



# Growing for Market

news and ideas for market gardeners

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## Sweet corn all summer!

*Integrated system helps you identify and control caterpillar pests for perfect ears*

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When customers flock to markets in search of sweet corn, they want it to be of the highest quality - sweet, fresh and worm-free. Yet in ecological or organic production of sweet corn, achieving worm-free corn is one of the most difficult challenges. Three major caterpillar pests - corn earworm, European corn borer, and fall armyworm - invade ears and cause ugly feeding damage. Without effective controls, it is impossible to produce high quality corn throughout the season.

Organic pest management relies upon a variety of methods to reduce pest populations below economically damaging levels. Crop rotation, tillage of previous crop residues, mechanical barriers such as floating row covers, planting resistant or tolerant varieties, conservation of existing beneficial organisms, and release of mass-reared beneficial organisms are all compatible with the methods described here, and may further enhance ear quality.

This article will discuss an integrated strategy for controlling these three caterpillar species, using methods that meet current certification standards for organic production. The two components of this strategy are 1) a direct treatment of each ear with vegetable oil mixed with *Bacillus thuringiensis* (Bt), and 2) foliar applications of Bt. Used with IPM scouting methods and thresholds, these can provide cost-effective control of key caterpillar pests throughout the season.

### Corn earworm

The corn earworm (CEW, *Helicoverpa zea*) is a widespread pest, which is also known as tomato fruitworm on tomato and cotton bollworm in cotton and tobacco. In southern areas of the United States, corn earworm overwinters and infests sweet corn throughout the season. Corn earworm moths reach northern states through annual migrations,

invading late-season corn from mid-July through September. In New England, large numbers of moths can arrive suddenly on storm fronts that move up the coastline and river valleys. The heaviest numbers are found in coastal areas, but corn earworm can be a devastating pest in late-season corn anywhere in the northeastern U.S.

Adult moths have light tan scales and are about 1.25 inches in length. Distinctive features are a dark dot on the forewing, a dark band near the margin of the hindwing and bright green eyes.

Female moths lay single cream-colored, globe-shaped eggs on the silk as well as other parts of the plant. They are attracted to the odor of corn silk, though dried silks are less attractive than fresh silk as egg-laying sites. They lay an average of 5.5 eggs per day over their 7-14 day life span. Eggs hatch in 3-7 days, depending on temperature, and newly hatched larvae move down the silk and into the ears to feed at the top of the ear. Unlike European corn borer and fall armyworm, earworm larvae do not tunnel through the husk to reach the ear.

Corn earworm larvae may be brown, tan, green or pink, with light and dark longitudinal stripes. The head capsule is always plain golden brown, and there are small bumps and hairs which give the body a rough texture. Caterpillars

*continued on page 4*

## Inside

Sweet corn production video.....	7
Another alternative to organic.....	8
Organic compost rules.....	10
Bird repellents.....	11
Herbs for bouquets.....	13
Imported flowers' environmental problems.....	17
Produce prices.....	18

# Sweet corn...

continued from page 1

reach 1.5 to 2 inches when full grown.

**Monitoring and thresholds:** Pheromone traps are a critical IPM tool for monitoring CEW flight activity. The Scentry Heliothis net trap, baited with Hercon lure tapes for CEW is reliable and effective. The trap should be placed in freshly silking corn with the base at about ear height. Lures are suspended in an opening at the base of the trap and replaced every two weeks. When the silk dries, move the trap to a new block of corn in fresh silk. Trap captures of two moths per week indicate that a damaging population of CEW is present. Damage will increase as trap captures rise.

Two sources for these traps and lures are Great Lakes IPM (517-268-5693) and Gemplers (800-382-8473).

