An Annual Fire Blight Management Program for Apples: An Update

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Seven years ago we wrote a guide for fire blight management in apples, stressing that fire blight needed attention every year. This followed a major epidemic in Massachusetts and other parts of the Northeast that occurred in 2007. Fire blight epidemics strike erratically, and often catch growers by surprise. In 2014, another major outbreak hit orchards from Pennsylvania/New Jersey to Nova Scotia, and we have decided to update our recommendations.

Fire blight frustrates growers and management consultants more than most apple diseases. Blight appears suddenly and moves quickly, and can cause significant damage in a matter of days. Orchards that have never had fire blight may suddenly be hit by an outbreak for no apparent reason. There are no foolproof ways to stop an epidemic in an orchard once it starts, and the chances that the disease may start up again the next year, and the next, are relatively high. Fire blight is both destructive and difficult to stop. Given how devastating a bad blight outbreak can be, it is important to be prepared.

There is an understandable but unfortunate tendency for people who have not experienced fire blight recently, or who have never faced it, to focus on other issues. But to keep an orchard fire blight free, it is critical that growers recognize that the potential for the disease is there every year, and use an appropriate management strategy. That strategy is to use multiple tactics in a year-round approach every year.

Know the Disease Cycle

Fire blight produces a well-known set of symptoms in a reasonably predictable cycle. Fire blight bacteria overwinter around the edges of cankers in tree wood, some of which may be very small and difficult to see. With warm weather, the bacteria produce a sugary, sticky ooze that attracts insects. The ooze with millions of bacteria in it sticks to insects, which then carry the bacteria to the apples and other plants they visit. When wind and rain come together, fire blight bacteria may be blown from tree to tree.

Blossom blight. Near bloom, the number of bacte-

Canker blight. The canker in this picture is active, with the bacterial ooze showing on the bark surface. (Photo: Utah State University)

ria will increase rapidly if temperatures are above 65ºF, and the warmer it is, the more rapid the increase. Bloom provides the most important natural entry point for the bacteria, and moisture that is sufficient to wash them to the base of flowers. This water may come as rain, but sometimes a heavy dew or the water in an airblast spray application is enough to move the bacteria to the base of the flower. Once there, they can enter nectaries, will lead to infections. Pollinating insects will also carry bacteria from flower to flower at this time. Once inside the plant, if there are enough bacteria, they will start to produce a toxin that kills apple tissue, releasing the contents of cells, which the bacteria use as food. The blossoms and stem tissue around them turn brown or black and wilt.

Canker blight. When bacteria become active in overwintering cankers, the edges or margins of the canker become less distinct. A water-soaked band of green or brownish tissue forms between the dead canker interior and the healthy surrounding bark. With warm weather, the bacteria move from the canker margins systemically into the new parts of trees. Even without blossom blight infections, in orchards where blight is established canker blight can cause significant damage, and is a source of inoculum for shoot blight.

Shoot blight. Fire blight bacteria can travel from blossom infections into the vascular tissue of the plant to shoots. Alternatively, new, succulent shoots can be infected directly well after bloom by inoculum from infected fruit clusters or active cankers. It is not clear whether bacteria gain entry to apple shoots via insect feeding or some other mechanism. Young trees, 3 to 8 years old, develop shoot blight rapidly. Infections can move from shoots to the main trunk in a few days. Bacteria in shoot infections often move a few feet ahead of any visible symptoms. New shoot blight does not develop after terminal buds have set.

Rootstock blight. Sometimes, bacteria from a few infections in the blossoms or shoots of a tree will move into the trunk and down it without causing any visible symptoms. If the tree is on a sensitive rootstock, for example M9, the bacteria will infect and destroy the rootstock. Symptoms including wilting, poor growth, yellow or red leaves may show up in mid-summer to fall, though sometimes the damage is not discovered until the next growing season. This damage is most common on relatively young trees, and inevitably it kills them.

