Diseases of Grapes in Michigan

For help in diagnosing grape diseases, see "A pocket guide for grape IPM scouting in the north central and eastern US," MSU Extension bulletin E-2889; or the MSU grape web site: www.grapes.msu.edu. Additional information on disease management in grapes may be found in the "Midwest Small Fruit Pest Management Handbook," Ohio State University Extension Bulletin 861.

Powdery mildew – *Uncinula necator*

The powdery mildew fungus can infect all green tissues, resulting in a whitish gray, dusty, or powdery appearance. Powdery mildew colonies are mostly present on the upper leaf surface. Infections of young, expanding leaves can result in distortion or stunting. Early berry infections can result in splitting of berries, secondary rots, and undesirable flavors in wine. Late infections are largely invisible except for a web-like necrotic pattern on the berry surface, which can still predispose the berries to rots. Severe infections reduce vine growth, yield, fruit quality, and winter-hardiness. In late summer, the fungus produces small golden-brown to black fruiting bodies (cleistothecia) on infected plant parts. The cleistothecia overwinter in bark crevices of the vine and release wind-disseminated ascospores in the spring. Leaves in proximity of the bark tend to get infected first. Powdery mildew is favored by high humidity and moderately high temperatures (68 - 81º F). Temperatures above 95º F inhibit new infections. Begin monitoring for the disease early in the season, checking inside the canopy first.

***Non-chemical control options*:** Plant resistant or less susceptible cultivars create open canopies to reduce humidity build-up, plant rows in direction of prevailing wind.

Downy mildew – *Plasmopara viticola*

Downy mildew is caused by a fungal-like organism and can infect leaves as well as flower and fruit clusters. Initial leaf symptoms show up as light green or yellow spots. These are termed "oil spots" because of their sometimes greasy appearance. The lesions eventually turn brown as the infected tissue dies. On older leaves, lesions are typically smaller and more angular as they are delimited by leaf veins. Leaf infections may lead to premature defoliation, which can reduce winter hardiness in severe cases. Under warm, humid conditions (>98% humidity and >55°F) at night, white, fluffy sporulation develops on the lower surface of the leaf. White spore masses also develop on infected flower and fruit clusters. Infected clusters or berries eventually wither and die. The pathogen overwinters in leaves on the ground. Spores are spread to new leaves and clusters by wind and rain. A film of water is required for infection. Lesions appear within 5-17 days after infection. The disease can spread rapidly under warm conditions with frequent rain or dew. Use the 10-10-10 rule to decide when to first start scouting for downy mildew: 10 cm (4 in.) of shoot growth, 10 mm (0.4 in.) rainfall and temperatures of at least 10°C (50°F) during a 24-hour period. Monitor leaves close to the ground as well as in the top of the canopy.

***Non-chemical control options*:** Plant resistant or less susceptible cultivars; create open canopies to reduce humidity and leaf wetness; plant rows in direction of prevailing wind.

Black rot – *Guignardia bidwellii*

The black rot fungus can attack all new growth, including leaves, petioles, shoots, tendrils, and berries. On the leaves, light brown, roughly circular spots appear in the spring and summer. These can be distinguished from herbicide damage by the presence of a ring of small black fruiting bodies, visible with the naked eye or a hand lens. Even though peak fruit infection occurs around midbloom in 'Concord' grapes in Michigan, symptoms only become apparent weeks later. The first symptom of berry infection is a small whitish dot within a rapidly expanding brown area that sometimes contains distinct "growth rings." Within a few days, the berry starts to shrivel and becomes a hard, blue-black mummy. Berries actually become resistant to infection about 3 - 5 weeks after bloom. If berries are infected close to the time of natural resistance development, lesions remain localized. The fungus overwinters in fruit mummies within the vine or on the ground. Ascospores are released from shortly after bud break until about 2 weeks after bloom and are dispersed by wind and rain. Leaf spots and newly infected berries can also yield infectious conidia, which are rainsplash-dispersed. The optimum temperature for disease development is 80° F, at which the wetness period required for infection is only 6 hours. At higher or lower temperatures, the wetness requirement increases.

***Non-chemical control options*:** Plant resistant or less susceptible cultivars; prune out dead canes and fruit mummies; remove fruit mummies from ground; create open canopy to reduce humidity and leaf wetness; plant rows in direction of prevailing wind.

Botrytis bunch rot – *Botrytis cinerea*

This fungus can infect all green parts of the vine, though bunch rot tends to be the biggest problem. In early spring, buds and young shoots may be infected and turn brown. In late spring, V-shaped or irregular brown patches may appear on leaves. Inflorescences may also be blighted and wither away. Some flower infections can remain latent until veraison. From veraison onward, the fungus can infect grape berries directly through the epidermis or through wounds and may continue to invade the entire cluster. Compact clusters, powdery mildew infection, hail, and insect damage (e.g., grape berry moth), can predispose grapes to Botrytis infection. Infected white grapes turn brown and purple grapes become reddish. During dry weather, infected berries dry out; in wet weather, they tend to burst and become

covered with a grayish mold, which contains millions of spores. These spores are spread by wind to new infection sites. The disease spreads rapidly during moist periods, especially close to harvest. In certain cultivars, slow-developing, late-season infections are termed "noble rot" because they contribute to the production of exceptionally sweet wines. The fungus overwinters as mycelium or sclerotia (small black structures) in mummified fruit and other infected plant parts. The disease is favored by temperatures of 59-68ºF and free water or at least 90% humidity.

***Non-chemical control options*:** plant resistant or less susceptible cultivars; leaf removal around clusters to reduce humidity and wetness; training systems that help expose the fruit.

Phomopsis cane and leaf spot – *Phomopsis viticola*

This fungus can infect all green parts of the vine, but infections of the fruit clusters are economically most important. Infected leaf blades show small, irregular light green or yellow spots with dark centers and may be puckered. On petioles, shoots, and rachises, chlorotic spots with dark centers develop into elongated black streaks or blotches, which make the tissue brittle and prone to cracking or breakage. Most shoot lesions occur on the basal three to six internodes. Actively growing tissues are most susceptible to infection. Rachis and berry infections become apparent several weeks before harvest and continue to get worse over time. Rachis infections can lead to withering of the rachis, causing berries or sometimes entire clusters to drop prematurely. The fungus can also infect berries, either directly through the skin or through the berry stem. Infected berries turn brown and become soft and rubbery. Pycnidia may appear as numerous small, black specks on the berry surface, sometimes oozing cream-colored droplets of spores. The fungus overwinters in bark of infected canes. Bleached areas, sometimes delineated by black lines, on dormant canes are indicative of infection. In spring and early summer, conidia are rain-splash dispersed from pycnidia on the overwintered canes. Prolonged periods of rainy, cold weather in spring promote disease development. At least 6 hours of wetness are needed for infection at the optimum temperature (59 - 68º F). Flower clusters are susceptible to infection from the moment they are exposed until harvest. Symptoms may appear 21 - 30 days after infection. Monitor carefully within 3 - 6 weeks from bud break.

Non-chemical control options: Plant resistant or less susceptible cultivars, pruning out infected canes (especially older wood), create open canopy to reduce humidity and improve spray coverage of clusters; timely harvesting to reduce losses to fruit drop and fruit rot; avoid hedging or minimal pruning.

Eutypa dieback – *Eutypa lata*

Eutypa dieback is a progressive fungal disease of the woody tissues of the grapevine commonly found in older vineyards. The disease develops slowly and symptoms may not be visible for several years after infection. Shoot symptoms are best observed in mid- to late spring. Symptoms typically show up on one arm. The leaves are smaller than normal, cupped, and chlorotic. As the leaves expand, the edges become tattered. Chlorotic streaks may be present between veins and along margins. Shoots are stunted to varying degrees and have fewer and smaller fruit clusters, sometimes with a mixture of large and small berries. Eventually the affected arm or entire vine will fail to develop shoots and die. Upon close examination of the perennial wood bearing symptomatic shoots, a canker can usually be found surrounding an old pruning wound. Removal of the bark may be necessary to see the canker. When cut across, a wedge-shaped area of dead wood may be present. Shoot symptoms are thought to be induced by a toxin in the sap flowing from the canker. Most Eutypa infections occur through pruning wounds. Spores of the fungus are released from fruiting bodies in old cankers during late winter and early spring when temperatures are above freezing and rainfall of 1/25 inch or more has occurred. Moisture from melting snow may be sufficient.

