

FUNGICIDE GUIDELINES FOR NON-BEARING VINEYARDS 2013

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The approach to non-bearing vines will be slightly different from bearing vines because you do not need to focus too much on the protection of berries. Also, some diseases such as Phomopsis tend to appear to the vineyards that are established for several years. The intention of this guide is to provide examples so that you can build your own spray program. Please keep in your mind that, development of diseases will depend on vineyard history, proximity to the existing vineyards and wild grapes, and weather conditions. Thus, your spray program needs to adjust for all of these conditions.

For this guide, I used mancozeb + sulfur as a backbone of the spray program. The reason is because it works good, and very cost effective. You can adjust it as needed, or use different set of tools, if you prefer that way. However, for 1st and 2nd year vines, you should be able to protect vines without extensive use of other materials. There are many different products available on both mancozeb and sulfur. The rate of the product depends on what label suggest, so, please make sure to read the label, which is a legal document.

For bearing vineyard, please refer to my other fungicide guide, which is available from my blog: (<http://grapepathology.blogspot.com/>). I am using the blog to discuss about grape diseases almost daily during the season.

The other excellent source of information on general pesticide guide is Virginia Tech's "Grape diseases and insects in vineyards" (Pest Management Guide or PMG): http://pubs.ext.vt.edu/456/456-017/Section-3_Grapes-2.pdf

Although you may not see many of major diseases for wine grape during the first two to three years, it is always a good idea to prepare your self for potential future issues. Thus, this guide includes a section on "disease note" where biology and management strategies of major fungal diseases for wine grapes in VA and other eastern growing region are discussed.

FUNGICIDE GUIDELINES FOR NON-BEARING VINEYARDS 2011

Growth stage or timing	Material and rate/Acre	Comments
<p>New shoots (2 to 3 sprays, depends on the weather)</p> <p>Begin at ½- to 1- inch shoot</p> <p>Spray every 10-14 days till pre-bloom</p> <p>Note: If rain is predicted between 7 and 10 days after your last spray, make another application before the rain.</p>  <p>to</p> 	<p>Mancozeb (Dithane DF, Penncozeb 75DF, etc) @ 3-4 lb/A or captan (Captan 50WP) @ 3 lb/A</p> <p>PLUS one of the following for PM:</p> <p>Sulfur (Microthiol D, etc) @ 3-4 lb/A or Liquid sulfur (Super Six, etc) @ 3-4 qt/A or JMS Stylet Oil @ 1% concentration</p> <p>+++++ Note +++++</p> <p>Since the first year vines will not bear fruits, you can use Mancozeb + sulfur spray for the whole season. Depends on the weather conditions, you may be able to protect your vines with just 5-6 applications. Please scout your vineyard often to see any development of diseases.</p> <p>If you see a significant development of downy mildew, you can apply Ridomil or Prophyt (Phosphorous acid) products. If PM is a major problem, an SI such as Rally and other newer materials such as Quintec will give somewhat better control than sulfur.</p>	<p>In non-bearing vineyards (1st and 2nd year), you may use a simplified program to control black rot (BR), Phomopsis (Ph), downy mildew (DM), and powdery mildew (PM). The main focus will be on DM and PM during the first year and DM, PM, and BR in the second year.</p> <p>A combination of mancozeb and sulfur is an inexpensive, effective option on French wine grape varieties. Sulfur and Stylet oil are inexpensive but require thorough coverage to be effective. Also, some varieties are sensitive to Sulfur. Captan is less toxic to predator mites than mancozeb but also less effective against BR. If you were using captan and an SI, the tank-mix choice for BR control would be Rally or Elite, but not Rubigan since it does not have a good efficacy against BR.</p> <ul style="list-style-type: none"> ▪ Concords, red-fruited French-American hybrids, are sensitive to sulfur. Please refer to the table in PMG. Alternatives are stylet oil, an SI, Quintec, or Endura. ▪ Do not combine sulfur with oil or spray them within 14 days of one another. ▪ Also: Do not combine Captan with oil or spray them within 14 days of one another. ▪ Application of sulfur when the temperature exceeds 85°F may cause injury to your vines <p>Most of these fungicides act only as protectants. They must be on the shoot before fungal spores arrive to be effective, and they do not move through the shoot to new growth. New growth must be protected by sprays at regular intervals.</p> <p>Increase spray volume as the canopy fills out to ensure thorough coverage.</p>

