FINGER LAKES
VINEYARD NOTES

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GRAPE DISEASE CONTROL, 2003

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Time for the annual review of new developments and various options on the disease-control front. As always, I'd like to acknowledge the outstanding team of grape pathologists here in Geneva, including faculty colleagues (D. Gadoury, R. Seem); research technicians (Duane Riegel, Judy Burr); and graduate students and post-docs becoming too numerous to mention; Rick Dunst and the crew at the Vineyard Lab in Fredonia also play a significant role. It is the combined research efforts of all of these people that serve as the basis for most of the following.

FUNGICIDE CHANGES & NEWS

1. Changes to the "Recommends. New categories of information have been added to complement the annual updates, including classification of specific fungicides according to their physical modes of action (protectant, post-infection, anti-sporulant, eradicant) and a reminder about resistance-management principles.

2. Topsin-M labeled for use on grapes. Topsin-M (thiophanate-methyl) is a benzimidazole fungicide that breaks down into the same active ingredient that was provided by Benlate. Hence, its activities and limitations are essentially the same as those for Benlate, and fungal isolates resistant to one product are also resistant to the other. Biologically, it should be viewed as a substitute for Benlate. Legally, however, Topsin-M is not registered for dormant treatment of pruning wounds to control Eutypa, as Benlate had been. As with all products, the label is the law, so be sure to read it.

3. Phosphorous acid products. Much of this was discussed last year, but for a quick review and update: phosphorous acid (also known as phosphonate or phosphite; or, PA for short) is a chemical that provides excellent control of many of downy mildew and closely related fungi, but has little to no activity against all other diseases. On grapes, we have consistently obtained excellent control of downy mildew with PA products, but virtually no control of powdery mildew (this distinction got confused in some quarters last year). There's no reason to expect it to control any other grape disease, either.

At least two different PA products are now registered for control of downy mildew, i.e., ProPhyt and Phostrol, and others may be on the way. PA also is a prime (often the prime) ingredient in a number of additional "plant tonics" and "nutritional supplements" that are sold without mentioning specific disease control properties. Because these products have not undergone the expense of EPA and state registrations for use as fungicides, they are often cheaper than the registered products. If you apply them according to directions for "conditioning" or nutritional purposes and obtain downy mildew control, that's a nice bonus; however, if you apply them with the specific intention of obtaining disease control and they're not labeled for this purpose, you've broken the law. Regardless of what you think of such distinctions, the law is the law, and you ignore it at your own peril.

PA works on the developing fungus in a post-infection mode. It is systemic and very mobile in the plant. Unlike traditional systemic fungicides such as Ridomil, it is shipped out of the leaves and accumulates in the roots and, presumably, the fruit. For this reason, the Australians (who have nearly 20 years of experience with the material) report that it has only a few days of residual (protectant) activity against foliar infections. Thus, they apply it after an infection period has occurred and figure they'll need to reapply after the next one if it starts more

than 3 days later, unless they've tank-mixed with something that provides forward protection against this next infection event (copper, mancozeb, captan, Abound, etc.). I trust what they say, but the data to support or interpret it are not available. Our own trials have been conducted on 'Chancellor', which is hyper-susceptible to fruit infection but quite resistant to foliar infection. In these trials, we've gotten excellent control each year when PA has been applied four times at 14-day intervals beginning about 2 weeks prebloom, regardless of when infection periods occurred. Of course, one would expect much better residual (protective) activity in organs where the material accumulates (fruit) than in those from which it's exported (leaves). The fact remains, however, that we have good experience with control of fruit infections but very little with control of foliar infections.

PA has a lot of potential. The material is exempt from residue tolerances, i.e., the EPA considers it so safe that there is no limit on the residues that can be found in any harvested product. It is considered a "biopesticide" by the EPA, so fits nicely into many programs that consciously strive for minimal environmental impact or "sustainability". And it works, which contributes to economic sustainability as well. We need to do more work to determine how it best fits into local management programs (the duration of residual activity in the leaves is the major issue), but the information above should help establish some basic principles for those who may be interested in trying PA products.

4. Serenade. As discussed previously, Serenade is a product whose active ingredient is a soil bacterium (*Bacillus subtilis*), which is registered for biological control of powdery mildew and Botrytis. One formulation being sold in NY is certified for organic production. Experiences with Serenade have been mixed. I've seen data from California where powdery mildew control has been very good. In my own trials, Serenade has provided some control but I would classify it only as "fair". Similarly, control of Botrytis has been a mixed bag. I obtained none in a 2001 trial, but fair to good control of Botrytis in a 2002 trial. However, in a trial conducted by Alice Wise in a commercial Long Island vineyard last year, bunch rot was severe where this product was used. My feeling right now is that Serenade has some activity, but it's limited. To their credit, the company that produces it has been very supportive of research efforts to find the right "fit" for NY vineyards. I don't think we've found it yet, although that doesn't mean it's not there.

5. Other "alternative" products for powdery mildew. As discussed at length previously, a number of non-traditional products are now registered for controlling grape powdery mildew (e.g., Armicarb, Kaligreen, Nutrol, Oxidate). These appear to work primarily (if not exclusively) as eradicants of very young developing colonies, with little or no residual (protectant) activity against subsequent infections. However, conditions are suitable for PM infections virtually every day once the weather warms up (see PM section below), so these materials need to be applied very frequently--generally, no more than 5- to 7-day intervals--for best results. Despite some claims to the contrary, I've seen no evidence that they provide control of Botrytis, nor would I expect them to, beyond the indirect control of this disease that is provided by reducing powdery mildew on berries (see Botrytis section below).