***Non-chemical control options*:** Plant resistant or less susceptible cultivars; pruning out infected wood well below the discolored area; renewal of infected vines; removal and burning of dead wood from vineyard (vineyard sanitation).

Anthracnose – *Elsinoe ampelina*

Anthracnose is a fungal disease that sporadically occurs in Michigan. Table grape varieties are particularly susceptible. This fungal disease affects most above-ground parts of the vine, and actively growing plant parts are most susceptible. On leaves, numerous circular to angular, chocolate brown spots (1/25-1/5 inch in diameter) develop. The centers of older lesions become bleached and fall out, leaving a "shot hole" appearance. Lesions along the veins may cause curling and distortion as the leaves expand. On shoots, spots are oval, sunken, and purplish-brown spots with gray centers and raised edges and can blight entire shoot tips. On older wood, infections look like small craters with raised edges. On berries, purplish brown "bird's-eye" spots form. Depending on the cultivar and possibly the fungus, spots on berries can also look light gray with a dark edge. Lesions may cause berry cracking. The causal fungi overwinter in infected parts of the vine, and conidia are rain-splash dispersed in the spring. Anthracnose is especially severe in years with heavy rainfall early in the season. Start monitoring in the period 2 - 8 weeks from budburst.

***Non-chemical control options*:** Plant resistant or less susceptible cultivars; pruning out infected wood; create open canopy to reduce humidity and improve spray coverage.

Sour bunch rot – fungi, yeasts and bacteria

Sour bunch rot is caused by a variety of fungi, yeasts and acetic acid bacteria. Low-grade powdery mildew infections or grape berry moth or fruit fly infestations can predispose clusters to infection. Insects can also spread the sour rot organisms on their feet and mouthparts. Sour bunch rot is a wet rot which can spread rapidly throughout the cluster and cause the berries to smell like vinegar. Unlike with Botrytis bunch rot, mold is usually absent. Prolonged periods of wetness or high relative humidity are conducive to sour bunch rot development. Some cultivars are more susceptible than others.

***Non-chemical control options*:** Avoid wounding and insect infestations; create open canopy to reduce humidity.

Armillaria root rot – *Armillaria mellea*

Armillaria root rot is a fungal disease of grapevines and many other woody plants. While there are no reports (yet) of *Armillaria* infection of grapevines planted at old infected cherry or apple orchard sites, it is generally recommended to avoid infested orchard sites and recently cleared forests particularly if infected stumps and roots remain. Infected grapevines may wilt severely and die quickly. Or they may suffer from a slow decline, characterized by a lack of vigor, stunting, small dark-green foliage, and eventually death. Usually, a number of plants in varying states of decline will be present in pockets within the vineyard. The fungus produces striated white mycelial mats underneath the bark on the trunk or larger roots at or below the soil line. Infected tissues have a distinct mushroom-like odor when moist. Rhizomorphs, black fungus strands that look somewhat like roots, may be present on the outsides of the roots. During the fall, the fungus may produce clumps of golden brown mushrooms (honey mushrooms) with caps that are 2 - 11 inches in diameter. The more mushrooms in a clump, the smaller they are. The fungus moves from one plant to the next by root contact and tends to move down rows. The fungus can live a long time in old roots in the soil.

***Non-chemical control options*:** Don't plant in infested orchard/forest sites; remove old stumps including the roots.

Crown gall – *Agrobacterium vitis*

Crown gall is a bacterial disease that can be a serious problem in areas where climatic conditions favor freeze injury. It is particularly damaging to *Vitis vinifera* and interspecific hybrids. The major symptom is fleshy galls on the lower trunk near the soil line. Aerial galls may also form as high as 3 ft up the vine. Young vines may be completely girdled by galls in one season. Young galls are cream-colored and fleshy but turn brown and woody with age. Affected vines appear weak and portions of the vines above the galls may die. Crown gall is caused by the bacterium *Agrobacterium vitis*, which is a different strain from *A. tumefaciens,* the cause of crown gall on fruit trees and many other plants. The bacterium lives in the soil and enters the plants through wounds caused by mechanical damage, grafting, or freeze injury. The bacterium may also be present on the surface of planting material, which could explain sudden and severe outbreaks of crown gall in young vineyards after frost events. Contaminated pruning or grafting tools may contribute to spread. Removing galls usually does not cure the plant as new galls will continue to form. Sometimes, galls may be confused with abundant callus growth at graft unions. Isolation of the pathogen will be needed to confirm the cause of the galls in this case.

Non-chemical control options: Don't plant in previously infested sites; buy plants from reputable nursery (preferably in eastern United States); avoid wounding plants; cut out and remove galls as soon as possible; sterilize pruning shears with bleach between vines.

Ringspot virus decline – Tomato ringspot virus (TomRSV) or Tobacco ringspot virus (TRSV)

This virus disease occurs sporadically in *V. vinifera* cultivars and interspecific hybrids. *Vitis labrusca* cultivars resistant. A typical symptom in older vineyards is missing or dead vines in a roughly circular pattern. In the first year of infection, the disease is difficult to detect. A few shoots may show leaves with mottling or an oak leaf pattern. In the second year, the disease becomes more evident. New growth is generally sparse because many infected buds are prone to winterkill. Diagnostic symptoms are shortened internodes with small distorted leaves, and sparse fruit clusters with uneven ripening of berries. In the third year, growth is very stunted and limited to basal suckers. The vine continues to decline and eventually dies. The disease is caused by either of two nepoviruses (TomRSV and TRSV) which are transmitted by dagger nematodes (*Xiphinema* spp.). Both can also be transmitted via seed and cuttings. The nematode vectors retain the virus for long periods of time and can acquire it from roots of infected grape or weeds. TomRSV infects a wide range of fruit crops, whereas both TomRSV and TRSV both infect many common weeds in vineyards, including dandelions, sheep sorrel, common chickweed, and red clover. Because of this, is it not uncommon for these viruses to be present in land used to establish new vineyards.

***Non-chemical control options*:** Buy virus-tested planting stock; don't plant in previously infested sites; remove and destroy infected vines; including nearby healthy-looking vines, practice good weed control before planting; cultivate infested vineyards last to avoid moving soil.

Peach rosette mosaic virus decline – Peach rosette mosaic virus (PRMV)

This virus disease occurs on *V. labrusca* cultivars in Michigan. The cultivars Concord and Catawba are particularly susceptible, whereas Niagara and Delaware are resistant. The disease also affects peaches in Michigan and Ontario, Canada. Infected vines exhibit an

umbrella-like growth habit due to shortened and crooked internodes. Leaves are misshapen with a flattened basal sinus. Clusters are scraggly and may shell berries. Other disorders, such as boron deficiency and infection by grapevine fanleaf virus may mimic this disease. Infected grapevines generally lack vigor, are prone to winter injury, and may die after several years. Dead and dying vines are usually found in a slowly spreading, circular pattern. The disease is caused by peach rosette mosaic virus (PRMV), which is vectored by nematodes (*Xiphinema* and *Longidorus* spp.). Some perennial weeds, such as dandelion, Carolina horse nettle, and curly dock are hosts of PRMV, and can be a source of infection. The virus may also be introduced via infected planting stock or spreading grape pomace from fruit of infected plants. About 10% of grape seedlings grown from seed of infected vines have been shown to be infected. The disease spreads about 3 ft per year to new vines in a circular pattern. There is a 3- to 4-year latent period between infection and the first expression of symptoms.

***Non-chemical control options*:** buy virus-tested planting stock; don't plant in previously infested sites; or remove and destroy infected vines including nearby healthy-looking vines; cultivate infested vineyards last to avoid moving soil.

Nematodes – Root knot nematode, dagger nematode, lesion nematode, etc.

