Successful Fire Blight Control is in the Details

Deborah I. Breth[1], M.V. Bhaskara Reddy[2], Jay Norelli[2] and Herb Aldwinckle[2]

[1]Area Extension Educator, Lake Ontario Fruit Team, Cornell Cooperative Extension, Albion, NY, [2]Dept. of Plant Pathology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY

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Controlling fire blight is an essential aspect of apple production in both young and old plantings. Since establishment costs for high density plantings are as high as $5000 per acre, fire blight control in a new planting is even more critical than in an old, established orchard. The intensity of the control program should be based on the susceptibility of the scion variety and the susceptibility of the rootstock. Susceptible varieties on susceptible rootstocks require the most comprehensive management program.

The basic fire blight management program is not described here in detail. The purpose of this article is to address specific fire blight problems and report results of ongoing research to solve these problems.

SUSCEPTIBILITY OF VARIETIES AND ROOTSTOCKS

Most of the new varieties demanded by the market and planted in New York in high density plantings are susceptible to fire blight. They include GingerGold, Gala, Fuji, Honeycrisp, Jonagold, Smoothee Golden, Fortune, NY 674, Cameo and more. A list of varieties susceptible to fire blight rated in previous research is included in Table 1. New varieties have not been rated experimentally as to the level of susceptibility. The incidence of infections under natural inoculum conditions has been reported in the table from personal communication with consultants and with Drs. Steven Miller and Alan Biggs from a variety trial in Kearneysville, WV, part of regional project NE-183 to evaluate varieties.

The combination of highly susceptible scion varieties on highly susceptible rootstocks such as M.9 and M.26 often results in rootstock blight and tree death. In an ideal world, the market would demand only varieties that are resistant to fire blight. In the real world, however, the first step in controlling fire blight is recognizing the potential for disaster and preventing it. Do not let fire blight get established in a new planting.

FIRE BLIGHT CONTROL FOR NEW PLANTINGS

Site selection is a critical component of an integrated fire blight control program for new plantings. Pick a planting site with well-drained soil and good air drainage. Before planting, add soil nutrients such as potash, phosphorus, and lime to provide calcium and magnesium and to correct pH. These nutrient deficiencies are harder to correct after planting. Set the planting as far as possible from an infected apple or pear orchard. Isolation always helps. Many times, however, we have to plant that new orchard right next door to a processing orchard that has plenty of fire blight. This is often a recipe for disaster.

Two major concerns may contribute to the risk of fire blight in newly planted blocks. First, many nursery trees are purchased with "feathers" (scaffold branches) that may produce flower buds in the first year. Some varieties like Gala and GingerGold flower on 1-year-old wood. Newly planted trees come into bloom after established orchards have bloomed, when growers have stopped monitoring for blossom blight conditions on the remainder of the farm. The blossoms in the new planting are then very vulnerable to infection. Second, many nursery trees come from areas where there may be streptomycin-resistant *Erwinia amylovora*. Resistance to streptomycin has not been documented in New York except for an isolated incidence. Most nurseries do a thorough job of controlling fire blight with streptomycin and copper as needed for high-risk infection conditions. However, *E. amylovora* is a successful epiphyte, surviving on the surface of bark and leaves. To get a theoretical "clean start" in the new orchard, an application of copper at bud-

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break after planting may kill any bacteria on the surface of the new trees.

To test management strategies for prevention of fire blight in susceptible high density orchards, demonstration plots were established in newly planted blocks on two farms in 1997.

Treatments were:

1) no copper with blossoms intact;
2) copper with blossoms intact;
3) no copper with blossoms removed; and
4) copper with blossoms removed.

The plantings were followed through 1999. Orchard A was set up in 8 rows of Jonagold on M.9 located windward of an established Idared orchard infected with fire blight. This block was not a replicated trial because the grower wanted to keep unprotected parts of the block very small to reduce the risk from fire blight. Orchard B was a block of Gala and Fuji on M.9 located on the windward side of a pear orchard with minimal fire blight infection due to cool bloom periods. Orchard B was replicated across varieties, and subsamples of treatment plots were evaluated for each treatment.

