Grapes: Organic Production

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Organic grape production provides a fairly predictable economic return in irrigated parts of the arid West. In the East, organic grape production is complicated by a climate that fosters insect and disease problems. Production is compounded by consumer preferences for grape cultivars (both dessert and wine grapes) that are difficult to grow in the East. This guide presents organic management options for diseases, insects and weeds, discusses cultivar choices in terms of disease resistance, and briefly presents marketing ideas for eastern labrusca-type grapes and organic wines. References and an appendix on disease resistance rating follow the narrative.

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Photo by Rex Dufour, NCAT

"Simply put: the principles of organic farming and sustainable practices are the single most important tools you can employ to improve wine quality." John Williams, owner, Frog's Leap Winery, Rutherford, California, speaking at the 54th Annual Meeting of the American Society for Enology and Viticulture (ASEV). June 20, 2003. Reno, Nevada.

Introduction

Grapes are grown in many parts of the U.S., in a wide range of climates and conditions. Certain considerations and practices in grape production will be the same for both organic growers and conventional growers within a given region. For instance, site selection, pruning and training, and planting techniques are similar for both conventional and organic grape culture. Information on these topics is available through the Cooperative Extension Service, grape growers associations, and common vineyard texts, bulletins, and trade magazines. Accordingly, this publication focuses primarily on organic controls for pests, diseases, and weeds. For general information on organic fertility management in tree and vine crops, refer to ATTRA's *Tree Fruits: Organic Production Overview.*

In some parts of the country, grapes are among the easiest fruit crops to grow organically. Diseases can be managed with a combination of cultural strategies (including specific pruning and training techniques, cultivar selection, and proper siting of the vineyard) and organically acceptable oils and soaps, and mineral- and biologically-based fungicides. A similar range of products, but including pheromonal controls, can be relied upon to control most mite and insect problems. Cover crops, mulching, mowing, and mechanical cultivation can be used to control weeds, and fertility needs can be met with ecological soil management practices and purchased organic fertilizers, when necessary.

Table 1. Wine Grape Species

Grape Species	Common Names	Cultivars and Hybrids	Native to	Climatic/pest considerations	Additional Information
Vitis vinifera	European Grape, Vinifera grape	Many	Asia Minor	Widely planted in western US, but on hybrid rootstocks, as *V. vinifera* rootstocks are susceptible to phylloxera. Generally not as cold hardy as native V. *labrusca* grapes, so less widely planted in the Northeast. Vinifera grapes can be generally characterized as requiring a long growing season, relatively high summer temperatures, low humidity, a ripening season free of rainfall, and mild winter temperatures.	
Vitis rotundifolia, *(Please note that some authorities place this species in a separate genus, Muscadinia.)* also: ***Vitis acerifolia*** (Le Conte), ***Vitis angulata*** (Le Conte), ***Vitis callosa, Vitis cordifolia, Vitis hyemalis, Vitis incisa*** (Rafinesque), ***Vitis muscadina*** (Rafinesque), ***Vitis mustangensis, Vitis peltata*** (Rafinesque), ***Vitis rotundifolia Flowers, Vitis rotundifolia Scuppernong, Vitis taurina*** (Bartram), ***Vitis verrucosa*** (Muhlenberg), and ***Vitis vulpina*** (Linnaeus).	Arkansas Grape, Big White Grape, Black Grape, Bull Grape, Bullace Grape, Bullet Grape, Bullit Grape, Bush Grape, Bushy Grape, Currant Grape, Flowers Grape, Green Muscadine, Hickman's Grape, Muscadine Grape, Muscadinia Rotundifolia, Mustang Grape, Roanoke Grape, Scuppernong Grape, Southern Fox Grape, Warty Grape, White Grape, White Muscadine, White Musky Grape, and Yellow Muscadine	Black Beauty, Black Fry, Bountiful, Carlos, Chief, Cowart, Darlene, Dearing, Delight, Dixie, Doreen, Florida Fry, Fry, Higgins, Hunt, Ison, Janebell, Janet, Jumbo, Loomis, Magnolia, Nesbitt, Noble, Pineapple, Regale, Scuppernong, Sterling, Summit, Supreme, Sweet Jenny, Tara, Tarheel, and Triumph	Southern Delaware to southern Illinois, south by southwest to northeastern Texas, south to the Gulf, and east to the Atlantic.	Adapted to humid southeast. Lacks frost hardiness and can be injured by minimum winter temps of 0 degrees F. Should avoid growing in areas that often have 10 degree F temps. It is most abundant on sandy, well-drained bottom lands and along river banks and in swamps, thick woodlands and thickets. They tolerate hot summers but do not withstand drought and do not adapt well to semi-arid conditions. Satisfactory growth in warmer grape growing areas of Washington, California and Oregon. Nearly immune to phylloxera, Pierce's disease and nematodes.	Because of its resistance to many pests, *V. rotundifolia* would be the ideal rootstock candidate for Vinifera grafts were it not for the fact that it will rarely accept a graft from any but its own species. Some authorities consider that this species (along with the related *V. munsoniana*) should be in a different genus, due to a number of morphological differences (not to mention that *V. rotundifolia* has a different number of chromosomes (n=20) than other Vitas species (n=19). California Rare Fruit Growers website provides much information about planting and care of this species, as well as a listing of the various cultivars and their characteristics: *www.crfg.org/pubs/ff/muscadinegrape.html*. Also, Jack Keller's website has a wealth of information on this species: *http://winemaking.jackkeller.net/rotundif.asp*
Vitis labrusca, also: ***Vitis blandii*** (Prince), ***Vitis canina, Vitis catawba*** (Hort.), ***Vitis ferruginga, Vitis labrusca alexandrer, Vitis labrusca champion, Vitis labrusca var. subeden tata*** (Fernald), ***Vitis labrusca var. typica*** (Regel), ***Vitis latifolia, Vitis luteola, Vitis sylvestris virginiana*** (Bauh), ***Vitis taurina*** (Walter), ***Vitis vinifera sylvestris americana*** (Pluk), and ***Vitis vulpina*** (Marshall)	Alexander Grape, Alexandria Grape, Beaconsfield Grape, Black Cape Grape, Black Champion, Black Fox Grape, Black Grape, Buck Grape, Cape Grape, Champignon Grape, Clifton's Constantia Grape, Clifton's Lombardia Grape, Columbian Grape, Constantia Grape, Early Champion Grape, Farker's Grape, Fox Grape, Frost Grape, Madeira of York Grape, Northern Muscadine Grape, Plum Grape, Rothrock Grape, Rothrock of Prince Grape, Schuykill Muscadel, Schuykill Muscadine, Skunk Grape, Springmill Constantia Grape, Swamp Grape, Talmam's Seedling Grape, Tasker's Grape, Tolman, Vevay Grape, Winne Grape, and York Lisbon Grape	Alexander, Catawba, Champion, Concord (80% of *V. labrusca* production), Delaware, Niagara, Lakemont, Reliance, and Himrod	Northeast and east of US.	Nearly immune to phylloxera. *Vitis labrusca* has long been used as rootstock for *V.vinifera* grafts and for development of hardy hybrids.	Tougher skin than European grapes. Deep purple in color. Major use is for sweet grape juice (Welch's) and associated products–jelly, jam, preserves, some wine.

Grapes grow all over North America, except in the most extreme desert and tundra. North America is home to more than half of the world's 50 or so species of grapes. Various authorities recognize between 19 and 29 species of native North American grape. Table 1 lists the four American grape species used in wine production: *V. rotundifolia, V. labrusca, V. aestivalis*, and *V. riparia*. Please note, however, that except for *Vitas rotundifolia* and *Vitas munsoniana,* these "species" readily hybridize, resulting in a situation where one specie's traits and range overlap with another (or several others!). Some areas may have two or more species co-existing and with the various permutations of hybrid offspring possible, identification becomes difficult. This is why there are so many names listed under "Grape Species"—some authorities described "new" grape species that had already been described by others under a different name. *(Table adapted from: Winemaking Homepage, Jack Keller, 2005.* http://winemaking.jackkeller.net/natives.asp*)*

Table 1. Wine Grape Species (continued)

