borer Decision Guide

Catch is less than 10 ECB moths per night.

- Moths probably will not lay enough eggs to justify treatment. Be aware that catches may increase drastically in the near future.

Catch is greater than 10 ECB moths per night for three consecutive nights.

- Moths are laying eggs. Sweet corn is in a vulnerable stage (pre-row tassel or later). Treat with insecticide. If you are catching females, eggs are already in the field.

Catch is greater than 100 moths per night (a reinfestation flight).

- Moths are laying lots of eggs in the field. If sweet corn is in a vulnerable stage, apply an insecticide, even if previously treated. Repeat treatment every 5 to 7 days (depending on the temperature) until brown silks.



Corn earworm larva and adult
(Photo Credit: R. Foster)



Pheromone trap to monitor corn earworm moths
(Photo Credit: A. Jacobson)

the ear can still be used if the damaged tip is removed. The larvae vary considerably in color, ranging from light green to tan, brown, pink, maroon, or nearly black, with light and dark stripes running lengthwise on the body. The skin is coarse and has many hairlike projections. Corn earworm larvae grow to be nearly 1-1/2 inches long.

Protectant insecticide sprays are necessary so that the silks are covered with insecticide when the eggs hatch. This will increase the likelihood that the young larvae will contact a lethal dose of insecticide before they reach the protected region within the ear. Maximize coverage by using drop nozzles on either side of the row directed toward the ear. Because the silks grow rather rapidly, especially during warm weather, spray every 2 to 5 days to keep a protective spray on the silks.

Male corn earworm moths can be monitored quite effectively with pheromone traps. The general strategy for controlling earworms in sweet corn is to spray only if moths are being caught in the pheromone trap and fresh green silks are present in the field. Treat according to the following decision guide. The exact determination of the spray interval depends on several factors, including how much damage you can tolerate, the value of the crop, and the cost and effectiveness of the insecticide. Some of the more effective insecticides for control of corn earworms on sweet corn are Warrior, Capture, and Mustang Max. All of these insecticides are pyrethroids. For many years the pyrethroids have provided exceptional levels of control of earworms. In recent years, there have been scattered reports of pyrethroid failures in small plot trials and in commercial fields. Recent research has shown that populations of earworms collected in Indiana and Illinois have low to moderate levels of resistance. For now, the pyrethroids, particularly Capture/Brigade, Mustang Max, and Warrior, provide the best levels of control available. Growers should be aware of the potential for the development of resistance. If resistance is suspected, please contact the author at rfoster@purdue.edu.

When corn earworm moth catches exceed 100 per night, it is often useful to include an insecticide that provides excellent adult (moth) control. Penncap-M has proven to be effective. Including a low rate of Penncap-M with your next corn earworm spray will improve control by killing the adults.

Obviously, you should not treat separately for corn earworms and European corn borers. Some of the recommended insecticides are effective against both species. Choose the insecticides that are more effective against the particular pest that is more prevalent at the time. If both pests are present, choose an insecticide that will adequately control both of them.

WESTERN BEAN CUTWORM

The western bean cutworm is a relatively new pest in Indiana, first observed in 2006. The larvae feed on the ears of sweet corn, as pictured on page 7. Moths begin flying and laying eggs in late June and continue through early August. Eggs are laid in clusters of 20-200. Newly-hatched larvae feed on the tassel, corn pollen, behind the leaf sheaths, and silks. As the larvae get larger, they may feed on the ear tips or enter the ear through the side of the husk. When they reach maturity, they will chew their way out of the husk and overwinter in the soil.

Corn Earworm Decision Guide

Catch is less than 10 CEW moths per night in pheromone traps.

- Moths probably will not lay enough eggs to justify specific CEW treatment.

Catch is greater than 10 CEW moths per night in pheromone traps.

- Moths are probably laying enough eggs to warrant treatment. If sweet corn is in a vulnerable stage (silks present), apply an insecticide, and retreat every 3 to 5 days (depending on temperature) until brown silks.

Catch is greater than 100 CEW moths per night in pheromone traps (a reinfestation flight).

- Treat with an effective CEW insecticide immediately if corn is in a vulnerable silk stage, and continue treating every 3 to 4 days, as long as catches remain high and until silks turn brown. Add Penncap-M to spray mixture for adult control.

Catch is greater than 500 CEW moths in pheromone traps.

