

Using IPM in the Field



Sweet Corn Insect Management Field Scouting Guide



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Note

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How to use this Guide

Over 40 percent of the vegetable acreage in Massachusetts is used to grow fresh market sweet corn. Consumers demand high quality, worm-free corn throughout the season. An Integrated Pest Management (IPM) approach helps growers achieve high quality corn while protecting natural resources and reducing costs. Using IPM effectively in sweet corn combines several methods to monitor pests, decide when insecticides are needed, and encourage biological control where possible.

This guide is designed as a tool to take to the field to help growers use IPM successfully. It shows step-by-step how to identify and monitor key pests, learn how to scout, what to look for, and what thresholds to use for insecticide applications.

A companion guide, the Field Records Workbook, provides a place to write down what you find and keep your scouting records all season long in one compact location.

Additional Resources

This Guide does not cover every pest of sweet corn. Additional information on less common pests, nutrient, weed and disease management, and organic pest management can be found in the following resources.

New England Vegetable Management Guide. Comprehensive guide on crop and pest management updated every two years. Available in printed copy from UMass Outreach Bookstore, 413-545-2717 or (<http://umassoutreachbookstore.com/catalog/>) and online at www.nevegetable.org.

Pest Identification Supplement. Photographs of every weed, insect and disease listed in the New England Vegetable Management Guide. Available from UMass Outreach Bookstore (see above) and also can be viewed online at www.nevegetable.org.

Organic Insect Management in Sweet Corn. This eight page fact sheet with color photos describes pest biology, monitoring and management using organic methods. Provides details on the use of direct applications to corn silk for control of corn earworm. Available from UMass Extension Vegetable Program office (413-545-3696) or online at http://www.umassvegetable.org/soil_crop_pest_mgt/crops/corn_sweet.html

University of Massachusetts IPM Guidelines. Provides a list of Integrated Pest Management methods (soil and nutrient, insect, disease, weed and water management) for many vegetable and fruit crops including sweet corn. The most crop-specific definitions may be found online at <http://www.umass.edu/umext/ipm/guidelines/index.html>.

European corn borer (ECB)

Identification



European corn borer survives the winter in the larval stage, protected inside the stalks of wild plants and corn stubble. Destruction of corn stubble in the fall, or in early spring before emergence of moths, is important for controlling overwintering populations of ECB.



Female moths lay flat white egg masses on the undersides of corn leaves, often close to the midrib of the leaf. Eggs may be laid from the whorl stage through early silk stage. Eggs hatch in four to nine days, depending upon temperature.



In southern and central New England there are two generations of ECB during the growing season. The first flight begins in May and ends by early July; the second flight begins at the end of July and continues into September. Female moths are lighter in color and slightly larger than the males.



Caterpillars are light brown or pinkish-gray with dark spots on each body segment. The head capsule is dark brown and flattened in shape. Full grown caterpillars are 3/4 to one inch long. Caterpillars initially feed within the whorl, then on the emerging tassel. After tassels open, they move downward and burrow into the stalk or into the side or base of the ear.

Damage



Caterpillars tunnel into ears through the side, base or tip to feed on kernels causing economic damage. During silking stage, moths lay eggs on leaves near the ear and young caterpillars may move down the silk channel directly to the ear.



ECB caterpillars also tunnel through the shank, sometimes injuring kernels at the base of the ear.

Monitoring for moth flights



Pheromone traps capture male moths and are used to monitor when the moth flight starts, peaks and ends, and how big the population is. There are two strains of ECB: the Z strain (Iowa, I) and the E strain (New York, II). Use one trap for each strain, and place the two traps 50-100 feet apart in a weedy or grassy border of the corn field. To catch the beginning of first flight Put traps up by May 15th.



Heliothis net traps are recommended, used with Trécé European corn borer IA and ZII lure. Lures should be hung in the center of the opening at the base of the trap. Replace lures every two weeks. Traps should be hung so that the bottom opening is just above the canopy of the weeds. Trim weeds if needed.



At least once per week, remove the trap top, empty and count number of moths. Keep records of the counts. See Yearly Trap Captures (page 18 and Field Record Book)

Monitoring for damage in the field



Field scouting for ECB begins when the tassels first appear in the whorl. Walk in a V or X pattern to sample plants in groups of five. To make a decision about the need to spray, you will need to sample from 25 to 105 plants. Use sequential sampling for most efficient use of time; additional copies in the field record book)



Close inspection may be needed to find small ECB larvae feeding within whorl or tassels. Pulling tassels for sampling makes inspection easier and will not hurt pollination. After one insecticide spray, do not count old damage that may have occurred before the spray.