Grape Species	Common Names	Cultivars and Hybrids	Native to	Climatic/pest considerations	Additional Information
Vitis aestivalis (Munson), also: ***Vitis nortoni, Vitis lincecumii, Vitis bicolor.*** The later two are considered varieties of *V. aestivalis*	Cynthiana Grape, Arkansas Grape, Norton Grape, Norton Virginia Grape, Norton's Seedling Grape, Norton's Virginia Seedling Grape, and Red River Grape	Norton, Cynthiana, America		Tolerant of Pierce's Disease. (Rombough, 2002)	Dormant cuttings of this species do not root well and this trait is commonly passed on to hybrids (an exception is the hybrid America, a cross with *V. rupestris,* which roots readily from dormant cuttings). Green cuttings will root on mist benches (Rombough, 2002). This grape can make an excellent red wine that can compete in quality with that made from vinifera grapes.
Vitis riparia, also: ***Vitis amara, Vitis boulderensis, Vitis callosa*** (Le Conte), ***Vitis canadensis acceris folio*** (Tournefort), ***Vitis colombina, Vitis concolor, Vitis cordifolia*** (Darlington), ***Vitis cordifolia riparia*** (Torr. et Gray), ***Vitis cordifolia var. Riparia*** (Gray), ***Vitis cordifolia var. culpina*** (Eaton), ***Vitis dimidiata*** (Le Conte), ***Vitis hyemalis*** (Le Conte), ***Vitis illinoensis*** (Prince), ***Vitis incisa*** (Planchon), ***Vitis intermedia*** (Nuttal), ***Vitis missouriensis*** (Prince), ***Vitis montana, Vitis odoratissima*** (Donn.), ***Vitis odoratissima*** (Pursh), ***Vitis palmata*** (Vahl), ***Vitis populifolia, Vitis riparia var. palmata*** (Planchon), ***Vitis riparia var. praecox*** (Englemann), ***Vitis rubra*** (Desf.), ***Vitis serotina*** (Bartram), ***Vitis tenuifolia*** (le Conte), ***Vitis virginiana*** (Hort.), ***Vitis virginana*** (Poir), ***Vitis virginiana sylvestris*** (Parkins), ***Vitis virginiensis*** (de Juss), ***Vitis vulpina*** (Linnaeus), ***Vitis vulpina var. praecox*** (Bailey), ***Vitis vulpina var. riparia*** (Regel), and ***Vitis vulpina var. syrt.*** (Fernald and Weigand).	Bermuda Vine, Frost Grape, June Grape, Maple Leaved Canadian Grape, Mignonette Vine, River Grape, Riverside Grape, Riverbank Grape, Scented Grape, Sweet-Scented Grape, Uferrebe Grape, and Vignes des Battures	The better rootstocks in France have been given varietal names such as Riparia Gloire, Riparia Grand Glabre, Riparia Scribner, Riparia Martin and others. There are no American or Canadian counterparts to these French varietals.	Riparia is the most widely distributed of any American species of grape. It is found in New Brunswick and northern Quebec to Manitoba and Montana, south to Tennessee, northern Texas, Colorado, and Utah, and from the Atlantic to the Rockies in all areas in between.	It is known to withstand temperatures to -60 degrees F., is moderately drought resistent when naturalized to such conditions, and is found along the banks of streams, in ravines, on the islands of rivers, and in wet places. It is very resistent to phylloxera. It is less resistent to rot than Aestivalis, but somewhat more resistent than Labrusca. The foilage is rarely attacked by mildew, but is susceptible to the leaf-hopper.	Riparia grows readily from from cuttings and makes a good stock for grafting, where the union with other species is usually permanent. Native Riparias are early bloomers but late ripeners, and their fruit is best for wine when left on the vine until over-ripe and even slightly shriveled.
Vitis rupestris, also: ***Vitis populi foliis*** (Lindh.), ***Vitis rupestris var. dissecta*** (Eggert), and ***Vitis vinifera var. rupestris*** (Kuntze).	Beach Grape, Bush Grape, Currant Grape, Felsenrebe Grape, Ingar Grape, July Grape, Mountain Grape, Rock Grape, Sand Grape, and Sugar Grape	Cultivated French rootstocks are variously known as Rupestris Mission, Rupestris do Lot, Rupestris Ganzin, Rupestris Martin, Rupestris St. George, and other names. These have no American counterparts other than simple Rupestris.	Southern Missouri to Kentucky, western Tennessee, Arkansas, Oklahoma, eastern and central Texas to the Rio Grande, westward into New Mexico. Wild stands in Pennsylvania, Delaware and Washington, D.C. are probably due to escaped cultivars.	Rupestris is remarkably resistant to phylloxera. Its propensity to put down deep rather than lateral roots make it especially suited to dry, rocky soils on southern slopes.	Rupestris bench-grafts well but is less successful in field grafts. It is not widely cultivated in the United States as rootstock and its own fruit are unprofitable. It is considered drought-resistent, but not if the land dries out deeply. It was widely and successfully used in France as grafting rootstock where deep roots were desired.

A note about French Hybrids: Seibel is the common name for a number of Vitis vinifera hybrids that have been introduced over the years in a quest to develop climate tolerant grape varieties that are resistent to rot, mildew and phylloxera. Some of these, notably the bunch rot resistant Chambourcin, were widely planted in France in the 1970s. However, stringent European Union rules forbidding the blending of hybrids in traditional wine varieties have led to their disappearance from most European vineyards. Nonetheless, several hybrids have found acceptance as wine grapes in the Eastern United States, Canada and England, including the dark-skinned Chambourcin (Noir), Chancellor (Seibel 7053), Chelois, and Vignoles (Ravat 51). Widespread light-skinned hybrids include Seyval Blanc, Vidal Blanc and Villard Blanc. Seyval Blanc is in fact so widely planted in parts of the Eastern United States that it is sometimes referred to as "Indiana Chardonnay." It is also quite widespread in England. (from: Grapes, Wines, and Vines, Bella Vista Ranch webpage, 1999. http://members.aol.com/bellavue/grapes.html)

Geographical Considerations and Disease Management

As with other fruit crops, the generally drier conditions in the western half of the United States are more conducive to organic grape production than in the humid East, particularly with respect to cultivation of *Vitis vinifera* (European grape). The many large-scale organic wine and table grape vineyards in California are testimony to the relative ease of organic grape culture in that part of the country. As recently as 1997, California had 96 percent of the country's organic grape acreage. A table with a state-by-state listing of acreage of organic fruit production may be found at *www.ers.usda.gov/emphases/harmony/issues/organic/table12.htm.*

Related ATTRA Publications

Organic Crop Production Overview

Tree Fruits: Organic Production Overview

Kaolin Clay for Management of Glassy-winged Sharpshooter in Grapes

Organic Orchard, Vineyard, and Berry Crop Documentation Forms

However, with careful attention to pest control (especially diseases) and cultivar selection appropriate for each climate, grapes can be grown organically almost anywhere in the United States. Native American grape cultivars, or crosses between American grape cultivars and *Vitis vinifera*, known as French hybrids, may be easier to grow organically in the East, because of their generally greater resistance to pests. (See Table 1, Wine Grape Species on pg. 2.)

In contrast to the West, organic viticulture in the eastern U.S. is still limited to a few innovative growers, and many questions remain about organic management practices, especially those regarding disease control in a humid climate. An eastern grower producing for the fresh market should have a disease-control plan. From 1990 to 1995, Cornell University researchers explored organic vineyard management in the Northeast in collaboration with grape growers. The results of this and other research are found in *Organic Grape and Wine Production Symposium.* The report can be viewed online at *www.nysaes.cornell.edu/hort/faculty/pool/organicvitwkshp/tabofcontents.html.*

Hard copies can be ordered as indicated in the **Publications and Resources** section at the end of this publication.

In the East, several diseases can be devastating, but black rot *(Guignardia bidwellii)* is perhaps the most important of these to control. It only takes a few black, rotted grapes to render a cluster unsaleable on the fresh market. On the other hand, grapes produced primarily for juice, wine, or other processed products will have a slightly higher tolerance for cluster damage.

Northern growers should choose cultivars with proven cold hardiness for their particular climatic zone. The European wine grape (*Vitis vinifera*) is not well-adapted outside of USDA climate zone 8; zone 7 can be marginal. In zones 5 to 7, American types (mostly *V. labrusca*) or some of the American-European hybrids (French hybrids) are the best choices. There are some American types that are cold hardy in zones 3 and 4.

To view a USDA zone map, see *www.usna.usda.gov/Hardzone/ushzmap.html*

As with other types of cultural information, cultivar recommendations for a particular region are best obtained through the county or state Cooperative Extension Service. A University of Illinois table indicating susceptibility of cultivars to low-temperature injury and disease is available online at *http://w3.aces.uiuc.edu/NRES/faculty/Skirvin/cfar/bbsusc.htm*. (See also Appendix I: Disease Resistance Rating Chart for Grape Cultivars.)

Cold Hardiness of Grape Cultivars:

Very Hardy: Swenson hybrids: LaCrosse, St. Croix, St. Pepin , Edelweiss, Frontenac, Foch , Leon, Millot , Ventura

Hardy: DeChaunac , Chancellor, Vignoles, Cynthiana, Steuben , Concord, Catawba , Niagara, Delaware

Moderately Hardy: Seyval, Traminette , Melody

Moderately Tender: Vidal, Chambourcin, Chardonel , Cayuga White

Tender: Cabernet franc, Riesling, Chardonnay, Cabernet Sauvignon

Very Tender: Merlot, Pinot Noir, Gewurztraminer

From: Bordelon, 2002.

Extreme disease pressure makes organic culture of bunch grapes very difficult in the deep South. However, many cultivars of the indigenous muscadine grape, *V. rotundifolia*, are readily grown without pesticides of any sort. Muscadines have a special appeal in southern markets and are consumed fresh as well as processed into jams, preserves, juices, and wine.

Diseases

The simplest and most practical approach to disease problems on grapes is to plant disease-resistant varieties (see **Appendix I**: Disease Resistance Rating Chart for Grape Cultivars) and to use certified disease-free stock. Unfortunately, the market often prefers those varieties not native to a particular region, and that are especially susceptible to diseases indigenous to the region. This is the case with the *V. vinifera* cultivars, the high-quality European wine grapes. In general, they are highly susceptible to all American grape diseases and pests, including downy mildew, black rot, Phomopsis leaf spot, powdery mildew, and phylloxera (a root-feeding, aphid-like insect). If a grower in a humid climate decides to plant *V. vinifera* cultivars, the grower will likely be culturing a susceptible plant under environmental conditions that invite disease. Therefore, profitable production of a marketable product without the use of fungicides will be very difficult. However, as already indicated, states with dry, Mediterranean climates are quite amenable to the culture of the European wine grape, and organically acceptable fungicides will be adequate for controlling most disease problems.

An excellent resource for those interested in organic grape production in the Midwest may be found at:

www.oardc.ohio-state.edu/fruitpathology/organic/PDF/OSU-Organic-Grape-Diseases.pdf

This document focuses on organic management of grape diseases, including black rot, powdery mildew, phomopsis cane and leaf spot disease, eutypa dieback, downy mildew, botrytis bunch rot, and crown gall.

