European Corn Borer

The European corn borer (*Ostrinia nubilalis*) was first discovered in North America in 1919 and in Manitoba in 1948. It belongs to a family of moths called the Crambid snout moths (Crambidae). It has been an economic pest in Manitoba corn fields on a sporadic basis. The European corn borer will feed on sweet, grain and silage corn. In addition, the European corn borer has a wide variety of other host plants including potatoes, hemp, quinoa, beans, millet, wheat and many species of large-stemmed flowers and weeds.

In Manitoba there is only one generation of corn borer per year. In some years, as much as ten per cent of the population will attempt a second generation although this generation will be unsuccessful. Infestations in Manitoba are quite variable from year to year, with some areas experiencing heavy infestations, while other areas have little or no damage caused by European corn borer.

Life History

The European corn borer has four stages in its life cycle.

Adult

Adult moths are tan (female) or brown (male) with wavy lines on their wings (Figure 1). The male moths are darker, with darker markings than the female moths, and males are usually smaller than the females. The adult moths emerge from the pupae in late-June and early-July. They are strong fliers. Newly emerged adults seek out dense areas of vegetation, preferring grassy ditches where they congregate and mate. After mating, females lay eggs during calm, warm summer evenings on the underside of corn leaves near the mid-rib.

Figure 1. Adult moths

Egg

Each egg mass consists of about 15 to 30 eggs. Each female can lay two egg masses per evening, for up to ten evenings. Newly laid eggs are white and overlap, resembling fish scales (Figure 2, upper egg mass). Just before the eggs hatch, they appear black. The dark appearance is caused by the dark heads of the young corn borers inside the eggs (Figure 2, lower egg mass). The eggs hatch within three to seven days, depending upon temperature.

Figure 2. Egg masses

Larvae

There are five larval instars of the corn borer. The first two instars (Figure 3) are whitish with black heads. After hatching, larvae will migrate to the whorl to feed. The first two instars feed within the whorl and cause shothole and

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windowpane damage. The first two instars complete development in seven to ten days. The third instar larvae bores into the stalk or stem of their host plant. Once inside the stem, it is too late to achieve effective chemical control. In corn, the later instars (third to fifth) feed within the stalk and ear shanks, disrupting the normal movement of nutrients, which results in decreased yield. Tunneling and boring may permit secondary infection and damage by rotting of the stalk and ear. Older larvae (Figure 4) are flesh coloured with black spots and may also feed on silks, kernels and cobs. Once they are finished feeding, the mature larvae overwinter in corn stalks, cobs and plant debris on the soil surface.

Figure 3. Early instar

Figure 4. Older larva

Figure 5. Pupa

Pupae

In the spring, mature larvae turn into pupae to complete the life cycle (Figure 5).

Damage

The European corn borer causes damage in several ways. In corn, the first sign of damage is the pinhole damage. If the larvae establish within a plant, it may cause several types of damage. The most severe damage is stalk breakage prior to harvest (Figure 7). Another type of damage is ear drop where cobs fall to the ground. The final type of damage may be the least obvious but can cause significant yield loss. By restricting nutrient flow in the plant, yield is affected by the production of smaller cobs (Figure 8).

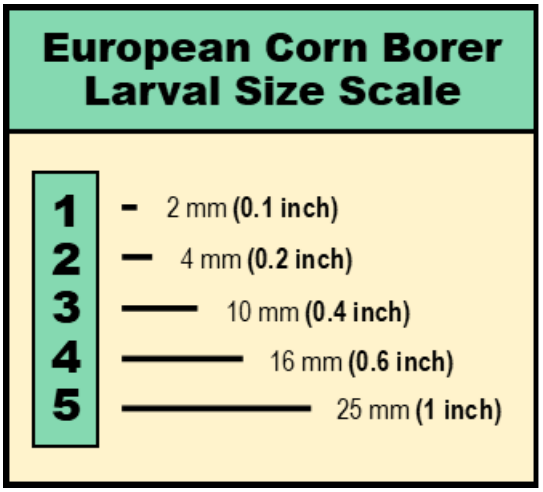

Figure 6. Scale for determining stage of European corn borer larvae

Figure 7. Stalk breakage

Figure 8. Smaller cobs

In potatoes, even though the direct injury due to European corn borer is often very minor, the injury sites can act as a port of entry for disease organisms, such as *Pectobacterium* spp. stem rot and blackleg.

