Tree Fruit Diseases in Michigan
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Tree Fruit Diseases in Michigan

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By E. J. KLOS
Department of Botany and Plant Pathology

Each year diseases cause large financial losses to the fruit growers of Michigan by lowering the yield and quality of fruit crops.

The purpose of this bulletin is to aid fruit growers to recognize the different tree fruit diseases in all stages; to outline the life cycles of the major diseases; and to point out critical periods of these life cycles when control practices should be carried out.

The major diseases are treated under the following headings: importance, symptoms, environmental conditions favoring the disease organism, life cycle, and control. Specific chemical controls are not included because of yearly revisions. The grower should consult the Extension Fruit Spraying Calendar, Bulletin 154, for current chemical controls.

Wherever possible, photographs illustrate the symptoms. Diagrams of the life cycles of the major tree fruit diseases show the different stages the fungus passes through in causing a disease.

I. APPLE DISEASES

Apple Scab

ECONOMIC IMPORTANCE

Apple scab *(Venturia inaequalis)* is the most important fungus disease of apples. It is found in all the apple growing areas of Michigan. If it is not controlled, a grower can lose most of his crop by reduction of yield and quality.

Yield reduction is caused by pedicel (fruit stem) infection of the young fruit. These fruit will drop prematurely. Severe leaf infection will result in leaf drop which in turn reduces the fruit size. Lack of leaf surface results in poor bud development for the next year's crop.

Fruit quality is reduced by size reduction, deformed fruit, and scabby appearance. Scabby fruit have a short storage life. Infected fruit decreases the marketing grade.

Fig. 1. Apple scab lesions produced on the underside of the leaves, showing their indefinite outline.

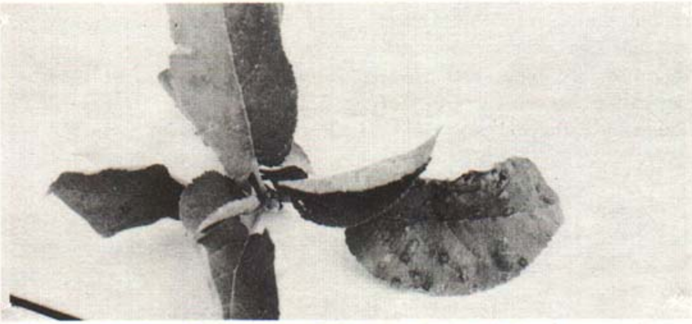

Fig. 2. Typical scab lesions produced on the upper surface of a leaf.

SYMPTOMS

Leaf—The first leaf symptoms appear on the flower bud leaves. The olive green, irregular lesions appear on the under surface of the leaves because this surface is first exposed when the buds open during early infection periods (Fig. 1).

Typical leaf scab lesions are found on the upper surface of leaves (Fig. 2). The young lesion is olive green and indefinite in outline. As it becomes older, it has a definite outline, and is olive green with a velvety surface. Later the velvety surface disappears and the leaf under the lesion is often raised.

Severe early leaf infection can result in dwarfed, curled leaves with dead margins. This is accompanied by leaf drop later.

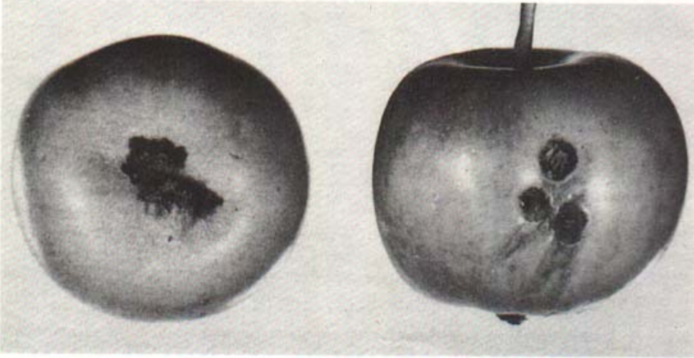

Fig. 3. Fruit showing scab lesions on the side and calyx end. Note the portions of the cuticle on the edge of the upper scab lesion on the fruit at the right.

Fruit—Primary infection may occur on the sepals of the flower bud early in the growing season. These structures are the first susceptible tissue to be exposed. The lesions are difficult to see because they are gray and indistinct.

Typical fruit scab lesions are distinct, almost circular, velvety and olive green in color with ruptured cuticle at the margin (Fig. 3). Older lesions are darker, scabby, and often cracked.

Heavily infected fruit are often misshapened, cracked, or drop prematurely. Some varieties such as Ben Davis produce knobs instead of becoming dwarfed at the scab region.

Twigs, blossoms and bud scales can also be attacked by this fungus, but such infection is uncommon in Michigan.

LIFE CYCLE

The life cycle of the apple scab fungus consists of 2 cycles, (1) Primary, (2) Secondary. Follow Fig. 4 as you read the text.

Primary Cycle—The fungus overwinters in the diseased leaves on the orchard floor. In the late winter, fruiting structures (perithecia) are formed in these fallen leaves. About bud break, spores (ascospores) begin to mature in the sacs (asci) within the perithecia. This maturity of ascospores usually extends 3 to 5 weeks after petal fall. This period can be reduced or extended depending on weather conditions. In dry springs, it will be extended.

Rainy periods sufficient to wet the fallen leaves will cause a chemical reaction within the spore sacs. Increased internal pressure generated by the reaction elongates the sac so it extends out of the perithecial opening and the mature ascospores are then discharged.

Spores start to discharge 5 minutes after leaf moistening, and reach their maximum in 30 minutes. Ascospores are discharged only a fraction of an inch above the overwintering leaf. Wind and air currents carry the spores to the susceptible tissue close by or at a distance.

Ascospores mature over a period of time. If there is no rainfall early in the season, the spores continue to mature in the perithecia and a large discharge can be expected during the next wetting rain.

Moisture must be present for several hours around the spore before infection can take place. Infection time varies with the temperature (See Table 1) under moist conditions. It is possible to have infection at low temperatures if the plant parts remain wet during this period.

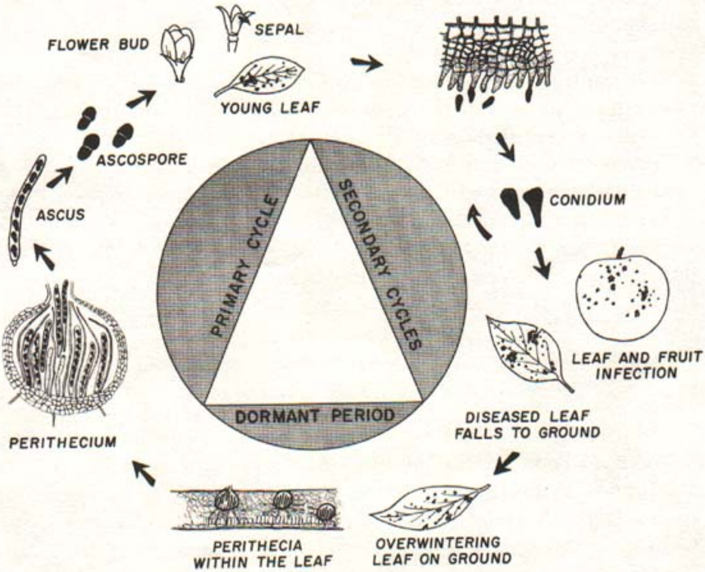

Fig. 4. Life cycle of the apple scab organism.

TABLE 1—The approximate number of hours of continued wet foliage required for primary apple scab infection at different air temperature ranges

Average air temperature range during wet period	Number of hours of continued wet period required for primary apple scab infection
32°—40° F.	48 hours
40°—42° F.	30 hours
42°—45° F.	20 hours
45°—50° F.	14 hours
50°—53° F.	12 hours
53°—58° F.	10 hours
58°—76° F.	9 hours
76°—	11 hours

(After W. D. Mills, Cornell Univ.)

On reaching the wet young leaves and fruit, the ascospores germinate, penetrate, and send out threadlike structures within the cuticle. From this mass of mycelia short upright stalks (conidiophores) are produced which bear summer spores (conidia). Table 2 indicates the time it takes for conidia to develop at different temperatures following primary infection. The conidia initiate the secondary cycle.

SECONDARY CYCLE

Under ideal conditions, it is possible to have both the primary and secondary cycles (approximately 5 weeks after petal fall).

Table 2 shows that conidia can form at low temperatures. Conidia are firmly attached to the conidiophores and are separated only when

TABLE 2—The effect of temperature following primary apple scab infection on the length of time required for the development of conidia (summer spores)

Average temperature following primary apple scab infection	Approximate period of time required for conidia (summer spores) development following primary apple scab infection
30°—40° F.	18 days
41°—45° F.	16 days
46°—50° F.	14 days
51°—55° F.	13 days
56°—60° F.	12 days
61°—65° F.	10 days
66°—70° F.	8 days
71°—75° F.	7 days

(After W. D. Mills, Cornell Univ.)

wet. These spores are disseminated by rain, driving rain, or dew. The conidia are usually spread within the tree. It takes about ⅔ the time for conidial infection to occur as compared to primary infection as indicated in Table 1.

This cycle consists of infection by conidia followed by production of conidia at or near the point of infection. There can be several secondary cycles in a season if this fungus is not controlled.

Storage scab is a result of infection occurring late in the summer during long rainy periods. The fruit is more resistant to scab at this time and the scab lesions develop very slowly. They often do not appear until the fruit are in storage.

Storage scab appears as black, shiny, smooth lesions. The cuticle usually remains intact. There is no cork layer under storage scab lesions.

CONTROL

Resistance—Although varieties vary in their susceptibility to the apple scab organism, no cultivated commercial variety has sufficient resistance to eliminate the need for chemical sprays. Research work in breeding for apple scab resistance has been initiated in a number of countries. However, the outcome of this project will not be known for several years.

Sanitation—Destruction of the fungus in the diseased leaves on the ground by spraying during the dormant season is practiced in some areas of the country followed by a regular spraying program.

In Michigan it is suggested that, if a grower does a *thorough and timely* job in spraying, this additional dormant ground spray is not necessary. Even if 99 percent of the perithecia are killed by a ground spray, the remaining 1 percent will have sufficient inoculum, however, to give a severe scab infection under ideal weather conditions.

Management—Wider tree spacing, open pruning, adequate equipment, rate of sprayer travel, and other production methods and equipment help give effective spray coverage of trees.

CHEMICAL SPRAYS

The apple grower is dependent on chemical sprays to control apple scab in Michigan. The key to an effective apple scab control program is to spray according to rainfall (wetting periods) during the primary cycle (see Fig. 4). If this disease is not controlled at this time, a grower is forced to spray longer into the summer.

Three types of chemical apple scab sprays are (1) protectant, (2) eradicant, and (3) combination of ½ strength eradicant + ½ strength protectant.

Apply protectant sprays before rains or before infection takes place. Generally, they are milder and do not cause plant injury as do eradicants. The protectant spray sets up a chemical barrier between the susceptible tissue and the germinating spore.

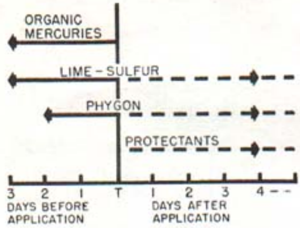

Fig. 5. Approximate periods of control of apple scab by different fungicides. (T = time of application.) The time to the left of the vertical line indicated the approximate period of eradicative action; that to the right indicates the approximate period of protective action. After D. Cation, MSU.

The eradicant sprays "burn" out the fungus within a certain period of time after infection. They should be considered as emergency treatments. These sprays include lime sulfur effective for 72 hours after infection, and are suggested for application up to pre-pink sprays. Organic mercuries are effective 72 hours and *Phygon* 48 hours after infection at recommended full strengths in the pre-cover sprays.

Half strength organic mercuries eradicate 40 to 45 hours and half strength Phygon eradicates 30 to 36 hours after infection.

Growers should keep track of the start of a rain and average temperature and calculate from Table 1 the length of time it takes for infection to occur. For example, at an average temperature of 58° F. it takes 9 hours for primary infection to take place after the start of a rain. This indicates that if a protective spray is not applied before or within this 9-hour period, you must rely on an eradicative application. Whether a half strength or full strength eradicant is used will depend upon how many hours after infection you apply the spray.

For good apple scab control, several points must be considered: (1) Good timing–put on protectants before infection takes place and eradicants within their effective period in pre-cover sprays. (2) Thorough coverage—adequate spray equipment, rate of equipment travel, well spaced and open trees all contribute to proper coverage. (3)

Proper selection of chemicals—select spray chemicals that are effective against apple scab but are still safe to the apple tree.

Fireblight of Apple

ECONOMIC IMPORTANCE

In some years in Michigan, fireblight *(Erwinia amylovora)*, a bacterial disease, causes extensive damage to several apple varieties. It reduces the yield by attacking blossoms, twigs, branches, and fruit. In some cases entire trees have been killed, especially in young orchards.

The more susceptible varieties in Michigan are Wagener, Tompkins King, Twenty Ounce, Rhode Island Greening, Yellow Transparent, and Jonathan. Many crab apple varieties are susceptible, especially Hyslop.

(See Fireblight of Pear on pages 23-26 for symptoms, life cycle, and control).

Powdery Mildew of Apple

ECONOMIC IMPORTANCE

In recent years, powdery mildew of apple has increased in Michigan orchards. This fungus *(Podosphaera leucotricha)* attacks leaves, terminals, blossoms, and fruit. Severe infection will reduce the yield and quality. It reduces bud development on current year's growth.

The recent increased usage of organic fungicides in place of sulfurs has increased the incidence of this disease. Poor wetting of plant parts by air blast sprayers also contributed to this increase.

SYMPTOMS

Leaves—Early in the season the mildew fungus forms gray feltlike areas on both sides of the leaves (Fig. 6). Severely infected leaves are twisted, narrow, cupped, and are covered with a powdery coating.

Terminals—This fungus attacks the wood, axillary buds, and terminal buds, often resulting in stunting (rosetting) of terminals (Fig. 7). Infected terminals have weak buds and are often winter killed.

Blossoms—Overwintering fungus filaments in the dormant buds infect the blossoms. The flower parts are often killed, and fruit set is reduced.

Fruit—Net russeting is the symptom on fruit (Fig. 8). This symptom is common on heavily infected trees.

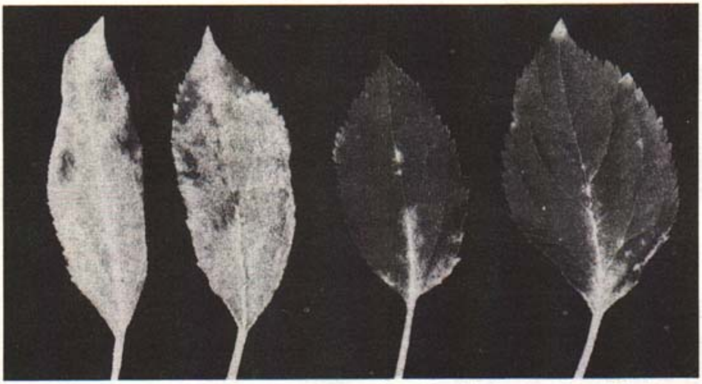

Fig. 6. Its powdery appearance on infected apple leaves gives this fungus disease its name.

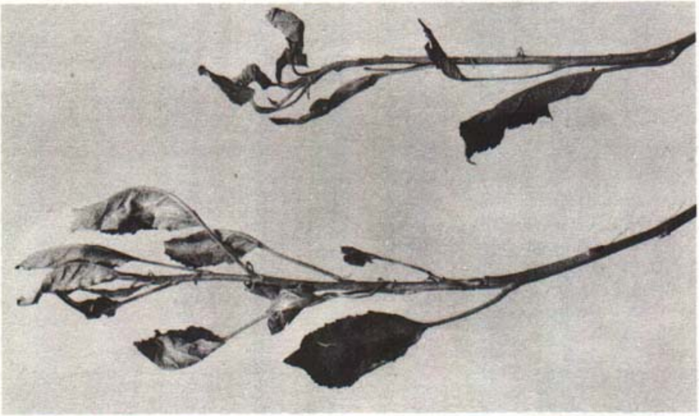

Fig. 7. These mildew-infected twigs show cupping, twisting, and rosetting of the leaves.

LIFE CYCLE

This fungus overwinters mainly as filaments (mycelia) in buds. These infected buds open about 5 days later than healthy buds. Spores produced on these infected plant parts (blossoms and leaves) infect healthy growing tissues during warm humid weather in the spring.

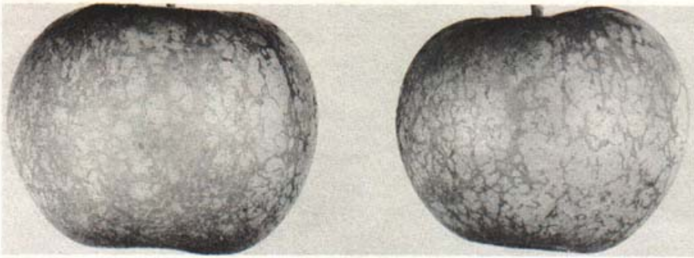

Fig. 8. These apples show net russetting, a symptom of powdery mildew.

As an external parasite, this fungus obtains its food by special sucking organs (haustoria). Within a few days, the fungus produces more filaments and spores on the newly infected tissues. Under favorable weather conditions, this cycle can be repeated several times during the growing season.

After terminal growth stops in the summer, minute globular dark bodies (perithecia) appear in the dense mildew growth. What role these bodies play in relation to the overwintering of the fungus is not completely known. It is generally accepted that this organism overwinters as mycelium in the infected buds.

ENVIRONMENTAL CONDITIONS FAVORING THE FUNGUS

High humidity and temperatures around 70° F. favor the development of this fungus. Temperatures below 55° F. and above 80° F. slow down mildew growth. The spores will not germinate in water.

CONTROL

Sulfur is a specific fungicide for this disease. Use sulfur in the pre-bloom sprays either alone or in combination with other fungicides. In severe cases, use sulfur (325 mesh) or *Karathane* in the early cover sprays until growth stops.

Remember: These materials only protect; they do *not* eradicate.

Caution: Applying sulfur or Karathane sprays before or during hot weather (90° F. or more) can result in fruit russeting. Read the chemical labels carefully for precautions.

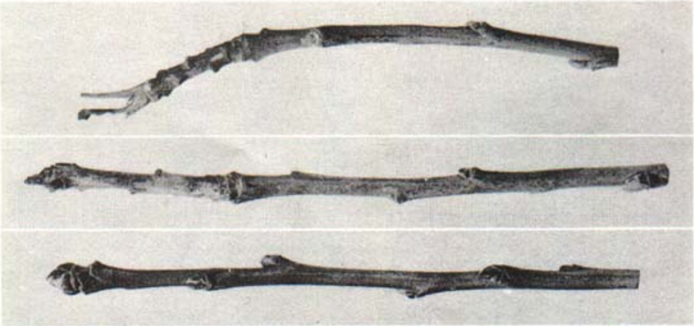

Fig. 9. The two upper twigs are infected with mildew fungus. Compare their growth and bud formation with the healthy lower twig.

Coverage—The mildew filaments are difficult to wet. Add a commercial spreader where needed and cover the tree thoroughly with a dilute spray.

Pruning—Prune infected terminals on young apple trees to reduce the source of inoculum. On mature trees this practice is not practical. Rely on a sound spray program.

Timing—The best time to control this disease is in the pre-cover sprays starting at bud break. A protective barrier on newly expanded tissues is required since the recommended mildew fungicides are protectants only and will not eradicate the fungus if it becomes established.

Crown Gall *(Agrobacterium tumefaciens)*

This bacterial disease is important on all tree fruit nursery stock in Michigan. The tumorlike outgrowth often located at the soil line gives this disease its name.

ECONOMIC IMPORTANCE

Growers have incurred losses of hundreds of dollars per acre. A plant with crown gall on the main root is unsaleable.

Losses are difficult to estimate because a tree in many instances will not show any effects to its growth or yield unless the gall attacks the main root.

Fig. 10. Cherry root with galls on the lateral and main root.

SYMPTOMS

Galls may be very minute—¼ inch in diameter, or very large—up to a foot or more in diameter. Generally they are globular in outline with an indented surface (Fig. 10). Some galls are soft on the exterior; others are hard or woody. Galls can be found at the bud or graft union, on the main or lateral roots.

LIFE CYCLE

Infection can take place only through wounds caused by cultivation, insects, grafting and budding, or other natural or mechanical means. The bacteria are widely distributed in the soil and can overwinter outside the plant. Once the bacteria gain entrance into a root, wild growth is stimulated which results in the tumor growth.

CONTROL

More infections result from grafting than budding of nursery stock. In Michigan budding is the common practice of fruit tree propagation. Growers should only purchase crown gall-free trees. Soil with a crown gall should be planted to a non-susceptible crop like corn or other grain crops for several years.

Control of soil insects in nurseries will reduce crown gall incidence. Also reduction of root cutting by more careful cultivation will help control this disease. In preliminary work, antibiotics show promise as a control.

Cedar Apple Rust *(Gymnosporangium juniperi-virginianae)*

Although of minor importance in Michigan, this fungus disease is serious in the southern apple-producing states.

Part of its life cycle is spent on cedar trees, and the rest of it on apple. Hence the name cedar apple rust. It takes almost 2 years to complete its life cycle.

SYMPTOMS

Small yellow spots appear on the upper surface of leaves early in the growing season. Later these areas enlarge, swell, and turn orange in color. Black dots (pycnia) are found in these spots.

In July and August, the spots thicken, and on the lower surface of the leaves many small tubular projections (aecia) are formed. The outer tip of the projections split and curl back. Spores (aeciospores) are produced within the projections.

Fruit—The symptoms are found at the calyx end of the fruit. The area around the infected area is darker green than that of the developing fruit (Fig. 11). Tubular projections, as in the case of leaf in-

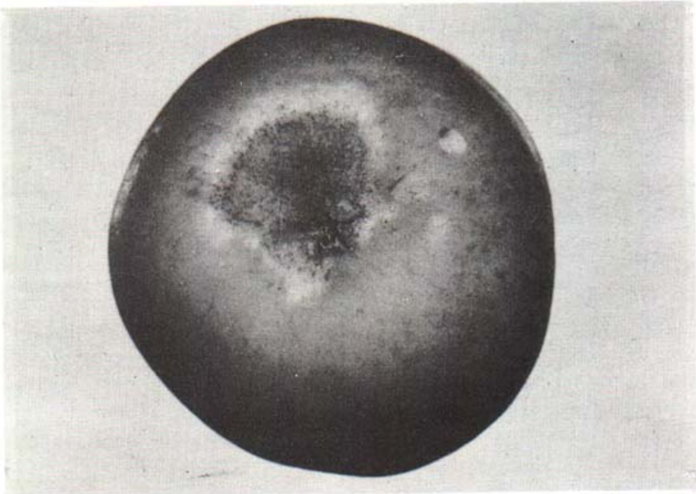

Fig. 11. Calyx end of an apple with cedar apple rust symptoms. The light band is dark green on the actual fruit. Note the small dots (pycnia) within the band.

fection, may or may not appear on the fruit. Black dots (pycnia) are often found within the darker green area.

The tissue below the infected area is dry and corky. In many cases the apple is misshapen at the calyx end.

On cedar—This fungus produces red to dark brown galls or "cedar apples" varying in size from a pea to 2 inches in diameter. During rainy periods in the following spring, hornlike structures are produced at the depressions on the surface of the galls. These horns contain spores (teliospores) that infect the apple.

Varietal susceptibility—Jonathan, Rome and Wealthy are considered susceptible. Slightly susceptible varieties are Baldwin, Delicious, McIntosh, Duchess, Red Delicious, Transparent, Wolf River, Stayman and Astrachan.

CONTROL

One of the most important controls is to eradicate red cedars within 2 miles of an orchard. Wild unsprayed pome fruits should also be eradicated in a problem area. Removal of galls from ornamental cedars near an apple orchard also reduces the inoculum.

Ferbam is very effective in the control of this fungus on apples when applied from pink through second cover.

Silver Leaf *(Stereum purpureum)*

This fungus attacks plums, sour cherries, apricots, peaches and apples. Silver leaf is a weak parasite, and usually shows up after a tree is winter injured.

SYMPTOMS

The chief symptom is the metallic sheen of the foliage. This appearance is caused by the air spaces between the epidermis and the palisade cells of the leaf. On infected leaves, the upper epidermis can be peeled back without difficulty.

A cross section of a diseased branch will exhibit dark discoloration of all or part of the heartwood. Infected trees become stunted and die, or in some cases may live for an indefinite number of years.

Fruiting bodies appear under moist conditions after the tree dies or on dead tissue of a tree. They are purple shelflike forms that are smooth on the underside.

LIFE CYCLE

The fungus is a wound parasite, once infection takes place it invades the heartwood. It blocks the water-conducting tissues, thus disturbing the movement of water with its content of nutrients. The cause of the silvery effect is not known. Once the fungus gets into the sapwood it kills the tissue it invades.

CONTROL

Remove and burn brush from the orchard because it can harbor this fungus. If possible avoid large pruning cuts. Keep the trees in a good growing condition to avoid winter injury.

Apple Blotch *(Phyllosticta solitaria)*

This fungus disease is found on Duchess (Oldenburg) and Transparent apples in a few instances in Michigan. It is a disease of minor importance.

The chief symptoms on the fruit are the irregularly lobed, black, shiny blotches varying in size from a small spot to areas covering most of the fruit (Fig. 12). Within these blotches, are found minute black specks or fruiting bodies.

Organic fungicides such as ferbam and zineb control this disease.

Blister Spot of Apples *(Pseudomonas syringae)*

This bacterial disease showed up in several apple orchards in Michigan in 1956. It is an erratic disease; it may appear one year and be absent for many subsequent years. It is recognized by the dark, minute blisters on the surface of the fruit (see Fig. 13). At present, there is no known control for this disease.

Fly Speck *(Leptothyrium pomi)* and Sooty Blotch *(Gloeodes pomigena)*

These two superficial fungi are often found on apple fruit at the same time. Their presence reduces fruit quality.

Sooty blotch is common during years that have cool wet springs, late summer rains, and low temperatures in early fall. It is recognized by the sooty-gray or cloudy blotches on the fruit. The spots may be from ¼ inch in diameter or larger, even coalescing to cover most of the fruit. The outline of these blotches is indefinite.

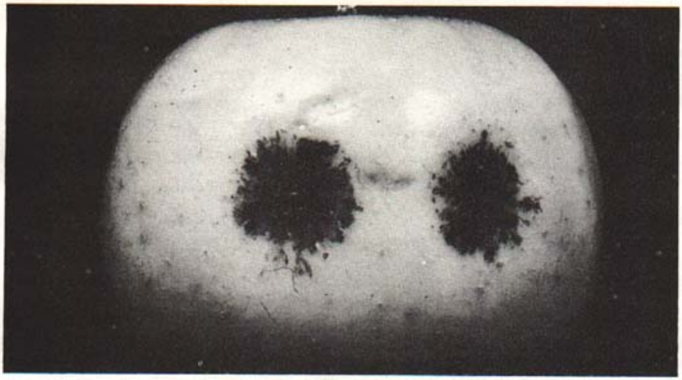

Fig. 12. Duchess fruit with dark radiating lesions caused by the apple blotch fungus.

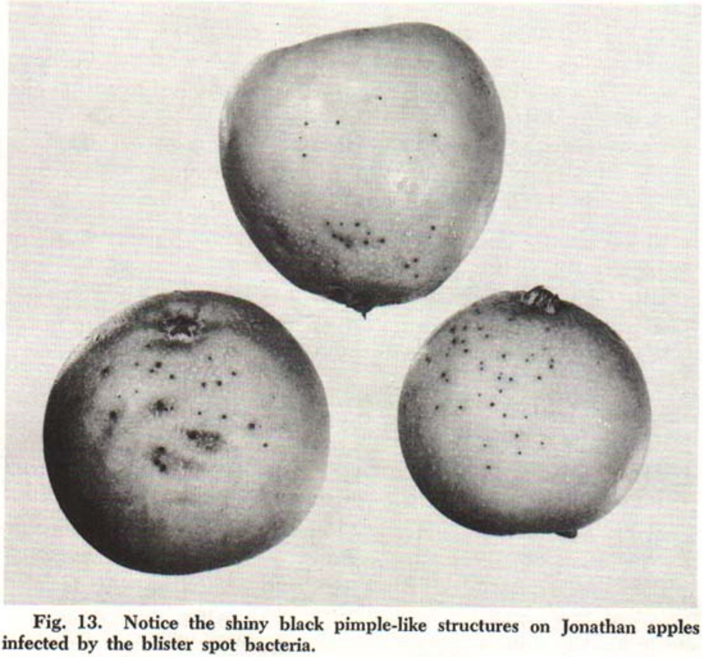

Fig. 13. Notice the shiny black pimple-like structures on Jonathan apples infected by the blister spot bacteria.

Fly-speck consists of black shiny dots with a definite outline. There are usually several specks together in one spot.

Summer sprays of zineb have controlled these diseases.

Soft Rot *(Penicillium expansum)*

This disease usually appears after the harvesting of fruit. It is the cause of a very high percentage of our storage rots in apples. (See Fig. 14).

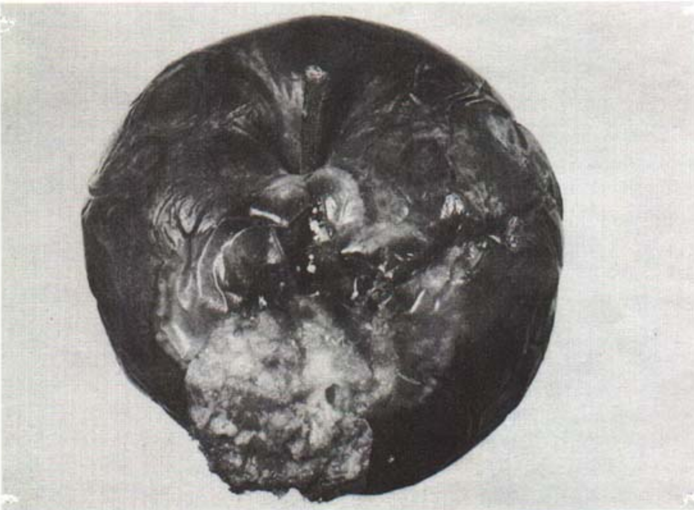

Fig. 14. Completely infected apple showing the soft texture and discoloration of the fruit. Notice the white fruiting structures (actually light blue) below the fruit stem.

SYMPTOMS

Soft rot first appears as soft watery spots in the infected areas. During warm temperatures the fruit will rot rapidly. A fruit can be completely rotted in about 14 days under these conditions. This rotted fruit is light brown, soft, and watery.

Rotted apples have a characteristic moldy taste and odor. Under high relative humidity, bluish masses of fruiting bodies are produced on the fruit.

CONTROL

The spores causing this disease are ever-present in the air. Infection usually occurs through lesions caused by other diseases, insect injury, or wounds and bruises occurring during harvest, packing, or marketing.

Practices that eliminate disease and insect attack should be carried out in the orchard. Injuries such as bruising should be avoided in picking, grading, and packing of the fruit.

Place the fruit in cold storage as soon as possible after harvest. The fungal development is retarded at low storage temperatures.

Apple Mosaic *(virus)*

Of minor importance in Michigan, this disease has been reported on Golden Delicious and Red Astrachen varieties.

Its chief symptom is a leaf mosaic consisting of creamy white areas throughout the leaf early in the season and then turning yellow in the summer (Fig. 15).

Apple mosaic virus is readily transmitted by budding or grafting in the nursery. This indicates an important control, that is, the selection of virus-free budwood or grafts for propagation by nurserymen.

Jonathan Spot *(physiological disease)*

This disease is found mainly on the Jonathan variety but it can occur on Rome Beauty, and Wealthy varieties.

It is readily recognized by the small (1/8 to 1/4 inch), round, sunken, brown-to-black areas of the fruit. The outline of these spots is definite but when placed in common storage they increase in size and become indefinite in outline. These spots extend only into few cells.

Fig. 15. Apple leaves with cream-colored areas on the foliage, a symptom of apple mosaic.

Fig. 16. Northern Spy apple with bitter pit showing the depressed pits over the surface of the fruit.

The best control is to pick the apples at an early stage of maturity and immediately place them in cold storage. Any delay between picking and cold storage will increase the incidence of Jonathan spot.

Apple Bitter Pit *(physiological disease)*

Bitter Pit is found on Stayman, Baldwin, and Northern Spy varieties in Michigan. The first symptom of this disease is the appearance of discolored spots on the surface of the fruit. These spots appear as darker red areas on red varieties and deeper green areas on yellow varieties. The pits become depressed and show no relationship as to position on the fruit (Fig. 16). The spots will vary in size from minute specks to over a ¼ inch in diameter. Two or more of these pits may coalesce to form a larger pit. Later the pits turn brown.

Masses of brown necrotic cells found inside the fruit may or may not be related to the external pits.

Although the exact cause of this condition is not known, several theories have been proposed. Fertilizer experiments in several parts of the world indicate that this condition is not caused by a deficiency of the common plant elements. A favored theory is that of disturbed water relation. Any cultural practice or environmental conditions that disrupt the even supply of water and nutrients predispose the fruit to this condition. Fruit of excessive size are more susceptible to bitter pit.

One worker has proposed that bitter pit is a symptom of a virus disease. This work is only preliminary and needs further substantiation.

Several cultural practices are suggested for the control of this disease: (**a**) avoid excessive pruning, (**b**) use cultural practices that will insure even distribution of soil moisture, (**c**) avoid excessive applications of nitrogenous fertilizer, (**d**) avoid excessive thinning of fruit, (**e**) pick the fruit at the right stage of maturity; early picking is conducive to development of this condition.

II. PEAR DISEASES

Fireblight

ECONOMIC IMPORTANCE

Periodically fireblight, *(Erwinia amylovora),* a bacterial disease, causes severe damage to pears and apples in Michigan. The damage or loss is manifested in several ways: blossom blight, twig blight, girdling of large branches or scaffolds (Fig. 17) and killing of trees, particularly young ones.

This disease is one of the major factors holding back expansion of the pear industry in the state.

VARIETAL SUSCEPTIBILITY

Bartlett, the leading variety in the state, is very susceptible. Beurre Bosc, Gorham, and Clapp Favorite are also very susceptible. Less susceptible varieties are Seckel, Kieffer, and Anjou.

SYMPTOMS

Blossom Blight is usually the first to appear on the tree. Blossoms become water-soaked, then shrivel rapidly and turn dark in color. The bacteria can spread to the neighboring flowers in the cluster. These blossoms may fall or remain hanging in the tree.

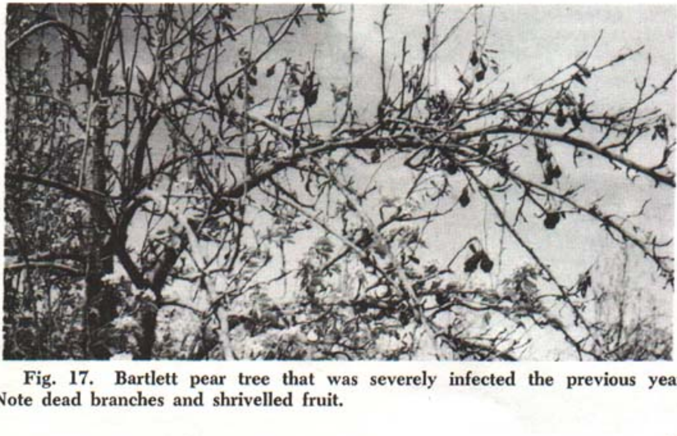

Fig. 17. Bartlett pear tree that was severely infected the previous year. Note dead branches and shrivelled fruit.

Leaf blight may result from the bacteria spreading from the blossoms to leaves on the fruiting spur. The leaf becomes dark colored, starting from the midrib and spreading to the large lateral veins. These leaves do not drop but remain hanging in the tree (Fig. 18). They often serve as an indicator for winter pruning of cankers.

Twig blight usually appears after blossom blight. It can result from a canker girdling the twig at the base of an infected fruit spur. Commonly, twig infection is the result of bacterial ooze dripping or being splashed by rain from an active, overwintering canker or from a current year's blighted twig. The blighted twig has a characteristic hook. The leaves and stem first turn brown then black (Fig. 19). Milky to brown exudate is often observed on these twigs.

Very often the bacteria work down the twig to a main scaffold to produce a canker at the junction.

Fruit blight is common on pears and apples. The fruit becomes water-soaked. Later, under humid conditions, ooze will appear on the surface. Still later, the fruit first turns brown, shrivels, mummifies, and then turns black in color (Fig. 20).

Fig. 18. Leaves and young fruit killed by fire blight bacteria early in the season.

Fig. 19. A blighted apple twig showing the characteristic hook.

Fig. 20. Bartlett fruit on the left infected with fire blight showing shrivelling and darkening as compared to healthy fruit on the right. Notice the white areas on infected fruit; they are bacterial ooze.

Fig. 21. Pear twig showing the outline of an overwintering canker.

Cankers develop at the base of blighted suckers, twigs, or flower spurs. The first symptom on smooth bark is a water-soaked appearance. Later the bark becomes darker, sunken, and dry. Dormant or inactive cankers form a crack at the edge of the canker (Fig. 21).

Late season infections particularly on apple may have an indefinite canker, and the only symptom is the dark water-soaked area and the reddish brown discoloration of the wood when the bark is cut away.

Cankers that completely girdle the twig or limb bring about death of the portion distal to it.

LIFE CYCLE

The bacteria overwinter at the margins of cankers; they survive more often in larger branches than in smaller ones.

In the spring as growth starts, bacteria ooze at the edge of the cankers. They spread to blossoms and twigs by rain and insects. They also spread from flower to flower and tree to tree by bees and other pollinating insects. Sucking insects (aphids, leaf hoppers, etc.) disseminate the bacteria by feeding on diseased twigs and then on healthy twigs (See Fig. 22) with bacteria-contaminated mouth parts.

In many years, ooze splashed by rain to young succulent twigs will result in infection in late spring and early summer. This means of spreading can be repeated several times under ideal conditions during the growing season until most of the young twigs are infected. The bacteria will travel down under the bark great distances under warm humid conditions. Late in the growing season, a crack will form at the point where the spread of bacteria appears to have stopped. Late infections often produce cankers that are difficult to distinguish because of the absence of the crack at the margin of the canker.

CONTROL

Several measures are needed for a successful fireblight control program. These practices are as follows: blossom and insect sprays, dormant eradication of cankers, summer cutting, chemical paints for summer treatment, cultural practices to produce moderate growth without excessive succulent growth.

Blossom and insect sprays—see Spraying Calendar 154 for details.

DORMANT ERADICATION OF CANKERS

Winter is the best time to remove blighted twigs and branches. At this time, the bacteria are limited to the edge of the canker. Cut back 4 or more inches from the canker or back to the next lateral wherever possible.

To treat cankers in the main trunk, use a blacksmith's hoofing knife. Remove all the dead and discolored bark down to the wood and about 1 inch of the healthy bark at the sides and 3 inches at the ends (see Fig. 22). The edge of the healthy bark should be cut clean and brought to a point at both ends to promote rapid healing. Paint this treated area with a disinfectant.

Disinfectant—Dissolve 8 half-gram tablets of cyanide of mercury and 8 half-gram tablets of bichloride of mercury in 1 pint of warm water. To this add 3 pints of commercial glycerine. Mark poison on outside of glass container and store in safe place when not in use.

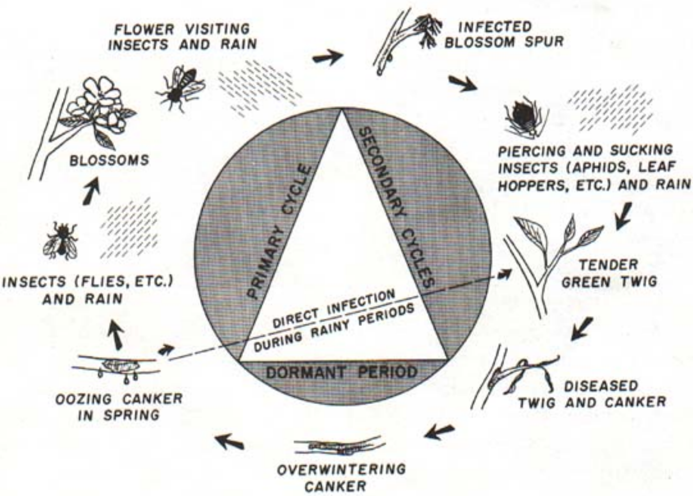

Fig. 22. Life cycle of the fire blight organism.

SUMMER CUTTING AND BREAKING OUT

When practicing summer cutting out, keep in mind that the bacteria are in a very active state. Therefore take care to keep at least 12 to 14 inches back of the last symptoms of the disease before cutting. Disinfect tools after each cut to avoid possible mechanical inoculation by contaminated tools.

Breaking out of twigs during late spring and early summer can reduce the inoculum and prevent the production of large cankers at the junction of a twig and a large limb. Again the practice of keeping back a foot or more of the last symptoms is recommended. This practice may be repeated several times in the growing season, depending on the severity of the disease.

Formula for disinfectant:

1 quart distilled or rain water

3 quarts commercial glycerin

¼ ounce cyanide of mercury (16 tablets)

¼ ounce bichloride of mercury (16 tablets)

When not in use, store in a safe place.

CHEMICAL PAINTS FOR CANKERS

Chemical paints have been used with some success. The chemicals penetrate the cankers and surrounding healthy tissue to stop the progress of the bacteria. Labor is reduced in cutting out cankers and the chance of spreading the bacteria by tools is eliminated.

Apply the paint soon after bloom. Paint only the infected parts and the neighboring areas.

When a blighted twig or branch enters a large limb or trunk, paint the suspected area at and around the point of entry. Then cut off the twig because, under humid conditions, it can serve as a source of inoculum. To determine the effectiveness of this treatment, mark the limits of the treated area with a light colored paint for future examination.

Do not apply chemical paint to leaves, fruit, or in wounds. The following are the ingredients and directions for making a chemical canker paint.

Zinc-chloride canker paint (43 percent strength, according to the formula of L. H. Day of California).

Solvent	Denatured ethyl alcohol	1.0 quart
	Water (soft or distilled)	¼ pint
	Hydrochloric acid (commercial)	¾ ounce
Zinc chloride		1½ pounds

Mix the liquid ingredients together. Dissolve the zinc chloride in the solvent. In dissolving, the solution becomes very hot. Stir the hot solution well with a wooden paddle and break up all lumps until all the zinc chloride is dissolved. Allow the solution to cool as rapidly as possible, covering to prevent evaporation. A few drops of bluing or dye will give it color. In well-corked bottles it will keep a long time. Store in a safe place.

Cultural practices—(that favor moderate growth and aid in fireblight control.) Some of these practices are: sod culture, balanced fertilization, and limited pruning.

Surveys in New York state indicate that there is less fireblight on well drained soils as compared to heavy drained soils.

Pear Scab *(Venturia pyrina)*

The fungus that causes pear scab is closely related to the apple scab fungus. Its symptoms and life cycle are similar to that of apple scab (Fig. 23). As in the case of apples, the susceptibility varies with variety. The more susceptible varieties are Flemish, Beauty, Sackel, Argon, Bosc, and Duchess. Bartlett is less susceptible and Keiffer is the least susceptible of the commercial varieties.

A well executed spray program will readily control this disease.

Fig. 23. Bartlett pear showing typical pear scab symptoms.

Stony Pit *(virus)*

Stony pit has been found on the Bosc variety in several orchards in Michigan. Western states have reported it on Bosc, Argon, Becure Clarigean, and William Duchess.

The main symptom is found on the fruit, which are deformed, pitted, and gnarled. The pitted areas contain "grit" (sclerenchyma) cells. Very often a slice through the deformed area shows up as a ring (see Fig. 24).

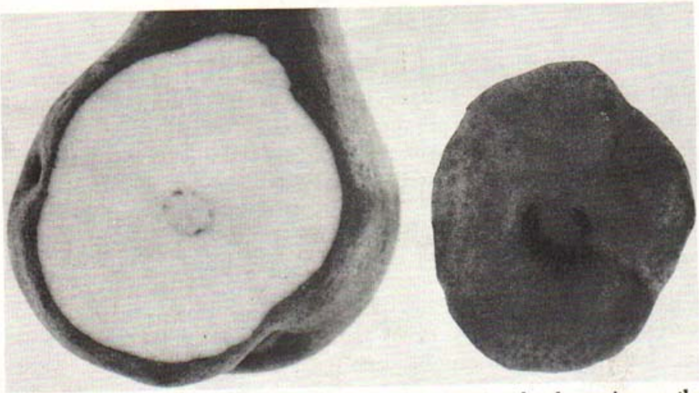

Fig. 24. Bosc fruit with stony pit symptoms. Notice the depression on the fruit section on the right and the ring of gritty cells in the flesh on the left.

Control

Report any trees with stony pit symptoms to the county agent. Confirmation of the disease will result in suggested removal of the tree. Nurserymen should select budwood from trees free of the virus.

III. PLUM AND PRUNE DISEASES

Black Knot of Plum and Cherry

Black knot is caused by a fungus, *Dibotryon morbosum.* It attacks American, European, and Japanese varieties of cultivated plums and prunes. To a lesser extent, it strikes sweet and sour cherries. It is found throughout Michigan, especially in home orchards and in wild plum and cherry thickets. In commercial orchards, black knot is easily controlled by pruning and spraying.

Black knot strikes woody parts of the tree. It is found on twigs, limbs, and sometimes, on trunks. By gradual girdling, the fungus can kill a twig or limb beyond the knot, thus reducing the yield.

SYMPTOMS

The common name, "Black Knot," describes this disease. Its first symptoms are small, light brown swellings on the twig or branch in the first fall or spring after infection (Fig. 25). In the second year, these swellings enlarge. An olive-green, velvety growth soon covers the surface. This green soon disappears and the knots become darker.

By the second fall, the knots are coal-black and hard (Fig. 26). These knots vary in size, location, and shape. Very often, the knots blend to form larger ones.

LIFE CYCLE

This fungus spreads by spores, which germinate and infect current year's twigs directly or through wounds. Infection takes place in a short time, usually between bud break and shuck split.

After infection, a light brown swelling develops late that same year or the following spring. The next year, the swelling produces spores on its olive-green surface. During April, May, and early June, winds and rain spread the spores to twigs on the same tree or to trees nearby. The spores germinate and infect young twigs.

By the second winter, these knots are coal-black. Fruiting structures exist under the surface of the knots. These structures contain many sacs which hold spores. The spores are ripe when the trees

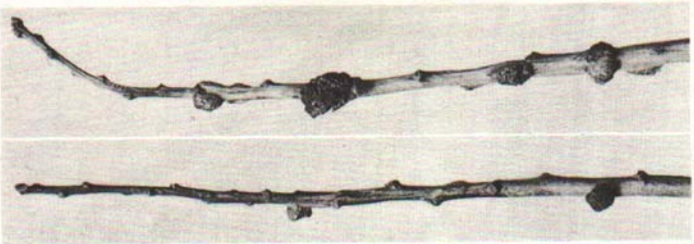

Fig. 25. These plum twigs show typical small, light brown swellings formed by the first fall.

resume growth in the spring. During rainy weather, the spores discharge into the air and are carried by air currents to new growth. This discharge of spores can occur in April, May, and early June.

Spores come from two sources: (1) young knots covered with olive-green, velvety growth; (2) older, coal-black knots.

The knots will extend their growth year after year. Eventually, they will girdle the branch and kill it above the knot.

CONTROL

Pruning—Since each infection is localized, you can control this disease by cutting off twigs and branches several inches below the last visible signs of the knot. Do this during the dormant period.

On large main branches and trunks, cut the knots out with a knife or chisel. Include 1 inch of healthy bark around the knot in these

Fig. 26. By the second fall, the fungus knots are coal-black and hard.

Fig. 27. It is better to destroy a badly infected tree than to try to control the black knot.

cuts. Cover the wound with a grafting compound. Check your trees in April for knots missed during pruning.

Destroy any nearby wild plum and cherry trees that are harboring this disease.

Burn all cuttings of infected parts before April 1. Spores may develop and spread from the knots even after you have removed them from the tree.

If a tree is covered with knots, it is better to destroy it rather than to attempt treatment (Fig. 27).

Spraying—If you have trouble controlling black knot by pruning alone, also use the suggested spray program in M.S.U. Extension Bulletin 154.

Plum and Prune Leaf Spot *(Coccomyces prunophorae)*

This fungus disease is closely related to the fungus that causes cherry leaf spot. However, a number of prune orchards in 1957 and 1958 have had severe infections of leaf spot.

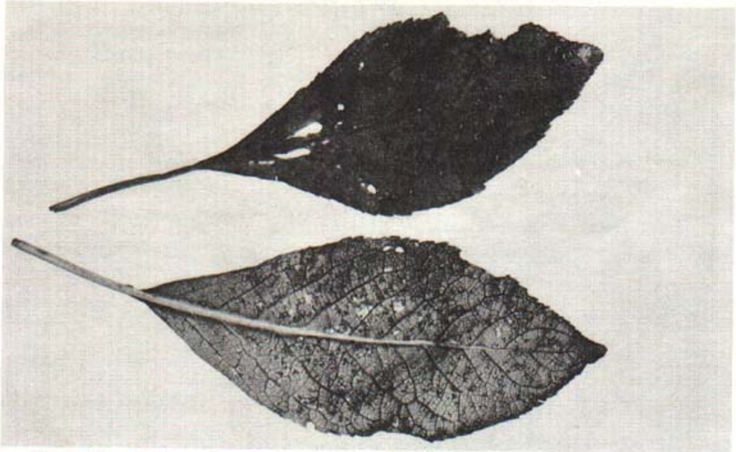

Fig. 28. Both surfaces of a prune leaf showing the leaf spot symptom. Notice the dead spots on the lower leaf.

The life cycle and symptoms (Fig. 28) are very similar to that of cherry leaf spot, see page 51.

CONTROL

A thorough, well timed spray program as suggested in Extension Bulletin 154 will control this disease.

Prune Dwarf *(virus)*

This virus disease is of minor importance in prune orchards of Michigan. It is recognized by small, narrow, strap-like and thickened leaves on twigs of infected trees. Depending on the severity of the disease, a few to most of the leaves will show symptoms. Small trees can show leaf symptoms throughout the tree.

CONTROL

The use of virus-free budwood in nursery propagation is suggested for its control.

IV. PEACH DISEASES

Brown Rot of Stone Fruits

Brown rot is the most serious fungus disease of peach, plum, and sweet cherry in Michigan. It harms fruit in several ways: (**a**) reduces fruit set by blossom blight; (**b**) kills or blights twigs; (c) destroys part or all of a crop by attacking developing fruits (especially fruit injured by insects or hail); and (**d**) rots fruits on trees, in transit, or in the market.

CONDITIONS FAVORING BROWN ROT FUNGUS

This fungus develops rapidly in warm (60 to 80° F.) weather. Infection takes place under wet conditions in 18 hours at 50° F. and in only 5 hours at 77° F. The crop is damaged most when these conditions prevail during bloom, and through the pre- and post-harvest periods.

SYMPTOMS

Blossom blight—The infected blossom turns brown, shrivels, and dries up. (See Fig. 29). The fungus may grow through the spur to the twig and form a canker.

Fig. 29. Brown rot. Note the shrivelled infected blossoms on the left twig.

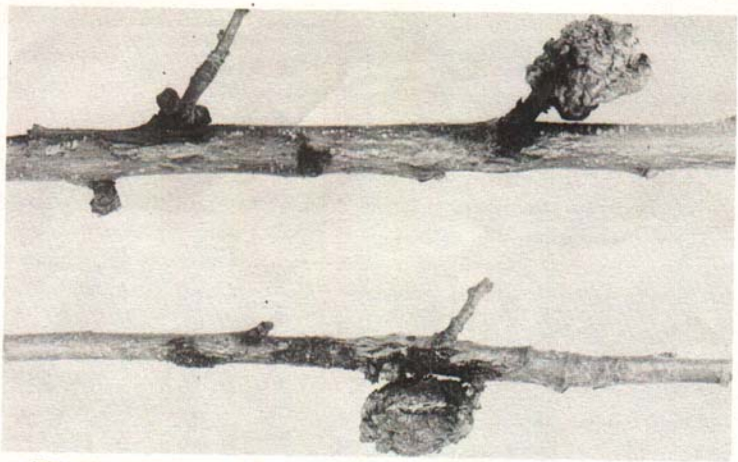

Fig. 30. **Brown rot cankers at the base of the fruit stems.**

Canker—At the base of the infected blossom spur or developing fruit, an oval sunken brown area shows up (Fig. 30). Later the bark at the edge of the canker cracks, gum oozes out, and a callus forms. In some cases, the canker will girdle a twig.

Twig blight—Twig blight is often a result of canker girdling at the base of an infected blossom or fruit. The leaves blight, bleach, and then turn brown and die (Fig. 31). Often the dead leaves remain on the twig.

Fig. 31. **Infection of a tender, young twig by brown rot fungus.**

Fig. 32. Rot of mature plum fruit and production of spores on the diseased fruit. Note the fruiting bodies on the diseased fruit.

Fig. 33. Development of brown rot on Montmorency fruit.

Fig. 34. Peach mummies left to hang on the tree during the dormant season.

Fruit rot—The first evidence of fruit rot is a small, light-brown spot. This spot enlarges rapidly under the right conditions and will cover the whole fruit in a day or so (Fig. 32). (Peach and cherry fruit turn brown, but on plum the disease is not so evident.) The infected areas then become covered with gray powdery masses (spores) (Fig. 33).

The fruit loses moisture, shrivels, and eventually becomes mummified (Fig. 34).

LIFE CYCLE

Brown rot fungus overwinters in Michigan in three ways: (1) Infected fruits that drop to the ground and are partly covered by the soil. (2) Mummified fruits that hang on the tree. (3) Cankers developed from last year's blossom infection (see Fig. 35).

Infected fruit that drops to the ground—In the spring, the partly-buried infected fruit produce small vase-like bodies. The bodies (measuring ⅛ to ½ inch across the top) ripen at blossom time, shooting up millions of spores into the air. The spores drift to the opened or unopened blossoms, infecting them if the weather is wet long enough. Soon the infected blossoms wilt and become covered with gray masses of summer spores or conidia. Often the fungus continues to grow through to the twig bearing the fruit spur to form a canker. Later, conidia produced on these cankers are washed onto the growing fruit during rainy periods. It takes only a few cankers during warm, wet periods to produce enough spores to cause severe rot at fruit maturity.

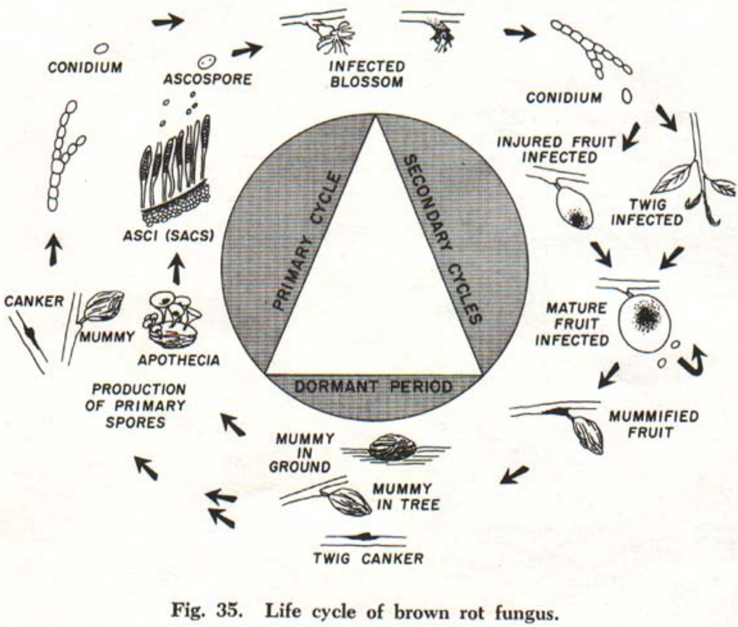

Fig. 35. Life cycle of brown rot fungus.

Mummified fruit in the trees—During rainy spells, these fruit become covered with summer spores (conidia) that may cause blossom blight or fruit rot later.

Twig cankers—Summer spores (conidia) are produced on twig cankers in the spring during wet periods. These spores spread brown rot during bloom and later.

Spores produced on currently rotted fruit on the tree will infect other maturing fruit. The fruit rots during marketing as well as on the tree.

CONTROLLING BROWN ROT

SANITATION

Work in some states shows that brown rot is easier to control if you pick up and destroy all infected fruit in the orchard for a number of years, besides using the regular spray schedule. This program is generally practical *only* in small isolated orchards. However, removing mummies from the trees is possible in commercial orchards.

SPRAY APPLICATION

Blossom sprays—The best insurance for successful fruit production during ripening is complete control of *blossom blight*. Use two to four sprays of the recommended materials at two- to four-day intervals, depending on weather conditions. If rainy conditions prevail, spray more often until all the blossoms open and get protection.

Before-harvest sprays—Fruit must be completely covered with the recommended fungicides as they approach maturity.

CULTURAL PRACTICES

Wider spacing and "opening" of trees to be sure of complete spray coverage and fast drying are a must in brown rot control. Where clean cultivation is practiced, disking prior to bloom will lessen chance of spore production in the diseased fruit on the ground.

INSECT CONTROL

Controlling insects is important to brown rot control. Insect wounds make it easy for the brown rot fungus to get into fruit. See M.S.U. Extension Bulletin 154 for specific controls.

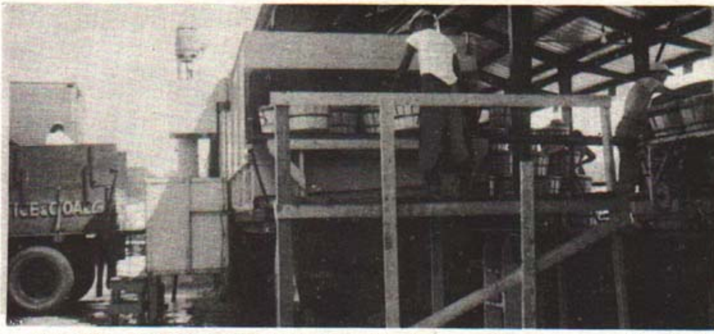

Fig. 36. Hydrocooling of peaches for brown rot control at the Benton Harbor Fruit Market.

POST HARVEST FRUIT COOLING

Reduction of fruit temperature immediately after harvest by hydrocooling and retention of low temperature in refrigerated conveyors has reduced brown rot in transit (Fig. 36).

Peach Leaf Curl

Peach leaf curl causes serious damage on unsprayed trees in about 3 out of 5 years under Michigan conditions. On infected trees the peach leaf curl fungus destroys the early leaves. The ensuing growth of new leaves lowers established food reserves, weakens the tree, and reduces the crop. These trees are more likely to be hit by winter injury. Repeated attacks can result in death of the trees. Severe leaf-curl years *cannot* be predicted.*

CONDITIONS FAVORING LEAF CURL FUNGUS

Only young, tender tissue can be infected. Cold, slow growing conditions that hold back leaf development plus a few wet periods are necessary for leaf infection. These conditions are common in the Great Lakes region.

SYMPTOMS

Leaves—Infected leaves become curled, puckered, and swollen. The color of the thickened parts varies from light green to red. Early

*Original publication, Extension Folder F-235, Cooperative Extension Service, Michigan State University, by Klos and Cation.

in the summer the swollen, infected leaves soon turn yellow, wither, and fall to the ground. (Fig. 37).

Shoots—Young shoots infected with this fungus are short, swollen, and pale yellow or green. Shoot infection is rather rare.

Fruit—Fruit infection is rare but can be recognized as slightly raised, roughened, red to scarlet areas without fuzz.

LIFE CYCLE

The disease fungus, *Traphina deformans*, is always present on the waxy coating of the peach twigs. It lives there harmlessly most of the year as single-celled yeastlike spores or plants. These cells multiply by division and spread by winds or air currents. In the spring, when the buds start to swell, the spores germinate and infect emerging leaves.

Infected leaves also produce spores which may increase the fungus, but these spores do not play an important role in increasing disease in the same season.

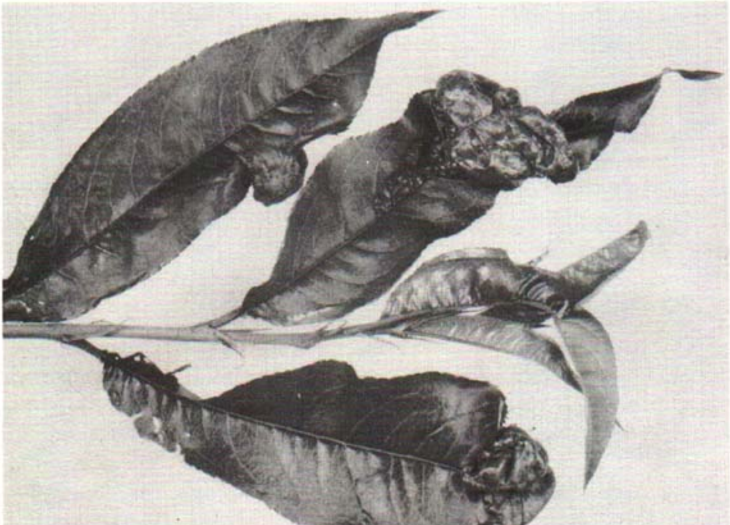

Fig. 37. Leaf symptoms of peach leaf curl. Notice the curling, thickening, and puckering of the leaves.

PEACH LEAF CURL CONTROL

This disease is effectively controlled with *one* spray, but this spray must be applied before infection occurs. If leaf curl appears, sprays are of no value for that season.

The following factors besides an effective fungicide are essential for control:

Thoroughness—The sprays kill the spores on all tree parts so that they are not present when growth starts in the spring. A good coverage of twigs, branches, and trunks is essential.

Timing—Failure may result if timing is late. To be certain of control, spray *before* buds swell in the spring. Fall spraying *after* leaf drop is also effective.

FERTILIZER

Effects of the disease may weaken peach trees. To strengthen the trees and to promote new growth, apply a nitrogen fertilizer to severely infected trees before June 15. The amount of fertilizer will depend on the tree size and vigor. Late fertilizer applications may prolong growth into late fall, making the tree susceptible to cold injury.

Bacterial Spot of Peaches

Generally, bacterial spot of peach is a yearly problem in only a few orchards in Michigan. However, in 1955 this disease organism, *Xanthomonas pruni,* became widespread particularly in the southwestern part of the state.

ECONOMIC IMPORTANCE

The bacteria not only attack the foliage but also the fruit, reducing quality and yield. Actually, early defoliation is the more serious effect because it promotes development of new growth late in the summer. This predisposes the tree to winter injury.

SYMPTOMS

One of the problems is to recognize the disease in its early stages. The characteristic early leaf symptoms are the angular dead spots. In the advanced stages the spots concentrate at the tip of the leaf,

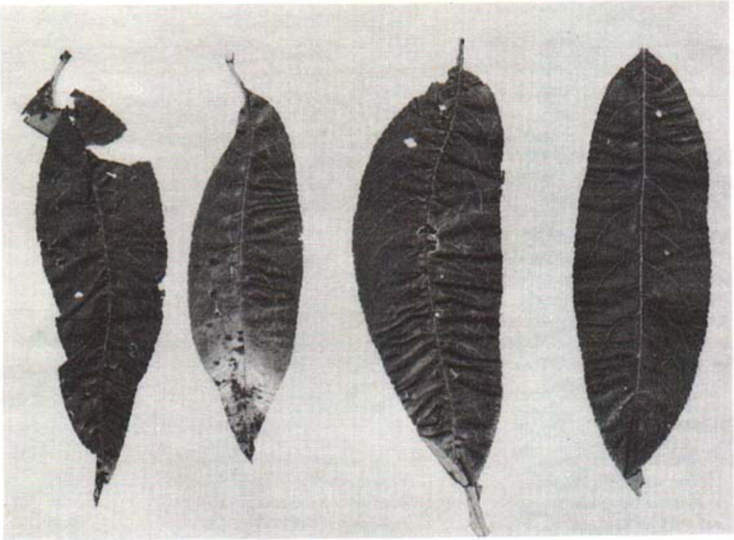

Fig. 38. The three leaves to the left show various stages of bacterial spot development. The leaf on the right is healthy. Note the angular spots and tip yellowing (light color) of the second leaf from the left.

because the rains and dews wash the bacteria toward the tip. Finally, the entire infected leaf turns yellow and falls to the ground (Fig. 38).

The early fruit symptom is a small brown sunken spot usually found on the exposed side (Fig. 39). Cracking or pitting occurs near the spot as a result of natural fruit enlargement. Coalescing of these areas results in a large lesion. Some varieties exude gum at the spot. Fruit symptoms are common when early season infections take place.

VARIETAL SUSCEPTIBILITY

Some of the major Michigan varieties that are most susceptible to the disease organisms are Hale, Hale Haven, Elberta, Kalhaven, and Sunhigh.

Environmental conditions favoring the organism—Moisture and temperature play an important role in the development of this disease. The ideal temperature during moist conditions is around 80° F.

Fig. 39. The exposed side of the three peach fruits on the left show typical bacterial spot symptoms. The fruit on the right side is healthy.

LIFE CYCLE

The bacteria overwinter in inconspicuous cankers and possibly terminal buds. These cankers were formed the previous fall from late twig infections on current year's growth before leaf drop took place. (See Fig. 40).

With the occurrence of warm spring rains, conditions become ideal for rapid multiplication of bacteria. The bacteria ooze from the enlarging cankers and are spread by wind and rain to expanding

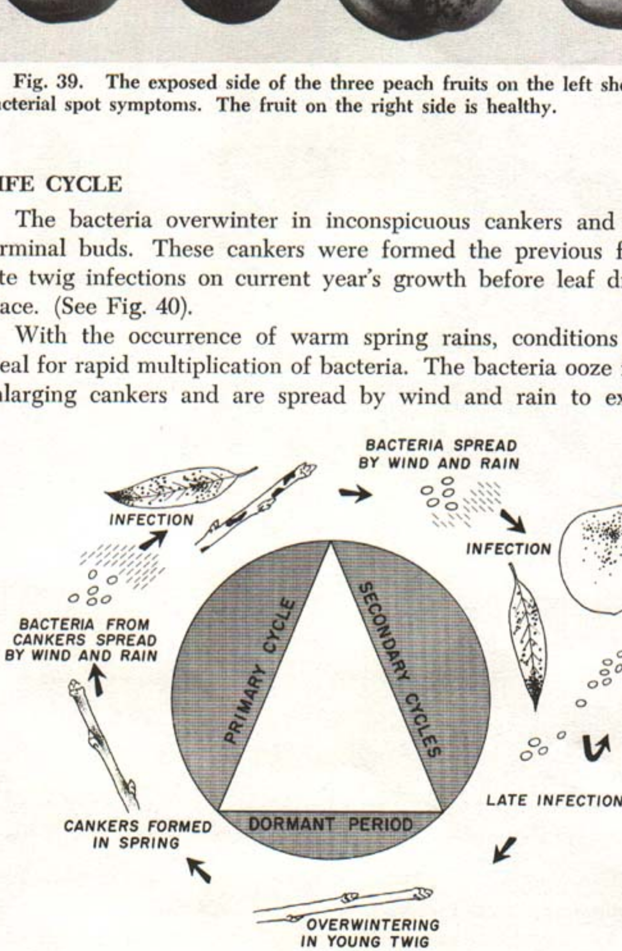

Fig. 40. Life cycle of the bacterial spot organism.

leaves and later to tender twigs, green fruit and other leaves. The bacteria gain entrance into the susceptible tissue by gaining entrance through the stomata or air pores. Usually, the symptoms first appear on the northwest and west sides of the tree.

There can be several cycles in a growing season under ideal environmental conditions, i.e., warm wet weather and driving rain.

In the fall, inconspicuous cankers are formed as a result of late infections.

CONTROL

In addition to spraying, consider the following factors:

- In orchard management use a program that encourages a good state of tree vigor. Trees in low vigor are more susceptible to this disease.
- Avoid planting varieties that are very susceptible to this disease.
- Peach breeding programs should screen new varieties for bacterial spot susceptibility.
- Selection of disease free propagation budwood by nurserymen and isolation of nursery stock from infected plantings or orchards.

Peach Scab *(Cladosporium carpophilum)*

In recent years peach scab has been of minor importance in most commercial orchards in Michigan.

ECONOMIC IMPORTANCE

This disease is common in home orchards where no specific fungicide is applied for the control of this disease. Once in a while commercial growers have a peach scab problem, which is often a result of poor timing of sprays or poor selection of fungicides.

Peach scab renders the fruit unsalable. Severely infected fruit split and afford an entrance for brown rot and other rotting organisms.

CONDITIONS FAVORING THE DISEASE

The ideal temperature for the growth of this fungus is around 70° F. However, spore germination can occur from 37° F. to 95° F.

Wet conditions during the spring after shuck split and early summer are necessary for severe infections.

SYMPTOMS

Fruit—The scab spots are distinct, small, circular, 1/16 to 1/8 inch in diameter and obvious. They appear when the fruit is half grown. The spots are usually on the stem end of the fruit. Severely infected fruit will often split at maturity. (See Fig. 41).

Twigs—Lesions are produced on current year's twigs. They are oval 1/8 to 1/4 inch in diameter and light to dark brown.

Leaves—Late in the season on the underside of a leaf, indefinite, pale-green or brown lesions are found on the midrib, blade, and petiole.

LIFE CYCLE

The fungus overwinters on twigs infected the previous year. Small, oval, brown lesions are formed. Spores (conidia) are produced on twig lesions during wet periods. The conidia are washed or wind blown to developing fruit, twigs, or leaves. The fungus, after ramifying under the cuticle, forms a mat of mycelial strands from which arise the stalks that bear the summer spores (conidia), which, in turn, infect fruit, leaves, and twigs.

The time between inoculation and appearance of secondary spores is very long on fruit, ranging from 40 to 70 days. The fruit may be half grown before the symptoms appear.

CONTROL

The control of fruit scab is relatively simple: a recommended fungicide applied 2 to 4 weeks after petal fall will control this disease.

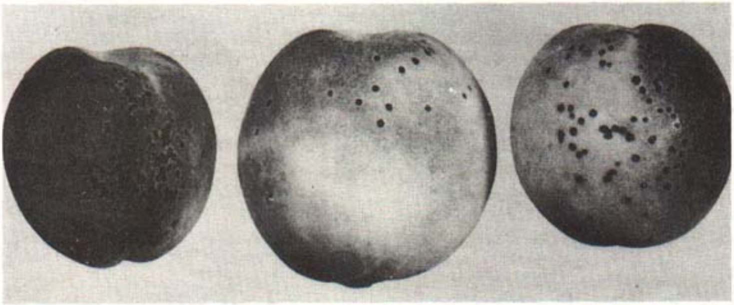

Fig. 41. Three peaches with black lesions formed separately or coalescing on the fruit surface.

Peach Canker *(Valsa leucostoma* and *Valsa vincta)*

These fungi attack woody parts of the tree—twigs, limbs and trunks. They enter the different parts of the tree through pruning wounds, dead twigs, brown rot cankers, and winter injured areas. Typical dark cankers are formed by these fungi on all woody parts of the tree.

These fungi are normally weak parasites; however when conditions are ideal, such as winter injury, they can cause severe damage to a tree.

CONTROL

Any practice that promotes early maturity of trees and rapid healing of wounds aids in controlling peach canker.

Cultural Practices—Fertilize and cultivate early in the growing season to promote tree growth early in the summer. Plant a cover crop by mid-July to harden off tree growth by fall. Train young trees to produce wide crotches.

Pruning—Delay pruning until March 1. This delay reduces the chances of infection to take place by having less time for the susceptible tissue to be exposed to infection as compared to late fall or early winter pruning. Wound healing is rapid at this time.

Leave no stubs when pruning and remove and burn all prunings immediately. Check the trees for dead and diseased wood after growth starts.

On trunks and large limbs where the canker does not go halfway around, trim out the dead tissue right after tree growth starts in the spring. With a knife and chisel, clean out the dead area and extend it to the live wood. Taper the wound at the top and bottom for rapid healing. Make sure the sides of the wound are smooth and straight.

Swab the wound with bichloride of mercury solution (1-1000, ½ gram tablet in pint of water). The wound should be coated with a grafting compound, or black gilsonite-asphalt paint or some other non-injurious wound dressing.

Insect Control—Control peach insects, especially peach tree borers, by spraying. Dead areas resulting from insect injury afford an entrance for the fungus.

Peach Yellows *(virus)*

The fruit matures several days to 3 weeks or more before the normal. Red areas are often found on the skin and extend as streaks toward the pit. The flesh around the pit is excessively red in color.

The leaves are chlorotic on infected trees, fold upward, and roll and droop downward. Wiry shoots sprout from main branches. They bear small narrow willow-like leaves that are pale yellow-green in color.

Little Peach *(virus)*

The symptoms are first noticed on a branch or portion of a tree. The fruit are reduced in size and delayed in maturity as compared to healthy fruit.

The foliage is darker green in color on affected branches. The branches are more upright than normal; the internodes are shortened giving bushy or compact appearance. The leaves on these shoots are leathery; they droop, bend inward, and curl toward the branch.

As the disease progresses, the leaves turn lighter green to yellow. The tree is weakened and the bushy appearance becomes less evident. The fruit become smaller and the flavor is insipid.

Rosette Mosaic of Peach *(virus)*

The first signs of this disease on mature trees is the reduced leaf size and crowding of leaves (rosette) on a few twigs on a tree. (Fig. 42). This rosette is due to the shortening of internodes on a branch. The foliage on affected parts may be darker than normal. In subsequent years the symptom will appear throughout most of the tree.

Control of Peach Virus Diseases

Immediate removal of infected trees marked by the Michigan Department of Agriculture peach virus inspectors is recommended. Nurserymen should use care to select only healthy budwood for propagation of peach trees. Insecticide sprays will reduce the population of known insect vectors of little peach and peach yellows.

Fig. 42. Peach twig from an infected tree that exhibits the rosette symptom of rosette mosaic.

V. CHERRY DISEASES

Cherry Leaf Spot

Cherry Leaf Spot is one of the most serious fungus diseases of both sweet and sour cherries. It is consistently our number one problem on Montmorency cherries in Michigan year after year.

ECONOMIC IMPORTANCE

Early defoliation causes dwarfed, unevenly ripened fruit. The most serious effect occurs in the season following extensive early defoliation. (Fig. 43). The results can be (**a**) winter injury—death of limbs or trees, (**b**) small weak fruit buds, (**c**) death of fruit spurs, (**d**) reduction of fruit set and size, (**e**) reduced shoot growth.

SYMPTOMS

The chief symptom of cherry leaf spot is found on the leaves. Symptoms can also be found on petioles, fruit, and fruit pedicels.

Small purple spots appear on the upper surface of the leaves about 10 days after infection. They may be pin point in size or up to ¼ inch in diameter. On the underside of the infected leaves during wet periods, whitish pink masses are found under the purple spots. (Fig. 44). These masses contain spores plus a gelatinous substance. The lesions usually dry, and a chlorotic (yellow) ring forms around

Fig. 43. Early defoliation as a result of severe leaf spot infection.

the edge. The center of the lesion may shrink and fall out causing a shot hole effect. This shot hole develops more on sour cherries than on sweet. The older leaves turn yellow and usually drop prematurely.

ENVIRONMENTAL CONDITIONS FAVORING THE DISEASE ORGANISM

Young leaves must have functioning stomata (air pores) before they are susceptible in the early spring. The fungus develop most rapidly under wet conditions when the temperature is from 60 to 70° F.

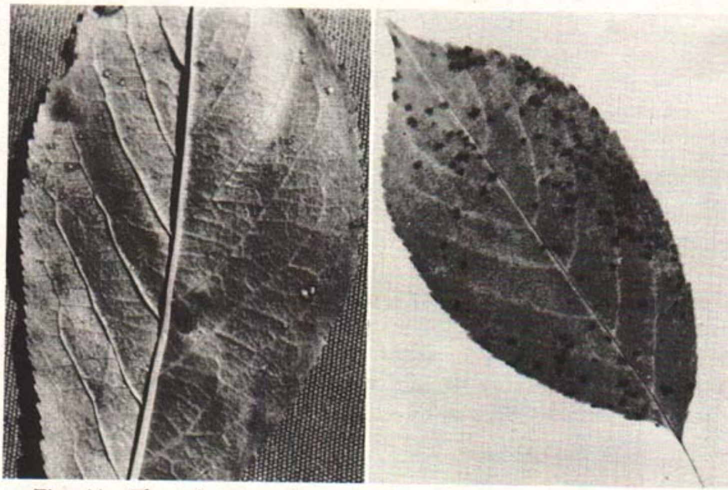

Fig. 44. The infected leaf on the right shows the purple spots on the upper surface. The white spots on the left leaf are fruiting structures (acervuli) that contain summer spores (conidia).

LIFE CYCLE (Fig. 45)

There are two cycles in the life cycle of this fungus.

Primary cycle—The fungus overwinters in the dead leaves on the ground. In the spring, fruiting structures called apothecia develop on these leaves in late April. Spores (ascospores) mature at various times depending on temperature and moisture.

Generally most of the spores are discharged from early bloom to 6 weeks after petal fall during wet periods.

The infection early in the primary cycle is limited because the susceptible developing leaves are small and most of the air pores (stomata) are too immature to be infected. Other factors are low temperatures and drying out of ascospores.

On germination, the fungus enters through the stomata (air-pores on the underside of the leaf), and the mycelium branches out inside the leaf and forms a fruiting structure (acervulus).

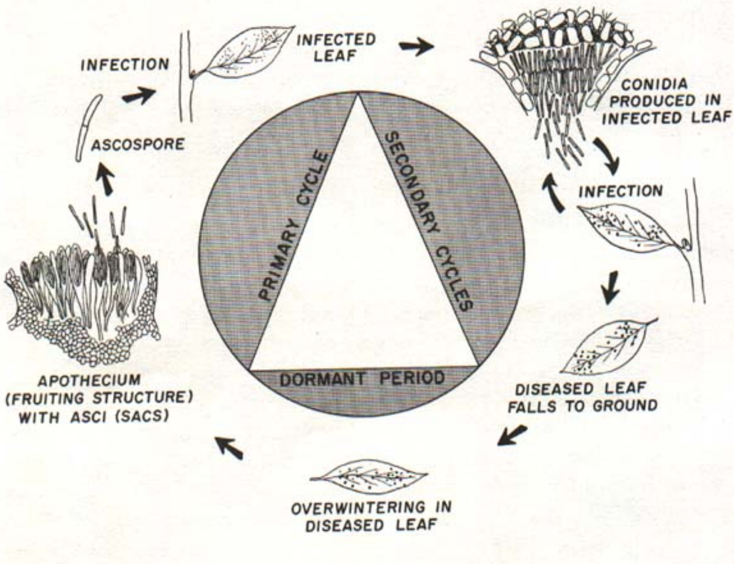

Fig. 45. Life cycle of cherry leaf spot fungus.

Secondary Cycle—Summer spores (conidia) are produced in the acervulus (fruiting structure) which give a pink to whitish-pink mass on the underside of the leaves. The conidia are borne in large numbers and are spread from leaf to leaf by water. The rapid spread of leaf spot fungus in the summer and fall is usually due to rapid increase and spread of the fungus by means of repeated generations of conidia throughout the summer.

CONTROL

Timing and thoroughness besides fungicides are very important in the control of cherry leaf spot.

Timing—Sprays are timed to prevent both primary infection and secondary infections in orchards. The first spray prevents primary infection and the 3 subsequent cover sprays at 10-day intervals prevent primary and secondary infections until harvest.

The post harvest spray checks any leaf spot that may have built up before or during harvest.

Thoroughness—Thoroughness is a must in leaf spot control. Cover all parts of the tree with spray particularly the top centres.

Poor coverage may be a result of one or more of the following: (1) close or thick plantings, (2) inadequate sprayer, (3) driving too fast. Correction of one or more of these factors will greatly reduce the incidence of cherry leaf spot fungus.

Armallaria Root Rot *(Armallaria mellea)*

This fungus has a wide range of suscepts including peach, plum, apple, cherry, and blueberry. In Michigan, the problem has been observed chiefly on Montmorency cherries.

Armallaria root rot is important only in a few red tart cherry orchards in Michigan. In these orchards this disease has become a problem on only a few trees.

On older trees this fungus can cause eventual death. Just below the soil line under the bark a white fungal mass can be observed at any time of the year. This symptom can be confused by other root rotting fungi. However, associated with the fungal matts are dark shoe-string like structures (rhizomorphs) which are characteristic with this disease. In early October, fruiting structures (mushrooms) will be observed at the base of partially or completely dead trees. (Figures 46 and 47).

Fig. 46. Sporophores (fruiting structures) at the soil line and white fungal mat beneath the bark are symptoms of Armallaria root rot.

Young cherry trees from 4 to 7 years of age attacked by this fungus suddenly dry up, and die at harvest time. Typical white fungal matts are observed below the bark of these trees at or below the soil line.

CONTROL

Control is difficult because the fungus can survive on roots in the soil for many years.

Several points must be considered in controlling this disease:

- Avoid planting susceptible plants on a nearly cleared land with an Armallaria history.
- Remove and burn all the roots when removing an infected tree.
- Do not use woodland soil around newly set trees.

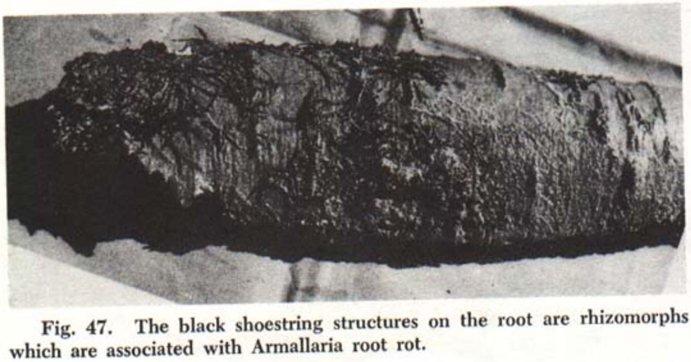

Fig. 47. The black shoestring structures on the root are rhizomorphs which are associated with Armallaria root rot.

In California, carbon disulfide is recommended for treating replant areas. Two ounces of carbon disulfide is applied at 8 to 10 inch depths at 18-inch intervals prior to replanting. Several other chemicals are under test in Michigan that show promise in controlling this disease.

Green Ring Mottle *(virus)*

During the last 3 years in Michigan, surveys in several bearing Montmorency orchards showed a rather high percentage of trees with green ring mottle.

SYMPTOMS

The symptoms of this virus disease show up on Montmorency trees 4 to 5 weeks after petal fall as green rings, spots, or arcs over a yellow background. The infected leaves drop over a period of 10 to 14 days after the symptoms become visible.

In a few rare cases, pitted fruit has been found on trees infected with green ring mottle. This pitting is caused by the killing of fruit cells just under the skin. This results in slight depressions (about 1/32 inch across) on the surface of the fruit (Fig. 48).

Any grower finding these fruit symptoms should contact his county agricultural agent to have the suspected trees diagnosed by a plant pathology specialist.

There is no control for *green ring mottle* on established trees. Buy disease-free trees for new plantings.

Sour Cherry Yellows *(virus)*

This is the most important virus disease of sour cherry in Michigan. In orchards 15 years or older, most of the trees have this disease. Trees that have had yellows for several years show a marked decrease in yield over healthy trees of the same age.

SYMPTOMS

The main symptom is the green and yellowing mottling of some of the foliage followed by leaf drop. (Fig. 49). Often leaves that are completely green are cast. Defoliation can occur 3 weeks after bloom and can continue in waves until harvest or even later. The first wave is usually the most severe.

Trees that have had yellows for a number of years have a characteristic "willowy" growth. This is due to the reduction of spur growth and production of fruit on lateral buds. The terminal bud is the only growing point. Fruit on yellows-infected trees are fewer but larger in size than on healthy trees.

In Michigan, when the temperature during the 3-week period after bloom is lower than normal, the grower can expect a heavy leaf drop due to yellows early in the growing season.

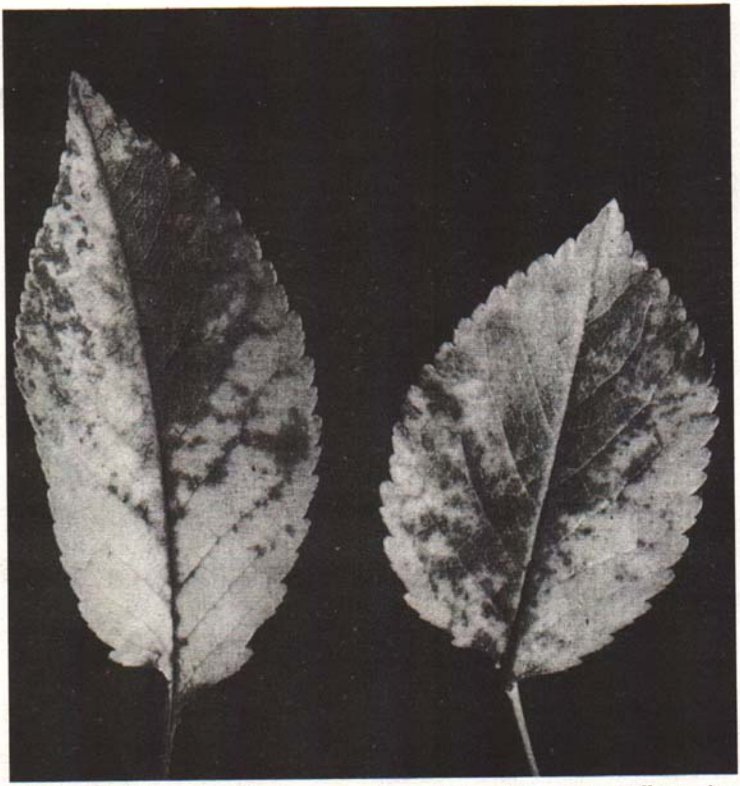

Fig. 48. These two Montmorency cherry leaves show typical yellows virus symptoms. The light area is yellow and the dark area green on the actual leaves. Note the absence of spots on the leaves as in the case of leaf spot infected leaves.

Fig. 49. The two leaves on the right show typical green ring mottle symptoms, the green (dark) rings or arcs. The fruit on the right show pitting or dimpling, a symptom found in a few cases on green ring mottle trees. Leaves and fruit on the left are healthy.

Yellows can be distinguished from leaf spot, the fungus disease, in that the leaves do not have the purple spots on the upper surface. Yellows is found on trees scattered throughout the orchard while leaf spot is evenly distributed in the orchard.

CONTROL

In a mature orchard it is *not* advisable to remove yellows-infected trees. Keep the orchard until it is no longer profitable.

Growers should purchase trees propagated from yellows-free budwood. If possible, plant these trees at some distance from older trees. In young plantings, rogue out trees showing yellows if the number is comparatively small. If allowed to grow, these trees will be small, and yields will be smaller as compared to healthy trees.

Necrotic Ring Spot *(virus)*

Ring spot virus is common in stone fruits. Ring spot on Montmorency cherry is discussed here.

SYMPTOMS

The first symptom in the spring is delayed foliation on part of the entire tree. (Fig. 50). Leaves on infected branches are reduced in size. Even before they unfold they show light green spots and dark rings. (Fig. 51). The rings will vary in size from less than 1/16 to 1/4 inch. In some cases partial or concentric rings are observed on the foliage. Rings may persist in some cases throughout the season but more commonly the tissue around the ring dies and drops out to give a tattered effect. Leaves formed later generally do not show symptoms.

Infected trees will not show symptoms following a "shock" year. However, if only part of the tree shows symptoms one year, the rest of the tree will show ring spot symptoms (shock) the following year. The yield is usually reduced the first and sometimes the second year but then the tree "recovers" to produce a normal crop. These trees are symptomless carriers of the virus for the rest of their existence.

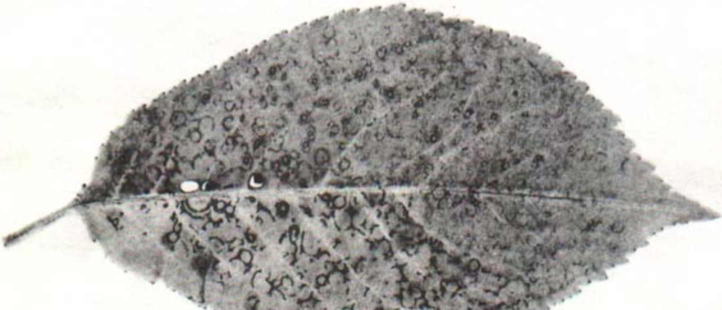

Fig. 50. A Montmorency leaf that exhibits typical rings or etch and necrosis of ring spot.

One strain of ring spot called recurrent ring spot produces ring on leaves year after year. Its effects are not severe.

Under severe cases of "shock", blossom symptoms are expressed by shortening of the pedicel, twisting, and distortion of the flower. Very few of these blossoms set fruit.

In Michigan with the virus-free budwood problem, we can expect ring spot "shock" to increase in young orchards. Before the certification program, many of the nursery trees were propagated with ring spot buds and therefore did not exhibit ring spot symptoms.

CONTROL

A virus-free budwood program has been set up by the Department of Botany and Plant Pathology at Michigan State University in cooperation with the Michigan Department of Agriculture for Michigan nurserymen.

The rootstocks that can carry yellows and ring spot are not entirely virus-free. At the present time a program to rectify this situation is under way.

Tatter Leaf (Ring Spot) of Sweet Cherry

Although a number of scientists have shown that tatter leaf and ring spot of sour cherry are one and the same virus or closely related, these diseases will be treated separately in this bulletin.

Early in the growing season young expanding leaves show fine dark lines that are limited in interveinal areas. Later these areas become necrotic and drop out to give a tattered effect. Other symptoms are mottled patterns which form lines, spots or rings on the leaves. The symptoms do not appear on leaves formed later in the season.

The tatter effect and mottling can reappear on the same tree for a number of years.

CONTROL

Virus-free budwood and stock is recommended for propagation of sweet cherries.

Fig. 51. Montmorency tree with severe "shock," a symptom of ring spot virus. Notice the killing of twigs.

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