Copper applications were made the first year using Kocide DF at 4 lb/100 gal dilute applied to drip at budbreak and 2 weeks later. In the second leaf, only one copper application was made at budbreak. In the 1st and 2nd leaf, the blossoms were removed by pinching them off at the stems to prevent removal of any potential apical bud that would develop into a growing point. Timing of blossom removal preceded weather conditions that were conducive for blossom blight infection conditions. Both orchards were mapped to identify all trees in the block. These maps were used to document where blossoms were intact and where any fire blight infections occurred.

Although insufficient incidence of infection occurred for statistical analysis, there was a trend in Orchard A that had more inoculum pressure from a nearby orchard. Plots with blossoms left intact had more fire blight infection than those where blossoms were removed (Table 2). There was no apparent difference between treatments with and without copper. In Orchard B with randomized plots of equal size, the only infection reported was in a plot with no copper applied and with blossoms intact. Under natural inoculum levels, these data do not show striking differences between treatments. As we continue to follow these plantings into the 4th leaf, observations will be made concerning the potential for rootstock blight development. So far, the major contributing factor for fire blight establishment in a new planting is the presence of blossoms and inoculum in nearby orchards. Over the years, there have been new plantings that have not had fire blight controls applied and no infection has resulted. Expensive

TABLE 1

Cultivar susceptibility to fire blight compiled from several sources (very resistant=no control needed; resistant=control needed only under high disease pressure; susceptible=control usually needed where disease is prevalent; very susceptible=control).

Apple cultivar	Relative susceptibility	Apple cultivar	Relative susceptibility
Ambrosia	?	Mollies Delicious	Susceptible[1]
Arlet	?	Monroe	Susceptible[2]
Beacon	Susceptible[1]	Mutsu	Very susceptible[1]
Braeburn	Very Susceptible[2]	Northern Spy	Resistance-Susceptible[1,2]
Cameo	Susceptible[3]	NY674	Susceptible[4]
Cortland	Susceptible[1]	NY75414-1	Susceptible[3]
Creston (BC8m15-10)	Susceptible[3]	Orin	Susceptible[3]
Delicious (Red, all strains)	Resistant[1]	Paula Red	Susceptible-Very Susceptible[1,2]
Elliot	?	Pinova	?
Empire	Resistant[1]	Pioneer Mac	Susceptible[3]
Enterprise	Susceptible[3]	Prima	Resistant[1]
Fortune	Susceptible[4]	Priscilla	Resistant[1]
Fuji	Very Susceptible[2]	Pristine	Susceptible[3]
Fuji 2	Susceptible[3]	R.I. Greening	Very Susceptible[1]
Gala (all strains)	Very Susceptible[2]	Redfree	Resistant-Susceptible[1,2]
GingerGold	Very Susceptible[2]	Rome Beauty	Very Susceptible[1]
Gold Rush	Susceptible[3]	Sansa	Susceptible[3]
Golden Delicious	Resistant-Susceptible[1,2]	Senshu	?
Golden Russet	?	Shizuka	?
Golden Supreme	Susceptible[4]	Smoothee (Golden Del.)	Resistant-Susceptible[1,2]
Granny Smith	Very Susceptible[1]	Spartan	Susceptible[1]
Gravenstein	Susceptible[1]	Spigold	Very Susceptible[1]
Honeycrisp	Susceptible[4]	Stark Bounty	Resistant[1]
Idared	Very Susceptible[1]	Stark Splendor	Resistant-Susceptible[1,2]
Jerseymac	Susceptible[1]	Starkspur (Delicious)	Susceptible[1]
Jonafree	Resistant-Susceptible[1,2]	Stayman	Resistant-Susceptible[1,2]
Jonagold	Very Susceptible[1]	Suncrisp	?
Jonamac	Susceptible[1]	Sunrise	Susceptible[3]
Jonathan	Very Susceptible[1]	Twenty Ounce	Very Susceptible[2]
Liberty	Resistant[1]	Tydeman	Susceptible[1]
Lodi	Very Susceptible[1]	Viking	Resistant[1]
Macfree	Resistant[1]	Wealthy	Susceptible[1]
Macoun	Susceptible[1]	Yataka	Susceptible[3]
McIntosh	Resistant-Susceptible[1,2]	Zesta!	?

