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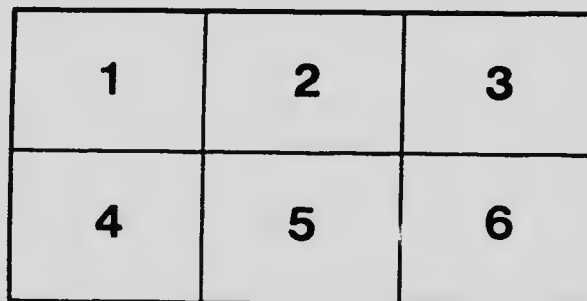
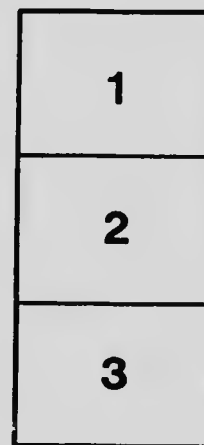
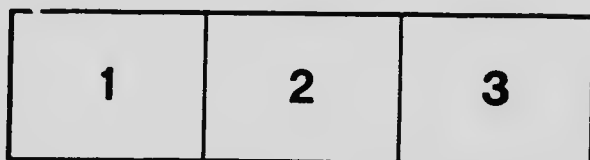
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PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE—HORTICULTURAL BRANCH.

FIRE-BLIGHT

(BACILLUS AMYLOVORUS—BURRILL).

BY W. H. BRITTAIN, B.S.A., AND R. HOY, B.S.A.



THE fire or pear blight has been known for many years as a serious disease of apples, pears, and occasionally quinces. Lately the disease has been reported as attacking plums and apricots. In some districts the disease has wiped out whole pear-orchards and caused more loss to the fruit-growers than all other factors combined. In British Columbia it has proved a very serious disease for the apple. Besides the trees mentioned, the hawthorn (*Crataegus*), the June berry (*Amelanchier*), and the mountain-ash (*Pyrus*) may also be attacked.

CAUSE OF THE DISEASE.

The fire-blight is of bacterial origin. The organism causing it is a small rod-shaped body, measuring about 1-16,000 of an inch long and about 1-45,000 of an inch wide. This germ commonly enters the plant by way of the blossoms, where it multiplies in the nectaries of the flowers and finally extends into the near-by twigs and leaves. It may enter growing shoots, limbs, or trunk through the agency of various insect pests. Having once gained admittance to the plant, the bacillus, if conditions are favourable, multiplies rapidly, feeding upon and destroying the cells of the inner bark and cambium. It winters over in the form of "hold-over" cankers on the limbs or trunk of affected trees.

SIGNS OF THE DISEASE.

As a rule, the disease makes its first appearance in the form of "blossom-blight." The tips, blossoms, and leaves will be seen to wilt, becoming dark brown or black, and finally shrivel up, presenting a scorched appearance. The bark at first has a dark water-soaked look, but later it becomes hard and dry.

In the twigs and smaller branches the disease is known as "twig-blight." Water-sprouts and other young rapidly growing shoots are particularly liable to attack. Where the disease is active, blisters will appear on the bark, through which will ooze a thick gummy substance, light yellow in colour at first, but hardening in the air it becomes dark red or brown. The leaves borne on such shoots have the characteristic scorched appearance. In many cases the disease is confined to the twig form and spreads no farther.

Frequently, however, it enters the main limbs or trunk by passing down twigs or water-sprouts. The bark will take on the water-soaked appearance and the

gummy exudate ooze from the affected part in large drops. Sometimes a canker of limited extent is formed around the base of the shoot down which the disease has passed. As the organism gradually dies out the bark loses its water-soaked appearance, and, becoming hard and tough, shrinks away from the healthy portion, frequently forming a crack or fissure between. In the apparently sound tissue



1. Blossom infection. 2. Later stage of blossom infection, showing canker formed at base of fruit-spur. 3. First stage of twig infection. 4. Two hold-over cankers. 5. Later stage of twig infection. 6. Final stage of diseased fruit.

outside this area a few germs may lurk to carry over the disease until another year. A further spread of the disease down the limbs or trunk, however, may sometimes occur. Extensive cankered areas will be developed, and from cracks in the diseased tissue the yellow gum will drip abundantly. Sometimes a canker will appear con-



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siderably farther down on the limb than any other, while the bark between is, to all external appearances, perfectly healthy. Upon cutting away the bark, however, a fine line of diseased tissue will be found connecting the two. The form of the disease that affects main limbs and trunk is called "body-blight."

