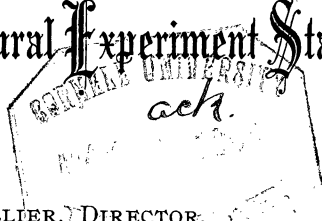


# New York Agricultural Experiment Station.



PETER COLLIER, DIRECTOR.

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BULLETIN No. 86—NEW SERIES.

FEBRUARY, 1895.

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TREATMENT OF COMMON DISEASES AND INSECTS  
INJURIOUS TO FRUITS AND VEGETABLES.

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NEW YORK AGRICULTURAL EXPERIMENT STATION, }  
GENEVA, N. Y. }

*The Honorable Commissioner of Agriculture, Albany.*

The following directions for treating some common diseases and insects injurious to fruits, vegetables and nursery stock are herewith submitted for publication pursuant to chapter 675, section 85, of the laws of 1894.

PETER COLLIER, Director.

## BULLETIN 86 NEW SERIES.

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### TREATMENT OF COMMON DISEASES AND INSECTS INJURIOUS TO FRUITS AND VEGETABLES.

The design of this Bulletin is to give plain directions for treating some of the common diseases and insects injurious to fruits and vegetables in New York State, either by spraying or otherwise. It is composed of four articles, namely :

- I. Common Diseases and Insects Injurious to Fruits.
- II. Common Diseases and Insects Injurious to Vegetables.
- III. Common Diseases and Insects Injurious to Nursery Stock.
- IV. Fungicides and Insecticides.

An index has been prepared to assist the reader in finding readily any subject that is treated in the Bulletin. The principal subjects in each article are presented in alphabetical order and under each fruit or vegetable the diseases are first considered and then the insects.

An account is first given of the common appearance or characters of the disease or insect and of the injury caused by it whenever it is thought necessary to do so in order that the reader may know just what insect or disease is meant. Then a remedy or line of treatment is "recommended" or "suggested." Nothing is "recommended" that has not proved good under trial. Remedies or lines of treatment are simply "suggested" whenever they have not been tested sufficiently to permit of their being confidently recommended. Recommendations quoted from other authors are given simply on their authority. In describing the appearance of insects or giving their life histories Saunder's *Insects Injurious to Fruits* has been freely consulted. Other authors are given credit in foot notes.

## I. COMMON DISEASES AND INSECTS INJURIOUS TO FRUITS.

### APPLE.

**APPLE SCAB.** Apple scab is the name commonly given to the dark rough spots that are frequently found on the surface of the fruit varying in size from small dots to large blotches that make the fruit one sided, frequently causing it to crack open and rendering it especially liable to decay. Some varieties, like the Fameuse and Fall Pippin are particularly subject to this trouble; others, such as Maiden Blush for example, are comparatively free from it.

The scab is caused by a fungus which grows on the leaves as well as the fruit. Attacking, as it does, both leaves and fruit, in many instances it undoubtedly causes a serious dropping of fruit that otherwise might develop into perfect specimens. There is a dropping of fruit soon after blossoming which is the result of the process of discarding the superfluous fruits in the clusters. This is a natural occurrence with perfectly healthy trees, and should not be confounded with the later dropping which may be caused by insect or fungous attacks.

The scab fungus may attack either the upper or under side of a leaf. When in an active condition it appears in spots like a very dark green velvety mould or spreads in irregular threads near the veins or over the surface of the leaf causing it to become crumpled. In connection with severe attacks the leaves turn yellow and fall in great numbers, a result for which the scab fungus is no doubt largely, though not always wholly, accountable. The fungus feeds on the leaf or fruit, causing the portion that is attacked to die. When the infested leaves do not fall the dead parts may become dried, break and fall away leaving the leaves ragged. If the fruit is not attacked too severely it will heal under the dead skin leaving a russet brown scar after the dead skin falls away.

This somewhat lengthy description has been given that the reader may know just what disease is called "apple scab" and something of the nature of the injury it inflicts on apple foliage and fruit.

**Remedy.** As explained quite fully in Bulletin 84 of this Station, it has been determined that three treatments with Bordeaux mixture, 1 to 11 formula, will control this disease even in a very unfavorable season. The manner of preparing the Bordeaux mixture is given in article IV on Fungicides and Insecticides. The treatments should be made as follows:

I. After the buds break but before the blossoms open.

II. As soon as the blossoms have fallen.

III. From ten to fourteen days after the second treatment.

Paris green or London purple may be used with the Bordeaux mixture in fighting injurious insects as stated hereafter. The trees should not be sprayed while in blossom for the spray may injure the delicate parts of the flower and the poison may kill the bees and other insects that play an important part in fertilizing the blossoms.

**BORERS.** The insects known as borers are the larvæ, or grubs, of beetles. The female beetle lays its eggs on the trunks of the trees, where they hatch in a few days. The larva at once gnaws its way into the sapwood where it feeds on the tender wood next the bark. One species lives in the tree three years. They may do great damage especially to young trees which are sometimes girdled and killed by them. The trees should be examined at least once a year, that the borers may be dug out and killed. This is done with a knife or they may be killed by inserting a piece of copper wire into the hole. They should be looked for at the base of the tree or just below the surface of the ground. Their presence may be detected by the darker colored bark and by their castings.

**BUD MOTH.** The adult insect is a small gray moth that lays its eggs in the summer. The eggs soon hatch and the larvæ at once form a web on the under side of the leaves where they feed. According to Slingerland they pass the winter as half grown larvæ in silken cases attached to the twigs. They come forth in the spring as small brown caterpillars, and begin their attacks as soon as the buds begin to unfold.

The caterpillar works its way to the centre of the bud where it feeds on the young leaves or flowers. Spray should be applied to the trees when the buds begin to open<sup>1</sup>, for when the caterpillar

<sup>1</sup>Bulletin 50 Cornell Expt. Station, p. 27.

is once inside the bud it immediately begins to form a covering by tying the leaves together with a web. When thus covered it is very difficult to reach it with the spray.

**Remedy.** Where an orchard is badly infested it will pay to spray with Paris green as the buds begin to open, using one pound for from one hundred and fifty to two hundred gallons of water. A second treatment with Paris green should be made within a few days, especially if rain falls so as to wash off the first application. If it is desired to treat the trees for apple scab, Bordeaux mixture may be combined with the Paris green for either of the above treatments, but only one treatment with Bordeaux mixture for apple scab need be made before the blossoms open.

**CANKER WORM.** After the codling moth, the canker worm is perhaps the next worst insect enemy of the apple grower. There are two forms of this insect known as the Spring Cankerworm and the Fall Cankerworm. They resemble each other in general appearance, and in the injury that they do. When an orchard is badly infested nearly every leaf may be stripped from the trees. When left undisturbed the insects increase rapidly from year to year and do serious damage. The eggs of both species hatch when the buds are unfolding and the little worms at once begin feeding on the tender leaves. They are commonly known as loop worms, or measuring worms. When first hatched the worms are very small and of a light green color, so that they are not readily seen. They grow rapidly, and when mature are about an inch long, varying in color from light green to brown. They now drop from the trees by a thread and go into the ground, where they enter what is termed a resting stage. Most of the Spring Cankerworms remain in the ground in this form over winter and in the spring the mature insect emerges as a moth. The female is wingless and is slow and awkward in her movements, so that it is difficult to believe that she is related to the graceful flying male. The moths come out of the ground in greatest numbers after the ground begins to get warm in the spring, but some of them appear before the snow has gone. After emerging from the ground, the females at once crawl up the trees to lay their eggs.

In the case of the Fall Cankerworm the moths issue from the ground in the fall, when the female lays its eggs on the twigs.

As mentioned above, the eggs hatch at the same time that those of the other species do, and the worms mature at the same time.

**Remedies.** The most practical way to combat this insect is to poison the worms. The infested trees should be sprayed with Paris green when the first leaves are expanding, as the little worms begin feeding at this time. It often happens that rainy weather in the spring of the year greatly interferes with spraying, by preventing the applications from being made when necessary, or if applied, a good share of the poison may be washed off the trees. In such cases the previous use of traps will be a valuable aid. If rain interferes seriously with the Paris green treatment it is suggested that kerosene emulsion be tried, being careful to hit as many as possible with the spray. The number of treatments that will be necessary to control this insect must be determined by the circumstances. When the trees are to be treated for scab, the Paris green may be combined with the Bordeaux mixture.

As previously stated the female moth is wingless and must crawl up the tree if she deposits her eggs on the branches. Advantage is taken of this condition and traps are used to prevent the female moths from ascending the tree. Cloth or paper bands five or six inches wide, made sticky with tar, printer's ink or some other sticky substance, are fastened around the trunks of the trees. Care should be taken to leave no crevice under the band through which either the moths or the young worms might crawl. The bands must be in position to catch those moths which emerge on warm days in spring, sometimes before the snow is all gone and they must be examined every two or three days if necessary, smearing them afresh and keeping them in working condition. Bands of raw cotton or of wool have also been advocated for this purpose.

In opposing this insect it should be remembered that prevention is better than cure and the trees should be sprayed regularly with arsenites each season as advocated for the codling moth and bud moth. Where an orchard has been allowed to become badly infested, probably more than one season's work will be necessary to free it from this pest and all practical remedies should be used vigorously and thoroughly.

**CASE BEARER.** The larva of this curious insect may be found in the spring attached to the twigs in what Saunders<sup>2</sup> describes

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<sup>2</sup> Insects Injurious to Fruits, p. 115.



as a pistol-shaped case. As the buds begin to swell, the insect commences to feed on them, often leaving nothing but the empty shell. Later on they move to the leaves and continue their depredations. Here they may be seen with their heads attached to the leaves on which they are feeding and the cases containing their bodies projecting out from the surface of the leaves.

**Remedy.** In some sections of the State these insects have appeared in sufficient numbers to damage the foliage to a considerable extent. In orchards where they are so numerous as this Paris green should be applied when the buds begin to open as recommended for the bud moth. If in addition to this treatment Paris green be used with Bordeaux mixture in the apple scab treatment this insect will probably be held in check.

**Codling Moth.** The adult insect is a small brown moth that flies mostly at night, so it is not commonly known. But we are all familiar with the work of its larva, which causes the wormy apples.

The moth first appears about the time the trees commence to bloom and deposits her eggs singly, in the open calyx of the flowers. About fifty eggs in all may be deposited by one insect. Later attacks may come from late appearing moths or from a second brood. The eggs begin to hatch in about a week, so here we have a hint as to when the first spraying should be made.

**Remedy.** Paris green is sprayed on the young fruit to poison the insect before it eats into the apple. This insect is such a universal pest, that where spraying is practiced to prevent the ravages of apple scab, Paris green is usually combined with the Bordeaux mixture, so that remedies for both pests are applied at the same time. At the second spraying for apple scab, applied when the last petals are falling from the flowers, Paris green is combined with the Bordeaux mixture. At the third spraying for apple scab, Paris green is again combined with the mixture. One pound of Paris green is used for from one hundred and fifty to two hundred gallons.

