Learning to Live With the European Corn Borer

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

The European corn borer continues to spread into the corn belt. Illinois farmers can avoid serious damage by this insect if they will make proper preparations to fight it before it becomes abundant in the state.

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A Program for Preventing Serious Corn-Borer Losses in Illinois

1. Keep soil in a high state of fertility in order to produce good yields and hasten the maturity of late-planted corn.

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 13. Such rotations allow the growing of the 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 or as finely shredded material.

5. Turn under or burn completely by May 15 all corn refuse and weeds in cornfields.

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

7. Practice clean plowing. Ninety-five percent or more of the corn borers will be destroyed if all crop and weed refuse is entirely covered.

8. Become familiar with quarantine and clean-up regulations and help in every way possible to carry them out.

9. Watch fields for the presence of this insect and send suspected specimens to the Natural History Survey, Urbana, for identification.

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Learning to Live With the European Corn Borer

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The European corn borer in 1927 has continued to advance into the corn belt of the United States and Canada. Approximately 100,000 square miles are now known to be infested in the United States and the area in Canada is nearly half as great.

The intensive large-scale clean-up campaign carried on in Ohio, Michigan, Indiana, New York, and Pennsylvania in 1927 may have retarded to some extent the rate of the spread of the insect, and there can be no question but that the clean-up has greatly reduced the abundance of the borer within these areas of infestation. From 90 to 95 percent of the borers in the cornfields in the infested areas were killed before the moths emerged in the spring.

Largely as a result of the clean-up very little commercial damage occurred in Ohio or Michigan, where the corn borer has been established for six years. Within the heavily infested area there was about a 50-percent increase in the borer population, but this increase would certainly have been much greater had there been no clean-up.

It seems evident from the results of the campaign of last year and the experience of previous seasons, that the European corn borer

**FIG. 1.—FIELD OF DENT CORN DESTROYED BY THE EUROPEAN CORN BORER**

Such a condition means not only a complete loss of the crop, but also that the labor of trying to grow the crop has been thrown away. (Canadian Department of Agriculture).
will continue to spread over the corn belt, and that the farmers of Illinois will have to learn how to live with it and to produce good yields of corn in spite of it. There is every indication from the experience of the past year that they can do this. As stated in the circular issued a year ago under this title, there are several practical methods which farmers can use in combating the insect. The clean-up campaign of the past season has disclosed no new methods, tho it has furnished information on how the previously known methods can be more effectively used and how they may be better adapted to Illinois conditions.

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 that has become infested, the insect has only one generation each year, but two generations may occur in the southern two-thirds of Illinois and Indiana, and in Missouri, when the borer becomes well established.

Injury Done in the Worm Stage

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

**Plowing Under Crop Refuse and Weeds Offers Best Method of Control**

In the United States, as well as in the Old World, the most effective method of controlling the corn borer has been to destroy the crop refuse and weeds which harbor it. While the borer goes thru four stages in its growth—egg, larva (or “worm”), pupa, and moth, as explained more fully on page 8—the entire period from September until June is passed in the second or “worm” stage, mainly within the stems and stalks of plants. The complete and clean plowing under, to a depth of 6 inches, of all infested crop refuse and weeds, or the burning of such material, will kill from 95 to 97 percent of all borers in a field. Even where such work is most carefully done, a few of the borers will escape, but experience in the infested areas indicates that it may be possible by these methods to clean up enough of the borers to prevent any serious crop losses the year following.

![Fig. 3.—Plowing Under Cornstalks with a Plow, Using a Rolling Coulter, Jointer, and Covering Wires](image)

With these attachments all cornstalks and trash can be turned under clean and deep. The best covering is secured by the wider-bottom plows. (U.S. D. A.)

Until better methods of control are developed, most of the crop clean-up will have to be done by mechanical measures, which include the gathering and burning of crop refuse, the ensiling, shredding, or cutting up of infested stalks and stubbles, and the clean and thorough plowing under of all crop refuse and weeds.
Surface of Ground Must Be Left Clean of All Trash

Field experiments in Ohio show that plowing-under infested cornstalks and stubbles is an effective method of control, provided the stalks, stubble, and trash are turned under so completely that nothing remains on the surface (Fig. 3) and no refuse will be dragged to the surface when the seed bed is being prepared or when the crops are being cultivated before the moths emerge. This plowing should be done in such a way that no large cracks or crevices are left in the surface.

