Grape Disease Control, 2007

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It's time once again for the annual review of new developments, forgotten factoids, proverbial reminders to eat your vegetables, and various options on the viticultural disease-control front. As always, I'd like to acknowledge the outstanding team of grape pathologists here in Geneva, including faculty colleagues (David Gadoury, Bob Seem); research technicians (Duane Riegel, Judy Burr); and graduate students and post-docs too numerous to mention. Rick Dunst and the crew at the Vineyard Lab in Fredonia also play a very significant role, particularly on projects related to native varieties. It is the combined research efforts of all of these people that serve as the basis for most of the following.

I'd also like to acknowledge the financial support of the coordinated public and private viticulture research funding bodies (the recently-demised USDA Viticulture Consortium-East, the New York Wine and Grape Foundation, the Grape Production Research Fund, Lake Erie Regional Grape Program, Dyson Foundation, New York Wine Grape Growers, American Vineyard Foundation), not to mention that of Cornell's College of Agriculture and Life Sciences, that allows us to keep moving forward. We're all very fortunate to be associated with one of the most dynamic segments of agriculture today, and this doesn't happen by chance.

FUNGICIDE CHANGES & NEWS

1. Special NYS label for Topsin-M vs. pruning wound cankers. For many years, we had a "Special Local Needs" (SLN) registration to apply Benlate to pruning wounds to protect them against infection by the fungus that causes Eutypa canker. With the demise of Benlate a few years back, we were left with no alternative to replace this particular use.

In February, the NYS DEC approved a new SLN registration of Topsin-M fungicide for application to grapevines to control "Eutypa and Botryosphaeria dieback" (the different names refer to separate groups of fungi that infect pruning wounds and cause similar canker diseases that lead to vine decline). Topsin-M is a fungicide that is very similar to Benlate; in fact, they both break down to form the same active molecule.

To use, prepare a concentrated solution of 3.2 oz of fungicide per gallon of water (1 lb/5 gal) and apply it to the pruning wounds as a paint or directed spray "immediately after cutting and before rain, dew, fog and Eutypa and Botryosphaeria spores come into contact with fresh wood". You haven't lost the whole game if the application is delayed and a rain occurs beforehand (I'd be much less concerned about dew and fog), but immediate treatment is certainly better. Note that there is a 4 lb/A per year limit, and a 7-day re-entry interval unless wearing suitable PPE.

<u>Important regulatory information:</u> This label was issued for New York State and does <u>not</u> apply in other states (although they are allowed to apply for something similar), and these use directions do not appear on the federal label attached to the product that you will buy. Users must possess a copy of both the federal label and this "SLN" label (obtainable on line and through product distributors) at the time of application.

So should we care? Pruning wound cankers are very common throughout New York, and indeed, most of the viticultural world. For the most part, we've learned to live with them, and practices such as multiple-trunking and trunk renewal have limited their long-term impact in a number of vineyards. Nevertheless, these diseases have been referred to as "silent killers" for a good reason, and they are most likely responsible for a greater loss in long-term profitability than we generally recognize.

It's too expensive and labor intensive to treat all pruning wounds routinely, but if a grower is making major cuts, Topsin can be a valuable tool, and treatment of these wounds a good investment. 'Major cuts' includes practices such as top-working to a new variety, converting to a new training system, and decapitating winter-injured vines to bring up new suckers and start over. Remember that large-diameter cuts are the ones most likely to become infected, and the consequence of cankers forming at pruning wounds such as those just described can be relatively high due to reduced productivity and/or dieback of all tissues beyond them.

2. Pristine label changes, continued. The US-EPA has approved a new label for Pristine, which has several modest but positive changes for grape growers who use this product. *However, please note that this new label will not appear on product containers until the next manufacturing run is packaged (which may not be until late this season), and applicators must abide by the label on the package that they use.* Nevertheless, one of these changes could impact use decisions later in the season, so it seems worth getting them on the radar screen now.

(i) "Supplemental" label for Botrytis control more user-friendly. As discussed last year, Pristine has a "supplemental" label that allows use at a rate of 18.5-23.0 oz/A to control Botrytis, versus a standard rate of 8-10.5 oz/A for all other specified diseases (or up to 12.5 oz/A for Botrytis "suppression"). Use of the higher "supplemental" rate has some real potential benefits for controlling Botrytis and other rot diseases (detailed in appropriate sections below), but has entailed two inconveniences beyond the obvious need to pay for it: (a) applicators must obtain and possess a copy of the supplemental label in order to use this rate legally; and (b) whereas use rates of 12.5 oz/A or less have required a 24-hr re-entry interval, rates greater than 12.5 oz required a 5-day REI. Both of these provisions will no longer apply to the new label: (a) allowance for the higher Botrytis rate will be "rolled into" the standard label on the packaging; and (b) the REI for all rates will be reduced to 12 hr. But remember, even though these changes have already been approved, you have to fight this (disease control) war with the (product label) army that you have.

(ii) "Native" and hybrid variety restrictions. The strobie component of Pristine regularly causes leaf burning when sprayed directly on Concords and the newly-named Noiret (NY73.0136.17). There have been a couple of local reports of more limited burning on Rougeon, although problems on this cultivar have been somewhat erratic. Most other natives and hybrids have not been affected (we've sprayed 23 oz/A throughout the season on a block of 17 different natives and hybrids in three different years, and have only seen injury on Concord). Nevertheless, to protect against the unknown, the label originally said not to use on Concord, Fredonia, Niagara, "or related varieties". Based upon commercial experience and various research trials over the past few years, the "do not use" restriction on the new label will now be limited to Concord and Noiret/NY73.0136.17, with the warning to use with caution on "Wordon, Fredonia, Niagara, Steuben, Rougeon or related varieties".

3. "New" product, Vintage. Vintage contains the same active ingredient (fenarimol) as Rubigan, is in a similar liquid formulation, and will be used in the same general manner (identical timings and rates except for very early in the season, i.e., Vintage cannot be used until 18-inch shoot growth and the minimum rate is 3 fl oz/A rather than 2). So what's new? The smell, or more precisely, the lack thereof. Both products contain 12% fenarimol and 88% "inert" ingredients (solvent, adjuvant, etc.). The inerts in Rubigan have a fairly strong "chemical" smell, and this has been toned way down for Vintage. Not surprisingly, the two products have provided virtually identical PM control for us in several trials. There may be a slight premium in cost for Vintage versus Rubigan, although that could vary among distributors.

4. Truly new product, Gavel. Gavel is a combination product that contains both mancozeb and an active ingredient (zoxamide) representing a new chemical class, but it is active only against downy mildew. Zoxamide, like mancozeb, is reported to be a protective fungicide, without post-infection activity. At a labeled rate of 2-2.5 lb/A, Gavel contains the same amount of mancozeb as 1.7-2.25 lb/A of a 75DF formulation of a product such as Dithane, Manzate, or Penncozeb, so it should be "spiked" with one of these products to provide adequate control of black rot and Phomopsis. Like mancozeb, it has a 66 day PHI.

In three separate trials that we ran several years ago, Gavel provided good control of DM, but was no more effective than a comparative program of Dithane or Penncozeb applied at a rate of 3 lb/A prebloom, 4 lb/A postbloom. Gavel is not yet registered for use on grapes in New York, and is unlikely to be this season.

5. Strobilurin resistance, update. Strobie resistance started causing a problem with PM control in the Finger Lakes and Long Island regions in 2002, and we all knew that it was just a matter of time until other areas had the opportunity to "share in our bounty". Dr. Anton Baudoin at Virginia Tech began reporting resistance to both powdery and downy mildews in the mid-Atlantic region in 2005, and Dr. Turner Sutton at North Carolina State found DM resistance in nearly every production region in his state in 2006. There also were suspicious reports of DM control problems on Long Island last year, but we cannot say if it was resistance or just the inherent limitations of these materials to stand up to the incredible disease pressure that was present last summer, since no tests were run. At the very least, real caution is in order now with respect to DM control throughout New York.

Control failures due to strobie resistance typically occur suddenly and without warning in an affected vineyard, and should be considered a very real risk for PM and DM even in regions where they have not yet occurred. As discussed in previous years, the development of fungicide resistance is a simple but classical illustration of the principles of evolution (natural selection), a "survival of the fittest" for individuals within a fungal population that's treated with the material. How quickly this progresses to the point of crop damage depends primarily on the number of selection events (spray applications) and the ability of the "selected" (resistant) individuals to multiply. This latter factor is determined by (i) the weather (the number and intensity of infection periods); (ii) the relative ability of the disease-causing fungus to grow and reproduce on the host plant (varietal susceptibility); (iii) the inherent "reproductive capacity" of the fungus (both the time between the start of an infection period and production of a new "crop" of spores and the extent to which these spores are dispersed over distance); and (iv) the extent to which reproduction is arrested (disease is controlled) by rotation and/or tank mixes with an unrelated fungicide.

