Recent Developments in Apple Disease Control

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In this presentation, I will review our current thinking in New York State concerning the best approaches for controlling the major diseases of apples. The material that I am presenting is derived from the work of many colleagues at Cornell and at other institutions, but I am especially indebted to Dr. Wolfram Koeller (Cornell-Geneva) and his students who have generated most of the available information on fungicide resistance to apple scab.

Apple Scab Fungicides: Don't Depend on Post-Infection Activity!

Resistance to SI fungicides (Rubigan, Nova, Procure) is now fairly common in apple scab populations in New York State. The fruit entomologists in NY completed a detailed study of pest damage on apple fruit from 15 orchards across the state in fall of 2002. Much to our surprise, four of those orchards had high incidences of fruit scab with 8% to 50% of fruit affected. Subsequent testing by Dr. Koeller showed that three of the four problem orchards had scab populations that were resistant to the SI fungicides. I have noted similar SI-related scab control failures in several other orchards in eastern NY during the past two years. In most cases, failures are occurring where growers have consistently used 3-5 applications of SI-fungicides per year for 10-12 years.

Now for the bad news: resistance to SI fungicides appears to be linked to loss of activity in several other fungicide classes. Dr. Koeller has found that when apple scab becomes resistant to SI fungicides, it also loses some sensitivity to the anilinopyrimidine and strobilurin fungicide groups. The anilinopyrimidines include Vangard and the not-yet-registered Scala. Sovran and Flint are strobilurin fungicides. In orchards with SI resistance, Sovran and Flint continue to work as protectants, but their post-infection activity is compromised. Resistance to the protectant activity of Sovran and Flint is likely to develop in the future as it already has in Europe, but resistance to the protectant activity of Sovran and Flint has not yet been detected in the U.S. Resistance to benzimidazole fungicides (Benlate, Topsin M) and to dodine (Cyprex, Syllit) has been widespread in NY orchards for many years. There are no new fungicides in university trials that can be used to replace the SIs. Thus, when an orchard develops SI-resistance, the grower will probably be left for the foreseeable future with only fungicides that have no post-infection activity.

Dodine resistance and SI resistance can lurk undetected in some orchards for many years. If dodine is used only at green-tip and/or half-inch green, loss of activity will not be noticed until a year in which that activity is really needed. In many years, there are no significant infections prior to tight cluster. Or the levels of inoculum in the orchard may be so low that no sprays are really needed prior to tight cluster (e.g., as predicted for orchards with a very low predicted ascospore dose or PAD). Similarly, the contact fungicides that are routinely tank mixed with the SI fungicides may mask the fact that the SI fungicides are no longer working until a really bad scab year over-whelms the low rate of the contact fungicide that is included in the combination.

How can growers know which products are still effective in specific orchards? The best solution would be to test scab samples from individual orchards to determine which fungicides are still working. However, no simple test is available. As a result, it is currently impossible to

tell whether or not dodine, the SI fungicides, or the strobilurin fungicides will provide post-infection activity in any given orchard.

Scab has never developed resistance to copper, captan, mancozeb, or metiram (Polyram). Therefore, these products remain effective in all orchards if applied as protectants. They will also arrest developing infections if applied within 12 hours from the start of a warm wetting period (>60 °F), within 18 hr at 53 °F., or within up to 40-48 hr from the start of infection periods with mean temperatures below 43 °F.

Current Recommendations for Controlling Apple Scab

1. Forget most of what you learned about scab control over the past 20 years and revert to conservative, protectant fungicide programs during the prebloom period. Even in orchards where SI-resistance seems unlikely, a conservative program is the best way to further delay resistance, thereby preserving the post-infection activity (read: emergency activity) that the SIs can provide. In orchards with resistance to dodine and the SI fungicides, just a little bit of prebloom scab can turn into a season-long management nightmare if the summer is cool and wet, so do everything possible to avoid further selection of isolates resistant to these fungicides.
2. Start protectant fungicide programs at green-tip unless a PAD assessment in the fall verifies that the start of the spray program can be delayed. The concept of delaying sprays in low-inoculum orchards was developed and tested using only protectant fungicides, so this program should still work in orchards with dodine and SI resistance. However, even when the PAD is low, the delayed spray program is riskier in orchards with dodine and SI resistance. Without an effective post-infection fungicide, the PAD/delayed spray system has no built-in redundancy to cover any errors in calculating PAD or to eliminate the occasional lesion that might arise as a result of inoculum blown in from external sources.
3. The protectant fungicide program should start with a copper spray at green-tip. Copper fungicides are just as effective as mancozeb for controlling scab. Copper applied at green-tip may help to suppress superficial cankers caused by *Botryosphaeria* species (black rot, white rot) that sometimes develop on trunks and scaffolds in older orchards that have been consistently sprayed with only mancozeb and SI fungicides during the scab season.
4. Protectant fungicides should be renewed at roughly 7-day intervals or just prior to predicted rains if intervals are greater than 7 days. Forget about the routine 10-12 day spray intervals that were promoted with SI fungicides.
5. In orchards containing large trees or high levels of carry-over inoculum, tank mixed combinations of mancozeb (3 lb/A of formulated product) plus captan have proven more effective than mancozeb applied alone. In this combination, captan can be used at the rate of 1.5 to 3 lb/A of Captan 50W, or an equivalent rate of a different captan formulation. Of course, captan cannot be included near oil sprays whether used alone or in combinations.
6. The anilinopyrimidine fungicides are not recommended for scab control. Vangard has rarely performed better than mancozeb used alone at 3 lb/A. Given our inability to predict where SI resistance may be lurking, and given the apparent linkage between SI resistance and resistance to the anilinopyrimidines, we see no reason to use this class of chemistry on apples.

