College of Agriculture, Food and Environment
*Cooperative Extension Service*

**Plant Pathology Fact Sheet** **PPFS-FR-S-14**

# Fruit Diseases of Grape

Nicole Gauthier
*Plant Pathology*
*Extension Specialist*

Cheryl Kaiser
*Plant Pathology*
*Extension Support*

## Importance

Kentucky's wet springs and warm, humid summers favor the development of several fruit diseases of grape. These diseases can cause significant losses in quality and yield in commercial and residential vineyards. Unfortunately, fruit diseases may go unnoticed until late in the season or at harvest. Although there are no curative treatments once fruit is infected, many diseases can be prevented by using cultural practices and fungicides. Accurate diagnosis, however, is critical to determine the best management practices and to prevent future losses.

Following is an overview of common grape berry diseases: anthracnose, bitter rot, black rot, Botrytis bunch rot, ripe rot, and sour rot.

## Anthracnose

Anthracnose, also known as "bird's eye rot," results in the loss of fruit quality and quantity. In addition, vines may become infected and weakened. This disease can be destructive once it becomes established in a vineyard.

### Symptoms & Signs

Anthracnose occurs on young shoots, fruit stems, leaves, petioles, and tendrils, as well as on berries. Only fruit symptoms will be discussed here.

Fruit clusters are susceptible to infection any time prior to flowering and through veraison (berry ripening). Initially, small, reddish, circular spots develop on infected fruit (Figure 1A). These spots enlarge to an average diameter of 1/4 inch and may become slightly sunken. The centers of the spots turn whitish gray and become surrounded by a narrow reddish brown to black margin. This distinguishing symptom often resembles a bird's eye (Figure 2B), thus the alternative name for the disease. Lesions may extend into the pulp and cause fruit to crack. Fungal fruiting bodies (acervuli), which eventually develop in lesions, exude a pinkish mass of spores (conidia) during wet weather. Diseased berries shrivel and mummify.



**Figure 1A.** Anthracnose can develop anytime from flowering to veraison. Spots are initially small, reddish-brown, and circular.
**Figure 1B.** As anthracnose lesions enlarge, they take on the typical "bird's eye" appearance.

## Anthracnose (cont'd)

### Cause & Disease Development

Anthracnose is caused by the fungus *Elsinoe ampelina*. This organism overwinters as survival structures (sclerotia) present in infected shoots. In spring, during prolonged wet periods, sclerotia germinate to produce abundant spores (conidia and ascospores), which are spread to developing tissues by splashing rain. Conidia germinate and infect succulent tissues when free moisture is present in the form of rain or dew. Once the disease is established, other fungal structures (acervuli) form and produce conidia during periods of wet weather. Secondary infections develop when conidia are spread to other susceptible tissues.

Rainfall causing tissues to remain wet for 3 to 4 hours, combined with warm temperatures (77°F to 86°F), are ideal for infection and spread. Although conidia can infect over a wide range of temperatures (from 36°F to 90°F), the higher the temperature, the more rapidly disease develops.

## Bitter Rot

Bitter rot is named for the bitter taste it imparts to infected berries. The unpleasant flavor carries over to wine and other value-added products made from diseased fruit.

### Symptoms & Signs

Bitter rot is primarily a disease of ripening fruit; immature fruit are not affected. This disease can also affect young leaves and shoots, flower buds, and pedicels (flower and fruit stems).

Fruit symptoms begin as brownish, water-soaked spots on maturing fruit. As the fungus continues to invade, lesions expand rapidly. A soft rot develops; however, infected fruit initially retain their shape. Tiny, black fungal structures (acervuli) appear as specks on decaying fruit (Figures 2A & 2B), often forming concentric circles or rings. Eventually, rotted fruit dry up and shrivel into black mummies.

### Cause & Disease Development

The bitter rot fungus, *Greeneria uvicola* (synonym *Melanconium fuligineum*), overwinters on stem lesions, in grape mummies, and as a saprophyte in plant debris. Spores (conidia) are released from fungal fruiting bodies (acervuli) during warm, wet weather and spread via splashing rain to susceptible tissues. The fungus initially invades fruit pedicels where it remains latent (inactive) until berry ripening.

Infections can occur when temperatures range from 54°F to 85°F; however, temperatures 72°F to 76°F with 6 to 12 hours of tissue wetness provide optimal conditions. Rotted berries become host tissue for secondary spores, which form within 4 days of symptom development.