These somewhat self-evident principles explain a lot about our recent history with strobie resistance, where we're likely to go with it in the future, and the options that we have to address it. For example: Why we got PM resistance in New York more quickly than DM resistance (a run of dry years shortly after introduction of the strobies—1998, 1999, 2001, 2002—that favored reproduction of PM but not DM); why the first PM problems were on Chardonnay (optimum pathogen reproduction); why we haven't hit problems yet on Concords, 5 years after hitting them on *vinifera* (fewer sprays, less reproduction); why the initial problems were so much less common in vineyards that had tank-mixed with sulfur (less reproduction of the resistant individuals); why nobody has encountered black rot resistance and why I'm much less worried about it (much lower reproductive capacity than PM and DM—longer time for infections to produce spores, and those produced are dispersed locally by splashing rain rather than being spread far and wide by wind currents).

Remember, it is imperative to limit the use of these products if you want them to last—no more than two sprays per season is our recommendation. If using a strobie product to control PM, growers should either use Pristine or tank-mix with sulfur if using one of the other strobie materials (tank-mixing sulfur with Pristine is a good idea, too, to protect the non-strobie component in vineyards where the strobie component isn't doing much). The non-strobie component of Pristine does not provide any appreciable control of downy mildew, so even this product must be tank-mixed with an effective DM fungicide (phoshonate, mancozeb, captan, copper) to be safe in regions where DM resistance has begun to appear. Whether or not this is cost-effective versus use of the tank-mix product alone will depend on individual circumstances, e.g., what other diseases might benefit from control by the strobie material. Alternatively, what is the risk of applying the strobie without a tank-mix partner and getting compromised control (disease pressure, varietal susceptibility, stage of crop development, etc.)?

6. Kocide 3000, new copper product. Kocide 3000 is a new copper hydroxide product (same ingredient as in other Kocides) that is formulated to make more of the active form of copper (the soluble Cu^{++} ion) available at any given time relative to previous Kocide formulations. This means that less total copper is needed than before to provide the same level of disease control, which is both better for the long-term vineyard environment (copper, being a basic element, doesn't break down into anything, but simply accumulates in the soil year after year) and also somewhat safer for vineyard workers. Several PPE requirements pertaining to other Kocide formulations (e.g., protective eyewear) do not apply to this one.

The use rates on grapes is 0.75-1.75 lb/A, a little less than half the per-acre rates of Kocide DF or 101, and the per-acre cost will be somewhat less than those other products (less actual copper, which has gotten expensive on the world market). This all sounds attractive and the advertising looks good, but I have no personal experience with the product nor have I seen independent data from other U.S. vineyard trials to back it up.

POWDERY MILDEW (PM) NEWS AND REMINDERS

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 survive the winter. In New York, spores produced within these cleistothecia are discharged between bud break and bloom (more or less) to initiate the disease, after which it can spread rapidly via the millions of new spores produced from each of these "primary" infections. 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 disease pressure will be higher, and PM sprays during the first few weeks of shoot growth are likely to be far more important, in blocks where PM control lapsed last year compared to blocks that remained "clean" into September. (Cleistothecia developing from infections initiated in the very late summer/early autumn are unlikely to mature before frost kills the leaves and eliminates their food source).

Let's look at why this is so. Several years ago, we conducted an experiment in a Chardonnay vineyard where we either (a) sprayed through Labor Day, maintaining a clean canopy throughout the year; (b) quit spraying a month earlier, simulating a vineyard with moderate levels of PM by the end of the season; or (c) quit spraying in early July, simulating a vineyard where PM control got away from us. The next spring, the levels of cleistothecia (number per kilogram of bark) in these treatments were (a) 1,300; (b) 5,300; and (c) 28,700, respectively. Now, consider the case where 20% of the overwintering spores are discharged during the first couple of weeks after bud break (a reasonable approximation). But 20% of what? In the clean treatment (a), this number might be relatively inconsequential, whereas in dirtier treatment (b) it's equal to the entire seasonal supply on the clean vines, and in treatment (c) it's four to five times the entire seasonal supply on the clean vines. Not surprisingly, this is makes a difference. When we intentionally withheld a modest spray program on these same vines until the immediate prebloom period the following spring, the resulting cluster disease severities were (a) 11%, (b) 22%, and (c) 48% cluster area infected, respectively, even though all were sprayed the same. Conclusion: Higher disease one year = More primary infections to start off the following spring = Many more new ("secondary") spores by the time that fruit were susceptible to infection = Increasing disease pressure to "overwhelm" the fungicide spray program.

(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 most important factor that governs the rate of reproduction is temperature, with a new generation produced every 5 to 7 days at constant temps between the mid-60's and mid-80's (more details are provided in the NY and PA Pest Management Guidelines for Grapes, and in an on-line fact sheet). Thus, days in the 80's and nights in the 60's and 70's during the bloom and early postbloom period provide ideal conditions for the fungus 24 hr a day, just when fruit are extremely susceptible to infection. Spray programs will need to be at their absolute best with respect to materials, rates, intervals, and coverage in years when this happens.

(iii) Although not as important a factor as temperature, high humidity also increases disease severity, with an optimum of about 85%. Although the PM develops to some extent over the entire range of humidities that we experience, research has shown that disease severity is twice as great at a relative humidity of 80% versus 40%. Vineyard sites (and canopies) subject to poor air circulation and increased microclimate humidity, and seasons with frequent rainfalls, provide a significantly greater risk for PM development than their drier counterparts. Thick canopies and frequent rainfall are also associated with limited sunlight exposure, which appears to greatly increase the risk of disease development in its own right (see below).

(iv) Berries are extremely susceptible to infections initiated between the immediate prebloom period and fruit set, then become highly resistant to immune about 2 weeks (Concord) to 4 weeks (*V. vinifera*) later. This is your annual reminder.

(v) Failure to control even inconspicuous PM infections on the berries can increase the severity of berry rots (Botrytis and sour rot) at harvest, and can promote the growth of wine-spoilage organisms such as *Brettanomyces* on the fruit. Another annual reminder. This is just one more reason to focus on providing excellent PM control on susceptible wine grapes from pre-bloom through bunch closing.

(vi) Powdery mildew is a unique disease in that the causal fungus lives almost entirely on the surface of infected tissues, sending little "sinkers" (haustoria) just one cell deep to feed. This makes it subject to control by any number of "alternative" materials (oils, bicarbonate and monopotassium phosphate salts, hydrogen peroxide, etc.) that have little effect on other disease-causing fungi, which live down inside the infected tissues. Recall that there are two primary limitations to the aforementioned group of products, which need to be considered if you want to use them effectively: (a) they work by contact, so can only be as effective as the coverage you provide; and (b) they generally work in a post-infection/curative mode with little "forward" activity. This means that they need fairly frequent re-applications, or should be tank-mixed with something that provides good protective (forward) activity. (Exception: Last year, we found that JMS Stylet Oil provided significant protective activity even a week after it was applied if the weather was dry, but much of this was lost after an inch of rain).

Effect of sunlight exposure

Observant growers have long noticed that PM is most severe in parts of the vineyard that are regularly shaded, e.g., near tree lines and in the centers of dense canopies. And a disproportionate number of our worst years for PM have been not only wet, but cloudy. The general admonition to provide good sunlight exposure as part of a PM management program has been a staple of this treatise for the past few years, but in 2005 we began a project to examine the phenomenon in detail.

Although we've "always known" that PM is inhibited by sunlight and prefers the shade, it now appears to me that the impact of this factor has been underappreciated. To illustrate: In a vineyard of cv. Chardonnay, we compared one group of vines in a portion of a row immediately east of a group of tall pine trees that provided a limited period of morning shade, versus a second group located in the same row away from the trees. Within each group, we inoculated shoots fully exposed to the sun on the outer edge of the canopy versus others confined within the heavily-shaded canopy center. Thus, there were four treatments: (i) outer canopy, no tree shade (maximum exposure); (ii) outer canopy, with tree shade; (iii) inner canopy, no tree shade; and (iv) inner canopy plus tree shade (maximum shading). Average disease severities over multiple runs of the experiment the past 2 years are provided in Fig. 1 below.

