Learning to Live With the European Corn Borer

By W. P. Flint, J. C. Hackleman, and F. C. Bauer

The red area on the above map shows the known spread of the European corn borer during 1926. The black area indicates the region previously known to be infested. Illinois farmers can avoid the most serious losses from this destructive insect by making adjustments in soil and crop practices before it becomes abundant in this state.
To Reduce Future Corn-Borer Losses
Begin Now to—

1. Adopt soil management practices that will build up the productivity of the soil and help to produce maximum yields of corn on large healthy stalks.

2. Select and grow earlier maturing varieties of corn, with heavier stalks, that can be planted late.

3. Adopt a good rotation of crops, using one or more of those mentioned on pages 12 and 14. Such rotations allow the growing of maximum acreages of crops which the borer does not injure. They are helpful also in improving the productiveness of the soil and they enable the farmer to handle crop and weed refuse to the best advantage and at a low cost.

4. Utilize as much of the corn crop as possible thru the silo and as finely shredded material.

5. Increase the acreage of legumes. They are injured less by the borer than are other crops, and are valuable in all crop rotations.

6. Practice clean plowing. A large proportion of the insects will be destroyed if all crop and weed refuse is entirely covered.

7. Become familiar with quarantine regulations and help in every way possible to carry them out.

8. Watch fields for the presence of this insect and send suspected specimens to the Natural History Survey, Urbana, for identification.
Learning to Live With the European Corn Borer

By W. P. Flint, Chief Entomologist, Natural History Survey; J. C. Hackleman, Chief in Crops Extension; and F. C. Bauer, Chief in Charge of Soil Experiment Fields

The European corn borer, undoubtedly the most destructive corn pest that has ever appeared in the United States, has become well established in an area of more than 100,000 square miles in North America. One specimen was found in Illinois in December, 1926. This fact does not mean that serious damage will occur immediately in this state. Judging by conditions in Ohio and Michigan, five or six years or more may elapse after the borer becomes established before any material damage from it will result.

To avoid the most serious damage from this pest, however, plans for combating it must be started before the insect becomes established. While it will not stop corn growing, it can place a tremendous handicap on the crop, and it should therefore be a matter of vital interest to every Illinois farmer to learn in advance how to live with it.

The purpose of this circular is to give the latest information concerning the spread of the borer and to suggest measures for combating it, both before it appears in any given section of the state and afterward.

Affected Areas Have Greatly Enlarged

During 1926 the corn borer spread very rapidly over a large area in the northeast part of the corn belt. It is now known to occur across the southern counties of Michigan and in six counties in Indiana, and has extended its range in Ohio, Pennsylvania, and western New York for a distance of 50 to 75 miles beyond the area known to be infested in 1925.

There has never been a case in which an insect that has become established over so great an area has not spread over all adjoining territory in which conditions were favorable for its existence. No natural barriers exist to prevent the spread of the insect over the entire corn belt. The adult moth is capable of flying at least twenty miles, and with a good wind to carry it, can probably go several times that distance. Other moths similar to the corn borer are known to travel for hundreds of miles when carried along by the wind.

The strict quarantines, both state and federal, that have been in force preventing the shipment of material which it is thought might carry the corn borer have apparently prevented any commercial spread of the insect, but the moth cannot be stopped by quarantines.
The greatest losses have occurred in the southern part of Canada, in Essex and Kent counties, Ontario. In an area of about 1,200 square miles in these counties the corn crop in 1926 suffered losses of 50 to 100 percent in all fields. Practically as severe injury occurred in 1925 in a smaller section, and the result has been about a 90-percent reduction in corn acreage.

Losses from the European corn borer have not been serious in every area infested. The damage in the area in eastern New York has never been severe, and damage in the area around St. Thomas, Ontario, which has been infested for twelve to fifteen years, has not been so great as in Essex and Kent counties, which have been infested for only about half that time. In the area in Ohio first known to be infested in 1921, real commercial damage did not occur until 1926, and then only in an area bordering Lake Erie. *Under favorable conditions for the insect, however, the same degree of damage now found in Ontario may occur in many parts of the corn belt.*

The European corn borer was probably first brought into North America about 1909 or 1910. It is widely distributed over Europe and Asia, and has been known in Europe for more than a hundred years as a serious crop pest attacking corn and other crops such as broom corn,
millet, and hops. While there are some areas in Europe where little damage occurs, there are other areas in which laws are in force to compel farmers to take measures for combating the insect each season.

