CIRCULAR 164
APRIL, 1947

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION
NEW HAVEN

Control of the EUROPEAN CORN BORER *by Dusts and Sprays*

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Large-scale experiments completed in 1940 and 1941 established the fact that dusts would control the European corn borer profitably in early sweet corn. In spite of the fact that four dusts applied at intervals of five days provided only 70 per cent borer-free ears, returns for dusted corn were from $200 to $250 an acre more than for untreated corn. Cost of treatment was estimated at about $42.50 an acre with labor at 50 cents an hour.

Research completed since these experiments were reported has added information which can be applied to provide more effective control of the European corn borer at a lower cost per acre.

DESCRIPTION OF BORER

The larva of the European corn borer is dirty white in color, almost an inch long when fully grown, and marked with rows of small round brown spots. It may be found in the stalk or ears of corn. It should not be confused with the corn earworm, a much larger caterpillar which feeds in the silks and tips of the ears only. Corn earworms may be colored from light green to brown and may be marked with alternating stripes running lengthwise of the body. The fall armyworm is about the same size as the earworm, and is usually light brown in color. It may attack leaves or ears, and the infestation in ears is not confined to silks and tips.

In general, the control measures given here will not prevent damage by these other caterpillars attacking corn.

SEASONAL HISTORY OF THE CORN BORER ON CORN

The mature larvae pass the winter within their burrows in the stalks of infested corn. During the last half of May these larvae transform to pupae, and the moths emerge late in May and during the first half of June. Eggs are deposited in masses on the underside of the lower leaves of the corn plants. The young larvae hatch within a week or ten days and may feed for a short time on the leaves, but they soon migrate to the stalks. There they seek out the developing tassel. Larvae hatching after the tassel emerges enter the young ear shoots. As the plant develops, the larvae that fed on the tassel migrate to other parts of the plant, chiefly to the stalk. The period of hatching of the eggs lasts about a month; in normal seasons it occurs during June.

The first generation larvae become fully grown in July, pupate at once, and emerge as moths during the last half of July and most of August. They fly to fields of late corn, and infest the plants as described above. Second generation larvae are found late in July and early in August and are present until late in September. They pass the winter in this stage.

It is obvious that the infestation of corn is influenced strongly by the generations of larvae. In general, sweet corn is most heavily infested when it matures at the same time the generation of larvae reaches maturity. This means that corn harvested during July, particularly the first three weeks of July, is usually seriously damaged. Corn harvested during the last week of August and early in September may also be heavily infested. The crop maturing during the last week of July and the first two or three weeks of August is usually not infested by the corn borer. Studies completed several years ago showed that the date of harvest was more closely related to the degree of infestation than the date of planting of varieties of different maturity.

In terms of planting dates, midseason varieties planted during the last two weeks of May and the first week of June usually escape serious damage by the corn borer. Seasons vary a great deal, but the factors that stimulate or delay the growth of corn usually affect the corn borer in a similar manner.

CONTROL BY APPLICATION OF INSECTICIDES

The use of sprays and dusts to control the European corn borer depends on the fact that in spite of being borers, the larvae feed where they can be reached by insecticides for a large part of their lives. They migrate as newly hatched larvae, and at this stage are particularly easy to kill. Larger larvae also migrate freely, but are not so easily killed. The method of treatment, developed originally by Dr. C. H. Batchelder of the Federal Bureau of Entomology and Plant Quarantine, involves several treatments during the period when larvae are hatching. Repeated treatments have been necessary because the plants grow rapidly during this period.

Timing and Number of Treatments

Studies by Beard have shown that larvae hatching before the tassel is formed in the whorl seldom survive. The appearance of the tassel is therefore an accurate measure of the time to start treatment. A convenient system is to dust or spray as soon as half of the plants have tassels that can be seen by looking directly down into the plant.

