



Developing An Effective Fungicide Spray
Program for Grapes in Ohio
— 2020 —



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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 overuse 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. ***In 2019, powdery mildew resistance to FRAC 11 (Qol inhibitors or strobilurins) fungicides was confirmed in Ohio.*** 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 2019 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 | \$\$\$\$ |

Grape Fungicide Spray Program-2020

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 crown and root rot (PHYT) are also included in this program.

The following fungicides should NOT be applied to Concord grapes as crop injury may occur:

- Flint Extra
- Inspire Super
- Intuity
- Luna Sensation
- Pristine *[Should also not be applied to Noiret.]*
- Quadris Top
- Sulfur *[Should not be applied to sulfur sensitive vinifera varieties.]*
- Revus Top

Dormant

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|----------------|--------------------------|-----------|--------------------------------------|-----------------|
| Dormant | Sulforix (1-2 gal) | M | \$\$ | ANTH |
| | Ridomil Gold SL (3.6 pt) | 4 | \$\$\$\$ | PHYT |

Bud Break to Pre-bloom

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|--|--|-----------|--------------------------------------|--------------------|
| Bud break to pre-bloom | Mancozeb 75DF (3 lb) or | M | \$ | BR, PHOM |
| | Captan 50WP (3 lb) or | M | \$ | BR, PHOM |
| | Ziram 76DF (3-4 lb) | M | \$ | BR, PHOM |
| ANY OF THE ABOVE PLUS ONE OF THE FOLLOWING: | | | | |
| | Aprovia (8.6-10.5 fl oz) or | 7 | \$\$ | ANTH, PHOM, BR, PM |
| | Endura 70 WG (4.5 oz) or | 7 | \$\$ | BOT, PM |
| | Fracture (20.5-36.6 fl oz) or | M | \$\$\$\$ | BOT, PM |
| | Inspire Super (16-20 fl oz) or | 3+9 | \$\$\$ | ANTH, BOT, BR, PM |
| | Intuity (6 fl oz) or | 11 | \$\$\$ | BOT, PM |
| | JMS Stylet Oil (1-2%) or | - | \$ | BOT, PM |
| | Kenja 400SC (20-22 fl oz) or | 7 | \$\$\$\$ | ANTH, BOT, PM |
| | Luna Sensation (4.0 – 7.6 fl oz) or | 7+11 | \$\$\$\$ | BOT, BR, PHOM, PM |
| | LifeGard (4.5 oz/100 gal) or | - | | PM, DM |
| | Merivon Xemium (4 – 5.5 fl oz) or | 7+11 | \$\$\$\$ | PM |
| | Mettle (3-5 fl oz) or | 3 | \$ | ANTH, BR, PM |
| | Potassium salts or | - | \$ | PM |
| | Procure 480 SC (4-8 fl oz) or | 3 | - | PM |
| | Quintec 2.08F (4 – 6.6 fl oz) | 13 | \$ | PM |

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|---|---|--|--|---|
| | or Rally 40WSP (4 fl oz) or Sulfur or TebuStar 45WSP (4 oz) or Topsin M WSB (0.75-1.5 lb) or Torino 0.85F (3.4 fl oz) or Vivando 2.5 F (10.3-15.4 fl oz) | 3 M 3 1 U6 U8 | \$ \$ \$ \$ \$\$ \$\$\$\$ | ANTH, BR, PM PHOMP, PM BR, PM BR, PM PM PM |
| OR ONE OF THE PRODUCTS BELOW BY ITSELF | | | | |
| | Abound (10-15.5 fl oz) or Flint Extra (1.5-4 oz) or LifeGard (4.5 oz/A) or Luna Experience (8-8.6 fl oz) or Pristine (8-12.5 oz) or Quadris Top (12-14 fl oz) or Revus Top (7 fl oz) or Sovran (3.2-4.8 oz) | 11 11 - 7+3 7+11 11+3 40+3 11 | \$\$ \$\$ \$\$ \$\$\$\$ \$\$\$\$ \$\$\$ \$ \$\$\$ | BOT, BR, DM, PHOM, PM BOT, BR, DM, PHOM, PM PM BOT, BR, PHOM, PM ANTH, BR, DM, PHOM, PM ANTH, BR, DM, PHOM, PM ANTH, BR, DM, PHOM, PM BR, DM, PM |