Nematodes are microscopic roundworms that live in the soil. Most nematodes are not harmful to plants and play an important role in nutrient cycling in the soil. However, plant-parasitic nematodes feed on plant roots and can cause direct damage to grapevine roots. In addition, some nematodes are important as vectors of certain viruses. Nematode damage can also predispose roots to fungal root rots. In newly established vineyards, nematodes may be responsible for poor establishment and weak growth of young vines, especially at sandy sites. Nematodes seldom kill vines, but cause a steady decline in vigor. Symptoms on above-ground plant parts are not very specific, e.g., poor growth, low yields, and "off" color. Infected plants are more susceptible to environmental and other stresses. Symptoms may also resemble certain nutrient deficiencies or virus diseases. Below-ground symptoms are poor root development, dark-colored root lesions, and stunting or death of feeder roots. Root knot nematodes characteristically cause small swellings (galls) of the young feeder roots or secondary roots. When the galls are opened, the glistening white bodies of female nematodes can often be seen with a hand lens.

Nematodes are spread via infected planting material or movement of soil on farm equipment and in run-off or irrigation water. Once established in a vineyard, nematode infestations tend to be permanent, so care must be taken to prevent new infestations. Nematode infestations can be confirmed by sending root and soil samples to a nematology lab.

***Non-chemical control options*:** don't plant in previously infested sites; cultivate infested vineyards last to avoid moving soil with nematodes; clean cultivating equipment.

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The rate of materials for use on grape is based on a standard of 200 gal/acre dilute spray. If you are concentrate spraying — (less than 200 gal of water/acre), use the rate/acre figures, regardless of the amount of water you are spraying/acre. To get sufficient spray coverage of fruit clusters within the canopy, it is recommended to use at least 50 GPA after bloom. Effectiveness of materials listed below is based primarily on trials using concentrate sprays of 50 GPA (water) on mature grape vines. After each pest appears a column of numbers and letters. These are provided to assist growers in choosing materials to use to control specific pests. The number refers to the pesticide in the column headed "Suggested Chemicals" and the letter is a rating of efficiency: e = excellent, g = good, f = fair and p = poor for the pesticide controlling the pest.

Products listed by the Organic Materials Review Institute (OMRI) for use in organic production will be marked with the following designation: ▲

BUD SWELL

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Phomopsis, Powdery Mildew, Black Rot	**14f-g***, **63f-g****	**14.** Sulfur [various formulations] (10 lb equivalent)* ▲ **63.** Lime sulfur (10 - 20 gal)**▲ or Sulforix (1 gal)**
Comments: **- Dormant fungicide applications kill fungi and insects that overwinter on the plants. A dormant application of sulfur or lime sulfur directly to the cordon will reduce inoculum of Phomopsis, powdery mildew, black rot, and mites. Liquid sulfur formulations tend to work better than powdered sulfur. Do not apply lime sulfur to green foliage. Do not apply any sulfur to leaves of sensitive cultivars, e.g., Concord. Make sure that label includes grapes.*		
INSECTS		**INSECTICIDES**
Grape Flea Beetle	**44e, 57f, 58g**	**32.** Lorsban 4 E (1 qt)*
Climbing Cutworms	**32e*, 44e, 65e**	**44.** Danitol 2.4 EC (10.6 oz) **57.** Pyganic EC 1.4 (16 - 32 oz) ▲ **58.** Evergreen EC 60-6 (8 - 16 oz) **65.** Capture 2 EC (3.2 oz)
Comments: **--This is a Special Local Needs (SLN) label, and growers must possess the SLN label at the time of application. Lorsban 4 E will not control flea beetles.*		

1- TO 5-INCH SHOOT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Phomopsis (cane, leaf, and rachis infection)	**50g, 51g, 54f-g, 59g-e**	**5.** Nova 40 WP (3 - 5 oz) **8.** Elite 45 DF (4 oz) **10.** Rubigan 1 EC (4 oz) **13.** Bayleton 50 WP (3 - 6 oz) **14.** Sulfur [various formulations] (labeled rates)* ▲ **50.** Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80 WDG (1.25 - 2.5 lb) **51.** Ziram 76 DF or Ziram Granuflo (3 - 4 lb) **54.** Procure 50 WP (4 - 6 oz) **59.** Dithane DF or Penncozeb 75 DF or Manzate 200 DF (1.5 lb)
Powdery Mildew	**5e, 8e, 10e, 13e, 14g*, 54e**	
Comments: *Review fungicide characteristics and restrictions in the section "Fungicides and Bactericides for Fruit Crops," pages 11-20. Also consider cultivar disease susceptibility and sulfur/copper sensitivity (Table 2, page 114) when making spray decisions.* ***Phomopsis:*** *Spores will be released during rain events from budbreak onwards. Start protecting flower clusters once they become visible (2 - 3 leaves expanded).* **Powdery mildew***: A powdery mildew spray may only be needed for highly susceptible varieties or problem areas (see Table 2, page 114).* **Black rot***: Sprays specifically for black rot at this time are not necessary. Instead, emphasize protection of the vines during the period of fruit susceptibility (immediately pre-bloom to 4-5 weeks post bloom for Concord and Niagara).*		***Comments:*** **-- Sulfur can provide good management of powdery mildew on sulfur-tolerant grapes (Table 2) but must be applied relatively frequently. Sulfur is much less active at temperatures below 65° F. Sulfur can cause injury even on tolerant varieties when temperatures are above 85° F. Do no apply within 14 - 21 days of an oil application. Sulfur has a detrimental effect on beneficial mites.*
INSECTS		**INSECTICIDES**
Grape Flea Beetle	See Bud Swell	
Climbing Cutworms	See Bud Swell	

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6- TO 12-INCH SHOOT

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Downy Mildew	**12e*, 15e*****, 16e*, 17g*, 21f-g, 50e**, 51g, 57e***, 58e***, 59e, 70e* ****	**5.** Nova 40 WP (3 - 5 oz) **8.** Elite 45 DF (4 oz) or Elite 45 WP (4 oz) **10.** Rubigan 1 EC (4 oz) **12.** Abound 2 F (11 - 15 oz)* **13.** Bayleton 50 WP (3 - 6 oz) **14.** Sulfur [various formulations] (labeled rates) ▲ **15.** Aliette WDG (3 - 5 lb)***** **16.** Sovran (3.2 - 5.6 oz)* **17.** Flint (1.5 - 4 oz)* **21.** ProPhyt (0.3% conc.) **32.** Quintec (3 - 4 fl oz)****** **50.** Captan 50 WP (4 lb)** or Captec 4 L (2 qt)** or Captan 80 WDG (1.25 - 2.5 lb)** **51.** Ziram 76 DF or Ziram Granuflo (3 - 4 lb) **54.** Procure 50 WP (4 - 6 oz) **57.** Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water)*** ▲ **58.** Fixed copper [various formulations] (labeled rates)*** ▲ **59.** Dithane DF or Penncozeb 75 DF or Manzate 200 DF (2 lb) **70.** Pristine (6 - 10.5 oz)* ****
Powdery Mildew	**5e, 8e, 10e, 12g-e*, 13e, 14g*, 16g*, 17e*, 32e******, 54e, 70e* ****	
Phomopsis (cane, leaf, and rachis infection)	**5f, 8f, 12e*, 16e*, 17e*, 21f, 50g**, 54f-g, 59g-e, 70e* ****	

Comments:

Downy mildew: *The downy mildew fungus becomes active at about 10 inches of shoot growth and infective spores are released during rainy periods if temperatures are above 50º F. A spray at this time may be important for highly susceptible varieties or if the disease was severe the previous year.*

Phomopsis*: Rachis infections are possible once the flower clusters become exposed. Rachis lesions do not become visible until 3 - 4 weeks after infection. Hedged and minimally pruned vineyards are most at risk of infection.*

Comments:

**--To limit the risk of resistance development, do not apply more than two consecutive applications of strobilurin fungicides.*

***--Captan applied here will give control of Phomopsis leaf and cane spot disease and downy mildew but is weak against black rot.*

****--Copper-sensitive varieties (see table 2) can be injured by copper. Even non-sensitive varieties can be harmed under slow drying, cooling conditions. Fixed copper formulations should not be used with Bayleton, Nova, Aliette, Guthion, Imidan, Sevin, or Thiodan.*

*****-- Do not use Pristine on Concord, Niagara, Worden, Fredonia, or related cultivars or injury may result. Do not apply more than 5 times.*

******--Do not tank-mix Aliette with copper compounds, surfactants, or foliar fertilizers. Apply on a 21-day schedule; do not apply more than 7 times per season.*

*******--Quintec may be applied at 21-day intervals when a higher rate (5 - 6.6 fl oz/acre) is used; however, this is not recommended.*

