PDMG-V3-15

2007 Florida Plant Disease Management Guide: Grape (*Vitis* spp.)[1]

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ANTHRACNOSE

Introduction

Also called bird's-eye rot, anthracnose on grapes reduces berry quality and may weaken the vine. The disease can be particularly severe in the southeastern United States due to the warm, humid weather.

Symptoms

Circular lesions on leaves are light to dark brown and sunken, with dried grayish white centers which often drop out leaving a “shot-hole” appearance. Lesions may cover the leaf surface or develop along the vein, preventing normal development. Tips of shoots may appear burned as the highly susceptible young leaves become malformed and dry. Lesions on shoots are small and isolated with a violet brown to violet black margin; lesions may eventually crack causing the shoot to become brittle.

Symptoms on berries resemble birds eyes. Lesions are surrounded by a narrow, dark margin and have a violet center that gradually changes to a whitish gray. Lesions may extend into the pulp and induce cracking or shriveling of the berries (Figures 1 and 2).

Figure 1. Grape Anthracnose and Bird's eye rot, *Elsinoë ampllina Shear*, damage. Credits: Clemson University - USDA Cooperative Externsion Slide Series.The Bugwood Network, NSF Center for Integrated Pest Management and the University of Georgia

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Figure 2. Grape Anthracnose and Bird's eye rot, *Elsinoë ampllina Shear*, damage. Credits: Clemson University - USDA Cooperative Externsion Slide Series.

Causal Organism

The causal organism of anthracnose is *Elsinoe ampelina* (anamorph *Sphaceloma ampelinum*). Acervuli are found on the exterior of lesions and contain short, cylindrical conidiophores. Conidia are small, hyaline and ovoid, with mucilaginous walls and one or two refractive spots. Asci contain eight brown to black, four-celled ascospores.

Disease Cycle and Epidemiology

Sclerotia overwinter in infected areas of the grape vine or infected berries on the vineyard floor and in the spring release conidia when wet for 24 hours or more at temperatures above 35.6°F. Conidia germinate in green tissue when free water is present for 12 hours or more. Optimal temperatures for disease development are 75.2-78.8° F. Disease development can be severe during years of heavy rainfall.

Management

Care must be taken in selection of grape varieties, as some are more susceptible to anthracnose than others. Fungicides should be applied at label-recommended intervals and rates. See Table 1.

BITTER ROT

Introduction

Bitter rot is a common disease of grape in the southeastern United States and can be particularly severe on muscadine grapes. Yield for grapes grown for direct consumption may be reduced as well as yield for those grown for wine, as the bitter taste of infected fruit is carried through the winemaking process.

Symptoms

The fungus usually invades the cluster stem causing initial berry discoloration at the attachment point. Brownish, water-soaked lesions develop on maturing berries and rapidly spreads, often in concentric rings. Black, raised acervuli appear on the decaying fruit (Figure 3) and can cause the epidermis and cuticle to rupture. Some berries become soft and are easily detached, others continue to dry and shrivel, appearing similar to grapes affected by black rot or ripe rot.

Figure 3. Close-up of fungal fruiting bodies on grape berry infected with bitter rot. Credits: Ohio State University Extension

Other symptoms may include flecking of young leaves and shoots, greenish brown lesions on young berries, and a blight of the pedicels which causes young berries to shrivel and drop.

Causal Organism

Greenaria uvicola is the causal organism of bitter rot. Acervuli are sub-epidermal, separate to confluent, with irregular dehiscence. Conidiophores are irregularly branched, septate, and hyaline. Conidia are dark in color, thin-walled, non-septate, fusiform to oval, with a truncate base and obtuse apex.

Disease Cycle and Epidemiology

G. uvicola overwinters on infected senescent and fallen leaves and berries, damaged shoot tips, and necrotic bark. The fungus invades the dead cells of corky lenticular warts on the berry pedicels and remains latent until the berries reach maturity. At berry maturity the fungus invades the pedicel, moves into the berry and produces conidia. At this stage any injury to the berries, such as bird pecking, insect damage or cracking of berries due to rain, can lead to rapid spread of the disease. The optimal temperature for infection is 82-86°F.

