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The European Corn Borer and Its Control

BY C. J. Drake, G. C. Decker and H. M. Harris.

In the relatively short time since the European corn borer reached the concentrated corn-growing areas of Illinois and Iowa, the population increase and rate of spread have been greatly accelerated. Its advance across Illinois and deep into Iowa has been from 50 to 100 miles a year. The spread of the borer after its discovery in Clinton County in 1942 is shown in fig. 1.

The last few years, which have been exceptionally good corn-growing years, likewise have been good for the borer. Thus, it appears that weather, soil conditions, farming practices and other agricultural factors most favorable for growing large acreages of high-yielding corn are also quite favorable to the borer. As the borer spread into Iowa during 1942 and 1943, its buildup has been most rapid in the counties of more intensive corn production. In general, the borer population is heaviest from Clinton and Scott Counties westward toward the central part of the state. Conversely, the population rise has been much less rapid in those in-

Fig. 1. Map shaded to show counties infested by European corn borer in 1942 and 1943.
fested counties along the southern and northern borders, where corn-growing conditions are less favorable and the corn acreage much smaller.

Inasmuch as the European corn borer has been in Iowa for only 2 years, it is too early to forecast with any degree of accuracy the future trends of infestation and to designate areas likely to be most favorable to its abundance. It is reasonable to assume, however, that the borer population in various parts of the state will rise and fall from time to time under the influence of varied environmental conditions. Several years of experience and research will be required to clear up some of the questions and uncertainties which now confront corn growers and agricultural workers.

ECONOMIC IMPORTANCE

Although no serious commercial losses have occurred in Iowa, it is time for farmers to familiarize themselves with special farm practices and other measures of corn-borer control. Slightly more than one-half of the state (fig. 1) is now known to be infested. In the easternmost two or three tiers of counties, borers can be readily found in almost any corn field. In 1943, slight commercial losses occurred in some fields in Clinton, Scott, Muscatine and Jackson Counties. Fall surveys by state and federal entomologists showed the borer population in the most heavily infested fields was from about 50 to more than 500 borers per 100 corn plants. According to the survey, the average number of borers per 100 plants was 114 in Clinton County, 98 in Scott County and 24 in Muscatine County.

No attempt has been made to estimate the borer damage in dollars in Iowa in 1943, nor to predict losses in 1944. The estimated 1943 yield from 10,860,000 acres was 640,740,000 bushels, an average of 59 bushels per acre. An increase in corn acreage to 11,500,000 is requested in 1944 by wartime planning officials. Corn borer losses of only a small percentage on this immense acreage would amount to a huge sum. Thus, the cooperation of all farmers and a coordinated state program are needed to protect Iowa's greatest crop.
LIFE HISTORY IN IOWA

From field observations, it appears that from 80 to 95 percent of the borer population passed through two generations a year in Iowa in 1942 and 1943. The remainder of the population was single brooded and had only one generation. The four different stages of the borer and the seasonal life history of the two-generation form are diagrammatically illustrated in fig. 2. As the details of the life history have not been worked out under Iowa conditions, the time of appearance and duration of the various life stages indicated in fig. 2 are only approximate.

The one-generation moths tend to appear slightly later in the spring, and the caterpillars then remain active during the entire summer. These borers do not transform into pupae and moths until the spring of the next year. Most of the research work in the Great Lakes region has been done with the one-generation borer.

TIME OF APPEARANCE OF THE STAGES

The corn borer passes through four stages in its development: (1) moth or adult; (2) eggs; (3) larva or caterpillar, commonly called borer; (4) pupa or resting stage.

Fig. 2. Life stages and seasonal history of the corn borer in Iowa.
Winter is spent by the borers as fully grown caterpillars, largely in tunnels in corn stalks. Some, however, hibernate within burrows in thick-stemmed weeds, others in cultivated plants or even corn cobs. The young larvae, moths, pupae and eggs do not survive the cold winters of the northern states. The fully grown borer is very hardy and when overwintering in its galleries within the stems of plants is not greatly affected by weather and low winter temperatures.

During May and June, the overwintered caterpillars transform into pupae and the moths issue about 10 days after pupation. The first moths appear in early June and emergence continues into July. They are active at night and can fly anywhere in a community on their own initiative, from farm to farm, or even from county to county. The life span of an individual moth varies from a few days to more than 3 weeks. During this period, the average number of eggs laid by a female is about 400. More than 1,900 eggs have been laid by individual females in cage experiments. The infestation and spread in Iowa are the result of dissemination through flight of the moths.