If it is not thought necessary to spray for apple scab the Paris green mixed with lime and water, can be applied alone at the time specified above. But these two pests, the scab and the codling moth, are so universal, and the cost of making the mixture is so small, that it is by far the better practice to apply both remedies at once.

Now to summarize: Where orchards are badly infested with canker worm, bud moth or the case bearer, the trees should be sprayed with Paris green as soon as the leaf buds begin to unfold in the spring. For apple scab, spray the trees with Bordeaux mixture after the buds break but before the blossoms open as recommended on page 70. If the trees are infested with the canker worm, bud moth, case bearer, codling moth, or any insect that chews its food, Paris green should be combined with each Bordeaux mixture treatment.

#### APRICOTS.

**FRUIT ROT.** The disease is more fully discussed under the subject of Cherry Fruit Rot on a subsequent page.

**LEAF BLIGHT.** This disease is caused by a fungus which also causes the leaf blight on cherry and plum. The diseased portion usually drops out leaving a hole in the leaf. The apricot appears to drop the diseased parts of the leaf in this way more readily than cherries or plums, and so the foliage of trees that have been attacked quite severely appears as if riddled with holes. Where the disease is prevalent it is suggested that the treatment set forth under "Cherry Leaf Blight" be given.

**CURCULIO.** This insect causes great damage in apricot orchards by attacking the fruit, causing wormy fruit. Frequently a large part of the crop becomes infested and drops unless measures are taken to kill the beetles before they deposit their eggs in the young fruit. This is best done by jarring as recommended in the discussion of this insect under the heading of "Plum Curculio."

The other insects mentioned as attacking the peach are also liable to trouble the apricot.

#### BLACKBERRY.

**ANTHRACNOSE.** Same as Raspberry Anthracnose described on a subsequent page.

**BLIGHT.** Same as Blight of Raspberries described on a subsequent page.

**RUST.** Same as Rust of Raspberries described on a subsequent page.

## CHERRY.

**BLACK KNOT.** The black knot of cherry is said by good authority to be caused by the same fungus that causes plum black knot, the treatment of which is discussed on a subsequent page under Plum Black Knot.

**FRUIT ROT.** The rotting of the ripening fruit of cherries, plums, peaches and other fruits, frequently causes serious loss to the fruit grower. A fungus of the genus *Monilia* attacks the fruit and causes it to rot. The rotted fruit afterwards becomes covered with a gray powdery mould and frequently hangs to the tree till the next summer in a dried or mummied form. The gray powder consists of the germs of the disease which may be washed by rains, blown by winds or carried by insects to other parts of the tree thus spreading the disease. The mummy fruits carry the disease over from one season to the next, and therefore the collecting and burning of these fruits appears to be a good sanitary measure. The fungus begins its attacks early in the spring, often destroying many of the blossoms. These decaying blossoms are blown about by the wind, thus spreading the infection. It also attacks the leaves and young twigs, but it is on the fruit that it commonly does the most damage. It attacks the fruit at any stage of its development, but spreads most rapidly when the cherries are nearly ready to pick. With warm, moist weather at this time, the disease spreads very rapidly, often nearly destroying a crop in a few days. Many of the cherries rot and fall to the ground while others dry, and hang to the branches over winter as stated above. The appearance of this disease on the plum is shown in Plate I, Fig. 1.

**Remedy.** As in the case of the leaf blight described below we are only prepared to offer suggestions as to the orchard treatment against the fruit rot, as follows:

I. Just before the blossoms open apply Bordeaux mixture, I-II formula.

II. Just after the blossoms fall apply Bordeaux mixture as before with the addition of one ounce of Paris green for eighteen gallons of the mixture. The Paris green is used against the curculio which causes wormy cherries.

III. Make a third application from ten to fourteen days after the second, using Bordeaux mixture and Paris green as before.

If later applications are found necessary use the Ammoniacal solution of copper carbonate which contains less copper per gallon than the Bordeaux mixture and leaves less stain. Directions for making this solution and also the Bordeaux mixture are given in article IV on Fungicides and Insecticides.

**LEAF BLIGHT.** See Plate I, Fig. 2. This is a fungous disease which attacks the leaves of other stone fruits besides the cherry. On the cherry it frequently does considerable damage in that it seriously injures the foliage or even causes it to drop from the tree. Some varieties, English Morello, for example, appear to be more subject to this trouble than others. Treatment of this disease on nursery stock has been quite thoroughly investigated at this Station but the treatment of orchards has not yet been as thoroughly investigated as is desirable.

**Remedy.** While it is known that the disease may be controlled by spraying with Bordeaux mixture, 1 to 11 formula, the best time for treatment and number of treatments can as yet be only suggested. Let the first treatment be made as soon as the blossoms fall; the second about two weeks later, and the third just after the fruit is picked. Should it be found necessary to spray when the fruit is nearly full grown, or ripening, use the ammoniacal solution of copper carbonate. Directions for preparing this and the Bordeaux mixture are given in article IV on Fungicides and Insecticides.

**CURCULIO.** This insect stings the cherries, causing the fruit to become wormy. It is the same insect as the plum curculio and is discussed more at length under the subject of "Plum Curculio," on a subsequent page.

**Remedy.** The curculio is commonly opposed in cherry orchards by one or two applications of Paris green or London purple at the rate of one pound to three hundred gallons of water. Two or three pounds, at least, of unslaked lime should be added for every pound of the poison. Slake the lime and add to the mixture the same as in making Bordeaux mixture. The poison may be mixed with the Bordeaux mixture if desired as stated on page 75. Make the first application immediately after the blossoms have fallen and a second application about ten days later.

**SLUG.** This insect also infests pear trees and it is discussed more fully under the heading of "Pear Slug" on a subsequent page. The remedies to be used are there given.

## CURRANT.

**LEAF SPOT.** Two of the fungous diseases which cause spotting of currant leaves have been successfully treated with Bordeaux mixture by Prof. Pammel.<sup>3</sup> The spot diseases are usually seen to some extent each year and in some cases their attacks are so severe as to nearly defoliate the bushes. Judging from the experiments thus far tried, the spraying should begin soon after the fruit sets and continue at intervals of about two weeks till the fruit begins to color. One or two applications may be made after the fruit is harvested if thought necessary.

**WORMS.** The imported currant worm, which is the larva of a sawfly, is the most injurious insect that feeds on the currant bush. The fly, as described by Saunders, resembles the common house fly somewhat, the female being larger and the abdomen is mostly yellow. These flies appear early in the spring on warm days, and deposit their eggs on the under side of the leaf, in chains along the veins and midrib. The eggs hatch in about ten days, when the larvæ appear as minute white worms. They at once begin to feed on the leaves, grow rapidly and spread over the bushes, often stripping them of their foliage in a few days. As the worms grow they assume a light green color and at one stage are covered with many black dots. They are about three quarters of an inch long when full grown.

**Remedy.** As soon as the little worms appear, the bushes should be sprayed with hellebore, one ounce to three gallons of water. The spraying should be repeated as often as the worms appear in sufficient numbers to do damage. The insect has two broods and careful watch for the little worms should be kept throughout the summer to prevent the bushes from being defoliated.

## GOOSEBERRY.

**MILDEW.** The mildew usually makes its first appearance on the young shoots and leaves. Here it will first attract the observer's attention as a collection of some bright, frosty substance. On close examination it will be found to be composed of a mass of glistening white threads that spread rapidly under favorable conditions. The more mature portions of the fungus take on

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<sup>3</sup> Bulletin 17, Iowa Expt. Station, pp. 419-421; Bulletin 20, pp. 716-718.

a dirty brown color. Later it attacks the fruit in a similar manner. The threads often spread over the berries until they are entirely covered with a mass of brown felt like mould, which renders them unsalable.

European varieties, when grown in this country, are particularly susceptible to the attacks of mildew. Many of those varieties produce very large, fine fruit and are so desirable both for home and market that they would be grown to a much greater extent than they now are, were it not for the attacks of this disease.

It has been found at this Station that with proper attention to location, cultivation and pruning, the mildew may be successfully held under control by spraying with potassium sulphide. When setting out a plantation, a site should be chosen where the land is well underdrained and where there is an abundant circulation of air. Branches that droop close to the ground should be pruned back and the ground underneath kept free from grass or weeds preferably by frequent shallow cultivation, otherwise by mulching.

**Remedy.** Spraying should begin early in spring after the buds break and before the first leaves unfold, using one ounce of potassium sulphide for two gallons of water. This treatment is repeated at intervals of from seven to ten days depending on the amount of rain that comes to wash off the applications. After the fruit is marketed spraying is no longer resorted to although the mildew may continue through the season on the ends of growing shoots. Bordeaux mixture has not been compared with potassium sulphide as a fungicide for mildew to a sufficient extent to warrant an exact statement of their comparative merits but so far as it has been used at this Station the results indicate that it is not as efficient as the potassium sulphide for this purpose. The potassium sulphide also has the advantage that it is easily prepared and leaves no stain.

**WORMS.** The Imported Currant Worm, which has already been described as injurious to currants, also attacks gooseberry foliage. It may be controlled in the way advocated for treating currants infested with it. See page 77.

#### GRAPE.

**ANTHRACNOSE.** This disease attacks any tender portions of the growing vine. When the leaves are affected dark spots are

first formed on their surface. As the disease advances these spots enlarge, and irregular cracks are often formed through the dead tissue. Frequently many of these small cracks run together, forming a long irregular slit through the leaf. Similar marks are formed on the tender shoots, though they are not so noticeable. When the fruit is attacked the disease is sometimes called bird's-eye rot. Circular spots are formed on the surface of the berry. The spots may be of different colors and usually have a dark border; as the spots enlarge and eat in, a seed is often exposed in the center. The berries do not rot, but the tissue becomes hard and wrinkled. Sometimes the disease girdles the stem of a fruit cluster cutting off the supply of sap from the grapes beyond the diseased line and causing them to shrivel and die.

**Remedies.** Anthracnose does not spread as rapidly as some other vineyard diseases neither does it yield as readily to treatment. When a vineyard is badly infested with anthracnose, it requires prompt attention and careful treatment to control the disease. In Austria and other portions of Europe, vines infested with anthracnose are treated early in the season, when the buds are swelling, but before the tips of the leaves unfold, with a warm saturated solution of copperas (iron sulphate) to which ten per cent of sulphuric acid has been added. Similar treatment was recommended for a vineyard near Cayuga lake that was very badly infested with anthracnose in 1893. It was sprayed in the spring of 1894, with a saturated solution of copperas, without adding sulphuric acid, and afterwards was given the customary Bordeaux mixture treatment for other vineyard diseases. The owner writes that the vines are now quite healthy. Inasmuch as no untreated vines were left for comparison this cannot be looked on as a satisfactory experiment, but this, and other similar cases, furnish sufficient evidence of the value of the copperas treatment to warrant the suggestion that vineyards infested with anthracnose be given the treatment as above described. It is hoped that careful tests of the value of this treatment in American vineyards may soon be made.

