

Managing Fire Blight in Apples

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INTRODUCTION

Fire blight of apples and pears has been known in North America for over 200 years, but its control has never been quite mastered to the degree possible with many other plant diseases. Epidemics can develop rapidly in orchards with no history of the disease, destroying much of the current crop and killing many large limbs or whole trees in a short time. They can also be fairly minor affairs, causing no significant economic damage, even in orchards with severe blight the previous season. Between these extremes, variation in the incidence and severity of fire blight that seems to follow no particular pattern from season to season and orchard to orchard is characteristic.

Given the sporadic nature of fire blight, it is not surprising that some of our management tactics sometimes fail to provide consistent control. There are instances, for example, where considerable blossom blight occurs despite a grower's best efforts to follow a recommended program of orchard sanitation and protective antibiotic sprays during bloom. In other seasons, a similar spray program seem excessive given the small amount of disease that occurs in nearby untreated orchards. Finally, even when no blossom blight occurs, damaging epidemics of shoot blight can develop and hail storms can trigger severe outbreaks.

Managing fire blight well is also difficult because our tactical options are limited largely to cutting out infected limbs and applying copper-containing formulations or antibiotics. Unfortunately, copper materials are often phytotoxic, antibiotics are really only effective against blossom infections, and cutting can be inefficient when the amount of disease is high. Excessive antibiotic use has also led to the emergence of resistant strains of the pathogen in some areas. Changes in modern orchard management practice and market demand over the last two decades have increased the vulnerability of many orchards. For example, instead of planting 100 to 200 apple trees per acre, orchards are now planted at up to 10 times that density. Such high densities require the use of size-controlling rootstocks, of which the two most widely used, M.26 and M.9, are highly susceptible to fire blight. Adding to the risk of loss is an increase in the acreage planted to new fresh market apple varieties like Gala, Fuji, Braeburn, and Granny Smith along with older favorites like Rome, Ida Red, and Jonathan, all of which are very susceptible. Finally, to maximize production efficiency in these high density orchards, strong vegetative tree growth is encouraged in young orchards so that trees fill their allotted space within 3 years. Various methods of tree training are then used to induce flowering at the expense of vegetative growth so that infections often lead to more limb and tree death than generally experienced with larger trees.

The purpose of this discussion is to outline an effective approach to fire blight management that is not only reliable for the current season, but reduces the risks of severe losses in subsequent seasons, even when conditions for infection are favorable. The program is one that I have developed over the last decade in conjunction with the Maryblyt™ program for forecasting fire blight infection events and symptom development. While good execution of this management plan is aided by the use of the Maryblyt™ program, it is not required. What is required, however, is a change in your philosophy about disease control and disease management.

CONTROL vs. MANAGEMENT

One of the first things to understand about agriculture is that it is not natural. Agroecosystems, whether they involve annual or perennial crops, exist only with the continued input of energy by man. Should that input be withdrawn, the system quickly reverts to the prevailing natural ecosystem for the region. Thus, man's aim in agriculture has really evolved into an approach designed to keep nature in abeyance. Such domination of nature is tenuous at best. Plant disease 'control' and 'management' are two terms often used interchangeably, despite the fact that they encompass very different approaches. Control implies a degree of finality of having controlled and, thereby, dispatched the problem through some specific action by the grower. Along this same line, it is often assumed that if a disease has been 'controlled', its reoccurrence at a damaging level then the tactics failed or that control can be reclaimed by simply repeating the treatment. Management, by contrast, implies a continuing process that addresses all phases of a disease and the crop rather than some single tactic. Management also implies that pathogens are a part of the natural ecosystem and that our primary goal is to reduce the harm caused by disease, not just to kill pathogens. In this sense, a management approach seeks to find ways in which man can establish and maintain his crops in a manner that is least disruptive to natural conditions. This requires continuous adjustments to meet conditions such as crop maturity and weather as they change over the course of a season as well as from season to season.

