Pest Control in Small Vineyards
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Fig. 1. Powdery mildew on the upper surface of a young Concord leaf as indicated by the sooty, grayish-white lesions.

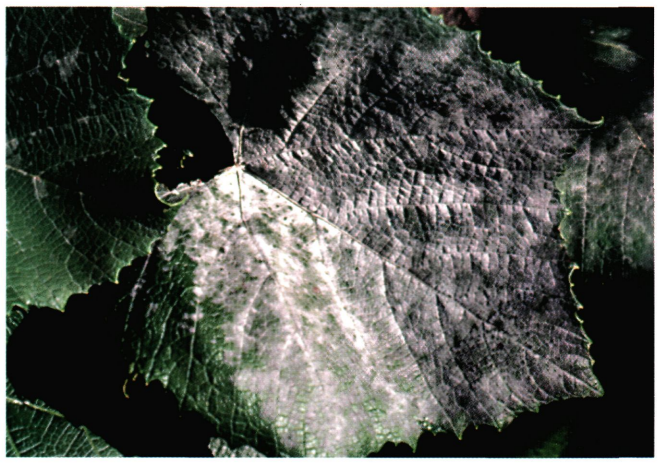

Fig. 2. Powdery mildew in an advanced stage of infection of a Concord grape leaf, becoming very whitish and causing a darkening of the leaf surface.

Fig. 3. Downy mildew symptoms on the upper side of a Niagara leaf.

Fig. 4. Downy mildew on the underside of a Niagara leaf with its characteristic cottony white mass of sporulation.

Fig. 5. Downy mildew late in the growing season on a Niagara leaf with angular yellow-brown areas concentrated somewhat along the main veins of the leaf.

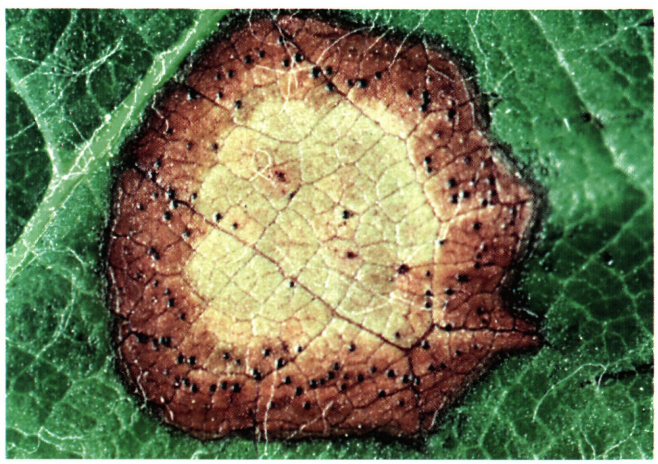

Fig. 6. A greatly enlarged black rot lesion on a Concord leaf with small black fruiting bodies apparent around the periphery of the infection.

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Preface

Pest control information for small vineyards is a difficult topic because of the limited choice of materials available to non-commercial growers. Moreover, the cost of several products is prohibitively high for small vineyards, and frequent changes occur in pesticide registration of materials approved for use on grapevines. Despite these limitations, this publication provides specific choices for controlling diseases and insects in small vineyards. It is intended for use in temperate-climate vineyards. This publication is revised periodically. Nevertheless, no guarantee can be made regarding the current status of this information, so it is presented with this disclaimer:

ALL PESTICIDE INFORMATION IN THIS PUBLICATION IS FOR GENERAL REFERENCE ONLY - NO EXPLICIT RECOMMENDATION FOR USE IS INTENDED OR IMPLIED. ANY USE OF PRODUCTS MENTIONED IN THIS PUBLICATION SHOULD FIRST BE CHECKED FOR CURRENT REGISTRATION STATUS AND POSSIBLE ALTERNATIVE SPRAY PROGRAMS WITH THE LOCAL COUNTY EXTENSION OFFICE. THE MENTION OF PRODUCTS IN THIS PUBLICATION DOES NOT CONSTITUTE AN ENDORSEMENT OF THOSE PRODUCTS BY MICHIGAN STATE UNIVERSITY OR BIAS AGAINST THOSE NOT MENTIONED.