[1]Ratings from MSU Web site, Nancy J. Butler, "Disease on Apples."

[2]Ratings from WV University, Kearneysville website, K.S. Yoder and A.R. Biggs.

[3]Ratings from Drs. Steven Miller and Alan Biggs in NE-183 plot, WV.

[4]Ratings from other field observations.

disasters are becoming more common though and, once established, fire blight will be a menace for the new planting for years to come.

Recommendations drawn from field experience and demonstration plots include:

1) Apply copper to "sanitize" the new trees at budbreak.
2) Remove blossoms in 1st and 2nd leaf plantings before the blossoms open or before the occurrence of a blossom blight infection. This can be done when central leader shoots are selected.
3) If blossoms are not removed, monitor weather conditions for blossom blight conditions and apply streptomycin as needed.
4) Monitor the planting weekly and remove any infections noted in the trees to prevent spread to other trees. The closer the planting is to an infected orchard, the more closely the new trees should be scouted.
5) Control aphids and leafhoppers which are suspected to spread fire blight.

BLOSSOM BLIGHT

Control Materials. Blossom blight is the epidemic phase of the disease that provides the inoculum for shoot blight, trauma blight, and rootstock blight for years to come. The most effective material for blossom blight control is streptomycin sprayed during bloom, when infection is predicted by the MARYBLYT™ model. However, streptomycin-resistant strains of *E. amylovora* have developed in many parts of the country due to frequent use of streptomycin.

Streptomycin is effective in fire blight control because it limits the multiplication of bacterial cells. Bacterial diseases require a certain number of bacterial cells to result in disease symptoms. One bacterium does not result in disease. Streptomycin is only locally systemic—it is absorbed only by blossoms that are open at the time of application. Slow drying conditions increase the absorption of streptomycin and make it more effective. Current recommendations for streptomycin are to apply it at a rate of 8 oz/100 gal dilute rate, or at 4 oz/100 gal if mixed with Regulaid. Using lower rates will not give reliable results and may increase the chance of resistance development. Dr. Tom Burr has shown that streptomycin has reduced efficacy when mixed with calcium and phosphate ions. Streptomycin should not be applied with foliar nutrients. Tank mixing with mancozeb has not been documented to reduce control. Thorough spray coverage is critical.

Alternatives to streptomycin for controlling blossom blight, such as copper, are limited in their usefulness due to inferior efficacy and phytotoxicity, especially russeting. Other alternatives such as a biocontrol agent (BlightBan C9-1), SAR (systemic acquired resistance) inducers (e.g., Actigard 50 WG and Messenger), a growth regulator (Apogee 125 11W), and new formulations of copper (Phyton 27) and antibiotics (Pace-17) are being evaluated for blossom blight control in replicated plots at Geneva, NY. BlightBan C9-1 is a living bacterium that colonizes the habitats of *E. amylovora* on the plant when applied before the infection takes place and inhibits the pathogen from multiplying. An SAR inducer is a chemical agent that activates natural resistance in the plant but does not have direct antibacterial activity. Most of these products are in the experimental phase of development and still require EPA and/or NYS-DEC registration for orchard use.

