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Fire Blight: The Search for Better Control

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FIRE BLIGHT: AN INCREASING THREAT TO APPLE ORCHARDS

Fire blight epidemics, caused by the bacterium *Erwinia amylovora*, in high density apple orchards have become increasingly severe in Northeast, Midwest, and mid-Atlantic states and are resulting in severe economic losses. These losses are primarily due to the increased susceptibility of newer apple plantings. Newer varieties, like Gala, Gingergold, Jonagold, and Braeburn, as well as some older ones, especially Idared, are highly susceptible to fire blight. In addition, the dwarfing rootstocks most frequently used in high density orchards, M.26 and M.9, and also Mark, are very susceptible in themselves to fire blight infection.

Case studies of New York commercial orchards in 1996 found severe outbreaks of rootstock blight with as much as 10% of the trees with rootstock infections. It was estimated that a 10% incidence of rootstock blight in a Slender Spindle planting would result in a cumulative loss of $3,570 per acre that would reduce income for up to 7 years from the date of replanting the orchard.

UNDERSTANDING FIRE BLIGHT

Fire blight develops in several phases. Blossom blight is the most studied, best understood, and the only phase of the disease that can be readily controlled. Blossom infection can usually be controlled quite effectively using sprays of streptomycin timed according to the MaryBlyt™ forecasting program.

However, streptomycin sprays do not work for shoot and rootstock infections. Shoot blight symptoms result from infections of vegetative shoot tips. From this initial site of infection, the bacteria then multiply and a lesion develops depending on the susceptibility of the tissue. The occurrence of shoot infections usually follows the appearance of blossom blight symptoms in and around the orchard and appears to be related to the presence and activity of insects with sucking or piercing mouthparts. Some infections (also called trauma blight) can also occur following physical injuries caused by frost, hail storms, or high wind that damage any susceptible tissue.

ROOTSTOCK BLIGHT

Fire blight can kill dwarf apple trees by girdling susceptible rootstocks or interstems. Typically, the crowns of fire blight infected rootstocks appear black and sunken. Leaves may wilt in summer and color and drop early in the fall. We now know that these infections can originate through infected root suckers and by internal movement of bacteria from infections in the scion. In a recent field experiment, 20 out of 150 trees (13%) had suckers. Seven (35%) of these 20 trees had infected suckers and died of rootstock blight. Of the 130 trees without suckers, six (5%) died of rootstock blight. Thus, about equal numbers of trees succumbed to infection via suckers and via some other entry path. Clearly, it is important to avoid suckers to eliminate half the risk of rootstock infection. It is also suspected that direct infection of rootstocks can occur through growth cracks or wounds caused by mechanical, insect or freeze injuries.

We have determined in greenhouse experiments that *E. amylovora* can move downward inside apparently healthy branches and trunk from scion infections in blossoms and leafy shoots into the rootstock. Movement of bacteria to the rootstock occurs rapidly. Twenty-one days after inoculating shoot tips, bacteria were detected in the M.26 rootstock of Empire trees 3 to 5 feet below the visible brown lesion on the shoot. In Golden Delicious the pathogen was detected in the M.26 rootstock 41 days after inoculation. Greenhouse and field tests also indicated, surprisingly, that bacteria move more from infections on mature shoots than from infections on young vigorous shoots. This suggests that late season infections of the shoots may be particularly hazardous for the health of the rootstock. When several resistant and susceptible varieties were inoculated with fire blight bacteria in the field and later tested for movement of the bacteria into the rootstock, we showed that the bacteria moved into the rootstock from both resistant and susceptible varieties.

Our preliminary results show that age of the tree may affect susceptibility to rootstock blight. After we inoculated shoot tips of newly planted, non-bearing trees on M.26 in the field and later dissected the trees, we saw internal movement of the bacteria in trees in their first year in the field, but no disease in the rootstock. In contrast, blossom inoculation of second year trees on M.9 in their first fruiting season and of third year trees on M.26 in their second fruiting season in the same field trial resulted in 5% and 11% rootstock infection, respectively. This suggests that trees coming into flowering and fruiting may be at greater risk of rootstock infection than non-bearing trees. It is not known if trees will outgrow this susceptibility to the rootstock phase of the disease as they mature, although this does appear to be the case from our observations for rootstock blight in growers' orchards.

The rootstock breeding program of Jim Cummins and Herb Aldwinckle at Geneva has developed a series of fire blight resistant rootstocks that range in dwarfing character from producing very small trees (similar to M.27 size tree) to large trees similar in size to seedling. To date, four rootstocks have been released: Geneva (G.) 65, G.16, G.11, and G.30. All have good fire blight resistance and tolerance to *Phytophthora*.

Geneva 65
M.9 to M.27 size range. Advantages: very early bearing, not brittle, moderately resistant to Woolly Apple Aphid. Drawbacks: too dwarfing for many applications, not as productive as M.9, moderate suckers, small fruit size, requires support, difficult to propagate, sensitive to Stem Grooving Virus. Liners of G.65 should be available in 1999.