Pesticides vary greatly in their toxicity to humans. All of the pesticides mentioned in this publication are rated as slightly toxic or relatively non-toxic to humans. They are approved for use according to directions on their labels by all individuals.

Acknowledgments

Thanks to Dr. Mike Ellis, Dr. Ron Perry, Lynnae Jess, Dr. Erwin Elsner, Robert Tritten and Al Lange for reviewing various stages of this manuscript. Dr. Roger Williams provided the color photo of the rose chafer. Thanks to Diane Dings for preparation of the color plates, and a very special thanks to Diane for preparation of the numerous drafts of this manuscript.

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Pest Control in Small Vineyards

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Introduction

A grape pest is anything destructive to grapes or grapevines. Pests include insects, diseases, birds and deer. This publication focuses on control of the principal insects and diseases affecting grapevines in small temperate-climate vineyards. The goal is to help growers identify the common pests of grapevines in small temperate-climate vineyards, choose effective control measures for those pests and apply those control measures in a timely manner.

Numerous disease and insect pests can attack grapevines. Commercial grape growers often need to consult comprehensive reference materials on these pests (Pearson and Goheen, 1988; Williams *et al.*, 1986). Fortunately, many grape pests occur only occasionally. Therefore, growers of small vineyards often need to be concerned about only a relative few insects and diseases that commonly threaten the productivity of their vines. This publication targets those common pests. Assistance with the multitude of less common pests should be obtained from the local Extension office.

See inside front and back covers for Figures 1-13.

Identification of Common Pests in Small Vineyards

Control of the common pests attacking vines begins with their identification. Four insect pests and five diseases commonly attack small vineyards in a temperate climate.

Common Diseases

Powdery mildew — This disease is caused by a fungus that attacks all green tissues on the vine. It often appears as a grayish white film on the surface of infected tissues. On leaves, it most often occurs on the upper surfaces (Fig. 1), but it can also occur on the undersides. Leaves are discolored and darken as the disease progresses (Fig. 2). Infected green shoots develop a blotchy, dark discoloration, which is apparent on canes when the vines become dormant. If powdery mildew is not controlled on grapevines, it can directly attack young berries, causing them to crack and rot. It can also reduce the hardiness of vines, making them more susceptible to winter injury.

Downy mildew — This disease can also infect all green tissues on the vine. On leaves, infection first appears as yellow, angular, blotchy areas on the upper surface (Fig. 3). Cottony white masses of spores soon develop on the lower surface of the leaf directly below the yellow spots (Fig. 4). The fungus that causes this disease

requires free water to infect vines. Therefore, it is especially prevalent during rainy periods and in the latter part of the growing season, when heavy dews remain on vine tissues. During hot, dry weather, the cottony white masses of spores (Fig. 4) often dry up and disappear, thus making identification of this disease somewhat difficult. In the latter part of the growing season, infected leaves develop angular, brownish yellow areas on the upper surfaces that tend to be concentrated along the main veins of the leaf (Fig. 5). When this disease is not controlled, it can directly attack the fruit of some varieties and severely defoliate vines. Premature defoliation can lead to a dramatic reduction in both grape maturity and the winter hardiness of vines.

Black rot — This is a major fungus disease of grapevines in temperate climates. It also requires water on the tissues for infection. Lesions caused by black rot on the upper surfaces of grape leaves appear as tan to orange spots (Fig. 6). These leaf spots contain small, blackish fruiting bodies around the periphery of the lesions (Fig. 6). These small, black fruiting bodies confirm that the leaf spot was caused by black rot. When black rot directly attacks grapes, it first turns green berries a caramel color. Then the berries quickly shrivel into dark, blackish mummies (Fig. 7). Fruiting bodies, which produce spores to spread this disease, can be readily seen on the surface of these shriveled berries (Fig. 7).