Evidence suggests that JMS Stylet Oil functions largely in the same way, i.e., by eradicating existing infections more than preventing new ones. However, Stylet Oil appears to have slight (?) protective activity and more activity against established infections than most or all of these other materials, which allows it to be effective when used at longer spray intervals. For example, last summer we compared Stylet Oil versus Nutrol for their activities as single-application eradicative treatments in a western NY vineyard, where PM infections on the fruit were severe. Although Nutrol has significant activity against microscopic infections or those that are just barely visible, it had little activity against these well-established PM colonies. In contrast, Stylet Oil killed many of them, particularly on the outside portions of the cluster where most of the spray was deposited. This should serve as a reminder that all of these materials act strictly by contact, so ***complete*** spray coverage is absolutely critical to their success.

6. Resistance to the strobilurin fungicides. This looks like the disease-management topic of the year for *V. vinifera* growers in particular, but should be a concern to others as well. First of all, resistance by the downy mildew fungus became widespread in the humid viticultural regions of Europe last summer. Downy mildew pressure is much higher there than it is for us, and they spray for it so intensively that resistance to other DM fungicides also has developed quickly (e.g., Ridomil has been ineffective there for the last 10 or 15 years due to

resistance). Nevertheless, their experience shows that the DM fungus also can develop resistance to the strobies very quickly, and should serve as one more warning to us (as if we need it).

As most people know, our problem was with powdery mildew. Last year, a number of Finger Lakes and Long Island vineyards containing varieties that are highly susceptible to powdery mildew (Chardonnay, in particular) experienced severe cluster infections when strobilurin fungicides were used during the bloom and early postbloom stages. This was due, in part, to weather that was unusually favorable for disease development during this critical period. In some cases, but certainly not all, lush canopy growth and questionable spray coverage may have played a role. Clearly, however, the problem also was due to a failure of the strobies (primarily Abound) to provide adequate control in the affected vineyards under high disease pressure. By chance, we conducted a trial in a Chardonnay block where a standard rotational program that included Abound resulted in severe crop loss, whereas a similar program utilizing an experimental mixture of a new strobie plus an unrelated compound gave clean fruit. But when we applied these two components separately, the new strobie also provided poor control, whereas the unrelated compound was very effective. Since spray coverage was adequate for this other compound to function properly, it looked like we were facing a resistance problem with the strobies.

As we've discussed many times, there are two major scenarios by which fungicide resistance occurs. One is the "all or nothing" type, wherein a simple mutation allows certain strains of the fungus to become completely immune to the material. When this happens, spraying the fungicide is no better than spraying water onto the resistant strains, and they quickly go to town and "eat up" the affected crop. This is how resistance to Benlate and Ridomil develops. It is also how virtually all cases of resistance to the strobies have been reported for other disease-causing fungi worldwide, including the one that causes grape downy mildew. However, the powdery mildew problems that I encountered in both the Finger Lakes and Long Island last summer did NOT fit this scenario. That is, PM was confined largely to the clusters of the most highly susceptible varieties (Chardonnay, Pinot blanc), but was relatively uncommon on the foliage of these same vines and on the fruit and leaves of most other vinifera varieties, all of which are pretty susceptible to PM. If the fungus is so resistant that you're just spraying water, you'd expect to see some of it on a much wider range of varieties and on most of the leaves of the vines with bad cluster infections.

The other scenario by which fungicide resistance develops is what I've called "shades of gray". With this type of resistance, there are no immune strains of the fungus involved. Rather, the fungus population consists of a collection of strains that exhibit a range of responses to the fungicide. In this so-called "bell-shaped curve" of distribution, most have "average" levels of sensitivity, but a few are much more sensitive than average and a few are much less sensitive than average. This latter group may be controlled marginally by full doses of the material but are poorly controlled by partial doses, such as those remaining towards the end of a spray interval or provided on parts of the vine where spray coverage might be restricted. Over time, these least-sensitive members of the population, which were originally rare before the fungicide was introduced, build up to higher and higher frequencies and disease control is compromised. This is what happened with the sterol inhibitor fungicides.

We were able to obtain good sample populations from our trial vineyard and from a badly-affected commercial vineyard on Seneca Lake, and assessed the distribution of strobie sensitivities within them. We also obtained more limited samples from affected vineyards on Long Island and one in Virginia. We found no evidence of immunity to the fungicides in all but one site, and even that is questionable. However, we did find clear "shifts" in all populations, so that the least-sensitive segment, which was a distinct minority 5 years ago, is now a distinct majority. The shades-of-gray model.

What's the bottom line? Most, if not all, of the problems that we've seen so far are of the shades-of-gray variety, which is harmful but somewhat manageable. That is, the fungicides provide some control of the least-sensitive isolates, particularly under more moderate pressure and on non-hyper-susceptible varieties. Note that even on Chardonnay, numerous growers obtained very good control when Abound was tank-mixed with sulfur, and it's questionable whether the sulfur component would have done as well by itself, since it was being applied on Abound-type (14 day) intervals under very high disease pressure. However, IF immune strains eventually pop up and multiply, these will not be controlled by the strobies. On all crops worldwide, there is only one other example

where strobie performance was compromised by shades-of-gray resistance, so we have no other history to go on. In that case, immune isolates popped up about 4 years after shades-of-gray problems arose, and the materials lost their remaining effectiveness. There's no way of telling whether our experience will follow that one or not.