What Type of Grape to Plant? Grape Cultivar Information:

Grape Cultivars for North-Central New Mexico
www.cahe.nmsu.edu/pubs/_h/h-309.html
This site provides names and descriptions of the various hybrids appropriate for cultivation in New Mexico.

Viticulture Site Suitability for North Carolina
www.ncwine.org/sitesuit.htm
This site provides maps with color-coded zones that outline regions rated as most reliable, good sites and risky sites for specific cultivars of grapes, as well as maps showing growing season, precipitation at harvest, extent of Pierce's Disease, and freezing temperatures.

Grape varieties—crosses and genetic composition
www.littlefatwino.com/grgenetics.htm
Provides a chart of non-traditional (American and French hybrid) grape varieties, including parentage, mostly for northern climes.

Wine and Juice Grape Varieties for Cool Climates
www.nysaes.cornell.edu/hort/faculty/reisch/bulletin/wine/
This site provides an excellent survey of grape cultivars suitable for planting in cool climates, including American, French hybrid, and European varieties. Includes descriptions of the grapes, pictures, and strong and weak points of each variety.

California Grapevine Nursury
www.californiagrapevine.com/rootstockchart.htm
This site has a table of information about 21 types of rootstocks, including parentage, maturity rates, nematode and drought resistance, best soil/climate conditions, and other useful comments.

Resistance of Grapes Grown in Michigan
www.msue.msu.edu/msue/imp/modfr/visuals/2643t1.jpg
This site has a table of relative resistance of grape varieties (American, French hybrid, and European) to winter freeze damage, disease (black rot, downy mildew, harvest season botrytis, and phomopsis), phylloxera, and sulfur-induced damage.

As noted earlier, some breeders are experimenting with French hybrids, and are backcrossing French hybrids to develop cultivars with cold hardiness, disease resistance, and good fruit/wine quality. The major breeding programs for French hybrids in the US are:

New York State Ag
Experiment Station, Geneva
Bruce Reisch
Geneva, NY 14456
315-787-2239
315-787-2216 FAX
bruce.reisch@cornell.edu

University of Minnesota
Peter Hemstad
952-443-14-92
hemst001@umn.edu
Jim Luby
612-624-3453
lubyx001@umn.edu

Elmer Swenson, Private Breeder,
Osceola, Wisconsin

University of Arkansas
Jim Moore
479-575-2811
jnmoor@uark.edu
John Clark
479-575-2810
jrclark@uark.edu
Justin Morris
479-575-4040
jumorris@uark.edu

American grape varieties (*V. labrusca* and others) differ in their susceptibility to various diseases. Concord, for example is quite resistant to anthracnose but susceptible to black rot. Ives is relatively resistant to black rot but highly susceptible to downy mildew. Edelweiss (*V. labrusca*) and Cynthiana (*V. aestivalis,* also known as Norton) are two American cultivars that appear to have significant resistance to most of the major grape diseases. Muscadine grapes (*V. rotundifolia*), suited only to the South, are very resistant to most bunch grape diseases and pests. See **Appendix I** for more information on varietal resistance.

Where varietal resistance, sanitation, and other cultural controls are not adequate, an organic grower will have to rely on organically acceptable mineral fungicides (various sulfur and copper formulations), microbial-based fungicides, compost teas, and vegetable and mineral oils used as dormant applications, or on foliage, depending on the weather.

Organic growers are allowed to use some mineral fungicides, since they are mined materials; however, sulfur and sulfur-containing fungicides can be disruptive to beneficial insects and other arthropods, such as spiders and mites that are present in the vineyard. Another problem associated with the use of sulfur is tissue injury, or phytotoxicity. This damage can occur when sulfur is used while temperatures are above 85°F. (about 30° C.). Some cultivars, especially those of *V. labrusca* origin such as the Concord, are highly susceptible to sulfur injury even at lower temperatures. The Disease Resistance Rating Chart, **Appendex I**, lists sulfur-sensitive grape cultivars. In regions where rainfall is plentiful during the growing season, wettable sulfur or flowable sulfur formulations are preferred for their retentive qualities. (Pearson and Goheen, 1988) Flowable formulations are less damaging to predatory mite populations and should be used whenever possible.

Bordeaux mix (copper sulfate mixed with hydrated lime) is less likely to be phytotoxic than sulfur due to the "safening" influence of the lime. However, damage can still occur on sensitive cultivars, especially in high temperatures.

Organically acceptable alternatives to mineral-based fungicides exist. A new generation of microbial fungicides, such as AQ-10™ (for powdery mildew control) and various commercial formulations of *Bacillus subtilis*, (i.e., Serenade™, Epic™, Kodiak™), provide organic growers with new tools to manage plant diseases. New fungicides of this type, and new uses for previously registered microbials, appear regularly on the market.

Compost teas have been successfully used in other plant production operations as a combined foliar feed and disease suppressive technique. There is potential for using aerobic compost tea in vineyards to manage diseases, but the parent material (i.e., manures vs. green waste) of the compost used to make the tea is an important consideration, as is the interval between last application of the tea and harvest. Additional information is provided in the following pages under specific disease headings. For more information, also see ATTRA's *Notes on Compost Teas* and *Use of Baking Soda as a Fungicide*.

The following discussion of grape diseases focuses primarily on organic controls. For disease symptoms, life cycles, and epidemiology, refer to the **Publications and Resources** section.

Powdery Mildew

Vitis species differ greatly in susceptibility to powdery mildew. *V. vinifera* cultivars are highly susceptible, whereas American species are much less so. The French hybrids developed by crossing *V. vinifera* with American species have varying levels of resistance. Cabernet Franc, Cabernet Sauvignon, Chancellor, Chardonnay, Chelois, Gewurztraminer, Merlot, Pinot Blanc, Pinot Noir, Riesling, Rosette, Rougeon, Sauvignon blanc, Seyval, Vidal 256, and Vignoles are considered highly susceptible. (Ellis, 1994)

Powdery mildew can reduce vine growth, yield, fruit quality, and winter hardiness. The fungus that causes powdery mildew, *Uncinula nector,* overwinters inside dormant buds on the grapevine or on the surface of the vine. Its control in commercial vineyards generally is based on the use of fungicides. Sulfur is effective against powdery mildew, but, as mentioned above, care must be taken to avoid damage to sulfur-sensitive cultivars. Cultural practices may reduce the severity of powdery mildew. Planting in sites with good air circulation and sun exposure, and orienting rows to take advantage of these factors, are helpful. (Pearson and Goheen, 1988) The use of training systems that promote good air circulation should be incorporated. Some vineyards manage the leaf canopy by leaf thinning so that both leaves and grape clusters are exposed to good air circulation, allowing them to dry off quickly after heavy fogs or rainstorms, and thus helping reduce the possibility of infection. Although moisture is not necessary for powdery mildew infections to occur, rains and heavy fogs can help spread the spores.

Applied materials for managing powdery mildew include sulfur products, bicarbonates, oils, and biologicals (including compost teas), described in more detail below.

Some formulations of sodium and potassium bicarbonate also have proven successful in controlling powdery mildew on grapes. Research in Germany demonstrated that sodium and potassium bicarbonate were highly effective against powdery mildew and can be used in organic viticulture to minimize sulfur or completely substitute the use of sulfur. (Kauer, et. al., 2000). See ATTRA's *Use of Baking Soda as a Fungicide* for further details on this topic. Oregon State University's 2002 *Pest Management Guide for Wine Grapes in Oregon* rated baking soda (bicarbonates) as "slightly effective" for powdery mildew. Results with these products will vary according to local factors, such as relative humidity, disease pressure, the grower's experience with alternative controls, and context of use (i.e., use in a heavily sprayed, conventionally managed vineyard vs. use in a lightly sprayed or organically managed vineyard.) Kaligreen and MilStop are OMRI-listed formulations of potassium bicarbonate.

Powdery mildew can reduce vine growth, yield, fruit quality, and winter hardiness.

Calcium has been shown to inhibit fungal spore germination. Low calcium or excess nitrogen levels in the grape leaf tissue can set up conditions for powdery mildew. (Jurgens, 2005) A 1:1 ratio of calcium to nitrogen in a tissue test is ideal. (Jurgens, 2005) There is some evidence that foliar sprays of milk, diluted 1:10 with water, can reduce powdery mildew levels on grapes (Bettiol, 1999; Crisp and Bruer. 2001), although it is not clear if the fungal inhibition is a function of calcium/milk toxicity to fungal spores, competition from other organisms feeding on milk nutrients, increased calcium uptake by leaf cells resulting in stronger cell walls, or some combination of these factors. Whey is also used by some practitioners due to its availability and is diluted at a ratio of 1:3 (whey:water). The milk/whey formulations are most effective when used on varietals that have some resistance to powdery mildew. David Bruer is a chemist and former professor of enology at the University of Adelaide. He is the owner of a 67 acre vineyard in Australia where some of the milk/whey trials were done. Dr. Bruer claims that under the influence of ultravio-

let light, a protein in whey (ferroglobulin) produces an oxygen radical that is extraordinarily toxic to fungal spores.

Various formulations of oils, some of them botanically based, can be used to manage powdery mildew. A commercial formulation of neem oil, Trilogy™, manufactured by Certis, is registered for use on grapes against powdery mildew and several other diseases and is also OMRI-listed. Research in Germany demonstrated that rapeseed oil reduced the incidence of *Uncinula necator* by 66 to 99 percent and reduced the severity of the disease by 96 to 99.9 percent on ripening berries. However, some side effects on predatory mites were observed (Trimborn et al., 2000). JMS Stylet oil is effective against powdery mildew and is OMRI listed.