Careful tests over a period of years have shown that the law of diminishing returns applies to the number of treatments. Application of two treatments did not provide twice as good control as one, and six treatments were not twice as effective as three. The application of three or four treatments was usually necessary to provide a high degree of control, however. Further, there did not appear to be any special time at which dusting or spraying provided unusually good results. Therefore, three treatments can be applied at intervals of seven days or four treatments at intervals of five days to cover the period of hatching.

The period of hatching of the second generation is about a week longer than that of the first, and a satisfactory schedule has been four treatments at intervals of seven days. Normally the corn requiring treatment for second generation larvae will be the plantings in which tassels have not emerged by August 1. Treatment can be started when half of the plants show tassels in the whorls after August 1.

Parts of Plants Treated

Tests have been made by applying dust to the entire plant in comparison with directing the nozzles at the whorl for the first treatment and at the ear shoots in the three subsequent applications. Much better

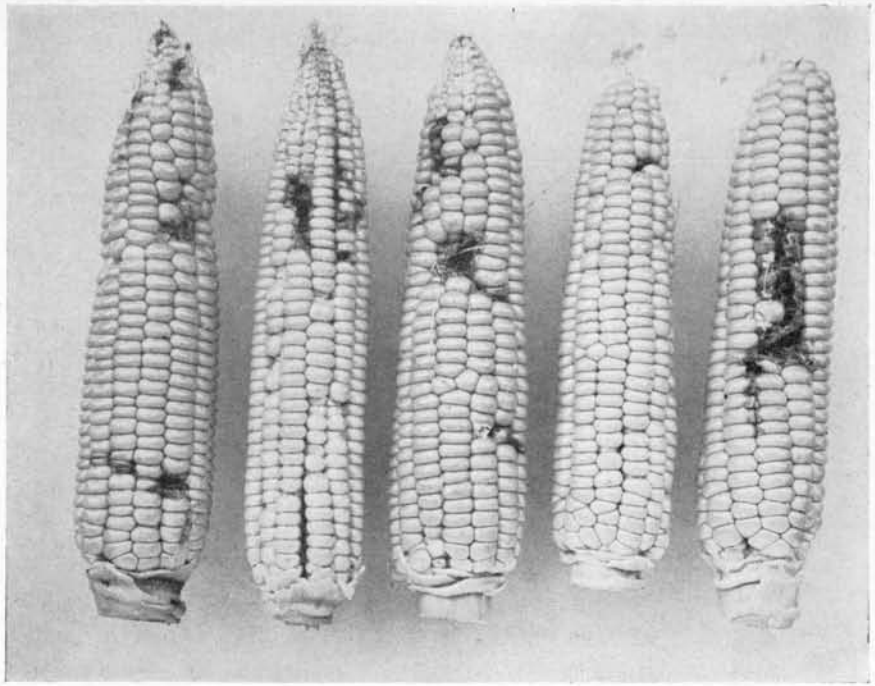
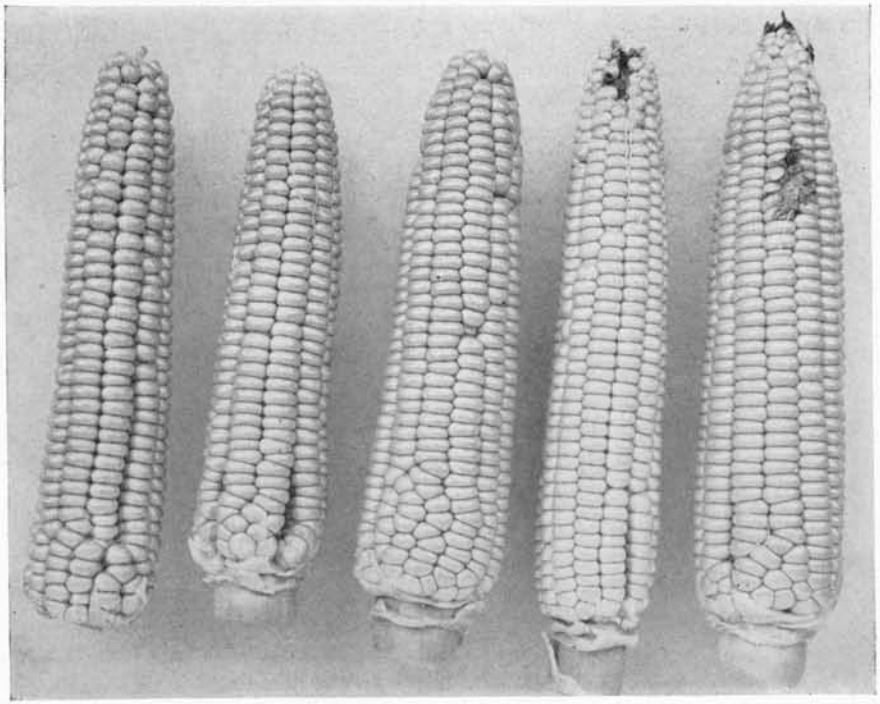


