Scaffolds Update on Pest Management and Crop Development
FRUIT JOURNAL

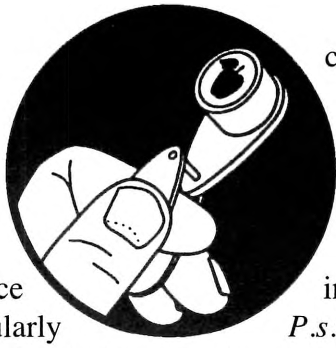
April 7, 2003 VOLUME 12, No. 4 Geneva, NY

DISEASES

HARD RAIN

BACTERIAL CANKER OF STONE FRUIT

(Bill Turechek, Plant Pathology, Geneva)



❖❖ After last weekend's ice storm, stone fruit growers, particularly sweet cherry and apricot growers, should be prepared to protect trees from bacterial canker. The 2-day ice storm damaged and cracked many trees throughout Monroe, Wayne, Ontario, and Seneca counties; these (unusually) large wounds can serve as entry sites for the bacteria. Below is an overview of the disease and its management.

The Disease

Bacterial canker is an important disease of sweet cherry in New York and Michigan, as well as in the neighboring province of Ontario. Although it is most serious on sweet cherry and apricot, it also affects tart cherry, peaches, plums, and prunes. Moreover, *Pseudomonas syringae* pv. *syringae* is a serious pathogen on many other fruit, vegetable, and ornamental crops. The most conspicuous symptoms on stone fruit are limb and trunk cankers, blossom blast, "dead bud", and leaf spotting. Cankers can girdle and kill entire limbs, reducing fruiting capacity of the tree. Infection of the trunk, particularly on young trees, often results in tree death. Infections of the blossoms cause blossom blast and loss of fruiting spurs. Infections of dormant flowering and vegetative buds result in a condition called "dead bud", in which buds fail to break dormancy in spring.

Two species of bacteria are associated with bacterial canker: *Pseudomonas syringae* pv. *syringae* (*P.s.s.*) and *Pseudomonas syringae* pv. *morsprunorum* (*P.s.m.*). A third pathovar, *P.s.* pv. persica, is problematic on peach but is not prevalent in the Northeastern states. *P.s.s.* and *P.s.m.* are disseminated widely in stone fruit production regions throughout the world and, although the two pathogens are lumped together as causing a single disease, the literature indicates clearly that there are substantial etiological differences between the two bacteria, enough so that orchard management practices may need to be tailored to the bacteria present. For example, anecdotal evidence scattered throughout the literature and some of our preliminary results suggest that *P.s.m.* is the primary bacteria involved in leaf spotting and may not be as aggressive in colonizing woody tissue as is *P.s.s.*

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IN THIS ISSUE...

Both pathovars overwinter in bark tissue at canker margins, in apparently healthy buds and/or systemically in the vascular system. In spring, i.e., under cool and wet conditions, bacteria multiply, emerge from their overwintering sites and are disseminated by wind and rain to blossoms, young leaves, and bark tissue. Populations of the pathogen fluctuate systematically over the course of a year. *P.s.s.* populations reach their peak around budbreak in early spring, decline to sometimes undetectable levels by midsummer, and then replenish again in autumn, but not to the same level as in spring. Bacteria of both pathovars survive without causing symptoms (i.e., an epiphytic phase) on the surface of symptomless blossom, leaf, and bark tissues from bloom through leaf fall. *P.s.s.* can also live epiphytically on a variety of weed hosts. However, Little et al. (1998) found that many of the *P.s.s.* strains isolated from weed hosts in plum orchards were dissimilar to those causing cankers on *Prunus* hosts according to genetic characterization. The role of wild *Prunus* spp. as a source of inoculum in bordering hedgerows is not well known, although some pathologists suspect that they serve as significant source of inoculum.

