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OF

BULLETIN. No. 119.

THE DOWNY MILDEW OF THE CUCUMBER AND
ITS TREATMENT.

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BULLETIN No. 119.

THE DOWNY MILDEW OF THE CUCUMBER AND ITS TREATMENT.

F. H. HALL.

Pickle crop a failure. The pickle growers and factory owners near New York City have seen with something like despair the steady and rapid decrease in productiveness of the late cucumber vines. The early vines from which are grown the large cucumbers sold in the markets for table use have not been affected; but those planted in late June or early July to furnish the small cucumbers, or "pickles," have yielded so poorly that, for two years at least, the crop has ceased to be profitable. A few years ago 125,000 little cucumbers per acre was not an uncommon yield, and the pickle factories now make their estimates upon a basis of 75,000 per acre; but during the season of 1896 the average was probably not one quarter of that number. One firm doing a very large business and having under contract the product of 800 acres received from the growers about 19,000 pickles per acre, and another firm reports the average yield as low as 13,000 per acre.

Causes of injury. Several causes have contributed to this lamentable state of affairs. The striped cucumber beetles did only very slight damage, the melon louse was present in destructive numbers in a few fields, the boreal lady-bird beetle caused some injury near Huntington

* This is a brief review of Bulletin No. 119 of this Station on the Downy Mildew of the Cucumber; What It Is and How to Prevent It, by F. C. Stewart. Anyone specially interested in the detailed account of the investigations will be furnished, on application, with a copy of the complete Bulletin.

and a mysterious wilt disease was found along the Port Jefferson Branch of the Long Island Railroad; but all these enemies combined probably caused only a little more than one-fourth of the 75 per cent shortage of small cucumbers. The principal source of loss was a fungus disease, the downy mildew of the cucumber.

This affection does not appear to any dangerous extent until midsummer, late July or early August, but about that time, especially if the temperature is high and the air full of moisture, it develops quickly and spreads over the cucumber fields. Yellow spots without definite outline appear on the older leaves near the center of the vine, enlarge rapidly and run together so that the entire leaf becomes yellow, and soon dies and shrivels as if touched by frost; or, spreading more slowly, the spots become brown and brittle. Leaves farther from the center are next attacked and finally the only green to be seen upon the vine is that of the few new leaves at the still growing tips of the branches. Flowers are produced but no cucumbers set, or if they do, they grow very slowly and become misshapen and unmarketable. When the disease first appears the center of each hill will show plainly the yellowish clusters of leaves, so that the rows can be traced for long distances across the field.

This feature helps to distinguish the disease from the effects of melon louse attacks; for the insects usually spread from the borders of the field, attacking first the vines near the fences, and affect the entire plant or scattered portions of it instead of the center. Neither does the wilt disease show this peculiar yellowing, but manifests itself in a sudden and unexplainable drooping of the leaves which is frequently accompanied by small rotting spots. The other prevalent enemies show plainly by their work that they are insects so the mildew stands alone and is easily recognized.

To understand clearly the work of the disease an idea of the structure of the cucumber leaf is necessary. Like all vegetable tissue the leaf is composed of boxes or compartments called cells which are of varied shapes and sizes and which contain the plant juices; the protoplasm, or living, creative substance of the plant;

