Plant Pathology Series No. 147 February 2018

Developing An Effective Fungicide Spray Program for Grapes in Ohio — 2018 —

Melanie L. Lewis Ivey and Rachel Medina
Fruit Pathology Program
Department of Plant Pathology
The Ohio State University-Wooster Campus
Wooster, OH

Revised January 2018

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Table of Contents

General Comments

1. **All spray programs should be designed to enhance an integrated disease management program.** Very rarely do chemicals alone prevent or slow disease to a level that minimizes economic losses. There is no single chemical that is effective against all foliar diseases, which means that a combination of products in a spray program is necessary to optimize disease management.

2. **A spray program should be designed with the critical periods of target diseases in mind.** For example, in anthracnose is a problem in the vineyard, dormant fungicide applications are very important for season long control. For successful Phomopsis control, early season fungicides (1 to 5 inch shoot growth) are critical. After bloom, the threat of Phomopsis infection is greatly reduced. The period from immediate pre-bloom through 4 to 5 weeks after bloom is the **MOST CRITICAL PERIOD** for controlling fruit infection by black rot, powdery mildew and downy mildew. Four to five weeks after bloom, the fruit become resistant to black rot, powdery mildew and downy mildew; however, the leaves and rachises (cluster stems) remain susceptible to both powdery and downy mildew for the rest of the season. Therefore, fungicide protection against both downy and powdery mildew may be required through harvest. For tight cluster *Vinifera* grape varieties an additional fungicide treatment should be added during bloom to protect against Botrytis bunch rot.

3. **A spray program should be thoughtfully developed to prevent and slow the development of fungicide resistant pathogens in the vineyard.** Fungicides that have a site-specific mode of action are classified as medium to high risk for fungicide resistance development. Fungicides with Fungicide Resistance Action Committee (FRAC) codes or numbers 1, 2, 3, 4, 7, 9, 10, 11, 13, 16, 43, 47, 49, U06, and U08, are medium to high risk fungicides and no more than two sequential applications of a high-risk fungicide should be applied before alternating to a fungicide with a different mode of action. Do not over use fungicides (there are restrictions on how frequently high-risk fungicides can be applied) and only apply fungicides at the recommended manufacturer rates. *It is unlawful to apply fungicides in a manner that is inconsistent with the product label*. The powdery mildew, downy mildew and Botrytis bunch rot fungi are the most problematic with respect to fungicide resistance problems on grapes. Usually the first indication of resistance in the vineyard is when a fungicide does not provide the same level of control compared to previous years, especially on susceptible varieties. In the worst case scenario, the material provides no control and the crop is lost due to disease. It is important to continually monitor (scout) the vineyard for signs and symptoms of reduced disease control.

   There are no commercial laboratories that screen pathogens for fungicide resistance. If you suspect that resistant fungi are present in the vineyard please contact Dr. Melanie Lewis Ivey for assistance in confirming resistance and developing an alternative fungicide spray program to slow or prevent additional resistance development in your vineyard.

4. **Be aware of incompatible chemicals.** Mixing pesticides can save time and labor costs but not all pesticides are compatible and may result in undesirable reactions. For example, the mixing of incompatible chemicals may reduce the effectiveness of one or more of the active ingredients in the mixture, cause an unwanted (and sometimes dangerous) chemical reaction, or injure the plant (i.e. phytotoxicity). It is illegal to mix pesticides with other products (such as other pesticides, adjuvants, or carriers) when such mixtures are expressly prohibited on the label. *The following*