**Figure 2A.** Bitter rot symptoms do not become evident until berries begin to ripen. As disease develops, tiny black fungal structures develop in the infected tissue.

**Figure 2B**. Close-up of fungal structures on a bitter rot-infected berry.

# Black Rot

Black rot is the most prevalent and important grape disease in Kentucky. Without an adequate disease control program, both home and commercial grape production is often severely limited. While the disease affects all green tissues, including leaves and vines, only the fruit rot phase will be discussed here. Refer to *Black Rot of Grape* (PPFS-FR-S-16) for more information on all phases of this disease.

## Symptoms & Signs

Black rot fruit symptoms begin as soft, light brown spots on immature fruit. These spots rapidly enlarge to envelop the entire berry (Figure 3A). Affected grapes then shrivel into black, wrinkled mummies (Figure 3B) that either drop to the ground or remain attached to vines. The mummies are covered with dark fungal fruiting bodies (pycnidia and perithecia) (Figure 3C).

## Cause & Disease Development

The black rot pathogen, *Phyllosticta ampelicida* (formerly *Guignardia bidwellii*), survives the winter as fungal fruiting bodies (pycnidia and perithecia) in mummies (on vines or ground), fallen leaves, and stem lesions. Spore production begins during wet weather in spring when temperatures rise above 50°F. Spring rains trigger the release of airborne spores (ascospores) from overwintering perithecia and/or rain-splashed spores (conidia) from overwintering pycnidia. The majority of ascospores from fallen mummies are discharged during the period between 1-inch shoot growth and 10 to 14 days after bloom. Mummies allowed to hang on the vine can continue to discharge spores throughout the growing season, providing an important source of inoculum for secondary infections.

Ascospores germinate and penetrate susceptible tissues when surface moisture is present. After infection, symptoms develop within 2 weeks. Once the fungus becomes established in susceptible tissue (leaves, shoots, and fruit), it starts producing secondary spores (conidia) capable of initiating new infections. This cycle of spore production and infection continues as long as environmental conditions are favorable. Grape berries are susceptible to infection until 3 to 4 weeks after bloom; they are no longer susceptible after veraison.



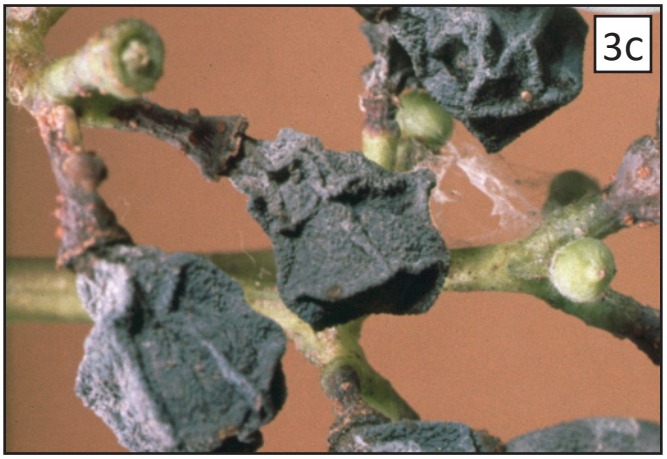


**Figure 3A**. Black rot symptoms initially appear as a light brown decay of immature fruit.
**Figure 3B.** As decay progresses, entire berries blacken and begin to shrivel into mummies.
**Figure 3C**. Black rot mummies become covered with fungal fruiting bodies that will continue to discharge spores throughout the growing season.

# Botrytis Bunch Rot

Botrytis bunch rot occurs everywhere grapes are grown. While field losses can be particularly severe on grape cultivars with tight, closely packed clusters of fruit, all cultivars are susceptible. The disease also causes a decay of fresh market grapes in storage.

## Symptoms & Signs

Early season *Botrytis* infections can cause blossom blight resulting in significant crop losses. The most common symptom on fruit is a soft, watery decay of ripening berries. Initially, one or a few berries within the bunch may be infected, but the fungus can rapidly spread to adjacent berries until the entire bunch is decayed (Figure 4A). Infected berries of white cultivars turn brown, while berries of red cultivars become bright red or purple. Under wet or moist conditions, fruit may be covered with a tan or gray fuzzy growth of fungal mycelia and spores (Figure 4B). Decayed berries eventually shrivel and fall to the ground as hard mummies.