## Controlling CEW

An effective way to control corn earworm infestation in corn ears is to apply a small amount of vegetable oil mixed with Bt directly to the silk of maturing corn ears. Oil applied directly to the silks in the neck of the ear acts as a barrier and a toxin, rapidly killing caterpillars that encounter the oil, thereby controlling larvae before they cause damage inside the ear. This technique was widely used by sweet corn growers in the 1940 before the development of effective foliar insecticides and organic standards. Research conducted at the University of Massachusetts, Hampshire College and farms throughout New England has reexamined this technique and developed some improvements on previous methods. The following recommendations are based on this work:

1. Vegetable oil gives effective control. Use vegetable oils that meet federal organic regulations. While we have primarily used corn oil in our trials, both corn and soybean oil are exempt from FIFRA (Section 25b, Federal Insecticide, Fungicide and Rodenticide Act). This means that they can be used on food crops without a pesticide label or registration. EPA regulations also exempt corn and soybean oil from food residue tolerance requirements. In addition, these oils are allowed under organic certification standards.

2. Mixing a Bt product with the oil improves control. If larvae begin to feed on oil-treated silk or ear tips they ingest Bt, cease feeding and die. Use a product that is labeled for sweet corn. Test the product to be sure it will dissolve or form a suspension in oil: continuous agitation may be needed. In liquid Bt products, a ratio of 1 part Bt to 20 parts oil is as effective as more concentrated solutions of Bt and results in application rates within the labeled rates per acre. Check with your certifier to be sure that the Bt you want to use is acceptable.

3. The best time to apply oil is 5-6 days after silk growth starts or 3-4 days after the silk is fully grown. At this time, the tips of the silks have begun to wilt and turn brown, and pollination is nearly complete. Although caterpillars that are already in the ear may be killed by the oil/Bt application, the best control is achieved when the oil is present prior to larval entry. The oil/Bt barrier persists after application and continues to kill newly entering larvae.

Within a field, plants grow at different rates and begin silking at different times. In a relatively even stand, silk emergence is concentrated in a 3-4 day period. To determine

the best time for oil applications, note the day on which 50% of the corn has begun to show silk, and count from that date.

Applications made earlier than 5 days after silk do not appear to give better control, but may result in a higher rate of "cone" tips. This occurs when oil interferes with silk pollination, resulting in unfilled kernels in the last half-inch of the tip. While partially filled tips are a relatively common occurrence in sweet corn, cone tips caused by oil are more pronounced.

Oil applied later than 8 days after silk initiation can result in more feeding damage to the kernels caused by caterpillars that entered the ear prior to the oil. There is a window between 5 and 8 days after silk initiation that provides the best combination of corn earworm control and ear fill.

4. Use 0.5 ml per ear. This is equivalent to five drops from an eyedropper. Apply it directly to the silk at the top of the ear so that it will coat the silk channel. Higher quantities do not appear to give better control, but may cause slightly oil ears at harvest. The Zea-later hand held applicator described below delivers 0.5 ml per ear.

5. One application per ear is adequate. Treat each block when most ears are close to the ideal stage. It is cost-effective to treat only one ear per stalk. If silk emergence is very uneven throughout the field it may be necessary to go through the stand a second time to treat late-emerging silks and achieve optimal control without tip fill problems.

continued on page 5



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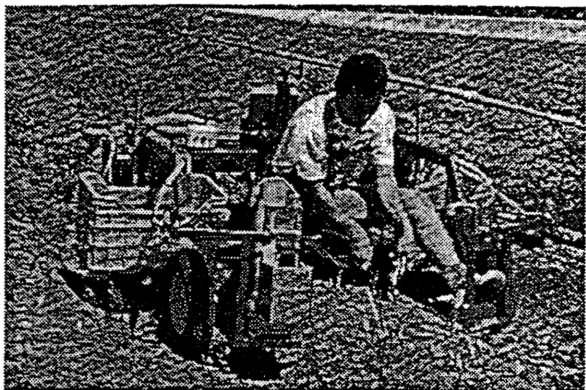
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## Humane Cultivation and Crop Harvesting



### Electric Vehicle being used to cut asparagus

The Hardest part of larger scale market gardening, using organic principles, is to get timely cultivation and harvest at peak of quality while keeping labor requirements humane. Minor farm layout changes and the appropriate machine can help you achieve these ends.

An electric vehicle, from Italy, known as a Frago-Line is that machine. Like a Farmall Cub or Allis Chalmers G, it can cultivate row crops but it can do far more. The operator's position close to soil allows him or her to plant, transplant, and cultivate within the rows, not just between the rows.