Finally, the preceding needs to be kept in context. Too many growers suffered too much loss last year. It was very sobering, and we don't want it to happen again. The fact remains, however, that the vast majority of the acreage in NY was not affected. Assuming that the affected growers were the proverbial "canary in the mine shaft ", what should be done? What's the extent of the danger? Should we abandon effective products before a problem arises? What are the available alternatives? There's no one correct answer. Consider, however, that the single most important factor driving resistance appears to be the aggregate number of strobie sprays applied, both here and in many other crop systems. If the "magic number" before problems arise is 16 (for the sake of argument), that would equate to four sprays per year for 4 years, or two per year for 8 years, or one per year for 16 years, etc. By this reasoning, a Concord grower who has been spraying strobies once per season is in a much different position than a Chardonnay grower who has used them three or four times per season. Thus, growers of Concord and other moderately susceptible varieties with limited use history should keep an eye on things, but the strobies will probably remain more effective than the available alternatives for a while to come. Remember that canary, though, and maintain rotational programs with limited usage.

V. vinifera growers have a tougher decision. In blocks where they failed, I'd be hesitant to go back unless I thought it was due to a problem that I could rectify (e.g., spray coverage). For everywhere else, you know what the alternatives to the strobies are, including their strengths and limitations. Maintaining the strobies in the rotation is a definite option, but be sure to:

(i) Maintain full rates and *excellent* spray coverage. Shades-of-gray resistance is rate-dependent, so reduced dosages (intentional or coverage problems) will only make things worse. Sovran and, especially, Flint are more active against PM than Abound, and it's possible that they'll give better control in fungal populations that have begun to "shift" towards the insensitive end of the scale (in essence, it's like using a higher rate of Abound). However, we haven't tested this concept yet to see if it will make a difference under such conditions. Remember that you'll need to provide supplemental control of downy mildew when using these two materials (especially Flint) if it's wet.

(ii) Limit them to no more than two sprays during the season. Absolutely no more than three, if you want to gamble, but that's likely to shorten their remaining life span.

(iii) Shorten spray intervals to 10 days or so if it's warm during the early postbloom period. I would have said 10-12 days, but that will turn into 12-14 once the inevitable delays arise. Shorter intervals not only maintains the dose on highly-susceptible young berries but also reduce the chance that some infections will sneak in at the end of the interval and be treated in a post-infection manner by the next spray. Research shows that the least-sensitive "problem" isolates of the PM fungus are particularly insensitive to post-infection applications of the strobies, more so than they are to protective applications. Thus, post-infection treatments not only provide less control, but they also help select the more resistant individuals in the fungal population. Furthermore, note that any leaves that emerge after one spray will, by definition, be treated in a post-infection manner by the next one, since virtually every day provides conditions suitable for some level of infection. The Flint label recommendation for stretching the higher (2.0 oz/A) rate to 21-day intervals is a bad idea for this very reason, in my opinion, even if it is convenient.

(iv) Tank mix them with sulfur. I haven't heard of anybody (yet) who tank-mixed the strobies with sulfur last year and had a serious PM problem. It's cheap insurance that apparently paid big dividends. I'd also tank-mix sulfur

with any of the SI fungicides (Rubigan, Nova, Elite), especially those that precede a strobie application. This is a controversial topic, because there is limited evidence that sulfur may actually reduce the activity of the SI fungicides. However, the SI materials act primarily in a "backward" (post-infection) mode with only limited forward activity. Thus, if you're following an SI with a strobie, you need to maintain forward protection until the strobie is applied, or it also will need to function in a post-infection mode (not good for resistance management, as just discussed).

OTHER POWDERY MILDEW (PM) NEWS AND REMINDERS

1. A quick review of PM biology with respect to management considerations.

(i) The fungus overwinters as minute fruiting bodies (cleistothecia) that form on leaves and clusters during late summer and autumn, then wash onto the bark of the trunk where they're protected. Thus, the amount of fungus capable of starting disease this year is directly proportional to the amount of disease that developed last year. An important consequence of this is that PM sprays during the first few weeks after bud break are likely to be far more important in blocks where PM was a problem last year, compared to blocks that remained clean through leaf fall.

(ii) Powdery mildew functions as a "compound interest" type of disease, that is, a few infections can "snowball" and build up to many in a short period of time if conditions are favorable for reproduction of the fungus. The primary factor that governs the rate of reproduction is temperature. The table below shows how a constant temperature affects this rate, i.e., the number of days from the time a spore lands on a leaf until it produces a PM colony with a new generation of spores capable of spreading the disease.

Temp (°F)	Days
48	25
54	18
59	11
63	7
74	6
79	5
86	6
90	not active

One practical application of these numbers is that spray intervals can be juggled somewhat according to temperature. That is, they can be stretched a bit during cool portions of the early season, but should be tightened up if we run into a spell of very warm weather, where high night temperatures allow the fungus to develop under optimum conditions nearly 24 hours a day. This is exactly what happened in the Finger Lakes and western NY last year. For example, the average daily temperature in Geneva for the first 3 weeks after the start of Chardonnay bloom was nearly 74°F in 2002, or nearly 5°F higher than the average for the previous 5 years. Ideal conditions for disease development during the critical period for berry infection undoubtedly contributed to the problems that some growers experienced.

(iv) Although not as important a factor as temperature, high humidity also increases disease severity. The optimum relative humidity is about 85%, although the disease functions to some extent over the entire range of humidities that we experience.

*2. Berries are extremely susceptible from the start of bloom through fruit set, then become highly resistant to immune about 2 weeks (Concord) to 4 weeks (*V. vinifera*) later.* This is your annual reminder.

3. Failure to control inconspicuous PM infections on the berries can increase the severity of berry rots (Botrytis and sour rot) at harvest. These so-called "diffuse" infections occur on unprotected berries just as they're becoming highly resistant (about the time of bunch closure for *V. vinifera* varieties). They certainly aren't the only cause of berry rots and wine spoilage, but they're one more reason to strive for excellent PM control during the first month after bloom.