A new product from Agraquest is also now available; Sonata is a formulation of *Bacillus pumilus* and is registered for use against powdery mildew on grapes. In the late 1980s and '90s, field and greenhouse studies on compost teas in Germany found that undiluted compost watery extracts (derived from cattle manure-based compost, as well as supplemented extracts of composts derived from horse manure) were effective against the causative agent of powdery mildew, *Uncinula necator.* The effects do not appear to be systemic, but are antagonistic in nature, correlating with high levels of active microbes on the leaf surface. (Trankner and Brinton, 1994) More recent research from Germany supports these findings, but found that at high rates of infection pressure, compost extracts were not able to provide a sufficient level of protection against powdery mildew. (Trimborn et. al., 2000) More research is needed to better understand how the components of the extracts interact with powdery mildew spores and the time duration between application and harvest needed to ensure no contamination of the grapes by pathogens that may be in the compost teas.

The use of compost teas in organic production has been reviewed by the Compost Tea Task Force of the National Organic Standards Board (NOSB). The Task Force issued a report in April 2004 outlining the issues associated with using compost teas (such as feedstocks, additives, and presence of human pathogens) and also made some recommendations. This report can be downloaded at

www.ams.usda.gov/nosb/meetings/CompostTeaTaskForceFinalReport.pdf

Black Rot

Black rot is the most important disease facing eastern growers, yet it is virtually unknown in the West. Black rot is caused by the fungus *Guignardia bidwellii.* This fungus overwinters in mummified berries on the soil or in old clusters still on the vines. Fungal spores (ascospores) are spread by air currents and blowing rain, both in the early spring and throughout the growing season. All cultivated varieties of grapes are susceptible to infection by the black rot fungus.

Hours of leaf wetness required for black rot infection period at various temperatures following a rain

Temp (°F)	Hours (of continual wetness from rain)
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

Source: R.A. Spotts, The Ohio State University

Proper sanitation is important in controlling black rot. Removing overwintering mummified berries from the vines and disking mummies into the soil are beneficial practices that reduce the amount of primary inoculum present in the spring. (Pearson and Goheen, 1988) Black rot control for bunch grapes is very difficult in the East due to high humidity and foliage density. For organic growers, liquid copper formulations, or copper-sulfur compounds such as Bordeaux mix, can be used for prevention of black rot, as well as suppression of powdery mildew, downy mildew, and phomopsis leaf spot. Some of the new microbial fungicides may provide control, though they may not yet be registered for use on grapes against black rot.

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Because copper and sulfur compounds cannot remedy an established infection, they must be used as protectants. That is, these compounds need to be present on the plant surfaces before an infection period is anticipated. In the case of black rot, growers with a history of the disease should begin spraying when the first vegetative shoots are 3 to 6 inches long. This is roughly when the pathogen begins releasing spores that may infect leaf or flower tissues. Protection should be maintained until the berries begin their final ripening stage (at about 5 percent sugar). (Pearson and Goheen, 1988) Depending on the cultivar, inoculum level, and weather conditions, it is possible that this could entail sprays every 7 to 14 days from bud break until mid-July or early August. For example, in the wet growing season of 1991, organically grown Seyval wine grapes (a rot-susceptible French hybrid) required 17 fungicide applications for disease control. (Ellis, 1994)

Serenade, a formulation of *Bacillus subtilis* QST 713 strain, has been effective in reducing incidence of black rot in grapes by 50-70% over control treatments of water. In other trials done by Agraquest, Serenade plus yucca, which is a natural detergent and acts as a sticker/spreader, also provided good control of black rot. (Smith, 2005) Serenade is available through AgraQuest in California (call 530-750-0150, or visit *www.agraquest.com/prod_frames.html*). Yucca Ag-Aide manufactured by Desert King International is a formulation of yucca that is OMRI certified and allowed in organic production.

However, because spores require free water and a certain temperature range for germination and infection, a rigorous spray schedule will probably not be necessary every year. Also, proper sanitation and good early-season control will help to reduce the inoculum levels of the pathogen.

With relatively resistant cultivars and good early season coverage, some eastern viticulturists have been able to control black rot with as few as two to four sprays of Bordeaux mix (the first when new shoots are 2 to 4 inches long, and the remainder at two-week intervals). There are few bunch grape cultivars with high levels of resistance, but some relatively resistant cultivars include Chambourcin, Cynthiana (aka Norton), Edelweiss, Elvira, Esprit, Foch, Ives, Cascade, Missouri Reisling, and Alwood. The non-bunching muscadine grape is very resistant to most races of *G. bidwellii*, but there are races of this fungus that are pathogenic to muscadines in some areas of the South. (Pearson and Goheen, 1988)

Black rot is the most important disease facing eastern growers, yet it is virtually unknown in the West.

Phomopsis

Phomopsis cane and leaf spot is caused by the fungus *Phomopsis viticola*. This fungus overwinters in the bark of the canes and can be especially severe in the early spring, when it rains for several consecutive days. Inoculum levels build over time, with disease problems increasing in severity with each successive cool, wet spring. Few cultivars are resistant to Phomopsis, though there are varying degrees of susceptibility.

Control of Phomopsis for the organic grower consists of a combination of appropriate sanitation measures and the use of liquid copper fungicides. Mycostop™, a commercial formulation of *Streptomyces griseoviridis*, is registered for use against Phomopsis. Growers should avoid introducing the problem into the vineyard by using only pathogen-free propagation material when planting or re-planting. Once the disease has appeared, growers should remove as much infected wood as possible from the vines during pruning. Severely infected wood in the basal areas of the cane appears bleached. Badly infected canes or spurs will have brown/black patches irregularly mixed with bleached areas. Debris should be shredded, disked, or plowed into the soil. (Pearson and Goheen, 1988)

In addition, measures such as avoiding shaded planting sites, providing good soil drainage and air circulation, and planting rows to take full advantage of sunlight and wind movement also can help control Phomopsis.

Botrytis is more of a problem on varieties with tight clusters where moisture tends to collect.

Downy Mildew

Another disease to which *V. vinifera* varieties are highly susceptible is downy mildew, caused by the fungus *Plasmopara viticola*. Downy mildew is a major disease of grapes throughout the eastern United States. It usually overwinters as spores in fallen leaves, but it may survive in buds as mycelium in regions with mild winters. Downy mildew is favored by all factors that increase the moisture content of soil, air, and host plants. Therefore, rain is the principal factor promoting epidemics. The most serious epidemics of downy mildew occur when a wet winter is followed by a wet spring and a warm summer with intermittent rainstorms every 8 to 15 days. (Pearson and Goheen, 1988)

Preventative management practices for downy mildew consist of draining soils, reducing the sources of overwintering innoculum, pruning out the ends of infected shoots, and speeding the drying time of leaves and fruit. However, because none of these measures is sufficient for cultivars highly susceptible to downy mildew, fungicidal control may be necessary. As mentioned above, organic growers can use liquid copper, or Bordeaux mix, for control of this disease. Another option for downy mildew management is Trilogy, a commercial formulation derived from neem seeds, which is a broad spectrum fungicide and miticide.

Vinifera (*Vitis vinifera*) varieties are much more susceptible than American types, and the French hybrids are somewhat susceptible. Several resistant cultivars are listed in **Appendix I**.

Botrytis

Botrytis bunch rot (causal organism: *Botrytis cinerea*), also known as gray mold, can be a problem throughout the U.S., but is especially troublesome in wet or humid regions. Botrytis is more of a problem on varieties with tight clusters where moisture tends to collect. California research indicates that the incidence of botrytis bunch rot can be greatly reduced by removing leaves around a ripening cluster, thereby improving sunlight and air penetration into the cluster. (Bettiga et al., 1989) Although this practice is labor intensive, and therefore relatively costly, it has positive side effects of increased fruit quality, including higher malic and total acids, decreased potassium, increased brix, and better grape color and wine quality. (Gubler, no date) Reducing fertilization, thereby reducing lush vine growth, will also help control botrytis.

Bordeaux mixture and sulfur-containing fungicides are generally regarded as ineffective control measures against botrytis. New biofungicides are available for management of botrytis. Trichodex, a formulation of the beneficial fungus *Trichoderma harzianum*, is now registered in the U.S. (call 212-661-9800 for the closest distributor). Serenade, a formulation of *Bacillus subtilis*, QST 713 strain, is a second biofungicide registered for botrytis in grapes; it is available through AgraQuest in California

(call 530-750-0150, or visit *www.agraquest.com/prod_frames.html*).

Pierce's Disease

Also known as PD, Pierce's Disease is a xylem-clogging bacterial (*Xylella fastidiosa*) infection generally fatal to European (vinifera) grape vines. The chief vector is the glassy-winged sharpshooter (GWSS). Both the GWSS and PD are endemic to the southern U.S., which would explain the native American grape's resistance to this pest, having co-evolved with the disease and the GWSS over tens of thousands of years. Some American grape rootstocks are able to transfer resistance to vinivera varieties grafted onto it. A Texas researcher found that vinifera grapes planted on Mustang grape, *V. mustangensis* (synonym, *V. candicans*) rootstocks survived for eleven years in an area where PD had killed all other susceptible grape varieties. (Rombough, 2002)

The PD-GWSS complex is responsible for the difficulty of growing vinifera grapes in infested areas and has had heavy impacts on vinifera grape production in New Mexico, Arizona, and California. Chardonnay and Pinot Noir are particularly susceptible. Researchers in California and Georgia have examined applications of terpene, a naturally occurring botanical substance, via drip irrigation. Terpenes found in plants are often associated with plant defense mechanisms. Unfortunately, the trials in California did not show any significant effect in treating PD.

