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STUDIES IN FRUIT DISEASES

IX

APPLE SCAB

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APPLE SCAB

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The most prevalent and destructive disease affecting the apple is that known as scab or black spot. With the possible exception of the irrigated orchards in British Columbia, no commercial orchard area in Canada is free from the disease. Orchardists in Ontario, Quebec and the Maritime Provinces spend hundreds of thousands of dollars annually in the purchase and application of chemicals to their apple trees in an effort to prevent the damage caused by apple scab. The disease attacks the leaves, blossoms and fruit and frequently causes a drop of blossoms or defoliation of the trees or severe spotting of the fruit to make it unmarketable. Losses of 200,000 to 400,000 bushels of fruit have been experienced annually in Nova Scotia during the 1950, 1951 and 1952 crop years.

Orchards in Eastern Canada require spray protection every year as weather conditions in this area favour the disease. When poor spray protection is given apples the disease may assume epidemic proportions and result in the loss of the current season's crop as well as materially weakening the trees for the production of the crop the next year.

This pamphlet has been prepared to acquaint growers with the cause of the disease and the relation of weather conditions to it, in the hope that a better understanding of their relationship will lead to a more efficient application of control measures.

Figure 1. Under surface of leaves showing primary infections.

Description of the disease

In the spring the disease is first found on the under surface of the leaves (Figure 1) as dark lesions. It appears later on the upper surface of the foliage (Figure 2) in mould-like patches. The scab lesions are dark olive green,

velvety, of indefinite form and frequently cause a puckering of the leaf surface. The disease is initiated each season by spores formed in the overwintering leaves on the ground, concerning which a fuller discussion will be given in a later section of this pamphlet.

Exposed parts of the blossoms are susceptible to infection and it is not uncommon to find the disease girdling the stems and causing a heavy drop of blossoms and young fruit. The lesions on the flower parts are not so conspicuous as those on the leaves. They are lighter in colour and sparse.

Figure 2: The common form of scab on the foliage.

Figure 3: Scab spots on apples. Cracking is common on the older spots.

The twigs of very susceptible varieties of apples may be infected with scab. Infection takes place when they are still quite green and succulent. The disease appears as small round to oblong lesions, seldom over one-eighth of an inch in diameter. These are most noticeable in the fall of the year.

The spots on the fruit (Figure 3) are well known to the majority of orchardists. During the early part of the season they are most prevalent at the calyx end of the apple but before harvest time may be found on any part

of the fruit. The spots are irregular in outline and like those on the leaves have a dark olive-green colour. They sometimes enlarge and unite to form extensive scab areas which may cause a dwarfing and cracking of the fruit. The young fruit is frequently deformed or when the stems are affected and girdled it may drop. Because of their small size late-season lesions on the fruit are sometimes known as "pin head" or "pin point" scab. These appear shortly before harvest. They are frequently followed by "storage" scab (Figure 4) occasionally called "ink spot" on account of the colour. The spots are very dark, lack the olivaceous velvety appearance of earlier fruit infections and may not develop until after ten to twelve weeks in storage.

Figure 4: Storage scab or "ink spot" on Golden Delicious. The infections undoubtedly spread from the larger spots near the stem end.

Susceptibility of Varieties

Most commercial varieties are susceptible to apple scab. McIntosh, Fameuse, Delicious, Northern Spy and others are well known for their lack of resistance. Practically all the seedlings and sports from these varieties, which have been used commercially, can be placed in the same category. Apparent resistance in some standard varieties has been found to be due to escape from, rather than resistance to, infection. Apple breeding work now in progress would suggest that varieties may be developed with resistance to scab.

Cause of the Disease

Apple scab is caused by a fungus named *Venturia inaequalis* (Cke) Wint. The fungus overwinters in the leaves which fell to the orchard floor the previous autumn. From the time of leaf fall until early spring the fungus slowly develops fruiting bodies which break through the top layer of the leaf tissue as they approach maturity. They may be seen with the aid of a pocket lens to be small, black round bodies scattered or in clusters. These fungus bodies are known as perithecia, a Latin term used to describe similar fungous growths which contain ascospores, spores developed in an ascus or sac. At the time the perithecia are breaking through the leaf surface they are developing spores

internally and by the time the spores are mature there may be several hundred perithecia on a leaf, each containing hundreds of spores. Since one spore produces a scab spot it will be realized that a few hundred leaves under a tree may produce sufficient spores to cause a severe epidemic of the disease in an orchard. When mature, the spores are readily discharged at any time the old leaves are thoroughly wetted by rain, and are carried by air currents to the trees. The first discharge occurs about the time the buds are in the "green tip" or "mouse ear" stage of development. Subsequent spore discharges occur over a period of six to eight weeks. The spores may infect any of the susceptible tissue on the tree and are the cause of the primary infections. When the spores reach the wet leaves, blossoms or fruit, they germinate and the germ tube penetrates the outermost layers of the tissue. Here the penetrating germ tubes develop into fungous growths which break through the surface in approximately two weeks, causing the dark olive-green, velvety lesions mentioned above.