**BLACK ROT.** This disease of the grape is quite prevalent in the Keuka lake region and along the Hudson River, but so far as known to the writer the Chautauqua region seems to be quite free from it. It may usually be seen first on the leaves where it

forms circular, bright reddish brown, or pale brown, spots on which there appear later little black dots or pimples. Within the black pimples are developed the germs of the fungus which causes the disease. These germs are given forth and washed by rain, or blown by wind, to other leaves or fruit where they grow and form new diseased spots. In the fruit it also forms circular spots and develops black pimples like those formed on the leaves. The diseased fruit withers, turns black, and becomes hard and shriveled, clinging to the stems sometimes till the following spring. The disease may also attack the green shoots.

**Remedies.** All diseased fruit should be taken from the vineyard since it is capable of spreading the disease the following spring. Trimmings from the fruit containing diseased berries ought not to be returned to the vineyard in the shape of compost as is sometimes practiced, since the diseased berries are liable to spread the black rot through the vineyard.

This disease may be successfully controlled by thorough spraying if done at the right time. Bordeaux mixture, 1 to 11 formula, is used for this purpose. It is prepared as directed in article IV on Fungicides and Insecticides. The applications are made as follows :

- I. Just as the pink tips of the first leaves appear.
- II. From ten days to two weeks after the first spraying.
- III. Just after the blossoming.
- IV. From ten to fourteen days after the third treatment.
- V. If a fifth treatment is necessary let it follow the fourth after an interval of from ten to fourteen days.

VI. If a later treatment than the fifth is needed Ammoniacal solution of copper carbonate should be used as that is less liable to stain the fruit than the Bordeaux mixture. Directions for preparing it are found in article IV on Fungicides and Insecticides.

The number of the treatments will be governed by the weather conditions and the severity of the disease. If the vineyard is not badly diseased, and if there is not an excessive amount of hot, wet weather, four treatments may be found sufficient for all practical purposes.

*The early treatments are extremely important.*

*Thorough treatment is essential to success.*

**DOWNY MILDEW.** In some grape growing sections of the State



this is a very serious disease. It attacks nearly every portion of the vine. Its first appearance on the leaves, that will be noticed by a casual observer, is in dry, brick red spots on the upper surface. On the under side of the leaf the diseased area will be covered with the interlaced threads of the fungus. The red spots increase in size until in many instances the entire leaf dies and falls to the ground. It frequently causes the berries to turn dull brown and become soft and shrivelled. This appearance of it has been commonly called "brown rot." The spores are found on the threads which issue from the under side of the leaves or from the stems or fruit, the whole giving when fresh a glistening white downy appearance from which the disease takes its most common, and preferable name of "downy mildew." Later these parts of the fungus exposed on the surface assume a gray hue and so the disease has also been known as "gray rot." Some varieties, like Delaware, appear to be quite susceptible to the attacks of the disease and none of the cultivated varieties are known to be exempt.

**Remedy.** It may be successfully treated in the manner just described for Black Rot. See p. 80.

**POWDERY MILDEW.** Unlike many of our fungous diseases, the powdery mildew flourishes best during the dry weather of mid-summer. It usually begins its attack in June, though it may appear earlier and destroy many of the grape blossoms. Its name is descriptive of its appearance, as it forms dull white, powdery patches on the young shoots and on the upper surface of the leaves. When the fungus is abundant it seriously checks the growth of the vines, by absorbing the nourishment that should have gone to their development. The berries may be attacked at any stage of growth and they are injured or destroyed in the same way as are the shoots or leaves.

**Treatment.** It may be successfully treated in the manner just described for the Black Rot.

**Summary.** The use of strong solutions of copper sulphate or iron sulphate is not recommended except in case of severe attacks of anthracnose as previously stated. Fortunately, Bordeaux mixture has been found to be almost a specific and with the exception just named, the various prominent vineyard diseases are controlled with the one line of treatment advocated for Black Rot. See p. 80.

## PEACH.

**Note.** Before discussing the diseases and insect enemies of the peach, attention should be called to the fact that the foliage of stone fruits and especially of the peach is peculiarly liable to injury from Paris green, London purple or copper in solution. For this reason the former should not be used stronger than one pound to about three hundred gallons of water and at least two or three times as much fresh slaked lime as poison should be used. It is doubtful whether more than two sprayings with Paris green or London purple should be given even if diluted to the strength just stated. If Bordeaux mixture is used especial care should be taken to have an excess of lime in the mixture as directed in article IV on Fungicides and Insecticides.

**FRUIT ROT.** This disease is more fully discussed under the subject of "Cherry Fruit Rot" on p. 75. It is caused by the same fungus that causes ripe rot in cherries, plums and some other fruits.

**Remedies.** Chester reports<sup>4</sup> encouraging results in spraying with a solution of copper sulphate, one pound to twenty-five gallons of water, applied as a heavy spraying in spring "before the buds began to swell." Previous to this the mummy fruits, relics of last year's diseased peaches and still capable of spreading the disease, were removed. A second spraying using, in one instance, eight ounces of copper carbonate mixed with one pound of ammoniac carbonate and dissolved in forty-five gallons of water, was given just before the blossoms opened. Immediately after the blossoms fell the trees were sprayed with Paris green, one pound to three hundred gallons of water, to kill the curculio and after twelve days this treatment was repeated. About a month later the trees were sprayed with the mixture used in the second treatment. As a result of these sprayings the trees lost considerable foliage but the yield of good, sound fruit was much increased as compared with the untreated trees. Further experiments are necessary to determine the line of treatment that may be relied on to give the best results. Care should be used in spraying as noted in the first paragraph under the subject of the "Peach."

**LEAF CURL.** This is a disease which causes the leaves to curl and drop early in the summer. It is caused by a fungus which lives within the twig as well as the leaf.

<sup>4</sup>Annual Report Del. Expt. Sta. 1893, pp. 106-109.

**Remedies.** Some orchardists claim that good results have followed the use of Bordeaux mixture sprayed on the young foliage soon after the leaves appear. Careful experiments need to be conducted to determine the extent to which the disease may be prevented by spraying. Since the fungus infests the twigs it appears unwise to get cions or buds from trees that have shown the disease, although so far as known to the writer, it has not yet been demonstrated that the disease may be propagated by using diseased cions in budding or grafting. Note the first paragraph under the subject of the "Peach" concerning spraying.

**YELLOW.** The best known treatment for peach yellows is to cut out and burn the diseased trees. The text of the New York State law on this subject is given on page 87.

**BORERS.** The peach is subject to the attacks of more than one kind of borer. The trunks should be examined carefully in spring and fall and the borers removed with wire or knife. Their presence may often be detected by gummy exudations mixed with the castings of the insect.

**CURCULIO.** The plum curculio sometimes is a serious pest in the peach orchard. Remedies for this insect are discussed under "Plum Curculio."

#### PEARS.

**BLIGHT. FIRE BLIGHT.** This disease shows itself in the dying of entire twigs, large branches or even the tree itself. It is generally known under the name of "pear blight." It is a bacterial disease that has long been known but whose real nature was first discovered by Dr. Burrill. It was afterwards studied very carefully at this Station by Dr. Arthur<sup>5</sup>, and more recently by Mr. M. B. Waite under the direction of the U. S. Department of Agriculture.

**Remedy.** Although the cause of the disease is now known, no method of treating it has proved successful. The only thing that can be done is to cut out and burn the diseased parts as soon as the blight appears. This should be done promptly, for the disease spreads rapidly. The affected part should be cut below any discoloration, back to perfectly healthy wood. Buds cut from infested twigs and set in healthy stock may communicate the disease to such stock.

<sup>5</sup> See Annual Reports of this Station, 1884, p. 357; 1885, p. 241; 1886, p. 275.

Among other plants that are subject to the attacks of this disease may be mentioned the apple and the quince.

**LEAF BLIGHT.** This is caused by a parasitic fungus which makes its appearance early in the spring. It is first found on the new leaves where it appears as bright, reddish spots on the upper surface. These spots rapidly increase in size and later the leaves turn brown and finally fall. It attacks the young twigs in the same manner and frequently kills many of them back. When the fruit is attacked the bright colored spots are first formed. These spots soon become dark colored, and spread out in every direction; the surface of the pear becomes rough where attacked by the disease and at these places the growth is checked. Sometimes the fruit becomes cracked as it does when attacked by the scab. This disease appears to be more severe in states south of New York and in regions near the Atlantic coast than it is in the interior of the State, where it causes little damage except as a nursery disease.

**Remedy.** The treatment advocated for pear scab is also recommended for this disease when it appears in the orchard.

**PEAR SCAB.** This disease is caused by a fungus very similar, both in appearance and in the injury which it does to leaves and fruit, to the apple scab fungus. It robs the leaves of the nourishment which they are preparing for themselves and for the growth of the tree and fruit; it spots the fruit and in very severe attacks causes it to become one sided, distorted or cracked. While it does not kill the trees or branches as the blight may do, still it is believed that no disease, year after year, causes so great loss in pear orchards of New York State as does the scab. Some varieties appear to be comparatively exempt from its attacks while others suffer quite severely. With varieties which are thus injured by its attacks, it weakens the tree, it lessens the yield, it makes a large part of the fruit unsalable or of an inferior grade, and even the number one fruit sells for less in the market than it would were it free from the blemishes caused by the scab. It is also conceded that fruit free from scab keeps better and is handled easier than the fruit of the same variety blemished with scab spots.

**Remedy.** The treatment of this disease is discussed quite fully in Bulletin 84 of this Station. It is the same as that recommended for apple scab. See p. 70.

**BUD MOTH.** This eye-spotted bud moth which attacks pears is the same as that which infests apple trees. It is also known as the bud worm. Treatment for it is given under apples. See p. 71.

**CASE BEARER.** This insect also infests apple trees and has been considered under apples. See p. 73.

**CODLING MOTH.** This insect which causes so much loss to apple growers by causing wormy apples also attacks pears. It may be treated in treating scab as recommended under apples. See p. 73.

**PSYLLA.** This is the name given to an insect which injures the tree by sucking its nourishment from the leaves. The insect when mature is nearly a tenth of an inch long, the full grown wingless form being about half as long. Its presence is usually betrayed by the honey dew which is secreted by the young wingless forms of the insect. The honey dew afterwards becomes covered with a black mold giving the leaves, fruit, or branches on which it is found a black, unsightly appearance. The following statements and recommendations for treatment are based chiefly on Slingerland's account<sup>6</sup> published in 1892.

The adult is an active, four winged insect, resembling in miniature a seventeen year locust or cicada. A number of broods of the psylla are produced during the summer, and the adults which live through the winter are distinct in form from the summer adults. They appear early in the spring and deposit their eggs which hatch in a few days and the little larva or nymphs at once commence to suck the juices from the young leaves and twigs. Where the nymphs are numerous they take so much nourishment from the trees that the new growth is seriously checked. The whole tree assumes a stunted, unhealthy appearance. The fruit crop of course is greatly lessened and, in some instances, trees have been killed. The first brood in the spring does the most damage.