Tiny ECB caterpillars feed inside the florets of the tassel. Look for the black head capsule, brownish damage and frass (excrement).



As they grow, caterpillars move around to feed in the florets or the stalk. Because caterpillars are moving on the surface, this is a good time for spray applications. Target controls from pretassel to open green tassel stage, before ears form and ECB tunnels into stalks and ears.



As caterpillars move down the stalk they settle just above the leaf nodes or tunnel into the side of the ear. A caterpillar feeding in the stalk produces white or light tan sawdust-like frass.



Caption????

Deciding when to spray based on action thresholds

The action threshold is the level of pest or damage at which controls are needed and are economically worthwhile; thresholds are based on achieving 95-100% clean corn. At the pre-tassel stage, the action threshold is based on field scouting.

Action threshold at pretassel to green tassel: If 15% or more of plants have one or more ECB caterpillars or show fresh feeding damage, a spray is needed. Repeat in four to seven days if scouting shows infestation is still above threshold. If infestation is high (>50%), two sprays four to five days apart may be needed to bring infestation below threshold.

Action threshold during silking: If corn is more than one week from harvest and trap captures are greater than seven moths per week, spray weekly. Target ear zone. This is especially important for early corn that was started under plastic, which reaches silking when the first ECB flight is high and eggs are still being laid.

Biological control of ECB with *Trichogramma ostriniae*

Using *Trichogramma ostriniae* (*T. ostriniae*) can reduce or eliminate the need for sprays, thus saving time, labor, pesticides, and fuel, and reducing soil compaction.

This method prevents the emergence and feeding of caterpillars in the first place, as opposed to rescuing the corn with insecticides after the caterpillars have become a problem. It is especially useful in early corn (corn to be harvested in July) because timing of sprays in the early corn can be tricky and control measures are not complicated by the need to control corn earworm and fall armyworm, a common situation in late season sweet corn.

T. ostriniae wasps reproduce during the season, and move into later corn plantings that are in the same or nearby fields. These subsequent generations have been shown to suppress second generation ECB later in the growing season.

Ordering Trichogramma: While some native species of *Trichogramma* persist in the wild, *T. ostriniae* (pronounced aw-STRIN-ay) need to be reared at an insectary, shipped to the farm and released each season. *T. ostriniae* may be ordered from IPM Laboratories in Locke, New York. 315-497-2063 www.ipmlabs.com. Order well in advance! Place your order based on acreage after you have made your first planting.

Biology



Trichogramma are tiny parasitic wasps, as small as the eye of a needle, that lay their eggs in the egg masses of host insects. *Trichogramma* larvae feed and pupate inside the egg, killing the egg and preventing hatch.



T. ostriniae lays its eggs in ECB egg masses, and is the species that has given the highest level of ECB control in field trials.



As they mature, ECB egg masses turn from a cream color to white, to white with a black head mass in the center of each egg; when parasitized by *Trichogramma*, the entire egg turns black. *Trichogramma* have excellent dispersal in the field. They do not overwinter but they will reproduce and contribute to the control of ECB through the season.

Release timing

Since *T. ostrinia* control ECB by parasitizing egg masses, they should be released just as ECB moths start to lay eggs, within a week after the initiation of ECB moth flight. For corn maturing in the middle of moth flight, target releases to corn that is in the four to six leaf stage (12-16 inches tall).

Knowing when ECB flight begins, reaches a peak, and ends in a given field is key to the proper timing of *T. ostrinia* releases, as each field has its own ECB population. You can use regional information about flight activity; however, to get the best coordination of timing on your farm, monitor ECB flight in your own fields. For *T. ostrinia*, two to three releases, each approximately seven days apart, will help match the timing of wasps and host eggs. Recommended release rates range from 30,000 to 60,000 per acre per release, depending on the level of infestation and level of control desired.



Handling Trichogramma



Trichogramma are shipped from the insectary as pupae inside protective cards. They are ready to emerge upon arrival, however there will be a range of pupal age so emergence will happen gradually over one to seven days, depending on temperature. It's best to put the cards out in the field the same day as they arrive. If you cannot release them upon their arrival, keep the cards in their shipping box in a cool location at about 50°F. The insects are alive: avoid exposing them to extreme temperatures (below 40°F or above 90°F) so they will still be alive and in good shape when you put them in the field.

Putting trichogramma in the field

Place the proper number of cards to provide the desired release rate in the center of the field, or at regular intervals throughout the field, away from the field edges. *T. ostrinia* wasps will disperse well throughout the field; one to four release sites per acre is adequate. Tie cards securely to corn leaves or on a stake. Do not put them on the ground. Try to locate them where they will receive some shade, such as under a leaf or on the north side of the plant. Leave the packet stapled shut, so that insect predators do not consume them.