When harvest time comes around fruits, vegetables, herbs or flowers can be dug, picked or cut with less effort while covering more ground. With relatively more comfortable operator position and time saving, some bunching, trimming and even packaging can be done in the field. Reducing rehandling saves time and more importantly preserves quality.

The "Frago-line" is battery powered, so it is quiet and non polluting. You will be able to hear the bees buzzing and smell the gardens perfume while you do your work. Then plug in the charger to the 110V circuit or a solar array, to refuel. Machine has been proven in Europe and USA in over 10 years of usage.

Just as with a horse drawn cultivator or tractor, the electric unit will be most efficient if you plant long rows minimizing the time spent turning.

Give us a call and we will help you select the best model for your crop system, and tell you about some hand held tools to compliment this technology.

## Sweet corn...

continued from page 4

6. A hand-held applicator is needed to deliver oil to each ear. Oil sprays are phytotoxic and result in sticky brown husks. There is no way to avoid taking time to apply the oil to each ear. The Zea-later costs \$214 from Johnny's Selected Seeds (207-437-4395). This device is comfortable to hold and use, and delivers 0.5 ml of oil with each squeeze of the trigger. Tubing connects the device with a 2-liter bottle for the oil that can be strapped around your waist for convenience.

7. The cost of this method including labor and materials is about \$120 per acre. Labor is about 8 to 10 hours per acre and materials include about 2 gallons of oil and 1 pint Bt per acre.

## European Corn Borer

European Corn Borer (ECB, *Ostrinia nubilalis*) is a resident pest that has two generations per year in most of New England. Larvae overwinter in stalks of corn and other host plants and pupate in the spring. Adult moths emerge in late May or early June and mate in weedy or grassy areas.

About one week after flight begins, females start to lay flat, white egg masses on the underside of leaves in early corn. Eggs hatch in about one week, depending on temperature. Larvae feed in the whorl and in the succulent emerging tassel. As the corn matures, these larvae move downward, bore into the stalk and tunnel into ears through the side or tip. When moths are active during silking, eggs are laid on leaves near the ear and larvae move directly into the ear.

Larvae are light colored, with a pattern of small dark spots on each segment. The head capsule is black or dark brown. Full-grown larvae are 3/4 to 1 inch long.

**Monitoring and thresholds:** ECB flight can be monitored with two Scentry Heliothis net traps baited with E (II) or Z (I) lures, placed at least 50 feet apart in weed borders of corn fields with the bottom at weed height. Both types of lures are needed in New England because both E and Z strains are present. Check with your state Extension service for information about which strain is found in your area.

Once flight is detected, corn with newly emerging tassels should be scouted weekly by inspecting the tassels of 50-100 plants, in groups of ten, for the presence of ECB larvae. If more than 15% of the plants have one or more larvae present, then ear damage will be greater than 5% at harvest if ECB is not controlled.

## Fall Armyworm

Like corn earworm, fall armyworm (FAW, *Spodoptera frugiperda*) moths do not overwinter in New England, but migrate into the area in mid to late summer. Larvae are smooth, brown or dark green with lengthwise stripes, and the head capsule is dark with a distinctive light-colored marking in the form of an inverted Y. Full-grown larvae reach 1.5 inches. They eat through the side of the corn ear, generally making a large, messy opening.

**Monitoring and thresholds:** Watch whorl-stage corn for

continued on the next page

# Sweet corn...

continued from page 5

signs of ragged feeding damage and scout for larvae in the whorl and the emerging tassel. The scouting method and threshold for FAW is the same as for ECB: if 15% of plants are infested with either ECB or FAW, controls are needed.

## Controlling ECB and FAW

Foliar sprays with products containing BT subspecies *kurstaki* give good control of ECB. For FAW, look for products with contain *Bt aizawai* or which have fall armyworm listed on the label.

