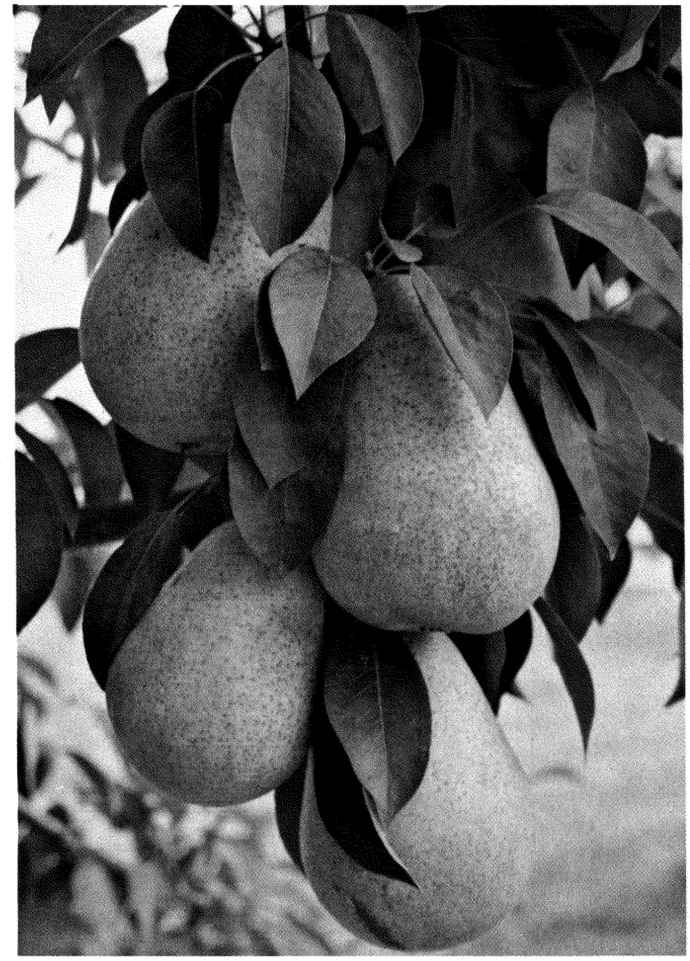
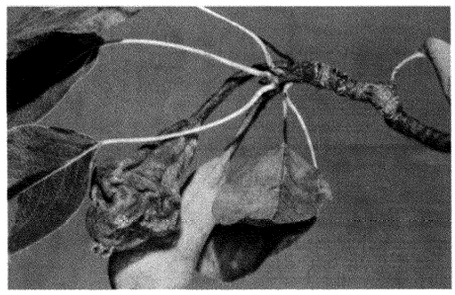
# Fire Blight of Apple and Pear and Its Control in Virginia





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and State University

Figure 1. Fire blight discoloration of leaf midrib.

Figure 2. Fire blight bacterial ooze adjacent to blossom cluster.

Figure 3. Fire blight (blossom blight stage).

Figure 4. Fire blight on young apple showing ooze.

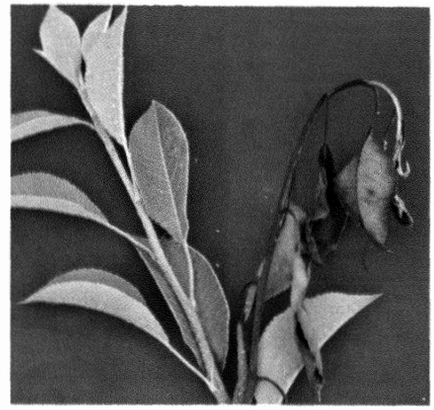

Figure 5. Blighted twig showing typical shepherd's crook (right).

Figure 6. Fire blight infection showing bacterial ooze.

Figure 7. Fire blight on sprouts at base of tree.

Figure 8. Fire blight canker.

Figure 9. Tree girdled by fire blight canker.

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# Fire Blight of Apple and Pear and Its Control

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## Introduction

### Apples

The history of the apple and its culture goes back to the dim mist of the past, beyond recorded history. It is a native of Southeastern Europe and Southwestern Asia. Some writers suggest that it originated in the region immediately south of the Caucasus. Apple seeds have been found in the remains of the Swiss Lake Dwellers of the Bronze Age. Apples were undoubtedly used for food by these early inhabitants. The Romans spread apples throughout much of Europe.

The apple occupies first place among fruits of the temperate regions in importance and extent of cultivation. Thus, through the centuries wherever civilization has flourished, the apple has been a staple food.

Since pre-historic times, improvements in the apple have been made through selection. Varieties were recognized in Europe more than 2,000 years ago and hundreds were recognized prior to the settlement of this country. The earliest settlers in the new world brought with them both seed and propagating wood of the better European varieties.

Europe produces ½ to ⅗ of the world apple crop. In the Southern Hemisphere, Australia, New Zealand, Argentina, and Chile all produce apples. The majority of these apples are harvested in March and reach northern markets when local supplies are largely exhausted.

The United States produces about one-sixth of the world apple crop or on the average about 140,000,000 bu. annually. Commercial apple orchards, found in almost every state, are most important in the Pacific northwest, in the areas south and east of the Great Lakes, and in the foothills of the Appalachians. The leading apple producing states are Washington, New York, Michigan, Pennsylvania, Virginia, and California, respectively.

Fire blight is present in all the apple-producing areas in the United States. It has been found in some areas of Canada, Japan, New Zealand, Mexico, England, Egypt, Poland, the Netherlands, Chile, and Guatemala. It is of economic importance only, however, in the United States. During some years it is so destructive that many of the scaffold limbs may be destroyed or severely weakened.

### Pear

The pear is one of the most important temperate zone fruits of the world. It is exceeded in world wide importance only by the apple. Its total production surpasses such fruits as peach, plum, and cherry. Currently, Europe leads all other countries in production. In the United States, ⅘ of the pear industry is located in the semi-arid regions of California, Oregon, and Washington, and water is supplied by irrigation. Although pears are grown as home orchard trees in most of the states in the union, commercial production has been limited by the destructive bacterial disease, fire blight. This disease is minimal in the semi-arid Pacific Northwest and sheltered areas of Michigan and New York.

Virginia was blessed with a short-lived pear industry that reached the boom stage in 1880, but it was suddenly snuffed out by the ravages of fire blight. Thus, what promised to be a great pear industry died in its infancy.

It has been almost a century since the discovery that fire blight was caused by a bacterium. During the intervening decades, many disease control measures have been suggested as well as recommended. Only in recent years, however, has progress been made with the discovery and use of the antibiotic, streptomycin. Although, at first, the results with streptomycin were somewhat sporadic and variable, with further research and a better understanding of the nature of fire blight, control measures with this compound during the last decade have been successful and economically feasible when it is applied properly.

# The Fire Blight Disease

Fire blight, caused by the bacterium *Erwinia amylovora*, is one of the most destructive diseases of apple and pear in the United States. It is not only the loss of current blossoms or fruit but the future potential loss through the destruction of the scaffold limbs that makes it the most feared of all apple and pear diseases. Although the fire blight bacterium attacks over 75 species in the rose family (*Rosaceae*), it is of major importance only on apple and pear. It is found almost every year to some extent in the major apple and pear growing regions of the United States.

Fire blight is thought to be of American origin, since it was noticed as early as 1780 in New York's Hudson Valley fruit region and was not reported from any foreign country until a century later. It was of little importance until the introduction of susceptible European apple and pear varieties in the latter half of the 18th century. By 1900, the disease was noted in California. It it now present in all fruit-growing areas of the United States. Because of the ravages of this disease, the commercial pear industry of the entire North American continent, with the exception of certain isolated sections, has been abandoned for the growing of high quality pears.

## Symptoms

The fire blight bacterium may attack any part of the tree from the roots to the leaves. The disease usually appears in the spring as blossom, leaf, and twig blight. Infected blossoms suddenly wilt and soon turn light to dark brown. As the disease progresses down the pedicel, the tissue becomes water-soaked and dark green. Droplets of pearly or amber-colored exudate often appear on the surface of the infected tissue. These droplets contain millions of bacteria which can cause new infections. If the infection moves beyond the pedicel it invades the fruit spur and out into the leaves where it follows the midrib and main veins. The leaves wilt and the entire spur growth turns brown on apple or dark brown to black on pear and dies. The blighted leaves remain attached throughout the growing season.

Twig blight begins with an infection of the young terminal shoots. The invading bacteria progress more rapidly down the shoots or twigs than in the fruit spur. Infected shoot tissue becomes watery, dark green, and has an oily appearance. Droplets of bacterial ooze or exudate may appear on the surface of the blighted twigs (Figure 10, also see Figures 2, 4, and 6 inside front cover). The leaves on the blighted terminals, as in spur blight, turn brown on apple or dark brown to black on pear and remain attached throughout the growing season, and in many cases they remain attached after the healthy leaves have fallen in the fall. A characteristic symptom of twig-blight is the bending of the blighted terminal which resembles a shepherd's crook (Figure 11, also see Figure 5 inside front cover).

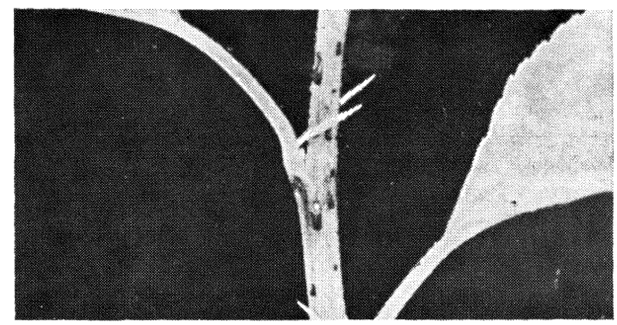

Figure 10. Droplets of bacterial ooze or exudate on the surface of the blighted twig.

The fire blight bacteria may move down the twig and into branches and limbs, where the infection becomes established (Figure 14 and also 8 inside front cover). These infected branches and limbs may become entirely girdled with the infection spreading upward and downward (Figure 9 inside front cover). Thus, the entire scaffold system of the tree may be destroyed or the conformation of the tree ruined (See Figures 20, 22, and 25 back cover). This latter characteristic of fire blight makes it the most dreaded and destructive disease of apple and pear trees. Movement of the fire blight bacteria is finally restricted by slowing down of growth of the invaded tree or maturity of the invaded tissue. A severely infected apple or pear tree may have so many terminals blighted that it has the appearance of being scorched or burned by fire. Thus, the name fire blight was coined for the disease (See front cover lower right side).

Fruit blight may occur on apple and pear fruit. The fruit becomes water-soaked with numerous exuding droplets of ooze (Figure 12). The diseased fruit is firm and later leathery. Still later the fruit shrivels, turns brown on apple or black on pear and usually remains attached to the spur (See Figure 24 back cover).

The causal bacteria overwinter in living host

tissue at the margins of cankers on the larger twigs, branches, and trunk. In the spring, highly infectious, milky-white to cream colored droplets of ooze containing tremendous numbers of bacteria are produced at the margin of active cankers (See Figures 2 and 6 inside front cover). The bacterial ooze usually appears first when the trees are in the late-pink to early-bloom stage of development. Wind-blown rain, and insects help spread the causal bacteria from the oozing cankers to the developing blossoms and young leaves. In addition to spread from the oozing cankers, the bacteria also are spread by bacterial aerial strands or threads which seem to be another form of ooze. The small bacterial aerial strands extrude through natural openings of the epidermis of infected twigs and when the matrix substance or ooze reaches the air it solidifies to form the strand (Figure 13). The strands may become several centimetrs in length, and they may be curled into different shapes. The strands are easily detached or broken into fragments by wind and carried to new areas to cause infections.

The bacteria gain entrance through natural openings (stomata, water pores, etc.) and micro- or macroscopic injuries to start new infections. Generally, with optimum temperature 70° F, the incubation period on young, succulent tissue is from 4 to 5 days. Bacterial ooze appears on the new infections shortly after the first symptoms to provide a source of inoculum for secondary infection. Thus, it is essential that control practices be initiated before infection starts.

# Control

Fire blight of apple and pear, like most bacterial diseases, is difficult to control. The peculiarity or uncertainty of the fire blight disease development in a given location or in a given year makes it difficult and expensive for growers to follow well planned control measures. For example, an orchard may be free of blight one year and heavily infected the following year. Further, a destructive fire blight infection resulting in severe economic loss may occur in a locality one year and not reappear, except in a mild form with little economic loss, for 5 to 10 years. Whether the explanation for such behavior lies in difference in virulence of different strains of the bacterium or factors in the environment has not been determined. It cannot be predicted with any degree of accuracy when or where fire blight will occur or to what extent it will develop, if it occurs. Generally, the disease is present somewhere in the fruit-growing environment every year, and even with good precautions, it continues to cause damage. Even though fire blight is peculiar and unpredictable, it can be controlled or its destructive ness greatly reduced with orchard management, sanitation, resistant varieties, and the use of chemical pesticides.

Figure 11. Fire blight on apple twig. Typical blighted twig on right showing characteristic shepherd's crook. Healthy shoot on left is for comparison.

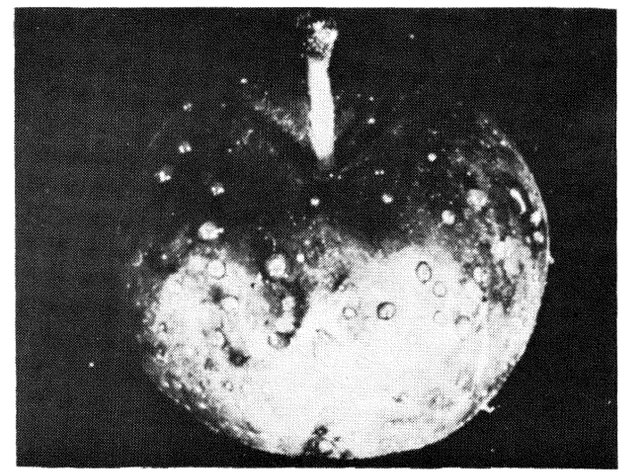

Figure 12. Apple infected with the fire blight bacterium. Note the droplets of bacterial ooze on the surface of the fruit.

## *Orchard Management*

As a rule fire blight is much worse on tissues that are succulent. Thus, growers should attempt to manage the orchard so as to prevent extensive rapid growth of young shoots in varieties of pear and apple especially susceptible to blight. The excessive use of nitrogenous fertilizers, and the cultivation of the orchard to

promote excessive growth and excessive pruning should be avoided. It is recognized that a level of vigor that will produce good yields of fruit is essential for profit in fruit production. The fruit grower, however, must face the situation realistically and use those cultural practices which stimulate excessive succulent growth with moderation.

Water sprouts or suckers should be removed as they are formed on susceptible varieties. Their removal will often avoid canker formation on limbs, trunk, and roots of the tree (See Figure 7 inside front cover).

If at all possible, pears and apples should not be planted in the same orchard or in adjacent fields. Most of the common varieties of pears are highly susceptible to fire blight. One or more badly diseased pear trees may be the principal source of inoculum for apples. Badly diseased pear trees should be cut down and burned.

## Varietal Reaction

There are no known varieties of cultivated apple and pear that are immune to fire blight. Some varieties, however, are more susceptible than others. When setting new orchards, varietal susceptibility should be considered as far as possible. The apple varieties Jonathan, Yellow Transparent, Wealthy, York, Rome Beauty, and Transcendent crabapple are highly susceptible to blight. Delicious, Golden Delicious, Stayman, Winesap, McIntosh, and Baldwin have some resistance.

The high-quality European pear types such as Bartlett, Clapps' Favorite, Anjou, and Bosc are highly susceptible to the disease. The varieties Kieffer, Seckel, Maxine, Orient, Magness, and Moonglow show some tolerance to blight. Resistance or tolerance seems to be related to the slow advances of the causal bacteria in the tissue. It should be pointed out that the varieties which show some tolerance or resistance will be blighted under the right conditions but the destructiveness is not as bad as on susceptible varieties.

## Sanitation

Sanitation is probably the key control measure of the fire blight disease. Young trees in the orchard are frequently badly deformed or stunted by twig blight. Some destruction of the trees may be saved by cutting out the blighted twigs as soon as they appear. Pruning should be started as soon as the first symptoms develop and almost daily inspections should be made to discover new cases of blight. Blighted twigs should be cut back to the limb or main leader from which they arise, unless this measure results in a badly deformed tree. In any case, the cut should be made 8″ below the point of visible infection (Figure 18). Generally, it is not practical or economical to remove blighted twigs from trees over 5 years old. Sterilize the pruning knife after each cut with either a 70% denatured alcohol solution or a household bleach (Clorox or other brands containing 5.6% sodium hypochlorite) solution (mix 1 part bleach and 1 part water).

All blighted twigs and small branches on mature trees should be removed during the late summer while the blighted leaves are still visible. Make cuts about 8″ below the point of visible infection (Figure 18).

Surgical treatment for complete elimination of fire blight in an orchard is not practical in most fruit growing areas. For example, the disease may be carried from orchard to orchard or from certain wild hosts by bees and other insects. Hold-over cankers, however, on trees in home plantings and isolated trees in commercial plantings should be removed during the dormant season to reduce the source of inoculum (Figure 16). To be safe, make cuts 2 to 4″ below the point of visible infection. Special care should be taken to detect and cut out cankers on large limbs and trunks. Cut the cankered area out, removing all discolored tissue, and paint the exposed surface with one of the above disinfectants. After the disinfectant has dried, the exposed wood should be painted with a Bordeaux oil paint made by stirring raw linseed oil in any of the commercial Bordeaux powders. Any type of good oil base or asphalt paint can be used for the wound dressing in case Bordeaux powder is not available (Figure 17).

## Extra Precautions

Avoid any pruning during the blossom period and immediately thereafter. Large populations of sucking insects are present in the trees during bloom, and it has been demonstrated that sucking insects spread the bacteria to blossoms and open wounds. The use of effective phosphate insecticides "following bloom" to control such insects as aphids, plant bugs, and leaf hoppers is advisable when blossom blight occurs.

## Chemical Pesticides

Numerous bactericides have been tested for fire blight control. Before 1950 results were sporadic and discouraging. With the introduction of antibiotics for bacterial disease control,

results became more encouraging.

Streptomycin sulfate, an antibiotic, is the most effective material for fire blight control. Although at first, the results with streptomycin were somewhat sporadic and variable, with further research and better understanding of the nature of fire blight, control measures with this compound during the last decade have been successful and economically feasible when applied properly. Use streptomycin at the rate of 60 ppm of dilute spray. The first application should be completed just before the center blossoms begin to open (See Figure 26 back cover). Additional applications should be made at 5-day intervals until all petals have fallen (See Figure 28 back cover). This will usually mean 2 or 3 sprays. CAUTION: Spray to wet only; antibiotics are usually locally systemic and overspraying may cause foliage chlorosis and reduce fruit set. If at all possible, do not combine streptomycin with other pesticides in the spray tank since some of its effectiveness may be lost. If it becomes necessary to mix streptomycin with other spray chemicals, its concentration should be increased to 80 ppm.

ADDITIONAL SPRAYS: The use of streptomycin sulfate after petal-fall at the rate of 100 ppm has been approved to within 50 days of harvest on apple, and 30 days on pear. The use of streptomycin sulfate beyond petal-fall may be particularly useful in young orchards as they come into bearing. It also may be economically useful to use on older trees beyond petal-fall during those years of critical fire blight infection.

If streptomycin is to be used beyond petal-fall it should be used at 60 to 100 ppm as needed (as soon as possible after hail storms; rain period, 1 to 2 days; periods of continuous high humidity, above 60%; and any other time when the trees have been mechanically injured). Since streptomycin loses its effectiveness after 4 to 5 days, additional applications should be made if the danger situation is repeated.

The residue tolerance for streptomycin is 0.25 ppm.

## *Preparation of Sprays*

Streptomycin is usually sold in small ½ lb. packages. A chart on the container shows the amount of streptomycin to add to either 50, 100, or 500 gallons of water to obtain 50, 60, or 100 ppm. By using the mixing chart, the amount of streptomycin to add to 10 gallons or less to obtain 50, 60, or 100 ppm can be determined.

Streptomycin is commonly formulated as streptomycin sulfate in the form of a dry wettable powder, 15 to 20% active ingredient. Some formulations may also contain a low percentage (1 to 2) of terramycin, another antibiotic, in addition to streptomycin sulfate; still other formulations of streptomycin contain metallic copper. Do not use streptomycin-copper formulations since severe injury may occur under Virginia conditions.

Figure 13. Twig killed by fire blight showing many bacterial aerial strands. Note their fragile appearance.

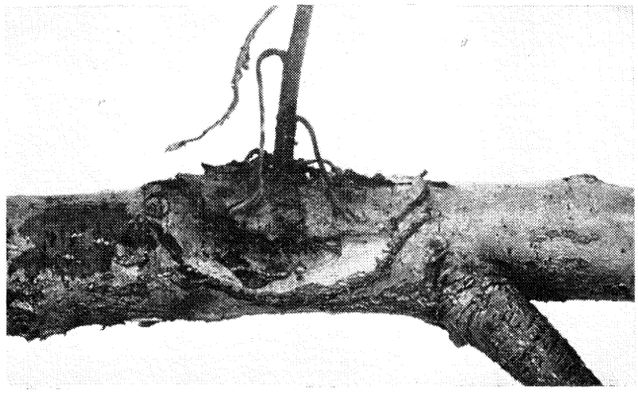

Figure 14. The fire blight bacteria have moved down the twig and established themselves in the branch, resulting in a severe canker on the branch.

Figure 15. Blighted spur in close proximity to old cankered spur (circled). Note early discoloration of leaf midrib that is attached to current blighted fruit spur.

Figure 16. Fire blight canker around a twig on the trunk. If any portion of the canker is active it may serve as a source of inoculum. Thus, the canker should be treated or removed and the wound treated.

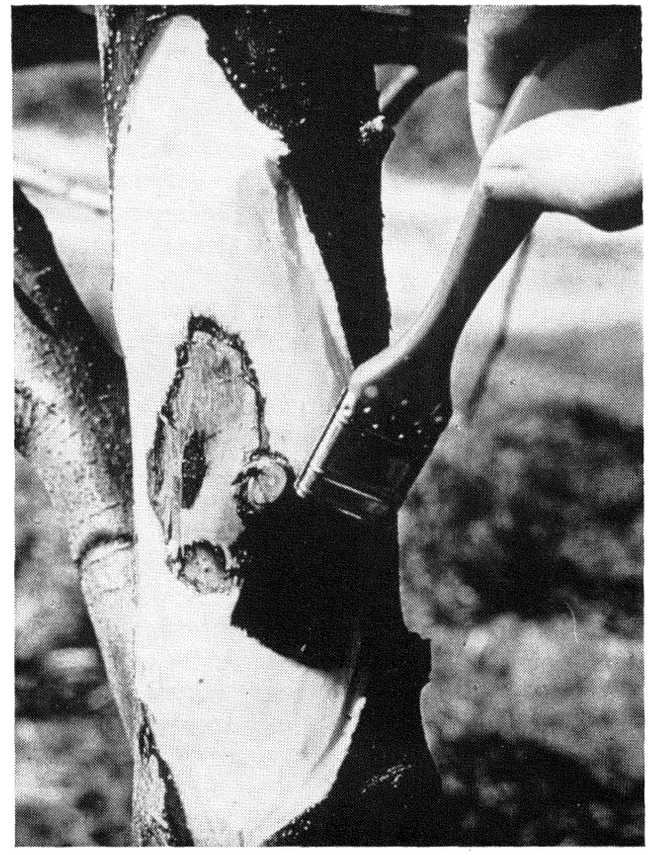

Figure 17. Bark removed from around a fire blight cankered area. Note the area should be treated with a disinfectant, then with a good paint as described in the text.

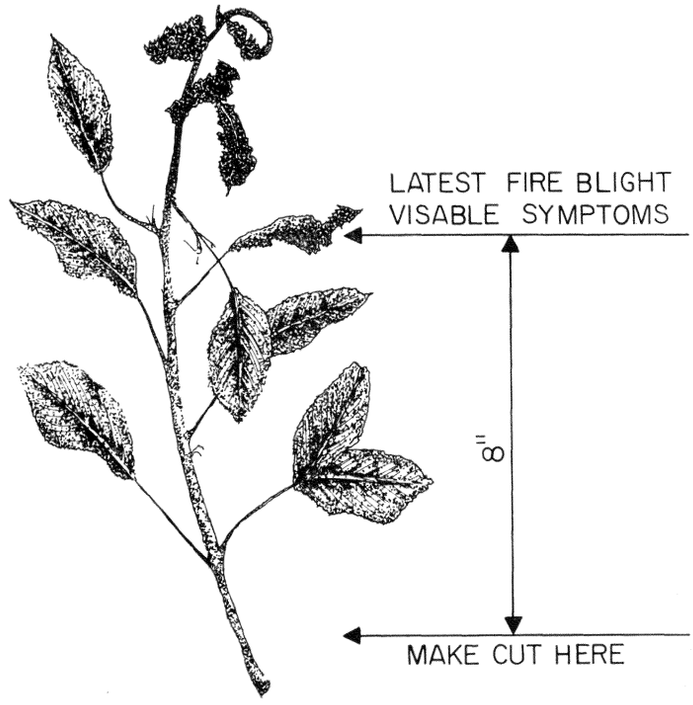


Figure 18. When pruning out blighted twigs from young trees make cut 8 inches below visible infection (symptoms). Note: sterilize the cutting tool between each cut.

## ACKNOWLEDGMENT

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This publication is dedicated to the apple and pear growers of Virginia. I sincerely hope that the information herein will assist you in undertsanding the nature of fire blight and the development and application of a more effective control program.

CHARLES R. DRAKE

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## KEYS TO PROPER USE OF PESTICIDES

1. Read the label on each pesticide container before each use. Follow instructions to the letter; heed all cautions and warnings, and note precautions about residues.
2. Keep pesticides in the containers in which you bought them. Put them where children or animals cannot get to them, preferably under lock and away from food, feed, seed, or other material that may become harmful if contaminated.
3. Dispose of empty containers in the manner specified on the label.

SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER USE OF PESTICIDES.

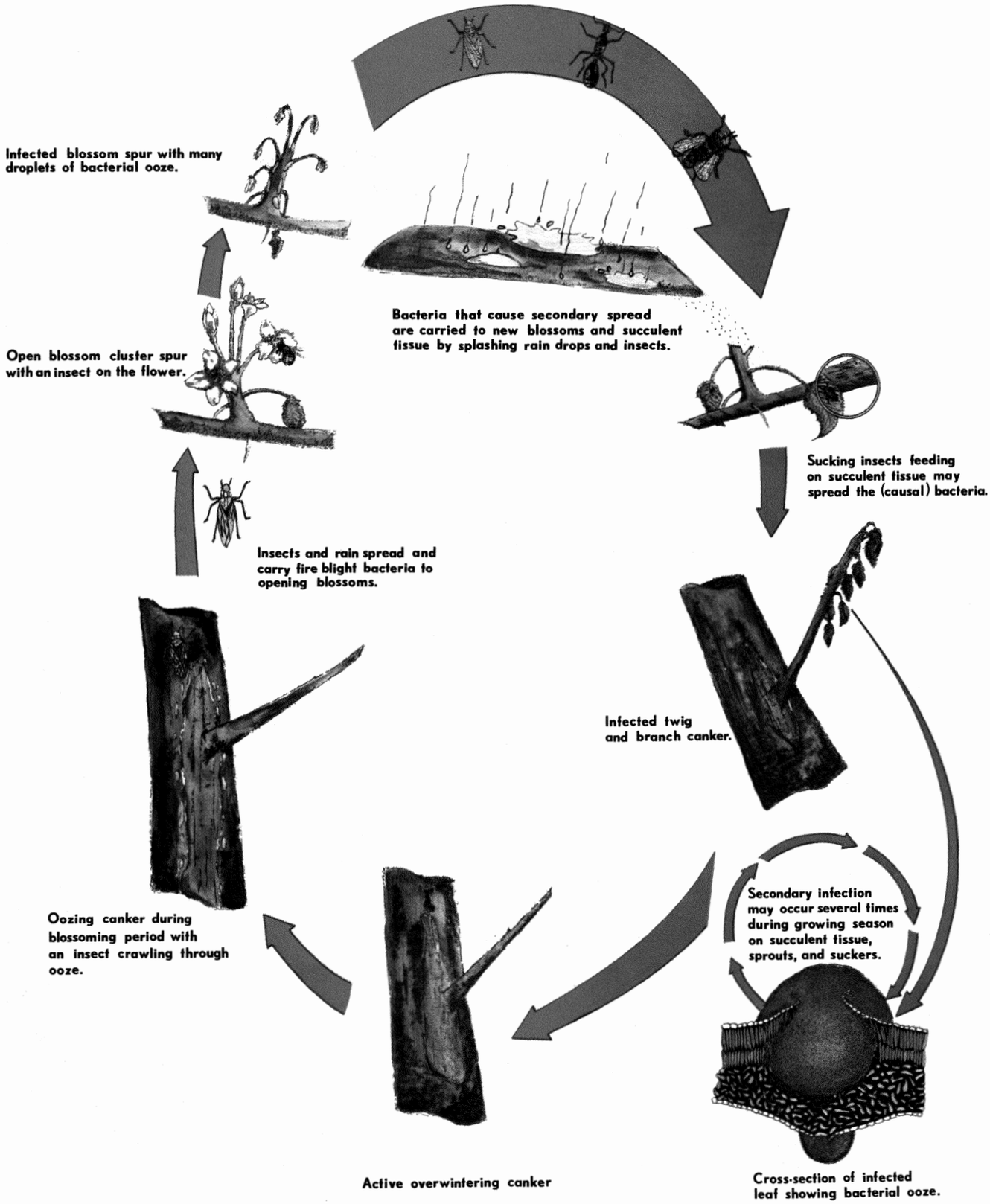


**Figure 19. Diagram of disease cycle of fire blight.**

Figure 20. Apple tree ruined by fire blight.

Figure 21. Loss of Golden Delicious from fire blight.

Figure 22. Fire blight infection of pear tree.

Figure 23. Pear tree killed by fire blight.

Figure 24. Fire blight on pear fruit.

Figure 25. Badly blighted row of apple trees.

Figure 26. Before blossoms open (pear).

Figure 27. Full-blossom (pear).

Figure 28. Petal fall (pear).