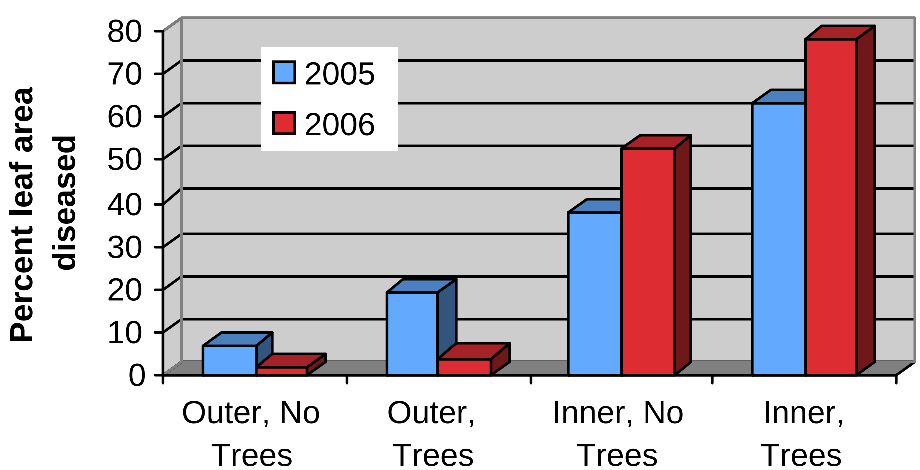

Figure 1. Disease severity on Chardonnay foliage subjected to various levels of natural shading in 2 different years (see text for treatment details).

In both years, the transient morning shade provided by the pine trees increased disease severity relative to the comparable portion of the canopy away from the trees, but constant shading within the canopy had an even more pronounced effect relative to shoots receiving full sun exposure. And these effects were additive, with the most shaded leaves developing 9 times more disease than those with the best exposure in 2005, and 45 times more (!) in 2006.

It appears that sunlight helps to limit PM development in two ways: (1) Because the PM fungus is unpigmented and lives primarily on the outside of infected tissues, it is subject to "sunburn" from ultraviolet radiation; and (2) at mid-day, sun-exposed leaves and fruit are typically 5 to 23°F hotter than shaded tissues (depending on water status of the plant), which are approximately the same temperature as the air. This can be detrimental or even lethal to the PM fungus during the summer. For example, on an 83° F afternoon, shaded tissues are at a temperature that is optimal for disease development, whereas those in the sun are often 95 to 100°F, which can start to kill the PM colony after just a few hours.

To separate these effects, unsprayed Chancellor vines were subjected to three different treatments: (1) Some were protected from 80% of natural solar radiation by covering them with a meshed shade cloth, which both filtered UV radiation and prevented leaf and fruit tissues from rising; (2) Others were exposed to the sun but protected from UV radiation by placing a clear plexiglass filter above the canopy, which allowed most solar radiation to pass through and heat the leaves and fruit, but removed >95% of the UV radiation; or (3) Still other vines were fully exposed to the sun, although fruit received some modest natural shading from the foliage of the well-pruned condon training system. The data in Fig. 2 below shows that cluster disease severity was twice as high on bunches in the shaded versus exposed treatment, and was intermediate between these two extremes on those exposed to the sun (tissue heating) but protected from UV.

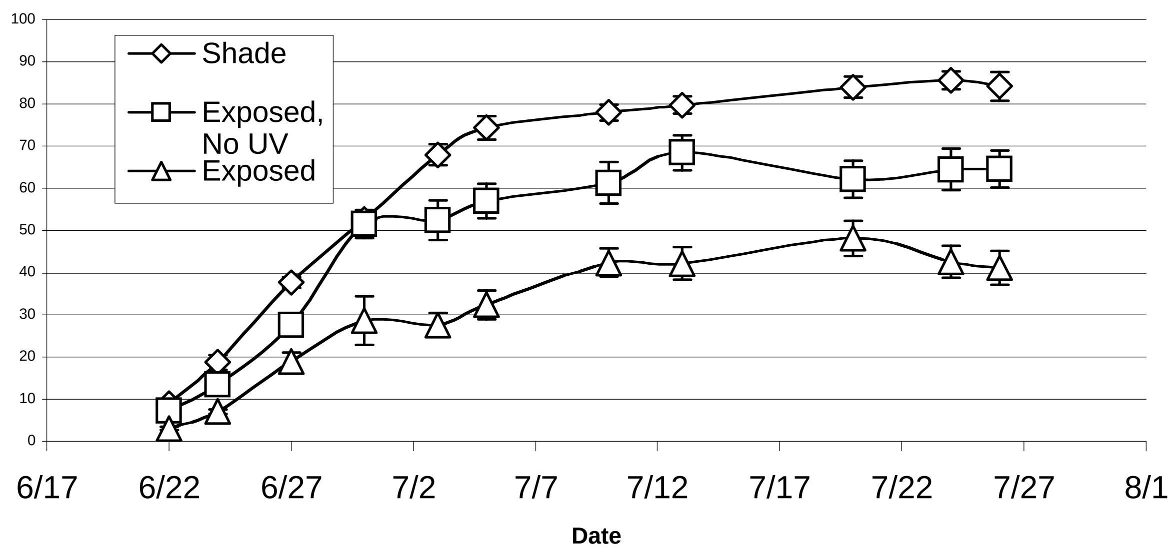

Figure 2. Disease severity on clusters of Chancellor vines, inoculated 1 week before bloom in 2006. Vines were either well exposed to the sun, exposed to the sun but filtered from UV radiation, or covered with woven shade cloth, removing 80% of solar radiation. Values represent the means from 20 replicate clusters per treatment, assessed two to three times per week.

Keep these concepts in mind, in terms of both (i) trying to limit PM by providing "optimal" levels of sun exposure through appropriate pruning and training systems, plus early leaf pulling (ASAP after fruit set) on varieties where that is to be practiced; and (ii) recognizing that prolonged periods of rainy, cloudy weather are taking away this natural control agent and may require the spray program to be turned up a notch, especially if the weather is warm.

A note to Concord growers:

Remember that the value of mid-summer control on Concords depends on crop level, and that foliar PM is one more limitation on the vine's ability to photosynthesize and ripen the crop. When its capacity to do so is not being pushed (plenty of water and sunshine relative to crop size, few other stresses), research has shown that it can tolerate a lot of PM. However, this same research has shown that at high cropping levels, good PM control can be necessary to get the fruit to commercially-acceptable levels of ripeness.

Unfortunately, there is no simple formula to tell you how much control is cost effective, and every case is likely to be different. The basic two-spray program (pre-bloom, 10-14 days later) will keep the berries clean and is probably good enough “average” vineyards in a "typical" year, but those with double-digit yields crops might benefit from (and be able to afford) one or two more, depending on the season. We’d like to—but shouldn’t—forget the 2003 season. You need leaves to ripen the fruit, and the more of it you have, and the less sun that there is, the more you’ll need the leaves that you do have to be healthy and firing on all cylinders. The principles are simple, it’s the choosing among a set of less-than-desirable options that’s hard.

Fungicides

Sulfur. A repeated summary of the major findings and conclusions from our recently-concluded study on sulfur activites:

- <u>We were unable to demonstrate any negative effects of low temperatures on either the protective or post-infection activities of sulfur.</u> In a number of repeated tests, utilizing the equivalent of either 5 or 10 lb/A (6 or 12 g/L, sprayed to run-off), control was the same at 59°F as it was at 82°F. Workers from Australia have recently reported very similar results, i.e., they found a slight decrease in activity when a very low rate of 2 g/L [1.7 lb/A] was used at 59°F versus 68 or 86°F, but no difference among temperatures when the rate was increased to the equivalent of 5 lb/A. It appears that the potential detrimental effect of low temperature on sulfur efficacy has been significantly over-emphasized in our region, particularly in light of the fact that the PM fungus itself is not that active at cooler temperatures. Nevertheless, don’t cheat on the rate or coverage if using it early, and don’t forget that rains will wash some of it off.

- <u>Sulfur’s protective activity is limited by the tendency of shoots to “outgrow” the spray coverage as shoots expand.</u> Sulfur can persist on sprayed tissues for quite some time (particularly in the absence of rain), but adequate redistribution to newly-developed, unsprayed foliage is questionable, even via the vapor phase. This may require more frequent application intervals during periods of rapid shoot growth.

- <u>Sulfur provided consistent and extensive post-infection activity when applied up through the time that young colonies emerged after inoculation with fungal spores</u> (about 1 week after the start of an infection under summer temperatures, longer under cooler conditions). As mentioned above, this activity was just as strong at 59°F as it was at 82°F.

- <u>Sprays applied to heavily-diseased tissues were less effective than those applied to incubating or very young colonies</u>. Sulfur is not the material of choice as an eradicant if you reach the “Omigod!” stage. That would be Stylet Oil or Oxidate. And remember that once the leaf or berry cells beneath a well-established mildew colony have been killed, nothing's going to bring them back to life even if the mildew is eradicated.