Growth stage or timing	Material and rate/Acre	Comments
<p>Pre-bloom to post-bloom (3 sprays) Begin at pre-bloom or early bloom Spray twice more at 10 to 14-day intervals</p>  <p>Note: You will not see, or want remove clusters, in the first year. You may want to keep some clusters in the second year, but make sure not to over-crop!!</p>	<p>Mancozeb (Dithane DF, Penncozeb 75DF, etc) @ 3-4 lb/A or captan (Captan 50WP) @ 3 lb/A</p> <p>PLUS one of the following for PM:</p> <p>Sulfur (Microthiol D, etc) @ 3–4 lb/A or Liquid sulfur (Super Six, etc) @ 3 qt/A or a sterol-inhibiting (SI) fungicide [Elite 45 WP @ 4 oz/A or Rally 40W @ 3-5 oz/A or Rubigan @ 3 fl oz/A] or Quintec @ 4 fl oz/A or Endura @ 4.5 oz/A</p> <p>If you see a significant development of downy mildew, you can apply Ridomil or Prophyt (Phosphorous acid) products. If PM is a major problem, an SI such as Rally will give somewhat better control than sulfur, along with some post-infection activity against BR.</p> <p>+++++ Important +++++</p> <p>If you are using a QoI, SI fungicide, Quintec, or Endura, you should rotate with a different mode of action to avoid resistance development.</p> <p>See Table 2 in the spray guide for classes of fungicides. Read labels for restrictions on the number of applications and amount to be applied in one season. In general, limit application of QoI to twice or less per season, and no more than 3 sprays of other resistance-prone fungicide per season. The same rule applies even if you tank-mix with sulfur.</p>	<p>For bearing vines, it is a critical period for controlling DM as well as BR, Ph, and PM because berries are susceptible to the disease. However, for 1st and 2nd year vines, it is not as critical.</p> <p>Compared with sulfur, an SI, Quintec, or Endura might also be preferable when you are planning to do canopy management tasks, as some people are sensitive to sulfur residues. But do not use Flint or Pristine on Concord grapes.</p> <p>If many PM colonies appear on leaves, avoid using SI, QoI, Quintec, and Endura and apply one of the potassium salts (Nutrol, Armicarb 100, or Kaligreen), because it can promote the development of resistance. Potassium salts provide moderate to good control of developing PM colonies but no protection against future infections, and thorough coverage is needed.</p> <p>Nutrol is more economical than Armicarb or Kaligreen but comparable in effectiveness, According to research in New York. Consult labels for usage rates and other recommendations. Use a high enough spray volume to ensure thorough coverage.</p>

<i>Growth stage or timing</i>	<i>Material and rate/Acre</i>	<i>Comments</i>
<p>Cover sprays (1 to 2 sprays, depends on weather conditions)</p> <p>Begin 10-14 days after last post-bloom spray</p> <p>Spray at 14- to 21-day intervals, depending on weather, until frost</p> 	<p>Mancozeb (Dithane DF, Penncozeb 75DF, etc) @ 3-4 lb/A or captan (Captan 50WP) @ 3 lb/A or a phosphorous acid product (Phostrol, ProPhyt, or Agri-Fos) at the labeled rate</p> <p>PLUS one of the following:</p> <p>Sulfur (Microthiol D, etc) @ 3–4 lb/A or Liquid sulfur (Super Six, etc) @ 3 qt/A or a sterol-inhibiting (SI) fungicide [Elite 45 WP @ 4 oz/A or Nova 40W @ 3-5 oz/A or Rubigan @ 3 fl oz/A] or Quintec @ 4 fl oz/A or Endura @ 4.5 oz/A or a potassium salt (Nutrol, Armicarb 100, or Kaligreen) at the labeled rate</p>	<p>DM and PM will be the main threats for the rest of the season. Please scout your vineyards so that you can be ready for needed application.</p> <p>In a non-bearing vineyard, you can use the combination of mancozeb and sulfur until frost. If you reach the seasonal limit on mancozeb (about 6 sprays at the 4 lb/A rate, but read the label for your formulation), switch to captan or a phosphorous acid for DM.</p> <p>Some of phosphorous acid-like materials are available as a nutritional supplement; however, the specific chemical composition may differ. Choose the product that is registered as a fungicide. Please consult the label for the correct rate.</p>

