Alternative Fire Blight Control Materials to Replace Antibiotics

The antibiotics streptomycin and oxytetracycline are the primary tools used by conventional and organic growers to prevent fire blight (*Erwinia amylovora*) infection of apple and pear trees during periods of high risk. Use of these materials is guided by disease models tailored to different regions of the country (e.g., COUGARBLIGHT, MARYBLYT, Thomson-Schroth Average Temperature Model, Zoller Degree Hour Model). Treatments are not applied in those situations when the models do not indicate sufficient risk. Growers deploy other practices as part of a fire blight management program, but antibiotics are the last line of defense when infection risk is high. Once infected, no available materials provide a curative effect; the antibiotics act in a preventative mode only.

The National Organic Program has included antibiotics for use only on fire blight on apples and pears as part of the National List of Allowed Synthetics since the program began in 2002. The National Organic Standards Board has now set October 21, 2014, as the expiration date for their use and has requested information on the status of alternative controls. Research on biological controls of fire blight has been on-going since the 1980s (Vanneste, 2011). Blight Ban A506 and Serenade were introduced in the 1990s, and Blight Ban C9-1 was registered, while Bloomtime Biological was put on the market in the 2000s. These developments have been supported by over $600,000 in grower funds on research for non-antibiotic controls and practices that would be organic compliant. The USDA-ARS supports at least three key research programs on alternative fire blight control (Wenatchee, WA; Kearneysville, WV; Geneva, NY for resistant rootstocks), with a cumulative investment of over $5 million. Other USDA grants funds have totaled over $1 million. There has been no lack of effort and support for developing non-antibiotic alternatives, just a lack of clear success with the alternatives.

The primary three biocontrol products that are EPA registered for fire blight, and that are OMRI-approved, are Blight Ban A506 (*Pseudomonas fluorescens*), Bloomtime Biological (*Pantoea agglomerans*), and Serenade Max (preparations of *Bacillus subtilis* QST 713). Several of the organisms in these products are antibiotic producers. These have been tested extensively as stand-alone replacements for streptomycin or oxytetracline in different regions of the country. Sundin et al. (2009) tested these products over 7 years in Michigan, Virginia, and New York. These materials exhibited low efficacy and high year-to-year and location-to-location variability. They did show promise when used in sequence with antibiotics, and were able to reduce the number of antibiotic sprays needed. Based on their results, the researchers concluded that "…the prospects for biological control of fire blight in the eastern United States are currently not high". The experience has been similar in Washington, Oregon, and California (Smith, 2011; Zoller, 2011). A complicating factor that has not been extensively explored is the interaction between other management practices used by organic growers, such as scab (*Venturia inequalis*) control or fruit thinning (Wend, 2011), and the use of biological control organisms (Lindow et al., 2008). This is especially critical for Midwest and Eastern U.S. growers where scab is the dominant disease challenge that occurs every year.

Recently, Oregon researchers developed an integrated control concept for fire blight that recognized differential control of the disease when on the stigma versus the nectary of the fruit tree blossom (Stockwell et al., 2008). They defined 'integrated' as the sequencing of a biological control followed by an antibiotic control, based on their hypothesis that the biological materials controlled the pathogen on the stigma in the early stage of bloom, and the antibiotic controlled it when on the nectary later in bloom. They were able to achieve control similar to an antibiotic-only regime, but reduced antibiotic use by half. A similar regime

without antibiotics has been tried by a number of eastern Washington organic growers who have reported satisfactory results from non-replicated tests.

A new biocontrol material was commercialized in Germany several years ago (Kunz et al., 2011) and is now being tested in the U.S. Blossom Protect is a live formulation of *Aureobasidium pullulans*, a naturally occurring yeast that is commonly found in orchards. In field trials in Oregon, a regime of Bloomtime Biological followed by Blossom Protect provided fire blight control similar to regimes that included antibiotics (K. Johnson, unpublished data). The Bloomtime Biological protected the stigma and the Blossom Protect protected the nectary, following the integrated control concept described above. Interactions of these controls with organic fruit thinning using lime sulfur plus fish oil are being evaluated as well (Fig. 1).