## Cause & Disease Development

The bunch rot fungus, *Botrytis cinerea*, overwinters as mycelia and as dark-colored fungal survival structures (sclerotia) that are resistant to adverse weather conditions. Sclerotia germinate in spring and produce spores (conidia) that are spread to susceptible tissues, primarily via air currents; however, water splash, insects, animals, and human activities can also spread spores. Because this pathogen has a wide host range, there are also abundant sources of inoculum outside the vineyard.

Spores may remain inactive on plant surfaces until conditions are favorable for infection. Although germinating conidia may penetrate directly into ripe berries, the fungus usually first gains a foothold by colonizing injured or dead tissue (such as fading flower parts) prior to infecting healthy tissue. Using dead tissue as a food base, the fungus invades developing berries and may remain dormant (latent) until fruit begin to ripen. Increased sugar and decreased acid levels of ripening berries provide a favorable environment for fungal growth. Tissue injured by hail, wind, birds, insects, and other grape diseases is readily colonized by *Botrytis*.

Warm, moist weather favors rapid symptom development. Moisture in the form of fog or dew (relative humidity greater than 85%) and temperatures of 59°F to 82°F are ideal for conidial production and infection. Rainfall is not required for disease development, although periods of rainfall are highly conducive to disease.


**Figure 4A.** The Botrytis bunch rot pathogen can spread from one infected berry to the entire bunch very rapidly. **Figure 4B**. Close-up of *Botrytis* fungal growth on infected berries. This fuzzy fungal growth can apear tan or grey, and its presence is diagnostic for this disease.

# Ripe Rot



**Figure 5A.** Ripe rot lesions developing on ripening berries are initially circular in shape.
**Figure 5B.** Grape cluster showing various stages in ripe rot disease progression.
**Figure 5C** Masses of salmon-to-pink colored spores exude from fungal fruiting bodies on ripe rot-infected berries.

Ripe rot, as the name implies, occurs on ripened berries at or near harvest. Disease can be a particularly devastating whenever warm, humid weather prevails. The ripe rot pathogen causes fruit rots on a number of other fruit and vegetable crops, as well.

## Symptoms & Signs

Ripe rot begins as small, circular lesions developing on ripening fruit (Figure 5A); lesions eventually cover the entire berry, and infections spread through the cluster (Figure 5B). Tiny black fruiting bodies (acervuli) form in diseased tissue and exude masses of salmon-colored to pink spores (Figure 5C). Once the entire berry is affected, it may remain on the vine or drop to the ground as a mummy.

## Cause & Disease Development

Ripe rot is caused by the fungus *Glomerella cingulata* (asexual stage: *Colletotrichum* sp.). This fungus overwinters in fruit mummies and infected fruit stems. Spores (conidia and ascospores) are released in spring and spread via splashing or wind-driven rain. While infections can occur at any time, even when fruit is still green, decay does not begin until fruit ripens. Abundant conidia are produced on rotting fruit and spread to other ripe fruit. Heavy losses can occur when frequent rains, coupled with warm temperatures (77°F to 86°F), occur during or near harvest.

## Sour Rot

Sour rot, also known as sour bunch rot, is a disease complex that affects both grape yield and wine quality. Cultivars with tight clusters and thin skins tend to be more susceptible to this late-season problem.

### Symptoms & Signs

Sour rot begins as a soft, watery decay of berries, which is followed by discoloration (Figure 6A). White grape cultivars turn tan to light brown in color, while red cultivars become brownish-red. Symptoms of sour rot may be mistaken for other grape diseases, such as Botrytis bunch rot; however, the presence of an obvious vinegar (acetic acid) odor and lack of fungal signs distinguishes sour rot from other diseases. As decay progresses, berries leak and collapse (Figure 6B), spreading decay microbes throughout the fruit cluster.

### Cause & Disease Development

Multiple organisms have been associated with sour rot, including fruit flies (*Drosophila* spp.), ethanol producing yeast, and acetic acid bacteria. Wounds (e.g., from hail, birds, other diseases) are necessary for infection, as they provide the entry point for the sour rot organisms. Fruit flies attracted to injured fruit transmit the yeast and bacteria, which initiate decay. The fruit flies subsequently lay eggs and multiply rapidly, and then the yeast and bacteria are carried to other fruit. *Botrytis* may also invade the already-decaying fruit. Warm temperatures (77°F to 82°F), rainy weather, and sugar levels above 15° Brix are conducive to infections.