Field Scouting for Egg Masses, Larvae and Injury to Crops

Field scouting should begin in early July. Fields should be prioritized by planting date and relative maturity. Older fields should be scouted first. For any of the host crops, assess a minimum of 10 plants, 3 plants in 3 areas, plus one additional plant in one of these areas. These three areas should be about equal distance apart, relative to the size of the field, and a minimum of 20 m apart. Avoid assessing plants within 10 m of the field's edge. Look for egg masses, young larvae and injury to the plant.

- Turn over leaves, looking for **egg masses** on the underside of the leaves. In corn, females are attracted to the silks and deposit egg masses predominately on leaves near the ear. If ears are present in corn, concentrate scouting on the three leaves above and below the ear zone.
- Look for **larvae and injury** on the plants. In corn, the larvae are most commonly found in the midrib and leaf axil. Look for any holes or tunneling along the mid-rib of the leaves, or on the stem/stalk where the leaf axil connects. Frass on the stem is a good indicator of larval tunneling. Pull open the whorl of corn to check for larvae feeding within the whorl.
- If there is evidence of frass or tunneling into the stem/stalk, plants can be slices lengthwise from tip to base with a sharp knife to look for the **older larvae**.

If the majority of larvae have bored into the stalk, do not apply insecticides as they are ineffective once the larvae have entered the stalk. If no larvae or egg masses are found, repeat scouting every five to seven days. Continue scouting until larvae start to tunnel into the stalk, or the end of July if no egg masses / larvae are found.

To monitor for European corn borer nationwide and in multiple host crops, the Insect Surveillance Working Group of the Canadian Plant Health Council developed the protocol outlined above. Those assessing European corn borer levels in corn, potatoes, quinoa, hemp, millet or any other host crop are encouraged to **submit your data** or observations using a free Survey123 app (available for both desktop and mobile devices):
Early to Mid-Season European corn borer monitoring (Before July) – https://arcg.is/0qCCHH
Later Season European corn borer monitoring (July to Pre-Harvest) – https://arcg.is/fSODf
To use, download the Survey123 app; you can click on "Continue without logging in", once on the login screen. Data will be used to answer questions about the preferred host crops of European corn borer in Canada, its distribution, and relative abundance across Canada.

Thresholds

Grain corn- the average grain weight reduction when stalk feeding was initiated during the 10-leaf, 16-leaf, blister and dough stages were 5.94, 5.01, 3.13, and 2.41 percent per larvae per plant, respectively.

If larvae were found in the whorls of the plants, the following Management Worksheet can be used to determine whether a foliar insecticide application would be economical and to what extent:

Management Worksheet for European Corn Borer

_____ % of 100 plants infested x _____ average # borers/infested plant = _____ Borers/Plant

_____ borers/plant x 5% yield loss/borer = _____ % Yield Loss

_____ % yield loss x _____ expected yield (Bu/A) = _____ Bu/A Loss

_____ Bu/acre loss x _____ price/Bu = $_____ Loss/A

$_____ loss/A x _____ % control = $_____ Preventable Loss/A

$_____ preventable loss/acre - $_____ cost of control/A = $_____ Gain (+ or -)/Acre if treatment applied

Silage corn - The threshold can range from about 10% of plants infested to about 40% of plants infested, depending on control costs and silage value.

Sweet corn – For fresh market sweet corn, through early silk stage, treat if 5% of the plants have egg masses, larvae, or leaf-feeding damage. Additional treatment may be required if more than one unhatched egg mass remains per 20 plants.

No economic thresholds are available for European corn borer in hemp or quinoa.

Control

Cultural Control

Stalk Management: Stalk shredding during or after harvest can significantly reduce European corn borer from overwintering.

