Control of the Potato Leafhopper

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IOWA AGRICULTURAL EXPERIMENT STATION

ENTOMOLOGY SECTION

C. F. Curtiss, Director

CONTROL OF THE POTATO LEAFHOPPER

By F. A. Fenton and Albert Hartzell.

Potato fields in Iowa for several years have suffered from "burning," which has seriously cut the yield of this crop. The trouble has been called tipburn. Its cause was unknown until recently, when it was discovered that it is due chiefly to the potato leafhopper, a little green, fly-like insect that appears in enormous numbers during the summer. The Iowa Agricultural Experiment Station has verified this connection between the leafhopper and tipburn or "hopperburn" and control measures have been devised.

DESCRIPTION OF INJURY

The first appearance of the injury is usually a triangular burned area at the tip of the leaf, running back along the midrib. Other more or less triangular areas soon follow along the margin. These enlarge until the entire margin of the leaf is brown and curled upwards. (Fig. 2). The burned margin gets wider until only a narrow strip of green near the midrib remains and this finally turns brown. The injury is usually noticed first on the older leaves below the growing point of the plant, but later spreads over the entire plant. Close examination of the under sides of the leaves discloses the presence of the small, pale green leafhoppers that are responsible for the injury. In severely infested fields the adults fly in swarms when disturbed.

BORDEAUX MIXTURE IS EFFECTIVE AS A CONTROL

The leafhopper is an insect with mouth parts adapted for piercing and sucking out the plant juices, but as such it cannot be controlled by the
usual contact insecticides, such as nicotine sulfate. These are not effective because they do not kill the thousands of eggs that have been laid by the females inside of the leaf midribs, petioles, and stems, and because the adults fly away, escape the spray, and then settle back again.

However, the leafhopper can be effectively controlled and the hopperburn thus prevented by covering the potato plants with a spray of bordeaux mixture. This spray repels the adults so that they will not lay their eggs in the plants, and kills many of the young insects. In addition, it is a fungicide and protects the plants from late blight, a fungous disease distinct from hopperburn. By adding from $\frac{1}{2}$ to 2 pounds of lead arsenate powder to every 50 gallons of bordeaux mixture, such leaf feeding insects as the Colorado potato beetle and its grubs can be controlled.

Bordeaux mixture of the formula 4-4-50 is made as follows:

<table>
<thead>
<tr>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump lime (unslaked)</td>
<td>Blue vitriol (copper sulphate)</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
</tr>
</tbody>
</table>

In one barrel or container, slake the lump lime and then add enough water to make 25 gallons. Only the best grade of fresh unslaked lime (but never air-slaked lime) should be used. In another barrel dissolve 4 pounds of blue vitriol (copper sulfate) in 25 gallons of water by suspending it in a bag so that the bag does not touch the bottom of the barrel. Do not use metal containers in dissolving the copper sulfate, as it corrodes them. Then before ready to spray, pour solutions I and II together. This forms a heavy, bluish liquid which should be strained before being poured into the sprayer. This spray should be applied as soon as possible after the slaked lime and blue vitriol have been mixed, as it loses its value within 12 hours.
Excellent results have been obtained by using a commercial form of dry bordeaux to which only water need be added. The commercial form is easily washed off the plants, while the home-made preparation adheres to the foliage better, if properly prepared. Undoubtedly in the near future a commercial bordeaux powder will be made that will prove satisfactory when mixed with water.

METHOD OF APPLICATION

Bordeaux mixture should be applied as soon as the adult hoppers are noticed on the vines, but it is effective even after hopperburn has already started. The time of application will vary with the season, but will be about the first week in June for central Iowa, and the last week in June for the northern part of the state. This should be followed by two more applications at intervals of ten days or two weeks.

A traction sprayer of 100 gallon capacity, capable of producing between 150 and 200 pounds pressure at the nozzle and spraying four rows at a time, proved the most effective in fields of about 20 acres. (Fig. 1). Larger fields require a power outfit.

In spraying the vines, it is very important that the plants be covered with the spray from above and below. Proper management of the spray boom is highly essential for success. The central nozzle should be high enough so that its spray may completely cover the tops of the plants. The side nozzles should be turned upwards at an angle of about 45 degrees, so that the under sides of the leaves are thoroughly covered. In addition, one side

Fig. 4. Showing the arrangement of the nozzles of the spray boom for early spraying when the potato vines are not full grown.