In most of the fruit-growing regions of the East body-blight of the apple rarely occurs, and then only in the form of cankers around the base of a shoot. In some districts it is not considered worth while to cut out the disease in apple-trees during the growing season, so rarely does it extend beyond the current season's growth. In these same districts the body-blight may be a serious menace to pear-orchards; so that while twig-blight may be found in pears and body-blight in apples, the reverse is the rule. In some parts of the Western States and in British Columbia, however, body-blight is commonly found upon all apple-trees. Certain varieties have suffered most severely from this form of the disease. Some cases have come under our observation in which the disease spread so rapidly down the trunk that the tree was soon girdled and its death accomplished in a single season.

A rot of the immature and occasionally of the mature fruit is also caused by the pear-blight organism, the disease entering by way of the stem or through an insect puncture. Fruit so affected turns brown or black as if bruised, and a whitish, slimy substance oozes through the skin.

HOW THE DISEASE IS SPREAD.

Among the foremost agents in the spread of the blight are bees, wasps, and other insects, which carry the disease from flower to flower during the blossoming period. More important than the bees, for it seems impossible to exercise any control over their work, is the green apple-aphis. Aside from the great harm this insect undoubtedly does by sucking the juices of the plant, it is one of the most fruitful sources for the spread of the blight. A large proportion of twig-infection can be traced directly to its agency. The apple-leaf hopper and the woolly apple-aphis doubtless bear a share in this work as well. The gummy exudate that oozes from diseased bark is swarming with the germs of the blight; and insects, becoming contaminated from this source, carry the disease to other trees, which in turn become infected. In Ontario the fruit-bark beetle (*Scalytus rugulosus*) has been shown to be an important agent in introducing the blight into the trunks of pear-trees.

The use of infected pruning-tools has more than once been responsible for spreading the blight over a whole orchard.

FACTORS WHICH INFLUENCE THE CONTROL OF BLIGHT.

After the blight-germs have gained entrance to a tree there are many factors which exert an influence on the spread of the disease through the tree. The weather conditions, kind of soil, age of tree, amount of irrigation and cultivation, pruning, fertilizer used, and variety of tree, all influence the growth of the tree and the rapidity with which the blight will spread.

It is commonly observed and has been proved by actual test that anything that tends to produce an excessive growth in the tree brings about this condition, which favours the rapid development of the fire-blight germ. The greatest damage by blight is usually done before the middle of July or the first of August, and unless the season is very favourable for the blight organism there is comparatively little damage after the latter date. This disease is spread further at blossoming-time than after; that is, the majority of trees infected by blight are infected at this season. There are many trees infected after this, but in comparison they are very few, and it is a matter of common observation that trees that do not blossom are not usually badly infected with blight even in areas that are severely attacked by the disease. The writer has seen trees surrounded with badly blighted trees, but apparently from being free of blossom they were not attacked. While there is a spread of blight throughout the season, it is confined to shorter distances and chiefly to other branches and twigs in the same trees that were infected in the spring. When there are running cankers in the district, no satisfactory measures for the

prevention of the blight in the blossom have been found. Spraying at blossoming-time has been tried, but with so little success that it is not worth the labour of application and the cost of the spray. Various tree-paints, etc., are advertised, and the manufacturers claim that they are sure preventatives against blight, but trusting to these is enriching the manufacturer and doing nothing for the control of blight. *Except by cutting out diseased parts and disinfecting thoroughly, there is nothing that will free an orchard or district from the fire-blight organism.*

Though cutting is essential for the removal of blight-germs from a tree, orchard, or district, there is much that can be done to check the rapid spread of the disease and shorten the season in which the blight will run. Blight is most severe in young trees just starting to bear fruit. Young orchards before they begin to blossom are rarely attacked by the disease to a serious degree; however, if the germs find entrance to the sap by insect puncture, or the use of pruning-tools carrying blight-germs, and gets a foothold in the sap of a young tree, they multiply and grow very rapidly, and unless the tree receives immediate attention may kill the tree in a short time. The most severe attacks of blight on our apple-trees has been on trees between the ages of five and nine years, and while older trees have been badly affected, because of the slower growth that they make, and their ripening-up earlier in the season, the blight stops running sooner and does not get into the big wood to the same extent.