Trauma blight. Sometimes physical damage may

Top: Damage from blossom blight. Bacteria entered through the flowers in the fruiting cluster, and spread into leaves and the stem. Middle: Shoot blight symptoms early July. Bottom: Tree with rootstock blight, showing healthy scion and dead rootstock. (Photos: J. Clements, Univ. of Mass.)

also allow bacteria to enter plants and establish infections. Wind whipping and hail associated with summer storms are the most common cause such infections.

As growth slows and trees set terminal buds, fire blight bacteria stop moving. The tree becomes much more resistant to them, stopping the spread of infection in trees, and from tree to tree. In response, bacteria collect around the edges of damaged tissue, the canker margin, and wait for the plant tissue to start growing again the next spring.

Dormant fire blight canker. It should have been pruned out when the infected branch was pruned, rather than leaving it in the orchard. (Photo: M. Longstroth, Mich. State Univ.)

Watching the Microbe

Unfortunately, unlike insects and most other kinds of pests, bacteria cannot be seen. Populations of *Erwinia amylovora*, the bacteria that cause fire blight, are usually present at some level in all apple and pear orchards, on the surface of most apple trees and on other plants as well. There just are not enough of them to cause disease. But bacterial populations explode, and when they do, they can cause serious damage in very little time. To avoid that, assume that *E. amylovora* is always in an orchard, and steps need to be taken to keep the population below damaging levels. In the next sections, we outline a set of practices that should be done each year to accomplish that goal.

Winter

1 - Winter pruning. Dormant pruning of infected wood is critical to fire blight management. Even in "clean" orchards, it is important to look for possible cankers and remove them. This pruning gets fire blight primary inoculum out of the orchard, so that it will not be there to launch an epidemic in the spring. Applying copper or other chemicals will not kill bacteria inside cankers, but only affects bacteria on the surface. The wood that contains the bacteria has to be removed.

Green Tip

2 – Early season copper. Regardless of whether fire blight has been a problem in the past, at silver tip to green tip growers should apply copper to the orchard. Copper is applied because it is toxic to the fire blight bacteria. It is applied this early in the season because it can also be toxic to new apple leaves and fruit. Copper applied later than half-inch green will russet fruit. To be effective, copper residues need to cover the tree as thoroughly as possible - think dilute. The purpose of the copper is not to kill bacteria inside the tree, but rather to reduce build-up of bacteria on apple buds and bark. The more dilute the spray, the better the coverage and efficacy. To minimize the risk of russeting, apply when drying conditions are good, and avoid applying to wet foliage or when drying will be slow.

There are many types of copper. Formulations used on apples have generally been "fixed", meaning that they are less soluble in water. Examples of the most common fixed coppers include basic copper sulfate, copper hydroxide, and copper oxychloride sulfate. Typical copper products contain from 20% to 50% metallic copper. Newer products, such as copper octanoate (Cueva) and copper ammonium (Previsto) contain less metallic copper (1.8% and 3.2%, respectively), and are being evaluated for use on apples against fire blight during active growth later in the growing season.

Because the amount of copper in different products varies, it is useful to think in terms of pounds of metallic copper applied per acre, though it isn't always easy to calculate. Apply a minimum of 2 lb. of metallic copper per acre, as this should generally provide enough copper residue on bark and leaves through to pink to have some impact on bacteria without causing russet. Formulations vary in how well copper is retained, and

of course weather will also have an impact, but the 2 lb./A rate of metallic copper is a reasonable rate for both efficacy and safety. If in doubt about how much metallic copper a product contains, use the high label rate recommended at silver to green tip. Copper may be used with oil (1 qt./100 gal.), which can act as a spreader/sticker for the copper. Copper also may be applied with a regular 3% oil spray applied at delayed dormant to quarter-inch green.