Foliar sprays should be applied just before or during tassel emergence but before silking and before larvae move into the ear or stalk. Here are some tips when using Bt products for ECB and FAW control in corn:

1. Apply when infestation exceeds 15%; re-scout to determine the need for further sprays.
2. Apply at 5-7 day intervals. Shorter intervals should not be necessary.
3. Use at least 2/3 the maximum rate. Low rates could result in poor control.
4. Configure your sprayer to get good coverage of the tassel, foliage and ear zones. Drop nozzles are recommended. Test with water-sensitive cards.
5. Using a spreader-sticker is recommended.
6. During silking, if ECB moths are active (pheromone trap

captures more than 5 per week), continue weekly applications.

7. Bt products can be used whenever ECB or FAW are the target pests, regardless of the time of season or stage of crop growth. Bt foliar sprays will NOT control corn earworm.

## Late-season

During August and September, it is common to have two or three of the key caterpillar pests in the field at the same time. ECB and FAW may be feeding at the tassel stage and can move into ears during silking. Some enter ears through the tips and some through the sides. CEW enters only through the tip and only during silking. An integrated strategy that has provided effective control of all of these pests in experimental trials:

1. Pretassel/tassel stage: Scout for ECB and FAW. If infestation is greater than 15%, make two foliar applications of Bt, 5-7 days apart.
2. At the beginning of the silk stage, if CEW is present, use the oil method to control all caterpillars that enter through the tip.

## Natural enemies

Sweet corn harbors numerous predators and parasites of caterpillar eggs and small larvae as well as of corn leaf aphid, another key pest. These include ladybeetles, insidious flower bugs, lacewing larvae, and aphid parasitoids. The methods described here are nontoxic to natural enemies and encourage the buildup of existing populations. These in turn will contribute to suppression of caterpillars and other pests such as aphids. ☺



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# Video shows sweet corn production

The preceding article on ecological sweet corn production does a good job of describing scouting, spraying, and oil application, but if you're still feeling a bit unsure about the system, you can see these and other corn-growing techniques on a new video. "Farmers and Their Ecological Sweet Corn Production Practices" is a 42-minute video showing specific practices at 10 farms in the Northeast. It was made by Ruth Hazzard, the University of Massachusetts entomologist who helped develop the Zea-later, and Vern Grubinger of the University of Vermont, who has made other videos of interest to direct market farmers.

The video is fun to watch (better than Star Wars for a vegetable farmer!) because it shows real farmers in their fields, finding real caterpillars on their corn. Seeing a farmer spot those little larvae in the tassels will help you identify them in your own tassels when the time arrives. It's also helpful to actually see how the Zea-later works so you can decide whether this is something you want to tackle on your farm. And who doesn't love seeing other people's farms - especially when they are neat and verdant, as all these farms are.

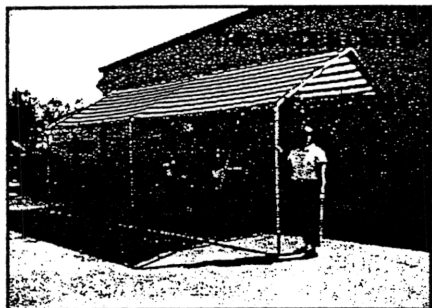
The segment on killing corn earworm with oil takes place on Walker Farm, an organic farm in Dummerston,

Vermont. Most of the other segments are filmed on bigger farms, with sweet corn production in the 50 to 200 acre range. Those farms aren't organic, either, but the farmers have devised practices that help them reduce herbicide, fertilizer and pesticide use. The other segments include:

- Hairy vetch cover crop
- Organic soil fertility
- Soil heat monitor and pre-sidedress nitrate test
- Floating row covers on corn
- Scouting for European Corn Borer and getting good spray coverage
- Mechanical cultivation of weeds and spraying Bt for European corn borer
- Banded herbicide application to reduce herbicide use
- Mapping fields for P and K fertilization
- Releasing beneficial organisms for corn borer.

The video costs \$15 in the U.S., \$20 to Canada or Mexico and \$25 elsewhere. Prices include shipping. Delivery takes three to five weeks, but if you need it faster, you can call or email for the rush rates. Contact Center for Sustainable Agriculture, University of Vermont, 590 Main Street, Burlington, VT 05405-0059; 802-656-5459; [susagctr@zoo.uvm.edu](mailto:susagctr@zoo.uvm.edu)

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