Phomopsis cane and leaf spot — This disease is easily identified by lesions on canes near their bases (Fig. 8). Where these are found, pinpoint lesions on the first three or four leaves of shoots are also likely to occur. Severe infections can also cause fruit loss. In many vineyards, however, this disease is not nearly as damaging as powdery mildew, downy mildew and black rot.

Botrytis bunch rot — Several fungi can cause fruit rot on grapevines in temperate-climate vineyards. The most common of these is Botrytis (Fig. 9). Botrytis bunch rot most commonly occurs on tight-clustered varieties. It begins with the decay of individual berries, which take on a tan color and often have fuzzy, brown fruiting bodies protruding from the surface. This fungus can quickly spread to adjacent berries and so consume a large portion of the cluster in just a few days.

Common Insects

Grape berry moth — This moth directly attacks grape berries by laying eggs on their surface. Eggs hatch into worm-like larvae (Fig. 10), which bore into the berries. Small holes and webbing between berries indicate the presence of this pest. Three or more generations of this insect can occur during a single growing season. If early infestations are not controlled, later generations can cause severe crop loss, either directly or by promoting an increase in fruit rot infections. Many vineyards will be untouched by this pest; however, where it occurs, it can destroy the entire crop.

Grape leafhoppers — These insects feed on the undersides of leaves. As they feed, they create a mottled pattern of dying leaf tissue (Fig. 11). If leafhopper populations are very high, this damage can render the entire leaf non-functional. However, slight to moderate populations of this insect are usually only a nuisance and do not significantly influence vine performance. A threshold for control of this insect has been estimated to be approximately five leafhoppers per leaf. This means that if leafhopper populations remain below five per leaf, no control is required.

Japanese beetle — This insect pest continues to expand its geographic distribution in the eastern United States. Where this insect occurs on grapes, it can severely defoliate a vine (Fig. 12) and reduce its productivity. When 15 to 25 percent of the leaf area is affected by this pest, control measures should be undertaken.

Rose chafer — This large, tan-colored beetle (Fig. 13) is often associated with light, sandy soils. It emerges from the soil in late May to early June; emergence often coincides with the time of grape bloom. It will feed directly on grape clusters and can greatly reduce crop size. Spraying is warranted whenever more than two beetles per vine are found. Pheromone trapping has also been used to control this insect. Of those insecticides available to non-commercial growers, Sevin (carbaryl) is rated as the most effective insecticide for this pest.

Growers of small vineyards should watch or "scout" for these pests. Their presence may signal the need for control measures. When pest problems other than those described above become significant in a small vineyard, a local Extension office can often provide the necessary diagnostic services and consultation.

Pest Control Strategies for Small Vineyards

Insect Control

Grapevines can frequently tolerate low to moderate levels of insect damage. In most situations, it becomes necessary to control insects only when they threaten either a significant portion of the leaf area of vines or the fruit itself.

Control of most insects requires observing or "scouting" the vines periodically. If a major infestation of insects such as leafhoppers or Japanese beetles occurs, choose an appropriate insecticide (Table 1) and make an application.

Grape berry moth is an exception to this strategy. Because this pest directly attacks the fruit, considerable fruit may be lost by the time the problem is discovered. Many small vineyards are not attacked by this insect. Unfortunately, however, vineyards severely infested with berry moth are often not identified until after the pest has severely damaged the crop. Such situations signal the need for preventive control of this pest in future years. When such a need arises, choose an appropriate insecticide (Table 1) and begin applications at the end of bloom. Label directions may indicate the frequency of subsequent applications. The basic strategy is to have insecticide residue on berry surfaces as soon as the young berries form. These protective residues kill the larvae emerging from eggs on the berry surfaces. If the first generation (called first brood) is controlled, second and third generations will be much less severe.

Weather greatly influences the emergence of this pest. In some grape-growing regions, Extension agents monitor berry moth emergence and give recommendations on when to spray. When this information is not available, the traditional times of berry moth spray applications are the first spray at the end of grape bloom, a second spray 7 to 10 days later and a third spray at the end of July (Brann and Arneson, 1973).