Immediate Pre-bloom to Early Bloom

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|---|---|-----------|--------------------------------------|-----------------|
| Immediate pre-bloom to early bloom (CRITICAL PERIOD) | <p>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.</p> <p>Spray intervals should not exceed 10 days.</p> | | | |
| | Same as for bud break to pre-bloom PLUS one of the following products for downy mildew: | | | |
| | Forum (6 fl oz) or | 40 | \$ | DM |
| | Ranman (2.1-2.75 fl oz) or | 21 | \$\$ | DM |
| | Reason 500SC (2.7 fl oz) or | 11 | - | DM |
| | Revus (8 fl oz) or | 40 | \$\$\$ | DM |
| | Ridomil Gold SL (2.5 lb) or | 4 | \$\$\$ | DM |
| | Ridomil Gold Copper (2 lb) or | 4+M | \$\$\$ | DM |
| | Ridomil Gold MZ (2.5 lb) or | 4+M | \$\$\$ | DM |
| | Sovran (3.2-4.8 oz) or | 11 | \$\$\$ | DM |
| | Tanos (8 oz) or | 11+27 | \$\$ | DM |
| | Zampro (11-14 fl oz) | 45+40 | \$\$\$ | DM |

First and Second Post-bloom

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|--|---|-----------|--------------------------------------|------------------------|
| First and Second Post-bloom (CRITICAL PERIOD) | The second post-bloom spray for many varieties 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. Spray intervals should not exceed 10 days. | | | |
| | Same as for bud break to pre-bloom PLUS one of the following products for downy mildew if conditions are highly conducive for downy mildew development: | | | |
| | Forum (6 fl oz) or | 40 | \$ | DM |
| | LifeGard (4.5 oz/A) or | - | \$\$ | DM |
| | Ranman (2.1-2.75 fl oz) or | 21 | \$\$ | DM |
| | Reason 500SC (2.7 fl oz) or | 11 | - | DM |
| | Revus (8 fl oz) or | 40 | \$\$\$ | DM |
| | Ridomil Gold (2.5 lb) or | 4 | \$\$\$ | DM |
| | Ridomil Gold Copper (2 lb) or | 4+M | \$\$\$ | DM |
| | Ridomil Gold MZ (2.5 lb) or | 4+M | \$\$\$\$ | DM |
| | Sovran (3.2-4.8 oz) or | 11 | \$\$\$ | DM |
| | Zampro (11-14 fl oz) | 45+40 | \$\$\$ | DM |
| | OR ONE OF THE PRODUCTS BELOW BY ITSELF | | | |
| | Pristine (8-12.5 oz) or | 7+11 | \$\$\$\$ | ANTH, BR, DM, PHOM, PM |
| | Quadris Top (12-14 fl oz) or | 11+3 | \$\$\$ | ANTH, BR, DM, PHOM, PM |
| | Revus Top (7 fl oz) | 40+3 | \$ | ANTH, BR, DM, PHOM, PM |

Third and Fourth Post-bloom

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|---|--|-----------|--------------------------------------|-----------------|
| Third and Fourth Post-bloom | <p>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.</p> <p>Spray intervals can be extended to 10-14 days unless conditions are highly conducive for downy mildew.</p> | | | |
| | Captan 50 W (2-4 lb) or | M | \$ | DM |
| | Forum (6 fl oz) or | 40 | \$ | DM |
| | Mancozeb (3 lb) or | M | \$ | DM |
| | Phosphorous acid or | 33 | \$ | DM |
| | Ranman (2.1-2.75 fl oz) or | 21 | \$\$ | DM |
| | Revus (8 fl oz) or | 40 | \$\$\$ | DM |
| | Tanos or | 11+27 | - | DM |
| | Zampro (11-14 fl oz) | 45+40 | \$\$\$ | DM |
| ANY OF THE ABOVE PLUS ONE OF THE FOLLOWING | | | | |