Stone fruits are most susceptible to infection during late winter and early spring. P.s.s. typically enters tree limbs and the trunk through pruning wounds in spring or sites of freeze injury in early winter and spring. Several reports have indicated that leaf scars exposed in the autumn after leaf fall are particularly susceptible to invasion by *P.s.m.*, resulting in cankers at the base of axillary buds. However, others were not able to verify these findings and suggest that P.s.m. enters the host through leaf stomata or wounds and migrate to substomatal cavities, enabling them to endure adverse environmental conditions during warm and dry periods. The bacteria then spread from infected leaves through the petiole and reach axillary buds by systemic invasion well before leaf fall throughout the season. Cankers subsequently appear at the base of infected buds.

Disease Management

Cultural control: Bacterial canker is difficult to control. Resistant cultivars offer the best option for disease management. Unfortunately, almost all stone fruit varieties in commercial production, particularly apricot and sweet cherry are susceptible to the disease. To slow the rate of epidemic development, growers should prune cankered limbs well below the visible canker **if possible, avoid pruning in early spring and fall when bacteria are most active,** and sterilize pruning tools before pruning healthy trees. Removal of wild *Prunus* species in hedgerows and forest stands adjacent to sweet cherry orchards is also recommended because it is presumed that these plants serve as a source of inoculum. The area around the base of young trees should be kept free of weeds and trash. This helps keep the trunk and crown dry and potentially reduces epiphytic populations of *P.s.s.*

If you are planning on planting a new orchard this season, plant on sites that do not have sandy, poorly drained, or waterlogged soils, or on sites that may suffer extended periods of drought. In newly planted orchards, train trees to wide crotch

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scaffolds

is published weekly from March to September by Cornell University—NYS Agricultural Experiment Station (Geneva) and Ithaca—with the assistance of Cornell Cooperative Extension. New York field reports welcomed. Send submissions by 3 pm Monday to:

scaffolds FRUIT JOURNAL
Dept. of Entomology
NYSAES, Barton Laboratory
P.O. Box 462
Geneva, NY 14456-0462
Phone: 315-787-2341 FAX 315-787-2326
E-mail: ama4@cornell.edu

Editors: A. Agnello, D. Kain

This newsletter available on CENET at: news://newsstand.cce.cornell.edu/cce.ag.tree-fruit
and on the World Wide Web at:
http://www.nysaes.cornell.edu/ent/scaffolds/

angles to prevent the formation of wounds in the crotches; injury to the bark perhaps provides the best avenue for infection. Wide crotch angles also help to minimize bark injury due to winter injury. Painting tree trunks with a bright white latex paint to reflect the winter sun and minimize temperature fluctuations at the bark surface should be done sometime after harvest. Any inexpensive white latex paint will do.

Chemical control: As is true for many bacterial diseases, there are a limited number of bactericides available to battle bacterial canker. Several copper-based bactericides, such as Bordeaux mixture, cupric hydroxide, cuprous oxide, tribasic copper sulfate, and mixtures of cupric hydroxide and EBDC's are recommended for disease control. In New York, current recommendations generally call for copper applications in the fall "before heavy rains begin" and another at late dormant. Another application is labeled for shortly after harvest in orchards where disease severe. This program does not provide adequate protection against disease. In Australia, researchers have tried spray schedules consisting of 2 autumn, 1 winter and 2 prebloom spring sprays with copper hydroxide on apricot and Bordeaux mixture on cherry. In the three years this program was tested, a 67% reduction in disease was observed.

For trees heavily damaged by last week's ice storm, growers may consider pruning back damaged branches before budbreak and then applying (with a small, handheld applicator) copper to the smoothed cuts. This can provide protection from invading bacteria as the wounds heal. This *additional* treatment should not replace an early application of copper to the entire orchard.

Copper Resistance: Resistance to copper is known to occur in populations of the bacterial canker bacteria in other states. Copper resistance is a quantitative rather than a qualitative trait; that is, copper resistance can be combated with the application of higher rates of copper. However, using higher rates of copper bactericides is discouraged because higher rates are known to be highly phytotoxic. Some growers have experimented with using half, quarter, and even lower rates during the season (usually after harvest) to try to get better control of the disease. Although these low-rate applications may not have resulted in phytotoxicity, keep in mind that the pathogen does not grow well in the heat of the summer so the timing of these applications is questionable.