Because copper sprays are meant to suppress the population of *E. amylovora* in an orchard, spray the whole orchard, not just the most susceptible cultivars or places where fire blight has occurred in the past. Leaving some trees unsprayed by the early season copper application may leave places for the fire blight bacteria to build up to dangerous levels. The tolerant cultivars may not be damaged, but bacteria may mover to susceptible trees after copper protection has decreased or disappeared. The spray will also protect against apple scab for a week.

3 – Monitor for fire blight risk at bloom. Protecting trees at bloom is critical. The overwhelming majority of fire blight epidemics start at bloom, with bacteria carried from flower to flower by insects. Fire blight bacteria grow on flower pistils, and with rain or other moisture, move to nectaries at the bases of flowers where they get inside apple tissue. The shock waves from these primary infections will reverberate in an orchard through the summer and beyond, so it is essential that growers make a focused effort to stop blossom blight. Growers or their advisors should use a fire blight forecasting model.

There are several options that may be used to forecast fire blight risk. Probably the simplest solution is to use an on-line service, such as NEWA (Network for Environment and Weather Applications, Cornell), SkyBit which sells E-Weather Service (Bellefonte, PA) or Ag-Radar (University of Maine Extension), that provide weather-based fire blight risk forecasts. Note that New Jersey growers have free use of NEWA via 55 weather stations managed by Rutgers University. The NJAES covers the cost of funding NEWA on behalf of New Jersey Growers. Take advantage of this service! Note growers can also purchase their own weather station and subscribe to NEWA directly. http://newa.cornell.edu/

Ultimately these forecasts rely on one or the other of two models, CougarBlight developed in Washington State or MaryBlyt developed in Missouri and Maryland. See the article in the upcoming 2015 summer issue of Horticultural News Or Fruit Notes on fire blight forecast models for details on differences between these options. Independent crop consultants or university outreach may also give either on-line or individual forecasts of fire blight risk. Regardless of how it is done, it is critical that growers know what the fire blight risk is during bloom and take appropriate action.

4 – Spray streptomycin at bloom if needed. There are other antibiotics and products that can be used to manage fire blight, but the most effective and cost effective is streptomycin. In some areas, resistance to streptomycin has developed, but so far in New England no resistance has been found. Recently, organic growers lost streptomycin as an option. While some growers may need to consider alternatives, it is more difficult or expensive or both to use these products.

To preserve its effectiveness, streptomycin should not be overused. If risk of fire blight is low, then it should not be sprayed. The only time streptomycin should be used is when there is a predicted risk of fire blight during bloom. Streptomycin is not effective against cankers or shoot blight, and should not be used in protective sprays targeting either problem. Using it at this time promotes resistance. (There is one exception

Russet caused by copper on apple fruit. (Photo: T. Smith, Washington St. Univ.)

to this, and that is when there is a damaging "trauma" event such as a hailstorm, when streptomycin can be applied within 12 to 18 hours to reduce the risk of fire blight infection).

Streptomycin is sold under multiple brand names including Ag-Streptomycin, Agri-Mycin, AS-50, Bac-Master, Firewall, Harbour. There are other antibiotics available. Kasugamycin (Kasumin) is an antibiotic that is as effective as streptomycin, and can be used where resistance has developed to streptomycin. However, at this time Kasumin is significantly more expensive than streptomycin products. Oxytetracycline (FireLine, Mycoshield) is another antibiotic that is registered for fire blight on apples, but it is not as effective as streptomycin or kasugamycin.

There are several biopesticides registered for use against fire blight, but these also are not as effective as streptomycin. These products include Bloomtime (bacteria, *Pantoea agglomerans*), BlightBan (bacteria, *Pseudomonas fluorescens* A506), Serenade (bacteria, *Bacillus subtilis* qst 713), Double Nickel (bacteria, *Bacillus amyloliquefaciens* D 747), Actinovate (bacteria, *Streptomyces lydicus* WYEC 108) and Regalia (a plant extract from giant knotweed). Blossom Protect (yeast, *Aureobasidium pullulans*) is registered in some states, but not New England. The performance of these biologicals is less consistent than the antibiotics, particularly streptomycin. In tests where they have been effective, they at best achieve about half the level of control as streptomycin.

