Control of the European corn borer

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COVER PHOTOGRAPH: Adults of the European corn borer, male *(right)* and female *(left),* shown with egg masses deposited on a leaf of corn.

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Control of the European Corn Borer in Sweet Corn.

CONTENTS

Economic importance

The European corn borer, *Ostrinia nubilalis* (Hubner), is a serious insect pest of corn in Eastern Canada and a nuisance in the Prairie Provinces. Whether a few rows of sweet corn are grown by a home gardener or several hectares are planted for the fresh market or processing, the grower should be familiar with the life cycle of this insect and learn particularly how and when to control it. The larva damages grain corn by boring into the stalks, causing breakage and ear drop. However, the largest economic losses are in sweet corn, in which the larva feeds directly on the ears, making them unmarketable. The European corn borer is not a problem in corn grown for silage, because the crop is harvested at the green stage, stored, and fed to animals.

Distribution in Canada

Corn borer populations are higher in Ontario and Quebec than elsewhere in Canada and are an annual threat to corn crops. Sporadic corn borer outbreaks occur in the Maritimes. In Manitoba and Saskatchewan, corn borer damage is normally slight, but occasionally control measures are required. Alberta is the most recent Canadian province to be invaded by this insect.

Strains

Two strains of the European corn borer are known in Canada. In most of the corn-growing areas of Canada, a single-generation strain predominates. However, in southwestern Ontario south of a line between Simcoe and Sarnia, a two-generation strain is most common. Since 1975, there have also been sporadic occurrences of the two-generation strain in Quebec, but the survival and economic importance of this strain under Quebec conditions remain questionable.

Description and habits

The larva (Fig. 1) is uniformly off-white or pinkish, covered with rows of small brown spots. It is about 3 cm long when full-grown and occurs in corn plants from July until June of the following year. The female moth (cover photograph, *left)* is cream colored with brown markings and has wavy lines on her wings; the male *(right)* is similar to the female but is normally darker and smaller.

Damage

The type and economic importance of the damage caused by the single-generation and two-generation strains in grain corn and sweet corn vary.

Grain corn

Single-generation strain

Newly hatched larvae move deeply into the whorl of the plant where they feed on the developing leaves. Holes and lesions, usually in the form of pinholes or elongate scars, become visible when the leaves unfold from the whorl. Severe feeding damage to the leaves is illustrated in Fig. 2. During later stages of borer development, most larvae enter the tassel, stalk, and ear shank, but they also sometimes feed on the silks, kernels, and cobs of ears. Thus, the entire corn plant is susceptible to damage and this pest can cause a reduction in yield. Insect injuries also make the plants more susceptible to disease organisms.

Two-generation strain

The larvae of the first generation of this strain behave similarly to those of the single-generation strain in their feeding habits, except that they usually complete their growth before there is much ear development. Second-generation larvae usually occur after pollination, when there is no whorl in which to feed.