**Remedy.** The insect is most easily killed in its young stages, so when the leaves are unfolding in the spring close watch should be kept for the appearance of the nymphs. They should be looked for between the axils of the leaves and the stem, as they have a habit of collecting at such points. At the first appearance of the pest no time should be lost in spraying the trees with kerosene

<sup>6</sup>Bulletin 44, Cornell Exp't Station, Ithaca, N. Y.

emulsion. For this purpose the emulsion may be used as weak as one part of the stock solution to twenty parts of water. The treatment should be repeated if more of the nymphs appear.

When spraying with kerosene emulsion it is absolutely necessary that the spray hit the insects as it is not a poison but kills by contact with their bodies. Therefore the trees should be drenched, instead of simply coating the leaves over with the mist-like particles as is one of the essentials in applying Bordeaux mixture.

**SLUG.** The adult insect is a small, dark colored, four winged fly. The slugs make their appearance in the latter part of May or early June. At first light in color they soon become darker and are covered with an abundance of slime. The slugs feed on the upper surface, skeletonizing the leaves. Leaves that are badly injured wither and fall, and where the insects are very abundant they cause serious injury.

**Remedies.** If upon examination it is found that the insects are likely to appear in sufficient numbers to cause much damage, no time should be lost in spraying the trees with Paris green. If the trees are being treated for fungous diseases the Paris green should be combined with the Bordeaux mixture. A second brood of this insect usually appears in August. The only thing to be done is to spray when the indications are that the slugs are numerous enough to be injurious. On low trees they are sometimes treated with air-slaked lime or road dust, by throwing the dust or lime over the trees.

#### PLUM.

**BLACK KNOT.** This disease causes swellings underneath the bark, finally rupturing it and developing a spongy texture covered with dark olive green mold. In this stage the summer spores are produced which spread the infection to other trees.

Late in the season the knot becomes hard with a black surface which finally becomes covered with fine black pimples inside of which are matured the winter spores. The winter spores escape late in winter or early in spring and serve to spread the disease. A more extended discussion of this disease is given in Bulletin 40 of this Station, and in the Annual Report for 1893, p. 686.

**Remedy.** The best known remedy for this trouble is to cut out and burn the knots. They can be found most readily after

the leaves have dropped in the fall. They should then all be removed before mid-winter so as to be sure of destroying them before the spores mature and escape. Early in the summer the new knots should be watched for and promptly removed and destroyed. The infection frequently comes from the knots on neglected plum or cherry trees along fence rows or in neighboring orchards. The black knot law, a copy of which is herewith inserted, provides for the destruction of infested branches wherever found. In removing the knots the branch should be cut off three or four inches or more below where the knot appears, so as to remove the threads of the fungus that may extend down the branch to a considerable distance from the knot. The same disease also affects various wild plums and wild and cultivated cherries. It is rarely found on sweet cherries but sometimes is very destructive to the Morello class.

*New York Black Knot and Peach Yellows Law.*

§ 82. The prevention of disease in fruit trees.—No person shall knowingly or willfully keep any peach, almond, apricot or nectarine tree affected with a contagious disease known as yellows, or offer for sale or shipment, or sell or ship to others any of the fruit thereof. Nor shall any person knowingly or wilfully keep any plum, cherry or other trees infected with the contagious disease of fungus, known as black knot. Every such tree and the fruit of a tree infected with yellows shall be a public nuisance, and no damages shall be awarded for entering upon premises and destroying such trees and fruit if infected with yellows or for cutting away the diseased part of any tree infected with black knot or altogether destroying such tree if necessary to suppress such disease, if done in accordance with the provisions of this article. Every person when he becomes aware of the existence of such disease in any tree or fruit owned by him, shall forthwith destroy or cause such tree or fruit to be destroyed or the infected part to be cut away.

§ 83. Appointment and duties of the agent of the commissioner of agriculture.—When the commissioner of agriculture knows and has reason to believe that any such contagious disease exists, or that there is good reason to believe it exists, or danger is justly apprehended of its introduction in any town or city in the state, he shall forthwith appoint a competent free holder of such town or city as his agent, who shall hold office during his pleasure and who shall within ten days after his appointment, file an acceptance of the appointment, with the constitutional oath of office, in the office of the town clerk of the town. Such agent shall on or without complaint, whenever it comes to

his notice that either of the diseases known as yellows or black knot exists or is supposed to exist within the limits of the town or city, proceed without delay to examine the trees or fruit supposed to be infected, and if the disease is found to exist, a distinguishing mark shall be placed upon the diseased trees. If the disease is the black knot, such distinguishing mark shall be placed on some affected part of the trees, or if in the judgment of such agent any such trees should be entirely destroyed, then the trunk of such tree shall be thoroughly girdled, and thereupon the owner notified personally, or by a written notice signed by such agent and left at his usual place of residence, or if a non-resident by leaving the notice with the person in charge of the trees or fruit, or in whose possession they may be. Such notice shall contain a statement of all the facts found to exist, with an order to effectually remove and destroy by fire or otherwise the trees or parts of trees so marked and designated, within ten days, Sundays excepted, from the day of the service of the notice. In case of fruit so infected, the notice shall require the person in whose possession or control it is found, to immediately destroy the same or cause it to be done.

§ 84. **Proceedings in case of owner's failure to destroy.**—If any person shall refuse or neglect to comply with the order of such agent to remove and destroy trees or parts of trees so marked by him, such agent shall cause such trees or parts of trees to be removed and destroyed forthwith, employing all necessary assistants and for that purpose; and such agent or his employees may enter upon any and all premises within the town or city for the purpose of such removal and destruction. Such agent shall be entitled to compensation for his service under this and the preceding sections at a rate of two dollars for each full day spent by him in the discharge of his duties, and the necessary disbursements paid or incurred by him, which with the expense and removal and destruction of any such trees or fruit shall be a town charge.

**FRUIT ROT.** The ripening fruit of plums frequently is destroyed by the fungus which attacks in a similar way peaches, cherries and other fruits. The treatment of this fungus has already been discussed under cherries, see p. 75. As stated there, this disease may attack the blossoms as well as the fruit. Under conditions favorable to the disease at the blossoming season it may thus cause great damage to the crop. The manner in which it destroys the fruit of plums is illustrated in Plate I, Fig. 1.

**LEAF BLIGHT.** This disease also infests cherries and other stone fruits. Its appearance on plums differs somewhat in general from its appearance on cherries, in that while the tissue of some cherry leaves does not readily break away and drop the



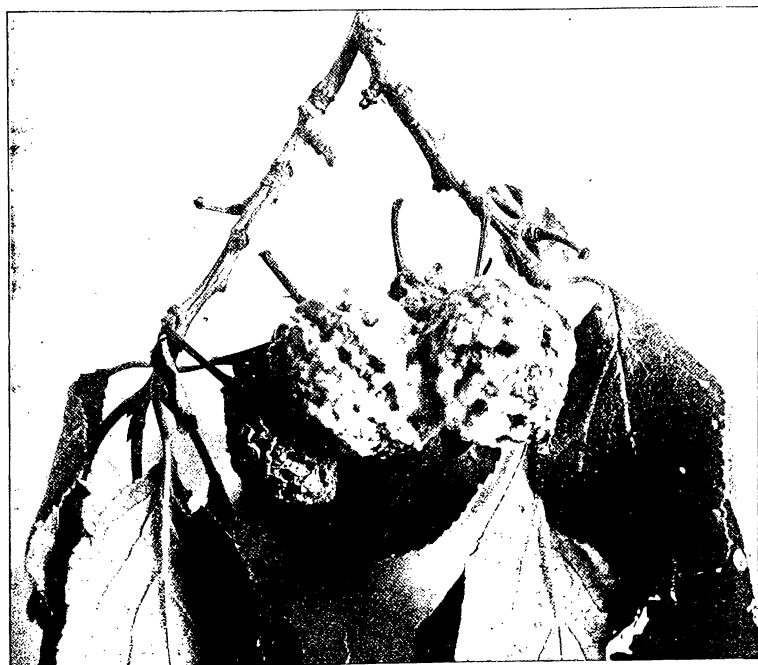


FIG. 1.—*Ripe Rot of Plum, Monilia fructigena.*



FIG. 2.—*Cherry Leaf Blight, Cylindrosporium Padi.*

infested portion out as illustrated in the largest leaf in Plate I, Fig. 2 in plums the diseased tissue is more liable to drop out leaving the leaf riddled with holes as a result of the attacks of the fungus, as illustrated by the smaller cherry leaves in Plate I.

The treatment of this disease is discussed under cherries, see p. 75.

**CURCULIO.** The curculio does not confine its attacks to plums, but it usually infests plum orchards and if left unmolested, often destroys an entire crop.

The mature insect is a small, curiously formed, gray beetle. It passes the winter under the bark of trees, or under rubbish, and comes forth early in the spring to deposit its eggs in the young fruits commencing as soon as they are formed. It does this by puncturing the tissue and inserting the egg. After the egg is deposited, the beetle cuts a crescent shaped groove around one side of the puncture evidently to prevent the growing tissue from crushing the egg. The eggs hatch in a few days when the little worm, or larva, at once commences to feed on the fruit causing much of the infested fruit to fall while still young, and that which remains on the tree ripens prematurely and soon decays.

**Remedies.** It has been found that the beetles' manner of protection is to fall to the ground, when disturbed. Here they curl up so as to resemble bits of bark. Advantage is taken of this habit in fighting the insect by a process known as jarring. The trees are jarred by three or four strokes with a padded crutch or mallet and the insects are caught on sheets spread underneath the tree and destroyed. Where only a few trees are to be treated the sheets are laid on the ground. But when large orchards are to be treated the sheets are stretched over a light frame so that they are constantly extended and no time need be consumed in stretching them into position after the tree is reached. One form of these extended sheets for catching the curculio is made by Mr. Henry Lutts, Youngstown, N. Y. The frame over which the sheet is stretched is suspended from the shoulders of the workman who does the jarring, occupying a position at the center of the sheet. The sheet slopes towards several tin cups in which the bugs are collected.

The curculio catcher commonly used in the vicinity of Geneva is one made by Mr. J. B. Johnson, Geneva, N. Y. The frame

over which the sheet is stretched is attached to a two-wheeled cart. The sheet slopes downwards to the center where an opening allows the bugs to be swept into a tin box underneath the sheet and between the wheels. A slit at one side allows the cart to be run directly under the tree and two or three jars bring down the bugs which are swept into the box above mentioned, by means of a short handled broom. The cultivated ground is made smooth by rolling to prepare it so that the cart wheels will pass over it readily.