Geneva 16
M.9 size range. Advantages: very good anchorage, highly productive (equivalent to M.9), immune to apple scab, nonsuckering. Drawbacks: susceptible to Woolly Apple Aphid and powdery mildew, sensitive to common latent viruses, difficult to propagate, and it was relatively untested at the time of release. Liners of G.16 should be available in 1998.

Geneva 11
M.26 size range. Advantages: early bearing, highly productive (equivalent to M.26), very good anchorage, easy to propagate in the stoolbed. Drawbacks: requires support, less productive than M.9, moderately susceptible to Woolly Apple Aphid. Liners of G.11 should be available in 1999.

Geneva 30
M.7 size range. Advantages: early bearing, highly productive (far more productive than M.7), good anchorage, few burrknots. Drawbacks: not as productive as M.9, moderately susceptible to Woolly Apple Aphid, susceptible to powdery mildew, many spines and feathers in the nursery, sensitive to common latent viruses. G.30 is currently commercially available.

These rootstocks should provide an effective means of controlling the rootstock phase of fire blight in the near future. Growers, particularly those intending to raise highly susceptible scion varieties, are encouraged to establish limited test plantings of them on an experimental basis. The rootstock breeding and development program is continuing at Geneva, with increased support from the USDA. Recently, Bill Johnson was hired as the new breeder/geneticist in the program, following Jim Cummins' retirement.

CURRENT CONTROL OF FIRE BLIGHT

There is no single control measure for fire blight that will totally eradicate the disease, provide an absolute cure, or fully protect an orchard. However, by integrating several orchard management practices, fire blight damage can be kept to a minimum. These practices include orchard site selection and maintenance, tree selection and nutrition, soil management, and chemical control measures.

Serious fire blight damage can be avoided simply by not planting highly susceptible scion varieties and rootstocks. Unfortunately, current markets and production economics are encouraging the industry to move in exactly the opposite direction. Therefore, if currently popular but highly susceptible cultivars such as Gala, Gingergold, Braeburn, or Fuji are planted, particularly on highly susceptible rootstocks (M.26 and M.9), there is a very high risk for serious economic losses and even tree death due to fire blight. Therefore, a fire blight control strategy should be a part of the planning process for all new plantings of susceptible cultivars **or** rootstocks. Recognize that the risk to such plantings will be even greater if they are planted within one-half mile of apple or pear blocks with a prior history of fire blight, and try to isolate new at-risk blocks from current inoculum sources to whatever extent is possible. In addition, select well-drained orchard sites and, if necessary, improve drainage with proper tiling. Sufficient lime should be applied to bring soil pH to 6.5, using standard recommended practices for incorporation.

The effects of mineral nutrients on fire blight have been investigated by several researchers. However, these studies never considered the effect of nutrition on rootstock blight nor did they look at nutritional effects on the currently popular dwarfing rootstocks M.9 and M.26. Inadequate levels of calcium and magnesium, either in the soil or in the tree, have been associated with increased susceptibility of trees to fire blight. Nitrogen status of the trees is consistently regarded as a primary factor in increasing blight susceptibility. This creates a serious problem for young trees of susceptible varieties that are being "pushed" with nitrogen. Several studies have shown greater susceptibility of trees that are low in potassium. Also a high nitrogen/potassium ratio has been found associated with higher susceptibility.

Although many papers have been published on the effects of mineral nutrition on the susceptibility of apple and pear trees to fire blight, many questions still remain. Furthermore, the nutritional requirements of dwarf orchards differ from those of the standard plantings in which the earlier research was conducted. In modern fruit growing it is essential to obtain early production in order to recover investment quickly. This requires rapid tree growth and early fruit set, which may increase susceptibility to fire blight, especially with the varieties and rootstocks now favored by the apple industry.

Remove fire blight cankers, blighted branches, twigs and spurs from trees during dormant pruning, making thinning cuts at least 3, and preferably 6, inches below visible symptoms. Fixed copper sprays applied at the green tip to 1/4 inch green stage of flower bud growth have been shown to reduce the amount of overwintering inoculum developing from cankers that do not get pruned out. Growers should not overestimate the effectiveness of these copper sprays (they **do not** eliminate the need for streptomycin during bloom if weather is favorable for disease development), but they can be helpful and are recommended as part of a total fire blight management program.

During bloom, streptomycin is effective in preventing infection and should be applied when needed to orchards planted with susceptible scion varieties, particularly those on M.9 or M.26 rootstocks. In some cases, it may also be worthwhile to treat orchards on these susceptible rootstocks even if the scion variety is not highly susceptible. Treatment is particularly important in young orchards in the first few years of production when they are most susceptible to rootstock infection or if the orchard is located next to an apple or pear block with a history of serious fire blight problems. Blossom infections in young trees can provide a source of fire blight bacteria that can later spread through healthy scion tissue and kill the rootstock. Treatment of blossoms with streptomycin is most likely to be justified when bloom conditions have been unusually warm. Precise timing of streptomycin sprays is required, since only those blossoms that are open at the time of the application are protected and there is no redistribution to new blossoms by rainfall. Use a fire blight predictive system, such as MaryBlyt™, or recommendations of local advisors to time the application of streptomycin during bloom. A discussion of the specific recommended practices for timing streptomycin sprays is provided on pp. 58-59 of the *1998 Cornell Pest Management Recommendations for Commercial Tree Fruit Production.*

