West Virginia University
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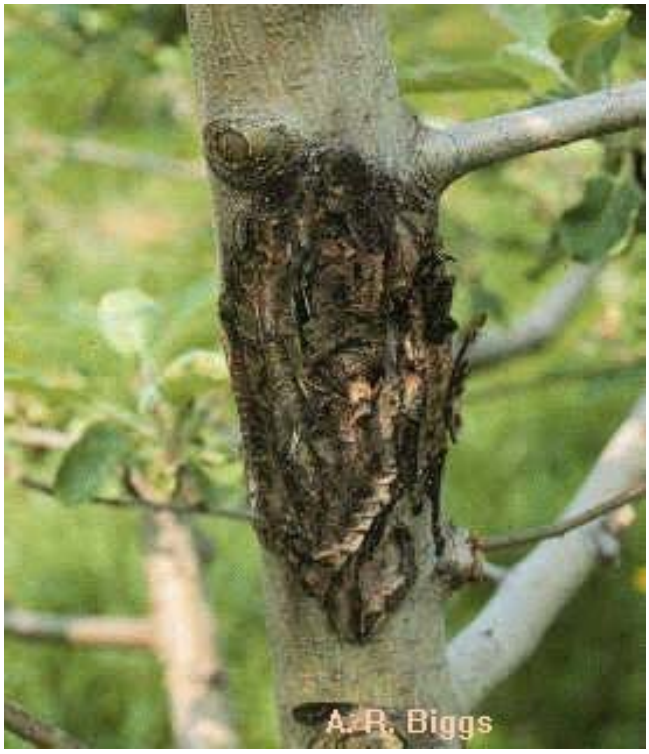
Fire Blight of Apple

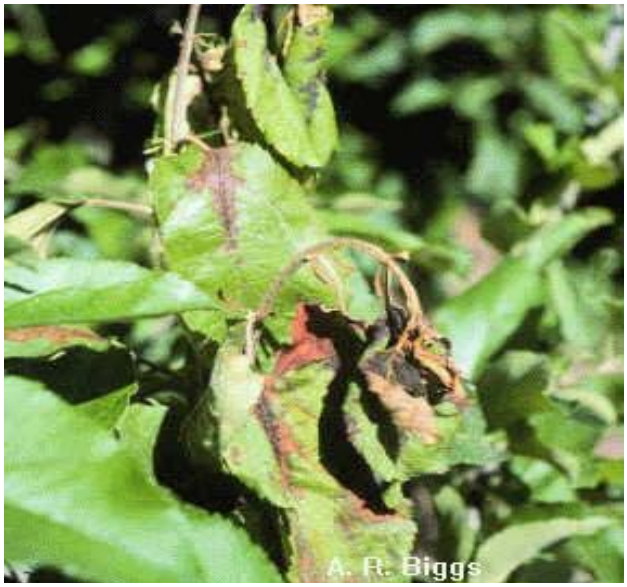
Erwina amylovora

I. Introduction: Fire blight is a destructive bacterial disease of apples and pears that kills blossoms, shoots, limbs, and, sometimes, entire trees. The disease is generally common throughout the mid-Atlantic region although outbreaks are typically very erratic, causing severe losses in some orchards in some years and little or no significant damage in others. This erratic occurrence is attributed to differences in the availability of overwintering inoculum, the specific requirements governing infection, variations in specific local weather conditions, and the stage of development of the cultivars available. The destructive potential and sporadic nature of fire blight, along with the fact that epidemics often develop in several different phases, make this disease difficult and costly to control. Of the apple varieties planted in the mid-Atlantic region, those that are most susceptible include 'York', 'Rome', 'Jonathan', 'Jonagold', 'Idared', 'Tydeman's Red', 'Gala', 'Fuji', 'Braeburn', 'Lodi', and 'Liberty'. 'Stayman' and 'Golden Delicious' cultivars are moderately resistant and all strains of 'Delicious' are highly resistant to fire blight, except when tissues are damaged by frost, hail or high winds.

II. Symptoms: Overwintering cankers harboring the fire blight pathogen are often clearly visible on trunks and large limbs as slightly to deeply depressed areas of discolored bark, which are sometimes cracked about the margins. The largest number of cankers, however, are much smaller and not so easily distinguished. These occur on small limbs where blossom or shoot infections occurred the previous year and often around cuts made to remove blighted limbs (photo 2-17). Since many of these cankers are established later in the season, they are not often strongly depressed and seldom show bark cracks at their margins. Also, they are often quite small, extending



less than one inch (25 mm), with reddish to purple bark that may be covered with tiny black fungus fruiting bodies (most notably Botryosphaeria obtusa, the black rot pathogen of apple).



Blossom blight symptoms most often appear within one to two weeks after bloom and usually involve the entire blossom cluster, which wilts and dies, turning brown on apple (photo 2-18) and quite black on pear (photo 2-19). When weather is favorable for pathogen development, globules of bacterial ooze can be seen on the blossoms (photo 2-20). The spur bearing the blossom cluster also dies and the infection may spread into and kill portions of the supporting limb. The tips of young infected shoots wilt, forming a very typical "shepherd's crook" symptom (photo 2-21). Older shoots that become infected after they develop about 20 leaves may not show this curling symptom at the tip. As the infection spreads down the shoot axis, the leaves first show dark streaks in the midveins, then wilt and turn brown, remaining tightly attached to the shoot throughout the season. As with blossom infections, the pathogen often invades and kills a portion of the limb supporting the infected shoot. The first symptom on water sprouts and shoots that are invaded systemically from nearby active cankers is the development of a yellow to orange discoloration of the shoot tip


photo 2-21 - K. D. Hickey


photo 2-22 - P. W. Steiner

before wilting occurs (photo 2-22). In addition, the petioles and midveins of the basal leaves on such sprouts usually become necrotic before those at the shoot tip.

Depending on the cultivar and its stage of development at the time infection occurs, a single blossom or shoot infection can result in the death of an entire limb, and where the central leader or trunk of the tree is invaded, a major portion of the tree can be killed in just one season. In general, infections of any type that occur between petal fall and terminal bud set usually lead to the greatest limb and tree loss. In addition, heavily structured trees tend to suffer less severe limb loss than those trained to weaker systems for high productivity. Where highly susceptible apple rootstocks (M.26, M.9, Mark) become infected, much of the scion trunk and major limbs above the graft union very typically remain symptomless, while a distinct dark brown canker develops around the rootstock. As this rootstock canker girdles the tree, the upper portion shows symptoms of general decline (poor foliage color, weak growth) by mid to late season. In some instances, the foliage of trees affected by rootstock blight develop early fall red color in late August to early September, not unlike that often associated with collar rot disease caused by a soilborne fungus. Some trees with rootstock infections may not show decline symptoms until the following spring, at which time cankers can be seen extending upward into the lower trunk (photo 2-23).

III. Disease Cycle: The bacterial pathogen causing fire blight overwinters almost exclusively in cankers on limbs infected the previous season. The largest number of cankers and, hence, those most important in contributing inoculum, occur on limbs smaller than 1.5 inches (38 mm) in diameter, especially around cuts made the previous year to remove blighted limbs. During the early spring, in response to warmer temperatures and rapid bud development, the bacteria at canker margins begin

multiplying rapidly and produce a thick yellowish to white ooze that is elaborated onto the bark surface up to several weeks before the bloom period. Many insect species (predominantly flies) are attracted to the ooze, and subsequently disperse the bacteria throughout the orchard. Once the first few open blossoms are colonized by the bacteria, pollinating insects rapidly move the pathogen to other flowers, initiating more blossom blight. These colonized flowers are subject to infection within minutes after any wetting event caused by rain or heavy dew when the average daily temperatures are equal to or greater than 60 F (16 C) while the flower petals are intact (flower receptacles and young fruits are resistant after petal fall). Once blossom infections occur, early symptoms can be expected with the accumulation of at least 103 degree days (DD) greater than 55 F (57 DD greater than 13 C) which, depending upon daily temperatures, may require 5 to 30 calendar days.

With the appearance of blossom blight symptoms, the number and distribution of inoculum sources in the orchard increase greatly. Inoculum from these sources is further spread by wind, rain, and many casual insect visitors to young shoot tips, increasing the likelihood for an outbreak of shoot blight. Recent research conducted in Pennsylvania indicates that aphid feeding does not contribute to shoot blight. More research is needed to determine whether or not leafhoppers play a role in the incidence of shoot blight. Most shoot tip infections occur between the time that the shoots have about nine to ten leaves and terminal bud set, when sources of inoculum and insect vectors are available, and daily temperatures average 60 F (16 C) or more.

In years when blossom infections do not occur, the primary sources of inoculum for the shoot blight phase are the overwintering cankers and, in particular, young water sprouts near these cankers, which become infected as the bacteria move into them systemically from the canker margins. Such systemic shoot infections, called canker blight, are apparently initiated about 200 DD greater than 55 F (111 DD greater than 13 C) after green tip, although visible symptoms may not be apparent until the accumulation of at least 300 DD greater than 55 F (167 DD greater than 13 C) after green tip. In the absence of blossom infections, the development of shoot blight infections is often localized around areas with overwintering cankers.

Although mature shoot and limb tissues are generally resistant to infection by E. amylovora, injuries caused by hail, late frosts of 28 F (-2 C) or lower, and high winds that damage the foliage can create a trauma blight situation in which the normal defense mechanisms in mature tissues are breached and infections occur. Instances of trauma blight are known to occur even on normally resistant cultivars like 'Delicious'.

Rootstock blight, yet another phase of fire blight, has been recognized recently and is associated primarily with the highly susceptible M.26, M.9 and Mark rootstocks. On these trees, just a few blossom or shoot infections on the scion cultivar can supply bacteria that then move systemically into the rootstock where a canker often, but not always, develops and eventually girdles the tree. Trees affected by rootstock blight

generally show symptoms of decline and early death by mid to late season, but may not be apparent until the following spring.

IV. Monitoring: Concentrate monitoring in orchard blocks where the disease occurred during the previous season. Observe blighted limbs and shoots for removal during normal pruning operation. There may be a need to remove whole trees on some occasions.

Where fire blight occurred the previous year in orchards grown on susceptible rootstocks (M.26, M.9, Mark), trees showing poor foliage color or dieback should be examined for rootstock cankers and, if found, removed from the orchard immediately and destroyed. A very important aspect of fire blight management involves monitoring the weather for the specific conditions that govern the build-up of inoculum in the orchard, the blossom infection process and the appearance of symptoms. A weather station (discussed in chapter 10) that records the daily minimum and maximum temperatures and rainfall amounts is needed. When 50 percent of the buds show green tissue, begin keeping a daily record of the cumulative degree days (DD) greater than 55 F (12.7 C; see Appendix B and F). This information can be used to signal when symptoms are likely to appear in the orchard for blossom blight [103 DD greater than 55 F (57 DD greater than 12.7 C) after infection] (photos 2-18, 2-20), canker blight [about 300 DD greater than 55 F (167 DD greater than 12.7 C) after green tip] (photo 2-22), and early shoot blight [about 103 DD greater than 55 F (57 DD greater than 12.7 C) after blossom blight or canker blight symptoms appear] (photo 2-21).

Continue to monitor and record the daily minimum and maximum temperatures and rainfall amounts, and continue to accumulate degree days (DD) greater than 55 F (12.7 C; see Appendix B and F). At the full pink stage (i.e., first flower open in the orchard), a record should also be kept of the cumulative degree hours (DH) greater than 65 F (18.3 C; see Appendix B and G). Once a total of 200 or more DH greater than 65 F (111 DH greater than 18.3 C) has accumulated after the start of bloom, any wetting event caused by rain or heavy dew that wets the foliage is likely to trigger a blossom infection event if the average daily temperature is 60 F (15.6 C) or more.

This information can be used to schedule streptomycin sprays, which are most effective if applied on the day before or the day of an infection event. Such sprays protect all flowers open at the time of treatment. However, because other flower buds may open after treatment, reassess the need for additional sprays at four-day intervals during bloom. Continue to monitor for strikes and remove all blighted limbs.

Monitor the orchard to locate blighted limbs (photo 2-22) for removal. For the greatest effect on the current season's damage severity, infected limbs should be removed as soon as early symptoms are detected and before extensive necrosis develops. Where the number and distribution of strikes is too great for removal within a few days, it may be best to leave most strikes and cut out only those that threaten the main stem. On young

trees, and those on dwarfing rootstocks, early strikes in the tops of the trees often provide inoculum for later infections of shoots and sprouts on lower limbs near the trunk, which may result in tree loss. Give these early strikes a high priority for removal.

Look for symptoms of early tree decline or early fall color in orchards planted on highly susceptible rootstocks (M.26, M.9, Mark) where the disease developed this year. These symptoms may appear either on one side or throughout individual trees. Examine the rootstock area of these trees just below the graft union for evidence of cankering or bacterial ooze. Remove any tree showing these symptoms during this period.

V. Management: Many practices can help reduce the incidence of fire blight and may help reduce the severity of the disease when it occurs. Not all measures suggested below are necessary or even feasible in every planting, since planting systems play a large role in contributing to the level of risk of disease development. No single control method is adequate and, in regions where it is established, a conscious effort must be made to control the disease each year. Even under the most conscientious efforts, in some years losses from fire blight can be devastating.

Chemical and biological control: A copper spray applied at the 1/4-inch green tip stage may reduce the amount of inoculum on the outer surfaces of infected trees. At bloom, antibiotic sprays are highly effective against the blossom blight phase of the disease. These sprays are critical because effective early season disease control often prevents the disease from becoming established in an orchard. Predictive models, particularly Maryblyt, help to identify potential infection periods and improve the timing of antibiotic treatments, as well as avoid unnecessary treatments. Strains of the pathogen that are resistant to streptomycin are present in some orchards in the eastern U.S., and are widespread in most apple and pear regions of the western U.S. Biological control agents, although not widely used, have provided partial control of blossom infections. More effective biological agents are required if their use is to become widespread.

Removing sources of infection: Dormant pruning to remove overwintering infections helps reduce inoculum for the next season. Make cuts about 4 inches below any signs of dead bark. Remove pruned material from the orchard. Beginning about one week after

petal fall, monitor the orchard to locate blighted limbs for removal. For the greatest effect on the current season's damage severity, infected limbs should be removed as soon as early symptoms are detected and before extensive necrosis develops. Where the number and distribution of strikes is too great for removal within a few days, it may be best to leave most strikes and cut out only those that threaten the main stem. On young trees, and those on dwarfing rootstocks, early strikes in the tops of the trees often provide inoculum for later infections of shoots and sprouts on lower limbs near the trunk, which may result in tree loss. Give these early strikes in the tops of trees a high priority for removal. Do not combine the practices of fire blight removal with pruning and training of young, high-density trees.

Insect control: The role of insects in the transmission of fire blight bacteria is under investigation. It is likely that insects that cause wounds (leafhoppers, plant bugs, pear psylla) can create places for bacteria to enter the tree, and some summer infections (shoot blight) are probably facilitated by insects. Where fire blight is a problem, and until more is known about their specific role in the spread of the disease, controlling these insects at levels below their economic injury threshold is advised.

Cultural practices: Use management systems that promote early cessation of tree growth without adversely affecting tree vigor. Excessive vigor is an important component of orchard risk for fire blight. When tree growth continues past mid summer, the likelihood that late season infections will overwinter increases. Orchards should be established on well-drained soils, avoiding low, frost-prone or potentially water-logged areas, and nitrogen fertilizer should be applied based on analyses of foliage N levels.

Resistant cultivars: When establishing new orchards, consider susceptibilities of the scion and rootstock to fire blight. Although none are immune, there is considerable variation among apple cultivars (and pear cultivars) in susceptibility to fire blight. Some cultivar/rootstock combinations are so susceptible to fire blight that investments in these are extremely high risk. In the eastern U.S., Gala on M.26 is a good example. Long range plans for establishing new orchards with fire blight susceptible cultivars should include contingency plans for controlling the disease without streptomycin.

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