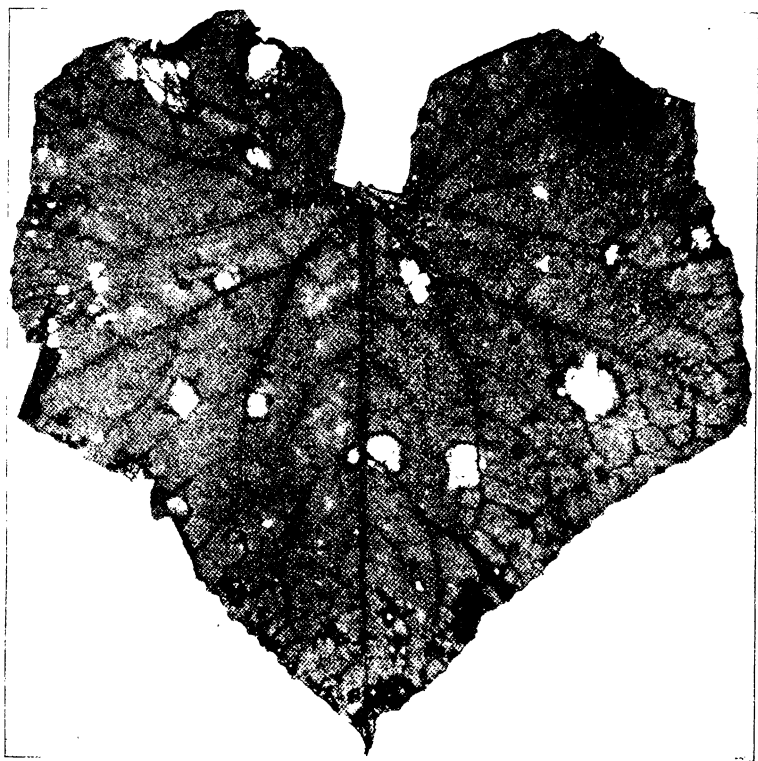


PLATE I.—A cucumber leaf affected with downy mildew.



PLATE II.—View of a portion of the experimental field at Woodbury. Taken August 27.

and, usually, the chlorophyll grains, or color giving bodies. Clustered closely together at the surfaces of the leaf are long, colorless cells which form protective coatings over the smaller, more loosely arranged, living, active cells within. Certain of these outer cells, however, are arranged in pairs to form little mouths, or stomata, which communicate by irregular passages with the cell structure beneath and allow the leaf to breathe in the carbon dioxide of the air, to exhale oxygen and to perform other functions.

It is through these little mouths that mildew gains entrance to the plants. Borne by the wind

What is mildew ? the minute spores of the fungus lodge upon the leaves and, stimulated by moisture found there, send out the active moving cells called zoospores which produce the new plants. For the mildew, like the cucumber, is a plant, though one of very low order, without leaves, nearly colorless and a parasite, living upon material already prepared by its host. The zoospores project portions of their walls in the form of tubes which pass through the mouths of the cucumber leaf, divide and send through the intercellular passages and into the cells a network of colorless threads which are known as hyphæ. Small knob-like outgrowths from the hyphæ feed upon the materials in the plant juices, thus robbing the host of its life blood, and probably also poison the cells themselves. The mildew plants mature very quickly, probably in less than a day, and send out through the stomata again colorless tubes bearing the spores from which a new crop quickly springs. These spores are microscopic grains usually elliptical in shape. They are violet in color and are sometimes borne in such countless numbers that despite their microscopic size they give a violet tinge to the under surface of the affected leaf. They correspond in function to the seeds of higher plants.

The disease has been given the scientific name, *Plasmopara cubensis*, and is very closely related, botanically, to the downy mildew of the grape, the spinach mildew, the onion mildew and the late blight of the potato. It lives not only upon the cucumber but upon many other plants of the same family: water-melon, muskmelon, squash, pumpkin and gherkin gourd. Its work upon these is similar to that upon the cucumber and pre-

Name, relations and history.

ventive treatment would have the same effect. It was first discovered in 1869 upon a wild plant in Cuba but did not appear in the United States until 1889 when it was noticed upon cucumbers grown under glass in New Jersey. It has spread rapidly and must now be placed among our most destructive fungous diseases.

During the season of 1896 the Station conducted **Spraying experiment.** Bordeaux mixture. This fungicide had already been proven almost a specific for the prevention of potato blight, grape mildew and other diseases similar to the cucumber mildew; and it was confidently expected to prove effective upon the cucumbers. It did not disappoint these hopes for excellent results were obtained.

The field selected for the experiment was owned by Mr. R. C. Colyer, of Woodbury, N. Y., and contained about one and three-fourth acres. It had been planted about July 1 and contained 42 rows of cucumbers, divided for the purpose of the experiment into alternating plots of 10 and 6 rows, 3 of the former and 2 of the latter. The plan at first was to spray the larger plots with Bordeaux mixture made by the 1-to-7 formula and to leave unsprayed the 12 rows in the smaller plots; but after two sprayings injury to the foliage indicated too great strength of the mixture or improper preparation, so the amount of copper sulphate in the mixture was lessened to 1 pound in 14 gallons of water, and two of the unsprayed rows were used as checks to test the effect of the two mixtures of different strength. Later it was found that the injury was due to improper preparation of the mixture used in the first spraying and no harm resulted to the check rows from the use of the 1-to-7 strength. Neither did the check rows indicate any decided difference in fungicidal power of the two mixtures; so that the weaker will probably protect against the disease as effectually as a stronger one if the spraying is carefully and thoroughly done, and of course it is cheaper.