Pruning out infected shoots to limit the spread of shoot blight is of doubtful benefit on large trees but is recommended on young or small trees, particularly those on M.9 or M.26 rootstock or interstems. To effectively limit damage, strikes should be pruned out as soon as they appear throughout the terminal growth period; begin checking for symptoms about 90-100 degree days (base 55˚F) after an expected infection event such as rain during bloom or a summer hailstorm. Should blight develop, it is also considered important to maintain control of insects with piercing-sucking mouthparts (aphids, leafhoppers) in order to reduce further spread. To reduce the chance of developing resistance, the routine use of streptomycin to control the spread of shoot infections is not recommended. However, an application of streptomycin is strongly recommended following a hailstorm in fire blight-affected orchards. Sprays should be completed within 24 hours after the start of the hail.

RESEARCH ON NEW CONTROLS FOR FIRE BLIGHT

We are working on several new ways to control fire blight in the future. The materials we are testing include biological agents and compounds that induce the natural resistance of plants. We are also testing a new experimental antibiotic (Gentamicin) that behaves like streptomycin. Copper compounds are known to be active against fire blight, but cause fruit russetting and some superficial injury to leaves. However, since they may be economical to use on apples grown for processing, we are looking at them again both alone and in combination with mancozeb (Mankocide), which may reduce their phytotoxicity. Good results were obtained from 1997 blossom blight tests (Table 1), and we will continue working with most of the materials in 1998 looking at both blossom and shoot blight control. In addition, VigorCal, an organic calcium compound, and hydrophobic clay will probably be included in 1998 blossom tests.

Plants can activate their natural defense protective mechanisms once they detect an invading pathogen. When this natural defense is expressed throughout the plant it is called systemic acquired resistance (SAR). Often SAR is active against a broad range of pathogens, including fungi, bacteria, and viruses. Actigard (from Novartis Crop Protection) has now been registered for commercial use in some countries as an inducer of SAR against wheat powdery mildew and is effective against certain diseases of rice, tobacco, and some bacterial diseases of tomato. Similarly, harpin, a protein from the fire blight bacteria, has been shown to stimulate SAR in tomato. We are looking at both of these "SAR inducers" for controlling fire blight.

Biological agents for the control of fire blight are being commercially developed and should be available for use in New York in the near future. These agents are "good" bacteria that do not cause disease but which can compete with fire blight bacteria, interfering with their establishment in the orchard and their ability to cause disease. The commercial product BlightBan, containing the bacterium *Pseudomonas fluorescens* A506, has EPA registration but as of March 1998 did not have registration in New York.

In our 1997 orchard trial, the SAR inducers Actigard and harpin and the biological control agent BlightBan A506 significantly reduced the amount of blossom blight of apple but were only about half as effective as streptomycin. The copper compounds Mankocide and Kocide 101 reduced blossom blight a little more than the SAR inducers and BlightBan A506, but russetted the fruit. The experimental unregistered antibiotic Gentamicin gave control approaching that with streptomycin.

In order to be effective, biological control agents and SAR inducers must be applied early in bloom so that they can become active before weather favorable for fire blight occurs; thus, they cannot be used with predictive systems such as MaryBlyt™. If you decide to try BlightBan, the material should be applied at 10 to 25% bloom and again at 60 to 80% bloom. Since growth of the bacteria is necessary for their establishment, do not apply BlightBan in cold weather (45 to 50˚F) or when cold weather is predicted within the next 24 hours. BlightBan can be used in combination with streptomycin. Studies in California and Oregon indicate that using both streptomycin and BlightBan (which is resistant to streptomycin but cannot pass this resistance to fire blight bacteria) was better than using either streptomycin or BlightBan alone. In our 1997 orchard trial in New York there was no statistical increase in the level of disease control obtained when both streptomycin and BlightBan were used in combination to control blossom blight when compared to streptomycin alone. The main advantage of biological control agents is that they are an alternative tool that can be used for fire blight control.

In addition, Apogee (BASF 125), a new growth regulator, is being tested for effects on shoot blight. In 1997, we saw no effect on the severity of fire blight lesions, but did observe an apparent reduction of secondary spread. We will continue tests in 1998.

We are optimistic that our research, in combination with that of other researchers and extension people at Cornell, will enable New York apple growers to manage fire blight better in the future. We look forward to working closely with them in this endeavor.

Table 1. Control of blossom blight of apple in an artificially inoculated field trial (the untreated check plot had 27.3% of the blossom clusters infected).

Treatment	% Disease control[z]
Untreated check	0 a
BlightBan A506	40 b
Harpin	42 b
Actigard	44 b
Mankocide DF	56 b
Kocide 101	62 bc
Gentamicin	69 bcd
Streptomycin	78 cd

[z]Values with the same letter are not significantly different.

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