- Catches this high indicate moths maybe migrating in from the South. Treat every 2 to 3 days with your best insecticide at the highest rate, as long as catches remain high and until brown silks. Add Penncap-M to spray mixture for adult control. When catches reach this level, you may still have infested ears despite your best efforts.

Although the western bean cutworm has the potential to be a serious pest of sweet corn, so far the populations in Indiana are at least 100X lower than those of corn earworm. At least for now, we do not expect the western bean cutworm to be an important pest. So far, the western bean cutworm is mostly confined to the northwest corner of Indiana. The Purdue IPM Program is monitoring moth flights of this pest each year and should be able to determine if populations increase to a potentially serious level. Sweet corn growers who think they have a problem with western bean cutworms should contact their county Extension educator or the author at rfoster@purdue.edu.

Like other ear-feeding caterpillars, western bean cutworm larvae must be controlled before they enter the ear. Insecticides used for earworm control should be effective against western bean cutworm. Applications should be targeted at the late whorl – early silking stages for optimum control.

For more information on western bean cutworm, please visit <http://ncipmc.org/alerts.wbc.cfm>.

BT SWEET CORN

Bacillus thuringiensis (Bt) is a naturally occurring soil-borne bacterium that produces crystal-like spores that kill insects. For many years, insecticides have been sold that contain a strain of Bt that kills caterpillars. Bt insecticides being highly selective and non-persistent have the advantage of being safe to users and non target organisms. However, sprayed Bt insecticides are only marginally effective for corn borers and are not effective for corn earworms and fall armyworms.

Bt sweet corn has been created through biotechnology by inserting genes from Bt that code for the production of the crystal toxin into the corn DNA. Bt sweet corn provides several advantages. The Bt toxin is present throughout the plant ensuring that the caterpillars will feed on it. The toxin is present throughout the season, so there are not problems with residual activity. Like Bt sprays, there are no effects on beneficial insects.

Growers should not plant Bt sweet corn and then assume that all their insect problems are taken care of. Bt sweet corn does not control cutworms, corn rootworm beetles, flea beetles, or western bean cutworm. In addition, particularly when corn earworm populations are high late in the season, there may be a significant number of small, stunted larvae present in the tips of ears. In some of our trials, up to 50% of the Bt sweet corn ears had small earworms present. Even though the larvae were small and not doing a lot of damage, their mere presence would make those ears unacceptable in most fresh markets. Therefore, I recommend that growers treat Bt sweet corn in much the same way as conventional sweet corn, spraying insecticides when appropriate. Particularly late in the season, the combination of Bt sweet corn and well-timed insecticide applications will give growers the best opportunity for producing insect-free sweet corn ears.

See ID-56 for information regarding specific insecticide recommendations:

<<http://www.btny.purdue.edu/Pubs/ID/ID-56/>>.

Northern corn rootworm *Diabrotica barberi* Smith and Lawrence

Western corn rootworm *Diabrotica virgifera virgifera* LeConte

Seedcorn maggot *Delia platura* (Meigen)

Wireworm *Melanotus* spp.

Agriotes mancus (Say)

Limonius dubitans (LeConte)

Black cutworm *Agrotis ipsilon* (Hufnagel)

Corn flea beetle *Chaetocnema pulicaria* Melsheimer

Stalk borer *Papaipema nebris* (Guenee)

Armyworm *Pseudaletia unipunctata* (Haworth)

Fall armyworm *Spodoptera frugiperda* (J.E. Smith)

European corn borer *Ostrinia nubilalis* (Hubner)

Corn earworm: *Helicoverpa zea* (Boddie)

Corn leaf aphid *Rhopalosiphum maidis* (Fitch)

Western bean cutworm *Richia albicosta* (Smith)



Western bean cutworm eggs (Photo Credit: Univ. of Nebraska), larvae, adult and damage (Photo Credit: J. Obermeyer)

READ AND FOLLOW ALL LABEL INSTRUCTIONS. THIS INCLUDES DIRECTIONS FOR USE, PRECAUTIONARY STATEMENTS (HAZARDS TO HUMANS, DOMESTIC ANIMALS, AND ENDANGERED SPECIES), ENVIRONMENTAL HAZARDS, RATES OF APPLICATION, NUMBER OF APPLICATIONS, REENTRY INTERVALS, HARVEST RESTRICTIONS, STORAGE AND DISPOSAL, AND ANY SPECIFIC WARNINGS AND/OR PRECAUTIONS FOR SAFE HANDLING OF THE PESTICIDES.

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