**Four Different Stages in Life of Borer**

The European corn borer always passes the winter in the form of a nearly full-grown worm or larva, which shelters mainly in the stalk or stems of plants. It has, in common with all moths, four stages of growth; the egg, the larval or worm stage, the pupal or changing stage, and the adult or moth stage.

When full-grown, the worm is about 1 inch long by $\frac{1}{8}$ inch wide. It has a brown head, a grayish to pinkish body with two dark brown spots on the back of each of the body segments or joints, and an indistinct stripe down the middle of the back. Upon becoming full-grown, the worm changes to the pupal stage, in which it is about $\frac{3}{4}$ inch long by $\frac{1}{10}$ inch wide, brown in color, blunt at the head end, and tapering to a point at the tail. In this stage it remains stationary in burrows in the plant, and does no feeding. The moth, or adult insect, emerges from the pupal stage. The female moth is a pale yellow to brown, with irregular dark lines running across the wings, and with a
wing expanse of a little over one inch. The male is usually dark brown with light lines on the wings.

Where the insect has been very abundant, and heavy damage to crops has resulted, it will seek winter shelter in plants other than those in which it feeds. It has been found in the stems of shrubs

![Image](image.png)

**FIG. 3.—EARS OF CORN INJURED BY THE EUROPEAN CORN BORER**

The burrowing of the insect in the stems of the corn plant is particularly injurious, as it interferes with the circulation of sap and prevents the proper maturing of the ear. (U. S. D. A.)

and in soft wood into which it burrows for protection from the weather. In the spring the worms change to the brown pupal stage, and from these the adult moths emerge during the last of June and the first part of July. They remain quiet during the day, flying about at
dusk of evening, and depositing their eggs mainly on the undersides of leaves of corn and other food plants. The worms hatch from these eggs in about two weeks, and at once begin to seek shelter in the stems or larger leaf veins of the corn or other plants. They continue

![Image of corn tassel broken off where injured by the European Corn Borer](image)

**Fig. 4.—Corn Tassel Broken Off Where Injured by the European Corn Borer**

Heavily infested fields will show very few tassels after mid-summer. The breaking of the tassel frequently is the first evidence the casual observer will see of the presence of the born borer. (U. S. D. A.)

to feed mainly in the interior of plants the remainder of the summer, reaching their full growth about the middle or latter part of September and going thru the winter as stated.

In the area now known to be infested in the New England states, the European corn borer has two generations each season. The first generation worms become full-grown the latter part of July and during August and produce a second generation of moths, which lay eggs for a second generation of worms. These worms reach maturity in
mid-fall and pass the winter in the same manner as in the central areas. In the corn-belt area which has become infested, the insect has only one generation each year, but two generations may occur when the

Injury Done in the Worm Stage

When in the worm or larval stage the insect bores into all parts of the stalk and ear of the corn plant. The interior of the stalk is partly eaten out, and the proper circulation of the plant sap is interrupted. By burrowing in the stem of the ear, the borer cuts off the flow of sap
to the ear. Worms working inside the ear often cause the grain to rot. Stalks frequently break off where weakened by borers, often below the point where the ear has formed. Ears on infested stalks fail to mature properly, and will not keep in storage. In heavily infested fields,

![Image](image_url)

**FIG. 6.—HEAVILY INFESTED SWEET CORN AT MONROE, MICHIGAN, AUGUST, 1926**

Practically all stalks in the field were in the same condition as these, and were found to harbor 4 to 10 or more borers. Only about half the crop was worth taking from the field. (U. S. D. A.)

where the borers may average from 20 to 30 or more to a stalk, complete destruction of the entire crop often occurs.

**Plants on Which the Borer Feeds**

In addition to damaging the corn crop, the corn borer also feeds readily on barley, beans, broom corn, celery, cotton, cowpeas, grain sorghums, sunflowers, sweet sorghum, hemp, hops, millet, peppers, potatoes, rhubarb, asters, beets, chrysanthemums, dahlias, gladioli, and Swiss chard.

In the most heavily infested areas it attacks oats, soybeans, Sudan grass, sweet clover, timothy, artichokes, buckwheat, calendula, cannas, cosmos, geraniums, golden glow, hollyhocks, Johnson grass, marigolds, mignonette, okra, parsnip, salvia, spinach, tobacco, tomatoes, zinnia, and many other plants, weeds, and flowering plants, but it shows a decided preference for the plants in the first list.
Some Farm Crops Only Slightly Infested

Practically no cultivated crop is entirely immune from attack by the corn borer, but in the infested areas in Canada and Ohio no damage has occurred to legumes, with a possible exception of cowpeas, and a very light injury to soybeans. It has not caused any damage in clover fields, including sweet clover, or in alfalfa. The insect does not feed to any extent on cucumbers, melons, pumpkins, squash, and a few other crops of minor importance. In the most heavily infested area in Canada, sugar beets, small grains, and tobacco are now grown more extensively than corn. The insect has not caused any commercial loss in these crops.

What Illinois Has Been Doing to Combat the Corn Borer

A close study of the European corn borer has been made by Illinois entomologists from the time the insect was first known to occur in this country. Representatives of the Natural History Survey or of the Agricultural Experiment Station have attended all important conferences held to discuss means of combating this insect, and have aided directly in clean-up campaigns which have been carried on in some of the infested states. All areas in the state which seemed exposed to infestation have been scouted during each of the last five years.

One of the parasites of the corn borer, which also will work on the smartweed borer, has been brought into the state, and several thousand have been liberated at four points in Illinois.

Exhibits showing the insect and the damage caused by it have been made at all of the principal fairs in the state, including the state fair. A small exhibit has been prepared which has been used by many of the farm advisers at county fairs. Mounted specimens of the insect have been furnished to all high school teachers of agriculture and to all farm bureaus.

Three publications dealing with the insect have been printed, numerous short articles have been furnished the agricultural and daily press of the state, and mimeographed sheets have been issued from time to time giving information concerning the extent of damage from the corn borer. Strict quarantines have been maintained by the Illinois State Department of Agriculture prohibiting the shipment into Illinois of any plant or plant products which it is thought may carry the corn borer.

Destroying Worms Is Most Effective Control Measure

The most effective method now known for controlling the European corn borer is to destroy the overwintering worms in the plants.

These were first introduced in Illinois in the summer of 1922.
where they are sheltering. This is true not only in the infested areas in this country, but also in Europe.

During the past few years much work has been done in developing low cutting attachments for corn binders which will cut corn close to the ground (within two inches), so that the majority of the borers will be removed from the fields and destroyed in case the infested stalks are shredded or cut for silage. Other types of machines are being developed to cut and husk the corn, and cut the stalks into very small pieces which are discharged on to the ground. When corn is run thru such machines, about 98 percent of all borers are killed. Another type of machine has been made for shredding the stubble in order to kill the borers remaining in it. This machine is of special value when the stubble is left high or when the corn is cut late in the fall.

Where the cornstalks, weeds, and other infested plant refuse can be plowed under thoroly in the fall or in the spring before May 1, experience shows that about 98 percent of the borers are killed. Plowing under stalks as ordinarily done will not suffice to destroy the insects; attention is therefore called to the fact that it must be done with especial thoroness.

Disking down cornstalks, as is usually done in preparing the ground for oats and other spring grain, will kill very few of the borers, and should not be practiced in infested areas.
Good Rotations Will Aid in Corn Belt

Late planting of early varieties of corn that will mature early enough to make satisfactory yields is of some value in reducing infestation in the areas where the insect has only one generation.

Good rotations which will permit all plant refuse to be removed from the field and utilized or plowed under, and in which only a moderate acreage is kept in corn and the remainder in non-susceptible crops, apparently offer the greatest promise for controlling this insect under corn-belt conditions. Some of the rotations which will give a maximum amount of non-susceptible crops are as follows:

Three-year Rotations

1. Corn, soybeans, and wheat, with sweet clover seeded in the wheat and plowed under the following spring for corn.

2. Corn, wheat, and clover; the clover to be sweet clover, mixed clovers, or any good biennial legume, and used largely as pasture and green manure.

Four-year Rotations

1. Corn, soybeans, wheat, and red clover; the clover to be cut for seed and hay.

2. Corn, soybeans, wheat, and alfalfa; the alfalfa to be used as a biennial legume seeded either in the wheat or in August after the wheat and turned under at the end of the second season as green manure.

3. Corn, soybeans and oats, wheat, and clover, with the acreage in corn to be divided the next year between soybeans and oats. Rotations in which oats follow corn are not desirable except that they furnish some oats for feed for horses. The cornstalk residue remaining on the ground will contain some borers which will infest the oats.

The Norfolk rotation of corn, spring grain (oats or barley), clover and wheat would not be well adapted to corn-borer conditions, especially when oats are used, since it would bring together two crops, corn and oats, in a rotation which would be unfavorable for corn-borer control. The essential features of this rotation, however, can be retained by lengthening it to five years and using soybeans between the corn and oats, as indicated in the five-year rotation given below. Among the four-year rotations No. 1 and No. 2 not only would give protection against the European corn borer, but also would tend to lessen the damage by several other corn insects.

Five-year Rotation

1. Corn, soybeans, small grain, clover, and wheat, with sweet clover sowed in the last wheat crop and plowed under in the spring for corn.
Fig. 8.—Illinois Farmers Can Well Afford to Give More Attention to the Growing of Sweet Clover in Anticipation of the Coming of the Corn Borer

This rank growing legume has not been damaged by the European corn borer even in the most heavily infested regions. Its use in rotations will provide a sure forage crop and at the same time will improve the productiveness of the soil, thereby making it possible to grow healthier corn plants which will be better able to withstand attacks of the borer.

Fig. 9.—Soybeans Are Not Seriously Damaged by Heavy Infestations of the European Corn Borer

This annual legume, which may be harvested for either hay or seed, may be grown in the rotation in place of oats the year following corn.
(2) Corn, soybeans, corn, wheat, legumes. In this rotation the legume may be sweet clover, alfalfa, red clover, or clover mixtures, which may be used for hay, seed, or pasture, according to the selection made.

**Six-year Rotations**

(1) Corn, soybeans, oats, mixed clover, wheat, and alfalfa.

(2) Corn, soybeans, wheat, mixed clover, corn, and soybeans.

(3) Corn, soybeans, oats, legumes, corn, wheat, with sweet clover seeded in the wheat and plowed under in the spring for corn. In this rotation the legumes may be similar to those described in No. 2 under the five-year rotations.

While these rotations offer considerable promise in corn-borer control, any one of them may have shortcomings from other points of view as applied to any particular farm. There are farms for which some would be unsuitable from the standpoint of labor distribution. For instance, several of them require spring plowing on two-thirds or more of the land, a practice which probably would not be feasible on large farms, but which might be profitably used on small farms, especially where considerable livestock is kept. Others might not give as large a proportion of high-profit crops as is desirable for maximum profits.
Some of these rotations would require a larger use of livestock in order to utilize most profitably the larger proportion of legumes called for.

Thus the selection of any of these rotations for any particular farm should be considered from the standpoint of the economical use of labor, power, and equipment, feed required for livestock, and a large proportion of high-profit crops, as well as from the standpoint of corn-borer control and soil fertility.

Put Land in Condition to Produce Maximum Yields on Large Healthy Stalks

Anything the farmer can do to put his land in condition to produce maximum yields of corn on large healthy stalks will be of considerable value in helping him to meet the problems imposed by the advance of the corn borer.

In the first place, corn plants with large stalks will not be so readily injured by the same number of borers as will small, weaker stalks.

In the second place, the advance of the borer will tend to reduce the acreage planted and to increase the acre cost since additional labor will be necessary to destroy the insects in the crop and weed refuse. Larger yields to the acre will tend to maintain a normal total production. They will also reduce the cost per bushel, thus compensating for the increased labor of growing corn under corn-borer conditions.

Larger yields per acre can best be obtained by adopting soil management practices that will keep the soil in a high state of productivity. Such practices include the use of good crop rotations, the growing and proper utilization of legumes, and the use of soil treatment materials such as limestone and phosphate on soils in need of them.

Insect Enemies of Borer May Prove Helpful

Parasites undoubtedly will be of value in helping to control the European corn borer, and a search for its most effective insect enemies is now being made in many different parts of the world where the pest has been known for a long period of years. Some of these parasites are being liberated in Illinois and many thousands of them have been put out in parts of Michigan, Ohio, New York, Massachusetts, and Canada. It may be at least ten or fifteen years, however, before much help can be expected from these insects. Judging by their work in Europe, they will not be able to kill more than 15 to 30 percent of the corn-borer worms. It is possible that more effective parasites may be found in other parts of the world.
Send Suspected Insects to Natural History Survey for Identification

Several other borers work in corn and weeds in much the same manner as the European corn borer. Of these, the smartweed caterpillar or borer resembles the European corn borer so closely that it is impossible to tell them apart except by microscopic examination. The common stalk borer, a native insect, is also frequently found in cornstalks, especially around the margins of the field. None of these insects, however, is very destructive.

In order to aid in locating the European corn borer in Illinois, any one finding insects which he suspects to be the corn borer is urged to send them in at once for identification to the Natural History Survey at Urbana. Such cooperation will help to control the spread of the insect in this state.