Plant disease management decisions are based on epidemiological principles aimed at disrupting the development of damaging epidemics rather than trying to prevent all disease. This is accomplished by reducing the number and distribution of inoculum sources and reducing the apparent rates at which new infections occur. The most stable disease management programs utilize both of these approaches, often using a variety of strategies and tactics. Plant disease management, therefore, is the knowledgeable selection and use of all appropriate strategies and tactics to suppress the harm caused by diseases to a level that is economically acceptable. This is a tall order for fire blight epidemics which have a high potential to develop explosively, reaching levels that seem beyond the limits of management.

FIRE BLIGHT MANAGEMENT

The essence of a good fire blight management program has three aims: (1) reducing the number and distribution of both primary and secondary inoculum before that inoculum can be widely dispersed; (2) preventing blossom infections; and, (3) reducing the rate at which infections progress. Removing sources of primary inoculum and reducing the efficacy of any remaining inoculum are generally the most efficient tactics in a disease management program while those employed to prevent infection are nearly always more effective than those taken after infection.

3.1 Reducing Primary Inoculum

Dormant pruning. *E. amylovora* overwinters only in living tissues at the margins of indeterminate bark cankers so thorough pruning during the dormant season to remove diseased limbs is an absolute necessity. This effort will also remove much of the primary inoculum of the black rot, white rot and bitter rot fungus pathogens that commonly colonize dead wood in trees.

Copper sprays. Copper is an effective bactericide and almost any copper material is effective [Bordeaux mix, Kocide, Copper Count-N, etc.]. The purpose of this treatment is not to kill bacteria within cankers, but to reduce the efficacy of the bacteria in colonizing bark and bud surfaces during the early, pre-bloom period. For this reason, spray coverage needs to be very thorough and is best achieved using 0.2 to 0.4 gallons of dilute spray mixture per 1,000 ft³ of tree row volume or at least 100 to 200 gallons per acre.

Since the bacteria generally become available in the orchard when infectious activity at canker margins begins at the tight cluster to early pink stage of bud development [estimated at 93 cumulative degree days (CDD) >550F after green tip], applying copper materials before green tip only subjects the residues to weathering before they need to be available. A second critical caution is that copper needs to be applied to entire orchard blocks, not just to rows of susceptible varieties. This is important because inoculum dispersal by flies and other insects during the pre-bloom period is largely a random process occurring throughout the orchard without regard to cultivar susceptibility. Spraying only the susceptible trees in an orchard allows the bacteria to colonize bark surfaces on untreated trees and, subsequently, to be splashed or moved to open blossoms where pollinating insects can easily move the inoculum to flowers on susceptible trees, completely bypassing any copper residues.

Orchard monitoring. Because many overwintering cankers are small or can be overlooked during the winter pruning effort, a follow-up monitoring effort is needed to locate and remove any remaining active canker sites. Here, the regular appearance of early canker blight symptoms with the accumulation of about 300 DD >550F after green tip is an opportunity not to be missed. This effort probably has the greatest impact in years when blossom blight does not occur or is well controlled. Where the dormant sanitation effort is thorough, the number of active canker sites remaining is likely to be small, but, when blossom blight is not a factor, these few sites are the only source of inoculum within an orchard to fuel an epidemic of shoot blight or to set the stage for a trauma blight situation.

3.2 Preventing Blossom Infections

The prevention of blossom infections has always been and will always be a major emphasis in any fire blight management program. In the past, even the most conservative approaches such as the routine application of 3 to 4 streptomycin antibiotic sprays during the bloom period sometimes failed for unexplained reasons. Now, with the Maryblyt™ program, infection events can be predicted accurately and far enough in advance to allow antibiotic treatments to be made on the day before or the day of an anticipated event so that the level of control is improved and, very often, while using only 1 or 2 and sometimes no sprays in a season. If streptomycin cannot be applied before infection, it can still provide up to 90 percent control if applied 24 to 48 hours

after infection which, depending upon the number of blossoms present can still mean a considerable loss and many sources of inoculum for secondary infections.