Management

Fungicide sprays are the most common form of management of bitter rot. See Table 1.

BLACK ROT

Introduction

Black rot is an economically important disease of grape, often affecting bunch grapes more severely than muscadines. Disease severity is dependent upon inoculum level, weather, and cultivar susceptibility. Crop losses can range from 5-80%.

Symptoms

The fungus can infect any new growth during the growing season. On leaves, lesions begin as small, tan to reddish-brown, circular spots on the leaf surface, then expand and darken, bordered by a narrow band of dark tissue (Figure 4). Within the dark border small, raised, black pycnidia appear. Around the same time, small, dark lesions may appear on the petioles, eventually turning black. Lesions may girdle petioles, killing the leaf. Throughout the season elongated black cankers containing pycnidia may develop on young shoots.

Figure 4. Black Rot lesions on grape leaf. Credits: Paul Pecknold, Perdue University

Berry symptoms differ between bunch grapes and muscadine grapes. On bunch grapes a small whitish dot bordered by a reddish brown ring is the first symptom of infection. The berries will dry and shrivel into hard, blue black mummies. Infected muscadine grapes develop dry, black scabby lesions which may enlarge and rupture, leading to mummification of the berries (Figure 5). Pycnidia may be found on mummified berries.

Causal Organism:

Guignardia bidwellii (anamorph *Phyllostica ampelicida*) is the causal organism of black rot. Produced in the stroma on overwintered mummies, pseudothecia are black and spherical with a flat or papillate ostioles at the apex. Asci are thick-walled, fasciculate, cylindrical to clavate, and eight-spored. Asci, often surrounded by a mucilaginous sheath, are hyaline, non-septate, oval or oblong, and biseriate. Pycnidia are solitary, black, spherical, erumpent, and ostiolate at the apex. Conidia are hyaline, nonseptate, ovoid or oblong, and rounded at the ends.

Disease Cycle and Epidemiology

G. bidwellii overwinters on infected vines, tendrils, fallen leaves and mummified berries on vines or in the soil. Ascospores are discharged by rainfall, causing leaf lesions and infecting blossoms and young fruit. The optimal temperature for leaf

infection and germination is 80.6°F. Longer wet periods are required for lower temperatures. Pycnidia develop in mummified and newly rotted berries, develop leaf lesions, and release conidia during rain, causing secondary infections of leaves, blossoms and young fruit.

Management

Removal of overwintering mummified berries from the vine and disking mummies into the soil can reduce initial inoculum. Chemical control of black rot has been based on the use of protective fungicides. See Table 1.

BUNCH ROT

Introduction

Bunch rot can be locally damaging if cool, wet weather prevails during the growing season. A reduction in yield and fruit quality can be substantial. Wine flavor may also be negatively impacted; however, in certain cultivars a late-season infection may contribute to exceptionally sweet wines.

Symptoms

In early spring infected buds and young shoots may turn brown and dry out. Later large, reddish-brown necrotic patches may appear on leaves. Before bloom infected inflorescences may rot or dry out and fall off.

Rot can occur quickly in compact grape clusters. Infected white grapes will turn brown, dark grapes develop a reddish color. Infected berries may dry out in drier weather, or become covered by a grayish brown fungal growth (Figure 5).

Causal Organisms

Botrytis cinerea is the causal organism of bunch rot. Mycelium are composed of brownish olive, cylindrical, septate hyphae. Conidiophores are slender, dark, and branched with apical cells bearing clusters of conidia. Single-celled conidia are gray, smooth, and ovoid or globose. Under adverse

Figure 5. Bunch rot of grapes caused by *Botrytis cinerea*. Credits: Photograph coutesy of R. M. Beresford, HortResearch, New Zealand.

conditions black sclerotia may be present on infected tissue.

Disease Cycle and Epidemiology

B. cinerea overwinters in mummified grapes, canes, bark and dormant buds. Conidia are disseminated by rain, overhead irrigation, and wind. Germination can occur in the absence of water if the humidity is above 90%. Optimal temperature for germination is 64.4°F. Penetration of hyphae is usually direct. However, injury from insects, birds, hail, or powdery mildew can facilitate infection.