Surveys for copper resistance have not been conducted in NY. However, use of low rates of copper during the growing season is not recommended because low-rate applications could speed selection of copper-resistant strains of the pathogen.❖❖

Little, E.L., Bostock, R.M., and Kirkpatrick, B.C. 1998. Genetic characterization of *Pseudomonas syringae* pv. *syringae* strains from stone fruit in California. Applied and Environmental Microbiology 64:3818-3823.

PHENOLOGIES

Geneva:
Apple: dormant
Pear: swollen bud

Highland:
Apple (McIntosh/Ginger Gold): green tip
Pear (Bartlett/Bosc): Swollen bud
Peach: Swollen bud
Plum: Dormant

INSECTS

BY DEGREES

ON ICE
(Art Agnello, Entomology, Geneva)

❖❖ (In view of the significant weather events of the past week, we're reprinting the following article from our 1999 Apple In-Depth School proceedings, which reviews a number of principles behind weather and pest management interactions.)

Weather Effects on Pest Activity and Control Measures

Of all the factors that can possibly have an effect on the development of a given pest population, the weather must certainly be one of the most critical. Nearly every discussion of how moderate or how severe an insect or mite problem is, was, or might be in a given season, starts with a general estimation of the temperature, wind, humidity and rainfall conditions to which that pest is subjected. We all have plentiful anecdotal evidence of how the spring rains of one year prevented one insect from taking off, or how the summer heat encouraged another. The point here is not to document specific effects, which are complex and abundant, but rather to indicate the need to take weather patterns into account when planning pest management programs, both before (prevention) and after (rescue) the fact.

Developmental Rates and Thresholds

Mammals are warm-blooded, developing at a constant rate regardless of the environmental temperature because they are able to maintain an internal temperature that allows their biochemical reactions to progress normally. Insects, which are exothermic, remain at the same temperature as their environment. They do not generate body heat and therefore depend on favorable external temperature. At a certain temperature, which varies among species, an insect's biochemical reactions cannot proceed and development stops. This temperature is known as the insect's developmental threshold or developmental base. Charting the ambient temperature makes it possible to track insect development, which is directly proportional to the amount of time accumulated above the developmental threshold (up to some maximum not often reached during the season). We divide this time arbitrarily into heat units or degree-days (DD).

Degree-Day Calculation Methods

There are different ways to determine the quantity of heat units accumulated, which is equivalent to the area under a temperature-vs-time graph on a given day. The methods are listed below in order of their precision in measuring small changes during the day or departures from idealized heating and cooling trends.

Average or Max/Min Method: This method is the simplest and least precise. It assumes that the daily temperature graph is linear and that the area beneath it is triangular.

DD = [Daily max temp + Daily min temp*]/2 - Devel. Threshold

(* If Daily min temp < Devel. Threshold, substitute Devel. Threshold)

Sine Wave (Baskerville-Emin) Method: This method is more precise and assumes that the daily temperature cycle takes the form of a sine wave. The area beneath this curve is determined by integration, which requires calculus. This method makes the same use of daily maximum and minimum temperatures and developmental threshold as does the Average Method. Using the Sine Wave Method tends to accumulate more DD's than the Average Method, particularly during the early part of the season.

Continuous Integration Method: This method is the most precise and requires multiple temperature readings hourly or more frequently throughout the day to obtain a temperature versus time graph that is truly representative of a field situation. The area beneath the curve is still calculated using integration. The data collection is most efficient if handled by a computer.

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Relating Degree-Days to Life Cycle and Development

These methods are attempts to correlate a pest event or activity with another event that can be measured more precisely. Events in an insect's life cycle often occur after the same heat units have accumulated each year, but many years' observations must be collected to measure this precisely. Degree-days can be used to predict events wherever weather data are available.

Temperature: By monitoring temperature and pest activity simultaneously for many years, it is possible to build up a data base of events and the range of accumulated DD's that correspond with them (refer to Table 14 in the 2003 Tree-Fruit Recommends, or see NY Food & Life Sci Bull. No. 142, "Fruit pest events and phenological development according to accumulated heat units").

