How Good Are Our Options with Copper, Bio-controls and Alliette for Fire Blight Control?

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Introduction

Fire blight is a greater problem today than in the past because our orchards and orchard management practices have changed considerably. There has been a shift toward the more lucrative fresh fruit market with many new varieties like Gala, Fuji, Braeburn, Gingergold, Jonagold which are very susceptible to fire blight. Orchards are also now planted at higher tree densities using 500 to 1,000 instead of 100 to 200 trees per acre. Such densities require smaller trees which is accomplished by using certain dwarfing rootstocks and tree training techniques that promote more bearing surface and less overall structure. The favored rootstocks are M-26 and M-9, both of which are very susceptible to fire blight and the tree training methods may contribute to the problem by reducing some of the inherent physiological resistance in apples to the progress of infections. In all, the risks for major limb and tree losses following even a modest outbreak of fire blight is much greater now than it was just 10 to 20 years ago.

With this increase in susceptibility to fire blight, the highly erratic nature of the disease and it destructive potential, it is often tempting to use existing materials for control more frequently than necessary Ajust for insurance@. This approach is especially dangerous now because we have only one effective antibiotic for preventing blossom infections -- streptomycin. Throughout the U.S., the emergence of streptomycin resistant strains in nearly all cases has been preceded by the excessive use of this antibiotic at six or more times per year on a routine basis. Fortunately, streptomycin has been traditionally used more conservatively in the mid-Atlantic region so we have yet to see significant problems with resistance. That situation, however, can change quickly in just a few years of excessive use when disease pressures are high.

In this situation we have two alternatives: [1] use streptomycin more efficiently, and [2] find alternative methods of control. Our best chances for stabilizing the risks for antibiotic resistance and for suppressing the damage caused by fire blight over the long term is to try to use both approaches wherever that can be done economically and effectively. Of the alternative methods currently available, three have received considerable attention in the research and trade literature: [1] use of copper containing materials; [2] use of Alliette or fosetyl-aluminum to trigger the apple tree=s natural defense mechanisms; and [3] use of bacterial bioantagonists for biological control. The purpose of this brief report is to review the current status of these options.

Copper Materials for Fire Blight Control

Copper sulfate was used in the mid-eighteenth century to control stinking smut of wheat. In the late nineteenth century, Millardet in the Bordeaux region of France found that a combination of copper sulfate and lime was effective against grape downy mildew. This so-called "Bordeaux mixture" has been used ever since in controlling a variety of fungus and bacterial diseases on many different crops. The effectiveness of copper against various pathogens is attributed to the availability of copper ions that inactivate many different enzymes and other proteins essential to vital cell membrane function. Unfortunately, this broad mode of action is not restricted to microorganisms but can also damage foliage and fruit on the crop plant. Indeed, on apples, this potential for phytotoxicity is the single most important factor limiting its effective use against fire blight beyond the green tip stage.

Alan Biggs (West Virginia University), Keith Yoder (Virginia Tech) and I have all looked at ways in which copper materials might be used safely after bloom to control, but we have all encountered problems with cumulative toxicity following multiple sprays and we still do not have reliable data on the efficacy of these materials used in this way. Thus, for now, we are limited to recommending copper treatments for use as a green tip spray. In making this treatment, however, it is important to first understand exactly what it is we wish to accomplish and how that might effect a developing epidemic. The primary purpose of this treatment is *not* to kill bacteria in the cankers or even to kill the bacteria as they ooze out of such sites. Indeed, even where copper residue covers the canker surface, the ooze is forced out in droplets or strands that "poke through" that residue exposing many live bacteria for dispersal in the orchard. The real role for copper in controlling fire blight is to provide an inhibitory barrier over all bark and bud surfaces in the orchard that will prevent the bacteria from colonizing these areas.

Keep in mind that, unlike apple scab, where spores are dispersed within hours of infection, the bacteria causing fire blight are dispersed, colonize and are redispersed repeatedly for several weeks before bloom when the first infections might occur. This, coupled with the fact that infections, when they occur, happen within minutes not hours, explains why incidents of fire blight often appear "explosive". Our recommendations for the use of copper materials at green tip, therefore, is to interfere with the widespread colonization of bark and bud surfaces throughout the orchard. For this to be effective, coverage must be thorough so a high volume spray is needed to completely wet all exposed surfaces in the orchard. In addition, since the dispersal and colonization of the bacteria is random and independent from the resistance or susceptibility of the trees, ***all of the trees in a treated block must be sprayed, not just those of susceptible varieties.*** Failure to also spray the normally fire blight resistant Red Delicious trees in an orchard interplanted with fire blight susceptible varieties provides a safe harbor for the bacteria to colonize and later be dispersed by honey bees to open flowers on all varieties, reducing if not totally negating the value of the treatment. Similarly, spraying only the fire blight susceptible crab apple pollinators in a Red Delicious orchard does not prevent the colonization of Red Delicious trees so that the stage is set for trauma blight damage to these if hail or high winds occur.

From a practical and economic standpoint, the copper material will serve effectively as the first scab spray of the season needed at green tip and it can also be tank mixed with 2 percent spray oil for mite and scale insect control at this time. The alkaline nature of most copper formulations, however, means that it cannot be used with most other insecticides and fungicides. For both efficacy and crop safety, the best timing for the copper treatment is after bud break at the green tip stage. Based on the modeling we=ve done in developing the *MARYBLYT*™ program, we think the greatest flux of bacteria onto bark surfaces occurs at about the tight cluster to pink stage. In some years this can be several weeks after a dormant application so that the copper residues we are counting on to prevent colonization can be greatly reduced through weathering. Work by Dave Rosenberger at Cornell warns against applications later than the half-inch green stage because these can produce unacceptable levels of fruit and foliar damage.

