Scab on the Pear

J. R. Kienholz

Pear scab is a disease of world-wide importance. Fungicides have to be used every year to control it in all but a few arid districts. During seasons favorable for scab infections, losses of 20 to 30 percent of the fruit are not uncommon, and if control measures are neglected, practically all of the fruit may be unmarketable.

The scab fungus (*Venturia pyrina*) may attack the flower parts, fruit, leaves, or young twigs. Wet weather, particularly early in the growing season, is probably the greatest factor in determining the increase or decline of pear scab from year to year. A closely related fungus (*V. inaequalis*) causes apple scab, but it cannot infect pears, and the pear scab fungus cannot infect apples. The observations reported here pertain mainly to the conditions in the Pacific Northwest.

About the time the petals fall in the spring, dark velvety or sooty spots may appear on young fruits. Infections may occur on the leaves, the fruit stems, the calyx lobes, or even the flower petals. If the fruit stems are attacked, the young fruits are usually weakened and drop. If fruit growth continues, a badly misshapen pear results. The scab spots usually enlarge as the fruit grows until arrested either by hot, dry weather or by fungicidal sprays. Early infections eventually may involve the whole side of a fruit; later infections may result in numerous smaller spots. The central, or older part, of an early scab spot may die and leave a corky or russeted skin area. An olive-brown rim of active fungus tissue often remains alive at the edge of the spot. This tissue may produce new spores and the spores in turn cause numerous new infections during wet weather.

Leaf infections are like those on the fruit, but they usually appear slightly later. They are more common on the lower surface of the leaves than on the upper. Individual spots rarely become more than three-fourths inch in diameter and appear black, because of the compact growth of the fungus. Sometimes the fungus threads radiate in less compact masses to produce a fernlike, irregular scab patch. Single scab spots are common on the leaves. They often envelop the midrib or leaf veins and cause considerable puckering or twisting of the leaf. As the scab spots mature and dry out, they may crack or tear, leaving a jagged, black-rimmed hole in the leaf. Less food is manufactured for the tree by scabby leaves. Numerous infections may cause the leaves to weaken, dry up, and drop prematurely. Continued attacks of the disease will devitalize the trees.

New twig growth on pear trees may be infected at any time during the growing season. Most infections result when rains are frequent. During spring and summer new twig lesions are inconspicuous. They appear merely as small, blisterlike pustules, no larger than a pinhead. Sometimes the fungus remains invisible within the twigs as a latent infection. Occasionally a shallow, spore-producing layer is formed. A corky layer often forms beneath the twig infections and many are sloughed off before autumn, leaving small depressions on the twigs. If the twig infections are not sloughed, the fungus remains dormant in the twigs until the following spring, when renewal of tree growth causes the fungus to become active again. The fungus breaks through the epidermis of the twig, forming a scab pustule. Numerous scab
Spores mature in the pustules, usually before the blossom clusters separate. The overwintered twig lesions also are generally sloughed off during the growing season, but occasionally a few remain to form spores the next season. Old sloughed lesions may appear in 2- to 5-year-old branches as small crater-like depressions.

The pear scab fungus has two distinct stages in its life cycle.

Throughout the growing season the fungus lives as a true parasite within the pear tissue. After primary infections occur in the spring the fungus pushes or breaks through the surface of infected fruit or leaves, and produces summer spores (conidia). These spores are formed in great numbers when weather conditions are suitable. They are dispersed by rain and wind to cause new infections. Each spore, if moisture and temperature are favorable, can develop a tiny germ tube, which may enter the host tissue and cause a new infection. These processes may occur many times during the season and numerous secondary infections may result.

The summer or parasitic stage may also overwinter in infected twigs. Because the spores are generally mature before the pear buds unfold, it is the most important source for primary infections the following spring.

The fungus also overwinters as a saprophyte on the infected leaves that drop in the fall. Thick-walled, flask-shaped, beaked structures, known as perithecia, are formed within the old leaf tissue during the winter. Numerous tiny, sac-like organs, called asci, containing eight small, two-celled spores (ascospores), are formed within the perithecia. The ascospores become pale olive green as they approach maturity, about the time the pear buds are unfolding. When moisture and temperature conditions are favorable, they are discharged through the beaks of the perithecia into the air. Air currents carry the spores to the trees, where they may germinate and cause primary spring infections. Those infections soon produce the summer spores, and secondary infections result when conditions are favorable for the fungus.

Scab spores are disseminated only during moist periods. Continual moisture for 5 to 48 hours is necessary before the spores germinate and infect susceptible pear tissue. If the temperature during the rainy period is about 75° F., a spore may germinate and infect the plant within approximately 4 to 5 hours. At lower temperatures moisture must persist for a longer time, so that at 40°, a wet period of approximately 48 hours is required before infection occurs. After infection has taken place, 12 to 25 days are required before the fungus grows enough to become visible to the naked eye. When scab spots suddenly appear on fruit during dry weather, it must be remembered that the infections occurred during a previous rainy period.