Phenology: Some events occur reliably at the same time as other, easily observed biological events in the field; for example, mites hatch from late tight cluster to pink; European apple sawflies lay eggs from late bloom to petal fall. These rules of thumb often draw on the evolved relationships between pests and their hosts.

Biofix: This is a distinct, easily monitored event in the life history of an organism, used to fine-tune our predictions of its activity; for example, first flight, first egg laid, first mine observed.

Direct Influence of Weather on Pest Activity

First of all, in NY particularly, early spring is considered to be the die-is-cast period; the growth of most prebloom arthropod populations is pretty much determined for the first half of the season by what sort of spring weather occurs. European red mite, rosy apple aphid, spotted tentiform leafminer, tarnished plant bug, San Jose scale, and mullein bugs are only the most obvious of the species that suffer from a cold, wet, rainy and windy (in other words, typical) spring. They may be slowed considerably until the summer generations, or they might fail to show up at all in some cases. Conversely, a warm, dry, quick spring can result in nearly spontaneous generation of most of these pests. After the petal fall period, the rate of heat unit (Degree Days) accumulation is a primary factor in the duration of plum curculio oviposition (hotter = shorter period) and the speed of summer mite population growth. This latter case is especially crucial, as the first summer ERM eggs are generally hatching in June so the population is already primed to expand; additionally, the trees are particularly susceptible to foliar feeding stress, so a failure to act against a threshold-level infestation early will result in a long, hard battle for the rest of the summer.

Moving into midsummer, an abundance of rainfall will obviously stimulate foliar growth, which may have some advantages to the tree's development, but can also encourage undesirable infestations of pests such as green aphids, leafhoppers and even leafrollers. Hot and dry weather can be a mixed blessing, since it's associated on the one hand with localized outbreaks of twospotted spider mites, and on the other it tends to discourage emergence of apple maggot adults and woolly apple aphid aerial colonies if the ground is hard and dried out. The objective is to keep in mind which problems the prevailing conditions might require you to watch out for (and which to de-emphasize) as you go through the year. You can prevent a lot of needless effort in some cases, and effectively respond to otherwise serious infestations in other cases, simply by being aware of these basic trends.

Weather Effects on Pesticide Activity

The effect of rainfall and humidity on pesticide behavior is a topic that is much debated, but about which few hard details exist. Certainly, everyone gets nervous by a long, hard rainfall immediately following a pesticide spray. How much rain does it take to wash off a residue? Does it need to be reapplied? If so, how soon? The truth is, the factors that determine the need for a re-spray are usually very specific to each case, and generalizations never give a specific enough answer. Research on this topic has shown that there are intrinsic differences between insecticides, and that advice on whether to respray if rain falls after an insecticide application is mostly dependent on the insecticide and its formula-

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tion, and not so much on the intensity of the rainfall. The guidelines we use are heuristic and anecdotal — in other words, fuzzy — but they may help you decide on the advisability of going back in with a respray. In general, we assume that a spray deposit is pretty much solidly in place on the plant surface if allowed to dry for 2 hr after being applied; at any length of time before this point, there may be cases where thorough drying has not taken place. After 2 hr, the potential loss in efficacy from a rain will generally vary with the duration and frequency of the rain, but not necessarily with how hard the rain falls.❖❖

ADDENDUM

POINTS TO PONDER

FURTHER COMMENTS ON SCAB MANAGEMENT PROGRAMS
(Dave Rosenberger, Plant Pathology, Highland)

❖❖ Several readers responded with questions and comments concerning the article on scab management that was published in last week's *Scaffolds*. The first recommendation in that article was as follows: "Start early: apply a protectant at green-tip or at least before the first scab infection period." Two points of clarification are needed.

The "start early" recommendation should have been modified to state that a spray should be applied "... before the first significant infection period," thereby allowing for some adjustment of starting time based on ascospore maturity information. In years with delayed spore maturity (probably NOT this year!), the first Mill's infection period may not be significant if spore maturity is delayed and temperatures are cold.