PD and the GWSS are severe obstacles to growing European-type (vinifera) grapes in the southern U.S. The PD-GWSS complex has recently become a threat to California grape growers. Although PD has been present in California since the 1880s, the strong-flying and voracious feeding glassy-winged sharpshooter was found in Ventura, California, only in 1990 and has become the primary, though certainly not the only, vector of the pathogen. The presence of the GWSS in California has resulted in the rapid spread and transmission of the disease to grapevines and probably many other plant species. The blue-green sharpshooter (*Graphocephala atropunctata*) is the most important vector in coastal areas. The green sharpshooter (*Draeculacephala minerva*) and the red-headed sharpshooter (*Carneocephala fulgida*) are also present in coastal areas but are more important as vectors of this disease in the Central Valley. Other sucking insects, such as grape leafhopper (*Erythroneura elegantula*) are not vectors. Management of this disease mostly revolves around management of the leafhopper vectors, and this information can be found in the leafhopper section of this publication.

Viruses

Viruses in grapes are managed through the use of clean planting stock. Viruses will spread from one plant to a neighboring plant, but the spread is generally slow. Each virus has a unique vector or set of vectors. The Virus Table on page 12 provides information on symptoms, cultivar susceptibility, and modes of transmission. (Rombough, 2002; Flaherty et al., 1992)

Root Rots

Good soil management, particularly practices that promote good soil drainage and avoid the creation of hard pans, will keep root rot problems caused by Phytophthora to a minimum. Standing water, or prolonged exposure of the trunk, crown or roots to water, will provide an environment on these plant parts that is infection-friendly.

Armillaria root rot is a disease that results from planting vines on ground on which host plants previously grew, either natural oaks or orchards of walnuts or plums. The armillaria exists in old roots of these crops that are still in the soil. When planting a new vineyard in such an area, it is important that the new vines are not overwatered, and that they be planted into healthy, well-drained soil that has good biological activity, which will allow beneficial organisms to compete with the armillaria fungus.

Virus Table			
Disease Name	**Vector/mode of spread**	**Cultivars Attacked**	**Symptoms/Comments**
Grape Leafroll	Nursery stock and possibly by mealybugs.	Vinifera—American rootstocks don't show symptoms.	At harvest/leaf fall, infected red-grape vines will have red leaves with major veins still green. White grape cultivars will turn yellow with major veins still green.
Corky Bark	Nursery stock, no known vectors	Can exist in many vinifera cultivars without symptoms, which appear only after infected bud grafted onto phylloxera-resistant rootstock	Grafted scions decline or die due to graft union incompatibility, rootstocks may survive, even be symptomless. Spread only by nursery materials in US.
Rupestris Stem Pitting	Nursery stock, no known vectors	High incidence of this virus in Vinifera cultivars and French hybrids are susceptible.	Can cause a slow decline, or can be fatal if grafted onto rootstock 3309, but Canada now allows material with this virus as a "virus without consequence".
Fanleaf Degeneration	Nursery stock (infected rootstock, buds or cuttings), and Dagger nematode is vector	Vinifera cultivars	Seldom fatal, but symptoms can take several forms: fanleaf deformation, vein banding, and yellow mosaic.
Peach Rosette Mosaic Virus (PRMV)	Nursery stock, and Dagger nematode is vector	American cultivars Concord, Catawba and Niagara are susceptible, Delaware less so.	Curly dock, Carolina horsenettle and dandelion are virus hosts. Grape pommace should be properly composted so seeds, which contain virus, do not germinate and allow feeding by nematode vectors.
Tomato Ringspot and Tobacco Ringspot	Nursery stock, and Dagger nematode is vector	French hybrid cultivars, particularly blue-fruited cultivars, are susceptible.	Plantain, chickweed, dandelion, beans, and other plants are virus hosts. Grape pommace should be properly composted so seeds, which contain virus, do not germinate and allow feeding by nematode vectors.

Geographical Considerations and Insect and Mite Management

Wherever grapes are grown, there will be insect pests. Existing with each pest, however, is a whole complex of natural controls, including parasites (other insects), predators (insects, birds, bats, mice, etc.), and diseases (fungi, bacteria, viruses). One of the grower's jobs is to develop a viticulture ecosystem that takes advantage of and encourages these natural controls, while also feeding the soil and supporting plant health. Providing habitat for beneficial organisms is a sustainable approach to managing insect pests, but it must be tempered with awareness of how the presence and management of habitat influences field operations, as well as other factors, such as incidence of harmful insects and diseases. More information about providing beneficial habitat can be found in ATTRA's *Farmscaping to Enhance Biological Control*.

In the West, mites, leafhoppers, and leafrollers are likely to be the most troublesome arthropod pests, and all of these are indirect pests; i.e., they do not directly attack the fruit. In general, indirect pests can be tolerated in higher numbers than direct pests, allowing more time for naturally occurring or purchased biocontrol agents to exert an acceptable level of control. Although the glassy-winged sharpshooter (GWSS, a leafhopper) is considered an indirect pest, it has recently emerged as a major problem in California vineyards because it vectors Pierce's disease. The GWSS/Pierce's Disease complex has long been an obstacle to production of vinifera grapes in the South.

The major insect pest for eastern organic grape growers is the grape berry moth (*Endopiza viteana*). The berry moth is a direct pest of the fruit and flowers and, if left unchecked, can render whole clusters unmarketable. A pheromone-based mating-disruption system for the berry moth provides organic growers with an effective non-pesticide option for berry moth control (see below).

Grape Berry Moth

The grape berry moth (GBM), *Endopiza viteana*, is native to eastern North America, where it originally occurred on wild grapes. It does extensive damage directly to grape berries, flowers, and buds east of the Rocky Mountains, particularly in the Northeast. It feeds only on grapes. The number of generations per year varies from 1.5 to 2 in New York, to 2 to 3 in Michigan, and 4 to 5 in Virginia. High populations and damage have been observed after consecutive mild winters. Substantial winter mortality occurs after several days of very cold temperatures (-6 to +5°F). (Pfeiffer and Schultz, 1986) The Website, *www.ento.vt.edu/Fruitfiles/GBM.html* discusses in detail recent research about how temperatures affect timing of GBM emergence and diapause.

The only biological control agent that has been found to be of appreciable value is the egg parasite *Trichogramma minutum*, which can be purchased from many insectaries. However, the grape berry moth does not appear to be an optimal host for the egg parasite, and resulting adults have poor vigor and exhibit developmental abnormalities. (Nagarkatti et al., 2002) It's possible that a different *T. minutum* ecotype, one that is naturally found parasitizing eggs of the GBM, would be more effective.

Destruction of fallen grape leaves, which are overwintering sites for the cocoon-protected pupa, can help reduce spring populations. Covering leaves with at least an inch of firmed soil is another control option. One popular method is to throw the soil from the row centers into a low ridge under the grape trellis with a grape hoe, disk, or plow. This should be done 30 to 45 days before harvest. The row centers should be almost level and seeded to a winter cover crop. In the spring, at least 15 days before grape bloom, the ridge soil containing the cocoons in its surface is pulled from under the trellis into the row centers with a mechanical grape hoe. Any islands of soil left around the posts and grapevines may have to be raked by hand into the row centers. The row centers are then disked and cultipacked to bury the cocoons. Rain or irrigation after this operation will help to seal in the cocoons. This practice has reduced berry moth populations to a point where shortened spray schedules can be used in commercial vineyards. (Pfieffer and Schultz, 1986) There is a higher risk of developing GBM populations in vineyards bordering woodlands. (Martinson et al., 1991)

Grape berry moth damage.

Grape berry moth larva.

Grape berry moth adult.

Pheromones can be used to monitor emerging populations. Pheromone traps can help time management activities, or pheromone dispensers can be used in a mating disruption system that disperses pheromones throughout the orchard, making it difficult for males to locate females. The table below provides contact information for some suppliers of these systems.

To augment populations of natural enemies of pests, farmers can apply beneficial insects purchased from commercial insectaries. This directory contains a comprehensive listing of companies raising biocontrol organisms in North America.

Suppliers of Beneficial Organisms in North America. Hunter, Charles D. 1997. California Environmental Protection Agency, Sacramento, CA. 32 p.

For a free copy, write to:

California Environmental Protection Agency
Department of Pesticide Regulation
Environmental Monitoring and Pest Management Branch
1020 N Street, Room 161
Sacramento, CA 95814-5624
916-324-4100

A Web-based version can be found at:
www.cdpr.ca.gov/docs/dprdocs/goodbug/benefic.htm.

Commercial Monitoring/ Disruption Pheromone Systems

Timely use of *Bacillus thuringiensis* (Bt) can suppress populations of the grape berry moth. Use of pheromone traps can aid the grower in timing Bt applications. The Bt should be applied as the first instar larvae are hatching out of eggs.

Pheromone Chart

Type of System	Company Contact Information
Mating Disruption, rope dispenser	Pacific Biocontrol 14615 NE 13 St, Suite A Vancouver, WA 98685 *www.pacificbiocontrol.com* 800-999-8805
Mating Disruption, sprayable	3M Canada *www.3m.com/intl/CA/English/centres/mfg_industrial/ag/spray_canada/grape_main.html*
Monitoring Traps	Gempler's 1210 Fourier Dr, Suite 150, Madison, WI 53717 *www.gemplers.com/items/R01023.asp* 800-382-8473

Leafhoppers

Grape leafhoppers, *Erythroneura* species, also can be a serious problem throughout the United States, but these pests more consistently trouble West Coast vineyards.

