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report on **PLANT DISEASE**

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FIRE BLIGHT

Fire blight, caused by the bacterium *Erwinia amylovora*, is a common and very serious bacterial disease. The disease is also referred to as blossom blight, spur blight, fruit blight, twig blight, or rootstock blight – depending on the plant part that is attacked. *Erwinia amylovora* infects approximately 75 different species of plants, all in the family Rosaceae. The hosts for this bacterium include apple, blackberry, cotoneaster, crabapple, firethorn (*Pyracantha*), hawthorn, Japanese or flowering quince, mountain-ash, pear, quince, raspberry, serviceberry, and spiraea. The cultivated apple, pear, and quince are the most seriously affected species, but many ornamentals serve as overwintering hosts for the bacterium and are important sources of new infections each year.

Figure 1. Infected blossoms wilt; turn light to dark brown on apple; black on pear.

Figure 2. Rough corky tissue forms at margin of canker.

Losses from fire blight in apples and pears include: (1) death or severe damage to trees in the nursery; (2) death of young trees in the orchard; (3) delay of bearing in young trees due to frequent blighting of shoots and limbs; (4) loss of limbs or entire trees in older plantings as the result of girdling by fire blight cankers; and (5) partial loss of the crop by the blighting of the blossoms and young fruit.

The seriousness of fire blight is demonstrated by its effect on the commercial pear industry. At one time, the pear was a popular and widely grown fruit in the Midwest, comparable in importance to the apple. Fire blight has eliminated the possibility of commercial pear production in most areas of the Midwest.

Symptoms

The fire blight bacterium can infect any portion of a susceptible plant. The common types of infection are blossom blight, shoot blight, and branch and trunk canker. Blossom blight is most common on pear, apple, hawthorn, mountain-ash, and *Pyracantha*. Infected blossoms

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become water-soaked and darker green as bacteria invade new tissues. Within 4 or 5 days, fruiting spurs may begin to collapse, turning dark brown to black (spur blight) (Figure 1). The leaves wilt, die, and turn dark brown to black, usually remaining attached to the tree throughout the summer. As the bacteria move through the pedicel, the tissue becomes water-soaked and dark green. Infected tissues may exude either small droplets of a milky-white ooze or fine, hairlike strands containing millions of fire blight bacteria that can initiate new infections. The ooze, which later turns an amber color, contains countless bacteria that also are capable of causing new infections. Surveys during 2010-2012 showed that blossom blight in Illinois is not as common as it has been reported from other apple growing areas. We believe that low incidence of blossom blight in Illinois is related to low temperatures during bloom in the state.

Figure 3. Apple shoot affected by fire blight. Note, "shepherd's crooks" at the tip. **Babadoost/UIUC**

Shoot blight is recognized by the rapid dieback of shoots. Infections begin in the shoot tips and move rapidly down from one to twelve inches a day. Newly infected tissue becomes water-soaked and dark green or reddish brown in color. As in spur blight, infected leaves die and turn either dark brown (apple, crabapple) or black (pear) and remain attached throughout the growing season. Frequently, the tip of the blighted shoot bends over and resembles a shepherd's crook (Figure 3). Hawthorn leaves turn yellow, then brown, shrivel, and fall prematurely. Relatively heavy infection of shoot blight occur in Illinois. Our studies showed that severe shoot infection is mainly because of warm and rain storm conditions during late bloom and a few weeks after bloom.

Figure 4. Droplets of bacterial ooze on immature apple. (Photo courtesy of A.L. Jones, Michigan State University).

The terminal shoots of Jonathan apple trees are often blighted back 12 to 36 inches (30 to 90 centimeters). The infection may continue down a shoot or flower spur into a larger branch or trunk, forming a canker. These cankers continue to enlarge during the growing season and may girdle the affected part, resulting in the death of the entire branch or tree. The surface of a canker is somewhat sunken, relative to the surrounding healthy tissue, and the bark is usually darker in color. A distinct zone of rough, corky tissue may form at the margin of the canker (Figure 2 and 6). In some cultivars, it is difficult to determine the margin of the canker without cutting into the wood to expose the discolored and infected tissue. The diseased inner bark of older branches becomes reddish brown and marbled, in contrast with the whitish color of normal wood. The surface of smooth-barked branches darkens; also, cracks usually develop at the margins of the diseased area.

Fruits are susceptible to infection until just before maturity. The incidence of fruit infection is usually low;

Figure 5. A three-year old Fugi apple tree killed from infection of M.9 root stock by fire blight.

however, infections can follow mechanical injury such as hail or insect feeding. Diseased fruit is first water-soaked, turns brown, shrivels, and turns black. Droplets of milky and sticky bacterial ooze are commonly observed on the fruit surface during wet, humid weather (Figure 4).

A phenomena called "rootstock blight" usually occurs in high density orchards planted with susceptible rootstock such as M.9 and M.26. Rootstock blight is caused by formation of cankers on susceptible rootstocks which can completely girdle and kill the tree in one to a few months (Figures 5 and 6). The bacteria in the infected blossoms or shoots pass through healthy limbs and trunks and reach the rootstock and produce the cankers. Root suckers and sprouts from susceptible rootstocks also may become infected, much as do the shoots. These infections can also lead to the invasion of the entire root system and the rapid death of the tree. Fire blight is often followed by Black Rot and Wood Rot.

Disease Cycle

The fire blight bacteria overwinter in living tissue at the margins of trunk and branch cankers that were formed by infections initiated in previous years, and possibly in buds. The bacteria resume growth in the spring when temperatures are above 65°F (18°C) with survival favored by rain, heavy dews, and high humidity. By the time trees are blossoming, ooze containing bacteria are present on the surface of cankers. Relatively few cankers survive winter, become active, and produce bacteria in the spring. However, a single active canker will produce millions of bacteria, enough to infect an entire orchard. The cankers most likely to produce bacteria in the spring are those with smooth margins between healthy and infected tissue, and those formed in older wood. Cankers produce bacteria in droplets of ooze that are spread by splashing rain or insects (mostly bees, flies, and ants) to open blossoms. The bacteria multiply rapidly on the blossom and invade the tissue through the nectaries (non-cutinized or flower parts). The bacteria then spread from blossom to blossom by rain or pollinating insects. The optimum temperature range for blossom blight infection is 65° to 86°F (18° to 30°C).

Figure 6. Fire blight on the M.9 root stock of an apple tree.

Succulent shoot tips are frequently infected by bacteria that have been spread from cankers and infected blossoms. The invasion of shoot tips can occur through natural openings, such as lenticels and stomata, but more commonly through wounds created by sucking insects such as aphids, leafhoppers, and tarnished plant bugs, by wind whipping, or by hail. The fire blight bacteria reproduce rapidly within an infected shoot. Droplets of ooze form on the shoots within three days. This ooze serves as a source of inoculum for the further spread of the disease. Shoots remain highly susceptible to infection until vegetative growth ceases and the terminal bud forms.

Warm (optimum temperature 76°F or 24°C) and moist weather is favorable for infection, and rapid growth encourages disease development. Nitrogen fertilization, late fertilizer application, poor soil drainage, and other factors that promote succulent growth or delay the hardening of the tissues from midsummer into autumn tend to increase the severity of this disease.

Dried bacterial ooze remains infectious for more than a year if it is not subjected to alternate wetting and drying. Contaminated boxes or other containers that are taken into orchards for fruit picking may serve as a potential source of infection.

Disease Management

No single method is adequate to effectively control fire blight. A combination of practices is needed to reduce the severity of the disease.

1. **Choose the proper cultivars**. Apple and pear cultivars and rootstocks differ widely in their susceptibility to fire blight (Tables 1-3). During warm and rainy weather, cultivars rated moderately susceptible or moderately resistant will develop shoot infections; however, the extent to which shoot infections progress will be less in resistant cultivars than in susceptible cultivars. **Commercial growers should select rootstocks that are less susceptible to fire blight. Bartlett pears are extremely susceptible to fire blight and are not recommended for planting in Illinois.**

2. **Select planting sites with good soil drainage**. Trees are more susceptible to fire blight in poorly drained sites than in well-drained ones. Tree productivity will also be lower on such sites. Drainage can often be improved by tiling.

3. **Follow proper pruning and fertilization practices**. Using nitrogen containing fertilizer and/or doing heavy pruning promotes vigorous growth and increases susceptibility. Fertilization and pruning practices on susceptible cultivars should be adjusted to limit **excessive** growth. For bearing trees, moderate shoot growth is 6 to 12 inches (15 to 30 centimeters) per year. If the growth is more than 12 inches, do **not** apply fertilizer until shoot growth is reduced to less than 6 inches.

   Apply fertilizer in the early spring (6 weeks before bloom) or apply in late fall after growth has ceased. Applications in midseason prolong the time during which shoots are susceptible to infection and increase the likelihood of winter injury to tender wood.

4. **Prune out fire blight cankers during the dormant season**. Delay the removal of infected shoots until the dormant season in order to avoid spreading infection to healthy shoots. Make pruning cuts at least 6 inches (15 centimeters) below the last point of visible infection. After each pruning cut, sterilize the pruning shears by dipping them in a freshly made solution of 1 part liquid bleach (e.g., Clorox, Purex, ...) added to 4 parts of water. Examine the larger branches and trunks carefully for cankers, since these are likely to overwinter and produce new infections in the spring.

   Root suckers and watersprouts should also be removed because infection of these parts can lead to infection and death of entire trees. Certain dwarfing rootstocks used for apples are prone to suckering. Commercial growers should select rootstocks that are resistant to fire blight or that show little tendency to produce root suckers.

   Examine wild, neglected, ornamental hosts of the fire blight bacterium growing in the vicinity of home or commercial orchards for cankers. In addition to seedling apples, crabapples, pears, and quince, check hawthorns (*Crataegus* spp.), firethorns (*Pyracantha* spp.), cotoneasters, mountain-ashes (*Sorbus* spp.), and spiraea. Remove the cankers when found or destroy the entire plant where feasible.

5. **Follow a bactericide spray program**. Like most bacterial diseases of plants, fire blight is very difficult to control; however, it can be reduced by spraying. Commercial orchardists should follow the spray schedule outlined in the annual "Midwest Fruit Pest Management Guide" (https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf). The antibiotic streptomycin is the most effective material for controlling fire blight; timely sprays will reduce the incidence of fire blight **but must be applied before the appearance of symptoms**.

   Temperatures at the prebloom and bloom stages are important in determining whether fire blight will occur in any given year. The bacteria reproduce **only** when the temperature is warmer than 65°F (18°C).

   Dr. Paul Steiner at the University of Maryland has developed a computer software package which accurately predicts the potential for fire blight occurrence. The prediction is based upon temperature and moisture during bloom. This computer software is called MARYBLYT and is available for all users.

   Streptomycin can effectively protect the susceptible apple and pear flowers, but for maximum effect it must be applied the day of, or the day before infection event occurs. Missing the critical window of effectiveness by even 24 hours can result in plant infection and buildup of a significant amount of bacteria for later infections. If the blossom blight is well controlled, the subsequent increase of fire blight in summer is often prevented. To prevent development of streptomycin-resistant strains of the pathogen, no more than 4 applications of streptomycin per season is recommended. Streptomycin is more effective in preventing blossom infection and the management of the shoot blight phase of fire blight should not be attempted with streptomycin. However, application of streptomycin immediately following hail storms is highly recommended.

   Application of a copper compound at the silver-tip growth state is recommended. Fixed copper fungicides, including copper hydroxide, copper oxychloride, basic copper sulfate, Bordeaux mixture, and cuprous oxide ca by used. Follow the label recommendations and the "Midwest Fruit Pest Management Guide" (https://ag.purdue.edu/hla/Hort/Documents/ID-465.pdf).

6. **Control sucking insects**. Good control of aphids, leafhoppers, plant bugs, and psylla on pears helps prevent shoot infection. Commercial orchardists should follow a spray program outlined in Midwest Tree Fruit Pest Management Handbook.

Table 1: Relative Susceptibility of Common Apple Cultivars to Fire Blight

Highly susceptible	Moderately susceptible	Moderately resistant
Balwin	Ambrosia	Arkansas Black
Beacon	Cameo	Baldwin
Braeburn	Cortland	Ben Davis
Burgundy	Golden Delicious	Empire
Fuji	Golden Supreme	Liberty
Ga	GoldRush	Melba
Ginger Gold	Gravenstein	Monroe
Granny Smith	Grimes Golden	Northern Spy
Greening	Honeycrisp	Northwestern Greening
Idared	Jerseymac	Stayman
Jonagold	Jonamac	
Jonathan	Macoun	
Lodi	McIntosh	
Mutsu	Mollies Delicious	
Niagara	Nova Mac	
Nittany	Pioneer Mac	
Paula Red	Quinte	
Pink Lady	Redfree	
Rome	Sansa	
Rome Beauty	Spartan	
Spigold	Summered	
Twenty Ounce	Wayne	
Yellow Transparent	Wealthy	
	Winesap	

Table 2: Relative Susceptibility of Common Pear Cultivars and Rootstocks to Fire Blight

Highly susceptible	Moderately susceptible	Moderately resistant
Bartlett	Anjou	Kieffer
Bosc	Asian Pears	LeConte
Clapp's Favorite	Comice	Magness
Flemish Beauty	Douglas	Maxine
Gorham	Ewart	Moon Glow
Hardy	Garber	Starking Delicious
Red Bartlett	Lincoln	Tyson
Reimer Red	Seckel	Waite
Sheldon		
Winter Nelis		

Table 3: Relative Susceptibility of Apple Rootstocks to Fire Blight

Highly susceptible	Moderately susceptible	Moderately resistant	Resistant
Alnarp 2	Antonovka 313	Bud. 9	Bud. 490
C.6 (interstem)	Bemali	Geneva 11	C-G 210
EMLA 9	Bud. 118	Geneva 30	Geneva 16
M 9	Bud. 140	Geneva 65	M.4
M.26, EMLA 26	MM.106	M.7a, EMLA 7	MM.111
M.27, EMLA 27		Novole	Seedling
Mark		P. 18	
Ottawa 3		Robusta	
P. 2			
P. 16			
P. 22			