Controlling Powdery Mildew

SI fungicides are less effective against apple powdery mildew today than when this chemistry was first introduced, but the SI fungicides are still provide good mildew control in most orchards when applied at appropriate rates and timings. Bayleton provided good control of

mildew at rates as low as 1.5 oz/A when it was first introduced many years ago, but today most growers need at least 3-4 oz/A to achieve the same levels of control. Nova applied at rates recommended for scab control still provides excellent mildew control in most orchards. Sovran and Flint are also effective mildewcides, especially if control programs are initiated at pink or bloom. Sovran and Flint are somewhat less effective if control programs are not initiated until petal fall.

The absolutely critical sprays for controlling powdery mildew are the petal fall and first cover sprays. In years when the prebloom and bloom periods are warm and humid (but without significant rainfall to wash away mildew spores), a pink or bloom spray may also be essential.

Never leave mildew-susceptible cultivars unprotected at petal fall. Applying the first mildewcide spray at first or second cover (or when extensive secondary infections are already evident) should be classified as "revenge spraying." Such delayed sprays seldom provide acceptable mildew control, but they do provide strong selection pressure for development of fungicide resistance within the large mildew population that is usually present within several weeks after petal fall.

Controlling Fire Blight

Anyone growing pears or blight-susceptible apple cultivars should be using either MaryBlyt or Cougar Blight to predict when fire blight blossom infections are likely to occur. These models are very helpful for proper timing of streptomycin sprays during bloom. Fire blight outbreaks in Quebec in 2002 and in New York's Champlain Valley in 2003 are reminders that fire blight can destroy orchards even in colder climates where this disease is occurs only sporadically.

Honeycrisp is very susceptible to fire blight. As with other blight susceptible cultivars, the greatest losses are likely to result from blossom blight control failures in orchards that are 3 to 6-years old. In such immature orchards, blight frequently spreads to the rootstock and kills entire trees. McIntosh growers who are switching to Honeycrisp should be aware that fire blight poses a much greater risk to Honeycrisp than it did to McIntosh. Thus, streptomycin sprays may be warranted for Honeycrisp in geographic regions where fire blight was never considered a serious threat in the past.

Controlling Flyspeck and Sooty Blotch

Ascospores of the flyspeck fungus are released during or soon after the petal fall stage on apples. However, this primary inoculum is probably more important in non-orchard hosts than in sprayed orchards where the apple scab fungicides prevent infection. The flyspeck fungus can grow on numerous wild hosts in woods and hedgerows. Primary infections on the non-orchard hosts produce conidia later during summer, and the conidia cause most of the infections on apple fruit.

Brown and Sutton, working in North Carolina, determined that after flyspeck spores land on apples, 270 hours of wetting are required before those infections become visible on the fruit surface. Observations of flyspeck development on unsprayed trees at the Hudson Valley lab suggest that most flyspeck infections on apple fruit are initiated only after at least 270 hr of accumulated wetting have occurred after petal fall. This corresponds with the time that would be required for primary infections on wild hosts to mature and begin releasing conidia. Flyspeck is more severe in wet years when conidia become available earlier in the season because wet years

allow more time for apples to become infected and also the potential for more secondary cycles to be completed.

More than four inches of rain was recorded for 1-2 September 2003 at the Hudson Valley Lab. Growers who opted not to re-apply a fungicide after that rain reported a flush of flyspeck symptoms appeared on fruit at the end of September. A total of 275 hr of wetting was recorded during September. This series of events provided indirect verification that 270 hr of wetting are required for symptom development of flyspeck: The rain on 1-2 September eliminated all fungicide residues and initiated infections. Flyspeck became evident in numerous orchards almost exactly after 270 additional hours of accumulated wetting. In most years, fungicide sprays are not necessary after mid-August. However, in 2003, a September spray was essential for preventing flyspeck in varieties harvested in October.

Topsin M, Sovran, and Flint are all very effective for controlling flyspeck. All three of these fungicides provide some post-infection activity and may control infections that have accumulated less than 100 of the 270 total hours of wetting required for symptom development.

The major limiting factor for controlling flyspeck during August is probably poor spray coverage. Getting complete spray coverage can be almost impossible in poorly pruned trees or where fruit are clustered. In orchards with dense canopies, summer pruning that reduces canopy density and hand thinning to break up fruit clusters may be essential for achieving flyspeck control in a wet year.

Controlling Summer Rots on Honeycrisp

Honeycrisp is more susceptible than most other cultivars to summer fruit rots caused by *Botryosphaeria obtusa* (black rot), *B. dothidea* (white rot), and *Colletotrichum* species (bitter rot). Bitter rot is primarily a problem in regions with hot humid weather during August, and such climates are less than ideal for producing Honeycrisp. However, black rot and white rot are likely to occur to some degree anywhere that Honeycrisp is grown. This cultivar tends to retain fruitlets that are killed by thinning sprays, and these small fruitlet mummies harbor the fungi that later produce spores to infect maturing fruit during August.

Topsin M, Sovran, and Flint are all effective for controlling black rot and white rot. A combination of Topsin M plus captan applied approximately 28 and 14 days before harvest may be needed to control fruit rot diseases on Honeycrisp, especially if the preharvest period is especially warm. Flint can be applied on a similar preharvest schedule, but Sovran has a 30-day preharvest interval and therefore is not useful for late summer sprays on Honeycrisp.