Use of Alliette Fungicide for Fire Blight Control

Alliette, a new fungicide from Rhone-Poulanc, has shown efficacy in controlling collar rot, caused by the fungus *Phytophthora cactorum*. Alliette is also registered for use as a preventative against blossom blight, but the data supporting such a use is not at all convincing. The material has been tried for several years in Europe, the U.S. and Canada. Test results show that Alliette is never better than streptomycin, often affords significantly less control and, sometimes, appears to be ineffective. Alliette is reputed to trigger the production of inhibitory substances within the apple tree that provide some degree of natural resistance to fire blight. Whether this is the only mode of action or whether it applies equally well across all apple varieties is not known. Because of its systemic activity, it may ultimately prove to be more useful in reducing canker blight or rootstock blight, but to my knowledge no research is underway along these lines.

The bottom line on the use of Alliette for blossom blight is that its activity is too unreliable given the risks for severe crop and tree loss that are present even where the amount of fire blight may be modest.

Use of Bioantagonists for Fire Blight Control

The use of biological control methods has always been an attractive goal for integrated crop management programs and, in some cases, they have proven to be very effective. However, it is important to understand the nature of biological control in that we are depending on a living organism to grow, multiply, and be dispersed as well and as rapidly, if not more so, than the pathogen or pest we hope to control. Just as the populations and dispersal of the fire blight bacterium vary with the weather, we can expect similar effects on most bioantagonistic microorganisms.

At present, there are two bacterial antagonists that have shown good activity in protecting against fire blight. One such material is marketed since 1995 as Blight Ban uses a strain of the bacterium, *Pseudomonas fluorescens,* Pf-A506. This agent multiplies rapidly and colonizes open flowers to the extent that it excludes any significant subsequent colonization by the fire blight organism. Tests in many locations, however, show that if this antagonist is applied after *Erwinia amylovora* is already present or even as a mixture with the pathogen, it is not effective. The second promising bioantagonist is another bacterium, *Erwinia herbicola,* strain C9-1, which is a common epiphyte on apples. In addition to the competition for space that occurs with Pf-A506, *E. herbicola* C9-1 also produces an antibiotic of its own that inhibits the multiplication of the pathogen. Like its A506 counterpart, this second bioantagonist must also be present in the flower before the arrival of the pathogen for it to be effective. This later strain, however, has not yet been approved by the EPA and so is not commercially available.

Both bioantagonists provide a moderate level of control against fire blight in most trials conducted across the U.S. There have been, however, a few unexplained failures which may have been due to other factors not under control of the researcher. Neither one nor both of these bioantagonists provide the overall control for blossom blight that is as dependable or as effective as streptomycin. Keep in mind, too, that while streptomycin appears to prevent or ameliorate some of the damage in trauma blight situations and is not effective against shoot blight, nothing is known about how these bioantagonists might affect phases of fire blight epidemics other than blossom blight. Since both strains are resistant to streptomycin (gene lies on the chromosome and not on a transmissible plasmid, so this type of resistance should be safe in that it is not likely to be transferred to pathogen strains), the best use of these bioantagonists at the beginning and at full bloom treatments along with streptomycin treatments scheduled in response to predicted infection events. At the present stage of development, these materials are probably a less attractive alternative to streptomycin in the mid-Atlantic region than in the western U.S. where it is reported that up to 85% of the pathogen isolates are already resistant to streptomycin.

On a more positive note, look for the development of other bioantagonistic strains of bacteria and, possibly, some yeasts as effective management tools for fire blight in the future. Early tests on some of these suggests greater activity and multiple modes of action that might work favorably in this region. Realistically, however, since apples is still considered a "minor" crop, one of the determining factors in how quickly and broadly new strains might be registered will be how well they act against other bacterial pathogens of other crops or have other complementary action such as frost protection.

Preserving the Effectiveness of Streptomycin

Given the limitations of the above alternatives to streptomycin, we must pay special attention to effective resistance management tactics when using this valued antibiotic. In this regard:

1. Limit the use of streptomycin to bloom sprays needed to prevent blossom blight. Make these treatments only when needed using a forecasting program such as *MARYBLYT*™ to anticipate primary infection events. In this area this will mean zero to two applications in most years and, sometimes, three or four when bloom periods are extended.

2. Streptomycin is ineffective against canker blight and shoot blight and it should never be used in a protective program for this purpose.

3. Adopt an aggressive fire blight management program aimed at reducing the number and distribution of inoculum sources for all phases of the disease every year regardless of how much blight occurs and *never* apply streptomycin when symptoms of fire blight are present in the orchard.

4. The only exception to Rule 3 above is when streptomycin might be used immediately (within 12-18 hrs) following hail or high wind damage where there is a risk for trauma blight and treatments can be made within the allowable preharvest interval of 50 days on apples or 30 days for pears. Understand that this last approach is a "rescue mission" and that follow-up cutting as described earlier in this meeting will be needed.

Summary

While there is a specific and justifiable role for copper materials in our current fire blight management program, copper treatments alone will not control this disease. Alliette is specifically not recommended at this time, because all test results thus far indicate that its effectiveness is too unreliable. The use of some Frost Ban (*Pseudomonas* A506) may provide some level of frost protection during the bloom period, but it should not be relied upon exclusively for fire blight control. Until we have more effective alternatives, we need to conserve the use of streptomycin by using it wisely as part of an overall aggressive fire blight management program.