IInsects carry fire blight bacteria from apple blossom to apple blossom. Adapted from photo by Orangeaurochs from Sandy, Bedfordshire, United Kingdom [CC BY 2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons

Streptomycin injury on apple leaves. (Photo: D. Rosenberger, Cornell Univ.)

Streptomycin has little ability to penetrate closed flowers; bloom must be open for the best effect. When streptomycin is applied to open flowers, those flowers generally will be well protected through petal fall. However flowers do not open all at the same time. Again - only open flowers at the time of the application are protected. New-formed fruit do not have an opening to allow bacteria to enter, and are much more resistant to infection. It is critical that streptomycin applications cover flowers well, so avoid poor spray conditions (wind, etc.) and no alternate row applications. Apply as high a water volume per acre as practical (100 gallons per acre minimum is suggested. Adding the nonionic spreader-activator Regulaid will improve coverage and uptake of streptomycin.

For maximum uptake, apply streptomycin when drying is slow. Evening or night applications are good, as light also breaks down streptomycin. Be careful about using Regulaid with some fungicides, such as captan, as uptake of captan into fruit can cause russet.

"Hopper burn" on apple (top). Browning along edges, curling and yellowing are typical of potato leafhopper damage on apple. (Photo: R. Bessin, Univ. of Kentucky Extension). Potato leafhopper adult and nymph (bottom). (Photo: Michigan State University).

(Many are recommending that Captan not be used until second cover. Instead, the EDBC fungicides should be used as protectants until then). Apply 8 to 16 oz. of formulated streptomycin (24 to 48 oz./acre) plus 1 pint of Regulaid per 100 gal in the first spray. If you have small trees and calculate tree row volume, do not drop below 12 oz. streptomycin product per acre. If no Regulaid or gylcerin is added, the minimum rate of streptomycin should be 24 ounces per acre.

While streptomycin may be concentrated in low volume sprays, Regulaid should be mixed based on the actual water volume. For example, if a sprayer holds 300 gal, and the spray rate is 50 gal per acre, at a rate of 12 oz. streptomycin per acre, put 60 oz of streptomycin in the tank with 3 pints of Regulaid.

When risk of fire blight remains high for several days during bloom it may be necessary to reapply streptomycin within two or three days of the first application because a significant number of new flowers open. In some cases, a third or fourth application may be required. Too much streptomycin in tissue can damage leaves, causing yellowing particularly around the leaf edges. It is not clear that this damage significantly impacts tree health or fruit yield. But if second, third or fourth applications are needed, use streptomycin alone at the 24 oz/A rate without Regulaid to minimize phytotoxicity.

5 – Deal with late blossoms. Another often overlooked problem with bloom sprays is that bloom is not synchronized across all trees in an orchard. It does not start or stop all at once. In any given cultivar, bloom may stretch over a week or two, and cultivars differ. As long as forecast models indicate a high risk of blight, and flowers are opening, streptomycin will need to be reapplied to them for protection.

Late blooming varieties, young trees, or cultivars that have a few late blossoms present a particular problem. As long as there are high numbers of bacteria and open flowers, blight can get started.

Remember that many of our newer cultivars have a significant amount of bloom occurring on one-year wood. This bloom is undesirable horticulturally as it produces small fruit which need to be thinned. It also may happen 7-10 days later than regular bloom. For these non-bearing trees, getting rid of the flower buds by pinching them off will remove the opportunity for bloom infections. But pinching can also open trees to infection. So, do not pinch off flower buds during wet weather, and apply streptomycin before pinching flower buds.

Finally, do not spray streptomycin after bloom. While limiting streptomycin to one to four applications during bloom has never been shown to cause resistance to streptomycin, spraying after bloom has. Spraying streptomycin after bloom has relatively little impact on fire blight, but will greatly increase the risk that *E. amylovora* will become resistant to it.