4. Sulfur. There are only two reasons to use sulfur: it's cheap and it's effective. It has been a viticultural staple for 150 years, and there's virtually no chance of resistance developing to it. It provides good vapor activity, which can compensate to a limited extent for irregularities in spray coverage. It helped a lot of growers last season, and I wish I were selling the stuff this year. All of that being said, let's not forget its limitations. It washes off and is most effective in a hot, dry year like 2002. You'll probably need to apply it more frequently than some of you may have gotten used to or have the capacity for, although higher rates will extend the period of activity. There are good reasons why some growers continue to rely on sulfur as their primary PM fungicide and why others have chosen not to. And on Concords, sulfur does more harm to the vine than leaving the powdery mildew uncontrolled.

BLACK ROT (BR) NEWS AND REMINDERS

*1. As fruit mature, they become increasingly resistant to infection **AND** infections take longer to show up.* Remember that berries are highly susceptible to black rot from cap fall until 3-4 weeks (Concord) or 4-5 weeks (Riesling, Chardonnay) later, then become highly resistant to immune after about 2 more weeks. Berries acquire resistance more quickly in warm summers relative to cool ones, hence the range given above. As often noted, we've regularly obtained excellent control with sprays applied at the start of bloom plus 2 and 4 weeks later, which provide protection during the period of peak susceptibility and most or all of the remaining time before they become highly resistant. Some growers get good control with just the first two of these sprays. Some try this approach and end up with the disease.

Obviously, inoculum availability and weather have a lot to do with how soon you can stop spraying. Mummified berries are the overwintering source of the BR fungus. Unless these are retained in the vine during pruning, spores from them are depleted within a couple of weeks after bloom. So if the disease has been controlled by the time the overwintering spores run out, there should be no source for new infections; in contrast, if new black rot infections are established, protection will need to continue.

2. The incubation period for the disease can be very long. Under Geneva conditions, we've also found that clusters infected during the first few weeks after bloom show symptoms about 13-15 days later and that disease progress is typically completed within 21 days after the infection event. However, clusters infected near the end of their susceptible period do not develop symptoms until 3 to 5 weeks after infection. In New York vineyards, black rot that begins to show up in early- to mid-August is probably the result of infections that occurred in mid-July. This fact should be considered when trying to determine "what went wrong" should such disease occur.

3. The SI fungicides are most effective in "reach-back" activity, whereas the strobilurins are most effective in "forward" activity. In field experiments, we inoculated young berries at various intervals both before and after sprays with Nova and Abound. Nova showed greater activity when applied after the infection period, whereas Abound was the opposite. These general trends aren't surprising, but they're worth considering in certain circumstances. For instance, if the first BR spray of the season is applied after a number of potential infection periods, Nova or Elite may be the best choice if this disease is of significant concern. Conversely, the superior residual activity of the strobilurins may make them more attractive as the final BR spray of the program. No need to get too fancy here, other diseases also need controlled along with BR, but understanding how these materials work can help sometimes.

4. Mummies retained in the canopy provide significantly more pressure for BR development than those dropped to the ground. Mummies in the canopy produce many more spores than those on the ground, and continue to produce them into August, long after spores have been depleted from mummies on the ground. Furthermore, these spores are far more likely to land on susceptible grape tissue than those produced on the ground, since they are released right next to leaves and fruit in the canopy. Even a few mummies retained within the vine can cause significant levels of infection around them. Don't forget how much additional control you can provide by the simple practice of dropping mummies to the ground during hand pruning or as a follow-up to mechanical pruning.

5. Fungicides. Nova and Elite remain the "kings". Unfortunately, the most important time to control black rot (bloom and early postbloom) is also the critical time for controlling PM on the clusters, and PM resistance to these materials makes them problematic at such a time in many vineyards.

However, if BR is a significantly greater concern than PM, this may not matter so much. Abound, Sovran and Flint provide very good to excellent control, equal to mancozeb, ziram, and ferbam under moderate pressure and superior under very rainy conditions (they're less likely to wash off). Of course, mancozeb, ferbam, and ziram are old standards and provide good control under most commercial conditions. Captan, Rubigan, and Procure are only fair. Copper is poor.

DOWNY MILDEW (DM) NEWS AND REMINDERS

Disease biology. Recall that primary infections can occur from the prebloom period through fruit set (maybe beyond), so this is the critical time to prevent DM from getting established. It is particularly critical because clusters and young berries are so susceptible at this time. Cluster infections were present to some extent in <u>many</u> Finger Lakes vineyards during and shortly after bloom last year, and additional spread could have been significant if it hadn't turned hot and dry so suddenly (the result being that we got PM instead). Scrutiny of Geneva weather data and disease observations over the last 20 years indicates that the first infection of the season can occur once (i) 'Chancellor' vines reach a growth stage corresponding to 5-6 unfolded leaves with fruit clusters clearly visible and expanding (about 2 weeks pre-bloom); and (ii) rainfall of at least 0.1 inch occurs at a temperature of 52°F or higher. Last year, this occurred during a prolonged rain from May 29-31; in 2001, it occurred on June 1. Remember, though, that the fungus is following accumulated heat units, not the calendar. So is the vine, so it is a good indicator of when the disease is ready to start.

The disease has a complex biology, requiring relative humidity of 95% or more during darkness and rain during the same night or early morning. The incubation period can be as long as 10 days to 3 weeks under suboptimal conditions but only 4 to 5 days when everything is right for the fungus (or wrong for the grower). Thus, spread of the disease can be explosive after a couple of weeks of wet weather unless it is well controlled. Spread is most rapid at temps of 65-77°F (no activity over 86°F), although it can occur down into the 50's.

