POPULAR EDITION.

BULLETIN No. 232. APRIL, 1903.

New York Agricultural Experiment Station.

GENEVA, N. Y.

DISEASED. HEALTHY. DISEASED.

AN UNSUCCESSFUL CABBAGE-ROT REMEDY.

F. H. HALL, F. C. STEWART AND H. A. HARDING.

PUBLISHED BY THE STATION.

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POPULAR EDITION*

OF

BULLETIN NO. 232.

AN UNSUCCESSFUL CABBAGE-ROT REMEDY.

F. H. HALL.

Bacterial diseases difficult to combat.

Black rot is the most destructive disease affecting cabbage and cauliflower in New York State. Several times the growers in various sections of the State, and in other state where these crops are extensively grown, have seen their plants rot down rapidly. In many cases from one-third to one-half or more of the heads were unfit to harvest; and the vile odors from the decomposing material made the vicinity of the fields far from agreeable.

Usually, diseases of such striking character and so destructive in their operation are not allowed long to continue unchecked; for the efforts of many pathologists are centered upon them and methods of combating the troubles are soon worked out.

But this rot, like a few other rots, blights and wilts, is quite different in origin from most plant diseases, and, like the others of the group, is very difficult to control. These diseases are caused, not by fungi, but by still lower forms of plant life, bac-

* This is a brief review of Bulletin No. 232 of this Station on Combating the Black Rot of Cabbage by the Removal of Affected Leaves, by F. C. Stewart and H. A. Harding. Anyone interested in the detailed account of the investigation will be furnished, on application, with a copy of the complete bulletin. The names of those who so request will be placed on the mailing list to receive bulletins regularly, either popular edition or complete edition, as desired. Bulletins are issued at irregular intervals as investigations are completed, not monthly.

teria. A bacterium is a plant made up of a single cell, so small that a high-power microscope is necessary to make it visible. One or more of these cells gains entrance to the host plant through one of several channels, and once within the tissues of the host or floating in the juices which flow through the vessels of the plant, divides, sub-divides, re-divides and continues the process of multiplication until the affected area is filled with living cells. The circulation of the invaded area is impeded, the materials which should go to build up the host plant are used by the bacteria, and the latter may attack and decompose the compounds in the living tissue of the sheltering plant or may throw off secretions which act as poisons, causing death of the part or of the entire plant.

The entrance of these bacteria into the higher plants is very imperfectly prevented by spraying, since the points of entrance are often untouched by the spray. Such entrances are the tender growing tips of rootlets, the unfolding leaves, the delicate organs in the center of flowers, or other rapidly growing parts which quickly expose unsprayed surfaces to infection.

Points about black rot.

The germs causing black rot of the cabbage gain entrance largely through the water pores, which are minute openings at the edges of the leaves. (See Plate I.) They live and multiply in the fibrovascular bundles (veins and veinlets) which make up the circulatory system of the plant. The blackening of these veins and veinlets in patches at the edges of the leaves is a very easily recognizable symptom of black rot from water-pore infection, the patches being brown and later dry and papery. The germs may also gain entrance through the roots of the cabbages, when the checking of the circulation makes the entire plant wilt and appear of a light green color. On cutting across stems of such plants, the vessels will appear as black dots. When the infection is through a water pore the bacteria work down the veins into the stem of the plant, after which the course of the trouble is the same as when the roots are infected first. The outbreak usually begins in July—root infection, or August—leaf infection. The severity of an outbreak is increased by moisture and hot weather during August and September. The conditions that

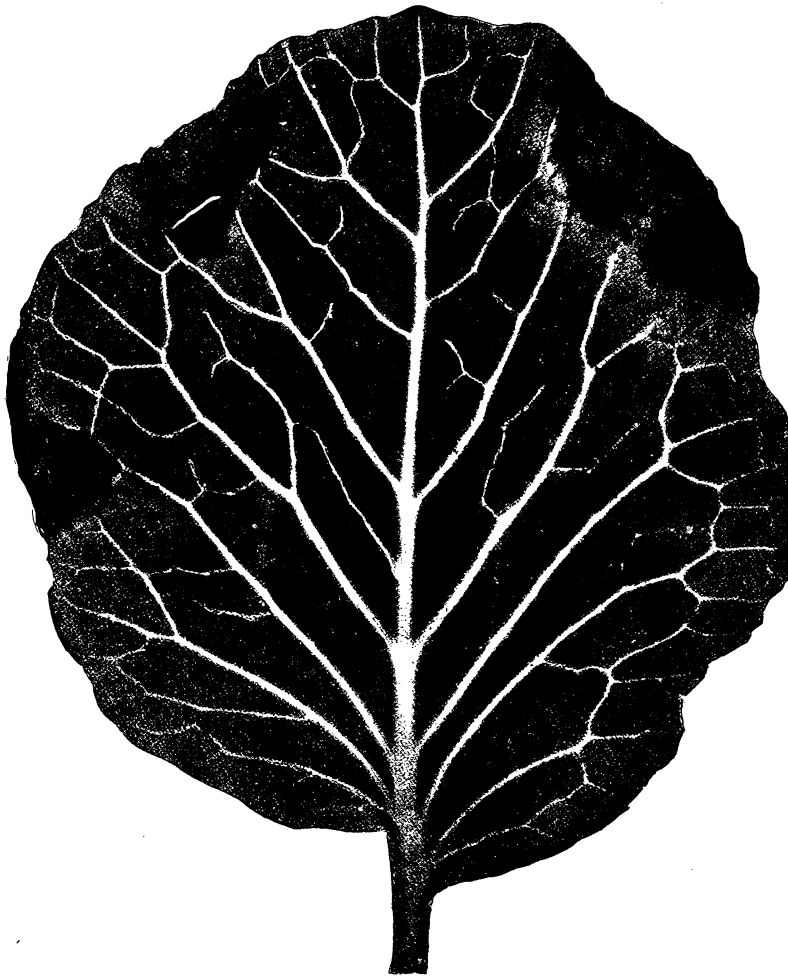

PLATE I.—CABBAGE LEAF AFFECTED WITH BLACK ROT, WATER PORE INFECTIONS.

cause rapid growth of cabbages also seem most favorable to spread of the disease.