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|--------------|--|-----------|--------------------------------------|-----------------|
| | Endura 70 WG (4.5 fl oz) or | 7 | \$\$ | PM |
| | Inspire Super (16-20 fl oz) or | 3+9 | \$\$\$\$ | PM |
| | LifeGard (4.5 ox/100 gal) or | - | \$\$ | PM |
| | Mettle (3-5 fl oz) or | 3 | \$ | PM |
| | Potassium salts or | - | - | PM |
| | Procure 480 SC (4-8 fl oz) or | 3 | - | PM |
| | Quintec 2.08F (4-6.6 fl oz) or | 13 | \$ | PM |
| | Rally (4 fl oz) or | 3 | \$ | PM |
| | Torino 0.85F (3.4 fl oz) or | U6 | \$\$ | PM |
| | Sulfur or | M | \$ | PM |
| | Vintage SC (see label) or | 3 | - | PM |
| | Vivando 2.5 F (10.3-15.4 fl oz) | U8 | \$\$\$\$ | PM |
| | OR ONE OF THE PRODUCTS BELOW BY ITSELF: | | | |
| | Copper (fixed) or | M | \$ | DM, PM |
| | Pristine (8-12.5 oz) or | 7+11 | \$\$\$\$ | DM, PM |
| | Quadris Top (12-14 fl oz) or | 11+3 | \$\$\$ | DM, PM |
| | Revus Top (7 fl oz) | 40+3 | \$ | DM, PM |
| | OR ONE OF THE PRODUCTS BELOW BY ITSELF | | | |

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|--------------|---------------------------------|-----------|--------------------------------------|-----------------|
| | Copper (fixed) or | M | \$ | DM, PM |
| | Pristine (8-12.5 oz) or | 7+11 | \$\$\$\$ | DM, PM |
| | Quadris Top (12-14 fl oz) or | 11+3 | \$\$\$ | DM, PM |
| | Revus Top (7 fl oz) | 40+3 | \$ | DM, PM |

Fifth Post-bloom to Veraison

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|-------------------------------------|--|-----------|--------------------------------------|-----------------|
| Fifth post-bloom to veraison | On tight clustered Botrytis bunch rot susceptible cultivars 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. 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. | | | |
| | Same as for fourth and fifth post-bloom PLUS one of the following: | | | |
| | Elevate 50WG (1 lb) or | 17 | \$\$\$\$ | BOT |
| | Endura 70WG (8 fl oz) or | 7 | \$\$ | BOT |
| | Pristine (18.5-23 fl oz) or | 11+7 | \$\$\$\$ | BOT |
| | Scala 5SC (9-18 fl oz) or | 9 | \$\$\$ | BOT |
| | Switch 62.5 WG (11-14 fl oz) or | 9+12 | \$\$\$\$ | BOT |
| | Vanguard 75WG (10 fl oz) | 9 | \$\$\$\$ | BOT |
| | OR | | | |
| | Rovral 4F (1.5-2 pt) PLUS Latron B1956 (6 fl oz/100 gal) | 2 - | \$\$\$ - | BOT |

Post-harvest

| Growth Stage | Product (rate/A) | FRAC Code | Relative cost (per acre/application) | Target Diseases |
|---------------------|--|-----------|--------------------------------------|-----------------|
| Post-harvest | Foliage should be protected from new downy mildew and powdery mildew infections until a frost event or natural senescence causes the leaves to drop. Post-harvest products and rates should be the same as pre-harvest products and rates for downy mildew and powdery mildew. Check the labels for season limits on the quantity of product that can be used. | | | |