Disease Control

Disease control in grapevines differs from most insect control because fungicides are typically applied as a preventive strategy before diseases become apparent in the vineyard. **Early-season disease infections are a major cause of more serious infections later in the growing season. Therefore, good grapevine disease control begins by controlling early-season infections.**

Fungicides are approved and labeled for use on grapevines by the Environmental Protection Agency according to their control of specific diseases. Unfortunately, product labels can at times mislead growers in their choice of appropriate fungicides to control specific grape diseases. First, products will always be effective but not necessarily highly effective against all diseases listed on a product label. Secondly, at the time a fungicide was registered for use on grapevines, it may not have been tested against all grapevine diseases. Therefore, products may be effective against diseases not listed on the label. Independent testing of fungicides by many plant pathologists at several universities provides an unbiased understanding of the effectiveness of many fungicides against all of the major grape diseases (Table 2). That information can be used by a grower to determine the efficacy of a specific product against specific grape diseases.

Because captan is a common fungicide used in products formulated for homeowner use on grapevines, we'll use this fungicide to illustrate the above points. Several products contain captan as the only fungicide in their product mix (Table 1). These products indicate on their label that they will control black rot, and sometimes they also list downy mildew, Phomopsis cane and leaf spot, or Botrytis bunch rot. However, the fungicide captan is only slightly effective for controlling black rot and Botrytis rot; it is highly effective against Phomopsis cane and leaf spot and downy mildew (Table 2). Therefore, a grower using these products may be disappointed in their control of black rot and Botrytis rot, even though they may be listed on the label, but unexpectedly pleased with their control of Phomopsis cane and leaf spot and downy mildew, which may not be listed on the label. All pesticides must be applied only for control of those diseases and insects listed on their label. However, it is perfectly acceptable to benefit from

the control of unlabeled diseases while making applications to control a labeled disease. Therefore, the information on fungicide efficacy in Table 2 can be very helpful for choosing products that are highly effective in controlling diseases of importance in a particular vineyard.

Choosing Fungicides for Backyard Plantings

Option 1 - Off-the-shelf Products

Home garden formulations of pesticides found in hardware stores, home improvement centers, etc., are the most realistic approach to a fungicide spray program for a very small vineyard of a half dozen or so vines. Products approved for use in Michigan are listed in Table 1. Compare the fungicides in these products (Table 1) to the efficacy of those fungicides to control specific diseases (Table 2) to determine how well a product is likely to control specific diseases. Please note that no single fungicide is highly effective against the five grapevine diseases listed in Table 2. Therefore, tank mixes of two products will often be needed to ensure broad-spectrum grapevine disease control.

Option 2 - Low-Cost Tank Mixes with Sulfur

If control of powdery mildew is important for the varieties being grown, the lowest cost approach for controlling this disease is to add wettable spray sulfur to home fruit or orchard formulations. Sulfur, however, may burn the leaves of some grape varieties. Sulfur-sensitive varieties include Chancellor, Concord, Concord Seedless, DeChaunac, Foch, Ives, New York Muscat, Price, Rougeon, Seneca, Suffolk Red and Van Buren (Jones *et al.*, 1999; Reisch *et al.*, 1993). Stop using wettable sulfur if leaf burning occurs.

Option 3 - Higher Cost Tank Mixes

Immunox (Table 1) has recently become available to home gardeners. Although more costly than traditional home orchard sprays, it is very effective against powdery mildew and black rot (Table 2). The active ingredient of Immunox is myclobutanil (Nova) fungicide, which does not control downy mildew (Table 2). Therefore, mixing Immunox with a home garden spray containing captan will give good control of all three of the major diseases of grapevines.