Figure 1. Comparison of untreated ears (above) with ears dusted (below) for control of the European corn borer.



control was obtained by directing the dust at the whorl and ear shoots. Apparently, the newly-hatched larvae wander over the plant freely and many of them are killed as they pass over the treated areas.

Amounts of Dust Applied

Dosage tests have been carried out with 12 and 48 pounds of dust per acre. In all comparisons use of 12 pounds of 8 per cent fixed nicotine dust was more effective than 48 pounds of 2 per cent dust, although the same amount of nicotine was applied. On the other hand, the larger quantity of dust provided somewhat better coverage of the plants.

Although the question of coverage is by no means settled, it is believed that 20 to 30 pounds of standard dusts as mentioned below per acre will provide adequate coverage for corn borer control.

Dust Materials

Development of new materials for insect control is proceeding at a very rapid rate. Many of these new insecticides have given excellent results in controlling the corn borer. Since they are new, complete information as to their effects on plants and on insects has not been obtained. Sufficient is known about them, however, to indicate that they will be of great interest to farmers who produce sweet corn. The materials which have been used to control the corn borer for many years are also available.

Nicotine-bentonite dust was developed to replace dual-fixed nicotine dust. It is a reasonably effective material and has been used successfully in commercial fields.

Dusts containing rotenone were much less effective than fixed nicotine dusts in tests made up to 1940. In 1944, however, rotenone dust was superior to nicotine-bentonite.

Ryania. Dusts containing the ground stems of the tropical plant *Ryania speciosa* have given excellent control of the corn borer. In tests conducted in New Jersey and New York, Pepper and Carruth found it to be much more effective than derris and at least as good as DDT. The material as sold commercially contains 40 per cent of the ground *Ryania.*

DDT. Dusts containing dichloro-diphenyl trichloroethane, commonly called DDT, have been very effective in controlling the corn borer. This material has caused some injury to corn growing on light sandy soil in New Jersey. Little or no injury was seen on heavy soils and no serious damage has been reported from other states.

Comparative tests of these four materials applied in a series of concentrations have been summarized in the accompanying table. It

will be noted that both DDT and *Ryania* were more effective than rotenone and nicotine-bentonite dusts. The 100 per cent or pure ground *Ryania* without a diluent dusted poorly, and the less effective control was caused by the low volume applied rather than by any lack of toxicity.

These tests show the relative value of some concentrations of these four materials. The choice of a material and of a concentration for use will depend on the cost and degree of control desired. *Ryania* available as 40 per cent dust should be about as toxic as 1 per cent or 2 per cent DDT dust. DDT will probably be marketed as 3 per cent and 5 per cent dusts. Either should be entirely satisfactory, the 5 per cent especially so when damage by the corn borer is expected to be severe.

Spray Materials

All of the materials listed under dusts can be used as sprays by purchasing spray formulations. Because most farmers have preferred to dust, no comparative figures of toxicity as sprays have been obtained. The following materials have been used successfully in other states.