Jarring should be begun as soon as the fruit sets and be continued as long as the curculio are found in sufficient numbers to pay for jarring, which is usually for about three weeks. Early morning is the best time to do this work. Towards the middle of the day, especially on bright days, they are more active and apt to fly. The beetle feeds on the plum leaves and for this reason spraying the trees with Paris green or London purple has been advocated. No doubt the insects may be killed to some extent in this way but the foliage of stone fruit trees is particularly liable to injury from Paris green or London purple so that these poisons must be used sparingly and much diluted. One pound of either may be used with about three hundred gallons of water, or mingled in the same proportion with Bordeaux mixture. In either case at least three times as much fresh slaked lime should be added as the weight of the poison. Should frequent rains come and wash off the poison from the foliage it would necessitate spraying again if spraying alone be depended on to fight the insect, and the cumulative effects of the different sprayings would probably result in injury to the foliage. So while it is doubtless true, that spraying against curculio may be practiced with good results, still in the light of the evidence thus far presented on this subject, we would prefer not to spray with an arsenite more than twice; follow the spraying with jarring if it is found necessary.

#### QUINCE.

**BLIGHT—FIRE BLIGHT.** This is the same bacterial disease as the pear blight which is discussed on p. 83.

**FRUIT SPOT.** Fruit spot and leaf blight of the quince are caused by the same fungus that causes pear leaf blight. When a fruit is attacked, numerous small black specks appear on its sur-

face. As the spots increase in size they often grow into each other and form a large, dark, diseased area. The disease does not extend so deep into the tissue of the fruit as to make it entirely worthless, but the market value is greatly lessened. When the fruit is attacked before it has reached its full size, it often occurs that the quinces, like the diseased pears, are misshapen and undersized. Greater damage is done to the trees when the leaves are severely attacked. The loss of foliage in midsummer not only leaves the fruit undeveloped but is a severe check to the growth and vigor of the tree.

**Remedy.** Favorable results in treating this disease with Bordeaux mixture are reported. It is suggested that the treatment recommended for apple scab be used against quince fruit spot and leaf blight, making the first spraying when the blossom buds have appeared, the second just as the blossoms are falling, and a third about two weeks later.

**LEAF BLIGHT.** See Fruit Spot above.

**RUST.** Judging from the unusual number of inquiries concerning this disease that were received at this Station in 1894 and from reports from other sources, quince rust was unusually prevalent last season. The rust is due to a fungus which becomes established and develops within the tissues of the quince branches or fruit. It causes knotty branches and peculiarly distorted fruit on which there appear tiny fringed pits filled with orange colored dust giving the diseased parts quite a brilliant appearance.

In a different form this rust fungus attacks the red cedar and the common juniper forming galls on their branches. In these galls are developed spores which distributed by the winds to quinces, junoberries, hawthorns and apples become established on these trees and cause the rust. Usually the rust is not abundant enough on quinces to cause serious injury. It is usually recommended that the cedar and juniper trees in the vicinity be destroyed to prevent the breeding of the fungus on them and that the rusted fruit or branches also be removed and destroyed. The former recommendation is not always practical and whether the latter course will do any good has not been definitely determined.

**BORERS.** These insects work under the bark, as described under apple borers and are one of the most serious insect pests the quince grower has to contend with. The trunks of the trees

should be examined carefully in spring and fall and the borers dug out.

Various other remedies have been advocated from time to time but none of them take the place of the examination of the trunks and the removal of the insect as above advised. Mr. C. K. Scoon of Geneva, N. Y., finds that strips of tarred paper tied carefully around the trunk of the tree have given encouraging results as a preventive of attacks of borers. The strips of paper are about eight inches high, the lower end being covered with earth. The paper is tied firmly in place encircling the trunk and tied at the top so tightly that insects cannot pass between it and the bark. Should creases or crevices occur in the trunk under the paper, sticks or twigs are driven between the string and the paper so as to force the paper tightly against the bark. The trees are examined for borers the same as before.

**CODLING MOTH.** This insect is the same as that which causes wormy apples and pears as previously described, see p. 73. It should be treated by spraying with Paris green or London purple as soon as the fruit sets, followed by one or two later applications at intervals of ten days, or even less if heavy rains fall in the meantime. The poison thus used is also recommended for the curculio mentioned below. It may be combined with Bordeaux mixture when that is used against fruit spot and leaf blight, using one pound for from one hundred and fifty to two hundred gallons.

**CURCULIO.** This insect, somewhat larger than the plum curculio, feeds on the quince and also deposits its egg in the fruit. The egg hatches and the larva burrows into the fruit but according to Saunders does not enter the core.

**Remedy.** Spraying with Paris green or London purple as for the Codling Moth mentioned above, is recommended for trees that are headed quite low. This system of training is commonly adopted in large orchards and jarring such trees is a rather slow and expensive operation. No carts adapted for jarring quinces have yet been devised, so that thorough spraying with Paris green or London purple appears to be as effective as any treatment that has yet been tried.

#### RASPBERRY.

**ANTHRACNOSE.** This disease is very common to both raspberries and blackberries, but is most injurious to black raspberries.

It lives over winter in the canes and begins its attack on the new canes when they are six or eight inches high. The first appearance of the disease is shown by minute spots that form on the tender shoots. These are at first grayish white in color, with a dark or purple outline. The spots rapidly enlarge and become darker colored. As the spots become more numerous and each one enlarges rapidly, they often grow into each other and form large blotches or scabs several inches long and extending nearly around the cane, effectually girdling it. Thus it often happens that the fruit withers before it is ripe, because the disease has cut off the circulation, so that not enough sap ascends to keep the plant alive. In some localities anthracnose is very destructive, many times killing out a plantation in a few years. It is oftener the case, however, that the disease is not so injurious, but remains in the plantation in an active state without the owner suspecting it, though he complains that his plants do not produce the crop that they once did.

**Remedies.** An experiment now being conducted by this Station tends to the conclusion that treatment with Bordeaux mixture will be successful. Good results have been obtained where the disease has been severe, by giving the first treatment to the canes when the leaf buds were swelling, using solutions of copper sulphate or iron sulphate. A second spraying is given when the new shoots are a few inches high, using Bordeaux mixture. The Bordeaux mixture treatments are repeated at intervals of about two weeks. The number of treatments that will be necessary to control the disease has not yet been fully determined. Where its attacks have not been so severe, the first spraying need not be given till the new shoots are a few inches above ground. As anthracnose is a disease more particularly of the canes, and the treatment is entirely preventive, the spray should be directed at the young shoots. An endeavor should be made to keep them coated with the mixture for the first few weeks of their growth.

**BLIGHT.** Pear blight occasionally attacks raspberries and blackberries. The following account is taken from Bulletin No. 6 of the Ohio Experiment Station.

"At the base of the canes, usually quite near the surface of the ground, occur brownish black patches from one-half inch to several inches long and extending completely around the cane.

There are also smaller patches at the bases of branches, on the petioles and under the surface of the mid-veins of the leaves, which curl downwards. The parenchymatous portion of the leaf does not seem to be attacked. These blackish patches differ from those caused by anthracnose in that the epidermis does not crack, and though blackish brown in color, they do not look dry. The discoloration extends to the sub-epidermal tissues.

The row of Marlborough raspberry was most affected, the leaves were all curled over and the whole row looked as though blasted. On July 19th I sent a diseased cane of the Marlboro to Professor T. J. Burrill, of Champaign, Ill. \* \* \* \*

Again July 28th, Professor Burrill wrote :

"It has now been satisfactorily determined that the disease of raspberry and blackberry canes showing wide dark discolorations of the bark without rupture of any kind is blight—'pear blight.' I have formerly suspected this, now it seems certain. We have the same trouble, and this year more than I had seen before. The same stems frequently are spotted with anthracnose, but the two diseases are very distinct.' "

No treatment is recommended, but from what we know of attacks of blight on pear trees, it would seem to be the part of wisdom to cut out and burn the diseased canes as soon as they are noticed.

**ORANGE RUST.** This fungus occurs in two forms or stages on the host plant, but the first stage is not commonly known. In the second stage the underside of the leaves are covered with a dense mass of orange colored spores, hence the name, orange rust. These spore masses rarely occur on the canes. Clinton states<sup>7</sup> that the fungus enters the very young underground shoots and grows up through the canes to the leaves. Since the disease grows within the canes and infection probably takes place at the root, it appears that any preventive treatment would be useless, other than destroying the infested canes at the first appearance of the disease. They should be dug out and burned promptly as soon as the disease makes its appearance, as it spreads rapidly and is very destructive. The rust is quite common on wild plants, therefore any wild berries that may be growing in the vicinity of a plantation may serve as a source of infection and should be looked after accordingly.

<sup>7</sup> Bulletin 29, Illinois Experiment Station.

## STRAWBERRY.

**LEAF BLIGHT.** This disease is also called strawberry "rust" or "leaf spot." It frequently causes much damage by injuring the foliage so that the plants are incapable of perfecting a full crop of fruit even though a full crop has set, or as Thaxter states<sup>8</sup>, it also attacks the fruit stems and hulls "cutting off the supply of nourishment from the berries and disfiguring them by the withering of the calyx."

When the spots first appear on the leaves they are of a deep purple color, but later they enlarge and the center becomes gray or nearly white. Portions of the infested leaves frequently assume bright red tints and when badly diseased finally wither and die.

**Treatment.** Bordeaux mixture, 1 to 11 formula, used as advocated by Hunn in the Annual Report of this Station for 1892, p. 682, gives beneficial results. When setting a new plantation be particular to remove the diseased leaves before taking the plants to the field, or if the plants must be trimmed in the field the diseased leaves should not be left where they can communicate the disease to the new foliage as it grows out. The following treatment is then suggested:

Spray the newly set plants soon after growth begins and follow with three or four treatments during the season as seems necessary. The following spring spray just before blossoming, and again in from ten days to two weeks. As soon as the fruit is gathered it is a good plan to mow off the foliage of badly diseased beds and burn it if the beds are to be fruited a second season.

**GRUBS.** The larva of the May Beetle, a white grub, frequently does much injury to strawberries by eating off the roots. It is said that the insect lays its eggs chiefly in sod ground. These hatch into the larvæ or grubs which feed on roots of various plants till the third year afterwards, when they come from the ground in the form of May beetles. Since the grubs live in the ground till the third season after the eggs are laid, it is a good practice not to use land for strawberries till the third year after it was in sod.

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<sup>8</sup> Annual Rep. Conn. Exp't Sta., 1889, p. 174.



## II. COMMON DISEASES AND INSECTS INJURIOUS TO VEGETABLES.

### BEANS.

**ANTHRACNOSE.** In many parts of the state the bean crop is severely injured by a disease known as anthracnose. It attacks the bean plant in all stages of its growth, and survives the winter in the beans themselves. The badly diseased beans can be readily told by the discolorations, which vary in size from a small spot to large pits and blisters. When such seed is planted the fungus begins to grow with the beans, and appears on the stems and seed leaves as almost black spots of variable shape and size. These rapidly enlarge and may eat into the stems so as to entirely destroy the young seedlings. When the infested plants are not destroyed in this way they continue to grow and spread the infection to neighboring plants. The disease attacks the under side of the leaves, causing dark spots, and shriveling and discoloring the veins and midribs. The damage which usually attracts most attention is that done to the pods and beans themselves. On the pods, small dark pits are formed with brown or red borders. At first small, they rapidly enlarge and become large irregular pits. When thus attacked, the pods are unsaleable as snap beans, and the discolored beans are unfit for either market or seed.

**Remedy.** The following recommendations for treating this disease are based on experiments conducted on the Station grounds.<sup>9</sup>

It will pay to pick over the beans so that no diseased seed shall be planted.

After the seed has come up, go over the rows and pull up all of the diseased seedlings and destroy them. If they are left lying on the ground the fungus will mature its spores and thus continue the spread of the infection.

About the time the plants have put out the third leaf, begin spraying with Bordeaux mixture, 1 to 11 formula. The method of preparing this mixture is explained in article IV on Fungicides

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<sup>9</sup>See Bulletin No. 48, Dec., 1892.

and Insecticides. Spray again when enough more foliage has grown out to justify another treatment. Probably three or four treatments at least will need to be made. Whether this treatment will make the bean fodder harmful to stock is a point that has not yet been investigated.

Wet weather is favorable to the development and spread of the disease. In infested fields the beans should not be cultivated when wet with rain or dew lest the germs of the disease be distributed rapidly and widely in this way.

**WEEVIL.** Dried beans are frequently found to be infested with the weevil, a small dark gray beetle that appears in the spring, many times being carried to the fields in the seed. The eggs are laid in the young pods. If the beans are picked while green, the eggs or larvæ are, of course, destroyed, and no damage is done. When the beans are allowed to ripen, the grubs mature inside the bean. The grubs are transformed into beetles, within the bean, and these come forth from the stored beans usually in the spring. Several grubs may enter the same seed, so that the beans may be pierced with many small holes. The insect does not feed on the germ of the beans so that infested beans may be used for seed, though they do not produce as vigorous plants as do beans that are free from the weevils.

**Remedies.** Care should be taken that none of the insects escape from the stored beans, or that none are taken to the field in the seed. The weevils may be killed by exposing the infested seed to the fumes of carbon bi-sulphide. This is done as recommended in article IV on Fungicides and Insecticides.

#### CABBAGE.

**APHIS.** This insect is treated more fully in Bulletin 83 of this Station from which the following account is taken: Probably there is no better known cabbage pest than the cabbage aphid, also known as cabbage louse and "greenfly." Many heads of cabbage are found to be filthy from the masses of lice on them. It is not an uncommon sight in the fields to see heads with the outside leaves dead and covered with the inflated skins of what have been parasitized aphids: above may be a few half-dead leaves covered with about an equal number of parasitized and live aphids, while within the withy head are masses of perfectly healthy

lice. This is especially true of Savoy varieties. Some gardeners have the idea that these varieties are more free from insect injury than other kinds. Observations indicate that this idea is simply due to an appearance contrary to the facts. Plant lice curl the leaves of all cabbage more or less. The Savoys furnish a natural protection for them. Any variety which forms a solid head rapidly will have the advantage over slow heading varieties.

**Treatment.** Nearly as many remedies have been recommended for this pest as for the cabbage worms. It should be remembered that plant lice are only killed by insecticides which smother or kill by contact. None of the poisons will kill them. The best remedy is kerosene emulsion diluted with ten parts of water. It should be applied to the lower as well as the upper sides of the leaves. The treatment should be begun when the lice make their appearance, and the applications repeated as often as may be necessary to keep them in check.

**MAGGOT.** The cabbage maggot is very injurious in some localities. The adult insect is a small fly that makes its appearance in the spring about the time the plants are set in the field. The female deposits her eggs on the stems of the plants at, or just below, the surface of the ground. The eggs hatch in a few days, when the little maggots begin feeding in the roots of the plants. When they occur in large numbers on the same plant the roots are soon reduced to a decaying and foul smelling mass.

**Remedy.** Prof. Goff<sup>10</sup> of Wisconsin has devised what appears to be the most practical method of combating this insect. Small cards of tarred paper are fastened tightly around the stems of the plants when they are transplanted so that the cards rest on the surface of the ground after the plants are set. The cards are cut from building paper with a tool made for the purpose. They are six sided and about three inches in diameter. A slit from one side to a star shaped puncture in the centre, permits the card to be fastened tightly around the plant. When properly applied the cards have proved very effective by preventing the fly from laying her eggs on the plants.

**WORMS.** The worms that feed on cabbage are so common that every grower is familiar with them and especially with the damage they do.

<sup>10</sup>Eighth Annual Report, Wis. Expt. Sta. pp. 169-173; also Bul. 78 Cornell Expt't Sta.

**Remedies.** Numerous remedies to be used in fighting these pests, are recommended each year. Poisoning with arsenic in some of its forms has given the best results. Paris green is commonly used. This may be applied in various ways ; mixing the poison with flour or plaster and applying with hand sifters has given good results. When the poison is applied in a spray, it has not been satisfactory for the reason that the liquid would not stick to the foliage. But it is now thought that this difficulty can be overcome by the addition of lime. In Bulletin No. 83, of this Station, it is recommended that a spray mixture for poisoning cabbage worms be made as follows :

Paris Green or London Purple.....	1 pound.
Lime unslacked.....	16 pounds.
Water (to make).....	160 gallons.

Slack the lime and add to the Paris green with sufficient water to make one hundred and sixty gallons. For a more complete discussion of some of the cabbage insects, the reader is referred to bulletin No. 83 of this Station.

#### CELERY.

**CENTER BLIGHT.** The soft rot of the centers of celery plants which results from attacks of bacteria has not yet been successfully treated by spraying. No further work has been done at this Station in treating this trouble than that reported in Bulletin 51 and in the Annual Report of this Station for 1892. The suggestions there given were, (1) to blanch with boards instead of earth during hot weather ; (2) to leave neither the rotted refuse from stripping the plants nor the diseased plants on the fields where celery is to be grown ; and (3) to keep the plants in an active growing condition from the time they are planted till marketed, by cultivation, fertilization and spraying for leaf-blight.

**LEAF SPOT DISEASES.** These diseases are caused by fungi of different kinds. The investigations above mentioned showed clearly that plants may become infested in the seed bed before they are transplanted. The experiments in treating the diseases were not conclusive but led to the suggestion that the seedlings be treated with Bordeaux mixture, 1 to 11 formula, before trans-

planting. The treatment should begin soon after the seeds germinate and should be repeated often enough to protect the new foliage as it develops. Treatment in the field as soon as the plants are transplanted, and afterwards at intervals of ten to fourteen days, is also suggested. Directions for making the Bordeaux mixture are given in article IV on Fungicides and Insecticides.

The investigations showed that celery sprayed this way was not at all injured for market purposes, as much copper being found in the unsprayed plants as in the sprayed plants after they were stripped ready for market. The very slight amount of copper found in both sprayed and unsprayed was sufficiently accounted for by the slight amount of copper present in the soil. In any case it would be necessary to eat a good many thousand heads of celery at one meal in order to introduce a serious dose of copper into the system.

In the investigations referred to above it was found that one of the fungous diseases of celery not only spots the leaves but also attacks the seeds. It is therefore recommended that seed showing black specks over its surface be not sown without first submitting samples of it to someone competent to say whether or not it is diseased. If it is diseased it should not be used.

#### PEA.

WEEVIL. The weevil that infests peas is quite similar to the one that attacks beans, but is somewhat larger. Its life history is the same, and the same treatment applies to this that has been given for the bean weevil.

#### TOMATO.

BLACK ROT. This disease is caused by the same black mold that attacks the potato causing what some have termed the early blight. It may attack the tomato vines, where it appears as dark spots. Nearly every grower is familiar with the black mold that attacks the fruit in all stages of its growth. It usually appears at the flower end which at first turns dark. If the tomato be cut in two more or less of the tissue will be found to be discolored. As the disease advances a dark velvety mould forms over the diseased area. The tomato clings to its stem until nothing is left of it but the skin.

Rolfs reports<sup>11</sup> good results from treating the plants with Bordeaux mixture, and recommends that the first treatment be applied when the flower buds begin to form. The treatment should be repeated at intervals of about two weeks. The number of treatments that will be necessary will depend on the prevalence of the disease. Howell reports in Bulletin 11, Section of Veg. Path., U. S. Dept. Agr., 1890, that one treatment when the first fruits were about three-fourths of an inch in diameter, and two later treatments at intervals of about two weeks were successful in controlling the disease. He used Bordeaux mixture, 1 to 3 $\frac{2}{3}$  formula.

#### POTATO.

**BLIGHT.** The disease which for many years has had the distinction of being known as *the* blight of potatoes is caused by a fungus that may be said to resemble in a general way the fungus that causes the downy mildew of the grape, although the two are not even classed in the same genus. It passes the winter in infested tubers where it may cause a discoloration beneath the surface which is best seen in the ring of darkened tissue near the circumference when a slice is cut through the middle of such a tuber. When the diseased potatoes are planted the fungus spreads to the stems and leaves and there manifests itself in the dark brown withered parts of leaves or stems. It sends out mildew threads, commonly on the under surface of the leaf, and there produces spores which may be called the seeds of the disease, and which are distributed by wind and rain, thus spreading the infection. In warm, moist weather it spreads most rapidly, in fact so rapidly that fields where the disease is present are frequently said to be "struck with the blight," so sudden, apparently, has been its attack. The disease also spreads to the tubers, and thus attacking both vines and tubers it may occasion very serious loss. If conditions are favorable it may spread rapidly early in the season but more commonly in this State it appears to do most damage after mid-summer.

**Remedies.** Spraying for blight should be begun when the plants are six or eight inches high. Three and four sprayings with Bordeaux mixture, 1 to 7 formula, making the first treatment as just stated and others at intervals of about two weeks, have been

<sup>11</sup> Bulletin No. 21, Florida Experiment Station, 1893.

sufficient here to control this disease, and also the one next described.

**MACROSPORIUM.** This disease, caused by a species of black mold, has been called by some "Early Blight," because it is commonly found on early potatoes. It makes its appearance usually in June, and attacks the foliage. It may be known by the peculiar spots that it produces on the leaves. These have been described as target shaped marks from the fact that a number of circles surround a common centre in such a manner as to represent a target in miniature. The affected portions of the leaves become dry and crisp. The disease spreads slowly and has not been known to be as injurious in this section as the blight first mentioned. The same treatment is used for this trouble as that given above for the blight.

**POTATO SCAB.** This disease is confined to the tubers, so its attacks are not noticed until the potatoes are dug. It causes the outer portion of the potato to become pitted, rough and corky, or "scabby." In some localities this condition is thought to be caused by the larva or grubs of the May beetle, hence the name "grubby potatoes" is applied to them. But the attacks of the grubs are local and their work can be told from the fact that they eat out rather deep grooves or furrows in the surface of the potatoes.