When the primary scab lesions are readily visible on the foliage or fruit they produce large numbers of summer spores frequently called conidia, to distinguish them from the ascospores. These are splashed by rain to other parts of the tree and cause secondary infections which may continue the spread of the disease throughout the season ending with "pin head" scab at harvest or the "ink spot" in storage.

Weather conditions

The fungus causing apple scab is dependent on weather conditions to favour its development. The perithecia will not mature spores unless the fallen leaves in which they grow are occasionally wetted. Ascospores will not be discharged from the perithecia unless the leaves are moist. Rainfall is essential to the spread of spores during the season as it not only liberates the spores from spore-bearing structures but provides a medium in which germination of the spores may take place. Continuous foliage wetting for a period of nine to fifteen hours accompanied by temperatures between 50° and 70° are most favourable for spore germination. Such environmental conditions constitute an "infection period". It is an advantage for growers to be able to identify infection periods as this may have a bearing on the choice of the fungicide to be used. Protectant materials must be applied before infection periods, whereas eradicant fungicides may be used to good effect immediately afterwards. The identification of infection periods can be made by a glance at the diagram (Figure 5). For instance, infection may be expected to follow a fifteen-hour wet spell with a temperature of 49° F or a ten-hour wet spell at 60° F. and so on. It may require from ten to eighteen days after an infection for the new scab lesions to show, with the exception of storage scab lesions which may not appear until several weeks after harvest.

Control of apple scab

From the above life history of the fungus it is apparent that there are two main sources of infection: (*a*) Ascospores from the old leaves and (*b*) conidia from the current season's lesions. Spores from twig lesions may be considered a minor source of infection in Canada. It is, therefore, necessary to prevent either the formation or discharge of ascospores or to protect the foliage and fruit from primary infection.

Ploughing under or burning the leaves will destroy a tremendous source of primary infection. Some chemicals applied as sprays to the leaves on the orchard floor will prevent maturation and discharge of ascospores in the leaves which are thoroughly covered with spray. The difficulties encountered in the practical application of burning, ploughing under or spraying of the leaves in an orchard are such that these practices are of limited value in the commercial orchards.

The control of scab in commercial orchards is dependent largely on the use of fungicides, thoroughly applied at the proper dilution and the correct time. Thoroughness of application can be determined by the operator and the recommended dilution for each material is usually stated on the spray calendar or on the fungicide container. The correct timing of applications requires a further explanation as it involves some knowledge of the function of the materials to be used. Fungicides, such as bordeaux mixtures, wettable or paste sulphurs and organics (e.g. ferbam, Crag,) are protective materials and to be effective must be applied before infection periods. Such materials as lime sulphur, the organic mercurials (e.g. Tag, Puratized Apple Spray, Erad,) and the organic non-metals (e.g. Phygon) are eradicant fungicides. These materials have given satisfactory control of scab when applied within forty-eight hours after the conclusion of an infection period.

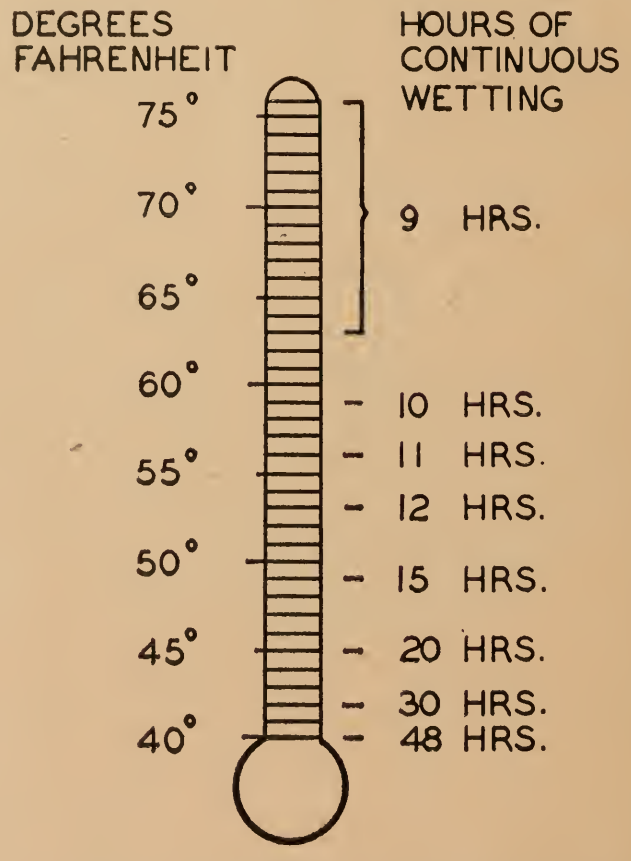

Figure 5: Apple scab infection periods. The diagram shows the approximate minimum number of hours of continuously wet foliage necessary for scab infection. The longer the period of wet weather, the more severe the infection. For example, 10 hours at 60° F. will cause a light infection, but 20 hours may cause a severe infection. Scab spots do not appear until from 10 to 18 days after a given infection period. (Diagram adapted after Dr. W. D. Mills, Cornell University).