- A number of different field and greenhouse trials designed to clarify the effects of rainfall produced sometimes variable results. Nevertheless, the data suggest that:
    - Rainfall of 1 to 2 inches decreases sulfur's protective activity
    - This effect is more pronounced with generic wettable formulations than with so-called "micronized" formulations, which have smaller particle sizes
    - The negative effects of rainfall can be somewhat compensated for by adding a "spreader-sticker" adjuvant to the spray solution and/or increasing the application rate; in our experiments, doubling the application rate (from 5 to 10 lb/A or equivalent) was more effective than inclusion of the adjuvant. See Table 1 below for field data, standardized to reflect % disease control relative to the unsprayed check. Recall that 2005 was very dry during the period of berry susceptibility, hence no benefit of higher rate or surfactant on cluster disease control.

Table 1. Powdery mildew control on Rosette grapes as affected by sulfur rate and adjuvant, 2004-2006 (Geneva, NY)

	Foliar disease control (%)			Cluster disease control (%)		
Treatment, rate/A	2004	2005	2006	2004	2005	2006
Microthiol, 5 lb……….	68	67	86	47	76	70
Microthiol, 5 lb + Cohere, 0.03% (vol)…	84	80	89	64	73	79
Microthiol, 10 lb………	87	89	91	76	77	85

***"Alternative"* materials.** As noted before, there are numerous "alternative" materials for PM control. Last year, we compared eight products currently registered by the EPA and classified as "biopesticides", on Rosette vines in Geneva under two different scenarios: (a) season long, to determine the extent of their activities without any help; and (b) using Elite and Pristine to provide control into the early postbloom period, then using the alternative products to maintain control of disease on the foliage and rachis (cluster stem) after the berries had become relatively resistant to infection. Unless noted otherwise, sprays were applied at approximately 10-day intervals. A "commercial standard" rotating Rubigan, Pristine, and Microthiol at 14-day intervals was also used for comparison. Details are provided in Table 2 for those who so desire. For the others, here's the bottom line:

- When applied at 10-day intervals, none of these products were as effective as the Rubigan/Pristine/Microthiol program at 14-day intervals. However, using Elite/Pristine through 10 days postbloom followed by the alternatives provided control of berry infections equivalent to the "standard", although many materials did allow some rachis infection to occur (thus, the increased values for percentage of clusters showing any disease, but low % area diseased values).
- There was a wide range in effectiveness re keeping foliar disease values down, with a few materials (Nutrol, Kaligreen, and Prev-Am) proving to be nearly as efficacious as the standard program. These may have particular interest for growers who are trying to avoid sulfur in late-season sprays.

- Kaligreen is a potassium bicarbonate product, as are several other labeled products not examined here, including Milstop and Armicarb. Nutrol is monopotassium phosphate. This is the fourth consecutive trial that we have run in which Nutrol and the bicarb products have provided the same degree of control. Where they do differ is price: at labeled rates, the per-acre price for Nutrol is MUCH less than that of the bicarbs (on the order of 75% less, that is). But unlike the bicarbs, which are formulated with a surfactant, you'll need to add one with Nutrol.

Table 2. Control of powdery mildew on Rosette grapes with EPA-registered "biopesticides", 2006 (Geneva, NY)

Treatment and rate/A	Timing[z]	Leaf disease [% control][y] % Area	Cluster disease [% control][y] % Clusters	Cluster disease [% control][y] % Area
Nutrol, 5.0 lb + Latron B1956, 0.06 % (v/v)	1,2			
Nutrol, 10.0 lb + Latron B1956, 0.06 % (v/v)	3 – 8	27.7 de [61]	54.0 bcd [44]	2.2 gh [91]
Kaligreen, 2.5 lb	1,2			
Kaligreen, 5.0 lb	3 – 8	25.9 ef [63]	60.0 a-d [38]	4.4 f [82]
Prev-Am, 25.0 fl oz	1,2			
Prev-Am, 50.0 fl oz	3 – 8	32.2 d [55]	75.0 ab [22]	5.4 e [78]
Elexa 4, 5.0 qt	1,2			
Elexa 4, 10.0 qt	3 – 8	33.6 d [53]	64.0 abc [33]	15.8 d [36]
Sonata, 4.0 qt	1 – 8	54.9 c [23]	76.0 ab [21]	18.2 c [26]
Oxidate, 40.0 fl oz	1 – 8	57.1 bc [19]	77.0 ab [20]	20.5 bc [17]
Serenade ASO, 4.0 qt	1 – 8	59.8 b [16]	77.0 ab [20]	23.7 b [4]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Nutrol, 10.0 lb + Latron B1956, 0.06 % (v/v)	4 – 8	18.0 hi [75]	7.0 e [93]	0.2 j [99]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Kaligreen, 5.0 lb	4 – 8	18.0 hi [75]	34.0 cde [65]	1.6 ghi [94]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Prev-Am, 50.0 fl oz	4 – 8	16.0 i [77]	45.0 cde [53]	2.9 fg [88]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Elexa 4, 10.0 qt	4 – 8	22.4 fg [68]	30.0 de [69]	0.8 ij [97]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Sonata, 4.0 qt	4 – 8	31.6 d [55]	49.0 bcd [49]	1.6 ghi [93]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Oxidate, 40.0 fl oz	4 – 8	27.2 ef [62]	37.0 cde [61]	1.8 ghi [93]
Elite 45WP, 4.0 oz	1			
Pristine 38WG, 10.5 oz	2,3			
Serenade ASO, 4.0 qt	4 – 8	20.7 gh [71]	45.0 bcd [53]	1.1 hi [95]
Rubigan 1E, 3.0 fl oz	1[x]			
Pristine 38WG, 10.5 oz	2, 3			
Rubigan 1E, 6.0 fl oz	4			
Microthiol 80DF, 5.0 lb + Cohere, 4.0 fl oz[x]	5, 6	10.6 j [85]	8.0 e [92]	0.2 j [99]
Untreated	------	70.9 a [0]	96.0 a [0]	24.6 a [0]

[z] Dates and approximate phenological stages for designated spray applications (except where noted): 1= 7 Jun (prebloom); 2 = 16 Jun (early bloom); 3 = 27 Jun; 4 = 7 Jul; 5 = 17 Jul; 6 = 27 Jul; 7 = 7 Aug; 8 = 15 Aug.

[y] Values represent the means from four replicate plots per treatment, 25 leaves or clusters per plot. Means not followed by a common letter are significantly different according to the Waller-Duncan k-ratio t-test ($P \cong 0.05$) performed on arcsin-transformed data (incidence) or Barratt-Horsfall ratings (severity). Nontransformed and converted values, respectively, are shown. Bracketed values denote percent control relative to the untreated check.

[x] Treatment applied to the same cultivar in a group of adjacent vines used in a different experiment, but included as a commercial standard for comparative data analysis. Dates and approximate phenological stages for designated spray applications in this treatment: 1= 6 Jun (prebloom); 2 = 20 Jun (full bloom); 3 = 5 Jul; 4 = 19 Jul; 5 = 1 Aug; 6 = 14 Aug. Foliar disease rated for this plot on 25 Sep.

BLACK ROT (BR) NEWS AND REMINDERS

1. *As fruit mature, they become increasingly resistant to infection.* Another annual reminder. Remember that under NY conditions, berries are highly susceptible to black rot from cap fall until 3-4 weeks (Concord) or 4-5 weeks (Riesling, Chardonnay) later. Then, they begin to lose

susceptibility, becoming highly resistant to immune after about 2 more weeks. Note that this means that Concords <u>can</u> become infected up to 6 weeks after the last cap has fallen, and *vinifera* varieties up through 7 weeks post-bloom. In the mythical "average" year, most growers won't need to be too concerned during the end of these periods, but they sure will if the disease is already established in the vineyard (lots of new spores for spread) and it's warm and wet.

Recall that mummified berries are the main overwintering source of the BR fungus. Unless these are retained in the vine during pruning, spores from them are typically depleted within a week or two after bloom. (But also remember that they're liberated from the mummies during rains. If it doesn't rain from prebloom until 3 or 4 weeks later, as happened in some locations in 2005, they'll just sit tight and finish coming out when the rain finally does arrive). So, if the disease has been <u>very</u> well controlled by the time the overwintering spores are depleted, there should be no source for new infections and additional sprays are not likely be necessary. In contrast, if new black rot infections are established (and producing spores right within the clusters), protection will need to continue so long as fruit remain susceptible.

As often noted, we've regularly obtained excellent control with Nova (or Elite) sprays applied at the start of bloom plus 2 and 4 weeks later, which provide protection throughout the period of peak susceptibility and during most or all of the time remaining before berries become highly resistant. But read the fine print! Growers routinely get away with stopping their sprays before berries are fully resistant when there are few to no new infections and/or the weather is dry, but they routinely get nailed when they quit too early, there are active infections capable of spreading the disease, and we get the rains to do so. This happened in more than one vineyard in 2006.