The disease typically "goes on vacation" once warm, dry weather hits in the summer, and it can take some time for it to reactivate and build up again after this occurs. The erratic occurrence of DM coupled with its explosive and potentially devastating nature make it an ideal candidate for scouting, especially after fruit have become resistant and the consequences of incomplete control are diminished (see below). No need to spray for it when it isn't there, but don't let it get rolling if it's active.

Fruit susceptibility. Clusters of some varieties are highly susceptible to infection as soon as the fungus becomes active during the prebloom period. Recent research indicates that berries become highly resistant to infection about 2 weeks after the start of bloom, although losses due to berry stem infections can occur for at least 2 additional weeks. For many years, the standard test protocol on Chancellor vines at Geneva has been to start spraying about 2 weeks prebloom and continue through 4 weeks postbloom. Recommended materials consistently provide excellent control of fruit and cluster stem infections using this schedule, on the worst possible variety under high inoculum pressure.

Fungicides. Ridomil remains the best downy mildew fungicide ever developed for use on grapes, but its cost and lack of activity against other diseases limit its general usage. It's also highly prone to resistance development. Abound has provided excellent control every year since we began testing it in 1996. Phosphorous acid formulations (see beginning section) have typically been equivalent to Abound in my trials on Chancellor (which only develops cluster infections). Sovran is marginal, seems to be OK under moderate pressure but don't rely on it in a bad year or site. Flint is poor. Copper, mancozeb, and captan are old standards because they work.

BOTRYTIS NEWS AND REMINDERS

1. Biology. The Botrytis fungus is a "weak" pathogen that primarily attacks highly succulent, dead, injured (e.g., grape berry moth), or senescent (expiring) tissues such as wilting blossom parts and ripening fruit. The fungus thrives in high humidity and still air (optimum temperature range is 59-77°F), hence the utility of cultural practices such as leaf pulling and canopy management to minimize these conditions within the fruit zone. Although the fungus grows well only in berries that are ripening, young fruit also can become infected through attached blossom parts, and perhaps through scars left by the fallen caps. Such infections remaining latent (dormant) until some of them resume activity

and rot the berries as they start to ripen. Although latent infections can be common following a wet bloom period, the vast majority remain inactive through harvest (the fruit stay healthy). Factors that cause latent infections to activate or not are poorly understood, although high humidity and tissues with excessive nitrogen content (how high, specifically, is not defined) appear to be two factors that promote this process. Botrytis is a disease that is governed by complex interactions between the grapes, the weather, and the fungus itself, many of which remain poorly understood.

Over the last 5 years, we've examined a number of issues concerning Botrytis. Some of the major conclusions from this ongoing study are as follows:

• If Botrytis spores and wet conditions are available, berry infection can occur anytime after bloom. However, berries are most susceptible to becoming diseased when conditions for infection occur after veraison.

• Most latent infections remain inactive through harvest (no rot develops). However, the few that do activate after veraison can provide a source for rapid disease spread as berries become highly susceptible during the preharvest period.

• Cluster compactness has a pronounced effect on disease development. This appears to be due largely to its effect on berry-to-berry spread. For example, in experiments conducted last year on tight-clustered clones of Chardonnay and Pinot noir, disease spread was extensive when even a single berry was inoculated at veraison and became rotted 1 week later. In contrast, disease spread was minimal when clusters on these same vines were thinned by hand to resemble the looseness of the 'Mariafeld' clone of Pinot noir, even when five berries per cluster were inoculated. I believe that finding practical means of loosening clusters is the "holy grail" of Botrytis management, but the watch word is "practical". We've been able to accomplish thinning by brushing the clusters with a special tool by hand shortly after bloom, as is done in table grape production, but this is economically prohibitive for most vineyards. A number of people have experimented with giberellic acid sprays, but these can have negative impacts on the vine and, therefore, are not allowed on wine grapes (product liability issues). Natural product extracts are being tested, but the jury is still out on them. We all know what we want, we just don't know how to get there yet.

• In additional experiments, we showed that preharvest spread was increased by increasing the N content of berries (foliar sprays of urea after veraison). This does NOT mean that such treatments should be avoided, since they may be helpful in combating the atypical aging phenomenon in white wines. However, it DOES mean that Botrytis management may need to be more intensive when they're applied. In particular, control of early latent infections may be even more critical where preharvest N is applied, to minimize the potential for the fungus to establish "footholds" from which it might spread before harvest.

• There is no single "correct" timing for fungicide applications in a Botrytis management program. In some years, early sprays (bloom and bunch closure) have been more effective than later sprays (veraison and preharvest). In more years, the opposite has been true. In some years, two early sprays OR two late sprays provided the same control as all four; in a majority of years, all four provided the best results. The relative benefits of early versus late applications, and the total number necessary, will vary among years (when in the season rainy periods occur). Early sprays seemed to be particularly important in the Finger Lakes last year (wet bloom period), especially on late-harvested varieties (October rains provided ideal conditions for a few early infections to spread extensively). Optimal spray timing may also be influenced by cultivar and clone. For example, the extremely tight-clustered Vignoles cultivar seems to benefit particularly from early sprays.

3. Fungicides. Cultural procedures (especially promoting good air circulation) are perhaps more important for controlling Botrytis than for any other of our common grape diseases. Recognizing this, consider that the availability of new Botrytis fungicides provides additional tools to <u>complement</u> (rather than replace) cultural control tools, such as canopy management and leaf pulling.

Vangard has been our most consistent performer over the last few years. It's absorbed by the blossoms and fruit, thus it appears to have limited reach-back activity and doesn't wash off. It's highly prone to resistance development, so shouldn't be the only fungicide used over a period of time. The label allows two sprays per season, some European countries allow only one (resistance management). DO NOT rely on this single fungicide year after year.