Scouting and spraying release fields

Where *T. ostrinia* has been released, you can scout as usual (see page X) Eggs that were parasitized and did not hatch will never reach the larval stage, resulting in a lower rate of caterpillar infestation.

T. ostrinia will suppress ECB, but does not necessarily provide complete control when the timing or rate of the releases is off. In addition, corn earworm may arrive during silking. Thus, insecticide applications may still be needed. Use selective insecticides in the release fields if possible. Trichogramma that are inside host eggs are somewhat protected from the spray and many will survive, but adult wasps may be killed by insecticides that are harsh on beneficials.

T. ostrinia parasitic wasps reproduce during the season, and move into later corn plantings that are in the same or nearby fields. These subsequent generations may suppress second generation ECB later in the growing season.

Corn Earworm

Corn earworm (CEW) moths do not survive winters in New England, but migrate annually into the Northeast, traveling north on storm fronts. They may arrive in late season corn anytime from mid-July through September. Heaviest numbers are found in coastal areas and up the major river valleys.

Identification



Adult moths are light tan with a distinctive dark spot on each forewing, and a dark band near the margin of the hind wing. Live moths have bright green eyes.



Female moths lay eggs directly on the fresh silk of newly developing ears. Eggs hatch in 2.5 to 6 days – more quickly at higher temperatures (up to 90° F) and very slowly as temperatures approach 55° F.



Corn earworm larvae may be brown, tan, green, or pink, with light and dark longitudinal stripes. Caterpillars reach one and a half to two inches when full grown.

The head capsule is always plain golden brown, and there are small bumps and hairs which give the body a rough texture.

Damage



Newly-hatched caterpillars tunnel into ears by moving down the silks. Once they are in the ear, caterpillars cannot be reached with insecticide sprays. Larvae feed on kernels at the tip of the ear, leaving unsightly frass.

Monitoring



Monitoring moth flight is critical to achieving CEW control all season long. Moth numbers may jump overnight, and sprays must be timed to prevent larvae from entering the ear. Pheromone traps attract male moths. Use *Heliothis* net traps baited with Hercon *Heliothis zea* lures. Traps should be placed in fields as soon as plants start silking.



Moths get a little beat up in the traps, but the dark dot and wing band are still visible.



Remove the trap top, empty it and count the moths in each trap twice a week. Average the numbers found in the two traps.



Use two traps per field and move one into a block with fresh silk each week. Suspend the lure in the center of the trap opening, with the base of the trap at ear height. Replace lures every two weeks. Blocks with fresh silk give the best indication of CEW flight activity.

Thresholds

CEW is controlled by maintaining insecticide coverage of the silks. The higher the CEW numbers, the more frequently you need to spray. To determine when to start insecticide sprays and how often to spray, use the average moth count per trap, and divide by the number of nights since the last count was taken. Spray intervals range from three to six days. If maximum daily temperature is below 85° F for two to three days, spray intervals may be extended by one day.

Moths/Night	Moths/Week	Spray Interval
0 - 0.2	0 - 1.4	no spray
0.2 - 0.5	1.4 - 3.5	6 days
0.5 - 1	3.5 - 7	5 days
1 - 13	7 - 91	4 days
Over 13	Over 91	3 days

Fall armyworm (FAW)

Like corn earworm, the fall armyworm is a summer migrant to New England, over-wintering in the south where soils do not freeze. Moths may arrive anytime from mid July into September. Flights are sporadic and difficult to predict, and do not necessarily correspond with corn earworm flights, so monitoring with pheromone traps is very useful. Flights are heavier near the coast, but move inland as well.

Identification



Moths (males) have mottled brown forewings with a slanting white bar across the wing, and plain light tan hindwings. They measure about three quarters of an inch long.

Female moths lay clusters of eggs on the leaves of a variety of host plants, preferring whorl stage corn over older corn. Eggs hatch in two to 10 days.



Caterpillars are smooth, (unlike CEW), and dark green or brown with lengthwise stripes and dark spots. Full-grown larvae reach one and a half inches. The head capsule is dark with a distinctive light colored marking in the form of an upside-down Y. This is contrast to CEW, which has a plain head capsule.

Damage



Feeding damage from caterpillars occurs first in whorl stage corn, deep within the whorl, on leaves and in the newly forming green tassel. Watch whorl stage corn for ragged feeding damage and masses of sawdust-like excrement.