Table 1. List of fungicides included in the 2020 grape fungicide spray guide

| Trade Name (Product) | Common Name | FRAC | Pre-harvest Interval (PHI) | Re-entry Interval (REI) |
|--|------------------------------------|------|----------------------------|-------------------------|
| Abound | azoxystrobin | 11 | 14 | 4 |
| Aprovia | benzovindiflupyr | 7 | 21 | 12 |
| Aliette | fosetyl-AL | 33 | 15 | 12 |
| Captan 50WP | captan | M | 0 | 48 |
| Dithane M-45, others | mancozeb | M | 66 | 24 |
| Elevate 50 WDG | fenhexamid | 17 | 0 | 12 |
| Endura | boscalid | 7 | 14 | 12 |
| Flint Extra | trifloxystrobin | 11 | 14 | 12 |
| Forum | dimethomorph | 40 | 14 | 12 |
| Fracture | Banda de Lupinus albus doce (BLAD) | M | 1 | 4 |
| Inspire Super | difenoconazole + cyprinil | 3+9 | 14 | 12 |
| Intuity | mandestrobin | 11 | 10 | 12 |
| JMS Stylet Oil | oil | - | 0 | 12 |
| Kenja 400SC | isofetamid | 7 | 16 | 12 |
| LifeGard | <i>Bacillus mycooides</i> J* | - | 0 | 4 |
| Luna Experience | fluopyram + tebuconazole | 7+3 | 14 | see label |
| Merivon Xemium | fluxapyroxad + pyraclostrobin | 7+11 | 14 | 12 |
| Mettle 125ME | tetraconazole | 3 | 14 | see label |
| Pristine | pyraclostrobin + boscalid | 11+7 | 14 | see label |
| Procure 480SC | triflumizole | 3 | 7 | 24 |
| Prophyt, Phostrol, Agri-Fos, Legion, Rampart | phosphorous acid | 33 | 0 | 4 |
| Quadris Top | difenoconazole + azoxystrobin | 3+11 | 14 | 12 |
| Quintec | quinoxifen | 13 | 21 | 12 |
| Rally 40WSP | myclobutanil | 3 | 14 | 24 |
| Ranman 400SC | cyazofamid | 21 | 30 | 12 |
| Reason 500SC | fenamidone | 11 | 30 | 12 |
| Revus | mandipropamid | 40 | 30 | 4 |
| Revus Top | difenoconazole + mandipropamid | 3+40 | 14 | 12 |
| Ridomil Gold MZ WG | mefenoxam + mancozeb | 4+M | 66 | 48 |
| Ridomil Gold SL | mefenoxam | 4 | 60 | 48 |