6 - Control leafhoppers- Once bloom is over, there is still a risk of new infections appearing as shoot blight. Shoot blight infections start on the very youngest two or three leaves at the end of a shoot, and the bacteria need some way to get into the leaves. Microscopic damage, the type caused by piercing and sucking insects, is enough. Whether leafhoppers actually carry bacteria from shoot to shoot is not known, but their feeding alone can open new leaves to infection if the population of bacteria on the leaf surface is sufficiently high. It is worth making sure that leafhoppers are controlled if conditions favor fire blight, and especially if there is fire blight in or near an orchard.

There are three species of leafhopper present in most orchards: 1) white apple leafhopper, 2) rose leafhopper, and 3) potato leafhopper. Of these, potato

Fire blight susceptibility ratings for apple rootstocks, listed in order of size reduction of the rootstock*

Rootstock	Fire Blight Rating	Rootstock	Fire Blight Rating
Seedling	Tolerant	Geneva 11 (G.11)	Mod. resistant
MM.111	Tolerant	Ottawa 3 (O.3)	Susceptible
MM.106	Mod. susceptible	Geneva 16 (G.16)	Very resistant
M.7a, EMLA 7	Tolerant	M.9 strains	Very susceptible
CG. 6210	Resistant	Geneva 41 (G.41)	Highly resistant
Supporter 4	Highly susceptible	Bud. 9 (B.9)	Field tolerant**
Geneva 30 (G.30)	Highly resistant	Mark	Susceptible
Geneva 935 (G.935)	Highly resistant	Geneva 65 (G.65)	Very resistant
Geneva 202 (G.202)	Highly resistant	M.27, EMLA 27	Susceptible
M.26, EMLA 26	Highly susceptible		

*Adapted from NC 140 report, http://nc140.org/2011/rootstockcharacteristics.pdf
**Bud 9 is sensitive to fire blight in laboratory tests, but shows resistance in field tests, particularly on trees over 3 yr old

Root suckers at the base of an apple tree. (Photo: J. Clements, University of Massachusetts.

leafhopper has been most often implicated in the spread of fire blight. Potato leafhoppers are yellowish to pale green, and nymphs move sideways when disturbed. They overwinter in southern states and near the Gulf coast, move into our area in early June, and are present until the end of the season. Physical feeding injury will appear along leaf margins as a dried "burned" look, and may often be confused with nutrient deficiencies. Again, if fire blight is present, no PLH should be tolerated. They should be controlled with an insecticide.

7 – An Apogee decision for shoot blight. The growth regulator Apogee has the ability to control shoot blight. Under normal conditions, Apogee does not control blossom blight. It works by thickening cell walls, making them more resistant to bacterial attack. Unfortunately, Apogee has to be applied well before shoot blight symptoms are visible. It takes 10 days for the first application to take effect. At the same time, Apogee's primary purpose is to slow or stop tree growth, and this will impact how quickly a new planting can be developed and brought to optimum productivity. Ultimately the decision to use Apogee has to weigh the risk of shoot blight against growth inhibition.

Increasingly plant pathologists are recommending that growers use low rates of Apogee on all young trees (2 to 5 years in the orchard). In addition to age, the risk of shoot blight increases with the severity and number of bloom infection periods, the susceptibility of the cultivars and rootstocks in the orchard. Research indicates that 3 to 4 oz./ 100 gal. Apogee (9 to 12 oz./A dilute on 300 gal./A trees) applied at bloom and again 7 to 10 days later gives significant protection against shoot blight, while allowing trees to still grow and develop adequately. This rate is well below the 18 to 36 oz./A rate recommended for 300 gal./A trees on the Apogee label and the approach must be considered experimental. Correct timing is critical and rates must be adjusted according to the tree row volume directions on the Apogee label if concentrating.

Do not use Apogee with boron or calcium as these will reduce its effectiveness. If spray water is "hard", that is, high in calcium and other minerals, it will reduce Apogee uptake. To insure good uptake, add ammonium sulfate equal to the weight of Apogee used, even if you are unsure about the amount of calcium in your spray

water. Two pints of the water conditioners Quest or Choice Weather Master can be used instead of 1 lb. of ammonium sulfate.

8 – Rootstocks and sucker control. Many of our commonly planted dwarfing rootstocks are highly susceptible to fire blight, though tolerant and resistant rootstocks are available. We recommend that growers consider moving away from the highly susceptible M9 and M26 rootstocks, and consider the Geneva rootstocks. It is interesting that B9 is rated susceptible in laboratory tests, but shows resistance in the field, and many growers are using it in tall spindle orchards.

Early fire blight symptoms in a fruit cluster. (Photo: V. Philion, IRDA, Quebec.

Controlling root suckers is essential as root suckers may provide an entry point for fire blight bacteria. They should be removed. Ripping or pruning suckers can leave an open wound, and that may be an entry point in itself. So chemical treatment of suckers with NAA should be done in blocks where there are susceptible rootstocks. Several herbicides have activity on apple suckers, though care needs to be taken in their use so as not to damage trees. Always avoid contact with green bark on the tree, and never use glyphosate for sucker control.

In blocks with active blight, it may be more important to prune (not rip) suckers as soon as possible rather than waiting for NAA or other chemical treatment to kill them. When it comes to pruning, the highest priority is for root suckers on M.9 and M.26 rootstocks.

Summer

If models indicated a risk of infection during bloom, monitor trees closely for signs of fire blight after petal fall. If trees were infected, the sooner the infections are found and removed, the better. In addition, new shoot blight infections may develop after petal fall but before terminal buds are set. After terminal buds are set, fire blight stops moving as the trees become much more resistant to the disease.

9 - To cut or not to cut? When a surprised and anxious grower first sees the hooked and wilting tips of blighted fruit clusters or shoots, the next question is almost always "Should I cut it out?" The answer is "Yes, as soon as possible." It is important to remove the infected tissue before the bacteria have a chance to move along shoots and into branches and cause significant damage. So keep an eye out for damage.

But do not prune during wet weather. It will spread the bacteria. Throw prunings on the ground in the aisle and allow them to dry a couple of days until the bark no longer slips and the cambium is brown. Moving them out of the orchard when they are fresh risks spreading bacteria.

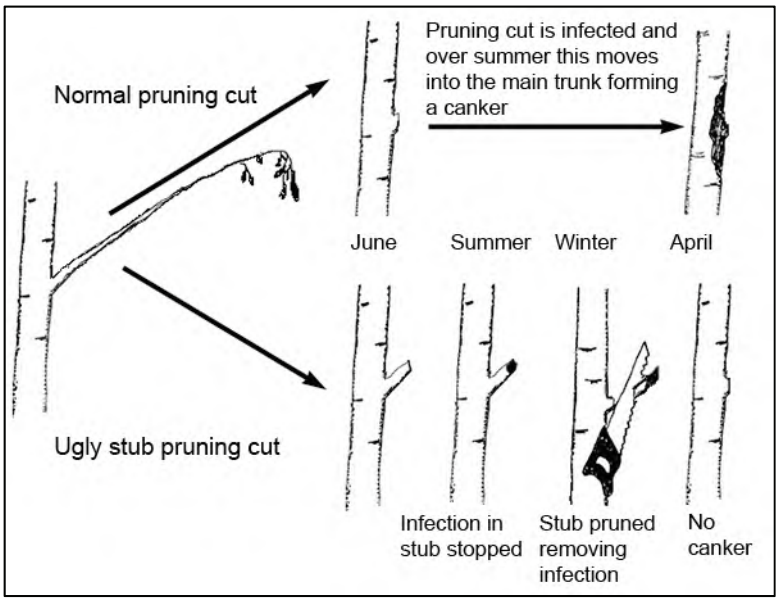
Dave Rosenberger of Cornell suggests a type of "fire blight triage" when it comes to making pruning decisions going from highest to lowest priority: 1) young orchards 3-8 years old with just a few strikes; 2) young orchards 3-8 years old with severe strikes; 3) older orchards with a few strikes; and 4) walk away group- orchards with so many strikes that most of the tree would need to be removed, severe pruning can stimulate new growth that can become infected.

Again, to be most effective, strikes should be pruned out as soon as symptoms appear, and daily checks should be done to stop developing disease. Fire blight bacteria move quickly, up to several inches a day, and new infections can be established in a matter of hours. Work fast, and train workers – pruning fire blight is far different from pruning for fruit production!

When pruning fire blight, the best method to use is the "ugly stub" approach developed by Paul Steiner. Make cuts into wood that is at least two years old. Two-year-old wood is more resistant to fire blight than one-year wood, and can slow or stop infection movement in the tree. Fire blight bacteria travel well ahead of visible infection, so cut at least 18 inches below visible infections. Cutting back to a 4 to 6 inch naked stub in

two-year-old or older wood allows the tree to use its own resistance to isolate disease in the stub.

Inevitably the fire blight bacteria will form a canker an inch or two in from a cut surface. Sterilizing tools will not stop this, so it is not worth the effort. As a result, if a flush cut is made back to the branch collar, the resulting bacteria colonization and canker will form an inch or two into the next limb or in the trunk. By leaving a stub, the canker forms in it, and the stub can be cut off with the canker during the next winter.



Ugly stub pruning to reduce spread of fire blight and canker formation. (Revised from University of Maryland Extension)

10 – Do not expect much from summer sprays. Most fruit growers are used to answering disease outbreaks with their sprayers. Unfortunately, there is no proven, chemical response that is effective against active shoot blight. Remember, streptomycin sprays at this time are largely a waste of time and will hasten resistance.

We mentioned newer copper materials and biological alternatives earlier. Any of the suggestions given here are new, and their effectiveness and potential problems are not well understood.

Field tests of a Cueva, a copper product (copper octanoate) containing a relatively low concentration of metallic copper, in combination with a biocontrol, Double Nickel (*Bacillus amyloliquefaciens* strain D747), has shown promise in stopping shoot blight comparable to the performance of Apogee, with minimal russet (Yoder, Virginia Tech). The Double Nickel apparently significantly reduces the russet produced by Cueva alone. Another new formulation of copper, Mastercop (copper sulfate pentahydrate) plus Double Nickel has shown similar results in one year of tests in Virginia.

Apogee can slow fire blight if applied at bloom to petal fall Applications made after that, for example on infected shoots, are not effective. Apogee is not effective on active fire blight.

In addition to Double Nickel, other biointensive products have shown some level of control against fire bight. Generally, these materials used alone are about half as effective as streptomycin against blossom blight. There are far fewer tests of biopesticides against shoot blight. Serenade Optimum (*Bacillus subtilis* QST 713) and Taegro (*Bacillus amyloliquefaciens* strain FZB24) have shown some efficacy. Taegro performs similarly to Double Nickel. Regalia, a plant extract, has also shown some efficacy. Again, these materials are still being evaluated.

Since the introduction of Aliette, there have been suggestions, even recommendations, that phosphorus compounds known as phosphites and phosphonates (e.g. ProPhyte, AgriFos, Phostrol) can control fire blight. Unfortunately trials indicate that these compounds are not effective against shoot blight.

Use an Integrated Approach

Keeping fire blight out of an orchard, or at least down to acceptable levels, takes year-round effort and involves several tools. Perhaps with fire blight more than other apple diseases, there is no silver bullet. Preserving the best single tool there is, streptomycin, requires that other practices for fire blight be used as well. But used together on an annual basis, an integrated program greatly reduce the chances that fire blight will become a serious epidemic in an orchard.

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