Like European corn borer, fall armyworm larvae feed in the tip, making a tunnel through the side of corn ears, leaving behind frass and a large hole.



Fall armyworm larvae also feed in the tip, making a mess of the kernels. The most effective way to prevent ear damage is to apply controls during whorl and pretassel stage. If flights are very high, silk sprays may be needed.



Monitor fall armyworm moths with a bucket trap (eg Universal Moth Trap or Multipher traps) with a lure clipped under the lid and a vapor strip placed inside the trap. Count moths at least weekly.



Hang the trap on a metal stake placed at plant height in whorl stage corn. Mark the trap and the end of the row with bright surveyor's tape – corn quickly hides the trap as it grows! Use a Scentry lure (PSU type is most effective), replaced every two weeks and dispose old lures in a plastic bag. Handle the vapor strips with gloves and replace every 4-6 weeks.

Thresholds



The scouting method and threshold for FAW is similar to ECB scouting. Check plants in a V or X pattern across the field in groups of 10. Avoid checking only field edges, and start at random, not only where you can see damage. A plant is infested if at least one caterpillar is found. If 15% or more of plants are infested with FAW, a control is needed. Use the sequential sampling plan to determine how many samples to take and what decision to make.

Sometimes feeding damage is old and no larvae are found; this usually means that the larvae have left the plants to pupate in the soil. In emerging tassels, combine counts for ECB and FAW. For example, if 10% of plants have FAW and 12% have ECB, the combined infestation is 22%, above the 15% threshold.

Sap Beetles

Sap beetles are usually secondary pests of sweet corn and are commonly associated with damage caused by other pests. Sap beetles overwinter as adults or pupae in crop refuse, decomposing corn ears, or decaying fruit on the ground. Eggs are laid in spring. There are several generations per year. They are more likely to be a problem on farms producing a variety of vegetable and fruit crops. They can also be pests of strawberry.

Identification



Dusky sap beetle is black and plain (3.5-4.5mm long), while four-spotted sap beetle (also known as picnic beetle) is black with four irregular yellow spots (5-6mm long).

Adults are first noticed about the time that tassels appear. They may invade corn borer tunnels or other insect damage, feed on pollen or silks, and lay eggs in these sites or in silks at the tip of ears. Eggs are milky white and resemble tiny grains of rice. The larvae are small, pinkish white or creamy colored grubs about one quarter inch long. They may hollow out kernels of the upper half of the ear.

Monitoring



Sample for sap beetles when silks begin to wilt. Inspect the silk area at the tip of 20 ears at each of five sites and determine the percent of ears infested with adults, eggs, or larvae. Sprays for other ear pests usually control sap beetles, but if other pests are absent and more than 10% of ears are infested with sap beetles, treat for sap beetles.

Cultural practices

Sanitation is important to prevent successful overwintering and reproduction during the season. Bury corn residue especially decomposing ears; remove or bury alternate hosts such as rotting tree fruit or discarded vegetables. Burial should be deeper than 10 cm.

Corn Leaf Aphids and Beneficial Insects

Corn leaf aphids feed in cereal grains and grasses as well as field and sweet corn. In Massachusetts, adult females arrive in sweet corn fields each year beginning in June, initially feeding in the furled leaves of whorl on the tender young tassel. As the tassel emerges, aphids disperse over the entire plant to feed.

Identification



This species of aphid is green to bluish-green (female wingless adults) or with black head and thorax (males and winged adults) with a pear shaped body and black legs. Wingless females produce live nymphs, and populations can build up rapidly especially in hot weather. Thick colonies may form in tassels, then move to leaves and corn husks. When aphids feed they produce a sticky substance called honeydew, which encourages the growth of dark sooty mold on leaves and husks. Presence of aphids or sooty mold on the ears makes them unsightly and unmarketable.

Biological control of aphids



Several insect predators and parasites feed on aphids and are very important in suppressing aphid populations in sweet corn. The twelve-spotted ladybeetle feeds on sweet corn pollen, aphids, insect eggs and newly hatched ECB larvae.



The multicolored Asian ladybeetle has increased in numbers in recent years, and feeds on aphids. Its coloration and patterns are highly variable.



Ladybug larvae are voracious aphid feeders. Sweet corn provides an excellent habitat for reproduction of ladybeetles. This larva is feeding on corn leaf aphids.



Another aphid predator, the insidious flower bug may be difficult to spot because it is only two to five millimeters long, but it is common on leaves, silks and tassels of sweet corn.

Other management tactics

Using selective insecticides that are less toxic to natural enemies, especially early in the season, will help to sustain populations of beneficial insects and reduce aphid problems later on in the season. See New England Vegetable Management Guide for more information on selective products.