The eggs are laid in small scale-like clusters, usually of 10
to 25 each, and are placed preferably on the under side of corn leaves. They are very small and white when laid, but soon turn yellow to dark in color as the larvae within develop (fig. 3). Development is rapid in warm weather, most eggs hatching in less than a week. After feeding on the foliage for a very short period, the larvae enter the leaf whorls or other parts of the plant and become internal feeders, and then tunnel the stalk, tassel, or ear until full grown (fig. 4). The moths of the second generation begin to issue about the last of July, and the peak of flight and egg-laying is reached near the middle of August. The larvae which hatch from these eggs become mature in September and early October, and then hibernate within the shelter of their burrows (fig. 2).

Generally speaking, there is a much higher survival of larvae of the second than of the first generation. In both broods, the larval mortality between the time of hatching and establishment in the corn plant is high. This critical time is a very short period immediately after hatching when the young larvae on the surface of the corn leaves (fig. 5) are exposed to the weather and to natural enemies.

Fig. 4. Heavily infested sweet corn plant's, showing damaged tassels, ears and stalks.
PLANTS ATTACKED BY THE CORN BORER

In America, the corn plant is the preferred food of the European corn borer. This includes dent and flint field corn, sweet corn and pop corn. Light infestations have been found in the Great Lakes region in certain other cultivated crops such as broomcorn, sorghum, oats, wheat, hemp, potato, soybean, buckwheat, gladiolus (fig. 6), dahlia and cosmos. Also, many common weeds are at times attacked directly as food plants or tunneled in the fall by borers seeking favorable shelter for hibernation. These include pigweed, smartweed, cocklebur, foxtail, panic grass and other wild plants growing in or near infested corn fields. Altogether more than 200 different species of plants are recorded as serving as host or shelter plants for the borers in the infested territory in New York State and along the Atlantic seaboard. The multiple-generation borer attacks a wider range of plants than the one-generation.

Fig. 5. Newly hatched and hatching corn borers.
SIGNS OF INJURY AND DAMAGE

Early evidence of injury to young corn plants (fig. 7) is in the nature of small holes and scars in the leaves. Severe ragging (fig. 8) soon becomes noticeable after the borers have begun feeding within the unfolding leaf whorls. Later, whitish frass cast out of tunnels (fig. 9) in various parts of the stalks, broken leaves resulting from the tunneling of small borers in midribs, broken tassels, and, as the season progresses, prematurely lodged stalks and fallen ears are characteristic of the presence of the borer. In moderately heavy to heavy infestation, the damage becomes more apparent from day to day, and injury is soon easily detected. In lightly infested fields, there are sometimes few or no very obvious external injuries to indicate the parts attacked or the presence of the borers.

As indicated above, the character of injury depends to a large extent upon the age or stage of development of the plant when it is attacked. Young borers working in the whorl or tassel are not in themselves serious, but larger borers working in the main stalk at the time ears are developing result in the production of smaller ears and “nubbins” or even no ears at all. A single borer in a plant may not do serious damage, but when several borers attack the same plant the stalks are frequently so weakened that serious breakage is inevitable.

The external openings to the
burrows within the growing corn plant form favorable avenues for the entrance and development of disease organisms. In heavily infested fields, stalks are frequently badly decayed before corn ripens in the fall (fig. 10). Late summer and fall rains hasten the destruction of heavily infested plants.

CONTROL

At present there seems to be little prospect of developing any one single remedy or practice that will control the European corn borer. Furthermore, since the moths fly freely from farm to farm, experience has shown that satisfactory corn borer control cannot be attained in any area without neighborhood cooperation. The degree of control will therefore depend to a large extent upon the degree of community action. The entire neighborhood should be organized so that each farmer will undertake the clean-up measures needed to kill the corn borers on his farm as well as to carry out the other remedial measures. Success depends upon thoroughness.

Natural Enemies: Native predators, parasites and diseases
have not been of very great consequence in reducing corn borer population.

A number of European and Asiatic parasites of the corn borer have been introduced into the Eastern and Great Lakes regions of the United States by the Bureau of Entomology and Plant Quarantine. Some of these promise to be of considerable value in helping American farmers in their fight against the corn borer. Three of the most promising species will be introduced into eastern Iowa in 1944. Although parasites may be valuable allies, they merely supplement but cannot substitute for other control measures. It should be emphasized that these introduced parasites live exclusively on other insects and therefore cannot injure plants, domestic animals or man.

**Insecticides:** To date, control of the corn borer by the use of insecticides has not proved practical except in the case of early market sweet corn and highly valuable breeding plots where the cost item for control is not prohibitive. In view of the shortage of insecticides and changing priority regulations, those interested in spraying or dusting should
write to the Entomology and Economic Zoology Section of the Iowa Agricultural Experiment Station for timely instructions.