Simplified table for spray schedule for non-bearing grape vines

(Note: it is just an example, you need to adjust your schedule based on what is happening at your place)

Approximate date	Approximate growth stage	Treatment				Diseases					
		Mancozeb	Sulfur	PM material (S/D/MI, e.g., Rally, tebuconazole)	DM material (Revus, Phosphite, Ridomil, etc)	Phomopsis (Don't worry about it in 1st - 2nd year)	Black rot	Powdery mildew	Downy mildew	Botrytis (Don't worry about it in 1st - 2nd year)	
15-Apr	bud break										
30-Apr	5-inch shoot	x		x							
15-May	12-inch shoot	x		x							
30-May	Pre-bloom	x		x				x		x	
15-Jun	at bloom	x		x				x		x	
30-Jun	BB-size	x		x				x		x	
15-Jul	Pea-size	x		x				x		x	
30-Jul	Bunch closure	x		x				x		x	
15-Aug	Veraison	x		x				x		x	
30-Aug	Pre harvest	x - if needed		x - if needed				x - maybe		x	
15-Sep	Post harvest	x - if needed		x - if needed				x - maybe		x	
Examples of fungicide sets for non-bearing grapevines											
	Essential				Supplemental						
Example 1	mancozeb	Sulfur	tebuconazole	Phosphite							
Example 2	Captan	sulfur	tebuconazole	Phosphite							
Example 3	Fixed copper		tebuconazole	Ridomil							

Disease Note

Phomopsis cane and leaf spot

Fungus itself

- It is a fungal disease caused by *Phomopsis viticola*.
- The fungus tends to be active in cool to warm temperature. The optimal temperature for germination is around 60-65F (15-18C), and it takes 4 hours of leafwetness (the times that the surface of the leaf is wet due to rain or dew) at that temperature range to have light infection. Please see the table below for infection requirements.
- The fungus produces two types of spores: conidia (alpha conidia and beta conidia).
- Spores will be protected by gelatinous substances; thus, it is probably safe to assume that they can tolerate some dryness.
- We do not have information about rainfastness of spores, but that gelatinous coating probably helps spores to stick to the surface.
- **Potential scenarios for infection:** A rain event that lasts more than a few hours with temperature ranges 60-70's. A short rain event followed by humid period. A rain event in the evening, followed by morning dew.

Table 1. Leaf Wetness Duration-Temperature Combinations Necessary for Cane Infection by Phomopsis of Grape

Temperature in °F	Temperature in °C	Minimum Leaf (cane) Wetness Duration (hr) for <u>Light</u> Infection (5-15% severity)	Minimum Leaf (cane) Wetness Duration (hr) for <u>Moderate</u> Infection (15-25% severity)
45	7	42	>48
50	10	9	17
55	13	5	8
60	16	4	7
65	18	4	7
70	21	4	8
75	24	6	12
80	27	11	22
85	29	22	44
90	32	Little or no infection	Little or no infection

- Data represent a compilation from several experiments with the cultivars Concord and Catawba. (Erincik et al., 2003, Nita et al., 2007)
- Leafwetness is the period when leaves are wet (moist). It is not the same as the duration of rain.

Disease cycle, critical period, and management

- This disease is monocyclic = can reproduce once within a season = need to know when it is active.
 - o The fungus survives in canes that were infected previously; it can survive at least two years, and keep producing spores in the spring.
 - o It requires rains to be splashed from old infected canes to new growth, thus, you tend to see this disease on leaves and internodes close to the main trunk.
 - o The leafwetness requirement is relatively short. You almost need to assume any rain events can initiate the infection (if you had the disease in the past years).
 - o The fungus becomes active when the shoots are very short (even at 1 inch)

- Thus, the critical timing of protection is from 1-inch to bloom. However, often time black rot fungicides will work against *Phomopsis* (but not Rally or Sterol-inhibitors); thus, applications specific to *Phomopsis* may be required only when shoots are short.
- The grape berries does NOT become resistant and the fungus can produce spores during summer; however, it tends to produce less spores during summer, it is often too warm for a significant infection to take place, and/or the canopy prevents spores to be moved around. These are possible reasons why we do not see many fruit rots.
- Canes and rachis seems to become resistant once it gets matured (anecdotal observation).