The materials listed above were evaluated in 1997-99 for control of blossom blight on Idared apple trees in a research orchard at Geneva, NY. Treatments were replicated five times with 150-200 blossom clusters per replication in a randomized complete block design. The products were applied at 1/2-inch green, pink, 10% bloom, 24 hours before inoculation and 24 hours after inoculation, depending on their mode of action, using a single nozzle handgun sprayer at 150 psi and sprayed to run-off. The blossom clusters were inoculated at full bloom with *E. amylovora* using a Solo backpack sprayer. Infected and healthy blossom clusters were recorded 3 weeks after inoculation and fruit russeting was assessed 7 weeks after the last spray.

The results of 1997 field trials showed a significant reduction in blossom infection when trees were sprayed with SAR inducers and biocontrol agents compared to untreated trees (Table 3). The disease control by biocontrol agents (BlightBan C9-1 and A506) alone was approximately half the control achieved with Agrimycin at 14.7 g and 29.4 g/50 L (4 oz and 8 oz/100 gal) dilute treatment. A significant reduction of blossom blight incidence was observed in Actigard and Messenger treated trees compared to the untreated check, but control was not as good as it was with the Agrimycin treatments. Although Mankocide and Kocide treatments significantly reduced blossom blight infection, fruit russeting was observed in both the treatments. In 1998 the weather during bloom was favorable for blossom blight infections with 50% infected blossom clusters in the untreated inoculated check. BlightBan A506 was not significantly different from the check. A 32% reduction in blossom blight was observed in BlightBan C9-1 treated trees. Less blossom blight was observed in Actigard and Messenger treatments but was not significantly different from the check. Kocide 2000 and Nu-Cop 3L gave similar control to Agrimycin 4 oz/100 gal treatment (52-57% control). The addition of mancozeb to Kocide 2000 improved control over either treatment alone, but was not significantly better than Microsperse, Nu-Cop 50DF or Agrimycin (4 oz/100 gal). Agrimycin at 4 oz/100 gal gave the best control, reducing infection by 73%.

The results from 1997 and 1999 field trials were similar in the control of blossom blight infections. In 1999 the weather during bloom was hotter than usual and bloom lasted for 20 days (7 May-26 May). During this period the MARYBLYT™ program predicted two high-risk days but no infection period. In our trials, inoculation coupled with high-risk days for fire blight infection during bloom resulted in 25.7% of blossom clusters infected and allowed for efficient screening of products for activity against blossom infection. Pace 17 (streptomycin) at 14.7 g/50 L (4 oz/100 gal) with Regulaid applied 24 hours before and after inoculation gave the greatest control (71.8%), closely followed by the same

TABLE 2

Effect of copper and blossom removal on fire blight development in a newly planted Jonagold orchard.

Treatment	# trees	% trees with blossom blight 1997	1998	1999	% trees with shoot blight 1999
+ Copper[z], -bloom	587	0.2	0.3	0.2	1.4
+ Copper, +bloom	32	3.1	3.1	0.0	3.1
- Copper, -bloom	52	0.0	0.0	0.0	0.0
- Copper, +bloom	26	0.0	3.8	11.5	23.1

[z]In 1997 Kocide DF applied at budbreak + 2 weeks. In 1998 Kocide DF applied at budbreak.

