PEST MANAGEMENT STRATEGIC PLAN
FOR WINE GRAPES
IN VIRGINIA AND NORTH CAROLINA

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SOUTHERN REGION IPM CENTER
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TABLE OF CONTENTS

EXECUTIVE SUMMARY .................................................. 3

SUMMARY OF PRIORITIES FOR WINE GRAPES IN VIRGINIA AND NORTH CAROLINA ........................................ 4

PRODUCTION AND CULTURAL PRACTICES .......................................... 5

PRODUCTION REGIONS .................................................. 5

CULTURAL PRACTICES .................................................. 5

ARTHROPOD PESTS ...................................................... 7

SUMMARY – ARTHROPOD CHEMICAL CONTROLS ........................................ 23

DISEASES ................................................................. 23

SUMMARY – DISEASE CHEMICAL CONTROLS ........................................ 30

WEEDS ................................................................. 30

SUMMARY – WEED CHEMICAL CONTROLS ........................................ 31

VERTEBRATE PESTS .................................................. 31

ACKNOWLEDGMENTS .................................................. 33

REFERENCES ......................................................... 33

AUTHORS ............................................................. 33

WORKSHOP PARTICIPANTS ............................................ 34

EFFICACY TABLES AND WORKER/PEST ACTIVITIES TIMELINES ........................................ 36
EXECUTIVE SUMMARY

With the passage of the Food Quality Protection Act, an urgent need has developed to address current pest management issues and embrace alternative or “reduced risk” pest control options for various commodities. The USDA Office of Pest Management Policy (OPMP) is funding the production of Pest Management Strategic Plans (PMSPs), which identify pest management needs and priorities for specific crops in particular regions. These documents are developed through the collaboration of growers, commodity associations, specialists, food processors, crop consultants, and the U.S. Environmental Protection Agency. A workshop was held on March 23, 2010 at Veritas Vineyard and Winery in Afton, VA. The purpose was to gather input from growers, wine grape Extension specialists, and Extension agents from Virginia and North Carolina in order to identify critical pest management needs in the wine grape industry. The following PMSP outlines the management practices used in vineyards along with the pests and diseases that are most troubling to the wine grape industry and community. Wine grape specialists have assembled data tables to demonstrate the efficacy of currently available chemical and nonchemical control methods. The priorities listed on the following page must be addressed in order to ensure the success of future wine grape production in Virginia and North Carolina.

NOTE: Please refer to “Abbreviations” at the end of this report for a list of abbreviations and acronyms used for organizations and other terms discussed below.
# SUMMARY OF PRIORITIES FOR WINE GRAPES IN VIRGINIA AND NORTH CAROLINA

## RESEARCH PRIORITIES
- Sprayer technology/drift mitigation/coverage – important to integrated pest management (IPM)
- Buffers to minimize drift, what species to plant, distance between
- When to spray, thresholds for our specific weather/environmental conditions, phenological models (time when things are active) – for arthropods and diseases – need to get local data
- How to ensure clean plant material
- Develop healthier vines
- Soil organisms, nematodes, impact on vineyard/soil health
- Organic practices – soft chemistry, especially organic black rot control
- Variety selection, hybrids much less susceptible to certain diseases/pests, how it affects spray schedule, affects layout of vineyard
- Crop sensitivity – states with database of locations for crops sensitive to herbicide 2,4-D

## EDUCATIONAL PRIORITIES
- How to ensure clean plant material
- New grower education – General information, especially how to develop healthier vines
- How to brand/market IPM, which is easier than trying to carve out a niche that is not strictly organic
- Teach growers about variety selection and hybrids; some are much less susceptible to certain diseases/pests. Also explain how this affects the spray schedule.
- Crop sensitivity – states with database of locations for crops sensitive to herbicide 2,4-D

## REGULATORY PRIORITIES
- How to ensure clean plant material
- Crop sensitivity – states with database of locations for crops sensitive to herbicide 2,4-D
- WA growers have to record all application data and report to state Department of Agriculture
- Get clearance for grape root borer pheromone (available in Europe)
PRODUCTION AND CULTURAL PRACTICES

Production Regions

Vineyards are widely distributed across Virginia, with most of the acreage found in the northern and central Piedmont areas. These areas are excellent natural grape-producing regions because of demographics as well as viticultural compatibility. The five viticultural areas approved by the federal government are: Monticello, Northern Neck, North Fork of Roanoke, Rocky Knob, and Shenandoah Valley. The 10 leading grape-producing counties in Virginia based on 2004 acreage data are: Albemarle (476 acres), Loudoun (268 acres), Fauquier (197 acres), Orange (161 acres), Nelson (122 acres), Shenandoah (79 acres), Westmoreland (74 acres), Rappahannock (64 acres), Patrick (60 acres), and Essex (43 acres).

Cultural Practices

Virginia is suited for viticulture because it is far enough south to avoid the extremely cold temperatures devastating to many vines in the North. At the same time, it avoids the more severe outbreaks of Pierce’s disease, common to areas in the deeper South. However, winter cold injury is still the number one climatic constraint in the state. Virginia vineyards are located roughly between 37°N and 39°N latitude, the same as the North Coast region of California. Therefore, the grapes can ripen fully in the temperate climate while retaining acidity. Site selection is still an important aspect of grape production because it affects both the frequency and severity of climatic problems and biological pests. Well-drained soils with a pH of 5.5 to 7.0 are required along with areas protected from frosts that receive full sun.

The four categories of grapes grown in Virginia include the common grape, Vitis vinifera, as well as interspecific hybrids, native American varieties, and muscadine grapes (Muscadinia rotundifolia). The first group, V. vinifera, accounts for 77% of Virginia’s grape acreage. Chardonnay, Riesling, and Cabernet Sauvignon are among the most abundant varieties. The French hybrids such as Seyval and Vidal Blanc constitute 16% of grape acreage in the state, with native American varieties making up an additional 6%. Concord and Norton dominate the last group. Muscadine grapes represent just 1% of Virginia production given their generally inferior wine quality. Typically, bunch grape varieties are far more susceptible to fungal diseases and require a much more rigorous spray schedule.

Vinifera grapes are typically grafted onto a pest-resistant rootstock, to provide protection and to impart greater vigor to the aboveground (scion) variety. The most commonly used rootstock in the mid-Atlantic region is Couderc-3309. Mgt 101-14 and C-1616E are also recommended for use within Virginia. However, they are usually more difficult to obtain from nurseries. All of the commonly grown bunch grapes can be planted in large, contiguous blocks without needing cross-pollination, although some muscadine varieties do require a pollinator. All varieties are trained on trellis systems and pruned each winter to maintain production and vigor. Before establishing a trellis system, producers plant prepared soils with a cover crop, such as fescue. Vines are then planted in weed-free rows between the established sod middles. Cultivation is avoided given the erosion potential of most vineyard sites; however, herbicides are used to keep weeds from beneath the trellises. Most of Virginia’s grapes are harvested by hand.
Worker Activities

Weed management
Preemergent herbicides are applied primarily in the early spring with tractor-mounted spray equipment. Postemergent herbicides are usually applied in early summer and then occasionally after harvest with tractor-mounted sprayers. However, backpack sprayers are also sometimes used for applications. During the growing season, row middles are also mowed to control weeds. In addition, grow tubes are used around each vine in the first season to promote growth and shield the vine from herbicides.

Fertility
Granular fertilizers are applied two to four times per year using tractor-mounted equipment. Some growers also distribute fertilizer using drip irrigation systems. Soil and leaf samples are collected periodically for analysis.

Pest control
Applications of fungicides and insecticides are primarily made with air-blast orchard sprayers from early spring to harvest. Typically, two to four insecticide/acaricide applications are made, while 10 to 12 fungicide applications are administered to bunch grapes yearly.

Summer training
New vines are hand trained to the trellis on which they will grow. This work usually requires several hours of manual labor per acre per week during the first two growing seasons.

Mature vines require hours of manual labor including removing basal suckers, thinning and positioning shoots on the trellis, and removing leaves or thinning clusters as needed several times during the growing season.

Harvesting
Most bunch grapes, mainly used in the production of wine, are harvested by hand. However, some grapes are harvested mechanically.

Winter pruning
Grapevines are pruned during the dormant season. Trimmings are either removed from the field or destroyed in place using a flail mower.

Special Use Labels
Section 18 Emergency Use Exemption and Special Local Need 24(c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need (SLN) labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. However, a fee must be paid annually by the registrant to keep the
product registered for use in Virginia. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually.

ARTHROPOD PESTS

INSECTS

Climbing Cutworms, Family Noctuidae

Several different species of cutworms are collectively known as climbing cutworms due to their nocturnal habit of climbing fruit trees during spring in search of buds to eat. Although occurring only sporadically, they can be serious problems in young orchards if the foliage and buds are completely stripped. Older trees can withstand several years of feeding before suffering ill effects. Cutworm caterpillars are approximately 1.5 inches long, smooth, with variable coloration and markings.

**Monitoring:** No treatment thresholds have been established due to the sporadic nature of this pest. Larvae are strictly nocturnal feeders. Although useful for trapping adult moths, black light traps are not effective monitoring tools because cutworms feed on so many different crops. Check for climbing cutworms by examining the lower center of young vines for early signs of feeding in the spring as well as checking the leaf litter and soil around the base of the plant for overwintering larvae. Examine buds frequently (every couple of days) from the beginning of bud swell until 2 to 3 inches of shoot growth appear.

**Chemical Control:** Chemical controls are applied at bud swell and to new shoots, in the evening, if possible. See the Summary – Arthropod Chemical Controls section for more information.

**Biological Control:** *Bacillus thuringiensis (Bt)* is an insecticidal bacterium used to control various grape pests. Additionally, natural enemies (e.g., bluebirds) usually control cutworm populations.

**Alternative/Cultural Control:** Early spring soil cultivation may help by killing young larvae. Additionally, some growers use tanglefoot to control cutworms. Natural enemies and their habitats should be established and/or conserved. Compressed air may be used to blow caterpillars off of vines.

**To Do:**
- Teach growers that treatment should probably be initiated just below 10% infestation, but this threshold can be crossed very quickly.

Climbing cutworm, Frank Peairs, Colorado State University, Bugwood.org
• Help growers learn to differentiate between cutworm and flea beetle damage
• Conduct research to develop an economic threshold
• Develop better monitoring methods and means of prediction

**Drosophila Flies, *Drosophila spp.***

Drosophila flies, also known as vinegar flies, are not usually serious pests of grapes. However, there is one particular species, the spotted wing Drosophila fly (*Drosophila suzukii*), which is of concern in the western United States because it attacks undamaged fruit. In its native Japan it is known to cause damage to grapes as well as other thin-skinned fruits. It was first detected on the east coast in August 2009 in Florida and has the potential to move northward, although it is not currently a problem.

**Monitoring:** Although not currently a pest in Virginia and North Carolina, growers should continue to monitor for the occurrence of this pest.

**Chemical Control:** No chemicals are currently labeled for this specific pest, but see the **Summary – Arthropod Chemical Controls** section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Growers should pay attention to harvest timing and practice proper sanitation, because flies will re-infest fallen fruit. For wineries in close proximity to vineyards, waste disposal is very important.

**To Do:**
• Ensure that chemical controls are labeled for this pest in the event it becomes a problem in Virginia and/or North Carolina.

**Grape Berry Moth, *Paralobesia viteana* (Endopiza viteana)**

The grape berry moth (GBM) has been considered one of the most severe grape pests in Virginia with populations increasing in many vineyards in recent years. Economic damage is caused primarily to the berries although secondary problems such as fruit rots of injured berries also occur. Damaged berries exhibit wide reddish spots, webbed clusters, and shriveled fruit while the foliage bears semicircular holes. Grayish-green grape berry moth caterpillars are found within the grapes, and infested clusters may be sticky with juice. Pupae overwinter in grayish silken cocoons spun within fallen leaves. Research in Virginia indicates three to four generations occur per year, with a possible fifth generation appearing in some seasons. Adults emerge after 10 to 14 days with emergence peaking in mid-August. They then proceed to feed on fruits and foliage. High populations have been observed following several consecutive mild winters.
Monitoring: Populations of grape berry moth may be monitored with a commercially available pheromone trap. However, the relationship between trap captures and damage is strongly influenced by vineyard surroundings. In vineyards surrounded by open terrain (such as cornfields or pastureland), trap numbers may be high but actual injury low. In vineyards surrounded by woodland (with wild grapevines), trap captures may be low but injury levels much greater. Researchers are currently assessing lures and research is being done on first flight.

Chemical Control: Several chemical options are available to control GBM; see the Summary – Arthropod Chemical Controls section for more information.

Biological Control: A naturally-occurring egg parasite, Trichogramma minutum, provides some biological control against GBM. Bacillus thuringiensis (Bt) is an insecticidal bacterium used to control various grape pests, but it has questionable efficacy. It may work well under low pest pressure situations, but not in open vineyards or those near woods with wild grapes.

Alternative/Cultural Control: A mating disruption (MD) pheromone (Isomate-GBM) was registered for GBM but is no longer available due to limited grower interest and perceived high cost. SPLAT-GBM (far more expensive than Isomate ever was) has also been used to disrupt mating. Mating disruptants can be very effective; however, efficacy may be limited due to edge effects in smaller vineyards. The edges of vineyards present diverse habitats. These habitats are the source of alternate hosts (e.g., wild grapevines) that harbor pests that then migrate to the vineyards. However, these plants also provide shelter to many beneficial organisms, which play an important role in the biological control that is compatible with MD. Thus, orchard edges contribute both positive and negative forces in a mating disruption program. It is generally recommended to spray the edge rows of the orchard to prevent immigration of fertile females and other potential pests (e.g., grape flea beetle). This is less of a concern in vineyards in open settings such as pastures and cornfields. In areas where GBM feeding has been severe, several cultural control options are available: (1) leaves may be raked and burned in the fall, (2) the soil beneath rows may be cultivated to bury overwintering pupae, and (3) soil from row centers can be piled beneath vines to trap pupating larvae, then plowed and/or disked.

To Do:
- Research the impact of infested grapes on wine quality (implicated with rots at harvest)
- Determine the threshold for insect parts in wine
- Develop better models to predict population trends and how many times of year to spray and when to spray (varies from year to year)

Grape Cane Girdler, Ampelogypter ater
Grape Cane Gallmaker, Ampelogypter sesostris
The grape cane girdler is a minor pest. It is a small (3 mm long), black weevil that causes shoot dieback. Female beetles use their mouthparts to make a band of holes into which they deposit their eggs. A second series of holes is made a few inches higher on the cane, but no eggs are laid. Larvae feed within the pith and complete development in approximately one month. Although damage may appear serious, it is usually not a cause for concern since girdling occurs past the grape clusters. However, it may be difficult to train infested young vines. Closely related to the grape cane girdler, the grape cane gallmaker is similar in size and appearance, although the beetle is red-brown, not black. The red galls it forms may be found on the new shoot growth just above the nodes. Affected vines are typically located along vineyard borders near wooded/trashy areas or at the ends of rows. There is usually no reduction in yield due to the galls occurring past the fruit cluster.

**Monitoring:** No specific monitoring protocol is currently recommended.

**Chemical Control:** If chemical control is needed (mainly on young vines), see the *Summary – Arthropod Chemical Controls* section for more information. Chemical control is not usually needed for the grape cane gallmaker.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Injured sections may be pruned, but this should be done below the lower girdle before adults emerge in the summer. Galls may also be removed by pruning by mid-July before adults emerge.

**To Do:**
- Do a risk assessment
- Educate growers; this pest rarely has an economic impact

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**Grape Curculio, *Crapionius inaequalis***

The grape curculio is a very minor pest of grapes. It is a small (2.5 mm long), black weevil that feeds directly on grapes. Adults overwinter and resume activity when Concord grapes bloom. Adult females begin to lay eggs approximately two weeks later. Holes are chewed in the grape skin and eggs are deposited in the cavity underneath. Larvae hatch from the eggs and feed on the surrounding grape flesh and seeds. After three weeks of feeding, larvae drop to the soil to pupate, and reemerge as adults approximately one month later. The adults feed on grape foliage for the remainder of the summer and hibernate when cold weather returns.

**Monitoring:** No specific monitoring protocol is currently recommended. However, the appearance of small groups of short, curved lines are indicative of adult feeding. Damage may be confused with that of the grape berry moth.
**Chemical Control:** None currently recommended, but see the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Proper orchard sanitation is usually sufficient to prevent severe infestations.

**To Do:**
- None.

**Grape Flea Beetle, *Altica chalybea***

The grape flea beetle is a small (5 mm long), metallic blue-green pest of vineyards. Adult beetles overwinter within debris in and around the fields but become active in early spring. Adult females deposit masses of pale yellow eggs in cracks in the bark, at the bases of buds, under bud scales, and on foliage. Larvae emerge from the eggs and feed on grape leaves for approximately one month before dropping to the ground to pupate. Adults emerge one to two weeks later in July and August. Little damage is caused by the feeding habits of the summer generation. Grape flea beetles also feed on Virginia creeper. Although mostly a problem of derelict vineyards, they are considered serious pests in some grape-growing operations. Adult beetles feed on buds during bud swell, making a large hole in the side of the bud while gouging out the interior.

**Monitoring:** No specific monitoring guidelines exist. Larval feeding damage appears as chain-like feeding marks; however, adult feeding is of greater concern due to their destructive feeding on buds. Adult feeding damage is more common on thick-leaved grape varieties (e.g., Concord, Niagara). Feeding damage is similar to that produced by climbing cutworms, although cutworm feeding marks are usually more ragged.

**Chemical Control:** Chemical sprays targeting grape berry moth help control flea beetles, although controls may need to be applied early in the season to control this specific pest. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Good sanitation and a fall vineyard cleanup will help control flea beetles by removing their overwintering sites.

**To Do:**
• Teach growers how to differentiate between flea beetle and cutworm damage

**Grape Leafhopper**, *Erythroneura* spp.

Adult leafhoppers are small (3 mm long), sap-sucking insects that are pale yellow with red, yellow, or black markings. Adults overwinter in plant debris in or near vineyards and resume activity when warm weather arrives in spring. Leafhoppers feed on whatever green leaves are available until May when they move to grapevines. Adults feed for two weeks, and then females lay eggs in the leaf tissue. Nymphs hatch from the eggs after approximately two weeks. Immature leafhoppers are pale, wingless, and have red eyes. They are commonly found on the underside of leaves and have a sideways moving habit. Two to three generations occur each year. Both adults and nymphs feed on plant sap and cause pale stippling on the leaves. When infestations are severe, foliage may turn yellow or brown, and eventually fall off. Fruit yield and quality may be reduced due to the presence of large numbers of grape leafhoppers. Populations are greatest in the late summer, especially on end vines and in border rows.

**Monitoring:** Monitoring is conducted using a sweep net and the treatment threshold is 5 nymphs/leaf prior to August 1st and 10 nymphs/leaf thereafter.

**Chemical Control:** See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Keep grass cut to minimize leafhopper pest issues.

**To Do:**
- Educate growers about grape leafhopper damage and how to differentiate between it and potato leafhopper damage (stippling vs. “hopper burn”)

**Grape Phylloxera**, *Daktulosphaira vitifoliae*

The grape phylloxera is an aphid-like insect native to the eastern United States that feeds on either the roots or the leaves of grape vines. The foliar or aerial form of phylloxera is usually seen in the form of small (5-7 mm) galls on the undersides of leaves. This pest, while not of concern in Virginia, nearly destroyed the vineyards of Europe. Many native American grape rootstocks are tolerant or resistant to grape phylloxera and European vines have been grafted onto resistant rootstocks to preserve the vineyards.

**Monitoring:** There is no specific monitoring protocol nor treatment threshold, but signs of infestation include feeding sites that swell and turn yellowish and roots with necrotic spots.
**Chemical Control:** Spray when yellow crawlers are first detected with a hand lens or when galls first appear. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Use resistant rootstocks.

**To Do:**
- Need to develop foliar thresholds, which are non-existent for different varieties
- Give growers better educational tools, provide information on earlier monitoring using a 10x hand lens to look for crawlers
- Soil borne phylloxera is not so much of a problem, just use resistant rootstocks

**Gallmakers, Family Cecidomyiidae**

Tiny gall midges cause small (1/8 inch), green or pink growths that occur on grape leaves, tendrils, blossom buds, and in the rachis. The most common gall midge affecting grapes is the grape tumid gallmaker, *Janetiella brevicauda*. Gallmakers are not usually present in large numbers, but huge infestations may occur occasionally. They do not usually cause economic injury to grapevines, although considerable damage may be caused to shoots and vines rarely. If present on the flower clusters, fruit clusters may be deformed or fail to form at all.

**Monitoring:** No specific monitoring protocol is recommended, but damage should be checked for and noted.

**Chemical Control:** Chemical control is not economically justifiable unless tumid galls have been a problem in the past, or the current infestation is heavy. It is also difficult to achieve good control, although targeting overwintered adults works to reduce the populations somewhat. However, since it is difficult to detect adults, it may be more practical to apply sprays as soon as white scars are noticed as larvae enter vine tissues, or when galls first appear. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended, but there are natural parasites and predators that will attack midge larvae.
**Alternative/Cultural Control:** Remove galls by hand before exit holes appear to reduce future populations. Mounding soil up around the base of a vine will bury pupae and prevent them from emerging as adults.

**To Do:**
- Conduct research on biology and impact, and control needs
- Teach growers about proper pest identification

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**Grape Rootworm, Fidia viticida**

**Southern Grape Rootworm, F. longipes**

Grape rootworm larvae overwinter in the soil around grape roots. The entire life cycle takes one to two years to complete. Feeding resumes in the spring and the beetle larvae pupate near the surface in late May and June when grapes bloom. Pupation takes about two weeks. Adult beetles are 6 mm long, brown, and have yellowish hairs. Adults feed on foliage for about a month, leaving chain-like holes in the leaves. This feeding damage is similar to that made by grape flea beetle larvae. Female beetles lay clusters of 20 to 30 eggs under loose bark on canes. After one to two weeks, larvae hatch, drop to the ground, burrow into the soil, and begin to feed on grapevine roots. Smaller roots may be completely consumed while larger ones become pitted from feeding activity. The injury to the root system can be severe, causing vines to become unthrifty, produce fewer grapes, or even die after several years. Where grapevines are planted on poor soil, the negative effects of grape rootworm are compounded. The southern grape rootworm, *F. longipes*, is more common in North Carolina than *F. viticida*.

**Monitoring:** No specific monitoring protocol is recommended, but check for adults feeding on leaves.

**Chemical Control:** Chemicals are usually applied when beetles appear, typically in late June or early July. Chemical control should target adults after they emerge, but before egg-laying takes place. First and second grape berry moth sprays may control grape rootworm; however, timing is critical. If sprays are applied too early, not all adults will have emerged from the soil and chemical residues may not last long enough to provide adequate control. If sprays are applied too early, eggs of the second generation will have been laid and will attack roots upon hatching. Few options are currently available. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Pupae can be destroyed by intensive, shallow cultivation of soil up until adult emergence occurs in late June.

**To Do:**
• Research and gather efficacy data on newer materials
• Register and label new materials
• Develop new monitoring and detection methods

**Grape Root Borer, Vitacea polistiformis**

The wasp-like grape root borer (GRB) can be a serious pest in some vineyards due to the root-feeding habits of the larvae. Adult females lay their eggs on trunks and weeds and the majority of the 2 to 3 year life cycle is spent as a 25 mm long, white, brown-headed larva. Larval feeding leads to hollowed out roots that become filled with frass. No longer able to transport water and nutrients, vines become susceptible to cold injury and eventually die. Once finished feeding, larvae spin cocoons near the soil surface in early summer and emerge as adults beginning in early July. Borer damage causes reduced vine growth, smaller leaves, and smaller berries.

**Monitoring:** Monitor populations by hanging traps baited with pheromones. Traps are placed 100m apart inside the vineyard and along woodland boundaries. Early signs of grape root borer infestations include a lack of plant vigor and the presence of pupal skins sticking up above the soil at the base of the trunk in late summer. Young larvae are located throughout the root zone while older larvae stay close to the trunk where larger roots are found.

**Chemical Control:** It is important to apply insecticides to the soil surface at the time of egg hatch because chemicals are ineffective once borers reach the roots. Weed control is also important because of increased larval mortality at the exposed soil surface. See the Summary – Arthropod Chemical Controls section for more information.

**Biological Control:** Nematodes have shown promise to control larvae.

**Alternative/Cultural Control:** Traps containing a pheromone blend (ODDA) may be placed 3 weeks after bloom. Good weed control usually prevents GRB populations from reaching high levels. One effective control method is to mound soil 8-12 inches high around base of vines and extending 2-3 feet from the trunk crown around mid-June to July 1st (after larvae have already pupated) and later leveling the ridges in fall or spring to prevent adults from emerging. Timing is critical because if mounding is done too early, larvae simply tunnel up into the mounded soil to pupate. Nitrogen fertilization may help overcome feeding damages when vines are already infested at a rate of 5%
of vines with pupal skins present. Proper weed management in the vine row is important in eliminating potential oviposition sites and increasing larval mortality due to desiccation.

**To Do:**
- Get mating disruption chemicals registered, have shown 97% reduction, not enough market to justify registration, tends to be a southeastern United States problem, not in Northeast or our West
- Determine impact on vineyard longevity after 5-10 years
- IR4 chemicals in pipeline – ensure they get to market

**Grapevine Looper, Eulythis diversilineata**

The grapevine looper is currently a very minor pest of grapes although it has been problematic in the past. There is one generation per year and females lay batches of 8-12 eggs arranged in a crescent shape on grape vines. Eggs overwinter and larvae hatch in late spring and early summer. Larvae feed on the foliage of grape vines and Virginia creeper for six to eight weeks and then pupate in loose cocoons for 10 days. Adults emerge in mid-summer, lay eggs, and die after two or three days. The looper species *Eulythis gracilineata* is more commonly collected in North Carolina.

**Monitoring:** None currently recommended.

**Chemical Control:** None currently recommended.
See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** None currently recommended.

**To Do:**
- None

**Japanese Beetle, Popillia japonica**

**Green June Beetle, Cotinus nitidus**

Japanese beetles (JB), along with other scarab beetles (e.g., rose chafer, green June beetle), are common in vineyards and cause the characteristic skeletonization of leaves when they feed. Fruit is occasionally attacked, as well. This makes them one of the most devastating insect pests of grapes in Virginia. Japanese beetles are metallic green with copper-colored forewings. Japanese beetles emerge in late June and July, preferring to feed on young leaves, especially those that are exposed to full sunlight. Plant productivity is decreased due to reduced leaf surface area and the corresponding reduction in photosynthesis. While older vines can tolerate some foliar feeding, young vines are vulnerable to complete defoliation. Adult populations are smaller in years following dry summers due to the drought-sensitivity of the soil-dwelling grubs. Cumulative rainfall during the summer months must be at least 10 inches to sustain grubs. Japanese beetles
are more abundant on grape in Virginia than other eastern states, including North Carolina, due to the proximity of preferred larval habitat (pastureland) to preferred adult food sources (vineyards).

Green June beetles (GJB) are fruit feeders and directly attack the berry clusters. Damage fluctuates from year to year, but grape varieties that reach maturity during the peak period of GJB flight are more likely to be attacked. The adult beetles are approximately one inch long and are green-gold and tan. Larvae feed on decaying organic material in the thatch layer of grasses and other plants. They pupate in the soil and emerge as adults in July and August.

**Monitoring:** Attractant traps are not useful for protecting vineyards but can help monitor population fluctuations.

**Chemical Control:** Growers’ acceptance of some defoliation on mature vines may reduce the number of chemical applications necessary for JB control. Slight defoliation has not been shown to have significant effects on grape yield. See the *Summary – Arthropod Chemical Controls* section for more information. Some growers simply spray the perimeter of the vineyard and leave the middles alone. Work has been done designing sprayers that direct chemicals to the top canopy, which saves chemicals, time, exposure, etc.

**Biological Control:** Milky spore disease (*Bacillus popillae*) is available for the control of JB, but it is only effective in protecting grassy areas from large larval populations; winged adults will continue to enter vineyards from untreated areas. Parasitic wasps and flies have also been used to control JB. Two species of tiphiid wasps (*Tiphia vernalis* and *T. popilliavora*) have been introduced to control JB larvae. The tachinid fly, *Istocheta aldrichi*, is known to parasitize adult beetles. Another biological control method is to trap and release native pests into the vineyard. The GJB has at least one natural enemy: the wasp, *Scolia dubia*, which digs in the soil to lay its eggs on the grubs.

**Alternative/Cultural Control:** Clean harvesting, which prevents an accumulation of overripe fruit, helps to prevent GJB from being attracted to plantings. Plowing or cultivation can destroy pupae in the soil. Netting or row covers may be used to physically exclude GJB if the holes are small enough to prevent their entry.

**To Do:**
- Education on using alternative spray material besides Sevin (carbaryl).
**Grape Mealybug, Pseudococcus maritimus**

The grape mealybug is a pale, flat, oval-shaped insect that feeds on plant sap. Mealybugs have been present at low levels for years, but broad spectrum pesticides are killing their natural enemies, so secondary pest populations are increasing. These pests overwinter as nymphs and resume activity in late spring. They spread along grapevines, feeding at the base of shoots or pedicels of grape clusters. Adults appear in late June, and females lay their eggs beneath loose bark. The nymphs hatch a few days later, and spread into fruit clusters or feed on leaves near veins. A second generation of adults emerges in late August. Adult female mealybugs continue laying eggs until cold weather, although any eggs that do not hatch before winter do not survive. Plants do not usually suffer much damage due to mealybug feeding itself; the main problem is the honeydew excreted by the pests that serves as a substrate for sooty mold fungus to develop. However, this is more of an issue in table grapes, not wine grapes. Mealybugs are also capable of spreading viruses. The vine mealybug, obscure mealybug, and long-tail mealybug are all capable of spreading leafroll viruses.

**Monitoring:** California specialists have suggested an action threshold of 20% infested spurs.

**Chemical Control:** If infestations are severe at harvest time, a delayed dormant spray may be applied the following spring. Apply chemicals if dormant oil spray does not provide adequate control. Leave a section of vineyard unsprayed to allow refuge for natural enemies. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Dormant oil may be used to control mealybugs. Buy only clean nursery stock. Remove diseased vines if leafroll virus is diagnosed.

**To Do:**
- Nursery stock education – get good plants early, phytosanitary certificates, monitoring program not in place – might be at just very low levels
- Develop better education program for growers on scouting and identification – educate about not applying broad spectrum insecticides
- Growers need to learn acceptable levels of damage before spraying
- Develop a separate document for first 3 years of vineyard (young vines)
- Research and develop an East Coast spray threshold

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**Redbanded Leafroller, Argyrotaenia velutinana**

The red-banded leafroller was once the most damaging leafroller in the eastern United States. It
has been held in check by traditional organophosphate spray programs and now only occurs very sporadically. This insect is a pest of many fruit and ornamental crops. There are four generations per year in Virginia. The adult moths have reddish-brown bands on their wings that form a “V” when held at rest while the larvae are yellow-green and approximately 17 mm long. Larvae feed primarily on foliage; however, they sometimes feed on fruit and cause severe scarring.

**Monitoring:** Monitor for adults beginning around bud break. Place pheromone traps in the vineyard and check weekly. A provisional economic threshold is 1% fruit injured at harvest.

**Chemical Control:** See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** *Bacillus thuringiensis (Bt)* is an insecticidal bacterium used to control various grape pests. Eggs are vulnerable to parasitization by *Trichogramma minutum*. Both larvae and pupae may be attacked by parasites. Larvae may succumb to granulosis viruses, as well.

**Alternative/Cultural Control:** None currently recommended.

**To Do:**
- None

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**Rose Chafer, *Macrodactylus subspinosus***

The rose chafer is a minor pest related to the Japanese beetle, which has a similar life cycle. Larvae overwinter within the soil and emerge as tan, long-legged adults around the time of grape bloom in late May or early June. Adult feeding occurs for approximately two weeks, and damage can be severe. Grape production may be impacted due to the beetle’s destruction of bud blossoms. Adult beetles also feed on newly set fruit and leaves. Rose chafer is more common in areas with light, sandy soil.

**Monitoring:** Controls are rarely needed, although vineyards should be monitored early in the season in case of high population numbers.

**Chemical Control:** Petal-fall sprays targeting grape berry moth also help control rose chafer. Recommended chemicals include Acetamiprid (e.g., Assail), phosmet (e.g., Imidan), and carbaryl (e.g., Sevin).

**Biological Control:** None currently recommended.
Alternative/Cultural Control: None currently recommended.

To Do:
- None

Sharpshooter Leafhoppers, Subfamily Tettigellinae

Sharpshooter leafhoppers are problematic in some vineyards located in the extreme eastern part of Virginia and in North Carolina’s Yadkin Valley. These xylem-feeding leafhoppers are known to vector Pierce’s disease (*Xylella fastidiosa*) and are more common after mild winters. Vinifera vines are more susceptible than native American grapes. Chardonnay and Pinot Noir are highly susceptible, Riesling and Chenin Blanc are less susceptible, and Cabernet Sauvignon, Merlot, and Sauvignon Blanc are moderately susceptible. Pierce’s disease has been positively identified in North Carolina. The severity of this disease is dependent on the age of the vine and what time of year it becomes infected. Spring bouts of the disease are more likely to lead to chronic infections, while later infections stay localized. Bacterial load becomes high enough to infect leafhoppers only in June and July, so vine-to-vine infections occur only in summer. Drought makes disease symptoms worse. Indicators of Pierce’s disease include chlorotic spots, dry leaf edges, dead leaves that fall off, delayed budbreak, green spots surrounded by normal, mature, dark tissue, and reduced shoot growth. Diagnosis must be confirmed by lab testing. Time from infection to death can vary from one to five years, depending on cultivar and climate.

Monitoring: Yellow sticky traps should be used, and any sharpshooters captured should be identified by an expert.

Chemical Control: See the Summary – Arthropod Chemical Controls section for more information.

Biological Control: None currently recommended.

Alternative/Cultural Control: Use more resistant varieties and select an appropriate ground cover.

To Do:
- Help growers identify and grow more tolerant grape varieties

Thrips

Thrips are more of a problem early in the growing season, especially when warm winters are followed by dry springs. Signs of thrips damage include scarring caused by the females laying eggs as well as split fruit that attracts flies and wasps. Thrips are known to be vectors of various diseases.
**Monitoring:** Inspect new shoots for scarring and distorted leaves. Monitoring is done on cool days after bud break has occurred by gently tapping the shoots or buds over a white piece of paper.

**Chemical Control:** See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** Natural enemies include predatory mites, pirate bugs, lacewings, and the fungus *Beauveria bassiana*.

**Alternative/Cultural Control:** None recommended.

**To Do:**
- Develop a threshold for the Eastern United States
- Educate growers about how to identify thrips damage

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**Yellowjackets**, *Vespula* spp.

Yellowjackets and certain other wasps may break open the skins of grape berries in order to reach the sugary contents. In the early part of the growing season, these wasps mainly prey on other small animals. However, toward the end of the season, the wasps’ foraging behavior changes as the sugar content of the fruit increases. Once yellowjackets pierce the skin, the fruit becomes vulnerable to attack by other insects such as honeybees and fruit flies, which are also drawn to the sweet contents.

**Monitoring:** No specific monitoring protocol is recommended.

**Chemical Control:** Bait stations containing an attractant and a pesticide can be set up in early spring to provide direct control against overwintering yellowjacket queens. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Destroying nearby yellowjacket nests is helpful but difficult because the nests are often hard to locate. It is very important to maintain good sanitation and vineyard practices. Eliminate other pests that open up grapes to secondary attack by wasps.

**To Do:**
- Educate growers and discourage pesticide use against wasps
- Research and develop baits for early season control
• Develop repellents for use on vines/plant parts

ARACHNIDS

**European Red Mite**, *Panonychus ulmi*

**Two-spotted Spider Mite**, *Tetranychus urticae*

The European red mite (ERM) can be a major pest within vineyards in Virginia, causing extensive injury if uncontrolled. Damage results mainly from foliar feeding, which destroys chlorophyll, reduces respiration, and decreases the ability of the leaf to make food. Lack of photosynthates can cause smaller fruit and lower yield the following season. Typically, overwintering eggs are fertilized and deposited in groups on the roughened bark area around buds and fruit spurs in early to mid-August. Egg hatch occurs together with bud development the following spring and continues through bloom. Once hatched, the larvae immediately begin feeding on the foliage and often develop into adults by bloom time. Occasionally, there is an early season population explosion when ground cover is removed, especially by using herbicides (e.g., Paraquat) that are damaging to predatory mites.

**Monitoring:** During the dormant period and up to early bloom, vines can be evaluated for overwintering ERM eggs. Careful attention must be paid to typical egg deposition sites. If a prebloom treatment was applied, then the first sample for motile mites can usually be delayed until early to mid-June. If no preventive applications were used before bloom, evaluation of the percentage of mite-infested leaves should begin during the bloom period. Acaricides should be applied only if ERM exceed 10 per leaf (20 per leaf on *labrusca* types) and more than minor bronzing occurs. The threshold for two-spotted spider mites is half that of ERM.

**Chemical Control:** Rotation of acaricides is important to prevent resistance development. Minimize broad-spectrum sprays. See the *Summary – Arthropod Chemical Controls* section for more information.

**Biological Control:** Natural predators of ERM include *Stethorus punctum* larvae and adults. The population size of this predator is important for adequate control. Generally, predatory mites may be purchased and can keep ERM populations in check. However, this is not always the case within Virginia vineyards.

**Alternate/Cultural Control:** Oil treatments (e.g., superior oil, JMS stylet oil) are typically sprayed when bud development begins to prevent the hatching of overwintering ERM eggs. Minimize dust in the vineyard to prevent mite populations from exploding. Avoid broad-spectrum pesticides.
To Do:
- Educate growers on scouting procedures; many are not doing it, but it is easy to do.
- Teach growers that cover crops may be planted to encourage predatory mites.

**SUMMARY – ARTHROPOD CHEMICAL CONTROLS**

For the most current chemical information (including information on formulations, application rates, and precautions/limitations), please refer to the Virginia Cooperative Extension Pest Management Guide: Horticultural and Forest Crops, 2012, Grapes: Diseases and Insects in Vineyards (PDF | 564KB)

**DISEASES**

*Disease descriptions were modified from Penn State University grape fact sheets.*

The most severe grape diseases in Virginia are crown gall, Botrytis bunch rot, black rot, and powdery mildew. Anthracnose, downy mildew, Eutypa dieback (*Eutypa lata*), Phomopsis cane and leaf spot, sour rot, Pierce’s disease (*Xylella fastidiosa*), tomato ringspot, stem necrosis, black measles, and grapevine yellows are other common diseases found in Virginia.

**Anthracnose.** *Elsinoe ampelina*

Anthracnose, also known as bird’s eye rot, is a minor disease that is sporadic and usually localized. However, it has the potential to do great damage and suddenly disappear. The disease-causing organism overwinters in canes and produces spores in the spring. Fruit, young shoots, tendrils, petioles, leaf veins, and fruit stems are all affected. Anthracnose spots may merge and cause girdling. Severely infected leaves curl downward from margins, and may become ragged as damaged parts decay and fall off. Fruit spots appear round, sunken, and gray.

**Monitoring:** Past history is a good indicator of future disease problems (e.g., Vidal). The bird’s eye spot on the fruit is a reliable indicator that the disease is present.

**Chemical Control:** Bordeaux mixture (copper sulfate + hydrated lime) is only necessary in vineyards where anthracnose has been a problem in the past. It is applied prior to bud swell. Lime sulfur (calcium polysulfide) can reduce overwintering inoculum. See the Summary – Disease Chemical Controls section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Sound vineyard sanitation practices will reduce the amount of inoculum present in the following year.

Anthracnose, Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org
**To Do:**

- Grower education on differentiating anthracnose from leafminer damage.

**Botrytis Bunch Rot, Botrytis cinerea**

The fungus *Botrytis cinerea* causes one of the most common diseases of grapes in Virginia: botrytis bunch rot. Although most often associated with the decay of ripe or nearly ripe grapes, fruit rot can also affect petals, flower stalks, fruit caps, and fruit. Susceptibility of these plant parts increases as weather conditions become moist. Fruit infections first appear as soft, light brown areas, eventually resulting in mummification of the fruit. Mummified fruit becomes covered with powdery spores through which the infection continues to spread. The bunch rot phase of the disease causes the greatest economic losses, especially on French hybrids and *Vitis vinifera* cultivars.

**Monitoring:** No specific monitoring protocol is recommended, but be aware of disease symptoms.

**Chemical Control:** Preharvest fungicide applications are recommended. Well-timed sprays of an effective fungicide are important, especially if weather is relatively wet between veraison and harvest. Earlier sprays will reduce the number of infected flower parts and the amount of young fruit infection. Botrytis strains with reduced sensitivity to iprodione have been found in Virginia vineyards. See the *Summary – Disease Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Canopy management practices that improve air circulation in the vineyard and reduce humidity within the canopy are beneficial (such as pruning, avoiding excess nitrogen use, and proper site selection). Also, techniques to reduce skin cracking or skin punctures around harvest time will help to control ripe fruit rot. Grape cultivars resistant to botrytis rot should be planted when possible.

**To Do:**

- Education

**Black Rot, Guignardia bidwellii**

Black rot is one of the most serious and widespread diseases of grapes in the eastern United States and, arguably, causes a greater loss to Virginia growers than all other diseases combined. This fungus can infect all young green parts of the vine including shoots, leaves, canes, blossoms, tendrils, and fruit. However, the most damaging effect is on the fruit. Disease symptoms become apparent in the spring with the appearance of tiny, reddish-brown, circular...
spots surrounded by a yellow ring. Eventually, the spots begin to merge forming large areas of diseased tissue that are frequently ignored until the half-grown grapes begin to rot in mid-summer. Infected fruit initially develop soft brown spots that eventually spread to the whole berry, which then shrivels and turns hard and black. Mummified fruit may remain attached to the vine for several weeks. Fungal fruiting bodies emerge from the surface of the grapes and release infective spores during humid weather.

**Monitoring:** No specific monitoring protocol is recommended, but be aware of disease symptoms.

**Chemical Control:** In vineyards with susceptible cultivars or where black rot was a problem the previous year, early-season fungicide sprays should be timed to prevent the earliest infections. For black rot control, fungicides are either used as protectants or applied after an infection has occurred. Application timing is critical. See the *Summary – Disease Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Sound vineyard sanitation practices will reduce the amount of inoculum present in the following year. Pruning to promote airflow is also beneficial. Resistant cultivars should be planted if possible. Mummies should be removed from trellises. Avoid planting vineyards near woods with native grapevines.

**To Do:**
- Develop organic controls
- Conduct research to develop and petition for alternate chemicals

**Vascular Diseases**

*(Bot Canker/Botryosphaeria, Eutypa/Dead Arm, Esca/Black Measles, Grapevine Yellows, Pierce’s Disease/Black Goo, Viruses)*

**Esca** (black measles) occurs in older grapevines (7 to 10 years old) while **Petri disease** (a.k.a. Young Esca, Young Vine Decline, Black Goo) occurs in young grapevines. Esca and Petri disease are caused by a complex of fungal pathogens, including *Phaeoacremonium* species and *Phaeomonilla chlamydospora*. Both are introduced to vineyards by infected nursery stock and are also found in soil. Infected nursery stock shows streaked vascular tissue or a small hole in the vine that is apparent when the trunk is cut. Disease symptoms develop when vines are stressed [e.g., insufficient irrigation, early fruiting on very young vines, J-rooting (when roots go up or laterally)].

**Esca** symptoms include brown-striped leaves, small yellow leaves, shoot tip/tendril dieback, reduced shoot growth, spotted/shriveled berries, and bitter fruit. Additionally, the woody cylinder will be streaked and exhibit stunted growth.
Young grape vines with **Petri disease** are weak and the woody tissue has black spots or streaks. Black goo also oozes from cut vines. The vascular system may be blocked and necrotic. The vine grows slowly and leaves turn yellow.

**Eutypa dieback** (*Eutypa lata*) can best be identified by abnormal, stunted, and deformed shoot growth in spring when shoots are 10 to 15 inches long. Leaves are malformed, cup-shaped, and chlorotic. Blossom drop may occur on infected shoots and fruits may be of different sizes. Cordons and trunks usually develop cankers (rotten, sunken areas) that spread outward and eventually girdle and kill the vine in 5 to 10 years. A wedge-shaped dead area may be observed in a cross-section of the stem; however, other factors can produce the same symptom so this is not a defining characteristic of the disease.

**Bot canker** (*Botryosphaeria* spp.) is similar to Eutypa dieback but is present in vineyards located in a wider range of climates.

**North American grapevine yellows** (NAGY) causes yellowing and downward rolling of leaves, shoot tip die-back, abortion of developing fruit, uneven bark development on shoots, and vine death. The causal agents are phytoplasmas, which are small, bacteria-like prokaryotes that lack cell walls. They can be found only in the phloem of infected plants and are spread between vines by way of insect vectors (e.g., leafhoppers).

**Monitoring:** No specific monitoring protocol is recommended, but be aware of the various disease symptoms.

**Chemical Control:** See the *Summary – Disease Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Sound vineyard sanitation practices will reduce the amount of inoculum present in the following year. Pruning to promote airflow is also beneficial, although it should be avoided during and before wet weather. If this is not possible, double pruning (leaving a stub to be removed later when it is dry) is recommended. Delay making large cuts on cordons and trunks until the end of the dormant period so that the vine will resume activity and recover more quickly. Mark diseased vines for future removal in spring when symptoms are most obvious. Remove infected wood 4 to 6 inches below the canker and train a new healthy shoot into position. If cankers are found below ground, remove and replace the vine completely. Avoid planting susceptible cultivars near woods that harbor wild grapevines or vineyards with diseased plants. Control insect pests that vector diseases.

**To Do:**
• Educate growers on symptomology, disease recognition, and infection periods
• Teach growers about nursery stock being a host for viruses, what to do when disease is found, testing for viruses vs. other diseases
• More East Coast testing

**Grape Crown Gall, Agrobacterium vitis**

Crown gall disease is caused by a soil-borne bacterium that is present in all nursery stock but seldom causes disease unless the vine is injured. If injury does occur, galls can develop rapidly, completely girdling a young vine in one season. When galls are numerous or when they are located on major roots or on the root crown, they disrupt the translocation of water and nutrients. This leads to poor growth, gradual dieback, and sometimes death of the vine. In general, affected plants are more susceptible to adverse environmental conditions, especially winter injury.

**Monitoring:** No specific monitoring protocol is recommended, but be aware of disease symptoms.

**Chemical Control:** Chemical sprays are not effective against this disease. See the *Summary – Disease Chemical Controls* section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Since chemical sprays will not control soil-borne crown gall, cultural practices such as pruning diseased tissues are extremely important in managing this disease. However, plant wounding caused by budding, grafting, or cold injury can provide suitable conditions for infection by the persistent bacterium. Practices that minimize the risk of wounding, especially those that also promote winter hardness, will help protect against crown gall disease. Using multiple trunk vines and replacing dead trunks with renewal spurs each year also help to better manage the disease. Certain cultivars such as *Vitis labrusca* are more resistant to crown gall than *V. vinifera* and may fare better against the disease.

**To Do:**
• Teach growers that topical treatments are not effective
• Conduct research on efficacy of cross-protection

**Downy Mildew, Plasmopara viticola**

Although downy mildew affects primarily foliage, it may kill young bunches of berries if it occurs early in the season. This ubiquitous fungus first appears as light-yellow spots on the upper surfaces of the oldest leaves in the center of a vine. White mold appears on the lower surface of
leaves and spreads from older foliage to new foliage as leaves mature. Susceptible varieties may be completely defoliated by fall, and fruit clusters may exhibit sunscald. If vines are defoliated prior to fruit ripening, the grapes will be of inferior quality. In North Carolina, this is the most important pest of grapes because it occurs at the end of the season and there are pre-harvest interval issues. Therefore, grape growers rely primarily on phosphorus acid products (e.g., Presidio).

**Monitoring:** Visual monitoring and forecasting are used to determine if downy mildew is present or may occur.

**Chemical Control:** See the Summary – Disease Chemical Controls section for more information.

**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Sound vineyard sanitation practices will reduce the amount of inoculum present in the following year. Disease forecasting is also important.

**To Do:**
- There is an IPM PIPE site for cucurbits, need to secure one for wine grapes
- Help growers learn to identify downy mildew and avoid confusing it with other diseases
- Teach growers about fungicide resistance and the importance of alternating pesticide modes of actions (MOAs)

**Phomopsis Cane and Leaf Spot, Phomopsis viticola**

Phomopsis cane and leaf spot, once known as Dead Arm, was discovered to be the symptomology of two different diseases, Eutypa dieback (*Eutypa armeniacae*) and Phomopsis cane and leaf spot. This disease affects the trunks and main branches of grapevines, as well as young shoots, fruit stems, and berries. The disease-causing organism overwinters in infected tissue and spores are formed in late spring or early summer. The most obvious symptom is a dead branch on the vine that is noticed in the spring when the vine produces shoots that die back quickly or it fails to produce shoots at all. Shoots that are produced are stunted, bear very small misshapen leaves, and have shortened internodes. Affected shoots will die by late summer. New canes bear small, purplish black sunken spots on the first three to four internodes. These symptoms are also seen on leaf petioles and fruiting stems. Necrotic lesions may be found under the bark of older canes and trunks two to three years before leaf symptoms appear.
**Powdery Mildew**, *Erysiphe necator*

Powdery mildew is ubiquitous and is the most economically important disease in Virginia vineyards due to the extensive planting of French-American hybrids and *Vitis* species. This disease attacks all green tissues (primarily foliage and cluster stems) and produces white powdery patches that later turn brown. Fruit may also be affected, appearing reddish or scaly, although this only occurs in years when the weather conditions are particularly conducive to disease development. Damage resulting from powdery mildew includes poor fruit set, cracked/rotten fruit, fruit shelling (unless harvested immediately), and/or a reduction in wine quality on varieties intended for that use.

**Monitoring**: Look for visual symptoms associated with this disease.

**Chemical Control**: To effectively manage this disease, sprays may be required as early as 1 to 2 inches of shoot growth on some cultivars (depending on rain and temperature). Treatment should not be delayed beyond the immediate prebloom stage on any vine. Apply chemicals only where the disease has been a problem in the past. See the Summary – Disease Chemical Controls section for more information.
**Biological Control:** None currently recommended.

**Alternative/Cultural Control:** Planting vines in sites with good air circulation and sun exposure can help to reduce disease severity. Also, use a training system that allows good air movement through the canopy and prevents excess shading. Sound vineyard sanitation practices will reduce the amount of inoculum present in the following year.

**To Do:**
- Education on varietal susceptibility to sulfur
- Education on resistance management (understanding modes of action)
- Research soft chemistry/biological control agents (e.g., mites, beetles)

**Summary – Disease Cultural Controls**

Disease-resistant cultivars are available to control certain pathogens. Use of certified vines at planting will help the initial health of the vineyard. Mowing or otherwise reducing undergrowth near vines will improve air movement and should help to alleviate mold and mildew problems. Vineyard sanitation practices such as timely harvesting and removing leftover fruit at the end of the season help prevent fruit rots the next year. Also, it is important to avoid excess late-season fertilizing to reduce both disease and the possibility of winter injury to cordons and vine trunks.

**SUMMARY – DISEASE CHEMICAL CONTROLS**

For the most current chemical information (including information on formulations, application rates, and precautions/limitations), please refer to the Virginia Cooperative Extension Pest Management Guide: Horticultural and Forest Crops, 2012, Grapes: Diseases and Insects in Vineyards (PDF | 564KB)

**WEEDS**

The most common weed species found within Virginia vineyards include yellow nutsedge, annual morningglory species, bindweed species, cocklebur, horserewt, jimsonweed, dandelion, bermudagrass, quackgrass, and wild garlic. Perennial weeds such as goldenrod, red sorrel, broomsedge, and johnsongrass are also common in Virginia.

Vineyard production systems usually consist of sod row middles alternating with vine rows or trellises. Weeds in the row middles are managed primarily through mowing. However, herbicides are used within rows. Herbicide usage in this case must be directed to the base of the vine to avoid burning the leaves and shoots of the plant. If weed control is not maintained within the rows, competition for water and nutrients may reduce productivity of the vines. Also, weeds may harbor diseases, e.g., Dandelion ring spot virus, or other pests.

**Monitoring:** No specific monitoring protocol is recommended, but growers should be aware of how to properly identify weed problems.
Chemical Control: See the Summary – Weed Chemical Controls section for more information.

Biological Control: No biological controls are currently recommended.

Alternative/Cultural Control: Mulching is an effective way to control annual weeds on small areas. Suitable materials include black plastic, landscape fabrics, newspapers, pine bark, and untreated grass clippings.

To Do:
- Identify alternate hosts for Pierce’s disease
- Educate growers with young vineyards about the need to protect young vines
- Rank competitiveness of various weeds

SUMMARY – WEED CHEMICAL CONTROLS
For the most current chemical information (including information on formulations, application rates, and precautions/limitations), please refer to the Virginia Cooperative Extension Pest Management Guide: Horticultural and Forest Crops, 2012, Grapes: Weed Control in Vineyards (PDF | 387KB)

VERTEBRATE PESTS
Portions of the following section as well as the control recommendations were taken from Wolf and Poling, 1995.

Birds

Many species of birds (e.g., turkeys and non-raptor birds) are fond of ripe grapes and will quickly cause appreciable crop loss if not controlled. Evidence of bird feeding includes peck marks on individual berries, remnants of berry skins retained in the cluster stem, and selective feeding on individual berries of the cluster, leaving the stem intact. Options to control bird feeding are limited and very few are entirely effective. Eventually, most birds will overcome their aversion to the recommended control methods.

Monitoring: No specific monitoring protocol is recommended, but growers should be aware of how to properly identify pest problems.

Chemical Control: Mesurol (methiocarb) was used in the past to repel birds but is now illegal.

Biological Control: None recommended.

Alternative/Cultural Control: Scare tactics are the primary type of bird control available. These include noisemakers, electrical wires mounted in the vineyard, flash tape, balloons, and simulated bird predators. Vines under or close to roosting areas are the most vulnerable. Therefore, avoiding these areas may discourage bird depredation. In situations where total, environmentally-benign control is desired, bird netting can be used. Installing large amounts of
holographic tape may be helpful. Noise cannons will scare off birds, but neighbors around the vineyard may find this method irritating. Bird-gard-type electronic devices have not provided satisfactory control for Virginia and North Carolina growers.

To Do:
- Research bird behavior in vineyards, repellent stations (e.g., cranes on corn in the mid-West), and ways to avoid affecting cover sprays or flavor parameters
- Study noisemakers (how long for adaptation, when to start, etc.)
- Determine if predatory birds are working
- Research all anecdotal evidence; research differences in species reactions to various control methods

**White-Tailed Deer, *Odocoileus virginianus***

One of the best-known mammals in North America, the white-tailed deer is commonly found in Virginia and North Carolina vineyards. Deer browse on rachises, shoot tips, and leaves, thereby reducing vine health and productivity. They also feed on ripening grapes within the vineyard but may be deterred by various scare tactics. Once deer discover a source of food, it is exceedingly difficult to discourage them. Therefore, early detection and management strategies are critical for deer control.

**Monitoring:** No specific monitoring protocol is recommended, but growers should be aware of how to properly identify pest problems.

**Chemical Control:** Taste and odor repellents are available to keep deer out of vineyards. Their effectiveness depends on population size, other deer food sources, and weather. These chemicals may become expensive if repeated applications are necessary. Repellents are generally applied during the dormant season either as aerial, ground, or spot treatments.
- **capsaicin** (Hot Sauce Animal Repellant) – applied as an aerial spray during the dormant period. Must be used in combination with Vapoguard.
- **hinder** (Hinder Deer) – active ingredients include ammonium salts of C8-18 and C18' fatty acids, ammonium soaps of fatty acids, and phenol, 2,4-dichloro-benzenesulfonate. May be applied during the growing season or dormant period to deter deer feeding.

**Biological Control:** None recommended.

**Alternative/Cultural Control:** Hunting licenses or special permits may be obtained to decrease population size. Trained dogs confined by invisible fencing as well as noise emitters may be used to reduce deer presence. Various forms of electric and nonelectric fencing are available to prohibit deer entry into vineyards. Combinations of these control techniques are usually more effective than any form used alone. In addition to the products listed above, deodorant soap, animal tankage, and human hair have been used to ward off deer, especially within young trees, but there is no evidence that these are particularly effective deterrents.

To Do:
- Research efficacy of various types of fencing
Other Vertebrate Pests

Other grape pests include raccoons, groundhogs, opossums, bears, rabbits, squirrels, chipmunks, voles, and mice.

**Monitoring:** No specific monitoring protocol is recommended, but growers should be aware of how to properly identify pest problems.

**Chemical Control:** None recommended.

**Biological Control:** None recommended.

**Alternative/Cultural Control:** Deer fencing keeps out natural predators, unfortunately. Dogs may be an effective deterrent. Trapping/hunting can be done where legal. Electrified varmint fencing is sometimes used to control certain vertebrate pests.

**To Do:**
- Research/register Ropel

**ACKNOWLEDGMENTS**

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**REFERENCES**


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**March 23, 2010 – WORKSHOP PARTICIPANTS – AFTON, VA**

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</table>

**Efficacy Tables and Worker/Pest Activities Timelines**
## Pest Management Tools

**Chemical/GMOs**

- abamectin (Agri-Mek)
- acetamiprid (Assail)
- Bacillus thuringiensis (Bt)
- bifenazate (Acramite)
- bifenthrin (Brigade)
- buprofezin (Applaud)
- carbaryl (Sevin)
- chlorpyrifos (Lorsban)
- cyfluthrin (Baythroid)
- diazinon (Diazinon)
- dinotefuran (Venom)
- endosulfan (Thionex)
- etoxazole (Zeal)
- fenbutatin-oxide (Vendex)
- fenpropathrin (Danitol)
- hexythiazox (Onager)
- imidacloprid (Provado)
- indoxacarb (Avaunt)
- kaolin (Surround)
- malathion (Malathion)
- methomyl (Lannate)
- methoxyfenozide (Intrepid)
- methoxyfenozide (Heracide)
- phosmet (Imidan)
- pyridaben (Nexter)
- rynaxypyr (Altacor)
- spirotetramat (Movento)
- spirodiclofen (Envidor)
- thiamethoxam (Actara)
- azadirachtin, pyrethrins (Azera)
- bifenthrin (Capture)
- spinosad (Entrust)
- pheromones (Isomate GRB)
- pheromones (SPLAT-GBM)
- pyrethrin (Pyganic)
- neem oil (Trilogy)
- clothanidin (Belay)
- spirotetramat (Movento)
- Karathane
- pheromones (SPLAT-GBM)
- kaolin (Surround)
- Early spring soil cultivation
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## Pest Management Tools

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<thead>
<tr>
<th>Pest Management Tools</th>
<th>Anthracnose</th>
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<th>Gray Mold</th>
<th>Phomopsis Cane/Leaf</th>
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<td>mephenoxam + copper (Ridomil Gold/Copper)</td>
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<td>tebuconazole + trifloxystrobin (Adament)</td>
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<td>ziram (Ziram V, Ziram Granular)</td>
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<td>ziram oxide + mancozeb (Gavel)</td>
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<td>Bordeux, fixed copper fungicides (Coppers)</td>
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<td>P-F</td>
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<td>difenoconazole + cyprodinil (Inspire Super)</td>
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<td>cyprodinil + famoxadone (Switch)</td>
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<td>mephenoxam + copper fungicides (Bordeaux)</td>
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<td>F</td>
<td>P-F</td>
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### Registered Fungicides

### Unregistered & New Fungicides

### Cultural & Nonchemical Pest Management Practices

- **Use good sanitation to reduce inoculum levels**
- **Improve air circulation/reduce humidity (e.g., pruning, proper site selection)**
- **Proper fertilization**
- **Proper irrigation**
- **Plant resistant cultivars**
- **Protect fruit from cracking/puncturing**
- **Protect plants from contact/puncturing**
- **Remove/destroy diseased tissues**
- **Prevent plant wounding (e.g., by budding, grafted, or cold injury)**
- **Promote winter hardness**
- **Use multiple trunks vines and replace dead trunks with renewal spurs each year**

### Biological Controls
### Table 3. Efficacy ratings for various pest management tools used against weed pests of wine grapes in Virginia and North Carolina.

Rating Scale: E = excellent, G = good, F = fair, P = poor, N = no control, - = information lacking or not registered. (Modified from information presented in the Pest Management Guide: Horticultural & Forest Crops - 2012 - Virginia)

<table>
<thead>
<tr>
<th>Pest Management Tools</th>
<th>Annual Grasses</th>
<th>Annual Broadleaf Weeds</th>
<th>Perennial Grasses and Sedges</th>
<th>Perennial Broadleaf Weeds</th>
<th>Special Perennial Weed Problems</th>
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<td>dichlobenil (casoron)</td>
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<td>diuron (karmex)</td>
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<tr>
<td>flumioxazin (chateau)</td>
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<td>isoxaben (gallery)</td>
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<td>napropamide (devrinol)</td>
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<td>oryzalin (surflan)</td>
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<td>pronamide (kerb)</td>
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<td>simazine (princep)</td>
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<td>norflurazon (solicam)</td>
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<td>carfentrazon (aim)</td>
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<td>clethodim (select)</td>
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<td>fluazifop-butyl (fusilade)</td>
<td>G</td>
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<td>glufosinate (rely)</td>
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<td>paraquat (gramoxone)</td>
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<td>sethoxycyan (poast)</td>
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<td>E</td>
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none recommended
Table 4. Efficacy ratings for various pest management tools used against vertebrate pests of wine grapes in Virginia and North Carolina. Rating Scale: E = excellent, G = good, F = fair, P = poor, N = no control, - = information lacking or not registered. (Modified from information presented in the Pest Management Guide: Horticultural & Forest Crops - 2010 - Virginia)

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<thead>
<tr>
<th>Pest Management Tools</th>
<th>Birds</th>
<th>White-tailed deer</th>
<th>Raccoons</th>
<th>Groundhogs</th>
<th>Opossums</th>
<th>Bears</th>
<th>Rabbits</th>
<th>Squirrels</th>
<th>Chipmunks</th>
<th>Voles</th>
<th>Mice</th>
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<td>Registered Chemicals</td>
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<td>Capsaicin (Hot Sauce Animal Repellent)</td>
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<td>Scare tactics</td>
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<td>Avoid planting vines near roosting sites</td>
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<td>Repellents (e.g., soap, human hair, animal tankage)</td>
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<td>Trained dogs confined w/ invisible fencing</td>
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<td>Fencing (electric and non)</td>
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### Table 5. Timeline of wine grape management activities in Virginia and North Carolina.

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Table 6. Timeline of wine grape pest activity in Virginia and North Carolina.

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