IMMEDIATE PRE-BLOOM

Pest	Efficiency
DISEASES	
Black Rot (fruit infection)	**5e, 8e, 10g, 12e*, 13e, 16e*, 17g*, 51g, 53g, 54g, 64g**, 70e* ******
Downy Mildew	**12e*, 15e, 16e*, 17g*, 21g, 50e, 51g, 57e, 58e, 59e, 70e* ******
Powdery Mildew	**5e, 8e, 10e, 12g*, 13e, 14g, 16g*, 17e*, 32e*****, 54e, 64f-g**, 66f-g***, 70e* ******
Phomopsis (rachis infection)	**5f, 8f, 12e*, 16e*, 17e*, 21f, 50g, 54f, 59g-e, 70e* ******

Comments:

Black rot*: Fruit protection against black rot should commence now and be continued until 5 - 6 weeks after bloom, at which time the berries become naturally resistant to infection by the black rot pathogen (some Vinifera cultivars may be susceptible for a few weeks longer). Infection risk increases with increasing leaf wetness and temperature (see Grape Black Rot table on page 109). Nova or Elite applied for black rot will also be highly effective against powdery mildew. Rubigan and Procure do not provide adequate control of black rot under moderate to high disease pressure. Tank mix with a mancozeb product if black rot control is needed.*

Downy mildew: *This is an important time to manage primary infections. Vineyards should be scouted for the disease throughout the summer, and the foliage should be protected based on weather conditions and presence of the disease.*

Powdery mildew: *If powdery mildew on the fruit was a problem in previous years, make sure to apply a spray of an effective fungicide now and maintain coverage of fruit clusters throughout fruit development period.*

Suggested Chemicals (Rate/acre)

FUNGICIDES

5. Nova 40 WP (3 - 5 oz)
8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz)
10. Rubigan 1 EC (4 oz)
12. Abound 2 F (11 - 15 oz)*
13. Bayleton 50 WP (3 - 6 oz)
14. Sulfur [various formulations] (labeled rates) ▲
15. Aliette WDG (3 - 5 lb)
16. Sovran (3.2 - 5.6 oz)*
17. Flint (1.5 - 4 oz)*
21. ProPhyt (0.3% conc.)
32. Quintec (3 - 4 fl oz)*****
50. Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80 WDG (1.25 - 2.5 lb)
51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb)
53. Ferbam Granuflo (4 lb)
54. Procure 50 WP (4 - 6 oz)
57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲
59. Dithane DF or Penncozeb 75 DF or Manzate 200 DF (2 lb)
64. Armicarb 100 (2.5 - 5 lb)**
66. JMS Stylet Oil (1 - 2% conc.)*** ▲
70. Pristine (6 - 10.5 oz)* ****

Comments

**--To limit the risk of resistance development, do not apply more than two consecutive and 3 - 4 total applications of strobilurin fungicides.*
***--Armicarb is a salt and kills fungi on contact. Apply in at least 50 gpa of water to get adequate coverage.*
****--JMS Stylet Oil will temporarily remove bloom on grapes. Stylet oil also helps to control mealybugs, mites, and leafhoppers. Do not tank mix Stylet Oil with spreaders-stickers, foliar fertilizers, or Captan. Do not apply sulfur with or following an oil application for 21 days. Do not apply oil for 14 days following a sulfur treatment.*
*****--Do not use Pristine on Concord, Niagara, Worden, Fredonia, or related cultivars or injury may result. Do not apply more than 5 times.*
******--Quintec may be applied at 21-day intervals when a higher rate (5 - 6.6 fl oz/acre) is used; however, this is not recommended.*

(Continued on next page)

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..IMMEDIATE PRE-BLOOM (continued)

INSECTS	
Grape Flea Beetle*	**8g, 9g, 11g, 23g, 44g**
Rose Chafer	**8g, 9g, 11f, 23g, 44e***, 53f****, 57, 58, 60e, 73**
Grape Berry Moth **	**48f**

Comments:

**Grape flea beetle larvae may feed in clusters and on leaves during bloom.*

*** The grape berry moth overwinters as a pupa and adult emergence begins at or before bloom. Pheromone traps are available to detect the presence and seasonal activity of these moths. Pheromone for mating disruption should be applied at the first adult emergence, according to the product label. Re-application may be necessary to cover all adult flights. Large acreage vineyards with relatively low populations are the most appropriate for mating disruption.*

****--Do not make more than one post-bloom application of Danitol.*

*****--Must maintain coverage for adequate performance.*

******--Newly manufactured Guthion no longer includes Grapes on the label. Existing Guthion stock with Grapes on the label is still legal for use but may be restricted by certain buyers.*

INSECTICIDES

8. Guthion 50 WP (1.5 - 2 lb)*****
9. Imidan 70 WP (2 lb)
11. Lannate 90 SP (.5 - 1 lb)
23. Sevin 50 WP (4 lb)
23. Sevin 80 S (2.5 lb)
23. Sevin XLR+ (2 qt)
44. Danitol 2.4 EC (10.6 oz)***
48. Grape berry moth mating disruption products ▲ *
53. Surround WP (25 lb)****
57. Pyganic EC 1.4 (16 - 32 oz) ▲
58. Evergreen EC 60-6 (8 - 16 oz)
60. Assail WSP (1.1 oz)
73. Baythroid 2 EC (1.4 - 2.8 oz)

POST-BLOOM

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Black Rot (fruit infection)	**5e, 8g, 10f-g, 12e, 13e***, 16e, 17e, 50e, 51g, 53g, 59e, 64g, 70e********	**3.** Rovral 50 WP (1.5 - 2 lb)* **5.** Nova 40 WP or DF (3 - 5 oz) **6.** Vangard 75 WG (10 oz)** **8.** Elite 45 DF (4 oz) or Elite 45 WP (4 oz) **10.** Rubigan 1 EC (4 oz) **12.** Abound (11 - 15 oz) **13.** Bayleton 50 WP (3 - 6 oz)*** **14.** Sulfur [various formulations] (labeled rates) ▲ **15.** Aliette WDG (3 - 5 lb) **16.** Sovran (3.2 - 5.6 oz)* **17.** Flint (1.5 - 4 oz)* **21.** ProPhyt (0.3% v/v) **27.** Endura (4.5 - 8 oz)******* **30.** Scala SC (18 fl oz; 9 fl oz in tank mixes)** **32.** Quintec (3 - 4 fl oz)******* **50.** Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80 WDG (1.25 - 2.5 lb) **51.** Ziram 76 DF or Ziram Granuflo (3 - 4 lb) **53.** Ferbam Granuflo (4 lb) **54.** Procure 50 WP (4 - 6 oz) **55.** Ridomil Gold MZ (2.5 lb)**** **57.** Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲ **58.** Fixed copper [various formulations] (labeled rates) ▲ **59.** Dithane DF or Penncozeb 75 DF or Manzate 200 DF (2 lb) **60.** Ridomil Gold/Copper (2 lb)**** **64.** Armicarb 100 (2.5 - 5 lb) **65.** Elevate 50 WDG (1 lb)***** **66.** JMS Stylet Oil (1 - 2% conc.) ▲ **70.** Pristine (6 - 10.5 oz)******
Phomopsis (rachis and fruit infection)	**5f, 8f, 12e, 16e, 17e, 21f, 50g, 54g, 59g-e, 70e********	
Powdery Mildew	**5e, 8e, 10g, 12g, 13e***, 14g, 16g, 17e, 27g-e*****, 32g-e*******, 54e, 58f, 64f-g, 65f*****, 66f-g, 70e********	
Downy Mildew	**12e, 15e, 16e, 17g, 21g, 50e, 51g, 53f, 55e****, 57e, 58e, 60e****, 59e, 70e********	
Botrytis Bunch Rot	**3g*, 6e**, 27g-e*******, 30e**, 65e*****, 70f********	

Comments:

Botrytis bunch rot: *A spray for Botrytis bunch rot at bloom is only warranted when conditions are extremely favorable (cool and wet) for disease development. The most important times for control of Botrytis bunch rot are at veraison and pre-harvest or when the disease is first spotted in the vineyard.*