Choosing Fungicides for Small Vineyards

Growers with more than a dozen grapevines will often find it cost effective to purchase fungicides and insecticides in small commercial containers and then make their own tank mixes. Follow all label instructions to store these materials in dry, cool places. When using this approach, it may be helpful to obtain a commercial guide for the control of grape pests. These are available from Michigan Extension (Jones *et al.*, 1999) and Extension offices in many other states.

Option 1 - Low-cost Tank Mix

Mancozeb (trade names include Penncozeb, Manzate and Dithane) or Ziram to control black rot and downy mildew can be mixed with wettable sulfur to control powdery mildew (Table 2) for an effective, relatively low-cost spray program.

Two tablespoons of mancozeb or Ziram and 2 tablespoons of wettable sulfur per gallon of water make a suitable spray mixture. When making applications, attempt to cover vine tissues thoroughly.

Option 2 - Higher Cost Tank Mixes

When the cost can be justified, fungicides more expensive than sulfur can provide better, longer lasting control of powdery mildew. These are called sterol inhibiting (SI) fungicides, and trade names include Bayleton, Rubigan and Nova. Because they do not control downy mildew, tank mix them with materials such as captan, mancozeb or Ziram (Table 2) to control downy mildew.

These materials are used at relatively low rates, such as ounces per acre. Therefore, the cost per application to a small vineyard is not large, but the initial purchase price of the product might prohibit their use in small plantings. For example, the smallest container of Nova fungicide available is 20 ounces, and the suggested retail price is approximately $77. Read the label to determine

Table 1. Home garden pesticide products that are approved for use on grapevines in Michigan, the companies selling these products, their active ingredients and the pests labeled for control.

Product name	**Company name**	**Active ingredients**	**Grape diseases/insects listed to be controlled according to product label**
Diazinon Ultra Diazinon	Ortho-Solaris Spectracide	Diazinon Diazinon	Grape berry moth Grape berry moth
Sevin (liquid concentrate)	Ortho-Solaris Spectracide	Sevin Sevin	Leafhoppers, Japanese beetles Leafhoppers, Japanese beetles
Malathion	Ortho-Solaris	Malathion	Leafhoppers, Japanese beetles
Home Orchard Spray	Ortho-Solaris	Captan Malathion Methoxychlor	Grape berry moth, leafhoppers, Japanese beetles, black rot, Phomopsis cane and leaf spot (dead arm)
Fruit Guard	Security	Captan Malathion	Grape berry moth, leafhoppers, black rot
Immunox	Spectracide	Nova (myolobutanil)	Black rot, powdery mildew
Liquid Fruit Tree Spray	Dragon Acme Rockland	Captan Malathion Methoxychlor Carbaryl (Sevin)	Flea beetles, Japanese beetles, rose chafers, grape berry moth, leafhopper, black rot, downy mildew, Botrytis rot
Home Orchard	Stark	Captan Malathion Methoxychlor Carbaryl (Sevin)	Flea beetles, Japanese beetles, rose chafers, grape berry moth, leafhopper, black rot, downy mildew, Botrytis rot
Bordeaux Mix	Dragon	Basic copper sulfate	Black rot
Garden Dust	Bonide	Pyrethrins Rotenone Sulfur Basic copper sulfate	Japanese beetles, rose chafers, black rot, powdery mildew
Copper Dragon Tomato & Vegetable Dust	Dragon	Carbaryl (Sevin) Copper	Leafhoppers, Japanese beetles, grape berry moth, black rot, downy mildew, powdery mildew

Table 2. Effectiveness of fungicides for the control of grape diseases.[1]

Fungicide	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis rot
Abound	++	+++	+++	+++	0
Bayleton	0	+++	0	+++	0
Benlate	++	+	0	+++	++
Captan	+++	+	+++	0	+
Ferbam	+	+++	+	0	0
Fixed Copper and Lime	+	+	+++	++	+
Mancozeb	+++	+++	+++	0	0
Nova	0	+++	0	+++	0
Ridomil Gold/Copper	+	+	+++	++	+
Ridomil Gold MZ 72	0	+	+++	0	0
Rovral	0	0	0	0	+++
Rubigan	0	++	0	+++	0
Sulfur	+	0	0	+++	0
Ziram	++	+++	++	0	0

+++ = highly effective, ++ = moderately effective, + = slightly effective, 0 = not effective.