Most of the commercial pear varieties commonly grown are susceptible to scab infections. Fruits of Anjou, Bartlett, Comice, Winter Nelis, Easter, Forelle, Seckel, and Flemish Beauty often are severely affected. Bosc fruits are very susceptible in the young stage, but about the time they shed their pubescence they become highly resistant. Frequently a variety only lightly attacked in one district may be the most seriously affected in another. The first spray is generally timed according to pear bud development. Since a pollinizer variety like Easter unfolds its buds earlier than Anjou, the early spray, if timed for the Anjou variety, may allow some infections on exposed Easter buds. If timed for the Easter variety, the spray is too early to be fully effective on the Anjou variety.

Twig infections have never been observed on Bartlett in the Hood River Valley of Oregon. Yet in districts with higher rainfall twig scab is common on the variety. Climatic conditions, fertilizers, pruning practices, soils, cover
crops, and other factors all have a part in modifying growth characteristics of pear trees and their susceptibility or resistance to the scab fungus. The fungus also varies its attack on pears. G. W. Keitt, at the Wisconsin Agricultural Experiment Station, determined in greenhouse tests that at least two strains of the scab fungus exist in Oregon. One strain attacks Bartlett but not Anjou pears. Another infects Anjou but not Bartlett. This condition has been observed under field conditions in Oregon. Probably other strains of the fungus exist in nature, but their relationships have not been definitely demonstrated.

Trees should be well spaced and pruned to give an open type of growth so that proper aeration occurs within the trees and to allow thorough spray coverages to be applied. Eliminating excessive water-sprout growth during the summer is often profitable, because it reduces the chance for additional twig infections. Early spring cultivation, to bury the old infected leaves, will lower the amount of the overwintering fungus, which may cause primary infections. Heavy cover crops often prevent rapid evaporation of moisture in an orchard, thereby extending the infection time for the scab fungus. On the other hand, sprinkling orchards during dry periods has not materially increased the scab problem.

The secret of scab control is to prevent the primary spring infections. Any overwintered twig infections are more important sources of spores that cause primary infections than those developed in overwintering leaves. Most of the twig lesions expose their spore masses by the time the delayed dormant spray is to be applied, although a small number may sporulate after that period. Therefore the lime-sulfur application is delayed as long as possible in order to "burn out" as many twig lesions as possible without causing damage to exposed pear buds. Lime-sulfur will usually cause severe russet on tender-skinned pears when applied in humid districts after the outer bud scales drop, but it is often used later without injury in drier and hotter districts.

Lime-sulfur (a minimum of 6 gallons to 100 gallons of water) is the most effective fungicide for destroying the spore masses in twig lesions. Bordeaux mixture and wettable sulfur do not penetrate under the epidermal covering of the scab pustules and kill only a few of the surface spores. Thorough coverage of the twigs is essential, since the fungicide kills the spores largely by contact.

Some twig infections may not open until after the delayed dormant spray has been applied, and ascospores produced on overwintered leaves usually mature after that period. Thus it is necessary to apply cover sprays to protect new pear growth from scab infections.

The proper fungicide for use as cover sprays depends mostly on the variety grown and partly on climatic conditions. In that respect we can put pears into two general groups: Those intended for cannery use, or varieties upon which a russet skin does not lower the fruit grade; and the tender-skinned, shipping varieties, which require a smooth skin surface to command top market prices.

Varieties in the first group may be sprayed with lime-sulfur at the pink and calyx stages of bud development or, if needed, until hot weather may be expected. Lime-sulfur has an advantage over many others in being an eradicant spray as well as a protective material. It is dangerous to use any sulfur fungicide on pears when temperatures of 90° F. or over may occur, or if an oil spray will be used within 45 days.

Tender-skinned varieties like Comice and Anjou may be severely russeted by sulfur sprays. The fruit set of Anjou has been cut an average of 30 percent by their use. The spray-sensitive varieties are susceptible to injury early in the season or until the young fruits shed their pubescence
about the end of June. As lime-sulfur and other potent eradicative fungicides cannot be used on the tender varieties, milder protective fungicides have to be used. Consequently, the spray applications must be well timed and applied thoroughly to realize satisfactory scab control.

Ferbam (ferric dimethyl dithiocarbamate) and ziram (zinc dimethyl dithiocarbamate) are substitutes for the wettable sulfur sprays. They have been used on tender-skinned pears in the Pacific Northwest since 1944. They have given satisfactory scab control when timed properly and applied thoroughly. They are generally used at the rate of 1/2 pounds to 100 gallons of water.

Following the delayed dormant spray of lime-sulfur, ferbam or ziram as a first cover spray is usually applied at the pink (preblossom) stage of bud development. If the weather is cool and the buds are slow in opening, it may be advisable also to spray at the prepink, or green-bud, stage before the "pink" spray. If primary infections are not prevented at this early period, the protective fungicides will give only partial scab control later.

Bordeaux mixture or prepared copper fungicides may be substituted for ferbam or ziram on Comice pears, but sulfur in any form is extremely injurious on this variety after the delayed dormant period.

Ferbam or ziram is generally applied at the calyx, or petal-fall, period. Additional applications of ferbam or ziram at 15- to 20-day intervals may be advisable if the season is excessively rainy.

Ferbam and ziram are compatible with most of the newer insecticides, but lime, casein spreaders, or other alkaline materials lower their effectiveness against scab. Applications of ferbam, especially if mixed with oil, are not recommended later than 30 days before harvest because of the difficulty in removing the spray residues. Thorough applications of the earlier sprays will usually make late applications unnecessary.

The spray schedule to control pear scab should consist of:

1. The delayed dormant, or green-tip, spray. Use 6 to 8 gallons of liquid lime sulfur (32° Baumé) or its equivalent to 100 gallons of water. Maximum control of the twig scab pustules will be obtained if the application is delayed until a few of the outer bud scales are so loose they can be shattered off during the spray operations. Severe injury may result if used after the bud scales have fallen to expose the young pear buds, particularly on Anjou and Comice pears.

2. Preblossom sprays. The first cover spray is applied at the pink, or preblossom, period when seasonal development is normal. If weather is cool and buds are slow in opening, an additional spray should be applied at the prepink, or green-bud, stage. Ferbam or ziram (1/2 pounds to 100 gallons of water) should be used on spray-sensitive varieties, or lime-sulfur (2 1/2 gallons to 100 gallons of water) on varieties not injured by sulfur. Bordeaux mixture or prepared copper fungicides may be substituted for ferbam or ziram on Comice pears, but beware of sulfur in any form on this variety after the delayed dormant period.

3. Calyx spray. A spray consisting of ferbam or ziram (1 1/2 pounds to 100 gallons) is generally applied at the calyx, or petal-fall, period. On varieties not sensitive to the action of sulfur, lime-sulfur (2 1/2 gallons to 100 gallons of water) is recommended unless hot weather may be expected.

4. Additional cover sprays. Additional applications of ferbam or ziram at 15- to 20-day intervals may be needed if the season is excessively rainy. Many of the spray materials, except sulfurs, that cause early injury on the spray-sensitive varieties can often be used with safety on them after July. It is too late by then to use them in an efficient scab control program, but
they might find usage in special cases. Copper sprays, while not usually causing russet at this time, will intensify any russet already present on the fruit. When scabby fruits or leaves are present on the trees after midsummer, a late outbreak of scab may appear if heavy dews or late summer rains occur. Ferbam or ziram, at the rate of 1 to 1½ pounds to 100 gallons of water, may be added to the last codling moth spray to protect the fruit from late infections or storage scab. This practice is not recommended generally, since the residues are difficult to remove after late applications, and scab should be controlled by the earlier sprays if they are applied in the proper way.

After pear fruits are picked from the trees at harvest they are no longer susceptible to scab infections. Clean fruits picked from scabby orchards do often develop new scab spots while in common or cold storage, but they result from late infections in the orchard. If rains occur 10 to 14 days ahead of harvest, fruit infections may become visible shortly after the fruit is placed in storage. If the infections occur only a few days before harvest, however, the appearance of scab spots on the fruit in cold storage may be delayed until December or January. To prevent scab from appearing on stored fruit it is necessary to control the fungus in the orchard.

Visible scab spots enlarge only slightly during the storage life of the fruit, but the occurrence of several scabby spots causes the fruit to be discarded or sold for less value. Scabby pears transpire and lose weight more rapidly than sound pears in storage, but generally less than 1 pound per box difference can be measured after 5 months in cold storage.

J. R. Kienholz is a pathologist in the Bureau of Plant Industry, Soils, and Agricultural Engineering. He has been stationed at the United States Fruit Disease Laboratory, Hood River, Oreg., since 1931.

Fire Blight of Pears in California

C. Emlen Scott

Outbreaks of fire blight wiped out the pear orchards in the San Joaquin Valley and southern California at the turn of the century. It threatened the industry in the Sacramento Valley and was found elsewhere in northern California in 1904. M. B. Waite, of the Department of Agriculture, was sent to California to inaugurate control procedures. He demonstrated the method of removing blighted parts by cutting below the point of infection and using a disinfectant on tools and cuts in the tree. The procedure, somewhat modified, has been the only control method available until recent years.

The application of copper compounds in sprays or dusts during the blossom period is now an established practice in most orchards of Bartlett pears in the districts of California where blight flourishes. Nearly all the experience with this preventative procedure is with the Bartlett pear, which accounts for more than 85 percent of the 39,000-odd acres of pears in California.

The successful program of fire blight prevention now in use in many pear orchards in California is based on facts and hypotheses developed by workers in the California Agricultural Experiment Station and elsewhere. In 1934 H. Earl Thomas and P. A. Ark published the results of a study on the relationship of pear nectar concentrations to the fire blight organism. George H. Vansell had pointed out