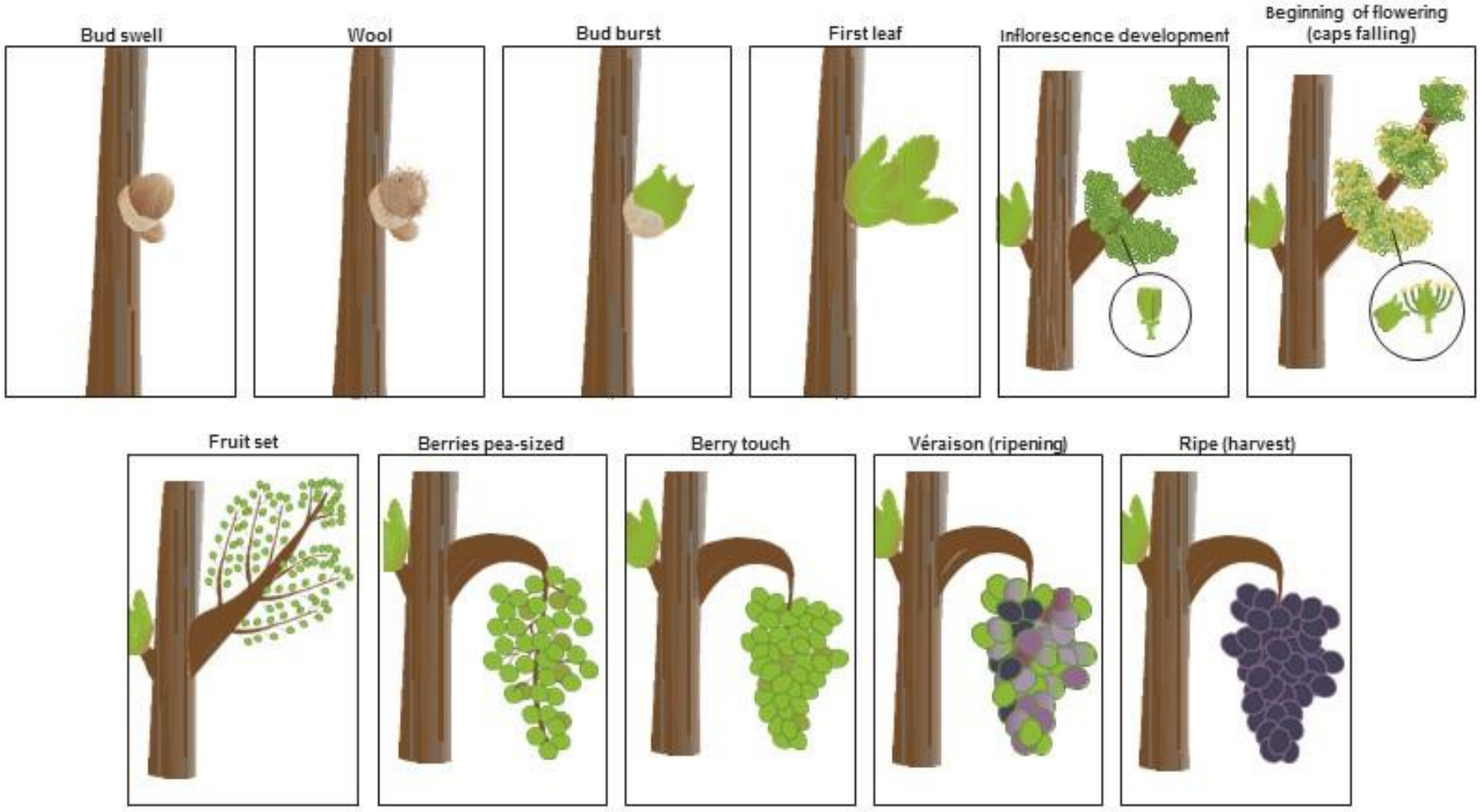
combinations of fungicides or plant protectants can cause serious vine injury when applied to vines at the same time or within 14 days of each other:

- Horticultural oils (i.e. JMS Stylet Oil) with sulfur
- Horticultural oils (i.e. Stylet Oil) with Captan
- Seven XLR (insecticide) with Captan

5. **Spray guides are recommendations only.** Product efficacy may vary depending on disease pressure, weather conditions, product coverage, the presence of resistant pathogen populations and/or the grape variety. For any given disease and at any specific application timing there are many registered fungicide options. The fungicides listed in this program are recommendations only and this guide does not include all of the fungicides currently registered for use on grapes. The cost of a fungicide per application and acre can vary significantly. The final fungicide spray program that you develop should consider the cost of specific fungicides selected as well as the targeted diseases and the potential for resistance development in the pathogen population. In this guide, the estimated relative cost of each fungicide per acre per application is provided based on 2017 retail costs (see Table below). The cost of fungicides will vary depending on the supplier and the quantity purchased.

Relative Cost Estimates Per Acre	
$10-20	$
$20-30	$$
$30-40	$$$
$40-above	$$$$

STAGES OF GRAPE BERRY DEVELOPMENT



THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Graphics by SarahCarafelli
July 2017

Grape Fungicide Spray Program-2018

This program emphasizes fungicide resistance management and is intended to provide *simultaneous protection* against anthracnose (ANTH), Phomopsis cane and leaf spot (PHOM), black rot (BR), powdery mildew (PM), and downy mildew (DM). Specific recommendations for Botrytis bunch rot (BOT) and Phytophthora root rot (PHYT) are also included in this program.