Elevate has been a bit less consistent in our trials, although it appears to be a good fungicide and others have had better results. In fact, it was better than or equal to Vangard under a number of different programs examined in our 2002 trial. It is a protectant fungicide that doesn't enter the blossoms or fruit, so it should not have any reach-back activity. However, it appears to be quite rainfast. It should be a component in rotational strategies.

Rovral has a long and well-discussed history. Although primarily a protectant fungicide, it does enter sprayed tissues; it has some limited postinfection activity and is a good antisporulant material. Activity is improved by mixing it with an agent that improves uptake into the fruit, such as an oil or a nonionic surfactant. Because Rovral (and the related Ronilan) were the only Botrytis fungicides available for many years, their repeated use led to resistance development and erratic activity in some vineyards. Rovral might be safe to use in some vineyards for a maximum of one application per year, but I don't think it should be the primary component in rotational programs, particularly in vineyards with a long history of use.

The strobies have performed well for us under moderate pressure, although it appears that Abound is weaker than Sovran and, particularly, Flint. In fact, Flint is now labeled for Botrytis control, although at a higher rate (3 oz/A) than what is used against powdery mildew and black rot (1.5 to 2 oz/A). In limited trials, the powdery mildew rates of these materials have provided benefit when applied at bloom and bunch closing followed by a Botrytis-specific fungicide at veraison and preharvest. However, in a trial that we conducted last year (early pressure was heavy), this approach was not as successful as two sprays of either Vangard or Elevate followed by two of the other.

PHOMOPSIS (Ph) NEWS AND REMINDERS

1. Early sprays are the most important for control of rachis infections. Although fruit infections by the Phomopsis fungus can cause serious and spectacular losses in wet years (especially on Niagaras), rachis infections are the most consistent cause of economic losses from this disease in New York. In four different fungicide trials, we have found that the early, traditional Ph sprays (early shoot growth, as clusters first become visible) are the most important for control of these infections. They are particularly important for control of the most serious infections, i.e., those that girdle significant portions of the rachis and cause berries to fall to the ground before harvest. In last year's spray-timing trial on Concords in Fredonia, a single spray at the 3- to 5-inch growth stage provided 80% as much control of infected rachises as a 6-spray program from 1-inch shoots until mid-July. Both programs provided equivalent levels of control of the most serious infections. In contrast, when the first spray was not applied until the immediate prebloom stage, virtually no control was obtained. This isn't the only spray that will be needed for control in a wet year, but it's probably the most important.

2. Fruit infection remains mysterious. Work conducted by Jay Pscheidt and Roger Pearson in the 1980's indicated that berries lose their susceptibility to infection after the pea-sized stage. In recent years, however, meticulous work by Mike Ellis and his students at Ohio State has shown that berries retain susceptibility throughout the season. Does that mean that highly susceptible varieties (e.g., Niagara) in problem blocks need protection all summer year? No. For one thing, we've been unable to detect spores of the fungus beyond mid-July. For another, in a spray-timing trial conducted in a problem Niagara block last year, we got virtually complete control of berry infection when sprays were stopped after the second postbloom application (mid-July). And finally, it's very difficult to get good spray coverage of juice grape berries (those at greatest risk) once the canopy closes up in mid-summer, whether you need it or not. There's still a lot that isn't known about fruit infection, but the critical sprays for this phase of the disease still appear to be the immediate prebloom plus first postbloom application. A second

post-bloom spray may be a good bet in a wet year, especially if it's a problem block with a history of this disease.

3. Canopy architecture and management. Phomopsis spores are rain-splashed onto susceptible tissues from their overwintering sites within old canes, spurs, and pruning stubs in the canopy. Gravity makes them go down. Thus, we tend to see much worse problems in native American varieties (pendulous growth, usually drooping beneath these inoculum sources) rather than upright-growing *V. vinifera* and hybrid varieties. The latter aren't necessarily more resistant, but they do escape many of the potential infections that natives don't. This is particularly true with training systems such as VSP, which cause most new growth to be above old wood (although some spores still do splash up). And of course, management systems that retain a lot of old canes and stubs in the canopy (e.g., mechanical hedging) increase the inoculum load and associated disease pressure within that vineyard.

4. Fungicides. Mancozeb, captan, and ziram have all provided good control of basal shoot infections in our fungicide trials. Captan is being touted by some individuals as far superior to the others. This hasn't been my experience, although it had a slight edge over mancozeb in one trial with extreme disease pressure. For those who aren't prohibited from using captan, I'd consider other issues (captan is better at conserving mite predators, mancozeb doesn't have the 3-day re-entry restriction) as more important than any modest differences in activity between the two, especially in commercial vineyards that have maintained relatively good control over the years (low inoculum). Experience with the strobies has been mixed. Fortunately, they've looked better against fruit (and maybe rachis) infections than they have against basal shoot infections. Of course, there's no reason to be using them early.

5. Dormant sprays of lime sulfur are likely to be beneficial. In the 1980's, Pscheidt and Pearson showed that a dormant application of lime sulfur (calcium polysulfide) drastically reduced overwintering inoculum of the Phomopsis fungus. Last year, Mike Ellis obtained similar results in Ohio, and showed that this single treatment provided nearly as much control as a standard fungicide program. Lime sulfur is unpleasant to work with, is hard on machinery, and the treatment isn't cheap. However, it's probably worth considering for any growers who have had trouble controlling this disease. The label rate is 12 gallons per 100 gallons of water, and although the label also specifies a volume of 300 gal/A, this seems excessive (and is prohibitively expensive). The principle is that lime sulfur works by contact, so spray volume and tractor speed should be appropriate for an excellent soaking of the vine. This treatment will also drastically reduce the overwintering bodies of the powdery mildew fungus (cleistothecia) if vines are thoroughly soaked.