Management

To reduce disease incidence avoid excessive vegetation, increase aeration and exposure of clusters to the sun, and protect against diseases and pests capable of injuring berries. Fungicides are best used as preventative treatments. See Table 1.

DOWNY MILDEW

Introduction

Downy mildew is common in regions such as the southeastern United States where it is warm and wet during the vegetative growth of the vine. Severe infections can cause losses to current season crops by reducing the sugar accumulation in fruit and the fruit

yield. Future crops can also be affected by reducing the hardiness of overwintering buds.

Symptoms

The causal fungus attacks all green parts of the vine as well as fruit. Leaf lesions begin as irregular yellowish spots on the upper leaf surface. They become reddish brown and angular, often limited by the leaf veins, and exhibit a dense, white, downy growth of fungal spores on the lower leaf surface (Figure 6). Severely infected leaves may drop. Infected shoots curl, develop water-soaked lesions, and become covered with downy, white growth before they turn brown and die. Symptoms similar to those of infected shoots may be seen on infected petioles, tendrils and young inflorescences.

Figure 6. Downy mildew symptoms on lower leaf surface. The patches of downy growth are usually directly beneath the yellowish green spots observed on the upper leaf surface. Credits: Hank Dankers, University of Florida, IFAS, NFREC Quincy

Infected young berries may develop brown lesions or appear grayish (gray rot) before being covered by downy fungal growth (Figure 7). Infected older berries may change to gray-green (white berries) or pinkish red (dark berries), develop brown-to-purple spots and drop easily, leaving a dry stem scar.

Causal Organism

Plasmopara viticola, an obligate parasite, is the causal organism of downy mildew on grape. Sporangia are ellipsoid, hyaline, 14 x11 µm and are borne on treelike sporangiophores. Biflagellate, uninucleate zoospores emerge from the side of the sporangia. Oospores form in parasitized tissue, are

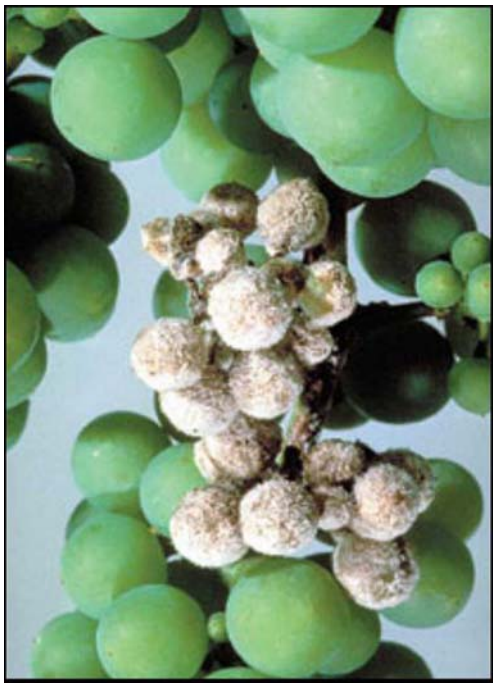

Figure 7. Downy mildew on grape fruit. Credits: Ohio State University Extension

enveloped by two membranes and covered by the wrinkled wall of the oogonium.

Disease Cycle and Epidemiology:

P. viticola overwinters in fallen and persistent leaves, and in moist soil. Oospores germinate in water when temperatures are above 51.8°F and produce sporangium from which zoospores are released via rain-splash. *P. viticola* penetrates the host via the stomata. Downy mildew is favored by factors that increase the moisture content of soil, air and host plant.

Management

Removal of sources of overwintering inoculum, improved soil drainage, and pruning the ends of infected shoots may help reduce incidence of powdery mildew. This may be impractical or insufficient in susceptible vineyards; therefore, use of fungicides is often necessary. See Table 1.

MUSHROOM ROOT ROT

Introduction

Mushroom root rot is also known as Armillaria root rot, oak root fungus disease, and shoestring root rot.

Symptoms

Infected vines may exhibit wilting, stunting, small dark green foliage and will eventually die. Foliar chlorosis and necrosis may develop depending on the speed of plant decline. A creamy white layer of fungus can be observed at the soil line beneath the bark on trunks of infected vines (Figure 8). In late fall or early winter honey-colored clumps of mushrooms may arise at the soil line around the trunk, adjacent to the stem, or within the root zone of a declining plant.

Figure 8. Armillaria root rot on grape roots. Credits: OSU Extension On-Line Guide, Everett Hansen, OSU

Causal Organism

Armillaria tabescens (anamorph *Armillaria mellea*) is the causal organism of mushroom root rot. Mushroom fruiting bodies vary in size, color and number. Distinguishing characteristics are the production of true rhizomorphs and large white plaques of hyphae found beneath the bark at the soil line.

Disease Cycle and Epidemiology

A. tabescens moves between plants by root contact; susceptible roots are penetrated by rhizomorphs. In grapes the fungus tends to move down rows, but can move across rows in older vineyards.

Mangement

Avoid setting vines where vines have previously died from this disease unless the root system has been removed and several years of fallow have passed, or in recently cleared land that had oak cover. Fumigation of soil can assist in the control of mushroom root rot.

PIERCE'S DISEASE

Introduction

Pierce's disease is a principal limiting factor in bunch grape production in the southeastern United States. The pathogen can be transmitted by grafting, but is spread primarily by insect vectors.

Symptoms

Symptoms vary with species and cultivar but involve a general loss of plant vigor followed by death of part or all of the affected vine. Leaves may display marginal scalding or interveinal chlorosis and necrosis, or appear mottled (Figure 9). Severely infected leaves often drop from the vine, leaving the petiole attached. Bud break may be delayed resulting in stunted shoots and smaller leaves. Berries that set may color prematurely, wilt, or dry up. Canes may mature unevenly, leaving green tissue surrounded by brown mature wood.

Figure 9. Concord grape leaf infected with Pierce's disease. Credits: Photo courtesy of Breno Leite, IFAS, University of Florida.

Causal Organism

The causal organism of Pierce's disease is *Xylella fastidiosa*. *X. fastidiosa* resides in the plant xylem tissue. It is a small, gram-negative bacterium with a convoluted cell wall of several layers and fibrous strands. It is difficult to culture, or fastidious, hence its name.

Disease Cycle and Epidemiology

X. fastidiosa can survive and reproduce in the xylem tissue of many native plants, both monocotyledonous and dicotyledonous. Varying genera of sharpshooter leafhoppers (Cicadellidae) and spittlebugs (Cercopidae) serve as vectors, transmitting the bacterium between plants during feeding. Bacteria form dense aggregates in xylem vessels and restrict water conduction to tissue. In Florida the disease is most commonly transmitted by sharpshooters from vine to vine.

Management

The use of resistant cultivars is the only effective control for Pierce's disease is the southeastern United States.

POWDERY MILDEW

Introduction

Powdery mildew is usually a minor disease in the southeastern United States. Left uncontrolled, however, it can reduce vine growth, yield, quality and winter hardiness. Infected berries may be unmarketable as fresh fruit and produce off-flavors in wine.

Symptoms

Like downy mildew, powdery mildew can infect all green parts of the grapevine as well as the fruit. The presence of mycelia on the surface of host tissue gives it a white to gray, powdery appearance (Figure 10). Both upper and lower leaf surfaces are susceptible to infection; upper leaf surfaces may also develop chlorotic spots similar to those of downy mildew. Infected petioles and cluster stems may become brittle and break. The tissue of infected shoots may appear dark brown to black in feathery patches.

Figure 10. Powdery mildew of grape. Credits: Photo by Ken Johnson, Oregon State University

Cluster infections may result in poor fruit set. Berries infected before they reach full size do not attain proper epidermis growth and split from the internal pressure of pulp growth. Split berries dry up or rot, often becoming susceptible to bunch rot or dropping. Berries may develop a blotchy appearance or a netlike pattern of scar tissue.

Causal Organism

Uncinula necator (anamorph *Oidium tuckeri*) is the causal organism of powdery mildew. Hyphae are septate and hyaline, and develop multilobed appressoria with penetration pegs. Multiseptate conidiophores form along the hyphae at regular intervals. Conidia accumulate in chains and are hyaline and cylindro-ovoid. Cleistothecia are globose with long, flexuous, multispetate appendages and four to six asci. As cleistothecia mature they change from white to yellow to brown and appendages develop a crook. Asci are ovate to subglobose with four to seven ascospores. Ascospores are ovate to ellipsoid and hyaline, with one or more short germ tubes.