The second clarification involves using predicted ascospore dose (PAD) to determine how long sprays can be delayed in spring. Contrary to what last week's article implied, the PAD system should still work fine IF scab control the previous year was not dependent on SI or strobilurin fungicides AND IF the PAD assessments are done using actual counts rather than tractor-seat observations. Where more than one SI or stroby fungicide spray is used to control scab, there is at least a slight risk that PAD counts will underestimate ascospore production and delaying sprays in such orchards can be risky.

Apple scab maturity counts(Highland, NY):
March 28
96% immature, 4% mature, 0% empty asci
April 4
86% immature,14% mature,0% empty asci

The lack of empty asci in the 4 April sample suggests that little if any spore discharge occurred during rains last week. However, we are pretty close to the 15–17% maturity threshold where we usually begin to get significant discharge. Leaves were wet when collected on 4 April, so no discharge test could be performed at that time. A tower discharge test on Monday morning, 7 April, yielded a count of 59 ascospores, indicating that some spores are now ready to discharge, although numbers are still low. We usually need >120–150 spores in a discharge test before we reach threshold levels in commercial orchards.

Cold conditions (and snow!) are predicted for the next several days, so there is little likelihood of scab infections occurring over the next few days. However, significant infection could occur with the next warm rain. Spore discharge during cold wetting periods (<40° F) will be minimal. Work performed by Stensvand et al. showed that virtually no ascospores are released during wetting periods with temperatures below 36°F and only a small proportion (up to 20%)of mature ascospores are released when temperatures are below 39°F. Given the predictions for continued cold weather in the Hudson Valley and the fact that we still have relatively few

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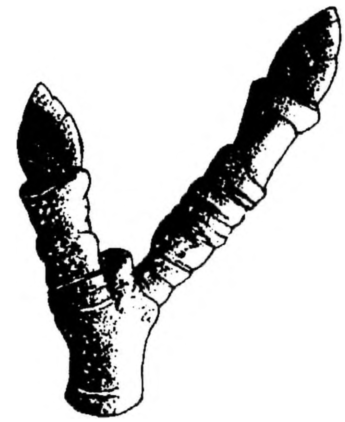
spores ready to discharge, significant infection is unlikely until we have wetting periods with mean temperatures in the mid-40's or above. However, growers should use any periods of decent weather to apply copper or a protectant fungicide so that trees will be protected if we get a warmer wetting period near the end of the week.



Relevant Literature:

Stensvand, A., D.M. Gadoury, T. Amundsen, L. Semb, and R.C. Seem. 1997. Ascospore release and infection of apple leaves by conidia and ascospores of *Venturia inaequalis* at low temperatures. Phytopathology 87: 1046–1053.

UPCOMING PEST EVENTS

	43°F	50°F
Current DD accumulations (Geneva 1/1–4/7):	79.3	34.2
(Geneva 1/1-4/7/2002):	98.5	31.2
(Geneva "Normal"):	94	39
Highland 1/1–4/7):	129.0	56.0
Coming Events:	**Ranges:**	
Green fruitworm 1st catch	36–173	9–101
Redbanded leafroller 1st catch	32–480	5–251
McIntosh at silver tip	54–137	17–58
Red Delicious at silver tip	54–117	20–59
Peach at swollen bud	67–184	17–82
Pear at bud burst	68–245	33–117
Plum at swollen bud	54–186	20–83
Sweet cherry at swollen bud	62–181	17–68
Tart cherry at swollen bud	62–221	17–101

scaffolds
Dept. of Entomology
NYS Agricultural Exp. Sta.
Barton Laboratory
Geneva, NY 14456-0462

NOTE: Every effort has been made to provide correct, complete and up-to-date pesticide recommendations. Nevertheless, changes in pesticide regulations occur constantly, and human errors are possible. These recommendations are not a substitute for pesticide labelling. Please read the label before applying any pesticide.

This material is based upon work supported by Smith Lever funds from the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.