6. Spray application technique. Many growers like to spray alternate rows in the very early season (critical time for controlling Ph rachis infections), assuming that sufficient spray will blow through the target row and impact on vines in the "middle" row. In each of the last two years, Andrew Landers has helped us examine this issue in a commercial Niagara vineyard. In both years, vines in the middle row received less spray and the coverage was more variable. Don't fix it if it ain't broke, but if you're having trouble controlling Ph and are using alternate-row spraying, the suggested remedy is obvious.

PUTTING IT ALL TOGETHER

We all know that there are many good programs for controlling these diseases. Here are some considerations. As always, just because it isn't listed here doesn't mean it's a bad idea. And remember, don't make it any harder than you need to. Only products currently labeled in NY State are listed.

1-INCH SHOOT GROWTH. A **Ph** spray may be warranted if wet weather is forecast and the training system or recent block history suggests high risk. Option A: Nothing. Option B: Captan or mancozeb.

3-5 INCH SHOOT GROWTH. A critical time to control **Ph** rachis infections. Also an important time to control shoot infections, since this is where the fungus will reside in the future if infected tissue is retained in canes, spurs, or pruning stubs. Since the late 1980's, we've considered this the time to start control of **PM** on *vinifera* varieties if temperatures consistently remain above 50°F. This spray is much more likely to be important in vineyards that had significant PM last year than in those that were "clean" (differences in overwintering inoculum levels). And as the table in the PM section shows, the fungus isn't moving very fast until temps get into the 60's and stay there. If

you're spraying anyway for Ph, it won't hurt to add something for PM, but this is probably the least important PM spray of the season. It's more likely to be important under relatively warm conditions, less important if cool. **BR** control is seldom justified unless you're trying to clean up a real problem block AND weather is wet and reasonably warm. Option A: Nothing. Option B: Mancozeb (BR, Ph). Option C: Captan (Ph). Easier on predator mites than mancozeb (or ziram), but not as effective against BR, which seldom matters at this time. Option D: Sulfur (PM). Not very active at temps below 60°F, but neither is the PM fungus. A cheap insurance option. Option E: Nova or Elite (PM, BR). Use 3 oz/A for economy with so little foliage now, but remember that coverage becomes even more important when you're working with lower tank rates. Option F: Rubigan (PM). At 2 fl oz/A (minimal labeled rate), cost is only about $4. Cheaper than Nova and Elite, especially if BR control isn't an issue, and it usually isn't at this time. Option G: JMS Stylet Oil (PM). Should eradicate young infections IF thorough coverage is provided. Can use with mancozeb (or ziram), but not with captan (phytotoxicity). Option H: Nutrol, Armicarb, Oxidate, Kaligreen. (PM). Should eradicate young infections IF thorough coverage is provided. Option I: Serenade, if you want to experiment with minimal risk. Option J: One of the PM products plus mancozeb or captan for Ph.

10-INCH SHOOT GROWTH. Traditionally, we've recommended not to wait any longer to control **BR**. Continued experience tells us that this recommendation is conservative (the spray generally isn't needed) unless BR was a problem last year (inoculum levels are high) and weather is wet and warm. Don't wait any longer to control **PM** on susceptible varieties, but wait until immediate prebloom on Concords. One of the best times to use an SI, also a possible time to experiment with "alternative" materials. **DM** control will be needed on highly susceptible varieties if disease was prevalent last year and rains of at least 0.1 inches at temps >52°F occur. Rachis infections by **Ph** are a danger in blocks with a history of the disease. Option A: Abound, Sovran, or Flint (PM, BR, some Ph; also, variable DM). Not the most efficient time to apply these materials. Remember, the more applications per year, the fewer years they'll last. Seems better to save a limited number of applications for later, when they're most useful. Tank mix with sulfur if using. Option B: Mancozeb (BR, Ph, DM). A broad spectrum, economical choice if PM isn't a serious concern. Or tank mix with a PM material to pick up everything. Excessive use sometimes leads to mite problems by suppressing their predators. Option C: Captan (Ph, DM, some BR). An alternative to mancozeb if you're trying to avoid it due to mite concerns. Limited BR activity should be sufficient if the disease was well-controlled last year (limited inoculum) and good BR materials will be used in the next three sprays. Option D: Sulfur (PM). Limited activity (of both the sulfur and fungus) at low temperatures can still be an issue at this time of year. Option E: Nova or Elite (PM, BR). Option F: Rubigan (PM). Limited BR usually is not a problem if effective materials are applied in the next three sprays, and is a non-issue if tank-mixing with mancozeb. Cheaper than Nova and Elite. Option G: JMS Stylet Oil (PM). If (and only if) coverage is thorough**,** this spray should eradicate early PM colonies that may be starting if previous PM sprays were omitted. But don't waste your money if you can't cover thoroughly. Also may help with mites. Option H: Mancozeb (BR, Ph, DM) + a PM material (SI fungicide, sulfur, JMS Stylet Oil). Choose PM material based on previously-discussed characteristics and cost.

IMMEDIATE PREBLOOM TO EARLY BLOOM. **A critical time for PM, BR, DM, and Ph (fruit infections). This and the first postbloom spray are the most critical sprays of the season--DON'T CHEAT ON MATERIALS, RATE, OR COVERAGE!** Option A: Abound, Sovran, or Flint. This has been the "go-to" option for the last 5 years, but the problems that some growers had in 2002 were discussed above. Where we stand now is just not clear, please refer to the earlier discussion. Whether to continue with the strobies or not will depend on your previous experience, how much you've used them in the past, and the available alternatives. ***Growers with varieties that are highly susceptible to PM should tank-mix with sulfur***. Concord growers, who can't, have much less need to. Previously, Abound has been very good to excellent against PM, DM, and BR, although the other two strobies have always been a bit stronger against PM. Whether or not they're enough stronger to have made a difference last year is not clear yet. Sovran is marginal against DM under pressure. Flint has been outstanding against PM, but was always inadequate against DM. All are equivalent against BR. Should also provide some control of early (latent) Botrytis infections. Option B: Either Nova, Elite, or Rubigan PLUS mancozeb (PM, BR, Ph, DM). Add sulfur on *vinifera* and PM-susceptible hybrids (unless "sulfur shy"). Nova and Elite are the

biggest guns against BR, so might be the best choice if pressure is high and BR control is more important than PM. Nova and Elite provide postinfection activity against BR, so would be the choice over Rubigan if significant unprotected infection periods occurred within the previous week. Rubigan is cheaper that Nova or Elite, but doesn't provide nearly the same BR control; however, the mancozeb part of the mix should be adequate if postinfection control isn't required. If wet, mancozeb (or captan) should be included for control of Ph fruit infections in blocks where this has been a historical problem (note some processor restrictions and poor BR control with captan). Option C: Mancozeb + sulfur (PM, BR, Ph, DM). Cheap and effective, particularly if used at shorter spray intervals. Neither material is as rainfast as the strobies or SI fungicides, so frequency of reapplication can be an issue in wet years. Potential mite problems.

MID- to LATE BLOOM. Vangard or Elevate for Botrytis control will probably be beneficial in wet years, particularly in problem blocks . Abound, Sovran, or Flint applied recently may be adequate, especially in drier years.

FIRST POSTBLOOM (10-14 days after immediate prebloom spray). **Still in the most critical period for PM, BR, DM, and Ph (fruit).** Shorten the spray interval on PM-susceptible varieties if weather is warm. Same considerations and options as detailed under IMMEDIATE PREBLOOM. Juice grape growers can substitute Ziram (very good BR and Ph, only fair DM) for mancozeb if necessary.

SECOND POSTBLOOM. **BR** control is still advisable under wet conditions and is likely to be important if infections are evident on the vine; can often be skipped if neither is true. Fruit are less susceptible to **PM** now, but those of *vinifera* varieties (and susceptible hybrids?) still need PM protection, particularly to guard against later bunch rots and promote wine quality. New foliage remains highly susceptible to PM, in all cases. Avoid SI and strobie fungicides if more than a little PM is easily visible. **Ph** danger is just about over unless very wet. Primary **DM** should be over, but continued protection may be needed on susceptible varieties if weather is wet, especially if disease already is established (look and see) Option A: Abound, Sovran, or Flint. See previous discussion. Provide good residual control of the listed diseases if used now, but avoid overuse to maintain their viability. Should provide some Botrytis control. Option B: Nova or Elite (BR, PM) + captan or mancozeb (66-day preharvest restriction, mites) if DM and Ph control are needed. Option C: Rubigan (PM) + either (a) mancozeb (if more than 66 days before harvest) for BR, DM, and Ph; or (b) captan (DM, Ph, some BR); or (c) ziram (BR, Ph, some DM). Option D: Sulfur (PM) + either (a) mancozeb (if still allowed, mites have been considered), or (b) captan, or (c) phosphorous acid (PA). PA is considered to work primarily in a post-infection mode, with little residual activity (see previous discussion). In most years, lessening disease pressure makes this economical option increasingly practical as the season progresses. Option D: Copper + lime (some PM, DM). Adequate PM control for Concords, not enough for *vinifera* and susceptible hybrid varieties.

ADDITIONAL SUMMER SPRAYS. Check the vineyard regularly to see what's needed, the main issues will be **PM** and **DM**. On *vinifera* and other cultivars requiring continued **PM** control, use sulfur as an economical choice to maintain control. SIs and strobilurins are theoretical options, but only if they've only been used minimally earlier AND little disease is evident. Both provide the advantage of longer residual activity than sulfur, especially in wet weather, but resistance management (limited use) is important. Copper + lime can be used on Concords, but is probably worth the expense only under high crop conditions. For **DM**, copper + lime or captan are economical standards; Phosphorous acid products also can be used, especially in a post-infection mode (see earlier discussion). Ridomil can be used in case of emergency. **BR** should not be an issue after the second postbloom spray, except in unusual circumstances (disease is established in the clusters of *vinifera* varieties, wet weather is forecast, and it's possible to direct sprays onto the clusters). **Ph** should not be an issue. See previous discussion for **Botrytis** at veraison, and preharvest.

NEW YORK WINE INDUSTRY WORKSHOP

TIMOTHY E. MARTINSON

Last week approximately 150 attended the annual NY Wine Industry Workshop at the Ramada lakefront inn in Geneva. Winemakers heard talks on tannin and color management, adding enzymes, filtration systems, malolactic fermentation, results of atypical aging (ATA) research, and Brettanomyces. New this year was a day (thursday) dedicated to an industry trade show and small group wine tastings. This took place at the pilot plant and Vinification Laboratory in the food science building in Geneva, and was a great success. Hans Justrich, extension enologist, and Thomas Henick-Kling put on a great show for area, New York, and out-of-state winemakers. Programs like this help make products of area wineries - large and small - better and more competitive in the marketplace.

Program session at the Ramada Inn in Geneva.

Thursday sessions were devoted to a trade show (Left) and special small group tasting (right) at the new Vinification and Brewing Laboratory at the Geneva Experiment Station.

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