Dormant and One Inch Shoot

Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
Dormant	Sulforix (1 gal)	M	$$	ANTH
	Ridomil Gold SL (3.6 pt)	4	$$$$	PHYT
One inch shoot 	Mancozeb (3 lb)*	M	$	BR, PHOM
	PLUS			
	Aprovia (8.6-10.5 fl oz)	7	$$	PM
	or			
	Kenja 400SC (20-22 fl oz)	7	$$$$	
	or			
	Fracture (20.5-24.4 fl oz)	BM01	-	
	or			
	Merivon (4.0-5.5 fl oz)	7+11	$$$$	
	or			
	Luna Sensation** (4.0-7.6 fl oz)	7+11	$$$$	
	or			
	Rally (4 fl oz)	3		
	or		$	
	Inspire Super (16-20 fl oz)	3+9		
	or		$$$	
	Mettle (3-5 fl oz)	3		
	or		$	
	Torino 0.85F (3.4 fl oz)	U6		
	or		$$	
	Endura 70 WG (4.5 oz)	7		
	or		$$	
	Vivando 2.5 F (10.3-15.4 fl oz)	U8		
	or		$$$$	
	Sulfur**	M		
	or		$	
	Quintec 2.08F (4.0-6.6 fl oz)	13		
	or		$	
	Potassium salts***	-		
	or		$	
	JMS Stylet Oil (1-2%)****	-		
			$	

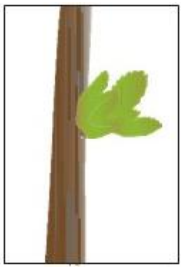
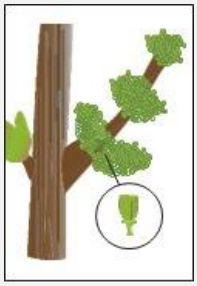
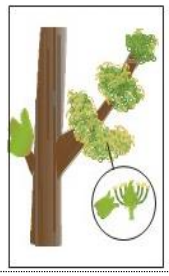
* Mancozeb is the backbone of the spray program for grapes in Ohio and should be used until the 66 day post-harvest interval (PHI) is met. The final application of Mancozeb will depend on the grape variety.

** Several sulfur formulations are available including wettable, flowable and dry flowable. Sulfur should not be applied to Concord grapes or sulfur sensitive vinifera varieties. Consult the product label for usage rates and restrictions.

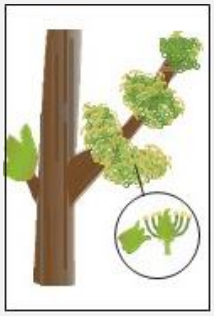
*** Potassium salts are not protectants. They provide moderate to good control of powdery mildew when applied to

developing colonies only. Several materials with potassium salts as the active ingredient are available including Nutrol, Kaligreen and Amicarb. Consult the product label for usage rates and restrictions.
**** The label for JMS Stylet Oil recommends a final concentration of 1-2%. When applied on a 7-10 day schedule at the high rate, physiological problems with fruit have been observed.

3-5 Inch Shoot to First Post-bloom Spray

Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
3-5 inch shoot (or 7-10 days after the last spray) 	Same fungicides as one inch shoot			PHOM, PM
10-12 inch shoot (or 7-10 days after the last spray) 	Same fungicides as one inch shoot			BR, PM, DM
Immediate pre-bloom to early bloom (or 7-10 days after the last spray) 	Same fungicides as one inch shoot **OR USED ALONE** Revus Top 2.08 F (7 oz)* or Pristine (8.0-12.5 oz)*	 3+40 7+11	 $ $$$$	BR, PM, DM BR, PM, DM

* Revus Top or Pristine used alone provides excellent control against black rot, downy mildew and powdery mildew. Revus Top should not be applied to Concord or non-vinifera hybrids as leaf burning may occur. Consult the label for other restrictions.

First post-bloom spray (no longer than 10 days after the last spray) 	Same fungicides as immediate pre-bloom to early bloom **PLUS*** Ridomil Gold (2.5 lb)** or Ridomil Gold Copper (2 lb)*** or Revus (8 fl oz) or Ranman (2.1-2.75 fl oz) or Forum (6 fl oz) or Zampro (11-14 fl oz)	 4 + M 4 + M1 40 21 40 45 + 40	 $$$$ $$$ $$$ $$ $ $$$	BR, PM, DM DM
* If conditions are highly conducive for downy mildew infections during this period (temperatures above 50 F, rainy and high humidity at night) the addition of a product specific to DM should be added to the program. It is very important to remember that these materials will need to be tank mixed with other fungicides because they will not provide adequate control of powdery mildew or black rot.				

