New York State Integrated Pest Management Program
Cornell Cooperative Extension

# TREE FRUIT

## Fire Blight

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Fire blight, caused by the bacterium *Erwinia amylovora,* is one of the most destructive diseases in apple and pear production. Fire blight can infect other members of the rose family including quince, juneberry, hawthorne, mountain-ash, and Pyracantha. With the exception of China and Australia, fire blight occurs worldwide in all regions where apples and pears are grown. Under conditions favoring disease, fire blight can infect, blight, and kill trees across large acreages over the course of only a few weeks. Disease outbreaks are often sporadic and the disease is difficult to manage. Estimated economic losses in the U.S. exceed $100 million annually.

### Causal Agent

*Erwinia amylovora,* is a Gram-negative bacterium in the Enterobacteriaceae. It grows most efficiently in warm, moist conditions, preferentially colonizing flower stigmas. The bacteria cannot penetrate cells directly and require natural openings or damaged tissue to enter the host. Once inside the plant, *E. amylovora* can move systemically within the plant via the vascular tissues, ahead of symptom expression by the infected plant. Some differences in host range and aggressiveness have been described between strains. *Erwinia amylovora* can share genes on small DNA molecules called plasmids, which is one way antibiotic resistance can spread through bacterial populations.

### Symptoms & Signs

*Erwinia amylovora* can infect flowers, shoots, fruits, and woody tissues. Blighted tissues initially have a water soaked appearance, then wilt and turn black or brown within 1-3 weeks. All infected tissues may produce droplets of bacterial ooze, pale yellow to dark amber in color (Fig. 1 and 2), which is attractive to insects and serves as inoculum for disease transmission. Four types of infections may occur, with slightly different symptoms.

**Figure 1.** Wilting, blackened shoot tip with droplets of bacterial ooze and necrosis (blackening) along the leaf mid-veins. Photo: K. Cox, Cornell University.

**Figure 2.** Gala fruit infected with E. amylovora producing droplets of bacterial ooze. Photo: K. Cox, Cornell University.

**Figure 3.** Wilting flower cluster and spur leaves infected with *E. amylovora*; typical blossom blight symptoms. Photo: K. Cox, Cornell Univ.

**Figure 4.** Blighted shoot infected with E. amylovora; typical shoot blight symptoms. Photo: K. Cox, Cornell University.

**Figure 5.** Canker producing bacterial ooze in early spring; typical canker blight symptoms. Photo: K. Cox, Cornell University.

**Blossom blight:** Open blossoms are colonized via the flowers' stigmas and from there they gain entry via natural openings in the nectaries. Infected flowers and peduncles wilt, shrivel and darken. Infected fruitlets wither, turning black or brown. The entire flower cluster may shrivel and die but remain firmly attached to the tree (Fig. 3).

**Shoot blight:** Shoot tips wilt, turn black or brown, and bend down, forming the characteristic symptom called a shepherds crook (Fig. 4). Infected leaves often turn black or purplish-brown along the mid-vein, as bacteria colonize the vascular tissue and move into the shoot. Young shoots are most susceptible and symptoms often stop at older, woody tissue. Apple leaves killed by fire blight turn dark orange-brown, whereas pear leaves will turn black.

**Canker blight:** As bacteria move into the tree from infected shoots, infected woody tissues may form cankers (Fig. 5). Shoots infected by bacteria moving into them from cankers, often appear distinctly orange-brown. Cankers may girdle the trunk, leading to tree collapse and death. The bacteria in overwintered cankers become active in the spring and may move systemically to adjacent, new growth. Bacterial ooze may form on the edges of cankers in spring.

**Rootstock blight:** Bacteria can move systemically through vascular tissue from blighted blossoms or shoots to the rootstock, where a local canker forms. Sunken purple or orange cankers on infected rootstocks may girdle the trunk, leading to tree collapse and death.

## Disease cycle and epidemiology

Fire blight bacteria require living host tissue to survive, but may persist on other materials for short periods and in pruned infected branches that are kept moist. Bacterial growth occurs over a wide range of temperatures, from 39°F to 99°F (4°C to 37°C), with an optimal range of 70°F to 77°F (21°C to 25°C). Blossom or shoot blight symptoms occur approximately 90 to 100 degree days base 55°F after infection or within about one to three weeks.

The bacteria overwinter at the margins of cankers. In spring, cankers produce ooze when temperatures rise and tree growth begins. Insects,

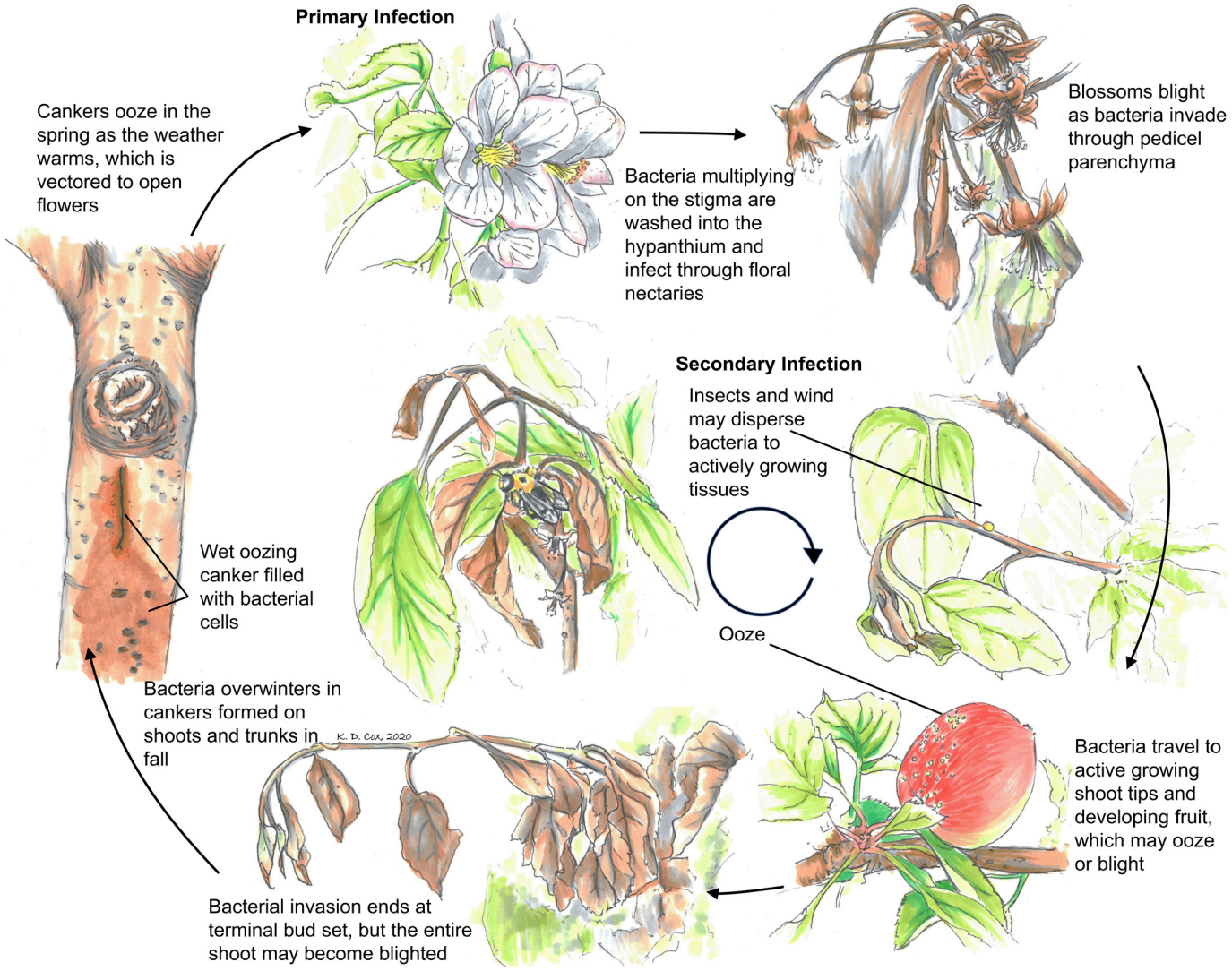


**Figure 6.** Disease cycle of *Erwinia amylovora,* causal bacteria of fire blight. Illustration: K. Cox, Cornell University.

wind, and rain can carry bacterial ooze from cankers to open flowers. Flies and bees visiting flowers can spread fire blight bacteria to other open flowers. On flowers, the bacteria preferentially colonize the stigma. Bacteria get washed into the floral cup during rain, heavy dew, or spray applications where they enter the host via openings in the nectary glands, leading to blossom blight infections (Fig. 3). The requirements for blossom blight infection include open blossoms, sufficient heat for bacterial population growth, a wetting event, and continued heat for infection.

Infected blossoms and other plant tissues produce high levels of bacteria that may spread by wind, rain, and possibly insects, for shoot blight infections (Figs. 1 and 4) later in the season. Shoot blight is favored by traumatic events that cause mechanical injury, such as strong winds, thunderstorms, hail, or piercing-sucking insects (e.g. leafhoppers and plant bugs). The bacteria enter through wounds and move systemically through the vascular tissue. Bacteria may travel to the rootstock, leading to rootstock blight and tree death. When trees remain alive and successfully compartmentalize the infection, cankers form on scaffold branches, trunks, and rootstocks that overwinter to complete the disease cycle.

## Management

A successful management program includes an integrated approach, including planting resistant varieties and rootstocks, avoiding excess nitrogen fertilization, controlling shoot vigor, reducing inoculum and its spread in the orchard, environmental monitoring for disease risk, and judicious application of crop protectants. Young trees and dwarf trees grown in high-density systems may be less resilient because they have less woody tissue, may be less capable of walling off infection, and infection will spread more readily into the trunk or rootstock to kill the tree.

**Cultural tactics:** Choose resistant cultivars such as Jonafree, Prima, Priscilla, RedFree, Empire, Delicious, Honeycrisp, Jonagold, Liberty, McIntosh, and Northern Spy whenever possible. Avoid highly susceptible cultivars such as Fuji, Gala, Gingergold, Honeycrisp, Idared, Jonathan, Lady Apple, Paulared, Rome, and SweeTango. Use resistant rootstocks, such as the Geneva series, and avoid susceptible rootstocks such as M.9 and M.26.

Vigorous shoot growth is highly susceptible to fire blight. Manage tree vigor by maintaining a balanced nutrient program without excess nitrogen and avoid excessive winter pruning. The plant growth regulator prohexadione-calcium can control shoot growth and can prove highly effective against fire blight infection, but may compromise shoot growth.

**Reduce inoculum:** Reducing overwintering inoculum is critical for managing fire blight. Remove cankers during dormant pruning. Trees with trunk or rootstock cankers should be removed completely. Copper products applied at late dormant or between green tip and bloom can reduce inoculum on the surface of the tree.

During spring and summer, prune shoot blight strikes at least 8 to 12 inches below visible symptoms as soon as possible after they have been observed. Always prune during dry weather. Sterilize pruning equipment with 10% bleach between cuts to help prevent spread of the disease; oil pruning equipment after using bleach to prevent corrosion. Avoid dragging infected prunings through the orchard and rubbing them against healthy trees. Destroy pruned material by burning or leave them to dry out completely and then flail mow.

**Disease forecast models:** Precise timing of blossom sprays is critical to blossom blight management. The disease forecast models, MaryBlyt 7.1 and Cougarblight 2010, predict fire blight risk and application timing. Consult the NEWA disease forecasting system for output from these models. The appearance of shoot blight symptoms may also be predicted using disease forecasts and can aide in determining when to scout to prune strikes.

**Chemical management:** In most commercial orchards with a history of fire blight or susceptible cultivars, chemical control is necessary. Copper products may be applied after pink, but only if fruit russett can be tolerated in the market. Antibiotics will effectively protect open flowers from blossom blight. Several new products, including biopesticides, have shown efficacy against fire blight by colonizing blossoms, outcompeting or killing the pathogen, or activating the plant's natural defenses. To protect against shoot blight, antibiotics should be applied only if a trauma event occurs, in order to minimize the risk of antibiotic resistance developing in the bacteria.

Prudent antibiotic resistance management practices, include limiting the number of applications during bloom to three or less, alternating sprays with other materials, and avoiding their use during summer against shoot blight. Streptomycin acts by killing bacterial cells and is effective if applied within 24 hours of infection. Streptomycin resistance in *E. amylovora* populations exists in nearly all major apple production regions in North America. Therefore, use management tactics to reduce the risk of streptomycin resistance. Two other antibiotics, kasumin and oxytetracycline, and other products labeled for fire blight provide options for rotating use with streptomycin for resistance management. Consult the Cornell Pest Management Guidelines for Commercial Tree Fruit Production, updated yearly, for detailed information on chemical management.


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