Management options:

- Sanitation by removing infected canes from your vines, selective pruning to cut out heavily infected canes
- Good air circulation
- Preventative fungicide application (Mancozeb, Captan, or Ziram) starting from 1-3 inch growth stage [There are no fungicides with curative (kick-back) activities against *Phomopsis* infection.]
- Dormant season application of lime sulfur (10 gal/100 gal/A) helps, but does not let you skip the spray in season.

Pristine is also labeled for Phomopsis. There are some studies done by Michigan State to aim for control of fruit infection, and results showed that disease intensity of Pristine alone treatment was significantly lower than the untreated control. Thus, it has efficacy against *Phomopsis*, but the degree of efficacy may not be as good as other options. Pristine by itself did not provide a significantly better control than a treatment with Pristine + mancozeb or Pristine + Abound. The same group tested Pristine in early season for leaf and cane infection; however, they did not have an enough level of disease to have comparisons. It is interesting to see how it does; however, I'm not sure you want to use a chemical with a short PHI (pre-harvest interval) early in the season when other cheaper chemicals can control the disease. Note: the PHI for mancozeb is 66 days.

Black Rot

Fungus itself

- It is a fungal disease caused by *Guignardia bidweillii*.
- The fungus tends to be active in relatively higher temperature ranges. The optimal temperature for germination is around 26C (80F), and it takes 6 hours of leafwetness at that temperature to cause light level of disease (please see the table below for infection requirements).
- The fungus produces two types of spores: ascospores (airborne and rain splashed) early in the season and conidia (rain splashed) in later.
- Spore (conidia) needs a drying time to adhere to the leaf surface; however, drying time (after wetting) exceeding 24 (ascospores) or 48 (conidia) hours decrease its chance of survival.

- During a rain event, the release of conidia happens after 45 min and last for 2.5 hours, a peak is around 1.5 hour.
- **Potential scenarios for infection:** Warm intermittent rain events, A rain event followed by relatively warm humid period, A rain event in the evening, followed by morning dew.

Table 3. Leaf Wetness Duration-Temperature Combinations Necessary for Foliar Infection by Black Rot of Grape

Temperature in °F	Temperature in °C	Minimum Leaf Wetness Duration (hr) for Light Infection
50	10	24
55	13	12
60	16	9
65	18	8
70	21	7
75	24	7
80	27	6
85	29	9
90	32	12

- Data represent a compilation from several experiments with the cultivars Concord, Catawba, Aurora, and Baco noir (Ellis et al., 1989, Spotts 1980 etc)
- Leafwetness is the period when leaves are wet (moist). It is not the same as the duration of rain.

Disease cycle, critical period, and management

- This disease is polycyclic = can reproduce several times within a season = once you fail to control, it can accumulate rapidly
 - o The fungus survives in crop debris, hanging berries from the last year is known to be the best source of inoculum for this fungus. You need to take them out.
 - o Once infection takes place, it takes about 2 weeks to produce spores at an average temperature above 70F (21C) (takes about 3 weeks at 60F (15C)). It will produce numerous spores for next infection. If the initial infection was not controlled, it could lead to serious secondary or tertiary infection events.
- The grape berries can become resistant to the infection by this fungus once it matures. It happens about 4-5 weeks after bloom for *V. vinifera* varieties. Leaves become resistant after 1 week or so.
- Thus, the critical timing of protection is from pre-bloom to 5 weeks after bloom (probably 2-3 sprays).

Management options:

- Sanitation by removing old bunches from the vines
- Good air circulation
- Preventative fungicide application (Mancozeb, Sterol-inhibitors, Strobilurins)
- Myclobutanil is known to have a good curative (kick-back) activity against black rot fungus. It has an efficacy up to 6 days after infection (see Table 3). (Unfortunately, myclobutanil does not work well against Phomopsis.)
- Azoxystrobin does have some curative activity against black rot fungus; however, the efficacy is not as good as that of myclobutanil.