Second Post-bloom Spray

Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
Second post-bloom spray (no longer than 10 days after the last spray) 	Same fungicides as immediate pre-bloom to early bloom **PLUS*** Ridomil Gold MZ (2.5 lb)** or Ridomil Gold Copper (2 lb)** or Revus (8 fl oz) or Ranman (2.1-2.75 fl oz) or Forum (6 fl oz) or Zampro (11-14 fl oz)	 4 + M 4 + M1 40 21 40 45 + 40	 $$$$ $$$ $$$ $$ $ $$$	BR, PM, DM DM
* The second post-bloom spray is near the end of the critical period (immediate pre-bloom through 3 to 4 weeks after bloom) for controlling fruit infection by black rot, powdery and downy mildew. However, cluster stems (rachis) and leaves will remain susceptible to powdery and downy mildew throughout the growing season; therefore, a good fungicide program needs to be maintained throughout the season. **If conditions are highly conducive for downy mildew development (rainy and cool to warm temperatures (64 to 76 degrees F), Ridomil Gold MZ ***or*** Ridomil Gold Copper is recommended.				

Third Post-bloom Spray

Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
Third post-bloom spray (10-14 days after the last spray) 	Mancozeb (3 lb)*	M	$	DM
	or			
	Captan 50 W (2-4 lb)	M	$	
	or			
	Phosphorous acid**	33	$	
	or			
	Revus (8 fl oz)	40	$$$	
	or			
	Ranman (2.1-2.75 fl oz)	21	$$	
	or			
	Forum (6 fl oz)	40	$	
	or			
	Zampro (11-14 fl oz)	45 + 40	$$$	
	PLUS			
	Rally (4 fl oz)	3	$	
	or			
	Inspire Super (16-20 fl oz)	3+9	$$$$	
	or			
	Mettle (3-5 fl oz)	3	$	
	or			
	Torino 0.85F (3.4 fl oz)	U6	$$	
	or			
	Endura 70 WG (4.5 fl oz)	7	$$	
	or			
	Vivando 2.5 F (10.3-15.4 fl oz)	U8	$$$$	
	or			
	Sulfur	M	$	
	or			
	Quintec 2.08F (4.0-6.6 fl oz)	13	$	
	or			
	Potassium salts	-	-	
	OR USED ALONE			
	Revus Top 2.08 F (7 fl oz)***	3+40	$	PM, DM
	or			
	Pristine (8.0-12.5 oz)***	7+11	$$$$	

* Mancozeb has a 66 day pre-harvest interval and should only be used on late maturing varieties at this period in the program. If you still have more than 66 days until harvest, Mancozeb should be used.

** Phosphorous acids (phosphonates, phosphites) are sold as nutritional supplements and “plant conditioners”, but a few products are registered for use as fungicides for downy mildew control on grape. They provide good control of downy mildew. Several materials with phosphorous acids as the active ingredient are available including ProPhyt, Phostrol, Agri-Fos, Rampart, Topaz. Consult the product label for usage rates and restrictions.

*** Revus Top or Pristine used alone provides excellent control against black rot, downy mildew and powdery mildew. Revus Top should not be applied to Concord or non-vinifera hybrids as leaf burning may occur. Consult the label for other restrictions.

Fourth Post-bloom Spray

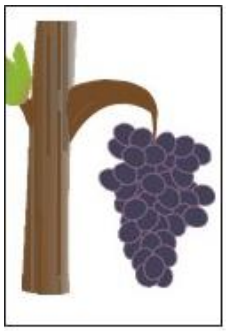
Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
Fourth post-bloom spray (10-14 days after the last spray) 	Captan 50 W (2-4 lb)*	M	$	DM
	or			
	Phosphorous acid	33	$	
	or			
	Revus (8 fl oz)	40	$$$	
	or			
	Ranman (2.1-2.75 fl oz)	21	$$	
	or			
	Forum (6 fl oz)	40	$	
	or			
	Zampro (11-14 fl oz)	45 + 40	$$$	
	PLUS			
	Rally (4 fl oz)	3	$	
	or			
	Inspire Super (16-20 fl oz)	3+9	$$$$	
	or			
	Mettle (3-5 fl oz)	3	$	
	or			
	Torino 0.85F (3.4 fl oz)	U6	$$	
	or			
	Endura 70 WG (4.5 fl oz)	7	$$	
	or			
	Vivando 2.5 F (10.3-15.4 fl oz)	U8	$$$$	
	or			
	Sulfur*	M	$	
	or			
	Quintec 2.08F (4.0-6.6 fl oz)	13	$	
	or			
	Potassium salts	-	-	
	OR USED ALONE			
	Fixed copper*and **	M	$	DM, PM
	or			
	Revus Top 2.08 F (7 fl oz)***	3+40	$	
	or			
	Pristine (8.0-12.5 oz)***	7+11	$$$$	

* Do not apply Captan, sulfur or copper fungicides within 30 days of harvest or the fermentation process may be adversely affected.