Fig. 5. Showing the arrangement of the nozzles of the spray boom for late spraying when the potato vines are about full grown. Compare with fig. 4.
nozzle in each set should be turned at a forward angle and the other at a
backward angle (fig. 4) to insure a more thorough covering of the vines. Later,
when the vines are larger, each side nozzle should be completely turned in
the opposite direction (fig. 5), thus giving a much wider angle to the covering
surface of the spray material. Care should be taken to arrange the lateral
nozzles when they are turned so that the stream from one will not interfere with that of the other; otherwise much of the force of the spray is
lost and poor results will follow.

For the garden, a spray rod with an upturned nozzle at an angle of 45
degrees, attached to a 10-gallon capacity hand spray pump, is entirely suf-
ficient.

RESULTS OF TESTS IN IOWA

Three years' spraying experiments carried out at Ames and in Mitchell
county, Iowa, have demonstrated that the potato leafhopper can be effect-
tively controlled, hopperburn thus prevented, and the potato yields profit-
ably increased by three sprays of bordeaux mixture applied at the proper
time. This spraying program was put to a very severe test during the Sum-
mer of 1921 in the experimental plots in Mitchell county.

Here a 20-acre field was sprayed three times, June 27, July 12 and July
25, and in spite of the fact that the season was extremely dry, very satisfactory results were obtained. No rain fell on this potato field for over
ten weeks. The varieties grown were Green Mountain and Rural New York-
er. The sprayed part of the field yielded at the rate of 110 bushels per
acre of first grade potatoes, while the average of the unsprayed checks was
49.5 bushels per acre of mixed grade. Green Mountain is an earlier variety
than Rural New Yorker and showed some burning when the first spray
was applied, while the latter showed little or no burning. The Rural New
Yorker yielded 120 bushels of first grade potatoes to the acre while the
yield of the checks was less than 35 bushels per acre.

COMPARATIVE RETURNS PER ACRE

Potatoes from sprayed vines were of a much better quality and sold for
$1.00 per bushel, field run, while those from the unsprayed vines could not
be disposed of at 90 cents a bushel, unless they were graded. The follow-
ing table summarizes the comparative returns per acre:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net return for sprayed</td>
<td>$110.00</td>
</tr>
<tr>
<td>Cost of spraying</td>
<td>11.70</td>
</tr>
<tr>
<td>Actual increase for sprayed</td>
<td>98.30</td>
</tr>
<tr>
<td>Net return for unsprayed</td>
<td>44.55</td>
</tr>
<tr>
<td>Gain per acre</td>
<td>53.75</td>
</tr>
</tbody>
</table>

The above figures are based on the actual cost of spraying the 20-acre
field. They include the cost of the bordeaux mixture for three applications,
and a ten percent depreciation on the spraying machine, and the labor of
three men and two teams for four and a half days are taken into consider-
ation.

LIFE HISTORY OF THE LEAFHOPPER

Potato leafhoppers are tiny, pale-green insects averaging about 1-8 inch
in length. They leap with agility and fly very swiftly. In the spring the
adults come out of their hiding places under old leaves and trash where
they have spent the winter and feed on curly dock and other weeds. As
soon as early potatoes have made a good growth, the hoppers leave the
weeds and fly to these. They feed on the tender foliage and begin to insert
eggs inside the leaves and stems. In about two weeks the eggs hatch into
wingless young, which feed on the under sides of the leaves, causing them
to roll up and burn. The young grow rapidly and mature in a remarkably
short time. There are two broods a year, the first being injurious to early
varieties in June and July. The second brood is abundant and destructive
to late varieties in August and early September and burns all the potato
vines that have hitherto been free from this trouble.
Dry Rot of Corn

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

C. F. CURTIS, Director
DRY ROT OF CORN

By I. E. Melhus and L. W. Durrell

Germination tests of thousands of samples of the seed corn on Iowa farms indicate that a large percentage of it is unfit to plant, due to the various corn ear molds which were so common last fall, and principally to the dry rot of corn. It is important that seed corn be carefully examined and selected this spring, and then tested. Some of the diseased ears can be detected by examination alone, but not all. It is essential also to use the germination test to be wholly sure of good seed.

Moldy corn was common in fields throughout the state last fall. In the central and eastern counties, from 2 to 15 percent of the ears were left in the field because of the mold, while many partially diseased ears found their way into the seed corn. The corn grower has already taken his loss incurred in the corn harvest, but the loss due to poor seed is still to follow.