2. The incubation period for the disease can be very long. Under Geneva conditions, we've 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 (since the fungus is responding to growing degree days rather than the calendar, these periods are probably a bit shorter in significantly warmer climates). 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 mid- to late August is probably the result of infections that occurred in mid- to late July, depending on the cultivar. 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. One more reminder of this fact, and why an SI + mancozeb combination gives such good control (forward protection from the mancozeb plus reach-back activity from the SI).

4. Mummies retained in the canopy provide significantly more pressure for BR development than those dropped to the ground. Mummies in the canopy produce <u>many</u> more spores than those on the ground and continue to produce them into August, long after spores have been depleted from the ground mummies. Furthermore, these spores are <u>much</u> more likely to land on and infect susceptible berries than are those produced from mummies on the ground, since they are released right next to the new clusters. When I go into a vineyard and find a BR "hot spot", the first thing I do is look for last year's mummies still hanging in the trellis near the current zone of activity. I almost always find them.

5. *Fungicides.* Nova and Elite remain the "kings", in my opinion, although in many of our

tests, the strobies have been right up there with them. 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 diminishing levels of PM control with the SI fungicides make them problematical at such a time in many vineyards. However, if BR is a greater concern than cluster PM (Niagaras, Concords after the 1st postbloom spray, some production regions considerably to the south of NY), this may not matter so much. All of the strobies provide very good to excellent control, equal to mancozeb and ziram under moderate pressure and superior under very wet conditions (more rain fast), when superior performance is most important. Of course, mancozeb and ziram are old standards and provide very good control under most commercial conditions. Captan, Rubigan, and Procure are only fair, and are likely to be inadequate if there's any pressure. Copper has significant limitations, and sulfur is poor.

6. Special considerations for "organic" growers. Black rot is probably the "Achilles heel" for organic grape production in the East. In the only good trial that we've run with copper, it provided only 40% disease control when applied at 2-week intervals, versus essentially 100% control with Nova. That being said, last year I visited an organic grower who had suffered some severe losses to BR in previous wet seasons, anticipating more of the same. But I had to search to find a black rot berry. What had he done? Implemented a rigorous program to remove mummies, and sprayed copper once a week.

Unfortunately, we don't know of any magic bullets for organic producers, although there are several out there that claim to be. Bryan Hed at Penn State has been looking at a number of possibilities and we've followed up with a couple of the most promising, but right now it looks like nothing is as good as copper. Sanitation and cultural practices form the critical first line of defense for growers who produce grapes organically, and they will need to pay <u>strict</u> attention to limiting inoculum within the vineyard. Ideally, this would include removing or burying (tillage, mulch) any mummies that they might encounter at the site. At the very least, it is <u>imperative</u> that <u>all</u> mummified clusters be removed from the trellis during pruning. And if you're able to patrol the vineyard from 2 to 6 weeks after cap fall and prune out any affected clusters before they allow the disease to spread, all the better (spores for disease spread are spread within the fruiting zone by rain, so should pose little risk if said clusters are simply dropped to the ground).

DOWNY MILDEW (DM) NEWS AND REMINDERS

After a dry 2005, many of us were reminded last year of DM's potential to "explode" under persistently wet conditions. Recall that the fungus persists in the soil as resting spores (oospores) that originate within infected leaves. Hence, the more infection last year, the more oospores this year. And as with PM, high overwintering inoculum levels mean that early sprays are more important than they would be in a vineyard that was clean last year, particularly in years when the weather favors infection during the 2 to 3 weeks before bloom, when the first oospores are mature and ready to cause infection.

These first "primary" infections, originating from overwintering spores in the soil, require a minimum rainfall of approximately 0.1 inch (to activate the infective spores and splash them into the canopy or onto nearby sucker growth) and a temperature of 52°F or higher. Of course, heavier rainfall and warmer temperatures will increase the probability and severity of primary infection.

Once primary infections occur, new "secondary" spores (sporangia) form in the white downy growth visible on infected clusters and, particularly, the underside of infected leaves. Several different weather factors must come together for sporangia to form and spread the disease, but this can occur rapidly when they do. Basically, what's required are warm, humid nights (to form the sporangia) with rain following soon thereafter (to allow germination and infection). Without rain, most of the ungerminated sporangia will die the next day if exposed to bright sunshine; however, many can survive for several days under cloudy conditions, which helps to keep the epidemic running.

Spread is most rapid with night and morning temps of 65-77°F, although it can occur down into the 50's. With an incubation period (generation time) of only 4 to 5 days under ideal conditions, disease levels can increase from negligible to overwhelming in very short order if the weather remains favorable (humid nights, frequent showers, long periods of cloudy weather). As we are periodically reminded.

Back when we had "typical" seasons, the disease would "go on vacation" once a long spell of warm, dry weather hit in the summer, and it can take some time for it to build back up should this occur. Maybe it will this year, maybe it won't. The erratic development 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. No need to spray for it when it isn't there, but you don't want to let it get rolling if it's active. Keep an eye on the vineyard to see which of these possibilities is the current reality. For additional guidance, my colleagues, Bob Seem and David Gadoury, have developed a computer model (DMCAST) that integrates a number of weather and crop development factors to advise when infections are likely to occur. This model can be accessed via the NYS IPM Program website (www.nysipm.cornell.edu/newa/).

Fruit susceptibility. Clusters of some varieties—including all *V. vinifera* cultivars--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 direct infection about 2 weeks after the start of bloom, although losses due to berry stem infections can occur for at least 2 additional weeks after that. For many years, the standard fungicide test protocol on Chancellor vines at Geneva has been to start spraying about 2+ weeks prebloom and continue through approximately 4 weeks postbloom. The best materials consistently provide virtually complete control of fruit and cluster stem infections using this schedule even in bad years, on perhaps the worst possible variety, under abnormally 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 have limited its general use. Although it's highly prone to resistance development, this has never been detected on grapes in the U.S., probably due to its limited use. (Remember that the PHI on Ridomil Copper has been reduced to 44 days, versus 66 days for Ridomil MZ). Abound has provided very good to excellent control every year since we began testing it in 1996, and Pristine has typically been even a little bit better. Note, however, the recent report of resistance to these materials in the mid-Atlantic region, discussed at the top of this tome. Sovran is marginal, it 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, but are prone to wash-off under heavy rains and may need to be reapplied more frequently in wet years.

Which brings us to the phosphorous acid (also called phosphite and phosphonate) products. We've discussed these *ad nauseum* for the past few years, so will only review the main points this time around. Recall that these are excellent materials for anyone consciously seeking a "least toxic" or "sustainable" approach to growing grapes, due to their low toxicity (4 hr REI, exempt from residue tolerances) and minimal environmental impact. They're also very good for anybody who wants a DM fungicide that's easy to use, price-competitive, and effective. Although there are occasional reports and testimonials alluding to the ability of these materials to control other grape diseases, I have not found this to be so. I'm not saying it's impossible, but their history of control of non-downy mildew (and closely related) diseases on other crops is erratic at best. I certainly wouldn't count on it.

Most of you know that products such as ProPhyt and Phostrol are labeled as fungicides for control of DM, whereas there are a number of "nutrient formulations" on the market that contain phosphonate but are not labeled for DM control. Which means that it's only legal to obtain disease control with these latter products if you do so unintentionally. Although this may seem somewhat less than fully rational, remember that the law requiring any material applied for a pesticidal purpose to be labeled for such generally benefits growers as well as the public at large.

Also recall that products claiming to be nutrient formulations must state the amount of P that they contain in terms of phosphoric acid equivalents (phosphate, the nutrient, which has no effect on DM), even if they contain only phosphorous acid (phosphite or phosphonate, the DM material which, ironically, has no nutritive value). Also note that it can be difficult to tell just how much phosphonate is in some of these nutrient solutions, and that the rate matters for DM control.

A summary of the major results from 3 years of field experiments designed to determine the so-called "physical modes of action" of phosphonates in control of downy mildew follows below. Most trsts were conducted with ProPhyt and/or Phostrol, applied at rates corresponding to the low and/or high rates on their labels.

- Phosphonates generally provided good to excellent protective activity when applied 3 to 8 days before an infection period, depending on the rate used. In some tests, activity declined significantly in the older leaves as the time between application and start of the infection period increased (phosphonates are "shipped" from older leaves to the growing points), particularly at the lower rate. These materials certainly have protective activity, but I wouldn't consider it their strength.

- Phosphonates provided excellent post-infection activity; again, there was some rate effect. When applied 3 or 4 days after infection, few lesions developed at either rate and spore production was greatly to totally inhibited. When applied 6 days after infection (small lesions visible), lesions continued to expand but production of spores was reduced by 86 to 98% relative to the unsprayed check. Control of both lesion expansion and spore formation was improved moderately at the higher rate or when the initial application of the lower rate was repeated 5 days later.