Research in California indicates that biological control of grape leafhoppers by a tiny parasitoid wasp (*Anagrus epos* and *Anagrus erythroneura*, egg parasites) can be achieved if habitat for non-pest leafhopper species—especially blackberry bushes and French prune trees—is maintained near the vineyard. The bushes and trees attract related *Erythroneura* species of leafhoppers, providing an important food source for the parasitic wasp. However, maintaining diverse habitat in this manner may conflict with management for the glassy-winged sharpshooter (see below).

Some vineyards are now using an innovative strategy of planting dwarf grasses in the alleys in order to manage excessive vigor of some varieties.

Clean cultivation in and around the vineyard can help reduce leafhopper populations, because the adults overwinter in shelters provided by weeds in these areas. If leafhoppers are a problem, and the grower wants to use alley cover crops, then selecting those covercrops least attractive to leafhoppers is an option. Organic growers can use insecticidal soaps and the botanical insecticide sabadilla to control leafhoppers. Soap sprays are only effective if they cover the leafhopper; i.e., if there is no residual effect from soap left on a plant surface. PyGanic, a formulation of pyrethrins, is an effective control of leafhoppers and also listed by OMRI.

Surround™, a kaolin clay-based insect repellent, is effective against leafhoppers, leafrollers, and the glassy-winged sharpshooter. It is accepted by the Organic Materials Review Institute for use in organic production. For leafhoppers and related insects, it seems to act as a deterrent to locating host plants, as well as deterring feeding and egg-laying. For additional information, contact:

John Mosko
Marketing Manager Crop Protectants
Engelhard Corporation
732-205-7140
john.mosko@engelhard.com
www.surround.engelhard.com

More information about kaolin clay-based management options for the GWSS is available in the ATTRA publication *Kaolin Clay for Management of Glassy-winged Sharpshooter in Grapes.*

According to Tom Piper, former manager of Fetzer's organic vineyards, leafhopper populations are proportional to the vigor

of the vine. He keeps close watch on both water and nitrogen inputs and tries to keep the vines just vigorous enough to make a good crop, but not so vigorous as to attract leafhoppers. If leafhopper populations get out of hand, Piper uses PyGanic.

The glassy winged sharp shooter, *Homalodisca coagulata*, emerged in the 1990s as a major pest of grapes in California. The GWSS feeds on stems and leaves of a wide range of plants and efficiently vectors Pierce's Disease (PD), a xylem-clogging bacterial infection generally fatal to grape vines. Although PD has been present in California since the 1880s, the strong-flying and voracious feeding GWSS has become the primary vector of the pathogen. PD and the GWSS are important obstacles to growing European-type (vinifera) grapes in the southern U.S. Riparian areas in the West have a wide variety of plants that are hosts to the GWSS and can be leafhopper corridors. Monitoring should be directed to areas of the vineyard closest to riparian zones.

Research in California has shown that, if properly managed, winter annual legume-grass cover crops—such as a vetch and oats mix—can reduce reliance on insecticides and miticides to control leafhoppers and spider mites in vineyards. This is in addition to the soil-improving and weed-suppressive benefits of cover crops. This research examined two cover crop systems: (1) cover crop biomass was cut and placed on row berms as a dry mulch to suppress weeds and reduce herbicides, and (2) cover crop biomass was cut and left in row middles. If sulfur dust (used for disease control) was used sparingly in late spring and early summer, the presence of these cover crops increased early season activity of predatory mites, resulting in reduced spider mite infestations. Similarly, where leafhopper numbers were not very low and cover crops were properly maintained through early July, the presence of cover crops resulted in reduced infestations of leafhoppers. These reductions were attributed to enhanced activity of certain groups of spiders that consistently attained higher densities in the presence of cover crops, compared to the clean-cultivated systems. Leafhoppers also used the cover crops as non-host crops, which may have resulted in less time spent on vines.

For more information on this study, contact:

Frank G. Zalom
Extension Entomologist
Department of Entomology
University of California
Davis, CA 95616
916-752-8350
916-752-6004 FAX
fgzalom@ucdavis.edu

Mites

Various mite species cause problems on grapes throughout the United States. Proper irrigation, dust reduction along roadways, and other practices that conserve and augment natural enemies (including predatory

Alternate disking of alleyways decreases dust and conserves beneficials.

Every other row in this vineyard is planted to an oats-bell bean covercrop.

Photos by Rex Dufour, NCAT

mites (*Metaseiulus, Typhlodromus*), sixspotted thrips (*Scolothrips sexmaculatus*), and other generalist predators) can help reduce spider mite problems.

In the West, the three major spider mite pests on wine grapes are Willamette mite, *Eotetranychus willamettei* (McGregor), twospotted mite, *Tetranychus urticae* (McGregor), and Pacific mite, *Tetranychus pacificus*. The most important mite prevention practice is dust control. Heat spikes in the weather, combined with dust-stressed plants, often result in a mite outbreak. Dust can be managed several ways: improving road surface from dirt to rock or gravel; using water, straw, or dust-suppressant compounds to prevent dust; reducing driving speed; and disking only every other alleyway—vehicle traffic is then routed on non-disked rows to provide a dust-free pathway for machinery performing agricultural operations.

Maintaining a ground cover on the vineyard floor is advantageous to predatory mites.

Growers in New Zealand use vegetable oil or fish oil as dormant sprays in combination with release of predatory mites. (Welte, 2000) Soap sprays also can be effective against mites, but thorough spray coverage is essential, since the mites reside and feed primarily on the underside of the leaf surface. Soap spray should only be used early in the season because of the possibility of altering the taste of the grape or the wine. Neem-based products such as Trilogy™ are registered for use on spider mites, but like soap sprays, can negatively affect wine quality if used too close to harvest. (Thrupp, 2003) Although sulfur dusts or pyrethrum can be used against mites, they are not commonly used since they can be disruptive to beneficial mites and other natural enemies of the pest mites, as well as natural enemies (such as the wasp *Anagrus epos*) of leafhoppers.

The beneficial predatory mite *Metaseiulus occidentalis* is effective in controlling spider mites in California. Another predatory mite, *Typhlodromus pyri*, is effective against spider mites in locations as widespread as New Zealand and Oregon. These beneficial mites can be purchased from several insectaries in California and elsewhere. Maintaining a ground cover on the vineyard floor is advantageous to predatory mites and various beneficial insects such as green lacewings, sixspotted thrips, and minute pirate bugs.

Grape phylloxera

The grape phylloxera (*Daktulosphaira vitifoliae*) is a very small, aphid-like insect that is very difficult to see with the unaided eye. It has two forms—an aerial, leaf-galling form and a subterranean root-feeding form. Historically, the root form has been the more economically damaging of the two.

Organic Management – Phlumoxes Phylloxera

A two-year field study by UC Davis researchers found that soil management practices can significantly influence the amount of root damage resulting from phylloxera-induced fungal infections. The researchers found that per-unit root populations of phylloxera did not significantly differ between organically managed vineyards (OMV) and conventionally managed vineyards (CMV), when both were infested with phylloxera. However, root samples from OMVs displayed significantly less root necrosis (9 percent) caused by fungal pathogens than did samples from CMVs (31 percent). Organic vineyard management is characterized by use of cover crops and composts and no synthetic fertilizers or pesticides.

This study sampled four OMVs in Sonoma, Napa, and Mendocino counties. Eight CMVs were initially sampled in these counties and San Joaquin County. This was later reduced to five CMVs for practical reasons. All vines except for those in San Joaquin (own-rooted) were on AXR#1 rootstock. No significant differences between OMVs and CMVs were found for single year comparisons of percent organic matter, total nitrogen, nitrate, and percent sand/silt/clay. The pooled data for the two years tell a slightly different story: OMVs' soil had a significantly higher (by .5 percent) percentage of organic matter (percent OM) than CMVs soil, and over all vineyards and all years there was a weak but significant inverse correlation between root necrosis and soil percentage OM. Cultures of the necrotic root tissue also revealed some interesting differences: significantly higher levels of the beneficial fungus *Trichoderma* were found in OMVs in 1997 (but not in 1998), and significantly higher levels of pathogens *Fusarium oxysporum* and *Cylindrocarpon* species were found in CMVs in 1998 (but not in 1997).

(Lotter et al., 1999)

Phylloxera is most injurious to *V. vinifera* roots, but foliar feeding on all grape species can be severe enough to cause defoliation, although this is rare. Roots of *V. rupestris* and other American species are tolerant or relatively resistant, compared to *V. vinifera*, which is why *V. vinifera* is commonly grafted onto *V. rupestris* roots. Grafting onto American species practically eliminates phylloxera injury.

Although there are no known controls for already infested roots, recent studies have shown that soil management practices can significantly influence the amount of root damage resulting from phylloxera-induced fungal infections. Phylloxera infestations in organically managed vineyards resulted in less root damage, compared to that caused by similar phylloxera populations in conventional vineyards. Root damage is caused primarily by secondary infections of plant pathogens at phylloxera feeding sites. (Lotter et al., 1999)

Caterpillars

Several lepidopterous species attack grapes, including the grape berry moth (covered earlier), orange tortrix, the omnivorous leafroller, cutworms, the grape leaf skeletonizer, beet armyworm, and the saltmarsh caterpillar. Providing habitat for beneficial organisms is an important management strategy to maintain "ecological pressure" against all life stages of these pests—eggs, larva, pupa and adult. Providing habitat for bats can help reduce these pests through direct predation—bats feed at dusk and at night, when many of the moth pests are flying—as well as through avoidance (adults of many lepidopterans are sensitive to bat echolocation and may avoid areas where bats are actively feeding). The naturally occurring bacterium *Bacillus thuringiensis* (Bt) is effective against most of these lepidopterans. Trade names include Dipel™, Thuricide™, and Javelin™. Some Bt formulations may contain inert ingredients that are not permitted in certified organic production, so be sure to verify product status with your certifier. Monitoring vineyards for these pests is important in order to time applications of Bt for best effectiveness. Bt works best on the younger, smaller caterpillars. It also degrades when exposed to UV light, so it will generally not retain effectiveness for more than three to four days.