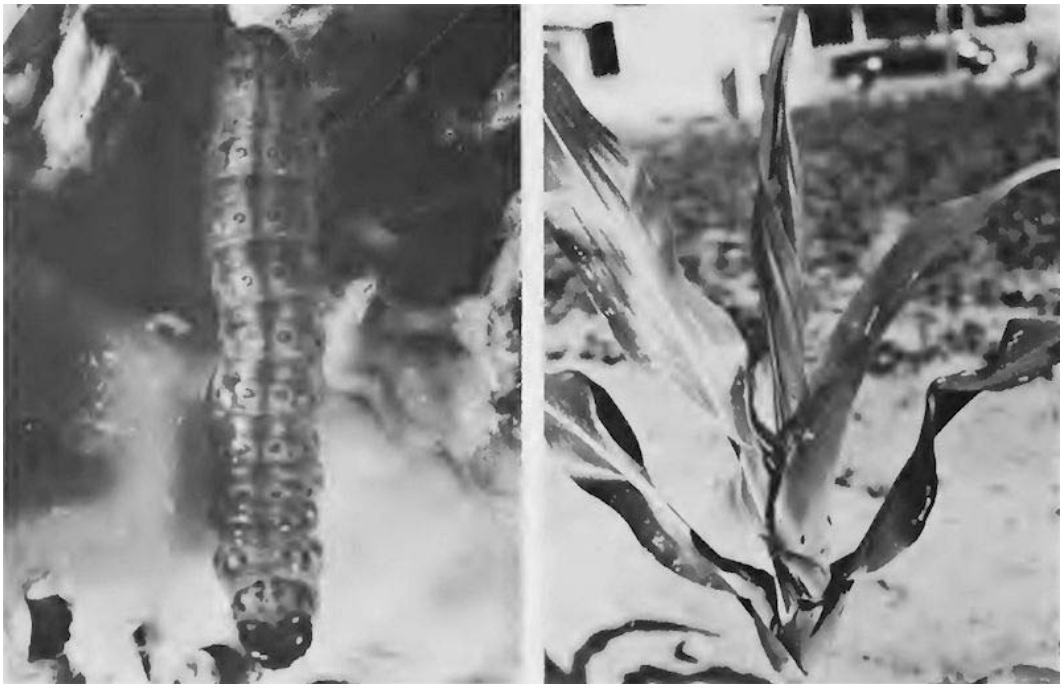

FIG. 1. Full-grown larva of the European corn borer *(left).*

FIG. 2 Corn leaves at the midwhorl stage, showing severe damage by the European corn borer *(right).*

Therefore in the early stages, this generation feeds mainly on sheath and collar tissue and on pollen that accumulates in the axils of leaves. Later in their development the larvae feed in the stalks and shanks and on the kernels and cobs of ears. Because the stalks and shanks are damaged, ears are sometimes dropped before and during harvest. Studies at the Harrow Research Station in Ontario have shown that the second generation always lays more eggs than the first and often causes significantly greater reduction in yield. The first generation mostly causes physiological damage, whereas second-generation infestation is responsible for both physiological damage and unharvestable ears.

Sweet corn

Damage to sweet corn is similar to that done to grain corn, in that all parts of the plant are attacked; however, with sweet corn more of the borers feed on the ears. Whereas the number of ears of grain corn damaged by larvae is relatively unimportant economically, infested ears of sweet corn are a great concern to processors and growers of fresh market produce.

Life cycle

The European corn borer overwinters as a full-grown larva inside its tunnel in the stalks, stubble, or ears of corn, in weeds, or in other plant material offering it shelter. In May or June, depending on locality, the borer spins a cocoon, inside of which it changes to a pupa. In southwestern Ontario first-generation moths of the two-generation strain usually start to emerge in early June. Oviposition begins within a few days and lasts for nearly a month, depending on temperature. In areas of Ontario and Quebec favoring the single-generation strain, moths begin to emerge at the end of June, with peak egg deposition occurring from the middle to the end of July.

Eggs are laid in a mass and overlap each other like fish scales. The number of eggs in the mass varies, normally from 15 to 25. The egg masses are usually laid on the undersides of leaves, but a few are placed on the upper surfaces of leaves, on stalks, and on the flag leaves of ear husks. Eggs are white when first laid (Fig. 3), become pale yellow, and finally appear black just before hatching. The dark appearance is caused by the dark heads of the young borers inside. This final phase is known as the blackhead stage. The eggs hatch in four to seven days, depending on the temperature.

In regions where the single-generation strain predominates, the corn borer overwinters as a larva. In regions favoring the two-generation strain, larvae of the first generation change to pupae in July, which give rise to the second generation of moths. These adults lay eggs from late July to early September, which hatch into the larvae that overwinter in these regions.