Phomopsis: *Rachis infections can continue at least until bunch closing if inoculum is available and are responsible for berry drop before and at harvest. Berries become infected through the berry stem or directly through the skin. It is important to keep the developing fruit protected, particularly during wet weather. Thorough fungicide coverage of the clusters is essential for control, especially when using protectant fungicides. Increase spray volume or decrease tractor speed and spray every row middle after bloom to obtain sufficient coverage.*

Comments:

**--Add a non-ionic surfactant, e.g. Triton B-1956 or Triton CS-7 at 0.05% or 6 fl oz/100 gal water. Where resistant strains of Botrytis occur, Rovral may not provide adequate control.*

***--Do not make more than 2 applications of Vangard or Scala (36 fl oz max) per season.*

****--If black rot pressure is heavy, increase Bayleton rate to 6 oz/acre.*

*****--Both of these products have a 66-day pre-harvest interval (PHI). Ridomil Gold MZ provides some black rot control but no powdery mildew control. Ridomil Gold/Copper will not control black rot but provides some control of powdery mildew.*

******--Do not apply Elevate more than 3 times per season.*

*******--Do not use Pristine on Concord, Niagara, Worden, Fredonia, or related cultivars or injury may result. Do not use more than 5 times per season.*

********--Apply Endura at 4.5 oz/A for powdery mildew and 8 oz/A for Botrytis bunch rot control. Do not use more than 3 times per season.*

*********--Quintec may be applied at 21-day intervals when a higher rate (5 - 6.6 fl oz/acre) is used; however, this is not recommended. Do not apply more than 5 times per season.*

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POST-BLOOM (CONTINUED)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
INSECTS		**INSECTICIDES**
Grape Berry Moth	**5g, 8e, 9e, 11g, 23g, 43g, 44e**, 46g, 50e, 65e, 73, 75g**	**5.** Diazinon 50 WP (2 lb) **8.** Guthion 50 WP (1.5 - 2 lb)**** **9.** Imidan 70 WP (2 lb) **11.** Lannate 90 SP (0.5 - 1 lb) **23.** Sevin 50 WP (4 lb) **23.** Sevin 80 S (2.5 lb) **23.** Sevin XLR+ (2 qt) **26.** Thiodan 50 WP (2 lb)* **26.** Thiodan 3 EC (1.33 - 2 qt)* **43.** *Bacillus thuringiensis* (B.t.) [Dipel (1.5 lb)] ▲ [Deliver AC (0.5 - 2.0 lb)] **44.** Danitol 2.4 EC (10.6 oz)** **46.** SpinTor 2 SC (6 oz) **50.** Intrepid 2 F (8 - 12 oz) **53.** Surround WP (25 lb)*** **57.** Pyganic EC 1.4 (16 - 32 oz) ▲ **58.** Evergreen EC 60-6 (8 - 16 oz) **60.** Assail WSP (1.1 oz) **65.** Capture 2 EC (3.2 oz) **73**. Baythroid 2 EC (1.4 - 2.8 oz) **75**. Venom 20 SG (0.44 - 0.66 oz)
Rose Chafer	**see immediate pre-bloom**	
Grape Phylloxera	**26e*, 44**	
Comments: **--Do not use Thiodan 3 EC formulation on Concord grapes to prevent severe injury. Check labels for other variety restrictions.* ***--Do not make more than one post-bloom application of Danitol.* ****--Must maintain coverage for adequate performance.* *****--Newly manufactured Guthion no longer includes grapes on the label. Existing Guthion stock with grapes on the label is still legal for use but may be restricted by certain buyers.*		

FIRST COVER (PEA-SIZED BERRIES)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Black Rot	See Bloom	***Comments:*** *The time interval between the last spray and harvest for EBDC fungicides and Ridomil Gold MZ is 66 days. The PHI for Ridomil Gold/Copper is 42 days.*
Downy Mildew		
Powdery Mildew		
Phomopsis (rachis and fruit infection)		
INSECTS		**INSECTICIDES**
Grape Berry Moth	See Bloom	**5.** Diazinon 50 WP (2 lb) **8.** Guthion 50 WP (1.5 - 2 lb)* **9.** Imidan 70 WP (2 lb) **11.** Lannate 90 SP (0.5 - 1 lb) **19.** Provado SoluPak (0.75 - 1 oz)** **23.** Sevin 50 WP (4 lb) **23.** Sevin 80 S (2 lb) **44.** Danitol 2.4 EC (5.3 - 10.8 oz)*** **45.** Nexter 75 WSB (7.0 - 10.67 oz) **53.** Surround WP (25 lb)**** ▲ **57.** Pyganic EC 1.4 (16 - 32 oz) ▲ **58.** Evergreen EC 60-6 (8 - 16 oz) **60.** Assail WSP (1.1 oz) **65.** Capture 2 EC (3.2 oz)
Grape Leafhopper	**5f, 8f*, 9f, 11g, 19e**, 23g, 44e***, 45g, 53f****, 57, 58, 60e, 65e**	
Potato Leafhopper	**5g, 8g*, 9g, 11g, 19g**, 23g, 44g***, 60g**	
Rose Chafer	**8g*, 9g, 11f, 23g, 44e***, 57f, 58g, 60e**	
Comments: *Pheromone traps are available for monitoring berry moth abundance and helping to time insecticide applications in vineyards.*		***Comments:*** **--Guthion is restricted to three applications per year.* ***--Do not apply more than 2.0 oz of Provado per acre per year.* ****--Do not make more than one post-bloom application of Danitol.* *****--Must maintain coverage for adequate performance.*

SECOND COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Black Rot	See Bloom	***Comments:*** *The time interval between the last spray and harvest for EBDC fungicides and Ridomil Gold MZ is 66 days. The PHI for Ridomil Gold/Copper is 42 days.*
Downy Mildew		
Powdery Mildew		
Phomopsis		
Comments: ***Botrytis bunch rot:*** *Applications for Botrytis bunch rot are usually recommended at bloom, bunch closing, veraison, and pre-harvest. The most important application times are veraison and pre-harvest; however, during a wet season, sprays at bloom and bunch closing may also be beneficial, particularly for tight -clustered varieties.*		
INSECTS		
Grape Berry Moth	See Bloom	
Grape Phylloxera	See Bloom	
Grape Leafhopper	See First Cover	
Rose Chafer	See First Cover	

THIRD COVER (BUNCH CLOSING)

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot	See Bloom	
Downy Mildew		
Powdery Mildew		
Phomopsis		
Botrytis Bunch Rot		
Comments: ***Black rot****: The berries of most grape cultivars, including Concord and Niagara, become naturally resistant at 5 - 6 weeks after bloom. Sprays for black rot may only be needed at this time for certain Vinifera varieties and hybrids that remain susceptible until veraison.* ***Phomopsis****: The risk of infection is much reduced at this time because much of the inoculum likely has been exhausted, especially in years with rainy springs.* ***Downy mildew****: Keep monitoring for symptoms. The disease tends to show up later in the season, especially in 'Niagara.' At this time, the berries have become naturally resistant to infection, however, the rachis may still be susceptible.* ***Botrytis bunch rot:*** *Applications for Botrytis bunch rot are usually recommended at bloom, bunch closing, veraison, and pre-harvest. The most important application times are veraison and pre-harvest; however, during a wet season, sprays at bloom and bunch closing may also be beneficial, particularly for tight-clustered varieties.*		***Comments:*** *The time interval between the last spray and harvest for EBDC fungicides and Ridomil Gold MZ is 66 days. The PHI for Ridomil Gold/Copper is 42 days.*

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THIRD COVER (BUNCH CLOSING) CONTINUED

INSECTS	
Grape Berry Moth	See Bloom
Grape Leafhopper	See First Cover
Twospotted Spider Mites	**10f, 28g, 41g, 44g, 45f, 61g, 63e, 65g, 74e, 78f**
Japanese Beetle	**9g, 23g, 44g, 53f*, 57f, 58g, 60g, 65g**