Blight Ban™, a biological control formulation using the bacterium, *Pseudomonas fluorescens* A-506, which aggressively competes for space on flower stigmas with the pathogen, *E. amylovora* is also registered for use on apples and pears. To be effective, however, Blight Ban™ needs to be applied 1 or 2 times each season, regardless of whether infection events occur. This biocontrol organism is not effective if it arrives on stigma surfaces at the same time or after the pathogen gets there. Tests using this material in the Mid-Atlantic area have not provided consistent control when compared with streptomycin programs. Another chemical option which is not yet registered for use is Actigard™ (Novartis). This material works very differently than other materials in that it induces the host tree's normal resistance mechanisms to become operable early and shows some promise for fire blight blossom blight control, especially where streptomycin resistance may be a problem. Like biocontrol agents, however, Actigard™ will also need to be applied each season regardless of any immediate risk of infection because it needs about 5 to 7 days lead time.

3.3 Reducing shoot blight

As methods for blossom blight control have improved, research on the nature and control of shoot blight has become more focused. Despite the long-held implication of sucking insects in outbreaks of shoot blight, there is little proof that such a relationship exists. Research in Pennsylvania has specifically excluded green apple aphids while work in Virginia and Utah fairly well excludes white apple leafhoppers. In Virginia, there is some evidence that potato leafhoppers may play a role, but it is doubtful that this one species explains the worldwide incidence and continuing occurrence of shoot tip infections over several months during the season. At the same time, there is mounting evidence that gusty winds may cause small injuries to tender shoot tips through which bacteria on their surfaces may then enter and initiate infections.

From a timely control program, this presents two problems. First, streptomycin has proven to be ineffective in preventing shoot tip infections and most copper formulations have the potential for phytotoxicity. Secondly, even if a good bactericide becomes available, it hardly seems practical to try spraying whole orchards every time the wind blows with gusts more than 8 to 10 mph between petal fall and terminal bud set. The most practical approach, therefore, is still to reduce the number and distribution of secondary sources of inoculum by aggressively cutting out new infections early to reduce supply the bacteria which colonize growing shoot tips.

One of the most promising developments for shoot blight control is a gibberellic acid synthesis inhibitor called Apogee™ (prohexadione-calcium, BASF) which appears to be on a 'fast track' for registration either this year or next. Excellent results in limiting shoot blight has been developed in Michigan (Al Jones, Michigan State Univ.) and Virginia (Keith Yoder, Virginia Tech) on the use of this material in one or two applications beginning at petal fall. There are few 'magic silver bullets' in plant disease management, however, so that even if Apogee™ does become available soon, it will still be important to continue all basic efforts to reduce the number and distribution of inoculum sources as outlined above.

3.4 Reducing Secondary Inoculum

As fire blight epidemics get underway, the number of secondary infections increases rapidly because each infection site supplies additional inoculum for dispersal throughout orchards by wind, water and insects. Even where blossom blight does not occur or is well controlled, vegetative shoot infections can still cause much damage to the tree including a loss of total bearing surface. Cutting out or breaking off infected shoots has been tried often, but its effectiveness has always been questioned because some years it seems to work and some years it seems to fail miserably. There is also the preconceived notion that when cutting has to be done the amount of cutting required is neither practical or economical because of the time and labor required. In truth, cutting out active infections can be extremely effective if done at the right time and in the right way.

Cutting out active infections. To be effective in slowing the current season's epidemic, cutting must begin as soon as early symptoms appear. The late Ron Covey in Washington state demonstrated that delaying the first of several cutting efforts by two weeks resulted in the removal of six times more wood than where cutting was begun immediately. 'Early', in this sense, means as soon as wilt symptoms are apparent and before significant necrosis develops. One reason for this is that even before shoot tips wilt, droplets of bacterial ooze are often present on otherwise symptomless shoots and these are sources of inoculum for further dispersal. One advantage of the Maryblyt™ program is that it has proven to be quite accurate (+ 0-2 days) in predicting the early appearance of blossom, canker, shoot and trauma blight symptoms so that orchard monitoring and cutting operations can be anticipated.