A suggested remedy.

Pear blight is another bacterial disease, for which almost the only remedy is cutting off the blighted twigs or branches and destroying them; and reasoning from analogy, it appeared possible to the early investigators of cabbage-rot that something might be done to check this disease by removing the infected leaves. It was hoped in this way not only to check the progress of the disease in a field by removing centers of infection, but even to save the plants attacked. The remedy was tried with apparent good success in early experiments—at the Wisconsin Station and by the U. S. Department of Agriculture—though proper checks upon the effectiveness of the method were not employed. When the measure was first announced it appeared well adapted to the purpose, because it was not known that infection took place except through the leaves; it was quite easy to detect diseased areas, the leaves could be quickly detached and the removed material with the bacteria contained could be easily taken from the field and destroyed.

Accordingly, when a severe outbreak in western New York in 1898 followed another epidemic of it on Long Island, it was determined by the Station to make a thorough test of the method.

Tests.

For three years no definite results were obtained on either the Long Island plats or those near Geneva, because the areas selected escaped any marked attacks of the rot. In 1902, however, a field was found near Phelps, which showed many signs of the disease about the middle of July. Arrangements were made by which an acre of this field was secured for experimental purposes, and the treatment was thoroughly tested. The acre was so selected that it contained 27 rows each of the varieties Henderson's Succession and Danish Ball Head; and was divided across the rows into two equal plats, one for the treatment, the other being left untreated for a check on the work.

The first treatment was made on July 22, at which date about one-third of all the plants were showing more or less of the disease. The treatments were made by either the Botanist or

the Bacteriologist of the Station or their assistants, not being left to ordinary labor; and great care was used to remove every infected leaf from the treated half-acre. This operation was repeated weekly until September 16—nine times, requiring 46½ hours' work for one man. The treatments did little to check the disease, as multitudes of new infections were found each time, although every diseased leaf had been removed the week before. For a time each plant showing the disease in the stem was taken out, but it was soon seen that this would greatly lessen the number of plants, and it was noticed on the check plats that such plants did not all die or rot rapidly, but many of them formed heads.

Result. At harvesting time, October 13 for Henderson's Succession and November 8 for Danish Ball Head, the cabbages were counted and weighed, showing the following results:

TABLE I.—RESULTS OF CABBAGE ROT EXPERIMENT IN 1902.

Variety.	Treated half-acre, one half to each variety.		Check half-acre, one half to each variety.	
	Heads.	Weight.	Heads.	Weight.
	No.	*Lbs.*	*No.*	*Lbs.*
Henderson's Succession	894	4,186	1,175	7,072
Danish Ball Head	302	1,122	761	3,521
Total	1,196	5,308	1,936	10,593

Thus the treatment was more than a failure, as the half-acre thus managed yielded at the rate of 5¼ tons per acre less than the check area.

Reasons for failure. This failure, and worse, of the remedy is due to several causes: First, the removal of so many leaves prevents the formation of heads. Leaves are the workshops of the plant; in them the crude minerals absorbed in solution by the roots are acted upon by the sun, brought into contact with the gases drawn from the air and changed into the compounds needed for the growth of the plant and stored up in the head for the development of the

future flowers and seeds. Removal of the leaves cripples these workshops, reduces the amount of materials elaborated and so makes smaller heads, delays their formation or prevents it altogether. This was proven by a test on the check area, where leaves were removed weekly from healthy plants until ten leaves had been taken from each plant. This reduced the yield at the rate of three tons per acre.

Second, infection occurs through the roots as well as through the leaves, so that it is impossible by pulling off infected leaves to control the spread of the disease in its earliest and most fatal form.

Third, it is impossible to detect all infected leaves, since the diseased area often occurs well down toward the stem on the "wing" of the leaf stalk where it is so concealed by overlapping leaves that it cannot be seen without very careful search.

Fourth, the black rot germs are widely distributed, so that chances of infection are not greatly reduced by the removal of the colonies found in the infected leaves. Just how and where these germs are located and how they are spread is not known at present, but it is very evident from this test that they are very numerous and widely spread.

No remedy known.

No practical treatment for black rot has yet been discovered. It has been shown that the leaf-pulling treatment instead of being beneficial is positively harmful. Rotation of crops affords little if any protection against the disease. Placing the seed bed on soil which has never grown cabbage or related plants is a good practice, but it remains yet to be proven that it is of any real value as a preventive of black rot. Spraying with resin-bordeaux mixture is, perhaps, worthy of trial, but can not be relied upon to control the disease.

The virulence of the disease depends largely upon weather conditions, and it is unfortunate that the conditions most favorable to the growth of cabbage are also the most favorable to the disease. Rapidly growing plants are especially liable to be attacked.

It appears to the writers that before much progress can be made toward the control of the disease it will be necessary to

determine more definitely how the germs spread from plant to plant and field to field; also, to what extent they live over winter in the soil, to what extent root infection occurs and whether the disease is transmitted through the seed. Experiments along these lines are to be made upon both cabbage and cauliflower.

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