Powdery Mildew

Fungus itself

- It is a fungal disease caused by *Erysiphe necator* (aka *Uncinula necator*).
- The fungus does not require water for infection; however, high relative humidity is often related with high disease intensity
- The fungus is active in wide range of temperature (mid-40's to upper-80). The optimal temperature for germination is around 75F (23C) and above. It does not require free water to cause infection. Surface water inhibits (or slow down) activity of the fungus.
- The fungus produces two types of spores: ascospores (airborne) early in the season and conidia (airborne) in later.
- High temperature (> 95F) inhibits activity of the fungus. If average temperature is above 90F for a while, disease development will be little or none.
- Diffuse sunlight promote disease development (leaves in shade of other leaves are good place for them).

Table 4. Approximate generation time for powdery mildew at different average temperatures (Delp 1954)

Temperature in °F	Temperature in °C	Days
44	7	32
48	9	25
52	11	16
54	12	18
59	15	11
63	17	7
74	23	6
79	26	5
86	30	6
90	32	little or no development

Disease cycle, critical period, and management

- This disease is polycyclic = can reproduce several times within a season = once you fail to control, it can accumulate rapidly
 - o The fungus overwinters as a fruiting body called cleistothecia (recently renamed to Chasmothecia) which hang themselves on bark surfaces.
 - o Cleistothecia requires rain (> 2.5 mm, or 0.1 inch, and more than 4 hr of wetness), and temperature between 43-75F (6 - 24C) to discharge ascospore. (A French study showed 0.1 inch, 2.5 hr, and >50 F). Ascospore discharge starts around bud break and continue to bloom. Lowest temperature requirement is about 50F and the optimal temperature is above 68F (Overall range and efficiency of infection are probably similar to the table 4).
 - o A French study showed that rain events during pre-bloom period had a correlation with more powdery mildew disease intensity later in the season. Early season protection of vines may be more important than we think.
 - o One infection takes place, it takes about 1 week to produce spores at temperature above 63F (takes about 2 weeks in 50's). It will produce numerous

spores at this point. Depends on how bad the initial infection was, it maybe too late.

- **Potential scenario for infection:** Humid days in 60's to 70's; Rain events during early growth stage may increase the chance of outbreak later in the season.
- The grape berries can become resistant to the infection by this fungus once it matures. It happens after 4-5 weeks after bloom for *V. vinifera* varieties. However, rachis tissue does not become resistant.
- Thus, the critical timing of protection is from pre-bloom to 4 weeks after bloom for protection of berries. And as described above, early season protection will help to delay exponential increase of disease (Fig 2).
- Management options:
 - o Good air circulation
 - o Preventative fungicide application: Sulfur, Fixed copper
 - o Curative fungicide application: Stylet Oil [early season, some varieties shows phytotoxicity]; Sterol-inhibitor [Rally, note: there are evidence of chemical resistance in Europe, VA isolates showed some shift, but have not become insensitive yet], Potassium salt products [requires through coverage, expensive]. Since this fungus grows superficially (i.e., they live on the surface of grape tissue), even sulfur treatment showed evidence of curative activity (up to 3 days to be on safer side. Some says it can be extended to up to 5 days).

Downy Mildew

Fungus itself

- It is a fungal disease caused by *Plasmopara viticola*. (It is technically not a fungus (belongs to Oomycete), but I refer it as a fungus for the convenience.)
- The fungal activity heavily depends on availability of water. It is a typical wet season disease.
- The fungus is active in wide range of temperature (low-50's to 85, 10 to 30C). The optimal temperature for germination is around 64-76F (18-22C).
- The fungus produces two types of spores: oospore (for survival) and zoospore (rain splashed, and has a capability to swim!).

Disease cycle, critical period, and management

- This disease is polycyclic = can reproduce several times within a season = once you fail to control, it can accumulate rapidly
 - o The fungus over-winters as a spore called oospore, which can survive inside of infected leaves on the ground or in a soil for a few years, or they can survive inside of previously infected twigs.
 - o Oospore requires rain to germinate to a fruiting structure sporangium. The process happens when temperature is above 52F (11C). The sporangium can be disseminated by wind or rain. Then, the sporangium can produce spores (zoospores).
 - o Zoospores swim to stomata (pores on the surface of a grape leaf for the gas-water exchange), and cause infection.
 - o When there is a night with temperature 55F or above and with high relative humidity, a sporangiophore (a tree of sporangia) will form. This is the "downy" appearance on the underside of a grape leaf. Sporangia on this sporangiophore can be disseminated by rain or wind and cycle goes on.