How the cuts are made is also important and has a substantial amount to do with how much carryover inoculum will be available the following year. Conventional recommendations often suggest that cuts be made 8 to 12 inches below the leading edge of symptoms and that cutting tools be surface sterilized with copper materials or alcohol between each cut. We've found the bacterial pathogen as far as 9 feet back on a branch with a single terminal shoot tip infection. This is far beyond the limit where most growers want to or is necessary to cut. In addition, because the bacteria are already internal in the infected limb, the sterilization of tools between cuts is of little practical value.

When infected shoots and branches are removed, living cells are cut and bruised, allowing their contents to be readily available for immediate colonization by the bacteria already present in xylem tissues so that small cankers (1/4-inch or less) forms around many cuts regardless of whether tools are sterilized. As this infection progresses into healthy wood where reserve carbohydrate levels exceed those of the bacterial ooze, water is denied the bacteria and canker extension stops. If cuts are made back to the next healthy branch union following conventional practice, this small canker will remain in the orchard and provide primary inoculum for next year's epidemic.

Through a process I call "ugly stub" cutting, cuts are still made 8 to 12 inches below visible symptoms, but always into 2-year or older wood (high carbohydrates) and then leaving a 4- to 5-inch naked stub above the next leaf, spur or branch. Although small cankers will still form around a significant number of these cuts, the ugly stubs can be easily recognized during the

dormant pruning operation and removed at that time. A number of growers adopting this practice on a regular basis routinely spray paint the ugly stub bright orange so that they can be more easily located during the winter. This procedure is an important step in that it removes sources of inoculum in the orchard quickly which reduces the rate at which secondary infections occur and it has longer term effects in that fewer cankers are left in the orchard to fuel next year's epidemic. It also has the very practical advantage of being much faster in that the tedious job of sterilizing tools between cuts is not necessary so long as the only consideration at the time is the removal of infected shoots. This last caution is important because such cutting forays should never be combined with routine summer pruning efforts.

3.5 Rootstock blight

As noted previously, rootstock cankers that kill whole trees is a problem largely experienced with the M.26 and M.9 apple rootstocks and C-6 inter-stems. We have also seen it develop on M.7 and M.111 rootstocks although, here, the rootstock cankers are not as aggressive as on M.26 and M.9 and rarely kill trees. The bacteria move quickly from scion infection sites down through the xylem elements in other otherwise healthy limbs and trunks and into the rootstock in most trees, even though only about 5 to 10 percent of trees with scion infections succumb to rootstock blight each year during the first 5-6 years after planting.

In Maryland, we have noted the odd situation in that rootstock cankers are not generally initiated where the bacteria first contacts the rootstock at the graft union but only at 4 to 6 inches below ground, regardless of how high the graft is located above ground. Research is continuing in Maryland to discover what event(s) might initiate the development of rootstock cankers. There are, of course, new fire blight resistant rootstocks under development which might replace M.26 and M.9, but these are still many years away from thorough field testing in growers' orchards.

SUMMARY

Managing fire blight well in high density apple orchards of highly susceptible varieties on highly susceptible rootstocks is entirely possible. It requires, however, an aggressive approach using a variety of well-timed and well-executed tactics that continually aim at reducing the number and distribution of inoculum sources throughout the orchard throughout the season every year, regardless of how much fire blight occurs. Indeed, the greatest impact on limiting the damage caused by fire blight is possible in those years when little blight occurs. Our experience with growers following the management approach outlined here is that within three years, they reach a point where they no longer have a high risk for catastrophic loss, even when conditions for severe blight (multiple blossom infection events and hail storms) occur.

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