treatment with Agrimycin 17 (streptomycin) at 4 oz/100 gal. Lower rates (7.35 g/50 L [2 oz/100 gal] dilute) of Pace 17 and Agrimycin 17 with Regulaid were tested at Geneva to compare the control of these treatments alone with the same rates used in combination with a biocontrol agent such as BlightBan C9-1. These rates are not recommended as standard practice for growers due to resistance development issues and normally provide less effective control. BlightBan C9-1 applied at 10% bloom and 24 hours before inoculation gave 40.5% control. When BlightBan C9-1 was applied during bloom and followed with streptomycin at the experimental low rate after inoculation, there was only slight improvement in control. Research from other states showed improved control from biocontrols if integrated with recommended rates of streptomycin. Sprays of Mankocide DF, Nu-Cop 50 DF and Phyton 27, 24 hours before and 24 hours after inoculation, all resulted in significant (50%) control of the disease. Mankocide and Nu-Cop caused the greatest amount of fruit russeting, although russeting was significantly less when Mankocide was applied once, 24 hours pre-inoculation, followed by Pace treatment. Phyton 27 is a very unusual copper compound that caused very little russeting. Messenger at 26 g/50 L applied at 1/ 2-inch green and pink resulted in 46% control, which was numerically but not statistically different from streptomycin. The level of infection in Apogee-treated blossoms was not significantly less than in the untreated inoculated check. Greater disease control was obtained with biocontrol agents when combined with SAR inducers or antibiotics, suggesting that the alternative materials are compatible and have good potential for an integrated management of a blossom blight program. The biocontrol agents and SAR inducers are still experimental and not registered in New York but show considerable promise, especially if used in combination. Further research on combination of biologicals and SAR inducers is being done in the lab, greenhouse and field in 2000.

In field trials on commercial farms in western New York without artificial inoculation, the use of copper/mancozeb to control fire blight during bloom gave comparable results to plots treated with streptomycin in low disease pressure conditions (no blossom blight infection predicted). However, commercial plots with natural inoculum and a blossom blight infection period showed that streptomycin provided superior control under high blossom blight disease pressure without the poor fruit finish that results from copper applications. If copper is used, it must be applied at the lower rates stated on the labels (Champ 2F at 2/3 pt/acre) starting at 10% bloom, at 5- to 7-day intervals. Research data in trials at Geneva suggest better control when the copper is mixed with mancozeb.

TIMING OF CONTROL SPRAYS

Blossom blight control using streptomycin hinges on critical timing of the application. The old standard timing in the mid-1980s was to apply streptomycin when the temperature was above 65˚F and rainfall or relative humidity was above 60% during bloom. In the absence of anything better, some growers sprayed and some did not. Many times, growers got away without spraying and had very little incidence of fire blight in apples. This gave growers a false sense of security when they ignored the system. However, more sophisticated predictive models have been developed that are risky to ignore when they predict blossom blight infections.

In New York, we have been working with MARYBLYT™ since 1992 and Cougar Blight since 1997 and have gained experience and confidence in their predictions. MARYBLYT™ 4.3 is a computer-based model, developed by Dr. Paul Steiner, designed to predict blossom blight infection potential and symptom development of most phases of fire blight. The model assumes an abundance of inoculum in the orchards. It predicts the potential risk of infection based on the occurrence of certain

TABLE 3

Effect of antibiotics, copper compounds, biocontrol agents and SAR inducers on blossom blight control in Idared trees, Geneva, NY, 1997.

Treatment	Rate/50 L^Z	Time of application^Y	Infected blossom^X clusters %
Untreated inoculated check			50.0 a
Agrimycin	29.4 g	3,4	6.9 gh
Agrimycin	14.7 g	3,4	6.1 gh
Vigor-Cal +Agrimycin	500.0 ml 14.7 g	2,3,4 3,4	8.8 fgh
Mankocide DF	79.75 g	3,4	12.0 cdef
GWN-9200 10W	37.5 g	3,4	10.7 defg
GWN-9200 10W	75.0 g	3,4	9.7 efgh
GWN-9200 10W	100.0 g	3,4	8.5 fgh
Kocide 101 77W	47.8 g	3,4	10.4 defg
BlightBanC9-1	12.6 g	2,4	14.1 bcde
BlightBan A506	13.1 g	2,4	16.4 bc
BlightBan A506 +Actigard 50 WG	13.1 g 6.0 g	2,4 1,4	18.7 b
BlightBan A506 +Agrimycin 17	13.1 g 14.7 g	2,4 4	7.5 fgh
BlightBan A506 +Agrimycin 17	13.1 g 14.7 g	2,4 3,4	5.2 h
Actigard 50 WG	6.0 g	1,4	15.3 bcd
Messenger	5.0 g	1,4	18.4 b
Messenger	10.0 g	1,4	15.9 bc

^Z All treatments were tank-mixed with Break-through (50 ml/50 L), a surfactant from Plant Health Technology Inc.