- Once infection takes place; it takes 8-15 days to produce mass of sporangia.
- It only takes less than 90 min for zoospores to cause infection. (That's why I don't have a table this time...)
- Oospores can survive throughout the season to produce sporangia

- **Potential scenario for infection:** Humid night above 55F followed by dew or rain; Rain events during early growth stage may increase the chance of outbreak later in the season.
- The grape berries are susceptible from 2-3 weeks prior to the bloom. They can become resistant to the infection by this fungus once it matures. It happens after 4-5 weeks after bloom for *V. vinifera* varieties.
- Thus, the critical timing of protection is from 2-3 weeks prior to bloom to 4 weeks after bloom for protection of berries. And as described above, early season protection will help to delay exponential increase of disease (Fig 2).
- Management options:
 - Good air circulation, removal of suckers (spores jump from the ground to suckers, from suckers to lower leaves, ...)
 - Preventative fungicide application: mancozeb, captan, fixed copper, and others
 - Curative fungicide application: metalaxyl [Ridmil Gold MZ etc]; Phosphorus acid [Prophyte etc, some claims that it does not have a good efficacy on rachis and berry infection]. These materials can have efficacy 1-3 days after infection event. (as with powdery mildew fungicides, under experimental conditions, it has efficacy up to 5-6 days. However, DM can produce spores in 8 days or so under optimal conditions.)
 - Downy mildew is a major concern on potato and other crop productions (Irish Famine was partially caused by downy mildew of potato). For those productions, cases of chemical resistance on number of downy mildew fungicides are reported. However, it is not the case with grape in the US (unfortunately there is evidence of resistance to metalaxyl in Europe). Thus, let's keep it that way. Please be careful with mode of action and mix it up.

Botrytis Rot

Fungus itself

- It is a fungal disease caused by *Botrytis cinerea*.
- The fungus tends to be active in wide temperature ranges. The optimal temperature for germination is around 70F (21C), and it takes 5 hours of leafwetness at that temperature to cause light level of disease (please see the table below for infection requirements).
- Moisture in the form of fog or dew and temperatures of 59 to 77°F are ideal for conidia production and infection.
- The fungus produces two types of spores: ascospores (rare: airborne) and conidia (airborne).
- The gray moldy appearance is due to mass of conidia
- It has wide range of hosts, strawberry and other small fruits, crop debris, etc...

Table 5. Leaf Wetness Duration-Temperature Combinations Necessary for Foliar Infection by Botrytis Rot of Grape berries

Temperature in °F	Temperature in °C	Minimum Leaf Wetness Duration (hr) for Light Infection (10-20% incidence)	Minimum Leaf Wetness Duration (hr) for Moderate Infection (20-40% incidence)
50	10	20	29
55	13	10	15
60	16	7	9
65	18	5	8
70	21	5	7
75	24	6	8
80	27	8	11
85	29	14	21
90	32	22	32

- Data is based on study by Nair and Allen (1993)
- Leafwetness is the period when leaves are wet (moist). It is not the same as the duration of rain.

Disease cycle, critical period, and management

- This disease is polycyclic = can reproduce several times within a season; however, spores are everywhere...
 - The fungus can infect flowers within a few hours, then the fungus can reside in flower parts until berry matures (latent infection). Also, infected flower debris (caps etc) can be a source of inoculum.
- The resistance to this fungus varies among varieties. Factors influencing the disease development are: cluster structure (compact and tight = more disease), canopy structure (air circulation), wounds (important), anthocyanins and phenolic compounds production, phytoalexins (plant's defense chemicals), etc
- It seems berries are susceptible throughout the season, but amount of conidia in the air tend to increase after veraison. (from other sources??)
- Even though it takes only a few hours of wetness to have infection, this fungus seems to be not a good pathogen by itself. In field condition, it is often associated with longer hours (>15 hr) of wetness (or high RH).
- However, if berries are wounded by hail, insect, etc, it will take a full advantage of it (the fungus also likes high sugar content).
 - Powdery mildew infection during fruit development can also attribute to scar development and subsequent Botrytis infection.
- Thus, the critical timing of protection at bloom (to protect flowers) and before veraison (to cover berries). The other potential timing is after veraison.
- **Potential scenarios for infection:** Physically damaged berries receiving high RH or long rain events. Early season infection on flowers. Early season berry infection by powdery mildew.