Moisture stress increases corn susceptibility to aphids. Aphids may vector maize dwarf mosaic virus; the best control is use of resistant varieties. Insecticide applications for aphids will not prevent transmission of the virus.

Photography Credits

All photographs are by Ruth Hazzard, University of Massachusetts Amherst, unless otherwise noted.

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- Wasp by needle - Sylvie Chenus, Cornell University
- Trich on European Corn Borer egg mass - Sylvie Chenus, Cornell University
- White and black egg mass - Sylvie Chenus, Cornell University

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- Adult Corn Ear Worm - David N. Ferro, University of Massachusetts

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- Adult Fall Armyworm - David N. Ferro, University of Massachusetts
- Fall Armyworm and Corn Ear Worm head capsule - Alan Eaton, University of New Hampshire

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- Universal moth trap for Fall Armyworm - Amanda Brown, UMass Extension

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- Aphids on tassel - David Ferro, University of Massachusetts
- Twelve spotted ladybeetle - Martin Spellman
- Multicolored Asian lady beetles - Bill Ree, Texas A&M University, www.ipmimages.org
- Ladybeetle larvae with corn aphids - Clemson University, USDA Cooperative Extension Slide Series, www.ipmimages.org.
- Insidious flower bug - photographer unknown, www.ipmimages.org.

How to Use the Field Scouting Form

For monitoring insect damage in whorl, pre-tassel and tassel stage sweet corn in the field, use the sequential sampling plan on the field scouting form to decide when the action threshold (15%) for an insecticide application has been reached.

If the infestation is very high or very low, an accurate decision can be made more quickly, based on fewer samples, than if the infestation is very close to the action threshold. It tells you exactly what counts are needed to decide “yes, spray” or “no spray needed” after each set of five samples. This is called ‘sequential sampling’ This saves time but still gives you a valid, reliable decision. A minimum of five locations (25 plants) must be sampled before a decision can be made. These should cover at least half the field. A maximum of 105 plants is needed to make a decision.

Walk through the block or field in a U or V shaped pattern. At randomly spaced locations in this pattern, sample five consecutive plants. Resist the temptation to sample only damaged plants! Thresholds are based on random sampling. One way to select your sampling spot at random is to decide how many paces you will walk before stopping to sample. It also helps to reach for a plant without looking.

If you are sampling pretassel corn, pull the whole tassel free from the plant. This makes it easier to inspect for feeding damage and caterpillars and makes scouting faster. You can be sure there will be plenty of pollen and those plants will produce ears.

Record the number of infested plants or those with fresh feeding damage at each location on the sampling sheet and move to another location. Keep a running total. After 25 samples, if the running total is greater than (>) the number in the “Treat” column, an insecticide application is warranted. If the running total is less than (<) the “No Treat” column, an insecticide application is not warranted. Continue sampling until a decision can be made.

This sequential sampling plan is adapted from: Hoffmann, M. P., J. P. Nyrop, J. J. Kirkwyland, D. M. Riggs, D. O. Gilrein and D. D. Moyer. 1996. A sequential sampling plan for use in scheduling control of lepidopterous pests of fresh market sweet corn. J. Econ. Entomol. 89: 386-395.

Quick Reference Guide

Sweet Corn Action Thresholds

At the following crop growth stages, an insecticide application is warranted if:

Whorl stage (based on field scouting)

>15% infestation of plants with fall armyworm

Pre-tassel to first silk stage (based on field scouting)

>15% infestation of plants with fall armyworm and/or European corn borer (combined count)

Silk stage

Less than five days to harvest: no spray. If:

European corn borer: trap capture (E+Z) exceeds seven per week (one per night), spray once per week.

Corn Earworm: trap capture (average per trap) determines spray interval (see table).

Corn Earworm Thresholds

Moths/Night	Moths/Week	Spray Interval
0 - 0.2	0 - 1.4	no spray
0.2 -0.5	1.4 - 3.5	6 days
0.5 - 1	3.5 - 7	5 days
1 - 13	7 - 91	4 days
Over 13	Over 91	3 days

Note: spray intervals can be lengthened one day if daily maximum temperatures are below 80 degrees F over a 2-3 day period.

Moth Trap Captures

Year: _____

Field	Date	# Nights	FAW	ECB Z1	ECB EII	Total ECB	CEW #1	CEW #2	Avg CEW	Avg CEW Per Night

Note: For ECB add counts for Z1 and EII traps to get a weekly total (Total ECB). For CEW take average of the two traps (Average CEW) and divide by the number of nights since the last count (Average per night): use this number when referring to the spray recommendation table.

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