**Clean-up Practices:** Since the European corn borer spends the winter as larvae in the corn stalks, plowing under all stalks, weeds and other crop refuse capable of harboring the borer in corn fields will, to a large extent, eliminate this source of infestation. In the Great Lakes region much of the corn is cut for silage or shredded fodder and the stubble fields are then frequently plowed for other crops, whereas in Iowa a large percentage of the corn stalks are neither removed from the field nor plowed under before seeding small grain in the spring. Breaking down and then disk ing corn stalks before oat or barley seeding does not adequately reduce the borer population. This cultural practice may in part account for the rapid increase of the borer population in this area and may also suggest that Iowa farmers will sooner or later have to adopt practices that will largely eliminate the crop residue hazard each year. Undoubtedly early adoption of such a program would materially retard the rate of borer population increase in the state. Plowing so as to completely cover all stalks and debris in corn fields before May 20 will destroy practically all borers. It is, however, essential that subsequent cultivation should not expose the buried crop residues before the insects emerge.

When infested crop residues are turned under the active borers soon leave the buried stalks, crawl to the surface of the plowed ground, and then enter almost any type of exposed debris in order to escape their enemies and obtain shelter. For that reason, even small amounts of uncovered plant materials in plowed fields may harbor large numbers.
of borers (figs. 11 and 12). When no suitable shelter is available the borers soon perish from exposure to the weather and natural enemies. Thus, complete coverage of debris is most essential (fig. 13).

The use of special plow attachments such as moldboard-type jointers, trash shields or wires with proper attachment and correct adjustment will greatly assist in obtaining complete coverage of stalks, weeds and other crop residues. Equally important too, in securing complete burial of the stalks is the skill of the plowman. Present plowing methods will need to be improved for borer control.

In the late summer and fall as the corn plants begin to ripen and dry, the borers tend to move down so that a large percentage of them are then found in the lower joints of the stalks. If low-cutting devices are used so as to cut corn at the ground level and the stalks are removed, plowing is then not essential before seeding to small grain. The reasons for the need of low-cutting devices are obvious.

Fig. 10. Corn stalk split open to show larvae, tunnels and advanced stage of decay resulting from borer attack.

 Burning of corn stalks is not good agronomic practice and is not recommended. In most cases, the loss of organic mat-
Fig. 11. Small pieces of corn stalk left on surface of plowed ground harbor large numbers of borers.

...ter and other disadvantages from burning more than offset any good that may be accomplished. Corn stover and the refuse in feedlots should be hauled out and also plowed under before May 20.

Delayed Planting: Corn borer moths of the first generation tend to select the fields of tallest corn available for ovi-position. Hence, fields planted very early, particularly on fertile soils, attract more moths and receive more eggs than fields planted at a later date, or on poorer soils. Delayed planting as a control measure has long been stressed in areas where the single-generation strain of the borer is predominant. In Iowa and other areas where the two- or multiple-generation condition predominates, this recommendation needs to be somewhat modified.

Since the moths of the first generation concentrate their eggs on very early corn and the second-generation moths concentrate on late corn, intermediate plantings are likely to escape most serious damage. In other words, the optimum planting dates, which normally are most favorable...
for maximum yield, remain unchanged. Survival of newly hatched borers of the first generation is much lower on the younger or later planted corn, therefore a delay of a few days in making the earliest plantings tends to increase larval mortality. Corn planted very late will be in a favorable state of development to attract second generation moths for egg deposition. The latest plantings may suffer a heavy yield reduction from the borers as well as from lateness of planting. Therefore very early plantings and very late plantings are to be avoided.

**Use of Resistant and Tolerant Strains:** Hybrids and open-pollinated varieties vary in their resistance, tolerance and susceptibility to corn borer attack. No immune or even near immune strains are now available. In some cases actual resistance is not easily proved, whereas in other cases resistance and tolerance can be definitely seen in the field as well as in yield tests. For the most part, the experimental data available deal with the resistance of inbred strains and their crosses. Data on field trials of many hybrids produced by commercial breeders are not readily accessible. Some hybrids are not as yet fully tested. Where the parentage of hybrids is not known, growers should use discretion in weighing various claims and counter claims.
In selecting a hybrid, it is well to consider the following:

1. The immediate concern of the corn grower is the production of a maximum yield of high quality corn, despite the corn borer.
2. Hybrids known to be well adapted for use in a community are most likely to produce well under borer attack.
3. Hybrids with strong stalks and ear shanks will probably be more tolerant and stand up better under borer attack.
4. Hybrids generally tend to be resistant in proportion to the resistance of the inbreds used in their production.
5. Information on hybrids adapted to a community may be obtained from the County Extension Director.

The recommendations given above have been studied and approved by the Agricultural Experiment Station and Extension staffs concerned. Clean plowing, so as to completely cover all stalks, weeds and crop residues in the heavily infested corn fields, the proper timing of the plantings, and the planting of adapted hybrids are the only control measures that need to be adopted for the 1944 corn crop in Iowa. As the borer population continues to build up and spread, the control program will have to be modified from time to time.