The actual plowing operation kills only about 15 percent of the borers in an infested field. The others work their way to the surface sooner or later. If all trash has been covered completely, the borers that come to the surface cannot find shelter and die or are killed by birds, ants, ground beetles, and various insects.

Poor or ordinary plowing will not control the corn borer. In fact, a poorly plowed field makes other methods of clean-up very difficult.

Plow Must Be Properly Adjusted

Good, clean plowing can be done only if the plow is properly adjusted and special attachments are used for covering the trash. The general-purpose bottoms have given better results than the stubble bottoms in burying the trash deeper and more completely. The wider bottoms, 16-inch and 18-inch, have given the best results in covering stalks. However, a 14-inch bottom properly adjusted and equipped for covering trash, has given very good results.

The adjustment of the rolling coulter and jointer is very important in securing a good covering of the stalks. The coulter should be set far enough to the land, usually 5/8 to 3/4 of an inch, so that the plow will make a clean furrow bank. The coulter should be set to cut one-half to three-fourths the depth of the furrow, just deep enough to cut thru all the trash. For average conditions the position of the coulter on the beam should be approximately over the point of the share when the share is new. When the trash is dry, the coulter works better if set forward and higher. In wet, heavy trash, the coulter may give better results by being set back closer to the shin of the plow. A rolling coulter with a large diameter should be used, as the clearance for the coulter yoke is greater.

The jointer should be set to cut from 1 1/2 inches to 2 inches deep, and it is very important that the point of the jointer be set up close to the coulter to prevent trash from getting in between the coulter and the jointer.

The use of covering wires is very desirable. No. 9 wire from 10 to 15 feet long is used. One end is fastened to the yoke of the coulter and the free end allowed to drag under the newly turned furrow slice. The weight of the furrow slice keeps the wire stretched tight, and the wire holds the trash firmly against the furrow slice.
and prevents the usual pitching of the trash. In many cases a second and third wire on each bottom is desirable. The second wire is

![Image: This type of plowing makes corn-borer control difficult](image1)

**FIG. 4.—THIS TYPE OF PLOWING MAKES CORN-BORER CONTROL DIFFICULT**

Without the use of rolling coulter, jointer, and covering wires it is impossible to do a satisfactory job of plowing, under corn-borer conditions. The amount of trash to be covered in this field was very small, but even then entirely too much was left exposed. As shown in Fig. 5, the borers that come to the surface after having been plowed under will find shelter in these pieces of stalk and trash. (U. S. D. A.)

usually fastened on the coulter shank just below the beam, and the third on the beam about 2 to 2½ feet in front of the coulter shank.

![Image: Larva of corn borer in piece of weed](image2)

**FIG. 5.—LARVA OF CORN BORER IN PIECE OF WEED**

A larva of the corn borer in a 6-inch piece of weed stem on the surface of a plowed field. When small bits of cornstalks or weeds are left in this way, the corn borer will shelter in them and later transform to the moth stage, laying its eggs on the growing corn and continuing its work of destruction. (U. S. D. A.)
The hitch of the plow should be adjusted so that the plow runs smoothly and cuts an even depth and width.

**Better Not to Disc Before Plowing**

Better results are obtained by not discing the stalks before plowing. If a tractor plow is used, no previous operation is necessary. When horses are used, some difficulty is experienced in getting them to walk at the right place. Under those conditions it is better to pole or roll the stalks down in the direction in which the land is to be plowed. Poling, raking, and burning stalks as ordinarily practiced in Illinois will not destroy a very high percentage of the borers.

**Cutting for Silage Kills Borers**

When corn is cut for the silo, the stubble which is left should not be over 2 inches high. If this precaution is taken, the majority of the borers will be removed from the field and killed by the ensilage cutter, and the remainder will be killed in the silo. Low-cutting attachments are now available for practically every make of corn binder.

**Discing Down Stalks Leaves Many Live Borers**

Discing-down cornstalks, as is usually done in preparing the ground for oats and other spring grain, kills only about 11 percent of the borers and should not be practiced in the infested area.
FOUR STAGES IN LIFE OF EUROPEAN CORN BORER

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

When full-grown, the worm is about 1 inch long by \( \frac{3}{8} \) inch thick. 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 back. Upon becoming full-grown, the worm changes to the pupal stage, in which it is about \( \frac{3}{4} \) of an inch long by \( \frac{1}{10} \) of an 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 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 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 this form 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 4 to 6 days and at once begin to seek shelter in the stems or larger leaf veins of the corn or other plants. They continue 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.