Observation and experiment show that once the blight-germs have gained an entrance to a tree the rapidity with which they will spread and grow depends (aside from the variety attacked) on the tree's rate of growth and the weather conditions. Trees that have been severely pruned during the winter, especially where they have been headed in severely, are always liable to make a very heavy growth the following season, with plenty of water-sprouts and soft, tender, sappy wood. Such trees are especially liable to the most severe injury once the blight-germs have gained entrance to the tree. Unless from lack of vigour, getting out of bounds, being too thick, or some other good reason, heavy cutting on bearing trees should not be practised. There are times, however, when this is essential for the best results from the tree, but the proper time should be chosen for the work and such cultural methods adopted the following season that will offset any excessive growth that may result from the pruning. When cutting bearing trees heavily, always choose a year before a heavy crop. That is to say, if your trees produced a light crop or no crop in the summer of 1914 and a heavy one is expected in 1915, do the heavy cutting (if it is necessary) in the spring of 1915. If the trees are on strong soil and clean cultivation has been practised and irrigation put on, and for any reason you expect an excessive growth, do less cultivating and irrigating, and if the conditions warrant it put the orchard in sod or some crop that will take out the moisture and plant-food and prevent a very heavy wood growth.

WINTER INJURY AND BLIGHT.

It is the common opinion among fruit-growers that winter injury and blight are in some way connected with each other. This is a mistaken idea, as blight is caused by a specific germ, and unless these germs are present there will not be any blight. Observation of the trees attacked by blight also proves that winter injury has nothing to do with the extent that blight will travel in the trees or with the severity of the attack. The Transcendent crab, one of the hardiest of our apple-trees, and one that is seldom injured by frost, is one of the varieties that is most severely attacked by blight, once the blight-germs have gained a foothold in the tree. The fastest growing trees are always the most subject to the disease.

Though a winter-injured tree is not any more subject to blight than any other tree, the same cultural conditions that are best for the control of blight are also the best for the control of winter injury. Fast, heavy, rank growing trees going into the winter in a soft immature condition are most liable to be frozen. Trees making such growth are also conducive to the spread of blight.

CULTURAL CONDITIONS.

No definite rules can be laid down for the handling of soils in all districts or all orchards in any one district. It is a question of personal study by the man on the ground. Some orchards do the best in permanent clover or alfalfa sod, while others are practically ruined by this same system. General recommendations are the best that can be offered. Usually, where there is a good supply of irrigation-water, alfalfa-sod is a cheap and satisfactory system after the trees reach about eight years old. If, however, only a limited supply of irrigation-water is available and the soil is shallow and poor, some other system of soil-management must be looked for. In a district where there is blight the following points must be kept in mind:--

(1) Excessive growth caused in any way makes the trees favourable for the spread of blight, and usually results in large, poor-quality fruit.

(2) A stunted, starved, dried-out tree means small fruit, undersized and of poor quality.

Ordinarily we do not want either of these conditions. The ideal condition is a normal, healthy growth that will mature the season's fruit-crop, wood-growth, and produce good healthy fruit-buds for the following season's crop. Where there is a blight epidemic, however, and extreme measures are adopted to get the blight under control as quickly as possible, it may even pay to starve the trees for a season in the badly infected orchards to save trees and check its spread. This may mean the loss of the crop, but there are conditions that warrant this, and where this method is cheaper than letting the blight run and ruin the trees.

SUMMER CUTTING.

To cut out blight whenever and wherever it is seen is good practice, but there are cases in a blight epidemic where this cannot be done. The first signs of blight are usually found in the blossom and later in the spur. Trees may have 75 per cent. of the blossoms infected. When such is the case the infection is usually spread over a large proportion of the area of the tree, and it is practically impossible to successfully cut off all infected spurs and blossoms, and if the blight is at all active, the mere cutting-off of the spurs would only stop a few of the infections, as by this method it is impossible to go back far enough to get beyond the infection when the blight is active. On many occasions when the blossoms are infected, owing to the conditions being unfavourable for the development of the blight-germ, the disease dies out in the blossom. This is very noticeable in the "Wealthy" in many orchards. For this reason the trees should be examined as carefully and as frequently as possible, and if the blight begins to run, cut off the infected branches well below the visibly diseased area.

Twig-infections should be treated similarly to blossom-infections. Twigs are usually infected first at the tip, the tips wilt and bend over, and in the later stage turn brown in the apple and black in the pear. The rate of growth and weather conditions determine to a large extent the rapidity and distance that the blight will run in the twigs. On young trees up to about six years of age it is good practice to cut out diseased twigs as they appear, and do all that is possible to keep the trees from the disease. The same is true in older trees when there is only a limited number of infections. However, in a blight epidemic on bearing trees infections may be so numerous that it would be impractical to try and wipe out the infection at this season of the year. The expense connected with this work would be very great, and there are few districts where enough competent labour could be secured to do the work. Where twigs are very numerous on large trees it will be noticed that on many of them the blight will run for a short time and die out after going back a few inches. In such cases it will continue to run throughout the season if not attended to. On the other hand, if these infections

capable of killing the tree. The summer cutting should therefore consist of weekly inspections (daily where possible), and everything cut out that threatens to do serious damage to the tree. In all cases, whether infected with blight or not, all suckers, water-sprouts, fruit-sprurs, and twigs of any kind should be kept off the root, trunk, and lower part of the main branches of the tree. These are all a constant source of danger, for one infection low down on the main branch or on the trunk may mean the loss of the whole branch or tree. Suckers from the root should never be allowed to grow, for it is through these that the blight is carried to the roots of the tree, and once the roots are infected the tree's chances of life are very small.

Much damage can be done in summer cutting if the cutters are not competent and careful. The writer has seen many instances where more blight has been spread by careless cutting than any other factor. Failure to disinfect the tools and cuts after each cut is responsible for a great deal of blight. Disinfection is very important and should never be omitted. Climbing the trees and bruising the bark should always be avoided. In blighted trees this method of getting up in the trees to reach the upper twigs and branches has been responsible for the loss of many trees that could easily have been saved. After a rain the exudation is washed down from the top of the tree and the bark is often covered with germs all the way to the ground. In such cases all that is necessary to start an infection is to bruise the bark, and this can hardly be avoided when trees are climbed by a pruner with shoes on. The infections caused in this way are usually low down on the main limbs and capable of doing more damage than several twig-infections in the top of the tree.

DISTANCE TO CUT.

This will vary with the variety, season, and age of the tree. Usually, if the cuts are made a foot below any sign of infection, there is not much danger of the blight continuing on the same branch unless there is a later infection, but the writer has seen cases where the cuts were made over 2 feet below where there seemed to be any infection (the cuts were well disinfected), and the blight continued to run. The susceptibility of the variety has much to do with this. On young, fast-growing Transcendent crabs it seems almost impossible to stop the blight during the early part of the summer without cutting down the whole tree. Spitzenburg, Wealthy, Alexander, and young Wageners are all difficult to handle in the early part of the summer, and cuts should be made 18 inches or 2 feet below any sign of infection where the blight appears to be travelling rapidly. No hard-and-fast rules can be laid down for the summer cutting, as much depends on the season and severity of attack. No matter how far back the cuts are made, stubs should be avoided as much as possible and ragged cuts should never be made. In order to get the best results with the smallest waste of tree, close observation and good judgment is essential in summer cutting. One must be interested in the work being done or poor results usually follow.

Scalping or cutting the bark out to the sap-wood where cankers are found is sometimes practised. In the early part of the summer, up to the middle of July, this is a very doubtful practice, as few people go back far enough from the diseased area. It is better to cut off all the branch or wait until the canker shows some line of demarcation between the healthy and diseased area and then cut several inches beyond this.

Gather and burn all prunings immediately after cutting.

CUTTING IN THE DORMANT SEASON.

As the blight-germs are carried over in the diseased areas and the infection is carried to the blossoms from the exudate coming from these, a systematic and thorough cutting must be done in the dormant season for the control of blight. At



Effect of careless blight cutting, showing, first, the rough uneven saw-cut, and, secondly, two fresh wounds made with the saw through carelessness, and through which the tree was reinfected, causing the death of the entire tree through the stem being completely girdled by the blight canker.

this season it becomes a community problem, and it behoves every fruit-grower to make a thorough inspection of his orchard and cut out every visible sign of fire-blight. *Slipshod methods and poor work are the greatest menace to the grower and to his neighbours.* The occasional grower who endeavours to mislead Inspectors by improper cutting or covering up cankers with whitewash or paint is distinctly an enemy to the welfare of the fruit-growing community. It would not matter about himself, but his neighbours suffer from his neglect.

Nothing should be left undone to remove every canker in the district. The germs exist, in the dormant season, only in the cankers. If all cankers are cut out and burnt, the disease is wiped out.

METHODS OF CUTTING IN WINTER.

In removing small twigs and branches, cut at least 3 inches below the line of demarcation between the healthy and diseased area. Disinfect cuts with corrosive sublimate, 1 to 1,000.

Where cankers are on branches up to $\frac{3}{4}$ or 1 inch in diameter, it is usually best to cut off the branches, especially in trees over three years old. In order to cut the bark far enough away from the dead area in branches of this size, it is almost necessary to girdle the branch and so render it useless.

Cankers on large limbs can be taken out and the limbs saved by cutting the bark away to the sap-wood. Always cut the bark away at least 2 inches above and below the infection and at least an inch at the sides, making sure that you are back to healthy, sound tissue. Disinfect the wound with corrosive sublimate and paint it with white lead. In painting, have the paint thick enough so that it will not run down the tree.

In cutting away diseased water-sprouts and suckers from the root, always dig down and see that there is no infection at the root.

In case of any twigs, suckers, water-sprouts, etc., coming from big limbs being infected all the way to the base of the twig, but apparently not into the limb, it is always well to cut away the bark around the base and disinfect well, so that there is no danger of leaving any of the germs to carry the disease over.

Cankers on the roots are treated the same as those on the branches above ground. Wherever there have been any diseased suckers or water-sprouts at the base of the tree, the soil should be dug away and the roots examined for hold-over cankers.

In cutting out branches in the top of old trees, every effort should be made not to leave large stubs. Even if it is necessary to cut back another foot or so, it is better to bring the tree back to a lateral branch. This will tend to stop sucker-growth and make a better-shaped tree.

CORROSIVE SUBLIMATE.

Corrosive sublimate can be bought in tablet form from any drug-store, and the druggist will give the directions as to the necessary number of tablets and amount of water to use to make up a mixture of 1 part corrosive sublimate to 1,000 parts of water. This varies with the size of the tablets.

The solution should never be carried in a metal container; always use a glass one. One of the handiest ways of carrying and using this solution is to carry it in a small flask in the hip pocket. A small sponge can be carried in the left hand attached to a string on the wrist, so when necessary to use the hand it can be let hang from the wrist in easy reach when needed again. Keep the sponge thoroughly soaked in the solution and swab over the tools and each cut after making a cut. This solution is poison and should be kept out of reach of children and animals.

SUSCEPTIBILITY OF VARIETIES.

Observation shows that different varieties of trees vary to a marked degree in power of resistance to the attacks of blight. In some places this is taken advantage

of, and the root, trunk, and main limbs of a resistant variety are used for the foundation of the tree, and some variety that may be capable of giving larger yields or is otherwise more desirable, but not so resistant to blight is grafted on to the more resistant stock.

A list of varieties and their susceptibility to blight is given below. This list is not absolute, but from observations made where the blight has been severe in British Columbia it is as accurate as is possible to make it.

(1.) Varieties not advisable to plant in districts where blight is found or may be serious:—

Transcendent Crabs.
Florence Crabs.
Spitzenberg.
Alexander.
Peewaukee.
King.
Beitlghelmer.

(2.) Varieties found seriously affected with blight in main limbs and body of trees as well as in smaller wood:—

Wealthy (suffer heavily in blossom also).
Wagener.
Baxter.
Winter Banana.

(3.) Varieties which suffer chiefly in blossom-spurs, twigs, and small branches (those marked * more seriously than others):—

*R.I. Greening (in spurs).
Ben Davis (moderate).
*Ortley.
Gano (moderate).
*Jonathan.
Rome Beauty.
*Ontario (in spurs).
*Grimes Golden (blossoms).
Baldwin.
Snow.
Hyslop Crab.

(4.) Varieties that have suffered only slightly from blight:—

Duchess.
McIntosh Red.
Delicious.
Winesap (Stayman).
Yellow Newtown (occasionally affected, as in (3)).
Canada Baldwin.
Canada Red.
Cox Orange.
New York Wine.
Northern Spy.
Winesap (Old).

Pears.—All varieties commonly grown and of commercial value are found more or less seriously affected in the large branches and trunks. There is, however, a good deal of variation, and often apparent immunity or very severe attacks, under apparently similar conditions.

SUMMARY.

- (1.) Discourage rapid growth in the trees. If necessary, put the orchard in sod, or modify cultural methods.
- (2.) Keep all suckers, water-sprouts, etc., off root and body of the tree.
- (3.) Keep aphides and other insects under control by spraying. Consult spray calendar.

- (4.) Plant those varieties that are most resistant.
- (5.) Cut out the disease as it appears so far as possible and practical. Always make clean cuts.
- (6.) Cut out every sign of disease in the dormant season.
- (7.) Disinfect tools and cut surfaces.
- (8.) Paint all large wounds.
- (9.) Use a ladder; do not climb trees.
- (10.) Gather and burn all prunings.

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