A California study on beneficial insect habitat found that creation of corridors of sequentially flowering native plants can serve as a key strategy to allow natural enemies emerging from riparian forests to disperse over large areas of otherwise monoculture systems. This study examined distributions and abundance of western grape leafhopper, *Erythroneura elegantula*, its parasitoid, *Anagrus* species, western flower thrips, *Frankliniella occidentalis*, and generalist predators.

(Nicholls et al., 2000)

Mealybugs

Mealybugs are not a major pest in the Northeast or the South, but three species—the grape mealybug, *Pseudococcus maritimus;* the obscure mealybug, *Pseudococcus viburni;* and the longtailed mealybug, *Pseudococcus longispinus*—can become pests in California vineyards. Natural controls generally keep these pests in check, although ants must be controlled if they are milking the mealybugs and warding off natural enemies. Trilogy™, a formulation derived from neem, is registered for use on mealybugs and is listed with OMRI (Organic Materials Review Institute). Female mealybugs can not fly, so must rely on other means of transport to spread, such as equipment, birds, infected vines and human traffic.

A new pest in California vineyards is the vine mealybug (VMB), *Plannococcus ficus*. The VMB has several attributes that make it a more damaging pest than most other mealybug species. It is native to the Mediterranean, so there are no parasites or predators that have evolved locally to control it. Hosts in its native range include grape, fig, date palm, apple, avocado, citrus, and a few ornamentals. In California, it has only been found on grapes. (Bently et al., 2003) It has five to six generations per year, so it is able to multiply quickly. It has a cryptic lifestyle, hiding in the roots or under the bark, especially as the weather cools. The VMB exudes more honeydew than other mealybugs, and this characteristic, along with infestations

below the soil line, will help vineyard workers identify the pest. Management of this pest requires managing the ants that spread it. Controlling the ants increases the chances of parasitism by the imported VMB parasite, *Anagyrus pseudococci*. As noted above, Trilogy™ is an option. Any machinery moving between infested and non-infested vineyards should be washed thoroughly. Beware of nursery stock or machinery coming from infested areas.

Plant Parasitic Nematodes

Nematodes are tiny worm-like creatures that live in the soil. Some nematodes are beneficial and feed on bacteria and fungi (playing an important role in nutrient cycling), while other species, such as root-feeding nematodes, are plant parasites and destructive to crops.

Bird control is generally more difficult because birds are so mobile and the fact that many species are protected.

There are many nematode species that attack grape roots. As a consequence, no single rootstock provides complete resistance. Grape cultivars recognized for broad resistance to nematode species include Ramsey, Freedom, and several rootstocks in the Teleki series. (Teleki 5C is the only one that has been specifically tested—this rootstock is also resistant to phylloxera types A and B, but does not do well on soils prone to drought.) (Kodira and Westerdahl, 1999)

Important points for nematode management:

- Soil type influences the type and severity of nematode infestations (i.e., sandy soils increase the potential of nematode problems).
- Ecological soil management—with its emphasis on building organic matter through additions of composts, cover crops, and green manures—helps manage nematodes in two ways:
  - Soil with increased soil organic matter, and especially soil humus, functions like a sponge and retains soil moisture for longer periods during the growing season, thus reducing vine stress.
  - Soil amended with organic matter possesses greater populations and diversity of soil organisms, which results in competition and predation of plant parasitic nematodes.

Cover cropping can cause increases, decreases, or no change in nematode populations in the vineyard, depending on the nematode complex that is present and the type of cover crop planted. For example, Cahaba White vetch as a cover crop is a good host for *Meloidogyne hapla* (northern root knot nematode), a poor host for *M. incognita* (root knot nematode), and antagonistic to *Xiphinema americanum* (dagger nematode). (Westerdahl et al., 1998) For more information about non-chemical control strategies, biocontrol mechanims, and ecological soil management practices, see the ATTRA publication *Alternative Nematode Control*.

Vertebrate Pests

Vertebrate pests fall into two categories: mammals and birds. Mammals, such as ground squirrels, voles, gophers, rabbits, and deer, generally damage the roots, the vine, or the foliage. High populations of these animals can be very damaging, particularly for young vineyards. Sustainable management entails:

- Identifying the animal causing the problem
- Identifying habitat modifications that may reduce population pressures
- Identifying practical short term management options (use of baits, fumigants, or traps)
- Identifying habitat modifications that will increase predator populations (i.e., hawk perches, owl boxes, snake habitats)

Birds are serious pests of grapes. Control is generally more difficult because birds are so mobile and the fact that many species are protected (so make sure the bird species is positively identified prior to taking

control actions). Again, habitat modification is helpful to reduce attractiveness of nearby areas as nesting and resting sites. Flags, noisemakers of various kinds, mylar strips, etc., generally are effective for only a short time, and then birds become habituated to these devices and ignore them.

The most important problem birds are the house finch (*Carpodacus mexicanus*), starling (*Sturnusbgh vulgaris*), and the American robin (*Turdus migratorius*). The house finch is not common in the central U.S., but starlings and robins are found throughout the country. Other bird species may be locally damaging. Local farm advisors should be consulted about management options and local, state, and federal laws governing them.

Bird Management Options Summary (adapted from Allen et al., 2005)

Control method/ product	Time of application	Remarks
Scare devices	Before damage occurs	Place in vineyard: distress calls, exploder guns, crackers, eye spot balloons.
Shooting	Before grapes ripen	It's illegal to shoot migratory birds without a permit from the U.S. Fish and Wildlife Service.
Netting	Before grapes ripen	Place on each side of canopy or drape over canopy; support above vines on a frame. Remove just before harvest. Labor costs may be high. Net costs at least $800/acre. Net life: 7-15 years. Nearly 100% effective.
Falcon Predators	From veraison [when the grapes first begin to color] through harvest—5-6 weeks	Practiced in northern and central CA. One falcon can cover roughly 350-500 acres, and falconers typically charge $50 to $70 an hour. (Cantisano and Alley, 2003)

Falcon Resources
The companies listed here can provide bird pest management services using falcons. This technique is generally more effective on larger acreages, due to the costs involved and the area effectively covered by a falcon.

Brad Felger
Airstrike Technology
4050 Tampico Rd., Atascadero, CA 93422
805-391-0444 • *coastfalcons@yahoo.com*

Tom Savory
Avian Abatement Technology
9700 Orofino Rd., Ft. Jones, CA 96032
530-468-2962

Thomas N. Stephan
Field Operations
Air Superiority Falconry Services
346 Oak St Ramona, CA 92065
760-789-1493 (office) • 760-801-2207 (cell)
www.air-superiority.com

Netting can be very effective at preventing grape losses due to birds, but does not integrate easily with other agricultural operations. In California, by the time the nets are placed, most operations that the nets might interfere with have occurred.

The nets can be "stored" by attaching to end posts and drawn up over the grapes when birds are likely to cause damage prior to harvest.

Photos by Rex Dufour, NCAT

Organically Acceptable Herbicides

Active Ingredient	Product Name	Comments on Use	Manufacturer/ Distributor
Citric and Acetic Acid (vinegar)	AllDown Green Chemistry Herbicide	*AllDown is a formulation of 5% citric acid and .2% garlic. Non-selective herbicide for broadleaf weeds and grasses. The need for and use of citric/acetic acid for weed control must be explained in the Organic System Plan. There are some uncertainties about the appropriate use of these products in an organic system, so growers should always check with their certifier prior to their use.*	SommerSet Products, Inc. 4817 Normandale Highlands Dr. Bloomington, MN 55437 952-820-0363 *www.sumrset.com*
Citric and Acetic Acid (vinegar)	Ground Force	*Ground Force is a formulation of citric acid and vinegar, but mostly (10%) citric acid. Non-selective herbicide for broadleaf weeds and grasses. The need for and use of citric/acetic acid for weed control must be explained in the Organic System Plan. There are some uncertainties about the appropriate use of these products in an organic system, so growers should always check with their certifier prior to their use.*	Abby Laboratories Inc Craig Morris 14000 Sunfish Lake Blvd NW, Ste 100 Ramsey, MN 55303 763-422-0402 888-399-2229 (toll free) 763-422-0405 (FAX) *cmorris@abbylabs.com* *www.abbylabs.com*
Clove oil	Matran 2	*A non-selective, post emergence herbicide for annual grasses and broadleaf weeds. Can be combined with vinegar. Matran 2 is 45.6 % clove oil. According to manufacturer, the use of the yucca extract ThermX 70 (0.3 fl. oz/gallon) and fulvic acid (6 fl. oz./gallon) significantly enhances the coverage and the performance of Matran™. The need for and use of clove oil for weed control must be explained in the Organic System Plan. There are some uncertainties about the appropriate use of these products in an organic system, so growers should always check with their certifier prior to their use.*	EcoSMART Technologies, Inc. 318 Seaboard Lane, Franklin, TN 37067 888-326-7233 (8 am to 4 pm CST) *www.biconet.com/lawn/matran.html*
Clove oil	Xpress	*For general broadleaf and annual grasses weed control. Xpress is a formulation of thyme oil (10.4%) and Clove Oil (10.1%).*	Bio HumaNetics Lyndon Smith 201 S Roosevelt Chandler, AZ 85226 480-961-1220 800-961-1220 (toll free) 480-961-3501 FAX *lyndon@biohumanetics.com* *www.biohumanetics.com*
Corn Gluten	Bio-Herb	*Bio-Herb is a non-selective herbicide that inhibits root development during germination and early root development of any plant. It will not kill established weeds or plants. Application must be done before the weeds germinate. It is also a slow-release fertilizer. The need for and use of corn gluten for weed control must be explained in the Organic System Plan. Must not be derived from GE sources.*	Biofix Holding Inc Martin Blair P.O. Box 2820, Denton TX 76202 940-382-2594 940-387-2294 (FAX) *exports@biofix.com* *www.biofix.com*
Corn Gluten	Bio-Weed	*Bio-Weed is a non-selective herbicide. The need for and use of corn gluten for weed control must be explained in the Organic System Plan. Must not be derived from GE sources.*	Bioscape Inc Ralph Zingaro 4381 Bodega Ave. Petaluma, CA 94952 707-781-9233 877-246-7227 (toll free) 707-781-9234 (FAX) *ralph@bioscape.com* *www.bioscape.com*
Corn Gluten	Gold-N-Gro 9.6-0-0	*The need for and use of corn gluten for weed control must be explained in the Organic System Plan. Must not be derived from GE sources.*	McGeary Organics Inc David Poorbaugh P.O. Box 299 Lancaster, PA 17608 717-394-6843 800-624-3279 (toll free) 717-394-6931 (FAX) *sales@mcgearyorganics.com* *www.mcgearyorganics.com*
Soaps		*For use on non-food crops (ornamental crops) only; use on food crops or fallow fields is prohibited. Allowed use for farmstead maintenance (roadways, ditches, right of ways, building perimeters).*	