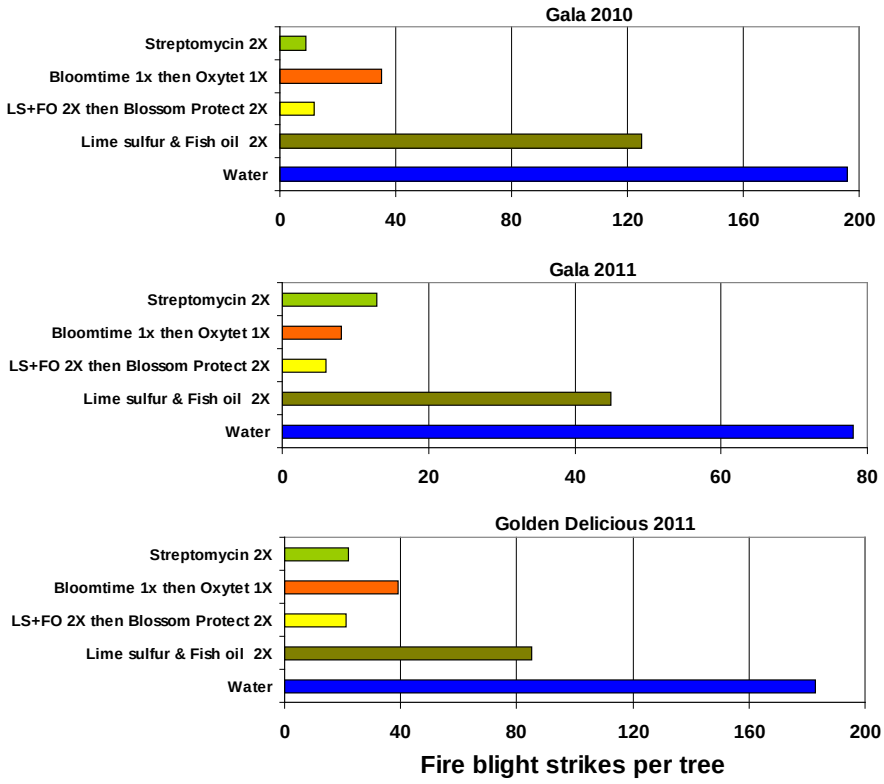

Figure 1. Examples of field trial results with non-antibiotic and integrated control of fire blight, Corvallis, OR (K. Johnson, unpublished data).

Field trials in eastern Washington have also evaluated Blossom Protect on apples and found it to provide control similar to oxytetracycline (Fig. 2; Smith, 2011). One year of testing on pears in California yielded positive results (Adaskaveg et al., 2010). In Michigan, Blossom Protect (63-64% control) on apples did not provide similar control to streptomycin (97-98% control) in two of three years when disease pressure was moderate and high, using 4 applications of Blossom Protect (Sundin et al., 2009, 2010). Similar tests in Eastern states have not been identified.

A USDA OREI project funded in 2011 (K. Johnson, principal investigator) will continue the work described above in Oregon, Washington, and California to further validate efficacy, design suitable integrated control programs, and educate growers. This is a 4-year activity that will begin with the 2012 field season.