**Figure 6A.** Sour rot results in a soft, watery decay of grape berries, often with the tell-tale vinegar smell that distinguishes it from other diseases.
**Figure 6B.** Close-up of sour rot symptoms showing collapsed berries.

## Disease Management

### Planting site

- Establish a new vineyard in a sunny site with good air circulation and drying characteristics.
- Orient vineyard rows toward the prevailing winds in order to facilitate drying.
- Avoid low lying, poorly drained sites.

### Cultivar & plant selection

- Select grape cultivars that are tolerant or semi-tolerant to bunch rot diseases.
- Consider cultivar characteristics when making grape selections. For example, tight clustered and thin-skinned cultivars are generally more prone to Botrytis bunch rot and sour rot.
- Purchase disease-free planting material from a reputable nursery.

## Disease Management (cont'd)

### Production practices

- Follow a training system and leaf removal practices that promote rapid drying of plant tissues (good air circulation) and increase sunlight penetration. Opening the canopy also improves fungicide spray penetration.
- Manage weeds to aid in improving air circulation and drying.
- Provide protection against insects and birds, which may injure fruit and predispose berries to bunch rots.
- Irrigate early in the day when using sprinklers so that foliage and fruit dry as quickly as possible. Avoiding overhead irrigation altogether is recommended.

### Sanitation

Good sanitation practices are critical for management of bunch rot diseases, especially black rot.

- Remove mummies from vines throughout the growing season, as they will continue to be a source of inoculum.
- Bury or cultivate mummies on the vineyard floor; exposed mummies can become a source of inoculum early the next growing season. This is difficult, so removal of diseased fruit and mummies during the growing season is recommended.
- Prune and destroy (remove from the vineyard) diseased shoots, cluster stems, and mummies during the dormant season.
- Eliminate wild grapes near the vineyard so they do not serve as a reservoir for diseases. This may be difficult in wooded areas, but wild grapes should at least be removed from fence rows.

### Fungicides

Commercial growers should refer to *Midwest Fruit Pest Management Guide* (ID-232) for specific fungicide names, timing, and applications rates. Residential growers will find this information in *Disease and Insect Control Programs for Homegrown Fruit in Kentucky, Including Organic Alternatives* (ID-21)

***Anthracnose***

Apply a dormant spray of liquid lime sulfur in early spring. If vineyard has a history of anthracnose, applications of foliar fungicides during the growing season may be necessary.

***Black rot***

Fungicide sprays are an important component to successfully managing black rot. Proper timing of applications is essential to be effective; prevention of initial infections is a primary means for season-long control. Apply fungicides beginning at bud break (after 1/2-inch of new shoot growth) and continue through berry maturity. The most important applications are from bloom until 3 to 4 weeks after bloom.

***Botrytis bunch rot***

Begin fungicide applications at bloom. As fruit clusters begin to close, make additional fungicide applications, especially in tight-clustered cultivars. Fungicide applications should continue through veraison; if conditions are wet, sprays should continue through harvest.

***Bitter rot***

Continue the protectant fungicide spray program used to manage other diseases. If vineyard has a history of bitter rot, fungicides should continue past veraison to protect maturing fruit. Pre-harvest applications of a fungicide may be beneficial if bitter rot is a threat.

***Sour rot***

Apply insecticides to manage fruit fly populations. Anti-microbials can be used to manage acetic acid bacteria. Fungicides are not effective for management of sour rot.

### Disease Forecasting

Disease prediction models are available for managing black rot. These models analyze local weather data and help growers determine risk for infection. Using prediction models, growers apply fungicides only during periods of high risk, resulting in fewer applications when compared to calendar-based spray programs. Kentucky growers should refer to the UK Ag Weather Center site for risk evaluations.