- Phosphonates did not eradicate well-established infections, but when applied to actively sporulating lesions, they limited further spore production by approximately 80%. Limiting their production of these spores should limit the potential for disease spread.

Two additional points:

- In simple "spray and count" trials using 14-day application intervals (probably too long under high pressure), we've seen significantly better control on clusters when materials like ProPhyt and Phostrol were used at rates in the high versus low end of their labeled range after bloom, and relatively poor control when a nutrient solution containing phosphonate was applied at the equivalent of 60% of the low rate. This latter dosage is similar to some of those I've heard rumored as contained within solutions applied for nutritional purposes in the Finger Lakes region. Rate matters.

- Although sudden and total resistance to these materials (as we've seen with PM and the strobies in some vineyards) is not likely, experience on other crops suggests that they can lose some of their effectiveness over time after long and repeated use (as we've seen with PM and the SI fungicides). These are useful materials, so don't burn them out by relying on them <u>exclusively</u> throughout the summer.

BOTRYTIS NEWS AND REMINDERS

The good news last September was that it only rained once. The bad news is that it lasted all month. These conditions were ideal for Botrytis in addition to a number of other rots. But since Botrytis is still "king", let's review it first.

1. Biology. The Botrytis fungus is a "weak" pathogen that primarily attacks highly succulent, dead, injured (e.g., grape berry moth, powdery mildew), or senescing (expiring) tissues such as wilting blossom parts and ripening fruit. The fungus thrives in high humidity and still air, hence the utility of cultural practices such as leaf pulling and canopy management to minimize these conditions within the fruit zone. Although the fungus does not grow well in berries until they start to ripen, it can gain entrance into young fruit through wilting blossom parts, old blossom "trash" sticking to berries, and scars left by the fallen caps. Such infections typically remain latent (dormant), but some may resume activity and rot the berries as they start to ripen.

Some recently-determined details re the above:

• Latent infections can be common following a wet bloom period, but the vast majority remain inactive through harvest and never rot the fruit. Factors that cause latent infections to activate (cause disease) are poorly understood. High humidity during the preharvest period and high soil moisture after veraison appear to be two that promote this process. <u>Note that for the preceding reasons, a wet bloom period (to establish latent infections) followed by a wet pre-harvest period (to activate them and provide conditions for further spread) is a perfect "recipe" for Botrytis. 2006 anyone?</u> Berries with high nitrogen levels or subject to various mechanical injuries also are more prone to becoming diseased via the activation of latent infections.

• Serious Botrytis losses result from spread during the post-veraison/ pre-harvest period, after berries begin to ripen and become highly susceptible to rot by the fungus. Latent infections established at bloom can be important if they become active and provide the initial "foot hold" from which subsequent spread can occur during ripening. Because so few of these early infections typically become active and turn into rot, controlling them at bloom provides only modest benefit if the post-veraison season is dry and doesn't support further disease spread. However, it can pay significant dividends if things turn wet before harvest. How good is anybody at predicting September and October weather in June?

• The pronounced impact that cluster compactness has on Botrytis development appears to be due largely to its effect on berry-to-berry spread. In one experiment with a tight-clustered Pinot noir clone, a single diseased berry showing up a week after veraison spread the disease to over 50 berries per cluster by harvest (spread was reduced by 90% in loose clusters where berries weren't so tightly compressed, but there are few practical ways of achieving this cluster architecture other than clonal and varietal selection). Note that this single diseased berry per cluster was meant to represent the post-veraison activation of a few latent infections initiated at bloom, and vividly illustrates the particular importance of controlling blossom infections on tight-clustered cultivars and clones.

• Preharvest spread can be increased by increasing the N content of berries (foliar sprays of urea after veraison). This does NOT mean that such treatments should be avoided if one is trying to use them to ameliorate the atypical aging (ATA) phenomenon in white wines. However, it DOES mean that Botrytis management may be more critical if they're applied.

• There is no single "correct" timing regimen for fungicide applications in a Botrytis management program. In some years, early sprays (bloom and bunch closure) have given us better control 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, applying all four provided the best results. The relative benefits of early versus late applications, and the total number necessary, will vary among years according to rainfall patterns and, quite likely, differences between cultivars and clones (e.g., cluster architecture). Think in terms of early sprays as limiting the establishment of primary infections, and later sprays as limiting disease spread.

3a. Fungicides, physical modes of action. Over the past few years, we've been looking at some of the "physical modes of action" of the available Botrytis fungicides, to get a better idea of some of their specific characteristics and differences. Following is a summary of the major findings and conclusions for this project:

- In one set of tests, we examined the ability of the fungicides to protect the **internal** berry tissue against infection from spores that might be deposited inside them after rain cracking, insect feeding, etc. Chardonnay clusters were sprayed at pea-sized berries, bunch closure and veraison, then berries were injected with with Botrytis spores (hypodermic needle) 2 weeks after the last spray. Scala, Vangard, Rovral, and Elevate provided excellent control, and Elevate was close. Pristine (19 oz/A) was comparable in preventing rot, but was less effective in limiting spore production from the limited number of berries that did develop symptoms. Flint and Endura provided the least control. All fungicides prevented spread from the inoculated berries to their neighbors, whereas this occurred in two-thirds the unsprayed clusters.

- In a more direct test for residual protective activity on the berry **surface**, clusters on a second set of Chardonnay vines were sprayed on the same dates as above and Botrytis spores were applied to the surface of the unwounded berries 2 weeks after the final application. As we would hope, all fungicides provided virtually complete control, whereas 22% of the cluster area was diseased in the unsprayed treatment.

- In another test, Pinot noir clusters were inoculated with Botrytis spores at late bloom and sprayed with fungicides for the first time at veraison. The purpose of this test was to see whether the fungicides could eradicate or suppress latent (dormant) infections long after their initiation, so long as the materials were applied before such infections became active. (Recall that preharvest activation of bloom-initiated latent infections is often the kick-start to a Botrytis outbreak). <u>Under the conditions of this test</u> (individual clusters sprayed by hand, <u>complete</u> spray coverage not likely in commercial production), a single application of Scala or Vangard at veraison provided almost complete control of latent infections established at bloom, 60 days earlier. Elevate and Rovral gave statistically comparable control, but did allow one or more latent infections to become active in approximately one-sixth and one-fourth of the treated clusters, respectively. When additional clusters were treated a second time, 15 days after veraison, Scala, Vangard, and Elevate provided complete control (versus 37% infection in the untreated clusters). Rovral reduced infection by about three-fourths, whereas Flint, Pristine, and Endura provided 55-60% control.

- Take home-messages and cautions:

  - All of the current "standard" fungicides registered for Botrytis control provided excellent protective activity on the surface of the berries. That's why they got developed and marketed in the first place.

  - The so-called AP fungicides (Vangard and Scala) and Elevate also provided very good protective activity <u>within</u> the berries. This was anticipated for the AP's, since such fungicides are known to be absorbed by plant tissues, but Elevate has always been sold as a surface protectant. But this appears to have more to do with "market positioning" than science (colleagues in South Africa tell me that they've repeated some of our work with Elevate).

  - Similarly, the same three materials provided very good curative activity against latent infections initiated at bloom, even when applied 2 months after infection. Nevertheless, we often get better control in our field trials when these fungicides are sprayed at bloom and bunch closure in addition to veraison and 2 weeks later. This suggests that any curative effects from the later sprays don't completely replace the need for earlier applications when conditions favor infection at bloom (incomplete spray coverage?). But our data at least suggest that the efficacy of these fungicides in the field is the result of curative as well as protective activities.

3b. Fungicides, Pristine. For biological reasons, most common fungicides provide relatively little control of Botrytis and, conversely, most good Botrytis fungicides (Rovral, Vangard, Scala, Elevate) provide relatively little control of fungi other than Botrytis (and a few close relatives that affect crops other than grapes). The resistance potential with the strobilurins notwithstanding, I have always thought that Pristine, which contains two different fungicides, one with activity against a broad spectrum of fungi and one with a "modestly broad" spectrum, might be a good bet for controlling some of the secondary fungi that attack grapes in very wet years (sometimes lumped into the "sour rot" category). And this, indeed, turned out to be the case in our trials in 2006.

As noted previously, Pristine is labeled for "suppression" of Botrytis at a rate of 12.5 oz/A and has a supplemental label for "control" at a rate of 18.5-23 oz/A. Even with the added cost and the current 5-day REI at this higher rate, I believe that it's worth considering for use at or after veraison on valuable highly rot-prone varieties and/or in wet harvest seasons, when Botrytis is but one of many concerns. This is something to keep in mind if you're trying to limit seasonal use to two applications.

The table below shows how the different rates of Pristine have performed in our trials on Vignoles the past few years, in comparison to Vangard and Elevate. Note the rate effect in the wet years (2003, '04, '06), and the fact that the 19 oz rate is consistently comparable to Vangard and Elevate.

Table 3. Control of Botrytis with different rates of Pristine on cv. Vignoles (Geneva, NY)

Material, rate/A*	% Botrytis control (relative to unsprayed) 2003	2004	2005	2006
Unsprayed	(16.3)**	(48.4)	(9.7)	(31.9)
Pristine, 10.5 oz	49	--	64	81
Pristine, 12.5 oz	76	75	93	80
Pristine, 19 oz	94	--	96	92
Vangard, 10 oz	80	87	95	93
Elevate, 1 lb	87	81	--	87

*Four sprays: Bloom, bunch closing, veraison, veraison+2 wk
**Parenthetical values denote percentage of cluster area diseased in unsprayed plots each year.

Note on "other" rots: A number of micro-organisms can decay ripening grape berries under very wet conditions, such as we experienced last fall. When acetic acid bacteria get in through wounds and cracks, they cause a vinegar-like smell, resulting in the term "sour rot". However, this term is often used to denote the general "snork" that develops once berries break down and become infected by a whole complex of fungi and bacteria.

Once this process begins, it's almost impossible to arrest. However, there are some things that can be done to minimize the likelihood of its occurring in the first place if we get hit with heavy pre-harvest rains: Excellent powdery mildew control earlier (elimination of these injury sites for entry). Excellent Botrytis control earlier (ditto). Use of a broad-spectrum fungicide to help control non-Botrytis rots (see discussion on Pristine above). And of course, canopy management and other cultural practices to help fruit dry off when it does stop raining.

There are several important rot diseases (e.g., ripe rot, bitter rot) that are important in the southeast, and have been reported in southern PA and even New England. To date, we have not seen these to be a problem in NY. I'll try to discuss them later this season in a separate newsletter article.

PHOMOPSIS (Ph) NEWS AND REMINDERS

1. Early sprays are the most important for control of rachis infections. Your annual reminder that in multiple spray-timing trials, we've found that applications during the early shoot growth period (as clusters first become visible) are the most important for controlling disease on the rachises. They also provide the greatest control of shoot infections, which serve as sources of Ph spores in subsequent years if retained as infected canes, spurs, or pruning stubs. A minimal Ph spray program should include at least one application during the period soon after clusters emerge, unless it's a very dry spring.

NOTE: In a trial on Niagara grapes last year (not unusually wet early spring), we documented a loss of over 3 tons/A, primarily due to rachis infections, when early Phomopsis sprays were withheld. I'm painfully aware of the current economic realities for juice grape producers, but fear that completely eliminating Ph sprays on highly susceptible varieties such as this is likely to lose more money than it saves, unless the weather is dry.

2. Dead wood and canes may be particularly important sources of Ph spores. The Ph fungus is especially prolific in dead tissues, including dead wood. The obvious practical implication of this observation is that removing dead wood during pruning operations is an important component of a Ph management program. This includes not only obvious sources such as dead canes and arms, but also less-obvious ones such as old pruning stubs. The Ph fungus can remain active in such wood for at least several years, so a "dirty" block is going to stay that way until you prune that stuff out.

3. Little fungal inoculum, if any, is available by mid-summer. We monitored the release of Ph spores in several Lake Erie and Finger Lakes sites over 3 consecutive years. And in each year, we detected few if any spores later than early- to mid-July, with the vast majority released between bud break and bloom. A similar study in Michigan has produced generally similar results. These data suggest that even though berries may remain susceptible throughout the season, as indicated by recent work from Ohio, the risk of infection is probably low once berries become pea-sized, since inoculum is scarce beyond that time.

4. Spray timing to control berry infections. In a trial conducted in a problem block of Niagaras, we were surprised to find that sprays applied shortly after cluster emergence (the important sprays for controlling rachis infections) also provided significant control of berry infections. These results suggest that some berry infections probably result from the fungus growing into the fruit from the berry stem, which is consistent with observations of symptom development in the field. Control improved when we continued applications through the immediate prebloom phase, and was almost complete when we continued until the 2^{nd} postbloom spray.

Note on berry infections: These seem to be most problematical in a very wet season, such as 2006, but are probably more common than some of us recognize (they look a lot like black rot, but don't show up until preharvest). In our test block of Vignoles, they were a significant component of the ugly mess that developed in lightly-sprayed plots. This isn't a "panic button" disease, but don't assume that you don't have to worry about it if you don't grow Niagaras.

5. Fungicides. Mancozeb, captan, and ziram have all provided good control of basal shoot infections in our fungicide trials. Captan has been touted by some individuals as far superior to the others. This hasn't been my experience, although it did show 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) to be more important than any modest differences in biological 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. We've seen no difference between the efficacy of Abound versus Ziram for controlling fruit infections when mancozeb was used prebloom and these materials were compared in subsequent postbloom sprays.

6. Spray application technique. Many growers like to spray alternate rows in the early season when it's the critical time for controlling Ph, assuming that sufficient spray will blow through the target row and impact on vines in the "middle" row. For 3 consecutive years, Andrew Landers helped us examine this issue in a commercial Niagara vineyard. Consistently, vines in the middle row received less spray than vines subjected to every-row spraying, and perhaps more importantly, the coverage was more variable. The benefits of alternate-row spraying are obvious and there's no reason to fix things if they ain't broke; however, if you've had trouble controlling Ph while using alternate-row spraying, the suggested remedy also is obvious.

PUTTING IT ALL TOGETHER

We all know that there are as may good programs for controlling these diseases are there are good growers and advisors. 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 this any harder than you need to.

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

3- to 5-INCH SHOOT GROWTH. A critical time to control **Ph** rachis infections if it's raining or likely to be. Early is better than late if it starts raining. 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, and recent research indicates that this spray will provide some benefit against fruit infections as well. Now is the time to start thinking about control of **PM** on *vinifera* varieties if temperatures remain above 50°F for long stretches of the day. This spray is much more likely to be important in vineyards that had significant PM last year than in those that were "clean", although it may be beneficial even in relatively clean blocks of highly susceptible cultivars in cloudy, wet years if temperatures aren't limiting. And if you're spraying for Ph, why not include something for PM on highly susceptible (and valuable) varieties while you're at it. In NY, spending extra money for **BR** control is almost never justified this early unless you're trying to clean up a severe problem block AND weather is wet and reasonably warm. Still too early for **DM**. <u>Option A:</u> Nothing. <u>Option B:</u> Mancozeb (BR, Ph). <u>Option C:</u> Captan (Ph, some BR). Easier on predator mites than mancozeb (or ziram), probably good enough against BR this early, but 3-day REI. <u>Option D:</u> Sulfur (PM). As discussed above, historical pronouncements concerning reduced activity of sulfur at temps below 65°F appear to have been significantly exaggerated. A cheap insurance option. <u>Option E:</u> 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 application rates (don't forget that the activity of these materials is very rate-dependent, particularly in vineyards with a long history of use, so partial coverage with a low rate is unlikely to cut it). Did somebody mention alternate row applications? <u>Option F:</u> Rubigan (PM). At 2 fl oz/A (minimum 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. Same issue with the need for superior coverage at low rates. Vintage isn't labeled for use this early. <u>Option G:</u> JMS Stylet Oil (PM). Should eradicate young infections IF thorough coverage is provided, but provides little forward activity. Can use with mancozeb (or ziram), but not with captan (phytotoxicity). <u>Option H:</u> Nutrol, Armicarb, Oxidate, Kaligreen. (PM). Should eradicate young infections IF thorough coverage is provided, but no forward activity. Nutrol is <u>much</u> cheaper than the other materials in this group, and has provided control equivalent to both Armicarb and Kaligreen in several of our head-to-head tests. Option<u> I:</u> Serenade or Sonata, if you want to experiment with these "biocontrol" products while disease pressure is low. <u>Option J:</u> One of the PM products plus mancozeb or captan for Ph.

10-INCH SHOOT GROWTH. We once recommend not waiting any longer to control **BR**. Continued experience tells us that this spray can be omitted under most commercial conditions in NY <u>unless</u> BR was a problem last year (inoculum levels are high) and weather is wet and warm. Don't wait any later than this to control **PM** on susceptible varieties. On Concord and similar cultivars, we generally recommend waiting until immediate prebloom. However, in 2003 (wet, cloudy spring) we started seeing PM on Concords around the 10-in shoot growth stage, and uncontrolled early infections really spread and caused havoc. Get out in the vineyard and have a look. No need to spray before you need to, but if you see PM this early, you need to. Now is one of the best times to use an SI, and a possible time to experiment with "alternative" materials if you're so inclined. It's also one of the best times to use an oil or other eradicant against young "primary" infections, particularly if the spray program up until now has been marginal or absent. **DM** control should be provided on highly susceptible varieties, especially if disease was prevalent last year and rains of at least 0.1 inches at temps >52°F are anticipated or have occurred recently. Rachis and fruit infections by **Ph** are a danger in wet years, particularly in blocks with some history of the disease. Option A: Mancozeb (BR, Ph, DM). A broad spectrum, economical choice for everything except PM; tank mix with a PM material to complete the picture if necessary. Excessive use can lead to mite problems by suppressing their predators. Option B: Captan (Ph, DM, some BR). An alternative to mancozeb if you're trying to avoid it due to mite concerns. The limited BR activity should still be sufficient if the disease was controlled well last year (limited inoculum) and good BR materials will be used in the next three sprays. Option C: Sulfur (PM). Historical concern about reduced activity during cool weather is going down and temps should going up by now. Post-infection activity may be useful against new "primary" infections before they have a chance to spread. Option D: Nova or Elite (PM, BR). Option E: 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. Bump up to the 3 fl oz/A rate by now. Still too early to use Vintage due to label oddity. Option F: JMS Stylet Oil (PM). If (and only *IF*) coverage is thorough**,** this spray should eradicate early PM colonies that may have started should previous PM sprays have been omitted or incompletely applied. But don't waste your money if you can't cover thoroughly. Also may helps with mites. Recent research indicates some protectant activity as well, although much of that will disappear after a rain. Some other petroleum-based oils such as PureSpray Green should have similar effects, if you can find them, although the botanically-based oils are generally less effective. Option G: Quintec (PM). If trying to limit seasonal applications to two or three, probably more efficient and cost-effective to wait until prebloom, when cluster protection starts to become critical. Option I: Nutrol, Armicarb, Oxidate, Kaligreen. (PM). Should eradicate young infections IF thorough coverage is provided, but no forward activity. Option H: Serenade or Sonata, if you want to experiment with "biocontrol" products before entering the critical period for disease control. Option I: Mancozeb (BR, Ph, DM) + a PM material, based on previously-discussed characteristics and cost.

IMMEDIATE PREBLOOM TO EARLY BLOOM. **A critical time to control PM, BR, DM, and Ph on the fruit! This and the first postbloom spray are the most critical sprays of the season--DON'T CHEAT ON MATERIALS, RATES, SPRAY INTERVALS, OR COVERAGE!** Option A: Quintec for PM control, plus mancozeb (for BR, DM, and Ph). Effective and no current resistance concerns. Option B. Pristine (PM, DM, BR). The 12.5-oz rate of Pristine will also provide some protection against Botrytis, I wouldn't go to the higher "supplemental" rate this early unless Botrytis pressure was really high. On highly susceptible cultivars, where SI resistance is usually an issue to at least some extent and strobie resistance has occurred or is deemed risky, Quintec, Pristine, and/or sulfur would be the materials of choice, unless BR is more of an issue than PM. Do not use Quintec or Pristine more than three times per season (considering the DM resistance potential, I'm more comfortable with a limit of two annual applications for all strobies, including Pristine), nor more than two times in a row. I'd toss in some sulfur, especially in blocks where PM has developed strobie resistance, just for additional protection. Option C: Abound or Sovran (plus sulfur). (PM, BR, DM). Still an effective option in some vineyards, but with significant cautions and/or restrictions. Refer to the discussion on strobilurin resistance in the "Fungicide Changes and News" section at the beginning of this epistle. Option D: Flint plus sulfur (PM, BR, Botrytis at the 3-oz rate) plus mancozeb, captan, or phosphonate for DM. Option E: Either Nova, Elite, Rubigan, or Vintage PLUS mancozeb (PM, BR, Ph, DM). Add sulfur on *vinifera* and PM-susceptible hybrids (unless "sulfur shy"). Nova and

Elite are excellent against BR, so might be the best choice if pressure is high and BR control is more important than PM; their postinfection activity against BR can make them valuable if significant unprotected infection periods occurred previously. Rubigan and Vintage are cheaper that Nova and Elite, but don'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). <u>Option D:</u> 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 both necessary and difficult in wet years. Potential mite problems.

BLOOM. Vangard, Scala, Elevate, Flint (3 oz rate), Endura, or Pristine for Botrytis control will probably be beneficial sometime around now in wet years. It's certainly easier to use or include one of these materials for Botrytis purposes in the "immediate prebloom/early bloom" or "first postbloom" spray, and from what we know of these materials' activities, they should be effective when applied then. The main problem is that for Botrytis-specific materials like the AP's and Elevate, you'll be distributing them throughout the entire canopy, whereas the only place they're effective is on the clusters. If sulfur was the only PM material in the previous spray, reapply about now on highly susceptible *viniferas.*

FIRST POSTBLOOM (10-14 days after immediate prebloom spray). **Still in the most critical period for PM, BR, DM, and Ph on the fruit.** Shorten the spray interval and/or jack up the rate 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 strongly recommended if infections are evident on the vine, unless you're sure it's not going to rain; however, BR sprays can often be skipped from here on out if neither case is true, particularly on native varieties. 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 wine-spoilage microorganisms. New foliage remains highly susceptible to PM throughout the season, although Concords can withstand a lot of foliar PM unless the crop is very large and/or ripening conditions are marginal. Try to avoid SI and, particularly, strobie fungicides if more than a little PM is easily visible. **Ph** danger is just about over unless very wet and a problem block. Clusters are still susceptible to **DM** and should be protected on susceptible varieties if weather is wet, especially if disease already is established (look and see). Foliar DM will remain a potential issue the rest of the season, depending on the weather. <u>Option A:</u> Pristine, Abound, Sovran, or Flint. See previous discussions. These provide good residual control of the listed diseases if used now, but limit their use to maintain viability. Pristine and Flint will provide Botrytis control when used as a pre-bunch closure spray (remember importance of rate). <u>Option B:</u> Quintec (PM) + captan or mancozeb (66-day preharvest restriction, mites) to control DM, BR, and Ph as needed. If DM is the only other issue, Ridomil (in a bad year) or a phosponate are additional options. Quintec and Pristine shouldn't be applied in more than two consecutive sprays, but are an option if not used in both the prebloom and first postbloom application. <u>Option C:</u> Nova or Elite (BR, PM) + the DM and Ph options presented in Option B. <u>Option D:</u> Rubigan or Vintage (PM) + <u>either</u> (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); or (d) Ridomil or phosphonate (DM). <u>Option E:</u> Sulfur (PM) + the additional options just listed with Rubigan. In most years, lessening disease pressure makes this economical option increasingly practical as the season progresses. Option F: Copper + lime (DM, some PM). Adequate PM control for native varieties, generally not enough for *vinifera* and susceptible hybrid cultivars.

ADDITIONAL SUMMER SPRAYS. Check the vineyard regularly to see what's needed, the main issues will be **PM** and **DM**. Also **Botrytis** on susceptible cultivars. On *vinifera* and other cultivars requiring continued **PM** control, use sulfur as an economical choice to maintain control. However, this can be a problem as you approach veraison, as some wineries are setting fairly long withholding intervals. SIs also are options, but only if they've been used minimally earlier (try to stick to a maximum of 3 applications per year) AND little disease is evident. So is an occasional application of Quintec or Pristine (or another strobie + sulfur), not exceeding the recommended maximum number sprays for each. All of these materials provide the advantage of longer residual activity than sulfur, especially in wet weather, but resistance management (limited use) is important. Not to mention cost. Copper + lime can be used on Concords, but mid-summer sprays for PM on this variety are probably worth the expense only under high crop and/or poor ripening conditions. Alternative materials such as Nutrol, Kaligreen, Armicarb, Oxidate, Serenade, and Sonata can have their place during this period, especially if you're trying to avoid sulfur later on, although they generally need to be sprayed more frequently and most of them are not cheap. The well-documented ability of oils to decrease photosynthesis and consequently decrease Brix accumulation makes me hesitant to recommend these products once the crop nears veraison, although a single application should be OK. For **DM**, phosphonate products have become economical and effective standards; copper + lime and captan are tried and true options as well. Ridomil can be used in case of extreme pressure or emergency, remember that the PHI has been reduced to 42 days for the Ridomil Gold Copper formulation versus 66-days for the MZ formulation. Pristine and Abound have provided excellent activity in the past when they still fit into the program this late, but avoid using them if you've already sprayed a strobie product twice or have reason to suspect that resistance may be developing. **BR** should not be an issue after the second postbloom spray, except in very 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. Sprays for **Botrytis** may be advisable at veraison and/or preharvest, see previous discussion under that disease for details.