DRY ROT IS ENCOURAGED BY HIGH TEMPERATURE AND RAINFALL

The greatest damage from dry rot was in the central and eastern sections of the state, where the percentage of dry rot ranged from 5 to 20 percent when the corn was husked. To the north and south, less of the disease was found, this being also true of the northwestern portion of the state. Sixty-five samples of ten-ear lots collected in the

![Map of Iowa showing rainfall distribution in August, 1921. The areas of greatest dry rot are in general the same as those of greatest rainfall. Parts of the state with less than 5 inches of rainfall in August were relatively free from dry rot.](image)
central and eastern sections and tested for germination, showed 11 percent of the ears infected with dry rot. Tests of 5,100 seed ears of 100-ear lots, collected in six counties representing all sections of the state, showed 11.5 percent infected with dry rot and unfit for seed. The amount of dry rot in various sections of the state seemed to increase as the rainfall increased. The map of Iowa in Fig. 1 shows this interesting correlation. It gives areas of greatest rainfall during the later part of the growing period of 1921. These same areas showed the greatest amount of dry rot, while the areas of low rainfall had much less. The dry rot fungus flourishes only when the rainfall and temperature are high. The corn crop of 1907, when rainfall was heavy, was badly infected with dry rot, according to published reports. In 1915 there was little dry rot, altho it was a wet season. The fungus was held in check by the low temperature that prevailed, 1915 being a very cool season. In 1921 there was a comparatively high rainfall in the central and eastern part of the state in August and September, accompanied by hot weather conditions which were almost ideal for the growth and destructive activity of the dry rot fungus on all parts of the corn plant.

SIGNS OF DRY ROT

Dry rot of corn attacks all parts of the corn plant, roots, stalks, shanks and ears. The roots of seedlings growing over old dry rot infected stalks or stubble may become infected in this way and fail to mature a full crop or die entirely. In either case a dark brown discoloration of the roots occurs. The rot may progress until the plant is entirely eaten off. On the stalks it attacks chiefly the nodes or joints,
which it discolors. At the end of the season it may be seen on the surface, fruiting as minute black specks. (Fig. 2.)

The shanks of the ears also suffer. In such cases they break over, interfering with the filling and maturing of the ear. In some cases the fungus travels in the shank up into the butt of the ear. The fungus may also attack the tip, entering with the silk. In other instances where an ear stands upright, the husks catch and hold the spores and enough water to start the mold around the butt of the ear or along one side. (Fig. 4.)

The fungus travels freely in the cob, where it usually causes a brown discoloration, but sometimes the signs are not noticeable. Where an ear is infected, the kernels are either dead or injured so seriously that they germinate poorly. Such corn makes poor seed and should be used for feed.

The most common point of attack, however, is at the nodes. Here infection takes place as follows: As the corn stalk reaches its largest growth, the lower leaf sheaths become loosened and spores of the dry rot fungus lodge on the leaves and wash or drop down between the leaf sheath and stalks and attack the corn node.

There is no consistent evidence that the dry rot fungus travels from the soil up to the ears inside the stalk. In studies made last fall, 39 percent of the infected ears were borne on healthy stalks. Only 22 percent of the infected stalks showed dry rot fungus as high as the third node from the ground. Furthermore, only 31 percent of the internodes have been found attacked and in the majority of such cases it was clear that the infection spread each way from the nodes, as shown in Fig. 3. As far as is known, the dry rot fungus attacks only field and

Fig. 4. Shank and butt of ear with dry rot fruiting on shank and growing as a white felt on the butt kernels.
sweet corn and no other plant. It will not spread from ear to ear in a dry crib. It grows at any temperature between 40° and 90° F., but prefers 80° to 86° F., as shown in Fig. 5. When corn is dried, the dry rot fungus lies dormant, but will grow when moisture is supplied.

SEED CORN GERMINATION

Germination tests are necessary to detect and reject seed ears injured by dry rot and other molds. It is not uncommon to find that the best, as well as the poorest looking seed ears are diseased and unfit for seed. Tests made on 6,000 seed ears from 20 counties showed that on an average 11 percent are unfit to plant, due to molds, chiefly dry rot fungus. Many of these ears looked good and no signs of dry rot could be detected in them. There is no way known of culling out the diseased ears with any certainty, except by the germination test.

There are many types of germinators, most of which will give satisfactory results from the standpoint of dead kernels on an ear, but only a few permit the reading of the diseased condition and its cause. To detect the diseased ears and the cause of the disease, the kernels must be placed some distance apart and so protected from one another that the molds that caused the disease cannot spread to adjoining kernels, thus giving misleading results. The materials making up a germinator must be such as to permit sterilization after each time the germinator is used. Otherwise, the spores of the dry rot fungus can live on the germinator and develop on the seed in the next trial. The whole germinator must be of simple construction, inexpensive and adapted to show the strength of the seed germ, the presence of diseased kernels, and the cause of the disease.