**Table 1.** Comparison of the characteristics of the major fruit diseases of grape in Kentucky.

| Disease | Distinguishing symptoms & signs on fruit | Comparison of infection & Symptom development | | | |
|---|---|---|---|---|---|
| | | Plant part(s) affected | Developmental stage(s) susceptible to infection | Conditions favoring sporulation/ infection | When symptoms appear after infection |
| **Anthracnose** | Whitish-gray spots surrounded by reddish-brown to black margin ("bird's eye" appearance). | Fruit, leaves, fruit stems, tendrils, young shoots | Pre-flowering to veraison | ▪ Spore germination & infection can occur at temperatures from 36° to 90°F with sufficient moisture.<br>▪ Optimum conditions: tissues wet for 3 to 4 hours & warm temperatures (77° to 86°F). | 4 to 13 days |
| **Bitter Rot** | Brown water-soaked lesion; black fruiting bodies that form in a ring-like pattern. | Fruit, fruit stems, young, shoots | Bloom to harvest (infects fruit stems & remains latent until fruit ripens) | ▪ Warm, rainy weather<br>▪ Infections can occur from 54° to 86°F.<br>▪ Optimum conditions: tissues remain wet for 6 to 12 hours & warm temperatures (72° to 76°F) | As fruit ripens |
| **Black Rot** | Brown soft rot on immature fruit; fruiting bodies on mummies. | Fruit, leaves, fruit stems, tendrils | 3 to 4 weeks after bloom; no longer susceptible after veraison | ▪ Infections at 50°F require a wetness period of 24 hours.<br>▪ Optimum conditions: tissues wet for 6 to 7 hours & warm temperatures (70° to 80°F). | 2 weeks |
| **Botrytis Bunch Rot** | Soft watery decay; berries become covered with gray to tan fuzzy fungal growth. | Fruit, leaves, flowers | Early developmental stages & from veraison to ripening | ▪ Relative humidity greater than 92%, free moisture present (rain, dew, fog, or irrigation) & temperatures from 58° to 82°F. | 2 to 3 weeks |
| **Ripe Rot** | Uniformly brown lesion form on part or all of berry; pink-to- orange spore masses exude from fungal fruiting bodies. | Fruit | Bloom to harvest | ▪ Favored by wet weather & warm temperatures.<br>▪ Infections can occur at temperatures from 77° to 86°F. | As fruit ripens |
| **Sour Rot** | Rotten berries exude vinegar smell; fungal growth absent. | Fruit | Wounded fruit, especially after veraison; overripe fruit | ▪ Optimum conditions for infection: 77° to 82°F when fruit is at 15° Brix & rain is present.<br>▪ Infections neglible at temperatures below 50°F. | N/A |

## Additional Resources

### Bunch Rot Diseases

- Black Rot of Grape (PPFS-FR-S-16)

https://plantpathology.ca.uky.edu/files/ppfs-fr-s-16.pdf

- Botrytis Blight (PPFS-GEN-19)

https://plantpathology.ca.uky.edu/files/ppfs-gen-19.pdf

- An IPM Scouting Guide for Common Problems of Grape in Kentucky (ID-254)

http://www2.ca.uky.edu/agcomm/pubs/ID/ID254/ID254.pdf

### Management

***General***

- Cultural Calendar for Commercial Grape Production (PPFS-FR-S-27)

https://plantpathology.ca.uky.edu/files/ppfs-fr-s-27.pdf

- Fruit, Orchard, and Vineyard Sanitation (PPFS-GEN-05)

https://plantpathology.ca.uky.edu/files/ppfs-gen-05.pdf

***Residential***

- Backyard Grape Disease, Pest, and Cultural Practices Calendar (PPFS-FR-S-24)

https://plantpathology.ca.uky.edu/files/ppfs-fr-s-24.pdf

- Disease and Insect Control Programs for Homegrown Fruit in Kentucky, Including Organic Alternatives, ID-21 (University of Kentucky)

http://www.ca.uky.edu/agc/pubs/id/id21/id21.pdf

***Commercial***

- Commercial Grape Fungicide Spray Schedule Worksheet and Sample Spray Guides

https://plantpathology.ca.uky.edu/files/ppfs-fr-s-20.pdf

- Effectiveness of Fungicides for Management of Grape Diseases (PPFS-FR-S-18)

https://plantpathology.ca.uky.edu/files/ppfs-fr-s-18.pdf

- Midwest Fruit Pest Management Guide (ID-232)

https://ag.purdue.edu/department/hla/extension/_docs/id-465.pdf

- Midwest Small Fruit Pest Management Handbook, B-861 (University of Kentucky in cooperation with the Midwest Fruit Workers Group)

https://plantpathology.ca.uky.edu/files/mw_sm_fruit_b861_osu_2004.pdf

### Predictive Models

- Ag Weather Plant Disease Prediction Models

http://weather.uky.edu/ky/agmodels.php

- Using Prediction Models to Manage Diseases in Fruit

https://plantpathology.ca.uky.edu/files/ppfs-fr-t-07.pdf

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