In Manitoba, **time of planting** does not alter the severity of the corn borer infestation due the much longer oviposition (egg-laying) period.

Crop rotation will also help control populations.

Resistant Cultivars of Corn

Cultivars of Bt corn (which express proteins from a naturally occurring soil bacterium called *Bacillus thuringiensis*) are available which are resistant to feeding by European corn borer, and for some cultivars feeding by certain other caterpillars. There are many different strains of Bt, each specific to a different group of insects. There are four Bt proteins that can make corn plants resistant to European corn borer (Cry1F, Cry1Ab, Cry1A.105 and Cry2Ab2)). If there is prolonged exposure to a Bt proteins, European corn borer populations can start to change genetically, so the protein no longer kill them at high levels, hence becoming resistant to Bt corn. The following steps are necessary to prevent European corn borer from becoming resistant to Bt corn.

Refuge of a non-Bt cultivar: If planting cultivars of Bt corn, a refuge of a non-Bt cultivar is required to be planted to reduce the odds of European corn borer developing resistance to Bt corn. There are 2 types of refuge. Many cultivars of Bt corn will be purchased containing an **integrated refuge** (sometimes referred to as refuge-in-a-bag), where seeds of a refuge cultivar have been pre-mixed with seeds of the Bt cultivar in the bag. This integrated refuge typically comprises 5% of the seeds in the bag. Other Bt cultivars will not have an integrated refuge blended in, in which case blocks or strips of a cultivar of corn susceptible to European corn borer needs to be planted within or adjacent to the Bt cultivar. This is called a **structured refuge**. Having a non-Bt refuge is a requirement set by the Canadian Food Inspection Agency. Failure to comply with refuge requirements may lead to insect resistance, slow down the introduction of new Bt corn technologies, and affect individual grower's access to these products. Growers of Bt corn are also required to **monitor** their crop for the presence of European corn borer and any feeding damage.

Avoid planting cultivars with only one Bt toxin: Do not plant Bt hybrids that contain only one European corn borer Bt toxin and avoid planting hybrids that have the same Bt toxins each year.

A table of currently commercialized **Bt corn cultivars** in Canada, showing refuge requirements and the Bt proteins providing protection, is available at: https://cornpest.ca/transgenic-corn/#corn-available

Reduced mortality to the Bt protein Cry1F has been detected in European corn borers from Manitoba in lab testing, although unexpected damage to Bt corn has not been seen in fields in Manitoba. However, it is highly recommended to avoid growing corn hybrids that just contain Cry1F for protection from European corn borer.

Biological Control

There are many natural enemies that will feed on corn borer larvae. These include lady beetle adults and larvae, syrphid or hover fly larvae and green lacewing larvae. Minute pirate bugs will search for and feed on eggs of European corn borer and other caterpillars on corn. Natural enemies may not provide adequate control in outbreak situations. In non-outbreak situations it is important to not apply chemical control measures unless the economic threshold is reached so that the populations of beneficial insects will not be affected.

A parasitoid of European corn borer called *Trichogramma* has been used in some parts of Canada for the management of European corn borer in sweet corn. *Trichogramma* parasitizes the eggs of European corn borer.

Birds may also prey on European corn borer larvae. Overwintering crows will perforate cornstalks and eat overwintering larvae of European corn borer. Red-winged blackbirds will also consume larvae of European corn borer, although they can also damage standing corn.

Chemical Control

Insecticides should only be applied when economic thresholds have been surpassed. To determine whether the population in a given field has reached the economic threshold, it is important to scout the field.

Caution: Honey bees will forage for pollen from corn, with peak foraging in the morning and early afternoon. If the corn is producing pollen and insecticides toxic to honey bees are to be used, insecticide application to corn should be timed to avoid this peak foraging activity of the honey bee.

Insecticide recommendations for European corn borer in field corn, potatoes, quinoa and dry beans can be found in Manitoba Agriculture's Guide to Field Crop Protection.

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John Gavloski, Entomologist, Manitoba Agriculture.