Pure ground *Ryania*, 4 pounds in 100 gallons.
50% DDT wettable powder, 1 to 2 pounds in 100 gallons.
Ground cube root (4 to 5% rotenone), 4 pounds in 100 gallons.

The timing of sprays and general methods of application should be the same as for dusts.

TABLE 1. COMPARATIVE TOXICITY OF DUSTS TO THE CORN BORER

Nicotine-Bentonite		*Rotenone*		*DDT*	
Per cent Concentration	*Control*	*Per cent Concentration*	*Control*	*Per cent Concentration*	*Control*
		RESULTS OF 1944 TESTS			
1	19.9	.25	41.8	.5	52.7
2	25.3	.5	12.3	1.0	55.8
4	41.4	1.0	53.7	2.0	56.8
8	52.4	2.0	57.9	4.0	69.9
		RESULTS OF 1945 TESTS			
Ryania		*DDT*			
12½	72.9	.5	75.5		
25	73.5	1.0	75.3		
50	79.7	2.0	84.9		
100	75.3	4.0	88.3		

Methods of Application

Both dusting and spraying can be done by hand, by small power machines, or by row-crop sprayers and dusters. In any case the nozzles

should be directed at the whorl for the first treatment and at the developing ear shoots for subsequent treatments. Large sprayers and dusters will require about 42 inches clearance to avoid excessive damage to the corn. Ordinarily, two dust nozzles or three spray nozzles have been used for each row. Nozzles directed downwards for the first treatment and on each side of the row adjusted to spray down into the ear shoots have been most effective.

RELATION BETWEEN INFESTATION AND CONTROL

Observations extending over a number of years have shown that the degree of control decreases as the infestation becomes heavier. Thus, a material that will kill 90 per cent of the larvae when there are five larvae per plant may kill only 80 per cent when there are 10 larvae per plant. Unfortunately, it is not always possible to predict the abundance accurately in advance of the growing season. Ordinarily, infestations are heaviest when the weather late in May and during June is warm, particularly so when there are warm calm nights.

EFFECT OF TILLERS ON INFESTATION AND TREATMENT

Experiments have shown that corn with tillers has a much smaller number of larvae in the ears than the same variety from which the tillers have been removed. In other words, the tillers "soak up" many larvae that would ordinarily infest the ears. Furthermore, it is possible to obtain excellent control by directing the dust or spray at the ear shoots on the stalk. Treatment of the tillers in addition to the main stalk did not increase the degree of control of borers in the ears.

RESULTS TO BE EXPECTED

As was shown in the table, no treatment was good enough to kill all the larvae. In the past a control of 75 per cent or more seemed to be practical. Not all of the surviving larvae are in the ears. However, at best there are usually a few infested ears after treatment. For this reason, corn should be sorted after treatment in order to remove the ears obviously infested. This practice is in reality no different than sorting apples to remove the fruit damaged by insects or diseases, or than sorting tomatoes to remove cracked fruit. Sorting can be done quickly on the basis of damage to husks and silks and without injury to the ears.

TREATING SUCCESSION PLANTINGS

The practice of planting on the same day a number of varieties selected for succession maturity adds no particular problem to corn

borer control. A treating schedule for such varieties may be arranged as follows:

(1) Start treating the earliest variety when 50 per cent of the plants have young tassels in the whorl. Treat at intervals of five days until July 1.

(2) Start treating later varieties as they reach the same stage, and repeat (if time allows) every five days until July 1.

(3) No treatment should be needed on the varieties showing tassels after June 25.

For the second generation:

(1) Start treating any variety in the 50 per cent early green tassel stage on August 1, and the later varieties as they reach that stage after August 1. Repeat treatments at weekly intervals until September 1.

(2) No treatment should be needed on varieties tasseling after August 20.

In general, treatment of early corn has been most profitable because the infestation has been heavier and the price higher than in late corn. In a few seasons, however, infestation of late corn has been severe enough to justify treatment.