**Remedies.** Since this disease does not appear on any part of the plant above ground any spray applied to the vines would be useless. The only way then to combat it is to improve the sanitary conditions. The first precaution to be taken is not to plant on ground that is badly infested with the fungus. It has been demonstrated that the fungus may persist in the ground for several years, and in cases where the soil is known to be badly infested, no remedy of practical value is known. On some soils applications of lime or wood ashes appear to produce conditions favorable to the development of the disease.<sup>12</sup>

Excellent results have been obtained in many instances by simply soaking the seed in a solution of corrosive sublimate (bichloride of mercury). The seed may be soaked either before or after being cut. *Corrosive sublimate is a poison* and should accordingly be used with caution. One ounce is used for seven or

<sup>12</sup> Bulletin 30, R. I. Exp. Station.

eight gallons of water. It dissolves more readily in hot water and may then be diluted. It should not be used in metal, but in wood or earthenware vessels. The seed should be soaked for one hour and the same solution may be used again and again. After being soaked the seed should neither be put in contact with scabby potatoes nor in receptacles which have held scabby potatoes or scabby beets. With these precautions the seed may be kept any convenient length of time after soaking before it is planted.

Manure from animals fed on uncooked scabby potatoes or beets is capable of communicating the scab to the potato crop for which it is used. For this reason manure of this kind should not be used for potatoes or beets. Scabby potatoes should not be used for seed since they are capable of communicating the disease to the new crop.

**POTATO BEETLE.** Every farmer is so familiar with the potato beetle that a description of it would be out of place here. It has been successfully combated for a number of years with Paris green. Formerly the poison was applied in the dry form, and with good results. But it is now considered much the better practice to apply it in the form of spray. This is especially true since the blight has become so universal, and remedies can be applied for both pests at the same time. The Paris green should be used whenever the beetles appear in sufficient numbers to be injurious. Usually it will be sufficient if the poison is mixed with Bordeaux mixture and applied at the time the potatoes are to be treated for blight.

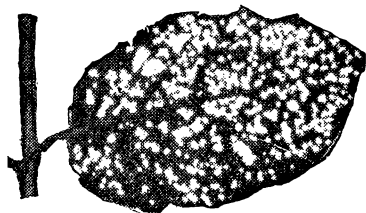


FIG. 3.—*Potato leaf eaten by Flea-beetles.*  
(Jones.)

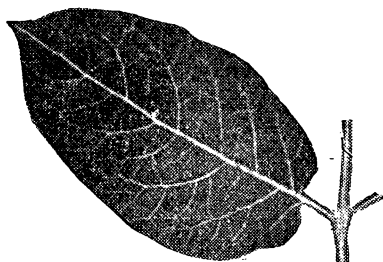


FIG. 4.—*Healthy potato leaf, sprayed with Bordeaux mixture.* (Jones.)

**POTATO FLEA BEETLE.** This is a little shiny black beetle, about a quarter of an inch long, which attacks the potato and



tomato vines and also tobacco. Jones reports<sup>13</sup> that the Bordeaux mixture as used against the blights prevents to some extent the attacks of this insect. Figure 3 illustrates the work of this insect on the potato leaf which may be compared with the healthy leaf sprayed with Bordeaux mixture illustrated in Fig. 4. For figures 3 and 4 we are indebted to Prof. Jones.

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<sup>13</sup> Bulletin 40 Vt. Exp't. Station, p. 25; Bul. 44, pp. 93-97.

### III. COMMON DISEASES AND INSECTS INJURIOUS TO NURSERY STOCK.

#### APPLE.

**POWDERY MILDEW.** Powdery mildew is seldom very injurious to apple stock in this locality. It attacks the leaves and young twigs, where it appears as a light powdery substance. When it is severe the seedlings may receive a serious check by the loss of foliage and the killing back of the young shoots. It usually makes its appearance in the latter part of September. It is suggested that treatment be given using Bordeaux mixture, 1 to 11 formula, beginning in the fore part of September and repeating at intervals of about two weeks until two or three sprayings have been given.

**APHIS** Either the green aphid or the wooly aphid may be treated as directed for cherry aphid below.

**BUD MOTH.** In the nursery this insect is sometimes fought by pinching the infested leaves and thus killing the insect. Spraying early in the spring, the same as for the same insect in the orchard, is also suggested.

#### CHERRY.

**LEAF BLIGHT.** The so called leaf blight, or shot hole fungus, that has been described as being particularly destructive to plum and cherry trees in the orchard, often causes great damage in the nursery. The injury is due to the loss of foliage; the energy of the tree is exhausted in its effort to produce new leaves, so its growth is impeded or remains nearly or quite at a stand still.

**Remedy.** Experiments conducted at this Station<sup>14</sup> show clearly favorable results from treatment with Bordeaux mixture, 1 to 11 formula. The number of treatments necessary to secure the best results have not been fully determined. Bordeaux mixture is preferable to any other remedy that has been tried for this trouble. It is suggested that three or four treatments be given, especially to young stock, beginning about the first of June and repeating the application at intervals of from ten to fourteen days. Direc-

<sup>14</sup> See Annual Report 1892, p. 654; 1893 p. 688.

tions for making Bordeaux mixture are given in Article IV on Fungicides and Insecticides.

**THE CHERRY APHIS.** This little insect is one species of a large family, commonly known as plant lice. They are similar in size and form to common green plant lice, but are nearly black in color. They appear early in the spring and begin sucking the juices from the expanding buds. They multiply very rapidly and as growth takes place move to the new shoots and leaves, where they collect in large numbers, especially on the underside of the leaves, causing them to curl up so to cover the lice and thus making it difficult to hit them with a spray after they have become well established. Since these insects suck their food they cannot be poisoned but must be killed by contact of the insecticide with their bodies.

**Remedy.** In fighting these insects close watch should be kept for their first appearance, so that they may be sprayed at once and not allowed to become established. The treatment should be repeated as circumstances require. Kerosene emulsion diluted from twelve to fifteen times is commonly recommended for plant lice. If the leaves are curled so that the spray cannot reach the insects, dip the infested twigs in whale oil soap and tobacco tea, or in kerosene emulsion prepared as directed in article IV on Fungicides and Insecticides. The mixture is poured into shallow pans and the twigs are bent over and dipped into it.

#### PEAR.

**LEAF BLIGHT.** The leaf blight that has been described as attacking the pear and quince in the orchard, often does great damage to nursery stock. The following account is based on investigations made at this Station.<sup>15</sup> For some as yet unexplained reason the blight is more severe on seedlings than on budded or grafted stock. The disease attacks the leaves and causes many of them to drop off, and in some cases the tender part of the stock is killed back several inches. As soon as the leaves fall, new ones are at once pushed out. This process is very exhausting and where the attack begins early in the season, the seedlings may lose several sets of leaves during the summer. Where this occurs

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<sup>15</sup>Annual Report of this Station, 1892, p. 652.

many of the seedlings die before winter sets in, and those that survive the winter, are mostly too small to work the next season. On pear stocks in particular, where the blight has been severe, it attacks the green tips of the twigs. Here it forms small dark pits where the disease lives over winter and spreads the infection to the first leaves that appear in the spring.

**Remedy.** Encouraging results in treating this trouble on pear stock have been obtained in experiments at this Station. Bordeaux mixture, 1 to 11 formula, thus far has given best results. This treatment has also given good results in some of the Geneva, N. Y., nurseries. It is suggested that treatment be given as soon as the first leaves become fully expanded, following with other treatments at intervals of from ten to fourteen days, making five or six treatments in all. Similar treatment is recommended for pear seedlings, beginning as soon as the first leaves unfold.

**BUD MOTH.** This insect, described as attacking apples also, is treated as described under apples.

**SLUG.** This insect attacks the leaves, sometimes doing considerable injury. It may be fought by dusting with air slaked lime or spraying with Paris green at the rate of one pound to from one hundred and fifty to two hundred gallons of water.

#### PLUM.

**LEAF BLIGHT.** This is caused by the same fungus which causes cherry leaf blight above described. The remedies there advocated have given good results in treating plums. In 1893 trees making their second season's growth from the bud were successfully treated with two applications of Bordeaux mixture, 1 to 11 formula, one given about the middle of June the other about the middle of July.<sup>16</sup> Directions for making this mixture are given in Article IV on Fungicides and Insecticides.

**APHIS, PLANT LICE.** Give same treatment as for plant lice on cherry as advocated above.

#### QUINCE.

**LEAF BLIGHT.** This is caused by the fungus that causes pear leaf blight, the treatment of which is given above, on this page.

<sup>16</sup> Annual Report of this Station 1893, p. 688.

## IV. FUNGICIDES AND INSECTICIDES.

## HOW TO SPRAY.

For a discussion of nozzles, pumps and machines used in spraying the reader is referred to Bulletin 74 of this Station. In order that any spraying may be effective it must be thoroughly done. The workman should not hurry through with the job in an effort to see how many trees he can hit with the spray in a day, but should aim to apply the spray thoroughly and evenly over all the foliage.

It is a mistake to think that when a nozzle is throwing a stream to a great distance and using up the liquid fast, that it is doing the best work. The Vermorel nozzle, which is considered the best, does its best work at from three to five feet from the nozzle. While it cannot force a stream to a great distance it throws a very fine spray, and is readily cleaned when it becomes clogged. For these reasons it takes first rank.

Throughout the preceding part of this Bulletin spraying with different mixtures has been recommended. The reader must not expect good results to follow the use of any of them unless the spraying be well done. The spraying may be done at the right time and the mixtures prepared correctly, but final success must depend upon thorough work in applying the spray. Thoroughness does not mean that the trees shall be drenched but that the spray shall reach every leaf. The ideal way is to have the spray settle in minute particles over the entire surface of all the foliage and dry there without running together in drops and dripping from the tree. This ideal cannot be accomplished completely but it should always be worked for.

*In applying Bordeaux mixture or Paris green great care must be taken to keep the mixture thoroughly stirred otherwise the heavy parts of the mixture settle rapidly and the spray is not applied in uniform strength. To keep the mixture stirred an agitator should be kept constantly moving. One of the best agitators for this purpose is described in Bulletin 74 of this Station, p. 400.*

In using such insecticides as kerosene emulsion, that kill by

contact with the insect, the aim is to hit the insects and the foliage may be drenched if necessary to do this.

### FUNGICIDES.

The following fungicides are mentioned on previous pages :

**AMMONIACAL SOLUTION OF COPPER CARBONATE.** The formula usually given for making this solution is as follows: Dissolve five ounces of copper carbonate in three pints of ammonia of 26° strength. When ready to apply, dilute with water so as to make fifty gallons. The undiluted solution may be preserved for some time in tightly closed vessels.

Penny finds<sup>17</sup> that the use of the strong ammonia undiluted in dissolving the copper is wasteful and unsafe. He recommends the following method of making the solution. "To one volume of 26° Beaumé ammonia (the strong ammonia of commerce) add from seven to eight volumes of water. Then add copper carbonate, best in successive quantities, until a large portion remains undissolved. The mixture should be vigorously agitated during the solution and finally allowed to subside, and the clear liquid poured off from the undissolved salt. A second portion should then be made by treating the residue of the former lot with more ammonia diluted as before, then with the addition of fresh copper carbonate, in every case with vigorous stirring or agitation. The method of making in successive lots will result in a richer solution of copper, at least unless an unwarranted length of time be taken." He finds that much less ammonia is required to dissolve a given amount of copper carbonate in this way than according to the method formerly followed of adding the strong, undiluted ammonia directly to the copper carbonate.