THE RAG DOLL GERMINATOR

The ordinary rag doll germinator, which is so widely known, gives excellent results in the ordinary tests for germinating strength. It consists of a strip of muslin about a foot wide and five feet long, marked into three-inch or four-inch squares running along the center of the cloth, from end to end.

The muslin is soaked in boiling water and smoothed out, and the squares are then numbered. From each ear to be tested, eight kernels are taken and laid in one of the squares, and the ear numbered to correspond with the number of the square. When the squares have all been filled, the cloth is firmly rolled up and the ends of the roll tied securely. Then the “doll” is put into a pall or other container and covered so that it will keep moist. It is held here for from five to eight days at a little above room temperature and then it is ready to “read.”

This ordinary rag doll tester is open to some objections in testing diseased corn, because it does not prevent molds from spreading from diseased kernels to healthy kernels during the test.
This is the modified rag doll tester, made of muslin and of glazed butcher’s wrapping paper.

MODIFIED RAG DOLL GERMINATOR

What may be called the "modified rag doll germinator" is more satisfactory. It consists of a strip of glazed butcher’s paper, nine inches wide and six feet long, and a strip of good quality bleached muslin of the same size laid together. The paper is used to prevent the promiscuous spread of the molds. The cloth is boiled in water and laid on top of the paper, as shown in Fig. 6. The kernels are laid in the germinator in rows across the cloth, with the germ side next the wet cloth and with the tips all pointing one way, the rows are numbered at the margin of the cloth as in the ordinary and well-known rag doll, and the ears are numbered to correspond. When the corn is in place, the tester is rolled, tied and placed on end in a tub or large pail containing about one quart of water. A moist gunny sack may be placed over the ends of the "dolls" and another tub or pail turned over the wet sack to prevent drying out. The "dolls" must be kept wet and at a temperature of 80° to 85° F. At this temperature the molds and corn germinate rapidly. At lower temperatures, neither the corn nor the dry rot fungus grow as well and it is not possible to determine whether the seed is infected.

The rag doll germinator, altho very simple and convenient, has certain limitations, as already suggested. The most serious one of these is the short distance between the kernels in the doll. The molds sometimes do spread from an infected to a healthy kernel and show misleading results. Some molds, and especially the dry rot fungus, can grow thru the cloth and paper and cause mold on some kernels otherwise healthy. Again, the development of the molds cannot be observed until the dolls are opened to be read.

GLASS TOP SAND-BOX GERMINATOR

The sand-box germinator, tho somewhat more expensive, does not have these shortcomings. It is merely a long wooden box 8 to 12 feet long by two to three feet wide and four inches deep, supported on legs raised to a convenient working height. The bottom of this box is made of narrow strips to prevent warping. The bottom is covered
with a clean, wet cloth, and filled within an inch of top with clean wet sand. Another wet strip of muslin is laid on top of the sand and the corn laid in rows, eight from each ear, allowing one square inch for each kernel. (Fig. 7.) Such a germinator will permit the testing of about five and one-half bushels every five to nine days.

Panels of glass of any convenient or available size are laid over the corn and the whole germinator covered with dry sacks or other thick materials, well tucked in at the edges of the frame. The glass holds the moisture on the corn and enables one to follow developments daily.

The greatest advantage of the sand-box tester is the distance between the kernels, which prevents the molds on diseased kernels from infecting healthy kernels. The square-inch space allowed each kernel is usually enough to hold the fungous growth until the germinator is ready to read. If a very active mold is present, it can easily be seen whether a moldy kernel is of itself moldy or whether the mold has spread from adjoining kernels.

All cloths must be scalded in boiling water before using and fresh, clean sand must be used. If new sand is not available for each trial, it may also be scalded or oven-baked. The wet sand holds sufficient moisture to carry the germination test thru, if the glass is firmly placed against the border of the box. The cloth over the sand keeps the roots from growing into the sand; they will stay on top of the cloth, unless held too long, and can be easily examined.

From the standpoint of a critical study of seed corn germination, the glass topped sand-box is recommended, but the modified rag doll type has its advantages as to compactness, convenience and adaptability to most farm conditions. The glass topped sand-box type is recommended only as a substitute for the modified rag doll, where a man has a warm room (as a furnace room), and is especially interested in making an unusually careful study of his corn. When the temperature of the room is held between 80° and 86° F., the corn will be ready to read in five to ten days. At lower temperatures, a longer time will be necessary. It is well to allow sufficient time for the roots and shoots to grow out three inches in length (Fig. 8); otherwise, the starchy kernels which take up water and start to germinate more quickly than the harder kernels will appear the strongest, whereas the harder, horny kernels may be equally or even more vigorous, but slow in starting.

Fig. 7. The sand-box tester, which may be quite readily built on the farm.