[1]This table adapted with permission from "IPM Disease Management Guidelines for Grapes in Ohio" by M. A. Ellis.

the use rates for these materials. For example, Nova is registered at the rate of 3 to 5 ounces/acre. This rate is usually dissolved in up to 100 gallons of water for a commercial application. A concentration of 4 oz/100 gallons translates to 0.04 oz or 1.1 g per gallon. One teaspoon of Nova weighs approximately 1.2 grams, so 1 teaspoon of Nova per gallon provides the appropriate concentration for spraying a small vineyard.

Option 3 - High-cost Spray Program

Abound, a relatively new fungicide, is effective against all major grape diseases except Botrytis (Table 2). It is used at a relatively low rate — 12 fluid ounces per acre — so it is ideal for minimizing visible residues on berry surfaces, which is especially important for table grapes. The deterrent to the use of this product in a small vineyard is the initial container price, which is approximately $260 per gallon. A 12 oz/100 gallon/acre concentration translates to approximately ¾ teaspoon per gallon for spraying a small vineyard. Therefore, a gallon of Abound will last a small grower a very long time!

Option 4 - Copper and Lime

Various forms of copper fungicides can be used with spray lime to control several grape diseases. This tank mix is often considered "organic", so some find it desirable to use for that reason. There are drawbacks to the use of copper fungicides, however, which a grower should be aware of. Foremost among these limitations is efficacy. Copper is only slightly to moderately effective against certain diseases (Table 2). Secondly, lime is often recommended to be used with copper fungicides as a safening agent to prevent copper from burning grape

leaves, but the combination of copper and lime is difficult to keep in suspension and spray through the nozzles of small sprayers. Nevertheless, with extra effort, this ages-old approach to grape disease control can produce satisfactory results. Rates of various copper fungicide products for small vineyards should be calculated from their labels.

Application of Fungicides

The size and type of pesticide sprayer is a personal choice. It is important to know that many pesticides are suspensions — they do not dissolve in water. Therefore, spray mixtures must be frequently agitated. Follow all label directions for safe handling and use of these materials.

Early-season Applications for All Vineyards

Begin spraying when shoots average 5 inches in length. If Phomopsis cane and leaf spot is severe, begin when shoots are 1 inch long. Repeat sprays at 10-day intervals until the start of bloom. Make a special effort to apply sprays so they will dry on the vine in advance of rainy periods. Apply a prebloom spray at the first sign of florets opening. Apply a postbloom spray when 90 percent of the florets are open or 7 days after the prebloom spray, whichever comes first.

Table Grape Vineyards

When using wettable powder formulations of products such as mancozeb, captan, Ziram and sulfur to spray table grapes, the first postbloom spray at 90 percent flowering will end your fungicide spray program for the season. Using these materials after bloom may cause visible spray residue problems at harvest. Sterol inhibitors used alone (see option 2) or Abound (see option 3) can be used throughout the growing season without causing visible residue problems on table grapes.

Wine or Juice Grape Vineyards

Grapes grown for pressing into juice or wine should be sprayed at 10- to 14-day intervals through the growing season. Product labels will indicate how many days before harvest one must stop using a specific product. If more than a two-week period is anticipated between the end of the harvest and a killing frost, postharvest fungicide applications can help reduce disease carryover for the next growing season. Avoid use of wettable sulfur when air temperatures exceed 85 degrees F. If leaf burning occurs with sulfur, discontinue its use. Note: sulfur is not highly toxic to humans, but it will burn if improper use brings it in contact with eyes.

Cultural Practices to Control Grape Diseases

Good pest control in grapevines involves more than the use of pesticides. Several vine cultural practices should be used in conjunction with pesticides to control insect and disease problems on grapevines. Grape diseases are often promoted by high humidity or water sitting on vine tissues. Therefore, vine management that promotes faster drying will decrease disease incidence. Sloping ground promotes airflow through the vineyard; trees or other structures inhibit airflow, block sunlight, slow drying conditions and promote disease. Therefore, practice good vineyard site selection (Zabadal and Andresen, 1997) and vineyard development (Zabadal, 1997a). Choose vine training systems for table grapes (Zabadal, 1998) or wine grapes (Zabadal, 1997b) to provide open vine canopies. Use canopy management practices including shoot positioning, leaf removal and summer pruning to keep vines open to sunlight and airflow. A grapevine with shaded leaves turning yellow and falling off during the growing season indicates inadequate vine training, canopy management or both. Vineyard floor management, both under the trellis and in row middles, should minimize weed growth, which can inhibit airflow through the vineyards. Sanitation of the vineyard floor in the fall can reduce the carryover of both insect populations and diseases from one year to another. In small plantings, removing and burying or burning leaf and berry litter under the trellis can reduce the incidence of Phomopsis, downy mildew, black rot and grape berry moth in the following year. Good pruning practices to reduce the amount of old wood on vines can reduce the source of spores of powdery mildew and Phomopsis cane and leaf spot.

Future grape varieties with a high level of disease resistance may one day be the key to grape production in a temperate climate. The present varieties of choice, however, often require a combination of good cultural practices and pesticide use to ensure the production of grapes with acceptable quality and yield.

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Fig. 7. Black rot on Concord berries showing the characteristic shriveling of the berry and the numerous fruiting bodies on the berry surface, which provide a source of spores for infection of other tissues.

Fig. 8. Phomopsis cane and leaf spot lesions on an internode of a Concord cane.

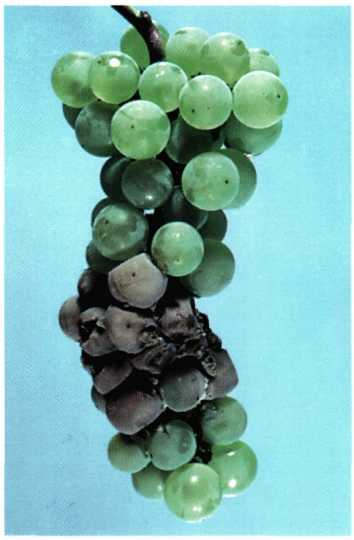

Fig. 9. Botrytis bunch rot on an Aurore cluster with its characteristic caramel-colored sporulation.

Fig. 10. Grape berry moth damage on a Concord grape cluster. Immature berries held tightly against each other indicate the presence of this pest. A grape berry moth larva has been placed on the surface of a healthy berry at the top of the picture.

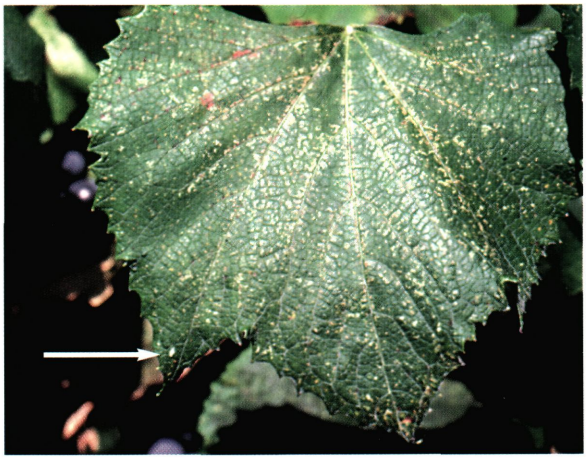

Fig. 11. Grape leafhopper damage on a Concord leaf with one leafhopper apparent on the lower left portion of the leaf.

Fig. 12. Japanese beetles feeding on leaves of the Merlot variety.

Fig. 13. Rose chafer.

Other Extension Bulletins in this series:

E-2642, Table Grape Varieties for Michigan
E-2643, Wine Grape Varieties for Michigan
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