Disease Cycle and Epidemiology

U. necator overwinters inside dormant buds (infected during the previous growing season), or on the surface of the vine. After bud break, white

mycelium covers emergent shoots and produce conidia which are dispersed by wind to nearby vines. Alternately, ascospores, released from cleistothecia during rain, may germinate and infect green tissue, producing conidia for secondary spread. Temperatures of 68-80.6°F are optimal for disease development, as is low, diffuse light.

Management

Orienting rows to provide good air circulation and sun exposure, as well as using training systems that allow good air movement through the canopy can reduce disease incidence. An open canopy can also allow for better penetration of fungicides. See Table 1.

PSEUDOCERCOSPORA LEAF SPOT

Introduction

Pseudocercospora leaf spot, also called leaf blight or Isariopsis leaf spot, occurs primarily in the southeastern United States. This disease often appears after harvest, when spraying is discontinued.

Symptoms

Symptoms first appear on the lower, more shaded leaves as brown angular spots that eventually darken and become brittle. The spots are often surrounded by a clearly defined border on upper leaf surfaces and a more diffuse margin on lower leaf surfaces. Dark bristle-like fruiting bodies can be seen on the leaf undersides when using a hand lens. Premature defoliation may occur in wet seasons.

Causal Organism

Pseudocercospora vitis (perfect stage *Mycosphaerella personata*) is the causal organism of pseudocercospora leaf spot. Fruiting structures are slender and black, bearing olive brown elongate conidia. Found on dead leaves in late season, perithecia are black, round, embedded and warty above. Asci are club-shaped.

Management

See Table 1 for fungicide control.

RIPE ROT

Introduction

Ripe rot affects bunch grapes, but can be particularly severe on muscadine grapes, especially in the southeastern United States where the weather is warm and humid. Losses vary between seasons, regions and cultivars.

Symptoms

Ripe rot occurs on grapes as they ripen and has symptoms similar to those of bitter rot. Infected berries develop circular reddish-brown lesions on their skins, which eventually enlarge to cover the entire berry. Within the lesions are concentric zones of salmon-colored conidia (Figure 11). Berries shrivel as they decay and remain attached to the vine or drop as the rot is complete.

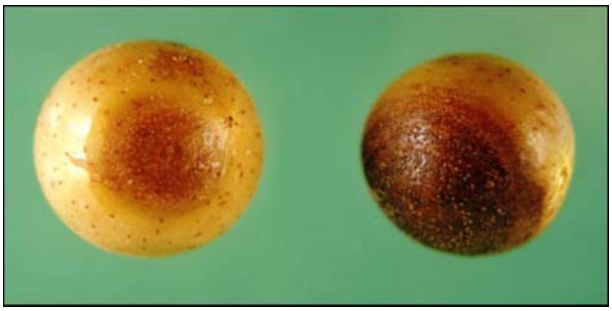

Figure 11. Ripe rot of Muscadine grape. Credits: Photo courtesy of Bill Cline, Plant Pathology Department, NCSU

Causal Organism

Glomerella cingulata (anamorph *Colletotrichum gloeosporioides*) is the causal organism of ripe rot. Acervuli are produced subepidermally in rings. Conidia are hyaline, salmon-colored, guttalate, rounded at the ends and slightly curved. Perithecia usually grouped and subspherical. Asci are subclavate.

Disease Cycle and Epidemiology

C. gloeosporioides survives between seasons in mummified berries and infected pedicels. Production of conidia is greatest in the early spring and decreases in the summer months; conidia are spread to other parts of the vine by rain. Disease development is

favored by warm, wet weather. Conidia germinate, produce appressoria and penetrate the cuticle of green or ripening fruit. The fungus will delay further growth until the grapes mature. Sporulation on ripe fruit near harvest can provide a secondary inoculum, which can be exacerbated by frequent rains and result in severe crop loss.

Management

Removal of overwintered mummies before new growth can reduce initial inoculum and disease incidence. Fungicides sprayed on green berries during the fruit-ripening period can reduce losses. See Table 1.