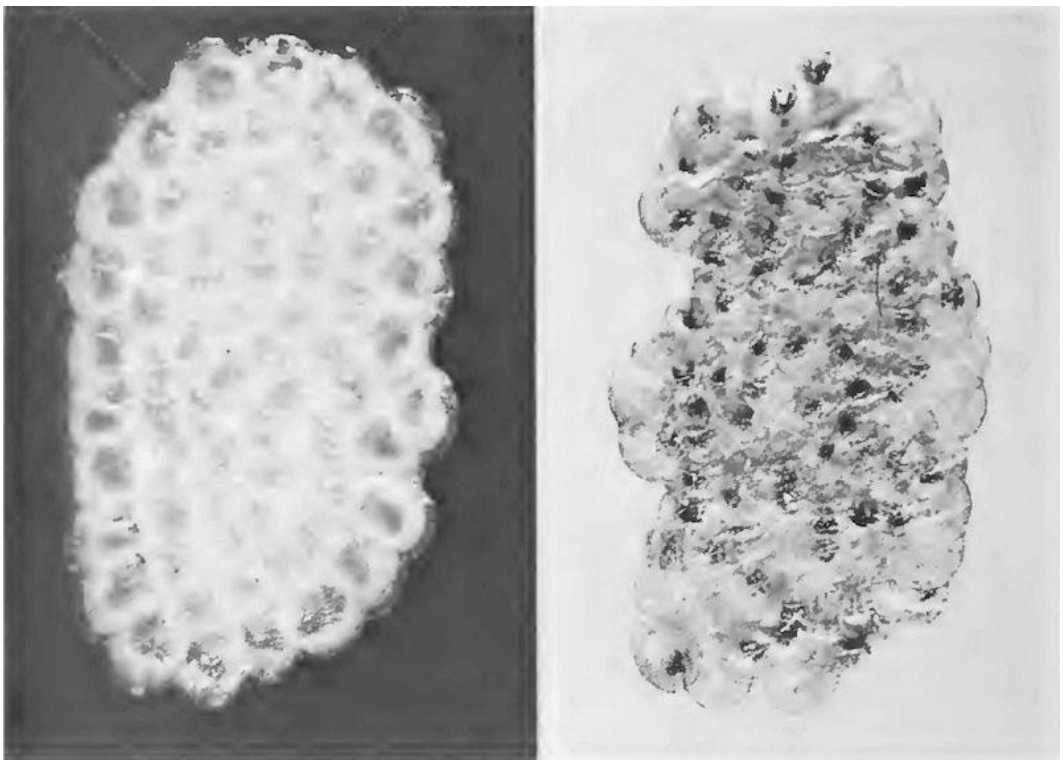

FIG. 3. Egg mass of the European corn borer at an early stage *(left)* and at the blackhead stage, just a few hours before hatching *(right).*

Control methods

Habits of the European corn borer and cultural practices used in corn production vary with the geographic areas of the country. Methods for control of the borer also vary, depending on the type of corn grown and the severity of attack. Insecticide treatments are always required on sweet corn. In grain corn insecticides are economically feasible only when the infestation is severe.

Cultural practices

Moths of the single-generation strain and of the first generation of the two-generation strain are attracted by the taller plants of early-seeded corn. However, second-generation moths prefer to lay their eggs on the leaves of younger, more vigorous, late-seeded plants. Therefore, in a two-generation area, it is best to grow a hybrid of grain corn resistant to feeding by first-generation larvae and to plant as early as possible to reduce second-generation damage. No commercial hybrids resistant to the second generation have yet been developed. Sweet corn growers in a two-generation area might also find that early plantings are more severely infested by the first generation and late plantings by the second. In areas where the single-generation strain predominates, time of planting does not alter the severity of the corn borer infestation because the oviposition period is much longer. In these areas, be sure to

select a hybrid with leaf feeding resistance and good stalk strength.

It is good practice to harvest as soon as moisture levels are low enough to allow machine harvesting. Wind storms in the fall can cause additional ear loss when the plants have extensively damaged stalks and ear shanks.

Plow under all cornstalks and weeds, preferably in the fall. Bury them as deeply as possible so that a minimum of debris harboring over-wintering larvae is brought to the surface with later cultivation. Plowing does not directly kill many borers, but when little debris is available for shelter, borers that reach the surface die from exposure or are eaten by birds and other predators. Properly adjusted plows with a rolling colter effectively turn stalks and trash under. Disking or chopping with a power-driven chopper can help to do an efficient job of clean plowing. Studies at the Saint-Jean Research Station show that although conventional cultural practices reduce overwintering larvae by 75%, the 25% remaining can still cause a severe infestation under favorable climatic conditions.