** If dry weather persists and the risk of downy mildew is low, fixed copper will provide good control of both downy and powdery mildew.

*** Revus Top or Pristine used alone provides excellent control against black rot, downy mildew and powdery mildew. Revus Top should not be applied to Concord or non-vinifera hybrids as leaf burning may occur. Consult the label for other restrictions.

Fifth Post-bloom Spray

Growth Stage	Product (rate/A)	FRAC Code	Relative cost (per acre/application)	Target Diseases
Fifth post-bloom spray through harvest (maintain a 10-14 day spray schedule) 	Same fungicides as fourth post-bloom **PLUS*** Vangard 75WG (10 fl oz) or Elevate 50WG (1 lb) or Scala 5SC (9-18 fl oz) or Endura 70WG (8 fl oz) or Switch 38 WG (11-14 fl oz) or Pristine (18.5-23 fl oz)** **OR** Rovral 4F (1.5-2 pt) PLUS Latron B1956 (6 fl oz/100 gal)	 9 17 9 7 9+12 7+11 2 -	 $$$$ $$$$ $$$ $$$$ $$$$ $$$$ $$$ $	DM, PM BOT

* On tight clustered Botrytis bunch rot susceptible varieties the addition of a product specific to *Botrytis* should be added to the program. The first spray should be made when symptoms are first observed or at veraison (or shortly thereafter). A second spray should be made if conditions favor disease development (wet, cool weather) or at least 14 days after the first spray. On late maturing varieties, a third spray may be required.

** For grapes grown for ice wine production an application of Pristine immediately prior to harvest may aid in controlling some fruit rots of ripe grapes, especially during falls and early winters when temperatures remain high. Rates listed are to be used for *Botrytis* control only. Other rates and restrictions apply for additional diseases, refer to the label for more information.

2018 Spray Program- At-a-Glance

The fungicides listed in this program are ***recommendations only*** and this figure does not include all of the fungicides currently registered for use on grapes.

Spray No.	Dormant	0	1	2	3	4	6	7	8	9	10	11	12
Growth Stage	Dormant	Bud Break	1 inch	3-5 inch	10-12 inch	Pre-bloom To Early Bloom	Fruit set (First post-bloom)	Pea-size (Second post-bloom)	Pea-size (Third post-bloom)	Berry touch (Fourth post-bloom)	Berry touch (Fifth post-bloom)	Veraison	Pre-harvest
						Critical Period For Clusters							
	Anthracnose		Phomopsis										
	Sulforix		Mancozeb	Mancozeb	Mancozeb								
				Powdery mildew									
				Stylet oil	Quintec	Revus Top	Quintec	Revus Top	Quintec	Revus Top	Torino	Torino	Potassium salts
				Downy mildew									
				Mancozeb	Mancozeb	Revus Top	Ridomil Gold MZ	Revus Top	Mancozeb	Revus Top	Captan	Captan	Ranman
					Black rot								
					Mancozeb	Revus Top	Mancozeb	Revus Top	Mancozeb				
											Botrytis bunch rot (Tight cluster varieties only)		
											Vangard	Vangard	

Acknowledgements

The spray program provided in this guide was developed using recommendations published by the Midwest Fruit Pest Management Guide and fungicide efficacy data from experimental trials conducted in Ohio and throughout the Northeastern United States. Rachel Medina provided the relative fungicide cost data. We are grateful to the Ohio Grape Industry Committee for funding to support this publication.

Contact Information

Dr. Melanie Lewis Ivey
Assistant Professor
State Fruit Pathology Specialist
State Fresh Produce Safety Specialist

The Ohio State University-Wooster Campus
1680 Madison Avenue
Selby Hall
Wooster, OH 44691

Office Phone: 330-263-3849
Email: Ivey.14@osu.edu
Website: u.osu.edu/fruitpathology/
Facebook: facebook.com/OhioGrapeIPM

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES