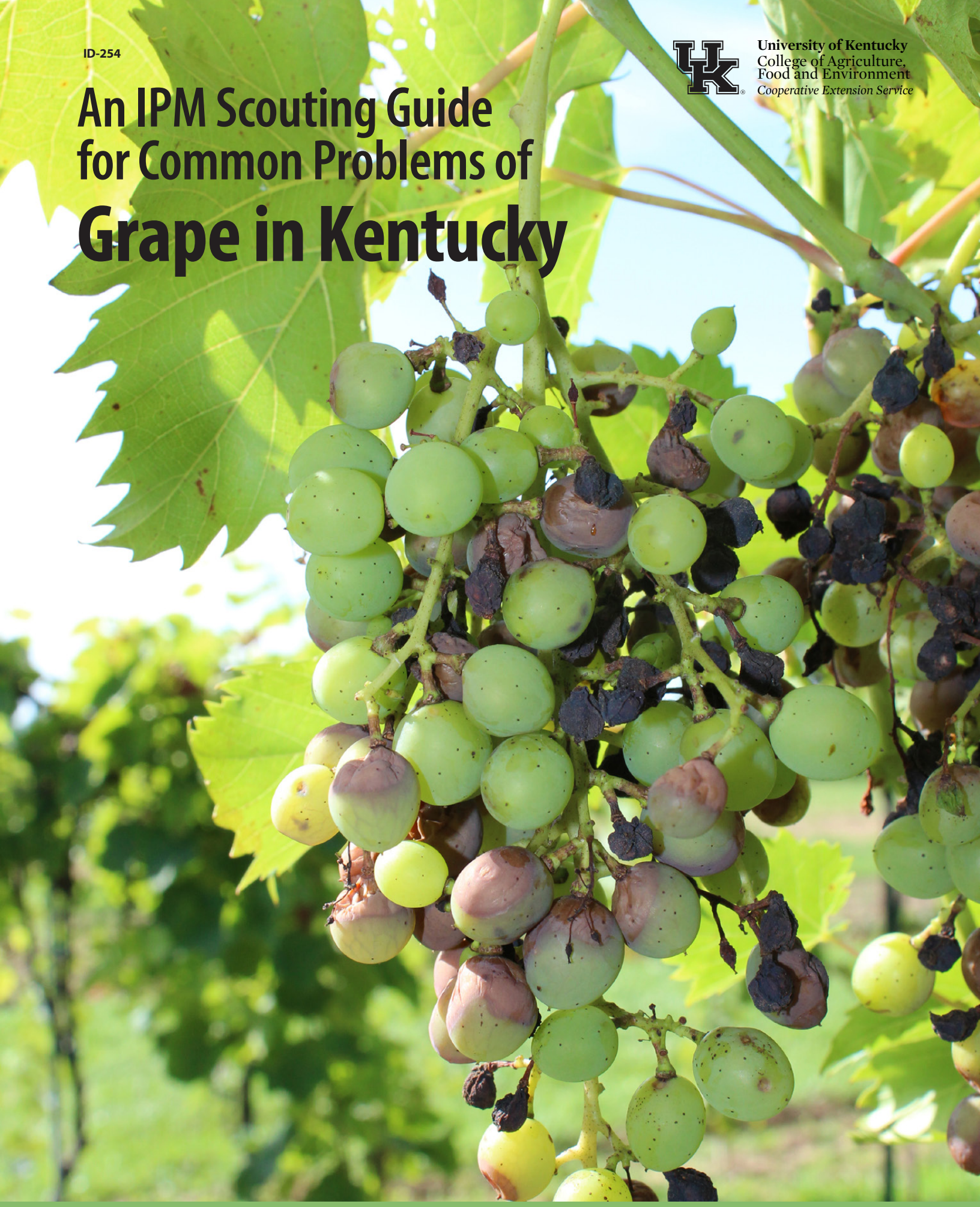
ID-254

University of Kentucky
College of Agriculture, Food and Environment
Cooperative Extension Service

An IPM Scouting Guide for Common Problems of Grape in Kentucky



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An IPM Scouting Guide for Common Problems of Grape in Kentucky

This manual is the result of efforts of the University of Kentucky Fruit Integrated Pest Management team.

Contents

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Cover:
Black rot of grape
Nicole Gauthier, UK

Long before the term "sustainable" became a household word, farmers were implementing sustainable practices in the form of Integrated Pest Management (IPM) strategies. IPM uses a combination of biological, cultural, physical, and chemical methods to reduce and/or manage pathogen and pest populations. These strategies are used to minimize environmental risks, economic costs, and health hazards. Pathogens and pests are managed (although rarely eliminated entirely) to reduce their negative impact on the crop.

Scouting and monitoring for diseases, insects, weeds, and abiotic disorders helps identify potential problems before serious losses result. This is essential to the IPM approach. The key to effective monitoring is accurate identification. The images included in this guide represent the more common abiotic and biotic problems that occur in Kentucky grape plantings.

This manual is not all-inclusive, and growers may encounter problems not included here. Growers should contact a local Cooperative Extension Service office for further assistance. Additional information on pathogen and pest identification and management, as well as grape production, can be found in the resources listed on page 35, available online or at county Extension offices.

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(Note: any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture)

Diseases

1. Anthracnose (*Elsinoe ampelina*) is a prevalent fungal disease that causes stem cankers and shoot dieback. Symptoms first appear as small red spots on succulent tissue, such as shoots, pedicels, tendrils, and cluster stems (rachises). Spots on shoots enlarge and become sunken with dark, reddish-brown to purple borders and gray to tan centers. Centers of lesions often crack and may resemble hail damage. Leaf spots resemble shoot lesions and become angular as they reach leaf veins; centers of spots may drop out. Berry symptoms also begin as red spots, enlarge to about ¼ inch diameter, and become sunken with wide, reddish-brown to purple borders and gray-tan centers. Tiny black fruiting structures (acervuli) are visible in centers of fruit spots and may exude masses of pink spores (conidia). The fungus overwinters (sclerotia, ascospores, or conidia) on infected shoots; in spring, infection can occur after 24 hours of wetness. Secondary spread is caused by splashing conidia. The higher the temperature, the faster the spread. Disease is more severe during years with heavy rainfall.

Anthracnose on grapevine (a); spots on canes with dark borders and tan centers (b); foliar symptoms (c); damage to fruit (d); and close-up of advanced symptoms on fruit (e).

Management—Practice proper sanitation (remove infected canes; destroy prunings or discard away from plantings). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (especially dormant application). Consider planting tolerant cultivars and/or species (American type).

2. Bitter rot (*Greeneria uvicola,* syn *Phyllostictina uvicola*) is caused by a weakly pathogenic fungus. Any damaged fruit or green tissues can become infected, particularly those injured by cold or insects. Pedicels are infected by rain-splashed spores soon after flowering; once ripening begins, the infection moves into berries. Concentric rings of rough, corky sporulation (acervuli) become visible as berries reach full size; berries soften or drop or may dry up and hang onto vines. Infected berries may resemble black rot or ripe rot. Rotted fruit taste bitter and can affect wine flavor. Shoot infections may girdle tissue and cause dieback, especially in *V. vinifera*. The fungus overwinters in fallen leaves and berries, as well as in woody shoot lesions. **Management**—Practice proper sanitation (remove infected tissue). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Manage diseases and insects; avoid wounding.

Bitter rot and visible acervuli on fruit.

3. Black rot (*Phyllosticta ampelicida,* syn. *Guignardia bidwellii*) is a fungal disease that primarily affects leaves and berries. Leaf infections cause brown to tan circular spots up to ½ inch diameter with visible black specks (pycnidia) around perimeters of lesions. Infected shoots, cluster stems (rachises), and tendrils develop purple to black sunken lesions with visible pycnidia. Spores (conidia) from pycnidia spread by splash and can cause secondary infections throughout the growing season. Conidia can continue to infect berries for 2 to 4 weeks after bloom. Fruit infections appear as light brown spots, which can have visible pycnidia on the surface. Entire berries usually turn brown, shrivel rapidly, and become hard and black. They remain on the rachis as "mummies" during the winter. The fungus overwinters as fruiting structures (pseudothecia) in the mummies and on canes. Spores (ascospores) are released in spring soon after budbreak when shoots are approximately 1 inch long (hard green stage).

Black rot leaf spots (a); close-up of leaf spots with pycnidia around margins (b); black rot fruit symptoms (shriveled berries) (c); close-up of decayed fruit with visible pycnidia (d); and shoot lesions with visible pycnidia (e).

Management—Practice proper sanitation (remove all infected berries, mummies, and infected tissue; destroy debris or discard away from plantings). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (especially early season applications to control primary infections).

4. Botrytis bunch rot (*Botrytis cinerea*) or **gray mold** is caused by a ubiquitous and opportunistic fungus with a wide host range. It colonizes dead and damaged tissue before spreading to nearby healthy tissue. Blossoms, young berries, injured tissue, and overripe fruit are susceptible to infection. Berry infections can occur early in the season and remain latent (dormant) until berry ripening; blossoms and young clusters are highly susceptible to infection. Symptoms during ripening vary with weather conditions: during dry weather, berries dry out, but in wet or humid weather, gray moldy growth develops on berry surfaces. Infected shoot tips wither and become blighted. Spore production occurs during wet or humid conditions; spores spread by wind or rain. Infections continue as long as moisture and susceptible tissue are present. The pathogen overwinters as sclerotia (which develop in autumn) in infected buds, in debris, or in rachises and fruit mummies.
Management—Practice proper sanitation (remove infected berries, remove damaged and infected tissue). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (especially before cluster closure).


4a


4b


4c

Botrytis bunch rot between berries (a) and advanced symptoms (b, c).

5. Crown gall (*Rhizobium vitis*, syn *Agrobacterium vitis*, *Agrobacterium tumefaciens biovar 3*) is a soilborne bacterial disease specific to grape species; this biovar is different from the one that infects other plant hosts. Galls first appear near the soil line as soft white spherical galls that resemble callus tissue. Expanding galls darken and increase in numbers; they girdle trunks, resulting in reduced yields, stunting, dieback, and eventual trunk death. Galls occasionally develop on cordons. Early dieback symptoms may be confused with nutrient deficiency. Infection occurs through injured tissue (e.g., mechanical injury or freeze damage); vigorous plants are often less susceptible to infection. The bacterium spreads from plant to plant through pruning and tillage equipment or through introduction of infected plants. The bacterium survives for 2 or more years in soil in the absence of plant tissue, and it can survive for many years belowground in roots.


5a


5b

Crown gall symptoms on young vine (a) and close-up of enlarged galls (b).

Management—Purchase indexed vines; take cuttings only from indexed vines. Avoid cold-sensitive cultivars/species. Protect plants from freeze. Avoid wounding. Avoid movement of soil from infested areas of the vineyard to non-infested areas. No bactericide has been proven effective for prevention or management.


6a


6b


6c


6d


6e

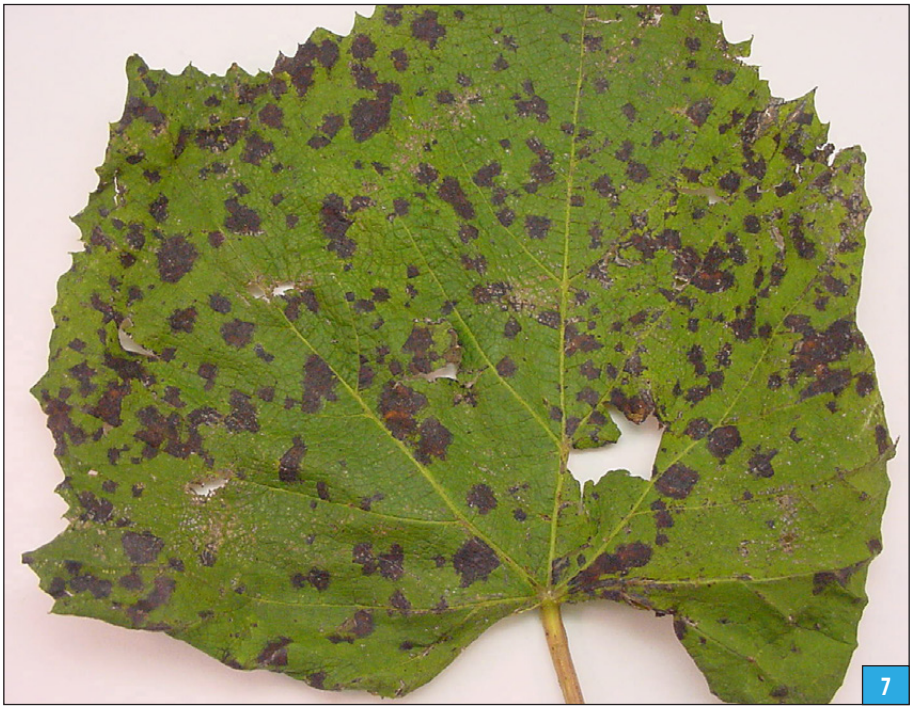
Downy mildew causing leaf symptoms and leaf drop (a); early symptoms on upper leaf surface (b); necrotic leaf spots (c); and downy mildew growth on undersurface of leaves (d), tendrils (e), and on rachises and pedicels (f).

6. Downy mildew (*Plasmopara viticola*) is caused by a water mold and is most severe in wet areas or during rainy seasons. All green plant parts, especially leaves, are susceptible. Leaf infections begin as yellow, mottled spots on upper surfaces; spots become reddish-brown along veins; downy growth develops on undersides of leaves. Leaf spots turn necrotic (dead), and severely infected leaves drop. Premature defoliation may decrease winter hardiness. Infected shoot tips, petioles, and tendrils become distorted and downy sporulation develops. Infection of cluster stems (rachises) can lead to loss of entire clusters. Fruit may become infected up to 3 to 4 weeks after bloom; infected fruit turn purple and shrivel. This cyclic disease depends upon rain and leaf wetness. Fruiting structures (sporangia) that contain swimming spores (zoospores) are produced when free water is available (greater than 95% humidity); zoospores are disseminated by rain splash and wind-driven rain. Overwintering occurs in leaf debris on the vineyard floor. **Management**—Practice proper sanitation (remove infected tissue). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (beginning at budbreak). Post-harvest fungicide applications can reduce infection and leaf drop that decreases winter hardiness. Consider planting tolerant cultivars.


6f

7. Leaf spots (*Cercospora, Septoria, Isariopsis/ Ppseudocercospora, Pestalotia*) are caused by a range of fungi. These minor leaf spots rarely become severe enough to cause yield losses. Well-managed vineyards seldom have leaf spot diseases when fungicides are applied for other diseases.

Management—Promote plant vigor. Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, and managing weeds). Apply fungicides (especially early season fungicides used to control primary diseases).



Pseudocercospora leaf spot.

8. Phomopsis cane and rachis rot (*Diaporthe* spp. and *Phomopsis* spp.) is a fungal disease that produces lesions in the first three or four basal internodes of shoots; girdled shoots die. Visible black fruiting structures (pycnidia) that contain spores (conidia) develop in these shoot infections. Conidia from lesions are spread by rain to developing shoots and leaves, as well as to cluster stems (rachises) and fruit. Stem, shoot, and rachis infections appear as dark brown or black streaks that coalesce; cortex tissue cracks, becoming rough and brittle. Fruit infections occur within the first weeks after bloom, but symptoms do not become apparent until berry ripening. Shoot infections may continue through the season if conditions are wet; spread usually occurs within a single canopy rather than from vine to vine. Fruit symptoms appear as a light brown rot with visible black pycnidia; berries shrivel. Overwintering occurs on older, infected shoots.

Management—Practice proper sanitation (remove infected canes; destroy prunings or discard away from plantings). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (from cluster development until 3 to 4 weeks after bloom).

9. Phytophthora crown and root rot (*Phytophthora* spp.) is caused by a soilborne water mold pathogen that favors wet conditions. *Phytophthora* infects roots and crowns (bases) of vines. Often, symptoms appear after a rainy season; disease is more prevalent in heavy or poorly drained soils. Newly planted vines are especially susceptible. Root loss and/or crown decay result in disruption of water uptake, and

Phomopsis foliar symptoms (a) and lesions on vine and rachis (b).

Phytophthora crown and root rot symptoms.

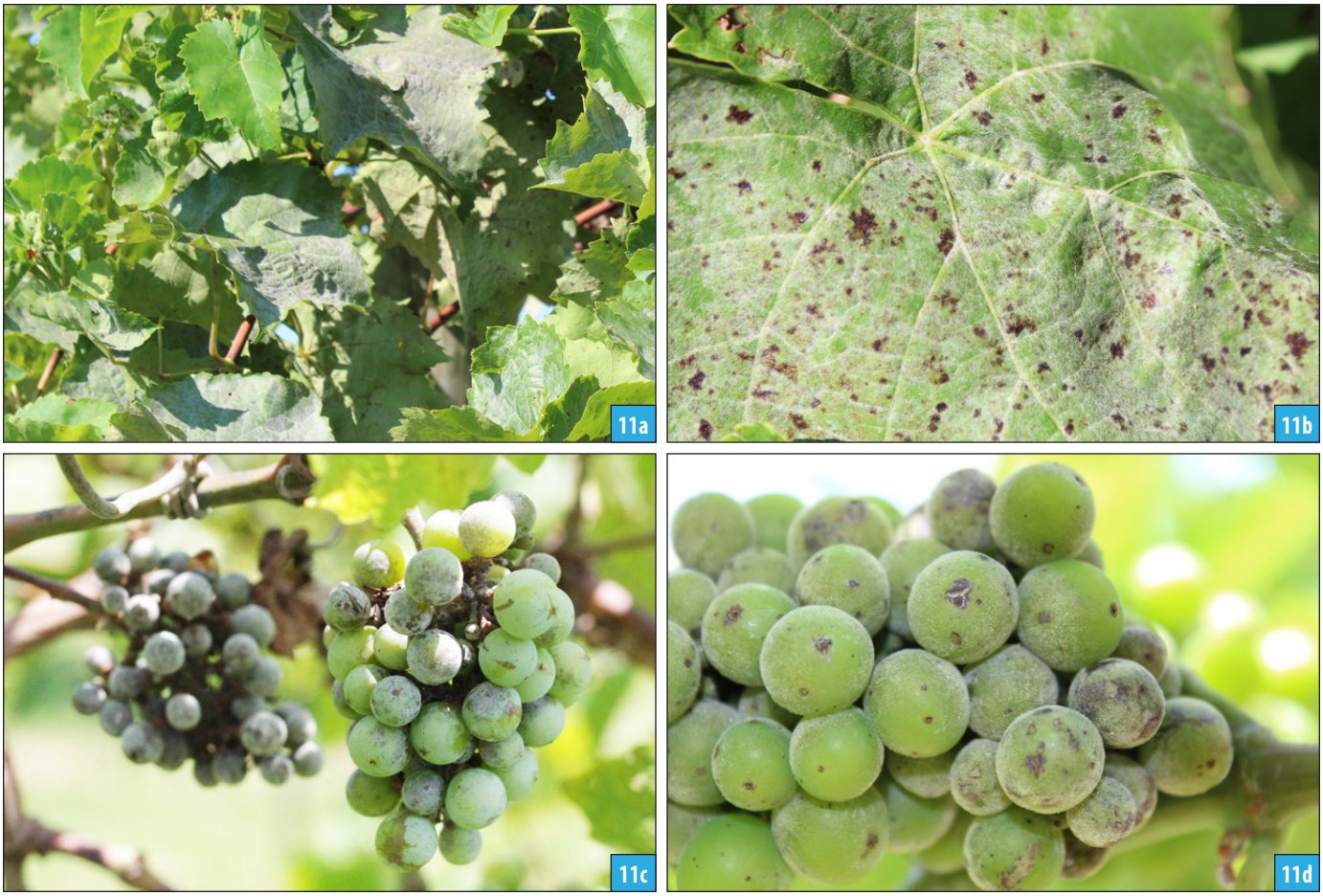
symptoms resemble drought stress. Leaves become chlorotic and plants become stunted; plants may die back slowly or may die abruptly. Wet conditions initiate spore production (sporangia containing zoospores); spores are transmitted via running water or infested soil. The pathogen overwinters as oospores in infected roots and crowns.

Management—Begin with clean stock. Improve internal drainage, plant onto raised beds, avoid movement of infested drain water or infested soil. Destroy infected plants before disease spreads to nearby vines. Specialty fungicide drenches help suppress disease as long as applications are made; these products do not cure disease.

10. Pierce's disease (*Xylella fastidiosa*) is a bacterial disease that causes leaf and cane dieback, and eventually plant death. The bacterium infects plant vascular tissue (xylem), resulting in restricted water uptake. Early symptoms begin as scorching, drying, and withering along leaf margins. As scorching spreads inward, leaves wither and drop; often petioles remain attached. Affected canes remain succulent and green but fail to mature; this symptom may extend into the dormant season. As disease progresses, plants exhibit delayed budbreak, stunting, short internodes, and small leaves. Sucker shoots are often associated with severely infected plants. Infected plants die within 5 years, and young or stressed plants die more rapidly. Transmission occurs when leafhopper, sharpshooter, and spittlebug vectors ingest bacteria from xylem fluids of infected plants (grapes, grasses, shrubs, trees) and then feed on noninfected grapevines. Symptoms are more severe on *V. vinifera* than on American species. Bacterial cells overwinter in xylem tissue of infected plants. Pierce's disease is not common in Kentucky vineyards.

Management—Avoid establishing orchards near alternative hosts. Select tolerant cultivars. Practice proper sanitation (remove infected vines). Manage vectors; insecticides used for other insect pests may control populations.

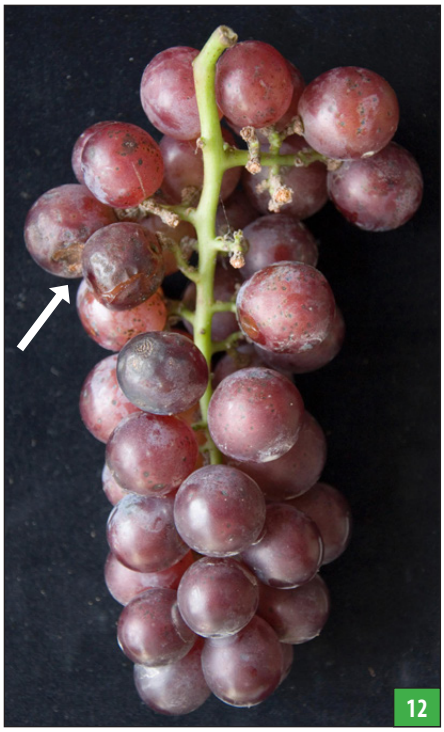
Marginal leaf scorch caused by Pierce's disease (a) and close-up of foliar symptoms (b).



Powdery mildew growth on foliage (a); symptoms and signs late in the season (b); powdery growth on berries (c); and close-up of powdery mildew on fruit (d).

11. Powdery mildew (*Erysiphe necator)* is a fungal disease that infects succulent tissues and spreads throughout the season. Losses result from fruit infection and reduced winter hardiness if disease is severe. Infected berries can become misshapen, develop scar tissue on cuticles, or split. Berry infections begin at bloom and extend until a few weeks after bloom. Infected berries become more susceptible to Botrytis bunch rot and sour rot. Cluster stems and leaves are susceptible to infection throughout the season. A powdery fungal growth covers infected tissues; leaves become curled, distorted, and stunted. High humidity promotes spore (conidial) development, but humidity as low as 40% is sufficient for infection; disease can occur at low humidity levels when other diseases are typically suppressed. The fungus overwinters on infected stems or buds as survival structures (chasmothecia, syn cleistothecia) that form during late autumn. In early spring, ascospores are released and primary infections begin the disease cycle.
Management—Practice proper sanitation (remove and destroy infected berries and tissue). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides (beginning at bud break).

12. Ripe rot (*Colletotrichum* spp.) is a fungal disease that causes berry rot during ripening. All berry stages are susceptible to infection, but symptoms develop as berries mature (after veraison). Early symptoms include circular reddish-brown spots that enlarge to cover entire berries. Salmon-colored masses of spores (conidia) appear during wet weather. Infected berries remain attached to vines until the entire berry is rotted; berries eventually shrivel to mummies. The fungus overwinters in mummified fruit and infected pedicels. Bitter rot is usually not a problem in well-maintained orchards when fungicides are used to manage other diseases.
Management—Practice proper sanitation (remove infected fruit; destroy mummies). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Apply fungicides to manage other diseases.



Ripe rot (arrow points to infected berries).


13

Damaged berries caused by sour rot.

13. Sour rot is caused by a combination of fungi, yeasts, bacteria, fruit fly larvae, and other organisms. Fruit symptoms include splitting, a sour vinegary smell, and oozing juice. Infections are initiated during wet weather when one or more berries in a cluster are injured; contaminated juice from infected berries spreads to others within the cluster. Black, brown, or green spores may be visible, and fruit fly larvae may be present. Cracked and damaged berries serve as a breeding ground for other microorganisms, which intensifies damage. Associated rots increase each year, especially in poorly managed vineyards; a dry season can stop or reduce disease progression.
Management—Practice proper sanitation (remove infected fruit). Increase air circulation to encourage drying of plant tissues (pruning, thinning, spacing, managing weeds). Manage diseases and insects, especially fruit flies.

14. Virus diseases (leafroll disease, corky bark, ringspot decline, red blotch) are caused by a range of different viruses. Symptoms vary from vine stunting and decline to irregular or deformed leaves or poor yields. Most viruses are transmitted by insect vectors and/or grafting of infected wood. There have been no confirmed cases of virus diseases in Kentucky during the past 20 years. However, leafroll disease (caused by Grape Leafroll-Associated Viruses GLRaV-1 and/or GLRaV-10) has been reported in *V. vinifera* cultivars in nurseries from the Eastern U.S. Ringspot virus decline (caused by either or both TRSV and TomRSV) is becoming more prevalent in the U.S., especially in the highly susceptible cultivar 'Vidal Blanc.' Risk for introduction of virus diseases is primarily via new plant introductions.


14a


14b

Grapevine yellows and leaf roll (a) and fanleaf virus (b).

Management—Begin with clean plant material, preferably indexed stock. Practice proper sanitation (remove and destroy infected vines). Resistant rootstocks are recommended for ringspot-susceptible cultivars.

Botyrosphaeria canker symptoms on cordons (a) and cross section of Botryosphaeria-infected vine (b).

15. Wood/cane cankers (*Botryosphaeria*, etc.) can occur in vineyards when plants are stressed and weakened. Canker-causing fungi enter woody tissue through wounds, such as pruning cuts, mechanical injury, and insect damage.

Management—Practice proper sanitation (remove and destroy infected vines). Promote plant vigor. Avoid wounding (mechanical or physical damage, insect wounds).

Insect Pests

16. Grape berry moth (*Lobesia viteana*) adults are active and about ¼ inch long. When moths are at rest with wings folded, a brown band is visible across the middle of the insect. Moths are gray-blue with brown markings on the hind portion of the body. Mature larvae are ⅖ inch long, pale olive-green, and can have a purplish tinge as a result of the food they ingest. Pupae are about ⅓ inch long, greenish-brown to dark brown, and are found under a flap that larvae cut from leaves and fold over. Larvae damage vineyards by feeding on grape blossoms and berries. Infested berries may appear discolored, shriveled, and covered with fine webbing; secondary fruit rots are also common. This insect has three generations per year.

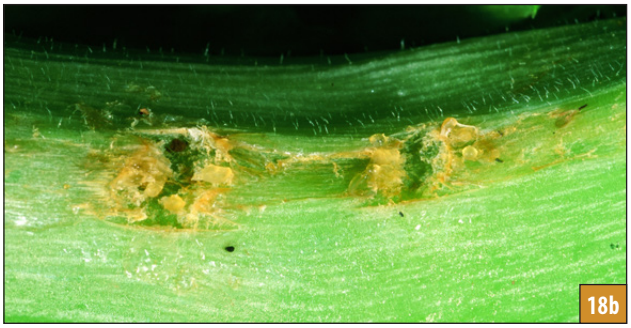
Management—Clean up or bury leaf litter in winter to eliminate overwintering pupae. Time insecticide applications using a developmental model on the UK Ag Weather website. Monitor adult moth activity using pheromone traps, which can enhance timing of insecticide applications.

Off-colored berry with webbing deposited by grape berry moth (a); grape berry moth larva on berry (b); pupa covered by a folded leaf flap (c); and adult (d).

17. Eastern grape leafhopper (*Erythroneura comes*) is a tiny leafhopper, about ⅛ inch in size with light-colored wings that have orange markings. It is common in midsummer and feeds on leaves with piercing sucking mouthparts, sometimes causing small, light-colored discolorations called stippling on foliage. Various other leafhopper species are also common in vineyards. Leafhoppers are known to transmit the pathogen that causes Pierce's disease of grapes, although the disease is uncommon in Kentucky vineyards.

Management—Monitor populations beginning in mid-summer. Use insecticides to keep damage below 10%.

Eastern grape leafhopper (a) and another leafhopper species that is common on grape (b).



Grape gallmaker adult (a). Eggs are laid in small holes above node (b); cause injury (c) and result in gall formation (d).

18. Grape cane gallmaker (*Ampeloglypter sesostris*) is a ⅛-inch common weevil that is present throughout the eastern U.S. in May and June. The female lays an egg in one of a series of holes she chews along the cane just above a node when canes are 10 to 20 inches long. This results in the development of 1-inch-long gall-like swellings on shoots; galls reach twice the diameter of a cane and may be discolored. Galls rarely reduce plant vigor or yield but can make vines more susceptible to breakage. Adults are active in late May and overwinter in debris on the ground. One generation occurs per year. **Management**—Prune and destroy galled shoots during summer. Apply late-spring insecticide sprays when infestations are heavy (scouting). While the galls are commonly found in most vineyards, they rarely cause economic losses.

19. Grape cane girdler (*Ampeloglypter ater*) is a ⅛-inch-long weevil that resembles the closely related grape cane gallmaker. Just before bloom, adult females chew several small punctures that encircle new shoots, followed by another series of punctures 3 to 4 inches above the first set. Eggs are laid only in the first series of punctures. These puncture sites make shoots susceptible to breakage. Damage is often located beyond the fruit clusters, but shoot breakage is especially damaging in newly planted blocks. **Management**—Prune shoots below the lower series of punctures in early summer prior to adult emergence. Destroy prunings. Apply insecticides to young vines early in the season before egg laying and girdling occur. This pest rarely reaches damaging levels.

Initial damage caused by grape cane girdler (a) and resulting vine breakage (b).

Grape flea beetle near a swelling bud (a) and flea beetle larva feeding on a developing fruit cluster (b).

20. Grape flea beetle (*Altica chalybea*) adults are dark metallic, greenish-blue jumping beetles about ⅕ inch long. Larvae are brownish and marked with black spots. Adults overwinter in protected areas around vineyards and begin feeding just as buds begin to swell. Larvae feed on expanded leaves and developing fruit clusters. Feeding on interior portions of primary buds and unfolding grape leaves results in hollow buds and ragged, tattered leaves. Damaged buds do not develop into primary canes, which can reduce yields. Injury is often restricted to vineyard borders, particularly near wooded areas.

Management—Apply an insecticide at bud swell when flea beetles are common and injury to the small buds is observed.

Phylloxera leaf galls (a); close-up of galls (b); and mature leaf gall containg phylloxera insects (c).

21. Grape phylloxera (*Daktulosphaira vitifoliae*) is a tiny aphid-like insect with piercing-sucking mouthparts. Damage can be identified by the characteristic galls produced on leaves and roots. Leaf galls are unsightly and result in minimal damage. Severe galling can suppress photosynthesis up to 50% and can cause defoliation and reduce shoot growth. However, the presence of leaf galls can be a sign of root infestations, which can be difficult to control and can lead to vine decline. Each mature gall may release dozens of phylloxera. Hosts include cultivated and wild grapes. There are several overlapping generations per year.

Management—Utilize resistant rootstocks. In small plantings, remove galled leaves by hand early in the year. Apply foliar insecticides.

Grape plum moth larvae (a) and adult moth on a flower (b).

A mating pair of grape root borer moths (a); grape root borer pupal case partially protruding from the soil (b); and root borer larvae causing root damage (c).

Adult grape rootworm.

22. Grape plume moth (*Geina periscelidactyla*) larvae are light green caterpillars with prominent light-colored hairs. These early-season caterpillars feed inside groups of young leaves that they have webbed together. It is a minor pest.

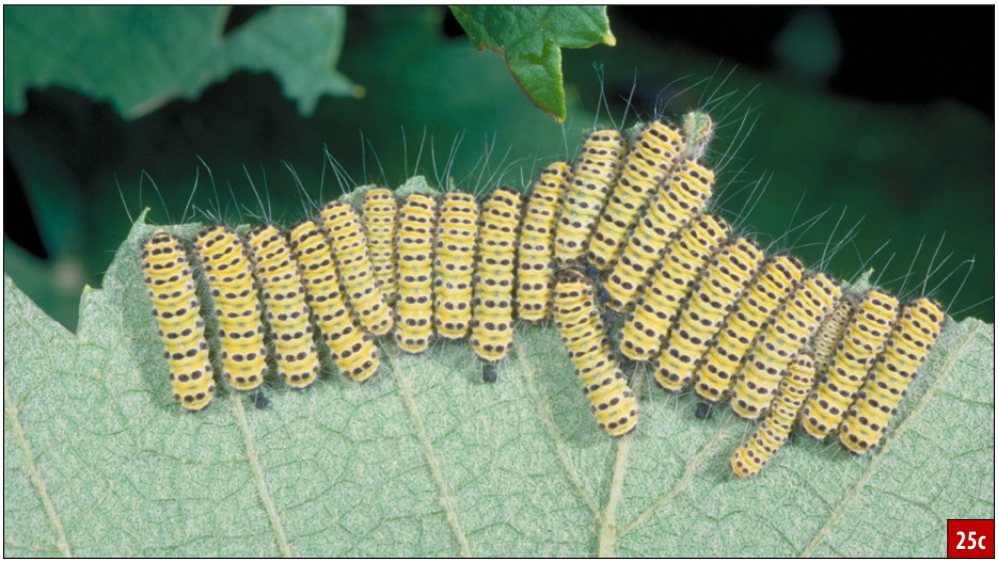
Management—Apply insecticides (especially early-season applications to control primary insect pests). This pest rarely reaches damaging levels.

23. Grape root borer (*Vitacea polistiformis*) is potentially the most destructive insect attacking grapes in Kentucky. Adults are brown moths with thin yellow bands on their abdomens; they resemble paper wasps. Front wings are brown, while hindwings are clear. Larvae are 1½ inch long when mature and have a retractable brown head. The root borer life cycle takes 2 years to complete. Damage occurs when larvae tunnel into larger roots and crowns of vines. Pupal cases appear protruding from bases of vines at soil level. Aboveground symptoms include poor vine growth, reduced fruit set, and vine loss. **Management**—Eliminate weeds around bases of vines to reduce egg-laying sites and to improve spray coverage. Monitor protruding pupal cases (especially in late summer). Apply insecticides around bases of vines. In small plantings and backyard settings, apply plastic mulch, which provides an effective barrier and prevents larvae from burrowing underground.

24. Grape rootworm (*Fidia viticida*) is a ¼-inch long, light brown to dark brown beetle. Adults emerge in late May and early June and make narrow feeding marks in leaves. Eggs are laid in crevices on vines. Upon emergence, larvae drop to the ground and feed on roots; in 1 to 2 years, they emerge as adults. Larval damage to roots is much more important than the leaf feeding by adults. **Management**—Manage adults to prevent egg-laying; proper timing and selection of insecticides are important. Some grape berry moth insecticide sprays help manage grape rootworm. This pest rarely reaches damaging levels.


25a


25b


25c


25d

Young grapeleaf skeletonizer larvae (a); resulting injury (b); older larvae (c); and adult (moth) (d).

25. Grapeleaf skeletonizer (*Harrisina americana*) larvae are yellow with transverse bands of black dots. Young larvae feed on undersides of leaves, eating through some leaf layers, but not all. This gives the leaf a skeletonized appearance; affected areas later become necrotic (dead). Older larvae eat completely through leaves.
Management—Apply insecticides (especially early-season applications to control primary insect pests) if populations are high. This pest rarely reaches damaging levels.

26. Grapevine aphid (*Aphis illinoisensis*) is a native pest that is easily recognized by its dark color, pear-shaped body, and two tailpipe-like cornicles on its abdomen. It feeds in colonies with piercing-sucking mouthparts, removing sap from leaves and shoots. It is occasionally found in vineyards, but it is rarely a serious pest.
Management—This aphid rarely reaches damaging levels.


26

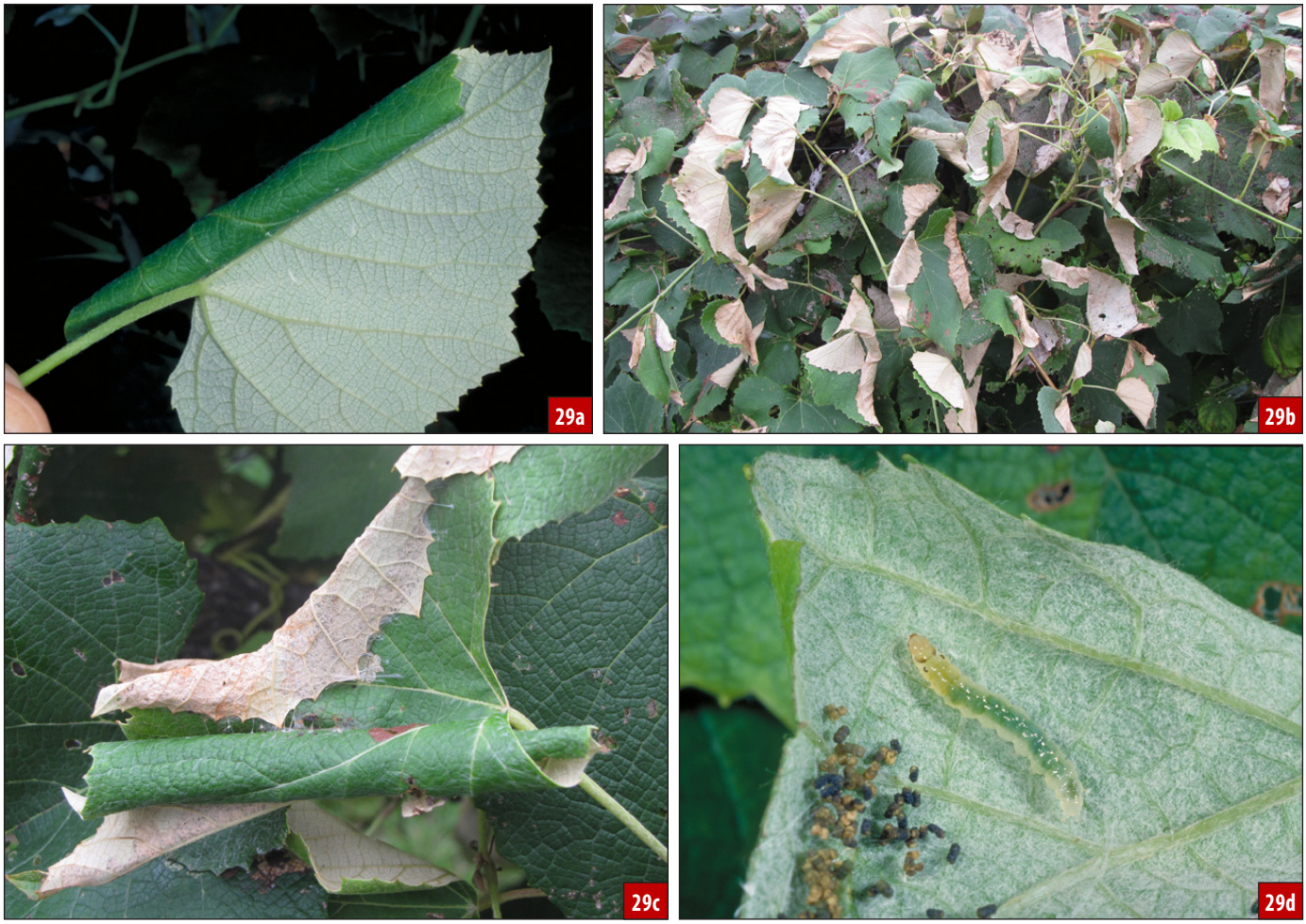
Grapevine adult and immature aphids.

Green June beetle adults feeding on fruit (a) and larva (b).

27. Green June beetle (*Cotinis nitida*) adults are about 1 inch long with dull, metallic green wings and bronze to yellow margins on their head and sides; undersides are shiny green. Larvae are cream-colored, up to 2 inches long, and crescent-shaped. Larvae crawl on their backs and project legs upward when moving. Berries are susceptible to adult beetle feeding as fruit turn color and soften, leading to damage near harvest of early-ripening cultivars. Green June beetle only feeds on fruit, not on foliage. **Management**—Apply insecticides, as needed (especially during harvest). In backyard and other small plantings, use netting with a mesh ¼ inch or smaller to exclude beetles.

28. Japanese beetle (*Popillia japonica*) is highly attracted to grape leaves and is a serious pest during some years. Adults are ⅜-inch-long metallic green beetles with copper-brown wing covers. Five small white tufts of hairs project from underneath wing covers at the tip of their

Japanese beetle damage (a); feeding damage to grape leaves (b); damage to berries (c); and grub (d). Grape cultivars vary in attractiveness to Japanese beetle; note the difference in grapevines in the foreground compared to those in background (e).



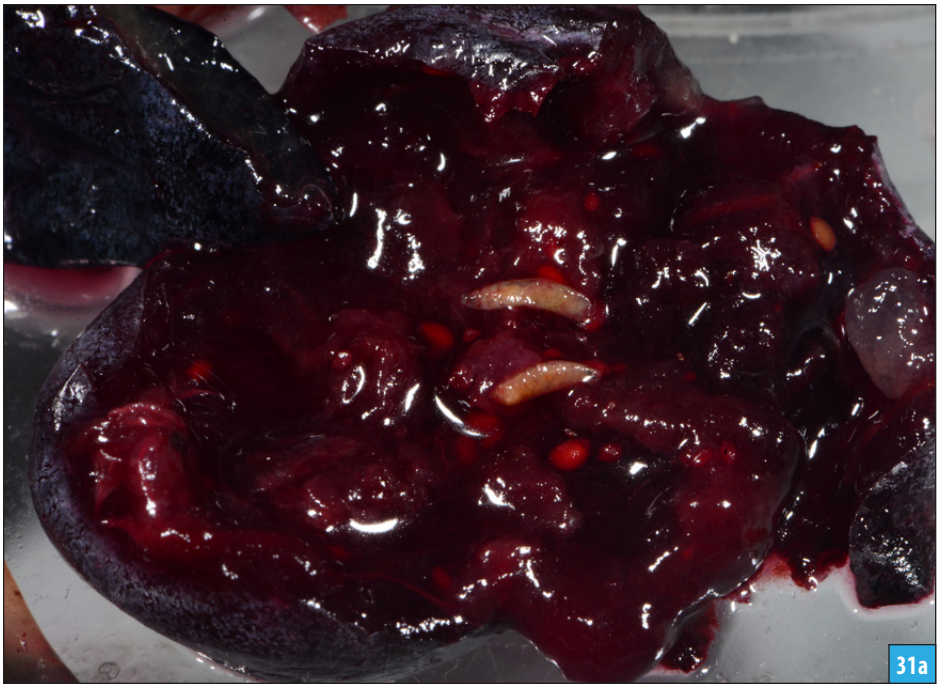
Leaf rolled with silk by leafroller larvae (a); foliage damage by larvae (b); leaf damage close-up (c); and leafroller larva feeding inside rolled leaf (with black and brown waste material) (d).

abdomen. Mature larvae, which feed on roots of grasses, are crescent-shaped grubs about 1 inch long with a brown head and grayish-black end. Hairs on the last segment (raster) form a V-shaped pattern near the anal opening of grubs. Feeding on leaf tissue between large veins results in skeletonized leaves. Beetle feeding begins on upper leaves and can be more severe with some thin-leaved varieties. Damaged leaves release volatile chemicals, which attract more Japanese beetles. Japanese beetle damage to berries can attract green June beetle and result in additional damage.
Management—Avoid use of Japanese beetle traps, as these generally attract more beetles and result in increased damage to plantings. Controlling grubs in the soil has little effect on adult management. Apply foliar insecticides mid-season.

29. Leafrollers (*Lepidoptera* spp.) appear in spring in their larval stage; there are several species of leafrollers present simultaneously. Larvae roll leaves together using silk, and they feed on leaves while protected inside the rolled leaves. Generally, leafrollers are not found in sufficient numbers; thus, they do not cause economic damage.
Management—Apply insecticides (especially early-season applications to control primary insects). This pest rarely reaches economically damaging levels.

30. Sap beetles (Family Nitidulidae) are secondary pests that are attracted to the smell of fermenting plant juices of ripe, damaged, or cracked fruits. This is a group of small flat beetles recognized by short wing covers that do not reach the tip of the abdomen. Sap beetles and their larvae feed on damaged berries and contaminate harvested clusters. Damage may appear as small holes in the bottoms of berries. Sap beetle damage often occurs after a rainy period that delayed harvest or as a contaminant in clusters of berries.
Management—Harvest regularly. Practice sanitation (remove damaged, diseased, and overripe berries in a timely manner). Apply insecticides, as needed (especially during harvest).

One of several species of sap beetle (adult).



Spotted wing drosophila larvae (on blueberry) (a); adult male (b); and adult female with distinct ovipositor (c).

31. Spotted wing drosophila (*Drosophila suzukii*) is a serious invasive pest of soft-skinned fruits, including some grape cultivars. Adults have red eyes, clear wings, and bodies that are amber-colored and 1/10 inch long. Adult males have a single dark spot on each wing near the tip (the spot may not be apparent on newly emerged males) and two small but distinct dark "bands" on each front leg. The female is more difficult to identify, as she is distinguished by less obvious characteristics: serrated ovipositor, unbroken banding of the abdomen, and sharp appearance to the cross vein in the wing. Larvae, which infest and damage fruit, are legless, white and about 1/8 inch in length.

Management—Collect overripe, damaged, or rotting fruit in clear bags and leave in the sun. Cool or refrigerate berries immediately after harvest to slow egg hatching and larval development. Fine screening or netting can be used to cover small plantings. Set traps for adults 10 days before harvest; treat weekly with insecticides if any adults are detected.

Weeds

Canada thistle seedling (a); foliage (b); and in bloom (c).

32. Canada thistle (*Cirsium arvense*) is a difficult-to-manage perennial that spreads by seeds and rhizomes. Leaves have spines and are deeply lobed; leaf margins wrap around bases of stems, causing stems to look spiny. Flower heads are purple to pink. Root systems may extend more than 10 feet deep.
Management—Avoid cultivation. Cut or mow plants to help reduce root reserves and to starve plants. Apply spot applications of herbicides when shoots are at least 10 inches tall and before flowers open (when plants are most susceptible to herbicides).

33. Crabgrass (*Digitaria* spp.) are common summer annual grasses that tolerate most soil conditions. Leaves are broad and up to ½ inch wide. The first seedling leaves are parallel to the ground, unlike most other grass cotyledons that are perpendicular. Plants spread readily by rooting at the nodes; however, reproduction is by seed. Seed heads typically consist of three to seven spikes, but they may have more. Plants die after the first heavy frost.
Management—Apply pre-emergent grass herbicides prior to seed germination (when soil temperature is 57°F at a 1-inch depth, approximately early April). Invest in a soil thermometer to ensure timely herbicide applications. Post-emergent herbicides are less effective than pre-emergents.

Crabgrass growth habit (a) and flowers (b).

Dallisgrass flowers (a) and seeds (b).

34. Dallisgrass (*Paspalum dilatatum*) is a perennial grass with short rhizomes that develops clumping patches. Clumps are often brown in the center. Leaves may turn reddish late in the season. Primary reproduction is by seed. Seeds are found on thin wire-like branches arising from tall seedheads; this is a key identifying feature.

Management—Apply a pre-emergent grass herbicide to seedlings; pre-emergents are ineffective against established clumps that have developed rhizomes. Manage established clumps by spot-spraying with a non-selective systemic herbicide, such as glyphosate.

35. Field bindweed (*Convolvulus arvensis*) is a deep-rooted herbaceous perennial that spreads by seeds and rhizomes. Arrow-shaped leaves are 1 to 2 inches across and 2½ to 5 inches long. Vines can reach 10 feet and will climb any nearby supports, including grape vines. Flowers are trumpet-shaped and can be confused with those of morningglories (see # 39).

Management—Apply glyphosate to plants or cut stems in late summer prior to the formation of overwintering rhizomes. Repeatedly cutting stems can be effective to starve root systems, but it is a slow process and must be repeated frequently.

Field bindweed in bloom.

36. Honeyvine milkweed (*Cynanchum leave*, syn *Ampelamus albidus*) is a vining weed with a large, perennial taproot, rapid growth rate, high seed production, and minimal treatable leaf surfaces. Leaves are 4 to 7 inches long and heart-shaped; they are paired and opposite each other along a tough, narrow vine with a milky sap. Green seedpods are 3 to 6 inches long and resemble other milkweed pods. This weed rapidly grows upward through grapevines, making it difficult to manage with post-emergent herbicides. Honeyvine milkweed is difficult to control.

Honeyvine milkweed growing up a vine support and into grape canopy (see arrow), (a) and growth habit (b).

Honeyvine milkweed growth habit (c) and milkweed seed pod (d).

Management—Apply pre-emergent herbicide. Apply post-emergent herbicide persistently and repeatedly after germination.

37. Johnsongrass (*Sorghum halepense*) is an aggressive perennial common in agronomic fields, along roadways, and in waterways and areas that are prone to flooding. Mature leaf blades are 5 to 20 inches long with obvious white ribs down their centers. Plants reproduce by seed and by perennial rhizomes, making control difficult. Rhizomes are stout compared to other grasses and can begin forming as quickly as 1 month after seed germination.

Management—Apply pre-emergent herbicides to help prevent seedling establishment. Post-emergent herbicides selective for grasses can be applied when plants are seedlings, but these are less effective once rhizomes have formed. Avoid cultivation, which spreads rhizomes.

Johnsongrass growth habit (a) and in bloom (b).

Marestail growth habit (a, b) and flowers (c).

38. Marestail/Horseweed (*Conyza canadensis*) is an annual to biennial weed that can reach heights of 3 to 6 feet. Stems are nearly completely covered with alternate ascending leaves approximately 2½ inches long by ½ inch wide. Leaves may even appear whorled due to their dense arrangement. Seeds germinate throughout spring, summer, and autumn. Plants mature and set seed the same year. Late-season plants overwinter in the rosette stage. One plant may release 20,000 seeds that disperse easily by wind.
Management—Cultivate to destroy young plants. Apply pre-emergent herbicides to prevent seed germination. Use burn-down herbicides during seedling or rosette stages. Glyphosate-resistant marestail is becoming more common. Herbicide-resistant populations should be confirmed by a county Extension agent or the Weed Science Society of America.

Morningglories in bloom (note color variations).

39. Morningglory (*Ipomoea* sp.) is a common vining weed; most Kentucky species are annuals. Leaves are 3 to 5 inches long, typically heart-shaped or ivy-shaped, and flowers are trumpet-shaped in a variety of colors. This weed will smother desired plants and interfere with pesticide applications and harvest. Seed can remain dormant for decades.
Management—Physically remove with hoe or string trimmer, cutting below cotyledons. Apply spot applications of burndown herbicides; most herbicides are only moderately effective.

40. Mulberry (*Morus* spp.) is a native tree with berry-like fruit. Young trees are fast growing with leaves of varying shapes (lobed and non-lobed) and emerge alternately on the same branch. Any other woody plant that produces fleshy fruit attractive to birds may also be a problem in vineyards. These weedy plants grow from seed deposited by feeding birds.

Mulberry leaf variations (a) and fruit (b).

Pokeweed seedling (a); foliage and growth habit of older plants (b); and immature (green) and mature (purple-black) fruit (c).

Management—Apply herbicides (spot spray with glyphosate). Dig up seedlings or cut repeatedly to prevent reestablishment. Manage bird populations to decrease deposited seeds.

41. Pokeweed (*Phytolacca americana*) is a broad-leaved perennial distinguished by its red stems and flower clusters. Leaves are 10 inches long and lance-shaped with smooth margins. Plants reach 8 to 10 feet and have a very large, deep taproots. Fruit grow in grape-like clusters and are a favorite among birds, which readily spread seeds.
Management—Cultivate or cut plants at the seedling stage. Apply glyphosate to cut stems.

42. Yellow foxtail (*Setaria pumila*, syn *S. glauca*) is a summer annual found in a wide range of soil conditions. Its yellow-tan, bristly seedheads distinguish it from green foxtail (*Setaria viridis*) and giant foxtail (*Setaria faberi*). Leaves are 5 to 10 inches long and ½ inch wide at the base. Leaves are mostly smooth, except for a few white hairs clustered near the leaf base. Yellow foxtail can be difficult to control if allowed to set seed because it is a prolific seed producer. Cultivation is difficult because of the extensive, fibrous root system. Populations resistant to ALS-herbicides and photosystem II-Inhibitors have been reported in the United States.

Yellow foxtail flower heads.

Management—Mow before seed set. Apply pre-emergent herbicides or herbicides selective for grasses.

Wildlife

Bird damage to fruit (a) and netting placed over vines to protect from bird damage (b).

43. Birds (various species of small birds, such as American robins (*Turdus migratorius*), mockingbirds (*Mimus polyglottos*), and many other similar sized avian species), consume or damage fruit as it begins to ripen. Depending on the species present, damage may range from pecking injury to absence of fruit. Secondary issues may include the introduction of weed seeds and subsequent weed establishment.
Management—Use netting over plants to help limit bird access and feeding. Check netting regularly and repair holes promptly. Use deterrents, such as lasers, auditory distress tapes, and propane cannons to limit damage or to protect crops during the harvest period. Deterrents that may be less effective but can be used in combination with other methods include predatory balloons, raptor decoys, or fake snakes. Combinations of deterrents will be more successful than using just one.

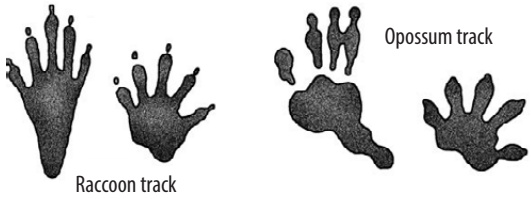
44. Black bear (*Ursus americanus*) damage occurs when they are attracted to ripe or near-ripe fruit. Bears eat fruit directly off plants; they can also break or damage plants or trellises during feeding. Black bears potentially exceed 300 pounds and are capable climbers. Look for tracks or scat around plants or for large numbers of broken/damaged plants close together.
Management—Protect vines using electric fencing (voltage of at least 8,000 volts). Use propane cannons, activated when fruit is almost ripe, to deter bears from the area (beginning 2 to 3 weeks before harvest).

45. Rabbits (*Sylvilagus* spp.) cause damage in spring to young shoots of newly planted vines or during winter to trunks of established grapevines.
Management—Protect young shoots with grow tubes; however, they should be removed to allow for proper shoot maturation. Apply taste-deterrents, such as capsaicin-based products or Thiram, to help deter chewing. Protect older grapevines with hardware cloth trunk guards. Remove brush piles and tall grass around grapevines to help decrease suitable rabbit habitat.

Eastern cottontail rabbit (a). Rabbit feeding on grape trunks is similar to the damage shown here on an apple tree (b).

Black bear.

Black bear track



Raccoons (a), and grape skins left on the ground after raccoon feeding (b). Opossum (c).

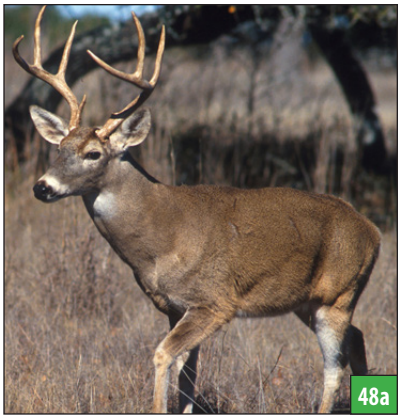
46. Raccoons (*Procyon lotor*) and **opossums** (*Didelphis virginiana*) cause damage when berries begin to ripen. They either consume grapes or damage plants while accessing berries. Damage is usually localized but extreme. Look for tracks or scat in or around plants to identify species. Raccoons also leave piles of grape skins on the ground after consuming fleshy portions of fruit. Because they are nocturnal, both opossums and raccoons cause damage at night. **Management**—Install metal fencing in small-scale operations to reduce opossum damage; however, metal fencing is not effective on raccoons. Electric fencing is effective for both opossums and raccoons when a live wire is located at nose level (about 4 to 6 inches off the ground). Trapping or shooting individuals is also effective. Set cage traps baited with tuna fish or cat food.

47. Voles (*Microtus* spp.) and mice (*Peromyscus* spp.) chew on irrigation lines as well as bases of grapevines near ground level. Voles are most problematic during winter months when they chew on trunks, whereas mice cause more damage to fruit during summer. Teeth marks on trunks or fruit and high concentrations of vole runs or holes are key identifying characteristics. **Management**—Use a combination of habitat management and avian predators to offset vole or mouse populations. Keep grass mowed between rows to limit habitat cover. Place 12- to 15-foot-tall perch (1-inch diameter PVC pipes with a 1-foot roost section mounted perpendicular at the top) to attract natural avian predators.

Meadow vole (a); vole feeding damage to trunk (b); and entrance to vole tunnel (c). Tall grass (left) is suitable habitat for voles, while mowed grass (right) deters voles (d).

48. White-tailed deer (*Odocoileus virginianus*) and **elk** (*Cervus canadensis*) consume new plant growth and fruit, depending on the time of year. During spring and summer, deer and elk clip leaves and new shoots, leaving behind distinctive angled teeth marks. They also consume ripe fruit, but this may be minor relative to destruction of vines and trunks. **Management**—Protect plants using 8-foot-high metal fencing for deer and elk; where elk are not present, a plastic 8-foot fencing is effective in protecting plants from deer. Side fencing or zone fencing options exist and can help prevent access to plant material. Off-set (double wire) and overhanging slant electric fence designs are also effective. Reduce the overall deer population on the property through hunting.

49. Wild turkey (*Meleagris gallopavo*) can be major grape consumers, especially as fruit ripens. Damage includes total fruit loss, but large peck marks in berries may also be apparent. Damage occurs during daytime hours. Look for tracks or scat present around vines. **Management**—Deter birds using propane cannons and lasers. Netting is less effective. Vertical netting can help limit access to fruit. Hunting to reduce numbers aids in long term management.


48a


48b


48c


48d

White-tailed deer (a); deer track (b); and feeding damage to grape shoots (c). Elk (d).

Elk track


49a


49b


49c

Wild turkey (a); tracks (b); and damage to grapes (c).

Abiotic Disorders

50. Frost and **freeze injury** results when cold temperatures kill young shoots and flower clusters in spring. Injured tissues usually drop from vines.

Management—Select vineyard sites with good air drainage. Delay pruning. Reduce vineyard freezing using equipment such as wind machines (air inversion), overhead irrigation (sprinklers), or supplemental heat sources.

Leaf distortion caused by freeze injury that occurred during the bud stage (a); partial freeze injury to foliage (b); severe frost injury resulting in shoot death (c); frost-injured primary buds with subsequent growth of uninjured secondary buds (d); and frost-injured flower cluster in which blooms were killed (e).

51. Hail injury damages canes, foliage, and fruit. Foliage becomes shredded and may be torn completely from the canopy. Injured shoots can have dents and broken epidermis. Bruises, cracks, and scarring develop on fruit; physical damage alone can cause significant berry quality and crop loss. Wounded tissues also become potential sites for infection by disease-causing organisms.

Management—Spray fungicides following a hail storm to protect vines from disease-causing infections.

Leaves torn from vines as a result of hail damage (a); damage to fruit (b) and fruit and vine injury (c).

52. Herbicide: 2,4-D (2,4 dichlorophenoxyacetic acid) injury symptoms include leaf twisting, malformation, and curling. Injury results when grapevines are exposed to the herbicide by spray drift, volatilization, or sprayer contamination. Grapes are extremely sensitive to 2,4-D, especially ester formulations.

Management—Avoid using 2,4-D in or near vineyards. Communicate with vineyard neighbors to request their cooperation when they are applying 2,4-D.

Leaf distortion caused by 2,4-D herbicide.

Dicamba injury to grape foliage (a), and reduced fruit set due to dicamba (b).

53. Herbicide: Dicamba injury symptoms include reduced leaf size, upward leaf cupping, delayed fruit ripening, and cessation of cane terminal growth (and subsequently, lack of lateral growth), often over entire vines. Fruit fail to set if exposure occurs during bloom. Symptoms are typically not uniform across a vineyard; individual plants or small groups of plants may show symptoms while adjacent plants may appear unaffected. Damage typically does not carry over to the following year.

Frequency of injury has risen with increased dicamba use (to control glyphosate-resistant weeds in dicamba-tolerant soybeans). Some grape cultivars (e.g., 'Aromella,' 'Edelweiss,' 'Fredonia,' and 'Niagara') are very sensitive, while others (e.g., 'Chambourcin,' 'Marquet,' and 'Vignoles') are moderately resistant.
Management—Communicate with nearby growers (e.g., soybean growers) to request their cooperation when they are making dicamba applications.

54. Herbicide: Glyphosate (e.g., Roundup) injury symptoms occurring at the time of exposure include crinkled leaves with cuplike depressions between major veins. Late season injury results in multiple stunted shoots emerging from nodes the following season. Damage may not be evident until the following year if vines are exposed to glyphosate after mid-July.
Management—Avoid contact with vines and minimize drift (shielded sprayers, low pressure spray, calm days).

Glyphosate injury symptoms (a, b).

Simazine injury to grape foliage.

Pale foliage due to nitrogen deficiency.

55. Herbicide: Simazine injury symptoms include interveinal chlorosis (yellowing) and can potentially progress to necrosis (browning, tissue death). Damage occurs when simazine is used repeatedly for a number of years or if the rate is too high.

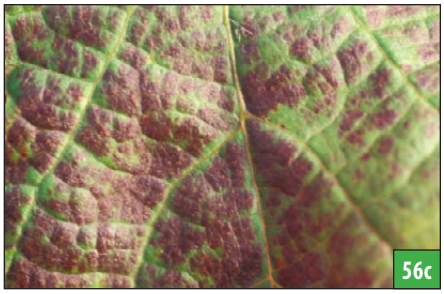
Management—Follow label instructions and label rates when applying simazine in vineyards.

56. Magnesium deficiency appears as interveinal chlorosis (yellowing), which may progress to necrosis (browning, tissue death) in severe cases. Symptoms develop in mid- to late summer on older leaves.

Management—Monitor nutrient levels through foliar analyses. For short-term correction, apply MgSO4 (Epsom salts) beginning after bloom. For long-term correction, apply dolomitic lime (if soil pH is below 5.5) or magnesium sulfate, magnesium oxide, or Epsom salts as a band beneath vines.

57. Nitrogen deficiency symptoms include reduction in shoot growth, small or stunted leaves, and foliar chlorosis (yellowing) over the entire plant. Nitrogen deficiency is common in poor soils or where annual nitrogen applications are neglected.

Management—Monitor nitrogen levels through foliar analyses and apply nitrogen annually based on need. Avoid excess nitrogen, which leads to excessive growth and adds a "grassy" flavor to wine.



Magnesium deficiency on green-fruited grape (a); on red grape (b); and close-up of symptoms on red grape foliage (c).

Poor fruit set and berry development.

Interveinal and marginal chlorosis caused by potassium deficiency.

58. Poor fruit set results in poor cluster development, reduced fruit quality, and low yield. Causes can include inadequate vine nutrition and an unbalanced carbon-to-nitrogen ratio, unfavorable weather conditions (cold, cloudy, wet), and/or early fungal disease development.
Management—Maintain proper vine nutrition and maintain an early-season spray program.

59. Potassium deficiency is a common problem since potassium is utilized in large amounts by grapevines. Mid-shoot leaves develop a dull, dark-green color (often called 'black leaf'), which progresses to basal leaves on older shoots. Interveinal chlorosis and marginal necrosis (browning, tissue death) may occur; in severe cases, necrotic areas may expand across leaves.
Management—Apply foliar sprays of potassium nitrate or potassium sulfate to temporarily alleviate deficiency symptoms. For long term correction, apply bands of potassium sulfate or potassium nitrate beneath the canopy (within the dripline); rate should be based on soil tests. Excessive potassium levels may result in magnesium deficiency.

60. Sunburn results in browning, cracking, and shriveling of fruit; light-colored and white cultivars are generally more susceptible. Damage occurs on the west side of vines where temperatures tend to be highest in the afternoon. Excessive leaf removal on the west

Sunburn on 'Venus' seedless table grape.

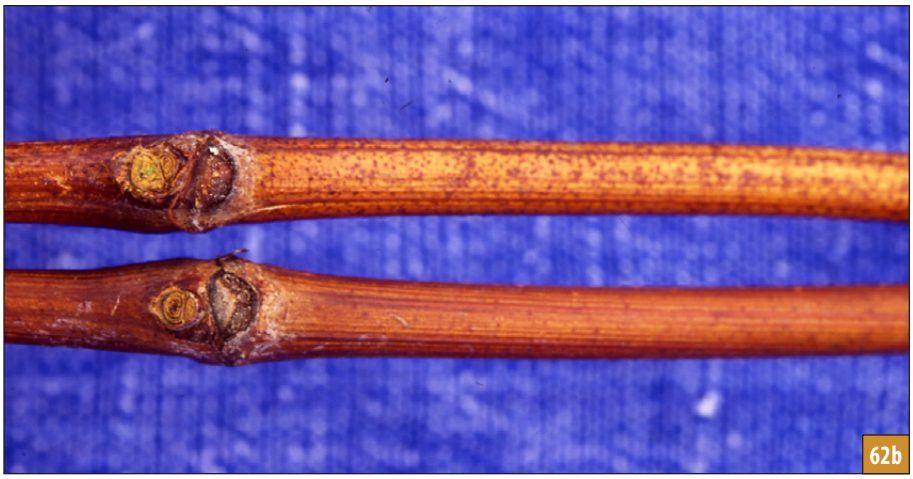
side of vines, summer pruning, late-season shoot positioning, drought conditions, and high temperatures induce sunburn injury.
Management—Avoid excessive and late-season leaf removal, shoot positioning, and summer pruning; complete maintenance pruning and shoot positioning before veraison (fruit coloring). Increasing sun exposure after veraison significantly increases fruit sunburn.

61. Uneven ripening is evident when some berries within a cluster fail to color-up and ripen. Over-cropping, nutrient deficiency, excessive canopy shading, or overexposure due to excessive leaf and/or shoot removal, disease, insect, or herbicide injury may induce uneven ripening. Hybrid cultivars derived from *V. labrusca* parentage are more prone to uneven ripening in hot climates; the cultivar 'Concord' is particularly sensitive.
Management—Follow proper cultural techniques: prune and manage canopy to prevent heavy shading, crop thin to balance vine growth, monitor nutrient levels through foliar analysis, avoid excess nitrogen, control disease and pests, manage weed growth (especially tall or climbing weeds), and avoid herbicide injury. Plant 'Concord' type cultivars (such as 'Sunbelt') that are less prone to this disorder.

62. Winter injury causes death of buds, canes, and vine trunks. It occurs when air temperature drops below the cultivar's critical temperature for injury. Muscadine grapes and *V. vinifera* species are frequently injured during cold winters.
Management—Plant hardy cultivars that are better adapted to the fluctuating winter temperatures in Kentucky (e.g., French-American hybrids or interspecific hybrids). Enhance winter hardiness development by selective, well-timed pruning, shoot thinning, cluster thinning, and nitrogen fertilization.

Uneven ripening in 'Concord' grape.

Cane killed by winter injury (top) compared to healthy cane (bottom).



Winter-injured primary bud (bottom) compared to live bud (top).

Additional Resources

Additional vegetable crop information on identification, production, fertility, and pest management that could be related to protected agriculture can be found in the following publications; University of Kentucky publications are available at county Extension offices and online.

An IPM Scouting Guide for Common Problems of Grape in Kentucky
(for mobile devices)
Scouting Guide for Problems of Grapes (Grape Scout)
https://grapescout.ca.uky.edu

UK Ag Weather Center Prediction Models
Plant Disease and Insect Prediction Models for Kentucky Counties
http://weather.uky.edu/plant_disease.html

Department Extension Publications Websites
Plant Pathology Extension Publications
http://plantpathology.ca.uky.edu/extension/publications

Entomology Extension Publications
https://entomology.ca.uky.edu/entfacts/

Horticulture Extension Publications
http://www.uky.edu/hort/

Wildlife Extension Publications
http://forestry.ca.uky.edu/wildlife-pubs

For Commercial Producers
Commercial Fruit Pest Management Guide (ID-232)
http://www2.ca.uky.edu/agcollege/plantpathology/ext_files/PPFShtml/ID-232.pdf

For Small Scale and Residential Growers
Backyard Grape Disease Management Using Cultural Practices (with Low Spray, No Spray & Organic Options) (PPFS-FR-S-24)
http://plantpathology.ca.uky.edu/files/ppfs-fr-s-24.pdf

Disease and Insect Control Program for Home Grown Fruit in Kentucky including Organic Alternatives (ID-21)
http://www.ca.uky.edu/agc/pubs/id/id21/id21.pdf

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Robert Videki, Doronicum Kft., Bugwood.org—38a, 41b, 42

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