To eliminate other hosts for the borer, good control of large-stemmed weeds in and around corn fields is also recommended.

Further yield-loss reductions can be achieved by selecting hybrids with good standing ability and planting them at the density recommended by the seed producers.

Natural enemies

During the 1940's, millions of corn borer parasites were imported from Europe and Asia and released over most of the heavily infested areas of Ontario and Quebec. Although some species became established, they have not proved effective in reducing borer populations. Less than 5% of the borer population is usually attacked by parasites. Predatory insects destroy some corn borer eggs and small larvae. Coccinellids (lady beetles), lacewings, and syrphid (fly) larvae are the most abundant of the insect predators found during the growing season. Birds feed on corn borer larvae, particularly in the spring and the fall, and some fungus diseases also attack the borer. However, natural enemies contribute very little to the economic control of the European corn borer.

Resistant or tolerant corn hybrids

Inbred lines with good resistance to single-generation borers, as well as to the first generation of the two-generation strain, have been released throughout the world during the past decade and are being used by corn breeders in the development of resistant hybrids. Other hybrids are tolerant to the European corn borer and yield well by withstanding attack by the larvae. Figs. 4 and 5 compare effects of borer attack on susceptible and tolerant lines. Tolerant hybrids normally stand well even when they are damaged by the borers and can be harvested efficiently. Growers should plant resistant or tolerant hybrids adapted to their areas.

FIG. 4. A susceptible line, USSR Ky27TB, showing breakage resulting from borer damage.

FIG. 5. France F574, a line tolerant of the European corn borer.

This information can be obtained from local seed dealers. Such hybrids are particularly effective against the single-generation strain because these larvae feed longer than do the first-generation larvae of the two-generation strain. No commercial hybrids have feeding resistance to the second generation.

Insecticides

Ground applications of insecticide are normally more effective than aerial applications in reducing borer damage. With aerial applications, the insecticides must be broadcast, whereas with ground applications the same amount of insecticide can be concentrated directly into the plant whorl where it is most effective. Granular insecticides offer an advantage over sprays for controlling the single-generation borer because they have a longer residual effect, are less toxic to bees, and are easier to time.

In southwestern and central Ontario, wait until the corn plant reaches the midwhorl stage (Fig. 6A), then look for feeding damage to the leaves (Fig. 2). The need to treat depends on whether the crop is sweet corn or grain corn and on the proportion of plants showing evidence of borer attack. Corn grows quickly during hot weather in July and the new plant growth is ideal for egg laying. In southwestern Ontario egg laying lasts nearly a month. Fig. 6 B, C, and D shows the approximate stages at which plants should be treated for control of the single-generation borers and the first generation of the two-generation strain.

In Ontario, information on corn borer population levels and timing of insecticide applications can be obtained by phoning coded numbers at the Ontario Ministry of Agriculture and Food.

In Quebec and eastern Ontario, egg laying begins during the late-whorl stage of plant development (Fig. 6B). Examine the leaves for feeding damage twice a week after the late-whorl stage to decide whether treatment is necessary. In Quebec, Agriculture Quebec mails out pest warnings to advise growers when to apply the first spray, or growers may phone a coded number in their locality.

In the Maritimes and Western Canada, unless signs of leaf feeding are noticed when plants are at the late-whorl stage (Fig. 6B), delay insecticide application until tassels appear within the whorls (Fig. 6C), and repeat applications when needed.

Sweet corn

Sweet corn is more valuable than forage and grain corn, and the ears of sweet corn are more extensively damaged by the borer than those of grain corn. Therefore, it is always economically feasible to treat sweet corn with insecticides to maintain borer-free ears. Apply sprays when eggs begin to hatch but not later than when signs of feeding first appear on the leaves. Direct the spray into the whorl of the plants. After tassels appear, direct the spray at

the ear zone. At least three or four treatments 5-7 days apart may be necessary for fresh market corn and one or two treatments for corn grown for processing (Fig. 6 C and D). For the proper insecticide and the rates to be used, consult the various vegetable protection recommendation guides published annually in your province. Be sure to observe the required number of days specified between the last treatment and harvest. Any grower not familiar with the timing of insecticide applications should consult his county agricultural agent or a representative from the processing company with which he deals.