**BORDEAUX MIXTURE.** This is made of various strengths. Successful results have been obtained at this Station and elsewhere with the 1 to 11 formula, that is to say with a mixture using one pound of copper sulphate for eleven gallons, and this is recommended for most purposes. In treating potato blights better results have been obtained from a stronger mixture, using the 1 to 7 formula, that is to say, one pound of copper sulphate for seven gallons of the mixture.

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<sup>17</sup> Bull. 22, Del. Exp. Sta.

The formulæ referred to in this bulletin may be given as follows :  
*1 to 7 formula* : One lb. copper sulphate ;  $\frac{3}{4}$  lb. lime, fresh slaked 7 gallons water.

*1 to 11 formula* : One lb. copper sulphate ;  $\frac{3}{4}$  lb. lime, fresh slaked ; 11 gallons water.

**Preparation of Bordeaux Mixture.** Dissolve the copper sulphate and dilute with from half to two-thirds of the required amount of water. Then add the lime in the form of thin white-wash, straining it if necessary to keep out particles that would clog the nozzle. Stir the mixture frequently and thoroughly as the lime is being added. Finally dilute to the required amount.

**Dissolving the Copper Sulphate.** For practical operations the copper sulphate may be dissolved in large quantities and kept on hand as a stock solution, as advocated in Bulletin 67 of this Station, p. 195. Such a solution should be kept covered to prevent evaporation which would increase its strength, and finally cause the copper sulphate to crystallize on the sides and bottom of the cask in which it is kept. It appears that for all practical purposes a solution containing two pounds of copper sulphate to one gallon of water, may safely be used for a stock solution. Thus one hundred pounds of copper sulphate dissolved in fifty gallons of water contains two pounds for every gallon of the solution so that one gallon of such a solution contains enough copper sulphate to make twenty-two gallons of Bordeaux mixture of the 1 to 11 formula or fourteen gallons of Bordeaux mixture of the 1 to 7 formula.

If, instead of using the stock solution, copper sulphate is dissolved each time the mixture is prepared it is well to get the pulverized copper sulphate instead of the crystals as that dissolves more quickly. If the solution is wanted immediately the copper sulphate may be dissolved in hot water. If it is to be dissolved in cold water use a large amount of water and suspend it near the upper surface of the water, in a basket, coarse sacking, or any other receptacle through which water may pass readily. Copper sulphate should not be dissolved in iron vessels, as it corrodes them very rapidly.

**Buying Copper Sulphate.** It is best to buy copper sulphate in sufficient quantity to get wholesale rates for it may be kept from season to season without injuring its value.

**Weighing and Straining the Lime.** When the mixture is used in power spraying machines with stationary nozzles it should be run through a sieve so as to take out all particles that might clog the nozzles. When hand pumps are used straining will not be necessary if care is used in pouring the lime.

The amount of lime necessary to form the Bordeaux mixture was formerly determined by weighing, using two-thirds as much lime as copper sulphate, but by means of the color tests as explained below the necessity of weighing the lime is now obviated.

**Excess of Lime.** It is important that enough lime be added, otherwise the mixture may injure the foliage, while an excess of lime will not harm the foliage.

**Color tests.** Various color tests may be used for determining whether or not sufficient lime has been added to the copper sulphate solution to form the Bordeaux mixture, as explained in Bulletin 84 of this Station. The one most commonly known is the potassium ferrocyanide test which is used as follows:

Pour the lime into the copper sulphate solution, stir the mixture thoroughly and then add a drop of the potassium ferrocyanide. If enough lime has been added the drop will not change color when it strikes the mixture, otherwise it will immediately change to a dark reddish brown color. More lime must then be added till the potassium ferrocyanide does not change color when dropped into the mixture. It sometimes happens if the mixture has not been thoroughly stirred, that some of the copper sulphate in the bottom of the barrel has not yet been precipitated, while at the surface the mixture shows no color when the test is applied, so that after the mixture has been standing a few minutes the potassium ferrocyanide will again give the dark color, showing that not enough lime had been used. On this account it is best to add more lime after the test shows no change of color, thus insuring an excess of lime which does no harm. A mixture with not enough lime in it will hurt the foliage.

The potassium ferrocyanide, also known as the yellow prussiate of potash, is a poisonous substance. It is a yellow salt which readily dissolves in water and a solution may conveniently be kept on hand in a small bottle. The commercial form of the potassium ferrocyanide may be used. A few cents should purchase enough to last through the season.



**COPPER SULPHATE SOLUTION.** As explained before, lime is added to the copper sulphate solution in making Bordeaux mixture, to prevent the solution from injuring the foliage or fruit, but in some cases the copper sulphate solution is used without the lime in making applications in the spring before the leaves put forth. It is made by simply dissolving the copper sulphate in water and diluting to the required strength. In treating raspberry canes for anthracnose before the buds open, we have used one pound of copper sulphate to eleven gallons of water, with good success. Do not prepare it in iron vessels.

**IRON SULPHATE, OR COPPERAS, SOLUTION.** This solution will injure foliage and, like the Copper Sulphate solution, it is used only before the leaves put forth. It is commonly used as a saturated solution, that is to say, a solution made by allowing the water to take up all of the copperas that it is able to dissolve. This has been used against raspberry anthracnose and grape anthracnose before the buds open.

**CORROSIVE SUBLIMATE SOLUTION, (BICHLORIDE OF MERCURY.)** This substance is very poisonous and care should be taken in handling it the same as in handling Paris green or London purple. The solution is used for soaking seed potatoes to kill the fungus which causes potato scab. One ounce of the corrosive sublimate is used for seven and a half or eight gallons of water. The seed is soaked for an hour in this solution. It dissolves more readily in hot water and may then be diluted to the required amount. It should be used in wooden or earthen vessels, not in metal. The solution may be used over and over again.

**POTASSIUM SULPHIDE SOLUTION.** This solution has given good results in treating gooseberry mildew and various other mildews. It may be sprayed on the foliage at the strength herewith given, with no fear of injurious results. One ounce of the sulphide is used for two gallons of water. It dissolves more readily in hot water than in cold.

#### INSECTICIDES.

Insects that chew their food are commonly fought by applying poison to their food. Among the prominent insecticides that are used in this way are Hellebore, London purple and Paris green.

Insects that suck their food pierce through the skin of the foliage

with their mouth-parts and suck the juices of the leaf so that they are not injured by poisons that may be applied to the surface of the portion of the plant on which they feed. Aphis and the pear psylla belong to this class of insects. Against such insects kerosene emulsion is commonly used.

The following insecticides have been mentioned on previous pages.

**CARBON BISULPHIDE.** The use of this substance is advocated for destroying the bean and pea weevils. It is highly explosive and no kind of fire or light should be allowed near it. It is a heavy, colorless liquid and the offensive fumes which it gives off are heavier than air. Care should be taken not to breathe them. In treating peas or beans with this substance it is placed in a shallow open vessel upon the peas or beans and allowed to evaporate, using it at the rate of about two small teaspoonfuls (two fluid drachms) to one cubic foot of space in the bin or receptacle that holds the beans or peas. It is well to cover the peas or beans with boards or blankets when they are being treated. Carbon bisulphide costs about ten cents per pound in fifty pound cans.

**HELLEBORE.** Fresh white hellebore should be obtained. Mix one ounce in three gallons of water and apply for insects that chew. It is commonly used against the worms that infest currant and gooseberry foliage as it may safely be used even when the fruit is developing.

**KEROSENE EMULSION.** This is made by dissolving one-half pound of either common soap or whale oil soap, in one gallon of soft water. Heat the mixture and when boiling hot remove it from near the fire and add it to two gallons of kerosene. The whole is now thoroughly mixed by pumping continuously through a small force pump for from five to ten minutes. Mix until the ingredients form a creamy mass that becomes thick when cool and from which the oil does not separate. When using on foliage dilute with from ten to fifteen parts of water; when used as a winter treatment it may be applied as strong as one part of the mixture to four parts of water. In diluting the stock emulsion first use three or four parts of boiling water and then dilute to the required strength. Soak off with paper any free oil that appears on the surface as it will work injury if applied to the plant. This emul-

sion is used to kill insects that have sucking mouth parts ; it is not a poison but kills by contact.

The emulsion causes rubber valves to swell and clog the tubes in which they work. Where rubber balls are used for valves they should be replaced with glass or marble balls when using the pump for kerosene emulsion.

**LONDON PURPLE.** This, like Paris green, is an arsenical poison and is used against insects in the same way that Paris green is, and in about the same proportion.

**PARIS GREEN.** This is used to poison insects that have biting mouth parts. It may be applied either in the dry form or in a spray. When the spray is used the Paris green may be combined with Bordeaux mixture, or it may be applied mixed with water. In either case the same amount of poison is used. For pomaceous, or kernel, fruits one pound of Paris green to one hundred and fifty or two hundred gallons is commonly used. For stone fruits the mixture should be weaker, using one pound of Paris green to two hundred and fifty or three hundred gallons. When used with water, fresh slaked lime should be added to prevent injury to the foliage. Smith,<sup>18</sup> in 1892, recommended an equal weight, while Sirrine, in Bulletin 83 of this Station, recommends sixteen times as much fresh slaked lime by weight, as Paris green, for the purpose not only of preventing injury to the foliage by the Paris green, but also to make it stick to the foliage more firmly.

**TOBACCO.** This is frequently used in greenhouses, and sometimes in gardens in the form of tobacco dust, against soft bodied insects like plant lice. The plants are dusted thoroughly with it on the first appearance of the insects and before they get established on the leaves. As a tea or decoction it is also often used by nurserymen against the lice which infest plum, cherry and other nursery trees. Tobacco stems, or any other cheap form of tobacco, is steeped and the liquid thus prepared is added whale oil soap at the rate of about one pound for from six to eight gallons. Tobacco differs much in its strength and before using this preparation of whale oil soap and tobacco it should first be tested on the foliage

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<sup>18</sup> Bulletin 86, p. 7, and Annual Report of New Jersey Exp't Station, 1892, p. 403.

to see how strong it may be used without injuring the foliage. No other method of determining the best strength at which it may be used can be safely followed. The preparation, after being properly diluted, is poured into shallow pans and the infested twigs are bent over and dipped in it. The lice at first are found chiefly on the tender leaves at the growing tip. The leaves soon become curled so that it is impossible to hit all insects with a spray and therefore dipping seems to be the best remedy in such instances. If careful watch is kept for the first appearance of the insects spraying can no doubt be used effectively if done promptly and thoroughly. Kerosene emulsion should then be used. It may also be used for dipping, diluted from twelve to fifteen times. Care should be taken that the emulsion is perfectly made and no free oil left floating on the surface, or the foliage will be injured by the oil.

**WHALE OIL SOAP.** This is used in solution chiefly against soft bodied insects such as plant lice. It is commonly combined with a decoction of tobacco as stated above, at the rate of a pound to about eight gallons. When applied alone without the tobacco it is used stronger, taking one pound of soap to four or five gallons of water.

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