The large plots were sprayed 7 times, at first at intervals of about 10 days, and later of about a week, the first application being made July 13 and the last September 9. On August 7 the disease appeared in the unsprayed plots and in two weeks the picking was practically ended and the vines ruined. Some signs of disease appeared upon the sprayed plots about this time, prob-

ally propagated from the diseased vines on the check plots by means of spores which were brought into contact with the unprotected lower surfaces of the leaves by the spattering of raindrops on the soil. A striking difference in appearance was shown by the two series of plots, the unsprayed rows showing bare and dead while the treated ones looked vigorous and green and healthy. Many remarks were heard about the "streaked" appearance of the field. The strength of the Bordeaux mixture was again increased to 1-to-8 in the hope of fully eradicating the fungus, but the disease spread slowly and lessened the yield somewhat.

Expense and profit of treatment. However, from the $1\frac{1}{2}$ acres of sprayed vines there was obtained after the unsprayed vines had ceased bearing, \$260 worth of cucumbers, or at the rate of \$173 per acre. Deducting from this amount the cost of making and applying the Bordeaux mixture, \$9.50 per acre, leaves a *net profit of \$163.50* per acre from the spraying.

Bordeaux mixture. Further experiment will be necessary to decide definitely the strength of mixture necessary or most economical to use, but it will probably be safest to use 1-to-8 formula, as there will be no danger of injury to the foliage and yet the protection against the disease will be certain. To make the Bordeaux mixture of this strength will require 6 pounds of copper sulphate, about 4 pounds of fresh lime and 50 gallons of water. Dissolve the crystals of sulphate in half the water by suspending them in it in a coarse bag, using a wooden vessel. Slake the lime in part of the water and dilute it to make a thin whitewash. When the sulphate is fully dissolved add the whitewash to the solution, stirring thoroughly and testing occasionally with a few drops of potassium ferrocyanide solution. If enough lime has not been added the drops of ferrocyanide as they touch the mixture will become dark, reddish brown. Add lime until no color reaction appears on applying the test and then put in a little more to be on the safe side. An excess of sulphate will "burn" the leaves but an excess of lime is harmless. Dilute the mixture to 50 gallons.

The quantity of Bordeaux required will vary with the size of the plants and the amount of rainfall. **Quantity and method of application.** Enough should be applied each time to leave upon every leaf a complete but thin coating of the lime and sulphate so that the spores can touch no point without finding the protective fungicide; and if rains wash off this coating it will be necessary to spray again. In the seven sprayings upon the experimental field 476 gallons were used. If the area to be sprayed be not too large a knapsack sprayer is probably most convenient to use although it involves much hard, dirty work. From 125 to 150 gallons can be applied in a day with the knapsack sprayer with one nozzle or 150 to 175 gallons with two nozzles.

Cucumber vines spread over the ground too much to allow of the use of carts or wagons and force pump sprayers without special planning. Spaces wide enough to raise two rows of cabbages or other low growing plants may be left separating strips of from seven to nine rows of cucumbers, and a horse and wide tread cart may be used to haul the barrel and pump while two men with hose and extension pipes spray the plants upon either side. A third man will be required to drive and pump. A narrower bare strip may be left and a narrow tread cart used to carry the apparatus. The Meyers' spraying outfit sold by J. S. Woodhouse, 191 Water St., New York City, seems well adapted for this work as it is compact and has tread of only about three feet.

Some have feared that cucumbers sprayed with **Is Bordeaux mixture poisonous?** Bordeaux mixture might be dangerous edibles; but all the evidence seems to indicate that the copper present upon such sprayed vegetables will not enter the system in poisonous amount. Spraying with Bordeaux has long been practiced but no injurious effects are reported from its use even upon grapes and other fruits. The stains left by the mixture upon cucumbers or melons or upon the hands can easily be removed by the use of a little vinegar.

The success of this experiment indicates that in **Conclusions.** Bordeaux mixture the grower has a convenient, inexpensive and certain preventive of the downy mildew of late cucumbers; and that if he will apply the remedy early, constantly and thoroughly, the pickle crop will again yield profitable returns.