^X Time of application 1=pink (8 May); 2=10% bloom (14 May); 3=24 hours before inoculation (20 May); 5=24 hours after inoculation (22 May).

^Y Treatments followed by the same letter did not differ significantly (P=0.05) as determined by Waller grouping.

environmental conditions in sequence. These conditions include:

1) The presence of blossoms.
2) The accumulation of 198 DH (>65˚F) from start of bloom.
3) A wetting event including rain, dew or a spray application, or 0.1 inch of rainfall the day before.
4) The average temperature of 60˚F the day of infection.

A second model, Cougar Blight, was developed in Washington State by Tim Smith. It is not a computer model but can be set up on a spreadsheet. The model uses a lookup chart to determine daily degree hours accumulated based on the maximum and minimum temperatures. Users calculate the sum of degree hours over 4 days during bloom leading up to a potential wetting period. Users must select the appropriate inoculum potential based on proximity to the inoculum source. Neither of these models will predict how many infections may result if the risk of infection is high.

We have collected weather data since 1997 from weather sensors across the region. The data were entered in the MARYBLYT™ 4.3 model for many sites and into the Cougar Blight spreadsheet as well. The predictions of both models were entered into a spreadsheet for comparison of blossom blight predictions. Comparison of predictions from both models for two seasons showed that the models are closely correlated in terms of heat units accumulated. Both models rely on growers to determine the occurrence of a wetting event. MARYBLYT™ 4.3 requires data entry for the wetting event; Cougar Blight assumes a wetting event has occurred or will occur. Figure 1 shows the risk prediction of both models on the Y axis, where 1=low, 2=moderate, 3=high and 4= "Infection" for MARYBLYT™ or "Extreme" risk for Cougar Blight. The "-H" (insufficient heat units), "-W" (lack of wetting event), "-WT"(lack of wetting event and temperature below 60˚F), etc., indicate the required factor missing for MARYBLYT™ when it predicted a lower risk potential than Cougar Blight, in 1998 and 1999.

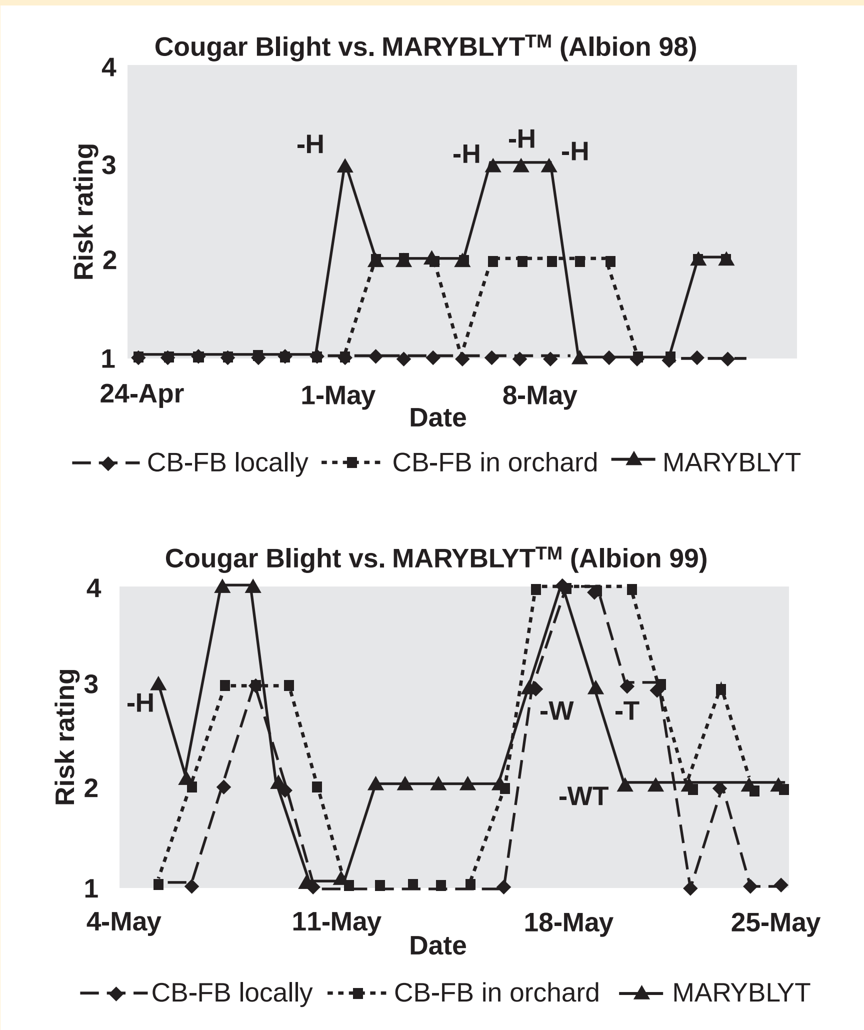
One factor that seems to reduce the correlation between models is the MARYBLYT™ requirement for 60˚F average temperature.