Since the fungus may attack any of the new current season's growth the spraying must be done thoroughly. Unsprayed parts of the leaves or fruit are liable to infection. Clean foliage and fruit in the early season usually result in clean fruit at harvest. Through the establishment of spray services in many districts, growers may receive advice on the proper time to make specific applications and the materials to use. Special weather forecasts are made for the benefit of growers so that they may be warned of critical periods and may time their sprays accordingly. Extra applications are sometimes necessary in the spring during prolonged periods of wet weather. On the other hand it is possible, frequently, to delay or eliminate applications during prolonged dry periods. However, changes in the spraying program should not be made without consulting the spray service in the locality concerned.

Spray Calendars and Materials

Spray calendars are published in all the provinces where apple production is carried on commercially. They are issued as a guide to the control of diseases and insects in those districts and are the result of extensive investigational work. The sequence of mixing and the dilution strengths for recommended materials should be closely followed.

Recent developments in spray materials make it possible for growers requiring several days to spray their orchards, to put confidence in the emergency use of eradicant fungicides. When an infection period interrupts the application of a protectant fungicide, a grower may spray with an eradicant immediately after the infection period in order to complete the program planned. The eradicant will arrest infections that may have started and provide protection for about one week. The use of an eradicant is recommended for such an emergency as indicated above and has been found in similar cases to be very satisfactory under experimental and commercial conditions.

Before a decision is made on what fungicide is to be used, it is advisable to inquire of the nearest plant pathological laboratory to secure a copy of the spray calendar or schedule recommended for the district concerned. Some materials are more effective and can be used with greater safety in some districts than in others.

It is generally accepted that sprays are more economical to use than dusts, especially in districts where scab is a serious factor. Dusts may be used for supplementary or emergency applications. Efficient dusting is just as essential as thorough spraying.

Equipment

The selection of equipment for the application of the fungicide is important. A large assortment of dusting and spraying equipment is available on the market, some of which is designed for the home garden. The commercial orchardist has a choice of power sprayers, speed sprayers and mist blowers. The power sprayers have been standard orchard equipment for many years. The speed sprayers are a more recent development and depend on a strong air blast for the distribution of the fungicide. The mist blower or concentrate sprayer is a modification of the air blast sprayers which will distribute a more concentrated fungicide mixture as a fine mist. Each type of sprayer has its advantages and disadvantages as well as its proponents. The size of the orchard area and the availability of water and labour are important considerations in the selection of suitable equipment.

Bordeaux mixture.—This fungicide, the oldest of the spray mixtures, still remains the standard copper fungicide. Many formulae are in use to satisfy local conditions. It is a good fungicide but, if used for either the "pink," "calyx" or first cover application may cause a severe russeting of the fruit. Bordeaux should be applied only when it will be able to dry quickly, otherwise severe leaf injury may result.

Copper Fungicides.—There are a number of "fixed" coppers available on the market as alternative fungicides to bordeaux mixture. Recommendations for their use are given by the manufacturers.

Lime Sulphur.—Lime sulphur has been in use for many years and is still the recognized standard sulphur fungicide in some districts. It should not be used under weather conditions that will prevent it from drying within half an hour after being applied. Applications of lime sulphur made during hot, humid weather may cause foliage injury and dropping of fruit. Russeting of fruit may follow the use of this material during very hot weather. Excellent results may be obtained with lime sulphur if used under suitable weather conditions.

Sulphur Fungicides.—Several forms of wettable and paste sulphurs are on the market under various trade names. The paste sulphurs have the greater adhesiveness. The manufacturers of these materials provide instructions for their use but they should not be used when the temperature is above 85° F.

Organic Fungicides.—During recent years some very useful organic chemicals have found their place as fungicides. Some are strictly protectants, such as Ferbam, Crag, etc., while others, such as Tag, Puratized, etc., are eradicants. The eradicant fungicides may be used in place of lime sulphur after infection periods with little or no fear of injury. Spray calendars frequently recommend organic fungicides.

Dusts.—These materials have very limited use at the present time. Various fungicide mixtures may be obtained for orchard use. Dusts may be used to advantage as emergency applications during severe scab infection periods.

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