INSECTICIDES

9. Imidan 70 W (2 lb)
10. Kelthane 35 WP (1.5 - 3.5 lb)
23. Sevin 50 WP (4 lb)
23. Sevin 80 S (2.5 lb)
23. Sevin XLR+ (2 qt)
28. Vendex 50 WP (1 - 2.5 lb)
41. Agri-Mek 0.15 EC (8 - 16 oz) plus non-ionic surfactant
44. Danitol 2.4 EC (10.6 oz)
45. Nexter 75 WDG (5.2 - 10.67 oz)
53. Surround WP (25 lb)* ▲
57. Pyganic EC 1.4 (16 - 32 oz) ▲
58. Evergreen EC 60-6 (8 - 16 oz)
60. Assail WSP (1.1 oz)
61. Acramite 50 W (0.75 - 1 lb)
63. Zeal 72 WP (2 - 3 oz)
65. Capture 2 EC (3.2 oz) (6.4 oz for mites)
73. Baythroid 2 EC (1.4 - 2.8 oz)
74. Envidor 2 SC (16 - 18 oz)
78. FujiMite 5 EC (2 pt)

Comments:

**--Must maintain coverage for adequate performance*

FOURTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		
Black Rot (fruit infection)	See Bloom	
Downy Mildew		
Powdery Mildew		

Comments:

Black rot: *Sprays may only be needed at this time for certain Vinifera varieties and hybrids that remain susceptible until veraison.*

Downy mildew*: Keep monitoring for symptoms. The disease tends to show up later in the season, especially in 'Niagara.' At this time the berries have become naturally resistant to infection.*

Botrytis bunch rot: *Applications for Botrytis bunch rot are usually recommended at bloom, bunch closing, veraison, and pre-harvest. The most important application times are veraison and pre-harvest; however, during a wet season, sprays at bloom and bunch closing may also be beneficial, particularly for tight-clustered varieties.*

Comments:
The time interval between the last spray and harvest for EBDC fungicides and Ridomil Gold MZ is 66 days. The PHI for Ridomil Gold/Copper is 42 days.

INSECTS/MITES		INSECTICIDES
Grape Berry Moth	**5g, 8e, 9e, 11e, 23g, 43g, 44e**, 46g, 50e, 65e, 75g**	**5.** Diazinon 50 WP (2 lb) **8.** Guthion 50 WP (1.5 - 2 lb)**** **9.** Imidan 70 WP (2 lb) **11.** Lannate 90 SP (0.5 - 1 lb) **19.** Provado SoluPak (0.75 - 1 oz)** **23.** Sevin 50 WP (4 lb) **23.** Sevin 80 S (2.5 lb) **23.** Sevin XLR+ (2 qt) **43.** *Bacillus thuringiensis* (B.t.) [Dipel (1.5 lb)] ▲ [Deliver AC (0.5 - 2 lb)] **44.** Danitol 2.4 EC (10.6 oz)** **45.** Nexter 75 WDG (5.2 - 10.67 oz) **46.** SpinTor 2 SC (6 oz) **50.** Intrepid 2 F (8 - 12 oz) **53.** Surround WP (25 lb)*** **57.** Pyganic EC 1.4 (16 - 32 oz) ▲ **58.** Evergreen EC 60-6 (8 - 16 oz) **60.** Assail WSP (1.1 oz) **65.** Capture 2 EC (3.2 oz) **75.** Venom 20 SG (0.44 - 0.66 oz)
Grape Leafhopper	**5f, 8f*, 9f, 11g, 19e**, 23g, 44e***, 45g, 53f****, 57, 58, 60e, 65e, 75g**	
Japanese Beetle	**9g, 23g, 44g, 53f*, 57f, 58g, 60g, 65g**	
Twospotted Spider Mite	**See third cover**	

Comments:
The third week of July is a key time to scout high risk vineyards for ***grape berry moth*** *and* ***grape leafhopper*** *and to make decisions on their control. Labrusca vines are naturally resistant to feeding by Japanese beetles, and can withstand some leaf area loss without affecting vine growth or fruit quality. Hybrid and Vinifera vines are at greater risk from Japanese beetle defoliation.*

**--Do not use Thiodan 3 EC formulation on Concord grapes to prevent severe injury. Check labels for other variety restrictions.*
***--Do not make more than one post-bloom application of Danitol.*
****--Must maintain coverage for adequate performance.*
*****--Newly manufactured Guthion no longer includes grapes on the label. Existing Guthion stock with grapes on the label is still legal for use but may be restricted by certain buyers.*

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FIFTH COVER

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Black Rot (fruit infection)	See Bloom	
Powdery Mildew		
Downy Mildew		
Comments: ***Powdery mildew:*** *On 'Concord' grapes, late-season foliar infections may not significantly affect yield or fruit quality.* **Downy mildew:** *On susceptible varieties, downy mildew has the potential for explosive spread during mid- to late summer under the proper conditions (moderate temperatures and wet). The need for a spray here should be based on the weather conditions and the presence of the disease as determined by scouting.*		***Comments:*** *Sulfur should not be sprayed on wine grapes less than a month from harvest, since it may interfere with the wine-making process.* *The PHI for Ridomil Gold/Copper is 42 days.*
INSECTS		**INSECTICIDES**
Japanese Beetle	See Third Cover	
Grape Berry Moth	See Bloom	

SIXTH COVER (VERAISON)

Pest	Efficiency
DISEASES	
Black Rot (fruit infection)	**5e, 8g, 10f-g, 12g, 13e, 16e, 17g, 50e, 51g**, 64g, 70e*******
Powdery Mildew	**5e, 8e, 10e, 12g, 13e, 14g*,16g, 27e****, 32g-e******, 51f**, 54e, 64f-g, 66f-g, 70e*******
Downy mildew	**12e, 15e, 16e, 17g, 21g, 50e, 51g**, 57e, 58e, 70e*******
Botrytis Bunch Rot	**3g***, 6e*****, **27g-e****, 30e***, 65e****, 70f*******

Comments:

Powdery mildew: *On highly susceptible varieties, additional sprays may be needed between veraison and harvest.*

Downy mildew: *The need for a spray here should be based on the weather conditions and the presence of the disease as determined by scouting. Additional sprays may be needed after veraison to prevent premature defoliation of vines. Premature defoliation may reduce fruit quality and winterhardiness.*

Botrytis bunch rot: *Veraison is an important timing for Botrytis bunch rot control, especially in susceptible cultivars.*

Suggested Chemicals (Rate/acre)

FUNGICIDES

3. Rovral 50 WP (1.5 - 2 lb)***
5. Nova 40 WP or DF (3 - 5 oz)
6. Vangard 75 WG (10 oz)***
8. Elite 45 DF (4 oz) or Elite 45 WP (4 oz)
10. Rubigan 1 EC (4 oz)
12. Abound (11 - 15 oz)
13. Bayleton 50 WP (3 - 6 oz)
14. Sulfur [various formulations] (labeled rates)* ▲
15. Aliette WDG (3 - 5 lb)
16. Sovran (3.2 - 5.6 oz)
17. Flint (1.5 - 4 oz)
21. ProPhyt (0.3% v/v)
27. Endura (4.5 - 8 oz)****
30. Scala SC (18 fl oz; 9 fl oz in tank mixes)***
32. Quintec (3 - 4 fl oz)******
50. Captan 50 WP (4 lb) or Captec 4 L (2 qt) or Captan 80 WDG (1.25 - 2.5 lb)
51. Ziram 76 DF or Ziram Granuflo (3 - 4 lb)**
54. Procure 50 W (4 - 6 oz)
57. Bordeaux mixture (6 lb copper sulfate and 6 lb hydrated lime per 100 gal water) ▲
58. Fixed copper [various formulations] (labeled rates) ▲
64. Armicarb 100 (2.5 - 5 lb)
65. Elevate 50 WDG (1 lb)****
66. JMS Stylet Oil (1 - 2% conc.) ▲
70. Pristine (6 - 10.5 oz)*****

Comments:

**--Sulfur should not be sprayed less than a month from harvest, since it may interfere with the wine-making process.*
***--Do not apply Ziram later than 21 days to harvest.*
****--Do not make more than 4 applications of Rovral (1 on table grapes) or 2 applications of Vangard or Scala (36 fl oz max) per season.*
*****--Do not make more than 3 applications of Elevate or Endura per season. Apply Endura at 4.5 oz/A for powdery mildew and 8 oz/A for Botrytis bunch rot control.*
******--Do not use Pristine on Concord, Niagara, Worden, Fredonia, or related cultivars or injury may result. Do not use more than 5 times.*
*******--Quintec may be applied at 21-day intervals when a higher rate (5 - 6.6 fl oz/acre) is used; however, this is not recommended. Do not apply more than 5 times per season.*