Management options:

- Canopy management ~ cluster management (leaf removal to promote reduce compactness, e.g., Vinoles), but you also need to avoid sunburn.
- Good air circulation
- Preventative fungicide application (Fenhexamid (Elevate), Boscalid (Endura), Trifloxystrobin (Flint), Iprodione (Roval), etc)

- These fungicides are tested for curative activity in the lab. They had some efficacy within 12 hr of infection; however, it is a lab experiment using detached berries (i.e., I wouldn't risk your vines.)

Ripe rot and Bitter rot

Ripe rot is caused by two species of fungal pathogens, *Colletotrichum acutatum* and *C. gloeosporioides*. Bitter rot is caused by a fungus *Greeneria uvicola*. Both diseases are similar in many aspects. Both diseases can cause infection early in the season (at bloom), but symptom expression develops close to harvest, both prefer much warmer condition (>75F), and both can alter the flavor of infected fruits and resulting wines.

Our lab is actively working on ripe rot pathogens since we have seen outbreaks of ripe rot in several VA vineyards. Preliminary results from our ripe rot inoculation studies showed that not only at bloom, but berries are susceptible throughout the season. Currently, mancozeb, captan, and QoI fungicides are recommended for ripe rot; however, studies showed that *C. gloeosporioides* was not sensitive to captan. In addition, efficacies among QoI fungicides were not equal. We will investigate more on these pathogens in the next few years to identify their infection conditions, fungicide efficacy, and application timing in order to develop effective management strategies.

There are not many data available for bitter rot on berry infection; however, this pathogen is known to cause infection from a pedicel of the berry during the berry development. Thus, the infection seems to happen throughout the development of berries. As with ripe rot, mancozeb, captan, and QoI fungicides are recommended for bitter rot, and Topsin-M is also moderately effective.

Cultural practice is a very important component in disease management. Many of grape pathogens mentioned here require extensive wetness hours to cause successful infection, thus, it is critical to maintain good air circulation for your canopies. In addition, both pathogens can survive in woody tissues. Therefore, it would be a good idea to remove infected tissues from the vineyard, especially when you make a big cut of older canes or cordons. In addition, ripe rot and bitter pathogens can take an advantage of wounds for their infection, so, insect management (i.e., grape berry moth), bird management as well as early season powdery mildew management can reduce the risk of an outbreak.

Sour rot and other late season rots

In addition to Botrytis, ripe rot, and bitter rot, there are other late season rots such as sour rot that you need to be concerned. These rots are caused by *Aspergillus niger*, *Alternaria tenuis*, *Cladosporium herbarum*, *Rhizopus arrhizus*, *Penicillium sp.*, and others. These late season rots come in when fruit sugar content accumulates around 8%, and often times, white varieties with tight clusters such as Vignoles and Chardonnay, tend to get this disease more than other varieties because of the structure of the cluster which can hold water inside and also because of the fair skin.

The sour rot pathogens, including Botrytis, are opportunistic in nature, and the damage and the risk will increase if Botrytis rot is involved. Typically, Botrytis management needs to be done at

early in the season. Plus, the management of grape berry moth, wasps, and birds can lower the risk of infection by reducing the risk of crating wounds on berries.

The cultural practice plays a very important role on the late season rots management.

- Proper shoot positioning and canopy management will decrease the risk of Botrytis infection by lower humidity of the fruiting zone. Leaf removal around fruit set has been recommended for some varieties to increase the air movement around clusters.
- Leaf removal around veraison will help thickening of skins.
 - o Thus, some people perform leaf removal around fruit set to open up the eastern-side of canopy and do it again around veraison to open the western-side.
 - o However, it may also increase the risk of sun damages on the berries, thus, check to see if the leaf removal is a good tactic for your varieties.
- Bunch thinning can also be done at veraison to reduce the risk of having berries with high sugar lying around the vineyard to invite insect pests.

There are only a few options with the chemical management against late season rots, and none of them will provide a complete control.

- Botrytis materials such as Rovral, Elevate, Pristine, etc., and captan is often recommended.
- In addition, the use of a copper fungicide (Bordeaux mixture, etc.) has been recommended as a tank mix with a Botrytis material because in addition to its fungicidal activities, some study showed that copper helps grape berry skins to become thick.