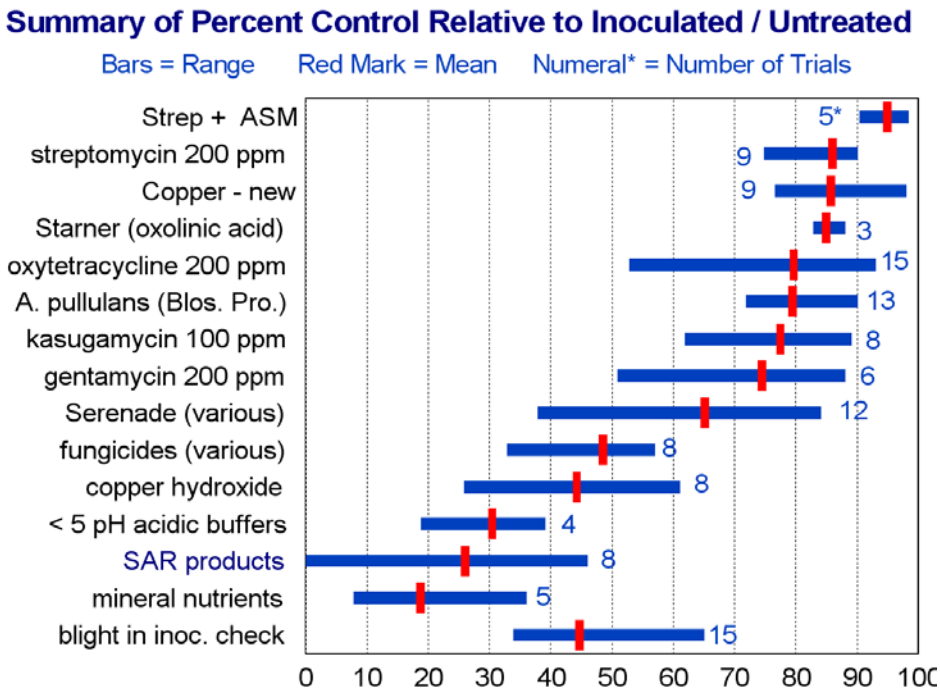

Figure 2. Summary of "percent control" of blossom infection in the past 10 years of similar fire blight control material trials in eastern Washington. Not all are organic-compliant. [Strep=streptomycin; ASM= acibenzolar–s-methyl; Blos. Pro.=Blossom Protect; SAR=systemic acquired resistance; inoc.=inoculated]

Certain copper products are already used by organic growers during the dormant season to help suppress fire blight bacteria in cankers on the trees. New copper formulations are being tested for use during bloom and have shown positive results (Fig. 2). More experience is needed to allay concerns about fruit russetting (which renders the fruit unmarketable), particularly in pears. It is also unknown if these products will be available to organic growers. Long term, coppers are not a suitable replacement for antibiotics. Copper is an essential plant micronutrient, but it is also a heavy metal and potential environmental contaminant that persists in soils. Organic farms in Europe have relied on repeated use of copper for disease control, which led to elevated soil copper levels far above what was considered normal and into ranges where scientific studies have shown potential for inhibition of soil microorganisms (Bogomolov et al., 1996). Thus, soil monitoring is needed when using these materials.

Research on the biology of fire blight and other possible controls is on-going as well (Johnson et al., 2009; Pusey et al., 2009; Johnson et al., 2000). This includes identifying stigma exudates and their role as a microbial food source, water dynamics and osmoadaptation possibilities, and use of bacteriophages attached to other biocontrol organisms (L. Pusey, pers. comm.). Also, the use of plant defense stimulators to help trees ward off infection is being actively investigated (Deckers et al., 2011).

Alternatives to antibiotics have been actively pursued by researchers and industry for several decades, with a significant infusion of grower funds for their evaluation. Several biological control materials are now registered for use by organic growers. However, availability does not equate to demonstrated equivalence with the material they are intended to replace, as shown above. At this time, the tools for non-antibiotic control of fire blight for organic apple and pear growers are not sufficiently proven to replace the antibiotic

controls use when indicated by disease development models. Some growers have reported success with non-antibiotic regimes, but these regimes have not been widely tested in the diverse growing environments across the country. The new Blossom Protect material shows promise but is not currently EPA registered (scheduled for February 2012) and thus not yet available for grower use.

As new materials become available, researchers validate them under different conditions and within overall orchard management systems to reduce the risk of failure or unanticipated side effects in grower orchards. This process is then followed by a period of education and grower experience to again refine the use of the materials in the diverse settings and environments encountered in commercial orchards. The process of moving a material from being available, to proving its efficacy, to integrating its use into an overall management system, to educating growers, is a multi-year effort (often 5 or more years) that needs to be recognized by bodies such as the National Organic Standards Board when making a decision to phase out a critical control option. Given the time required, it is questionable whether organic apple and pear growers will have in place a suitable and nationally applicable alternative management regime for fire blight by the October 21, 2014 date set by NOSB for expiration of antibiotic use.

Citations

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- *Drafted by David Granatstein on behalf of the Organic Tree Fruit Industry Work Group; November 2011.*