If the MARYBLYT™ infection risk is "high" (three of four requirements for blossom infection are met) with the only missing factor being the average temperature of 60˚F, the model will recommend the consideration of a streptomycin application to protect open blossoms. If a wetting event is the only factor missing, growers need to do some critical thinking about the potential for dew in low spots in orchards or note any spray applications that are made that could wet the blossoms, resulting in an infection. When growers are inputting maximum and minimum temperatures to run the models, it is important they run a range of temperatures in the forecast to cover differences across the microclimates of the farm. There are always warmer spots on a farm that will surprise us with fire blight infections.

It is important to remember that all models rely on accurate weather data and forecasts. All models have some flexibility in risk prediction for growers to adjust risk according to variety, rootstock, inoculum source, etc. Based on 3 years of comparison, the two models correlate well when enough heat units have accumulated and there is a wetting event. Accuracy of the model predictions is evident from the severe level of fire blight incidence in blocks not treated with streptomycin when they predicted infection in 1999. In order for either model to be useful for blossom blight control, streptomycin must continue to be both available and effective. When we start to use the new SAR inducers and biocontrols, the models will need to be modified to recommend applications earlier than 24 hours before or after an infection.

FIGURE 1

Comparison of MARYBLYT™ blossom blight prediction with prediction by Cougar Blight in orchard with fire blight in orchard last season and fire blight in local area last season (-H=insufficient heat units; -W=lack of wetting event; -WT=lack of wetting event and temperature below 60°F; CB=Cougar Blight; FB=fire blight).



SHOOT BLIGHT CONTROL

If blossom blight is completely prevented, shoot blight will usually be minimal. To date, there is no effective registered control for shoot blight. We recommend streptomycin be sprayed after bloom to control shoot blight only in the case of hail or severe wind and rain. Repeated applications of streptomycin in a heavily infected orchard will quickly lead to selection of resistant strains of *E. amylovora* and loss of this valuable material for blossom blight control. Alternative controls have been tested in replicated inoculated plots in Geneva and in two replicated commercial plots with natural inoculum.