INFORMATION SOURCES

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Compendium of Grape Diseases. 1990. American Phytopathological Society.

CDMS Chem Search. http://premier.cdms.net/webapls

Table 1. Fungicides approved for disease management of Grape in Florida.

Chemical (a.i.)	Fungicide Group [1]	Max rate/acre		Min. days to harvest	Disease	Remarks [2]
		Application	Season			
Pristine (boscalid + pyraclostrobin)	7	8-12.5 oz	69 oz	14	Anthracnose, Black Rot, Bunch Rot, Downy Mildew, Powdery Mildew, Pseudocospora Leaf Spot, Ripe Rot	
Basic Copper 53, Cuprofix Disperss (basic copper sulfate)	M1	2.5-6 lb			Anthracnose, Black Rot, Downy Mildew, Powdery Mildew	Some vinifera may be copper sensitive
Kocide 101, Champion WP, Nu Cop 50WP (copper hydroxide)	M1	2-4 lb			Black Rot, Downy Mildew, Powdery Mildew	Use hydrated lime for copper sensitivity
Kocide 2000, Kocide DF, Nu Cop 50DF (copper hydroxide)	M1	1.5-4 lb			Black Rot, Downy Mildew, Powdery Mildew	Use hydrated lime for copper sensitivity
Kocide 4.5LF, Champ Formula 2F, Nu Cop 3L (copper hydroxide)	M1	11/3-22/3 pt			Black Rot, Downy Mildew, Powdery Mildew	Use hydrated lime for copper sensitivity
Dithane DF Rainshield, Manzate 75DF, Penncozeb 75DF (mancozeb)	M2	1.5-4 lb	24-25.6 lb	66	Black Rot, Bunch Rot, Downy Mildew	
Dithane F45 Rainshield, Manzate Flowable (mancozeb)	M2	1.2-3.2 qt	19.2 qt	66	Black Rot, Bunch Rot, Downy Mildew	
Dithane M45, Manzate Pro-Stick, Penncozeb 80WP (mancozeb)	M2	1.5-4 lb	24 lb	66	Black Rot, Bunch Rot, Downy Mildew	
Manex (maneb)	M3	1.2-3.2 qt	19.2 qt	66	Black Rot, Bunch Rot, Downy Mildew	
Dusting Sulfur, Kumulus DF, Micronized Gold, Micrthiol Disperss, Sulfur 90W (sulfur)	M1	rate varies see labels			Powdery Mildew	

Table 1. Fungicides approved for disease management of Grape in Florida.

Chemical (a.i.)	Fungicide Group [1]	Max rate/acre		Min. days to harvest	Disease	Remarks [2]
		Application	Season			
Thiophanate Methyl 85WDG (thiophanate methyl)	1	0.6-1.2 lb	3.2 lb	14	Bitter Rot, Black Rot, Powdery Mildew	
Topsin M 70WP, Topsin M WSB (thiophanate methyl)	1	0.75-1.5 lb	4 lb	14	Bitter Rot, Black Rot, Bunch Rot, Powdery Mildew	
Ziram 76DF, Ziram Granuflo (ziram)	M2	3-4 lb	28 lb	21	Black Rot, Bunch Rot, Downy Mildew, Ripe Rot	
Nova 40W, Rally 40 WSP (myclobutanil)	3	3-5 oz	1.5 lb	14	Anthracnose, Black rot, Powery mildew	

[1] Fungicide group (FRAC code): Numbers (1-37) and letters (M, U, P) are used to distinguish the fungicide mode of action groups. All fungicides within the same group (with same number or letter) indicate same active ingredient or similar mode of action. This information must be considered for the fungicide resistance management decisions. M = Multi site inhibitors, fungicide resistance risk is low; U = Recent molecules with unknown mode of action; P = host plant defense inducers. Source: http://www.frac.info/ (FRAC = Fungicide Resistance Action Committee).

[2] Information provided in this table applies only to Florida. Be sure to read a current product label before applying any chemical. The use of brand names and any mention or listing of commercial products or services in the publication does not imply endorsement by the University of Florida Cooperative Extension Service nor discrimination against similar products or services not mentioned.