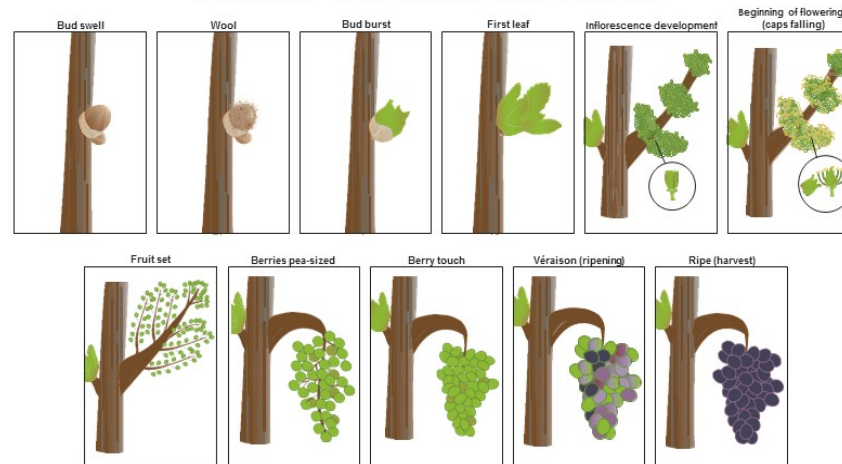
| Trade Name (Product) | Common Name | FRAC | Pre-harvest Interval (PHI) | Re-entry Interval (REI) |
|----------------------|-----------------------------|---------|----------------------------|-------------------------|
| Ridomil Gold Copper | mefenoxam + copper | 4+M | 42 | 48 |
| Rovral 4 Flowable | iprodione | 2 | 7 | 48 |
| Scala SC | pyrimethanil | 9 | 7 | 12 |
| Sovran | kresoxim-methyl | 11 | 14 | 12 |
| Sulforix | calcium polysulfide | M | 0 | 48 |
| Sulfur (wetable) | sulfur | M | 0 | 24 |
| Switch 62.5 WG | cyprodinil + fludioxonil | 9+12 | 7 | 12 |
| Tanos | famoxadone + cymoxanil | 11+27 | 30 | 12 |
| TebuStar 45 WSP | tebuconazole | 3 | 14 | 12 |
| Topsin M WSB | thiophanate | 1 | 7 | 2 days |
| Torino | cyflufenamid | U6 | 3 | 4 |
| Vanguard WG | cyprodinil | 9 | 7 | 12 |
| Vintage SC | Fenarimol | 3 | 21 | 24 |
| Vivando | metrafenone | U8 | 14 | 12 |
| Zampro | ametoctradin + dimethomorph | 45 + 40 | 14 | 12 |
| Ziram 76DF | ziram | M | 21 | 48 |

2020 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. Do not use sulfur on sulfur sensitive varieties. Always refer to label before applying fungicides.

| Spray No. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|--------------|-------------|-----------|------------------------|------------------------|------------------------|------------------|----------------------------|-------------------------------|----------------------------|----------------------------|---------------------------|------------------------------|------------------------------|-------------------------------|-------------|
| Growth Stage | Dormant | Bud Break | 1 inch | 3-5 inch | 6-9 inch | 10-12 inch | Pre-bloom to early bloom | Pre-bloom to early bloom | (1st post-bloom) | Pea-size (2nd post-bloom) | Pea-size (3rd post-bloom) | Berry Touch (4th post-bloom) | Berry Touch (5th post-bloom) | Veraison | Pre-harvest |
| | Anthracnose | | Phomopsis | | | | | | | | | Botrytis Bunch Rot | | | |
| | Sulfurix | | Mancozeb (M) | Mancozeb (M) | Mancozeb (M) | Mancozeb (M) | | | | | | Vanguard (9) | Vanguard (9) | Endura (7) | |
| | | | Powdery Mildew | | | | | | | | | | | | |
| | | | Stylet Oil | Sulfur (M) or LifeGard | Sulfur (M) or LifeGard | Revus Top (40+3) | Inspire Super (3+9) | Pristine (7+11) or Sulfur (M) | Quintec (13) | Torino (U6) | Quintec (13) or LifeGard | Torino (U6) | Vivand (U8) or LifeGard | Potassium salts | |
| | | | Downy Mildew | | | | | | | | | | | | |
| | | | Mancozeb (M) | Mancozeb (M) | Mancozeb (M) | Revus Top (40+3) | Zapro (45+40) | Pristine (7+11) | Captan (M) or Mancozeb (M) | Captan (M) or Mancozeb (M) | Captan (M) | Captan (M) | Captan (M) | Potassium salts or Revus (40) | |
| | | | Black Rot | | | | | | | | | | | | |
| | | | Mancozeb (M) | Revus Top (40+3) | Inspire Super (3+9) | Pristine (7+11) | Captan (M) or Mancozeb (M) | Captan (M) or Mancozeb (M) | | | | | | | |
| | | | Critical Period | | | | | | | | | | | | |

STAGES OF GRAPE BERRY DEVELOPMENT



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.

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