The efficacy of two antibiotics, two copper compounds, and two SAR inducers against infection of shoots by fire blight was evaluated on Idared trees in a research orchard at Geneva. Treatments were replicated five times with each replicate consisting of a single tree in a randomized complete block design. All treatments were applied to run-off using a single nozzle handgun sprayer. Following the treatments, 20 growing tips of current season shoots, 20 to 40 cm long, from each tree were inoculated by bisecting the two youngest leaves with scissors dipped in *E. amylovora* inoculum. Shoots of Empire were inoculated as an untreated, moderately resistant check. All inoculated shoots were labeled. Six weeks after inoculation the lengths of necrotic infection and of the whole shoots, including the infected length, were determined. A week later, the proportion of fruit with russet and of the russeted fruit surface area was estimated.

In inoculated untreated checks, 89% of shoot length became blighted, which was significantly higher than for all other treatments (Table 4). Pace and Agrimycin treatments, which are both streptomycin formulations, applied before and after inoculation, gave the highest level of control (61% and 56%, respectively). There was no significant difference in the level of control obtained with Agrimycin, Actigard or Messenger treatments applied prior to inoculation. The Mankocide and Phyton 27 treatments were both significantly better than the untreated check but not as effective as the streptomycin treatments. Both resulted in fruit russet, although Phyton 27 caused significantly fewer russeted fruits than Mankocide.

Copper does not have systemic activity against fire blight bacteria and will not provide control of the internal spread of *E. amylovora* within the tree once a shoot is infected. However, it does have the potential to reduce the population of epiphytic bacterial populations from oozing infections to limit further spread to wounded tissue in the tree. In 1999 there were no differences in levels of shoot blight in replicated commercial plots where Champ 2F (2/3 pt/acre) cover sprays were applied starting at 1 to 2 weeks after petal fall and 10- to 14-day intervals. However, 1999 was a very dry season causing terminal buds to set early, shutting down succulent growth that probably limited the spread of fire blight. There was significantly more fruit russet in copper-treated plots than in the plots without copper.

SUMMARY

In conclusion, there are very few new options to apply on the farm for fire blight controls, but changes may be on the horizon. The one big change that has occurred over the past 10 years is the increase in disease pressure and an increase in the urgency for maintaining a tight, full season management program for fire blight on the whole farm. At present, the use of precise disease prediction models is critical in timing application of streptomycin for blossom blight control and resistance management. In the future, integrating antibiotic sprays with other “softer” plant protection methods like biocontrol agents, SAR inducers and growth regulators is a potential option to keep the development of antibiotic resistance and fire blight under control. Unfortunately, the cost of these integrated programs with antibiotics will be more expensive. For now, streptomycin continues to be the critical control material to manage fire blight.

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TABLE 4

Effect of antibiotics, copper compounds, SAR inducers on shoot blight control in Idared trees, Geneva, NY, 1999.

Treatment (rate/50 L)	Surfactants (rate/50 L)	Time of application[1]	% blighted shoot length	% russeted fruit	% russeted fruit surface
Untreated control			89.7 a[2]	0.2 c	1.0 bc
Empire (inoculated)			7.2 g		
Pace 17 14.7 g	Regulaid 15 ml	4,5	35.2 f	0.3 c	0.5 c
Agrimycin 17 14.7 g	Regulaid 15 ml	4,5	39.9 ef	0.0 c	0.0 c
Mankocide DF 79.75 g	Regulaid 15 ml	4,5	55.8 bcd	21.3 a	4.5 a
Phyton 27 13.3 ml	Regulaid 15 ml	4,5	61.0 b	6.9 b	4.1 a
Actigard 50 WG 10.0 g	Regulaid 15 ml	2,3	50.8 bcde	0.6 c	0.6 c
Messenger 26.0 g	Reguard100 ml	2,3	43.9 def	0.6 c	3.0 ab

[1]1=petal fall + 5 days (21 May), 2=2 weeks after #1 (4 June), 3=1 week before inoculation (11 June), 4=24 hours before inoculation (16 June), 5=24 hours after inoculation (18 June), 6=10 days after inoculation.

[2]Treatments followed by the same letter did not differ significantly (P>0.05) as determined by Waller grouping.