The following colored plate shows the borer in its different stages and indicates the places where, in connection with infested corn plants, it is to be found each month of the year.
WHERE TO FIND THE CORN BORER EACH MONTH OF THE YEAR—
May—larvae in bits of old cornstalks scattered over planted fields.
June—larvae and pupae in old stalks, moths on wing, eggs being laid.
July—some pupae, many moths, eggs, and young larvae. August—still
a few moths and eggs, many larvae in various stages. *September—many full-grown larvae. October—full-grown larvae within stalks. November to March—larvae in corn and weed stalks in and about cornfields. April—larvae in broken or disced cornstalks.*
Burners Not for General Farm Use

Special oil burners and stubble pulverizers will probably be very little used in Illinois. Destroying borers with oil burners costs from $12 to $15 an acre. A large outlay is required for expensive equipment, and a large force of men for the operation.

![Image](https://example.com/image.jpg)

Fig. 7.—Feed Lots Should Be Cleared of Cornstalk Refuse

If infested stalks are left in the lots during May and June, many corn-borer moths will emerge from them to lay their eggs in nearby cornfields. All such refuse should either be burned or moved to the fields and thoroughly plowed under. (U. S. D. A.)

The stubble pulverizer proved only partially satisfactory in the infested area last spring. For best results the stubble should stand erect, and be not over 10 inches high. Since there are very few stubble fields in Illinois, the stubble pulverizer will have little if any use in this state.

Growing Right Crops Will Help

In order to use mechanical measures to best advantage, Illinois farms must be put into shape to meet the borer. This means having as many acres as possible in crops that will not be seriously damaged by the borer and planting corn only on land which is capable of producing good yields. Under borer infestation the cost of growing corn will be increased because of the expense of clean-up. For this reason, the corn acreage should be reduced if possible and the yield per acre increased by keeping the land planted to corn in the highest possible state of fertility.

It should also be borne in mind that many of the common farm crops are not commercially injured even tho they may be slightly infested. Of the field crops commonly grown in Illinois, corn, sorghum and broom corn are the only ones likely to be seriously damaged. Legumes and small grains are not commercially damaged even in the most heavily infested areas in Canada. A few borers may be found in these crops, however.
Borer Feeds on Many Plants

While the corn borer is recognized primarily as a corn pest, it does feed to some extent on other farm crops, such as barley, beans, broom corn, celery, hops, millet, peppers, potatoes, rhubarb, asters, beets, chrysanthemums, dahlias, gladioli, and Swiss chard. Altho the borer feeds readily on these crops, its damage is not equally serious on all of them. In the case of barley and millet, for example, the plants mature a crop before the larvae become most destructive. For this reason some crops which are really susceptible may not be commercially damaged.

FIG. 8.—SOYBEANS ARE NOT SERIOUSLY DAMAGED BY HEAVY INFESTA-
TIONS 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.

As the borer population becomes greater and the eggs, and therefore the larvae, more generally distributed, other plants not mentioned in the above list are usually found infested. The following crops, while not among the preferred foods of this insect, nevertheless are damaged more or less in heavily infested areas: oats, soybeans, sudan grass, sweet clover, timothy, artichokes, buckwheat, calendula, cannas, cosmos, geraniums, golden glow, hollyhocks, Johnson grass, Marigold, Mignonette, okra, parsnip, salvia, spinach, tobacco, tomatoes, zinnia, and other plants and weeds.

Under conditions of heavy infestation in the corn belt, where the borer will likely feed chiefly on corn, the weeds in the cornfields and along the margins of the fields are likely to be found infested. Other crops growing in adjoining fields are almost certain to show a heavier borer population than the same crop somewhat farther removed.
Injury Less to Short-Season Varieties of Corn

The corn borer, destructive as it is, apparently finds some difference between varieties of corn. Susceptibility or resistance to attack by the insect is a somewhat recent but apparently worth-while line of investigation. The studies carried on thus far seem to indicate that the variety, strain, or hybrid having a relatively short, thick stalk, has much more resistance to corn-borer attack than the variety with a tall slender stalk.

Early maturity is another character that is highly desirable in a resistant corn, for it will permit later planting, which will prove of some value in reducing losses, especially in the areas where the insect has only one generation. Hastening the growth and maturity of such varieties by means of the right soil treatment and good rotation practices will increase their yields on most farms.
Good Rotations Will Aid in Corn Belt

Crop rotations which will improve the productivity of the soil, and 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 rotations which provide a maximum of non-susceptible crops are the following:

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.