Grain corn

The need for an insecticide treatment on grain corn is determined by the price of corn, the resistance of the hybrid planted, and the intensity of the infestation. Although insecticides do improve the yield and the quality of the corn crop, the financial return must be sufficient to compensate for the high cost of treatments.

FIG. 6. Approximate stages of plant growth at which insecticides should be applied in Ontario and Quebec. (A) First application, southwestern Ontario. (B) First application, Quebec and central Ontario; second application, southwestern Ontario. (C) Second application, Quebec and central Ontario; third application, southwestern Ontario. (D) Third application, Quebec and central Ontario; fourth application, southwestern Ontario.

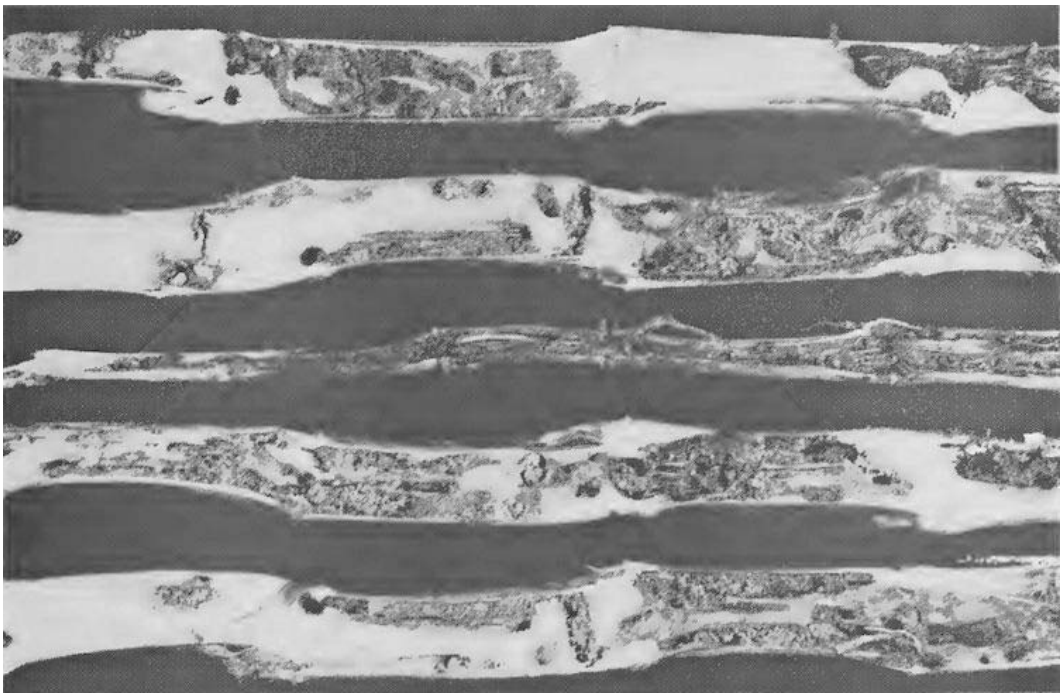

FIG. 7. Stalk damage by corn borer larvae in a susceptible inbred line.

In single-generation areas examine the plants every 5-7 clays for signs of leaf feeding before tassels show in the whorl, and spray when more than 40-50% of the plants have been attacked. One application may be sufficient for effective control of the borer, even under epidemic conditions. Once the larvae bore into the stalks (Fig. 7), insecticides are not effective and should not be applied. Consult the various field crop recommendation guides published annually in your province.

In two-generation areas, the same criteria used for control of the single-generation strain can be followed for controlling the first generation. Select rather resistant hybrids and spray with an insecticide, as described above. Although the second generation has proved more damaging than the first, controlling a moderate infestation of the first generation can be beneficial by reducing the number of moths available to initiate the second generation.

Insecticides are more difficult to apply against the second generation because the plants are so large at this stage. High-clearance ground equipment or aircraft are required.

CONVERSION FACTORS		
Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1 .2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 0.035	cubic feet
hectolitre (hL)	x 22	gallons
	x 2.5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare(mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g /ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre