



Fire Blight Annual Management Guide

Marion Murray, IPM Project Leader

In spring 2007, conditions in Utah were optimal for fire blight infection on blooming apples. At least 5 days had favorable conditions that resulted in high infection risk. By late spring, it was apparent that there were severe losses in many Utah orchards. Severe infections in sensitive apple blocks also occurred in 2008 and 2009. Because this disease moves invisibly and rapidly, it can catch growers off guard. Having a well executed and integrated year-round management program can reduce fire blight inoculum and future infections.



Fig. 1. Cankers often appear water-soaked or sunken (top). Scraping the bark away reveals the canker margin (bottom).

Why has Fire Blight Increased in Utah?

- due to consumer demand, most apple varieties grown today are also more susceptible to fire blight (Fuji, Gingergold, Gala), as opposed to the more resistant varieties previously grown (McIntosh, Red Delicious, Cortland)
- high-density orchards produce greater yield, but also allow the bacteria to spread rapidly from tree to tree
- trees planted in high-density orchards are often on dwarfing rootstocks such as M-26 and M-9 that are very blight susceptible

FIRE BLIGHT BIOLOGY

Fire blight is caused by the bacterium, *Erwinia amylovora*. Bacteria survive the winter in cankers, some of which are small lesions associated with wilted terminals, while others are large areas on scaffold limbs (Fig. 1). In spring, bacteria multiply and start oozing out of infected plant tissue, colonizing the bark surface. Bacteria become slowly active at 50° F and multiply more rapidly as temperatures increase.

In Utah, the most important infection entry point is through the blossoms. Bacteria from the oozing cankers are spread within plants and from plant to plant by wind-driven or splashing moisture and by pollinating bees or other insects (Fig. 2). When *Erwinia* bacteria are



Fig. 2. Bees can spread *Erwinia* bacteria to other flowers.

delivered to the flower stigma, they will multiply in temperatures greater than 50° F. Infection occurs when large amounts of bacteria on the stigma are washed into the floral cup by rain, irrigation water, or heavy dew. Only 2 hours of moisture is needed; heavy dew plays a big role in Utah in the infection process. Infected flowers wilt and turn brown or black, and bacteria quickly spread to leaves and down succulent shoots.

Shoot infections can sometimes occur later in spring or early summer, when bacteria is carried by moisture to foliage that has been injured by hail or other trauma. These infections are not associated with blossom blight or existing cankers, but are considered new infections. Once plant tissue has hardened off, the risk of shoot blight declines.

As tree growth slows down in hot weather, bacterial progress also slows. In some trees, damage may be minimal, while in others the tree may be severely damaged or killed, especially if bacteria have entered a susceptible rootstock. The bacteria “rest” in infected shoots, where the margin between dead and healthy tissue is usually obvious. The bacteria will stay in this tissue until trees come out of dormancy and temperatures rise the following spring.

WINTER

Pruning/Removal

Removal of overwintering cankers from dormant trees is one of the most important steps in managing fire blight. The bacteria overwinter in cankers, and removing infested plant tissue will reduce the amount of inoculum in the orchard, thus reducing future infections. Pruning can be done in winter and early spring when the weather is dry. Infected twigs are easy to identify because the leaves will remain attached well into winter (Fig. 3). Limbs with bark that appears wet, off-color, or sunken indicate a canker (Fig. 1). Cut the twig or branch at least 8 inches below the visible margin of the infection. It may take



Fig. 3. Leaves remain attached on infected twigs well into winter.

several trips through the orchard with the pruning crew, but the results will be worth it. Tools do not need to be sterilized between cuts.

The prior summer, the orchard crew may have pruned larger infected limbs back to a 4-inch stub or longer (see “Summer” section, below). That stub can be cut back to the main stem in winter (Fig. 4).



Fig. 4. Some trees may need heavy pruning, which is best done in winter. If larger branches are removed in spring, leave a 4-6-inch stub to be removed that winter.

All dead trees or severely infested trees should be removed at this time. Heavily infested trees are unproductive, and often it is impossible to remove all the blighted tissue with pruning.

Debris does not need to be burned or chipped. A cut branch on the ground will not be able to spread inoculum the following spring.

Remove all root suckers and rootstock sprouts at this time during regular pruning practices. If they become infected, they may put the entire tree at risk. Common dwarfing rootstocks such as M9 and M26 are highly susceptible to blight.

SPRING

Copper

Copper can damage foliage and fruit, so it is limited to applications when the tree is at or near green tip stage. The efficacy of copper sprays has been debated for years, with some experts claiming that copper has little effect while others claim that copper can reduce infection in the orchard.

Copper's effect is related to how it is applied and the weather after application. Copper does not kill bacte-

ria on existing cankers nor does it prevent bacteria from oozing out of cankers. It works by providing an inhibitory barrier on bark and buds, preventing widespread colonization of bacteria on these surfaces. As a result, copper must be applied as a high volume spray so that all exposed surfaces in the orchard are thoroughly wetted, including any trees considered to be resistant that are growing near susceptible trees (e.g., Red Delicious).

The greatest spread of bacteria through an orchard via wind-driven rain or insects is sometimes during the tight cluster to pink stages, which can sometimes be more than 2 weeks after green tip, when copper would have been applied. By this time, copper residues will have been reduced through weathering. We have not conducted studies on the use of copper in Utah. Whether a grower uses it or not will depend on a variety of factors including weather, cost, amount of inoculum in the orchard, and personal experience.

Copper could be an effective tool when used on flowers of young, non-bearing trees. The other alternative is to remove blossoms from these trees.

Detection of *Erwinia*

A new test to detect *Erwinia* bacteria in flowers called LAMP (loop-mediated isothermal amplification) will soon be available for a fee to apple growers in the state. LAMP will be used for early detection of fire blight bacteria in blossoms so that the grower can be prepared for antibiotic treatment when the model predicts a high risk.

Cougarblight Model

Cougarblight is the name of a fire blight risk prediction model for apples and pears in bloom. The model is based on several factors:

1. *local blight history of the orchard*: The presence or absence of blight in the orchard or nearby will affect the risk potential for infection. Infection is most likely to occur if there was fire blight in the orchard or in neighboring orchards last year.
2. *daily maximum temperature*: Although bacteria can start multiplying at 50° F, the most accelerated bacterial division occurs between 78 and 90° F. Infection may occur during slightly cooler conditions if there is a recent history of blight infections in the orchard. The model uses a 4-day accumulation of values related to each day's maximum temperature to determine risk potential. (The 4-day tally is used because stigma tips, on which bacteria colonize, are viable for about that long.) The 4-day tally may equate to low risk, caution, high risk, or extreme risk. For example, if the running 4-day tally for an orchard that had fire blight in the area last year is 250, then there is an extreme risk of infection.
3. *moisture*: If flowers are colonized with bacteria, infection will not occur without sufficient moisture to

wash the bacteria into the floral cup. The Cougarblight model provides a risk of infection if the flowers are wetted. The model does not tell whether there is moisture or not in the orchard. So this final step is up to the growers in their own orchards to determine. Wetting that triggers flower infection may come from 2 hours of rain, dew, misting from nearby irrigation, or light wetting from any form of sprinkler irrigation. Heavy rain or irrigation water that directly strikes the blossom does not seem to trigger infection, perhaps because the blossoms are actually washed relatively free of bacteria colonies.

You can access the fire blight model on the USU Climate Center website at: climate.usu.edu/pest. If you collect weather data for your own site, you can download an excel spreadsheet that will calculate blight risk based on the temperatures you enter: www.ncw.wsu.edu/treefruit/fireblight/2000f.htm.

Antibiotic Treatments at Bloom

Streptomycin (Agri-Mycin) is the most effective fire blight antibiotic available, but in parts of Utah, fire blight bacteria have developed resistance, limiting its use. Currently, the only other alternative antibiotic is oxytetracycline (Mycoshield). Antibiotics should only be used on open blossoms. They are not effective at any other time (for example on shoot blight or existing cankers).

1. **Streptomycin** is effective because it has slight systemic activity, it lasts 3-4 days, and it kills the fire blight bacteria. It can be applied up to 24 hours before or after a wetting event. Adding the nonionic spreader-activator Regulaid will improve coverage and uptake of streptomycin.

In areas of documented resistance, streptomycin can be used once per season, and it must be mixed with oxytetracycline on that one use. So it should be saved for the "most important" spray where it will be the most effective. In areas where there is no resistance, it is recommended to use only when necessary, and mixed with oxytetracycline to avoid resistance.

2. **Oxytetracycline** is not as effective as strep because it works by slowing down the division of bacteria rather than killing it. As such, it works best if applied 12-24 hours before a wetting event to target the bacteria before it is washed into the floral cup. Oxytet lasts about 3 days.

It is important to realize that not all trees bloom together, and that there can be late blooms even within cultivars. Because they are later, these blossoms are occurring when temperatures are warmer, resulting in a great risk for infection. As long as forecasts predict a high risk and blossoms are open, antibiotics may need to be reapplied for protection if there is 2+ hours of moisture.

Biologicals plus Antibiotics

The use of biologicals alone has not shown to be very effective in managing fire blight. Their best use is in an integrated management plan by combining or alternating with antibiotics. In areas of streptomycin resistance, biologicals can help oxytetracycline be more effective.

Biologicals work by competing for space and nutrients on the flower stigma, or by actually preventing fire blight bacteria from multiplying. They must be present on the flower stigmas before the fire blight bacteria arrive.

For best effect, follow these guidelines when using biologicals:

1. Increase water volume to 200 gal/acre. Trees must be wet for the biological to get started.
2. Apply the material when flowers are about 15-30% open (early bloom). A second application can be made when flowers are 75-100% open.
3. Apply in early morning when temperatures are in the low 60s. Below 50, the biologicals are ineffective and will die. The idea is to for the biological to colonize the flower before the fire blight bacteria have had a chance. A warm day after application is perfect. After successful colonization, it is OK if the weather turns cold the following day.
4. Do not mix other pesticides with biologicals.
5. Continue to watch the Cougarblight model and follow with an antibiotic when risk levels are high and 2+ hours of moisture is expected. When following with streptomycin, wait 1 day after biological application, and with oxytetracycline, wait 2 days after biological application.
6. Do not apply biologicals after fruit set.

There are a few options:

- **Serenade Max** is a gram positive bacteria (*Bacillus subtilis*, QST 713) that should be applied when flowers are just starting to open (1-5% bloom), and if temperatures are warm enough (above 60). It can be reapplied every 4-7 days.
- **BlightBan C9-1** and **Bloomtime Biological** contain different gram negative bacterial strains of *Pantoea agglomerans*, a commonly occurring orchard bacteria. BlightBan C9-1 and Bloomtime only work on blossoms that are open at the time of application, so thorough coverage is important.
- **Blightban A506** contains the beneficial bacteria *Pseudomonas fluorescens*.

Adding biologicals to your fire blight arsenal is certainly going to increase production costs, but where streptomycin is proving less and less effective, it may be a good option, and could help prevent losses in the orchard. New alternatives are constantly being evaluated and in the future there may be more effective products.

SUMMER

Control of Shoot Blight

The growth regulator Apogee (prohexadione calcium) can be used to control shoot blight (but not blossom blight). Apogee does not affect the pathogen directly, and is not a substitute for streptomycin during bloom for blossom blight control. Apogee-treated shoots have hard cell walls, physically barring the spread and growth of fire blight, reducing build up during the summer.

The decision to use Apogee is based on past blight history. Where infections are high and antibiotics and pruning are not proving effective, Apogee can help to lessen the spread within trees. The drawback is that the rate of Apogee that is required stops new growth and applications may slow development and result in reduced fruit size and return bloom. It costs about \$40-60 per acre.

To be effective, Apogee must be applied at 18-36 oz/acre in 300 gal at late bloom or early petal fall, with a follow up application 3 to 4 weeks later only on very vigorous trees (Fig. 5). Use Regulaid to improve coverage. It takes 10 days to 2 weeks for the first application to take effect against fire blight. Using Apogee later than recommended is not be effective against fire blight.



Fig. 5. To help stop or slow shoot strikes, Apogee should be applied at late bloom or early petal fall (1-3" shoot growth). Applications later than this timing will not be effective.

Prune New Infections

Where possible, pruning crews should be sent through the orchard on a regular basis to prune out new fire blight infections. Early detection and removal is the most effective management strategy, slowing the spread of fire

blight and reducing inoculum. Young orchards are most sensitive and should be given high priority. If crews can catch blossom strikes just as they begin (i.e., the leaves/flowers are just starting to turn color and wilt), the amount to remove should be double the length of the strike (Fig. 6). If the infection is older, find the edge of the canker and then prune 12" beyond that.



Fig. 6. Early pruning is important when battling fire blight. If crews can catch brand new infections, the amount to prune should equal the length of the visible infection. Otherwise, prune 8-12 inches beyond (the more the better).

Prune only in dry weather. Research in Quebec, Canada showed that it is not necessary to disinfect pruning tools between cuts so long as proper cuts are made (below, and not through, cankers). Pruning debris can be left on the orchard floor to be mowed, so long as the weather is hot and dry.

Where infections are more severe and older wood is affected, it is often best to wait until winter to do a thorough pruning. Research has shown that heavy pruning of fire blight during the growing season can actually increase the spread within the tree. If you decide to prune during the summer, some have recommended leaving a 4-6-inch stub on larger limbs rather than pruning directly back to the main trunk or larger scaffold. The fire blight bacteria will continue growing 1-2 inches beyond the cut surface, and the stub can be removed that winter.

To date, there are no effective sprays to be used on fire blight during the summer.

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