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SIXTH COVER (VERAISON) CONTINUED

INSECTS		INSECTICIDES
Grape Berry Moth *	**8e, 9e, 11g, 23f/g, 43f/g, 44e, 46g, 50g, 65e**	**8.** Guthion 50 WP (1.5 - 2 lb)** **9.** Imidan 70 WP (1.5 lb) **11.** Lannate 90 SP (0.5 - 1 lb) **23.** Sevin 50 WP (4 lb) **23.** Sevin 80 S (2.5 lb) **23.** Sevin XLR+ (2 qt) **43.** *Bacillus thuringiensis* (B.t.) [Dipel (1.5 lb)] ▲ [Deliver AC (0.5 - 2.0 lb)] **44.** Danitol 2.4 EC (10.6 oz) **46.** SpinTor 2 SC (6 oz) **50.** Intrepid 2 F (8 - 12 oz) **65.** Capture 2 EC (3.2 oz)
Comments: ** Required only if vineyard scouting indicates grape berry moth is present. High risk vineyards should be checked for infestation at this time. Increase spray volume to cover clusters for berry moth sprays.* ***--Newly manufactured Guthion no longer includes grapes on the label. Existing Guthion stock with grapes on the label is still legal for use but may be restricted by certain buyers.*		

PRE-HARVEST

Pest	Efficiency	Suggested Chemicals (Rate/acre)
DISEASES		**FUNGICIDES**
Botrytis Bunch Rot	**3g*, 6e,* 27g-e**, 30e*, 65e*****	**3.** Rovral 50 WP (1.5 - 2 lb)* **6.** Vangard 75 WG (10 oz)* **27.** Endura (8 oz)** **30.** Scala SC (18 fl oz; 9 fl oz in tank mixes)* **65.** Elevate 50 WDG (1 lb)***
		Comments: **--Rovral, Vangard, and Scala have a 7-day PHI Do not make more than 4 applications of Rovral (1 on table grapes) or 2 applications of Vangard or Scala (36 fl oz max.) per season.* ***--Endura has a 14-day PHI. Do not apply more than 3 times per season.* ****--Elevate has a 0-day PHI. Do not apply more than 3 times per season.*

Table 1. Relative effectiveness of fungicides for grape disease control in Michigan.

Fungicide	Black Rot	Downy Mildew	Powdery Mildew	Botrytis Rot	Phomopsis
Abound (azoxystrobin)	+++	+++	++	+	+++
Agri-Fos	?	++ / +++	+	?	++ / +++
Aliette (fosetyl-AL)	?	+++	?	?	?
Armicarb (potassium bicarbonate)	++	0	+ / ++	+	+
Basic Copper Sulfate (copper)	+	+++	++	+	+
Bayleton (triadimefon)	+++	0	+++	0	+
Captan (captan)	++	+++	0	+	++
Ferbam (ferbam)	++	+	0	0	0
Copper hydroxide (copper)	+	++	+	+	+
EBDCs (mancozeb)	+++	+++	+/++	0	++/+++
Elevate	0	0	0	+++	0
Elite (tebuconazole)	+++	0	+++	0	++
Endura (boscalid)	?	?	++	+++	?
Flint (trifloxystrobin)	+++	++	+++	+	+++
JMS Stylet Oil (paraffinic oil)	0	0	++	+	0
Kaligreen (potassium bicarbonate)	++	?	+ / ++	?	?
Lime sulfur (calcium polysulfide)	0	0	+	0	++
Messenger (harpin)	?	?	++	+	+
Nova (myclobutanil)	+++	0	+++	0	++
Oxidate (hydrogen peroxide)	?	?	+	+	?
Phostrol	?	++ / +++	+	?	++ / +++
Pristine (pyraclostrobin + boscalid)	+++	+++	+++	++	+++
Procure (triflumizole)	++	0	+++	+	++
Prophyt (potassium phosphite)	+ / ++	++ / +++	+	?	++ / +++
Quintec (quinoxifen)	+ / ++	?	+++	?	?
Ridomil Gold MZ (mefenoxam + mancozeb)	++	+++*	0	0	++
Ridomil Gold/Copper (mefenoxam + copper)	+	+++	++	+	+
Rubigan (fenarimol)	++	0	+++	0	0
Rovral (iprodione)	+	0	0	++	?
Scala (pyrimethanil)	+	?	++	+++	+ / ++
Serenade (*Bacillus subtilis*)	?	+ / ++	++	+ / ++	+ / ++
Sulfur (elemental sulfur)	0	0	++	0	+
Sovran (kresoxim methyl)	+++	+++	++	+	+++
Topsin M (thiophanate methyl)	++	0	+++**	++	+
Vangard (cyprodinil)	?	?	+	+++	+
Ziram (ziram)	++	++	+	+	++

0 = not effective, + = slightly effective, ++ = moderately effective, +++ = highly effective, ? = effectiveness not known.
Ratings are based on published information and modified based on observations in Michigan vineyards.

*Ridomil also has eradicative properties.

**If benzimidazole-resistant strains are present, efficacy will be reduced.

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Table 2. Relative susceptibility to disease and sulfur and copper sensitivity of grape varieties. (The ratings[1] apply to an average growing season under conditions favorable for disease development. Any given cultivar may be more severely affected).

	Black Rot	Downy Mildew	Powdery Mildew	Phom-opsis	Botrytis	Anthrac-nose	Eutypa	Crown gall	Sulfur Sensitive[3]	Copper Sensitive[4]
Aurore	+++	++[2]	+++	++	+++	?	+++	++	No	++
Baco Noir	+++	+	++	+	++	?	++	++	No	?
Cabernet Franc	+++	+++	+++	?	+	?	?	+++	No	+
Cabernet Sauvignon	+++	+++	+++	+++	+	?	+++	+++	No	+
Canadice	+++	++	+	?	++	+	?	++	No	?
Cascade	+	+	++	++	+	?	++	+	No	?
Catawba	+++	+++	++	+++	+	?	+	+	No	++
Cayuga White	+	++	+	+	+	?	+	++	No	+
Chambourcin	+++	++	+	?	++	?	?	++	Yes	?
Chancellor	+	+++	+++	+++	+	?	+	++	Yes	+++
Chardonnel	++	++	+++	++	++	?	?	++	No	?
Chardonnay	+++	+++	+++	+++	+++	?	++	+++	No	+
Chelois	+	+	+++	+++	+++	?	+++	++	No	+
Concord	+++	+	++	+++	+	+	+++	+	Yes	+
DeChaunac	+	++	++	+++	+	?	+++	++	Yes	+
Delaware	++	+++[2]	++	+++	+	?	+	+	No	+
Dutchess	+++	++	++	++	+	?	+	++	No	?
Elvira	+	++	++	+	+++	?	+	+	No	++
Einset Seedless	+++	+++	++	?	+	?	?	+	?	?
Foch	++	+	++	?	+	?	+++	+	Yes	?
Fredonia	++	+++	++	++	+	?	?	+	No	?
Gewürtztraminer	+++	+++	+++	?	+++	?	?	+++	No	+
Himrod	++	+	++	?	+	?	?	?	No	?
Ives	+	+++	+	?	+	?	++	+	Yes	?
Limberger	+++	+++	+++	?	+	?	+++	+++	No	?
Marechal Foch	++	+	++	?	+	?	+++	?	Yes	?
Marquis	?	+++	?	+	?	+++	?	?	?	?
Mars	?	+++	?	+	?	+++	?	?	?	?
Melody	+++	++	+	?	+	?	?	+	No	?
Merlot	++	+++	+++	+	++	?	+++	+++	No	++
Moore's Diamond	+++	+	+++	?	++	?	++	?	No	?
Muscat Ottonel	+++	+++	+++	?	++	?	+++	+++	No	?
Niagara	+++	+++	++	+++	+	++	+	++	No	+
Pinot gris	+++	+++	+++	?	++	?	+++	+++	No	?
Pinot Meunier	+++	+++	+++	?	+++	?	+++	+++	No	?
Pinot blanc	+++	+++	+++	?	++	?	?	+++	No	+
Pinot noir	+++	+++	+++	?	+++	?	?	+++	No	+
Reliance	+++	+++	++	++	+	?	?	?	No	+
Riesling	+++	+++	+++	++	+++	?	++	+++	No	+
Rosette	++	++	+++	++	+	?	++	++	No	+++
Rougeon	++	+++	+++	+++	++	?	+	++	Yes	+++
Sauvignon blanc	+++	+++	+++	?	+++	?	?	+++	No	+
Seyval	++	++	+++	++	+++	?	+	++	No	+
Steuben	++	+	+	?	+	?	?	+	No	?
Vanessa	+++	++	++	+	+	+	?	+	?	?
Ventura	++	++	++	+	+	?	?	++	No	?
Verdelet	+	?	?	?	+	?	?	?	No	?
Vidal 256	+	++	+++	+	+	?	+	++	No	+
Vignoles	+	++	+++	+++	+++	?	++	++	No	?
Villard noir	?	+	+++	?	+	?	?	?	?	?

[1]+ = slightly susceptible or sensitive, ++ = moderately susceptible or sensitive, +++ = very susceptible or sensitive. ? = relative susceptibility not established.
[2]Berries are not susceptible.
[3]Sulfur injury can occur on tolerant varieties when temperatures of 85° or higher occur during or immediately after application.
[4]Copper applied under cool, slow-drying conditions is likely to cause injury.
Most of the data in this table were obtained from the New York Cooperative Extension Service.

Dormant fungicide applications

Dormant sprays are typically applied in the fall or spring when no green tissue is present on plants. The purpose of dormant sprays is to eradicate pathogens and insects that are overwintering on the plant. Lime sulfur (a mixture of calcium polysulfides formed by boiling slaked lime with sulfur) has long been used as a dormant spray in tree fruit and brambles. Copper formulations are also used, particularly for control of bacterial diseases. These products kill mainly through direct contact, so applications must be applied with maximum coverage. Lime sulfur, while effective, is smelly and corrosive to farm equipment. While lime sulfur used to be relatively inexpensive, the price has gone up significantly in recent years.

In Michigan, several years of trials with dormant sprays in grapes, including less expensive products like sulfur and copper, have shown promise for reducing Phomopsis and other diseases. In general, liquid sulfur was equivalent to lime sulfur and tended to be better than powdered sulfur. Copper products also performed well. Reductions in black rot, downy mildew and powdery mildew were also observed. Indications are that spring applications perform somewhat better than fall applications, and that applications should be made as close to budbreak as possible.

It is important to note that Concord foliage is sulfur sensitive (Table 2). While we have not seen any phytotoxicity in our trials, the product can potentially be redistributed to newly emerging leaves. Niagara is not sulfur sensitive. Both cultivars are considered slightly sensitive to copper. When choosing a product, make sure that it is labeled for use on grapes.

Do not use dormant sprays as a stand-alone measure of disease control. Research suggests that when a dormant spray is included, it may be possible to reduce seasonal sprays. However, more research is needed to confirm this.

Phosphorous acid fungicides

Recently, a number of new fungicides that have phosphorous acid as the active ingredient have come on the market. Other names that you might hear for this group are “phosphonates” or “phosphites.” Examples are ProPhyt, Phostrol and Agri-Fos, all of which are labeled for grapes. An older fungicide, Aliette (fosetyl-Al), is the prototype for this group of fungicides. However, the long-standing patent on Aliette had prevented similar fungicides from being developed up to recently. In Australia, where the patent did not apply, growers have been using these types of fungicides for over a decade.

The term “phosphorous acid” should not be confused with phosphoric acid or phosphorus (P), a fertilizer component. In fertilizers, P is normally found in the form of phosphoric acid (H_3PO_4), which readily disassociates to release hydrogen phosphate (HPO_4^{2}) and dihydrogen phosphate ($H_2PO_4^{-}$). Both of these ions may be taken up by the plant and are mobile once inside the plant. Phosphorous acid is H_3PO_3 and releases the phosphonate ion (HPO_3^{2-}; also called phosphite) upon disassociation. Phosphonate is easily taken up and translocated inside the plant. Phosphorous acid does not get converted into phosphate, which is the primary source of P for plants. Because phosphorous acid and its derivatives do not get metabolized in plants, they are fairly stable and probably contribute little or nothing to P nutritional needs of the plants. Some researchers have investigated the ability of phosphorous acid to act as a nutrient source for plant growth and found that P-deficiency symptoms developed with phosphorous acid as the sole source of P. This means that although phosphorous acid can control diseases it is not a substitute for P fertilization. The inverse is also true: phosphate is an excellent source of P for plant growth, but is unable to control diseases other than improving the general health of the crop. So applying high amounts of P fertilizer will not work as a disease control measure. The phosponate ion is highly systemic and fairly stable in plants and has good rainfastness.

Phosphorous acid fungicides are especially effective against Oomycete pathogens, such as downy mildew, and have protective as well as curative activity. In general, they have less protective activity than Ridomil and the strobilurins. In fungicide trials in Michigan, ProPhyt had good efficacy against downy mildew and Phomopsis, moderate efficacy against, and poor efficacy against powdery mildew in grapes.

Phosphorous acid fungicides are relatively safe and can be used up to and including the day of harvest (0-day PHI). They have a 4-hour re-entry interval. This also means they can be applied to control late-season downy mildew outbreaks where before there were few options. There is a risk of crop injury, especially when mixing with certain surfactants, foliar fertilizers, and pesticides. Burn potential higher when temperature is > 90ºF or shortly after a rain event. Due to varietal sensitivity, it is recommended that a test for sensitivity is performed before use. Also, do not apply to plants under stress (e.g., drought stress), since that may increase the potential for injury.

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Table 3. Approximate number of hours of wetting required for foliar and fruit infection by the grape black rot fungus (*Guignardia bidwellii*) at different temperatures.

Average Temperature (^{o}F)	Hours of Wetness
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

Source: R.A. Spotts, Ohio State University. Data represent a compilation from several experiments with Concord, Catawba, Aurora and Baco Noir.

Effectiveness of Insecticides and Miticides in Controlling Arthropod Pests of Grapes

(Note that a product's effectiveness rating on a pest does not necessarily indicate that it is labeled for that use.)

Ratings of control are **E** = excellent, **G** = good, **F** = fair, **P** = poor Ratings against beneficials are **T** = highly toxic, **M** = moderately toxic, **S** = relatively safe		Diazinon	Guthion	Imidan	Kelthane	Lannate	Provado	Sevin	Thiodan	Vendex	Lorsban	Agri-Mek	B.t.'s ◄	Danitol	Nexter	Spintor	Mating disruption	Intrepid	Surround ◄	Assail	Pyganic ◄	Evergreen	Acramite	Zeal	Baythroid	Envidor	Venom	FujiMite	Oberon
	Insect / Mite	**Life Stage**	**5**	**8**	**9**	**10**	**11**	**19**	**23**	**26**	**28**	**32**	**41**	**43**	**44**	**45**	**46**	**48**	**50**	**53**	**56**	**57**	**58**	**61**	**63**	**73**	**74**	**75**	**78**	**79**
Pests	Grape Flea Beetle	Adult		G	G		G		G						E							F	G			G				
	Climbing Cutworm	Larva										E			E											E				
	Grape Berry Moth	Egg/Larva	G	E	E		G		E					G	E		G	F	G							G		G		
	Rose Chafer	Adult		G	G		F	G	E						E					F	E	F	G			E				
	Grape Phylloxera	Aerial forms								E																				
	Grape Leafhopper	Larva/Adult	F	F	F		G	E	G						E	G				F	E					E		E	G	
	Potato Leafhopper	Larva/Adult	G	G	G		G	G	G						G						G					G		E		
	Japanese Beetle	Adult	F	G	G		F	G	G						G					F	G	F	G			G				
	Mites	Motile				G					G		G		G	G								G	G		E		F	G
Beneficials	Bees		T	T	T	N	T	T	T	M	S	T	T	S	T	M	M	S	S	S	M	S	M	M	S	T	S	T	M	S
	Predator Mites		M	S	S	M	T	S	T	M	S	S	S	S	T	M	S	S	S	M	S	S	S	S	S	T	S	S	M	
	Insect Predators		T	M	M	N	T	M	T	M	S	S	S	S	T	M	M	S	S	M	M	S	S	S	S	T	S	M	M	