Rotations in which a winter grain, such as wheat, follows corn, are not practical under corn-borer conditions except when the corn can be removed for silage or for other feeding purposes by an effective low-cutting device or else in plenty of time to allow for thorough plowing.

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.

A rotation of corn, spring grain (oats or barley), clover and wheat is not well adapted to corn-borer conditions. This is true especially when oats are used, since the bringing together of two crops such as corn and oats would be favorable to the corn borer, unless the oats ground was well plowed. The essential features of this rotation, however, can be retained by lengthening it to five years, and using soybeans between the corn and the oats, as indicated in the five-year rotations given below. The four-year rotations not only would give protection against the European corn borer, but would also tend to lessen the damage by several other corn insects.

Five-Year Rotations

(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.

(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, 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 will require a larger use of livestock in order to utilize more profitably the larger proportion of legumes.

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 the proportion of high-profit crops, as well as from the standpoint of corn-borer control and soil fertility.

Put Land in Good Condition

Anything the farmer can do to put his land in condition to produce high yields of corn on large, vigorous stalks will be of 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 smaller, weaker stalks.

In the second place, short-season varieties that may be planted late to avoid heavy infestation are much more likely to produce satisfactory yields on soils that are productive.

In the third 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.
Illinois Takes Active Measures Against the Corn Borer

From the time when the European corn borer was first discovered, entomologists of the Natural History Survey and members of the staff of the Experiment Station have been making a close study of the insect and cooperating in experiments carried on by federal and state agencies with a view to controlling it. Assistance has been given in clean-up campaigns in the infested states. Previous to 1927 the areas which apparently were most exposed to infestation were thoroly covered by trained scouts from the United States Bureau of Entomology working in cooperation with scouts from the Illinois State Department of Agriculture. The area where a borer was reported found in Illinois in 1926 has been thoroly and repeatedly gone over during 1927 without finding any trace of infestation. One of the European parasites of the corn borer which will also parasitize our native smartweed borer, has been bred at the laboratory of the Natural History Survey in Urbana for the past five years, and several thousand of these parasites have been liberated at four points in the state.

Exhibits showing the European corn borer in its different stages, and the work of the insect, have been used at all the principal fairs in the state, including many of the county fairs. Such exhibits were shown during 1927 in cooperation with the farm bureaus at some 76
fairs and large farmers' gatherings in the state. Mounted specimens of the borer have been furnished to all high school teachers of agriculture, and all farm bureaus in Illinois.

An attempt has been made to keep the farmers and business men of the state fully informed concerning the progress of the insect by articles in the daily press, the farm press, and talks given at farmers' meetings and meetings of business men.

Four publications dealing with this insect have been put out by the Experiment Station and Natural History Survey.

The Illinois State Department of Agriculture has cooperated with the federal Department of Agriculture in maintaining the strict quarantine which prohibits the shipment into Illinois of any plant or plant product which is thought likely to carry the European corn borer.

During the season of 1927 field experiments were begun at several points in the state to study the yielding possibilities of a considerable number of varieties of corn when planted late. A number of the varieties are being studied in connection with various kinds of soil treatment. Preliminary observations indicate that some very interesting differences will be obtained when the final yields are secured. This work in a few years should give valuable information as to the varieties and soil treatments which will prove most satisfactory under corn-borer conditions.

Arrangements have also been made for starting other and more extensive corn-borer experiments along agronomic lines. The aim of these experiments will be to test out farm practices that have been found effective in other areas to see whether they can be used under Illinois conditions. A large number of the most widely grown Illinois varieties of corn are being tested for their susceptibility to borer infestation on the federal corn-borer plots at Monroe, Michigan, and at Bono, Ohio.

Insect Enemies of the Corn Borer

The United States Bureau of Entomology has been making a very determined search for insect enemies of the European corn borer. From those parts of the world which are known to have been infested by the borer for hundreds of years some twelve species of parasites have been successfully shipped to North America. After being carefully studied, they have been liberated in the infested area in New England and the Middle West. The Canadian government has cooperated with the United States in this work, and to date more than 5,000,000 parasites of 12 different species have been liberated. Six of these species are known to have become established. Judging by what is known of the effectiveness of these parasites in reducing the numbers of the corn borer, it will require a number of years for them to produce any noticeable reduction in corn-borer damage. None of the parasites which are being liberated are capable of causing any damage to cultivated crops.
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 insect in this state.