Weeds

Weed management will vary widely in vineyards across the country, due to differences in climate, soil, and irrigation. It is helpful to discuss weed control strategies in the context of goals for the vineyard floor. Goals for the vine row or berm ("in-row") will likely be different from those for the alleyway ("middles").

In-Row Weed Management

The most difficult task in farming grapes organically may be managing weeds under the vine rows. A common in-row strategy is to eliminate all forms of vegetation (weeds as well as cover crops) to avoid competition and interference with the vines, at least during the first three to five years of establishment. Thereafter, living mulches are sometimes grown in the vine row during certain parts of the growing cycle.

Especially in young vineyards, a weed-free zone around each vine or down the entire row is commonly recommended to eliminate vegetative competition. Specialized tillage implements designed for vineyards and orchards are widely used to stir the soil and disrupt weeds in organic vineyards. These include a tractor-mounted French plow or grape hoe, as well as articulating swing-arm implements (with rotary harrow and disk attachments to stir the soil) that retract when a sensor touches the vine. Thermal weed control equipment is becoming more popular in organic vineyarding and includes flame, infra-red, and steam options. Drip irrigation should be hung on trellis wires when thermal weeding is planned and to avoid interference with mechanical implements.

"Mow and blow" cover crops can provide an in-row mulch from cover crop biomass raised in the alleyways. This can prevent germination of weed seed, but it is not very effective in killing weeds that are already there, so it's important when using this technique to start with a clean in-row area. Mulching will also minimize temperature and moisture fluctuations in the upper soil layer, which may benefit the grape vine. A study in California found that dried cover crop residue varied among vineyards (1,800 to 8,726 pounds of dry biomass per acre), so weed suppression using the mow-and-mulch technique can vary. Perennial weeds, such as field bindweed, were not well-controlled. (Hanna et al., 1995.) Use of alternative herbicides—with ingredients such as acetic acid (i.e., vinegar), lemon oil, and clove oil—provide a burn-down option for management of weeds and living mulches, but their use may be restricted to roadsides, ditches, and non-cropping areas.

Growers in areas with summer rains may be able to mow their covers several times per season, adding to the in-row mulch layer. Two disadvantages to be aware of with in-row mulches are that they can be a fire hazard in dry environments and can provide habitat for rodents that can damage vines.

Finally, in mature vineyards, cover crops are sometimes managed as living mulches or an understory intercrop during part of the year. In conventional production these are managed with herbicides. In organic vineyard management, living mulches can be suppressed by mowing, tillage, thermal methods, and alternative herbicides.

Alleyway Vegetation Management

Sustainable vegetation management in alleys is as much an art as a science. Particular attention must be paid during the first few years after vine planting, and during dry years, that alley vegetation does not reduce vine vigor. Many organic growers are constantly experimenting with cover crop blends for the alleys, seeking mixtures that will maximize benefits (beneficial insect habitat, improved soil tilth, equipment traction and access to alleys during wet periods, reduced dust and soil erosion) and minimize costs (fuel, equipment and labor costs associated with planting cover crops, as well as the cost of mowing, seeds, and fertilizer). The needs of a particular vineyard will dictate the goals for the row middles (Pool et al., 1990), which might include:

- Creating optimal competition with the vine to prevent over-vigor-

ous growth, but not interfere with production.

- Increasing soil organic matter and soil quality.
- Decreasing water/wind erosion of soil (important for mite management).
- Reducing soil compaction caused by heavy equipment moving through the vineyard.
- Providing habitat for beneficial organisms.
- Increasing access for machinery to the vineyard (alleyways planted in covercrops will tend to provide machinery with better "footing" sooner after rains).

Several management tools can be used singly or in combination to achieve these goals, including use of cover crops, living mulches, and mowing, in addition to vegetation and weed control through mulching, flaming, and tillage. There are different costs and benefits to each method or combination of methods of weed control. For example, regular tillage, though an effective weed control, has high costs in terms of equipment and fuel as well as degrading soil structure and increasing the potential for soil erosion.

Photos by Rex Dufour, NCAT

This subclover cover crop provides a weed-suppressive mulch as well as good habitat for spiders and other beneficial organisms.

General Categories of Alleyway Vegetation

Resident vegetation. Well adapted to local environment, and may reseed itself easily. Growers can use mowing to shift resident vegetation toward a particular species or set of species if the flowering/seeding times of the plants are closely monitored. Because resident vegetation is typically a complex mix of plants, there will generally be a good cover no matter what type of weather the season brings, since some plants will do better in wetter years, others in dryer years. Some growers have planted native grasses and forbs to good effect.

Mixtures of cereals and legumes. These mixes can provide both nitrogen and organic matter to vineyard soils. The planting times for these mixtures will vary according to locale. More than one legume species should be planted to take advantage of differences in climatic preferences, so that at least one of the species will provide reasonable ground cover. Mixtures heavy on legumes will degrade relatively quickly when mowed. Mixtures high in cereals will last longer when used as in-row mulches due to the high C:N ratio of the plant material.

Perennials. Perennials do not need replanting and save on seed and equipment costs. These plants will generally need a year to become well established. Perennial cover crops may be more competitive with the vines, particularly in newly planted vineyards or in shallow or less fertile soils. (Elmore et al., 1998) Use of perennial legumes may encourage gopher activity. Some sod grasses would do well in this situation, particularly some of the new dwarf cultivars that respond to minimal management practices such as low water and low fertility. (Allen et al., 2005) However, research in New York that examined both grass-only and legume-only cover crops on ownrooted Concord grapes found that all living covers, regardless of species, depressed vine size, particularly if growing during the post-bloom period, and did not contribute to higher grapevine tissue nutrient concentrations. (Pool et al., 1995) This research was done on a conventionally managed vineyard,

however, and may not reflect the soil dynamics of an organically managed system.

No species or species mix will do well in all locations and in all years. It is up to the grower to observe and learn to adjust management practices accordingly, so that weed management and vine growth can be optimized with minimum inputs of costly labor and material.

It is important to remember that continuous use of any single management strategy will tend to select for weeds that tolerate that strategy. Continuous mowing may select for prostrate weeds. Continuous flame weeding will destroy small, broad-leaf plants and select for grasses and perennial plants that have growing points protected by the soil.

In the context of alley cover crops, this means that some growers use two sets of cover crops in adjacent alleys, rotating the cover crop mix used in a particular alley every year. Other growers will clean cultivate one alley for frost protection and plant cover crops in the adjacent alley, then switch the two the following year. Still another strategy is to keep one alley in a perennial cover and plant an annual cover in the next alley, which is disked at grape bud break.

The following machinery is used in organic vineyards for managing weeds and vineyard floor vegetation. The table is adapted and modified from *Growing Organic Winegrapes Sustainably: An Introductory Guide for Growers*, by Ann Thrupp, Fetzer Vineyards.

Weeding Equipment

Type of Machine	Short description
French, or Hoe Plow	*Heavy duty, traditionally used, does best in moist soil, needs to have soil thrown back under the vine in subsequent pass.*
Clemens Cultivator	*Sturdy, few moving parts, slices under weeds, can be mounted in front, mid, or rear. Can handle tight spaces, and is faster than some of the other cultivators. Does not work well if ground is hard.*
Kimco Cultivator	*Extremely heavy duty, usually very slow. Can be fit with cultivator or mower head. Has some ability to adjust the angle, allowing use on slopes. The cultivator teeth wear out rapidly.*
Gearmore Cultivator	*Similar to the Clemens, but not as heavy duty. It's considered reliable though lighter, and uses a blade to slice weeds. Less expensive than Clemens.*
Weed Badger Cultivator	*Fairly heavy duty; different models vary in durability. Lots of moving parts; fair reliability, but slow. Can be fit with cultivator or mower; works for any size weed. Head can be adjusted to work on a variety of angles & slopes, but may be too wide for narrow rows.*
Pellenc Sunflower Cultivator	*Works on single and dual rows, mid or rear mount. Good ability to handle slopes; works best on small and medium weeds. Teeth wear out rapidly; hardfacing is needed. It's fairly slow and expensive.*
Bezzerides Cultivator	*Shallow cultivator with single rod/blade, durable, better for use on mature vines, generally used on flat land, but can be adapted for slopes, faster than most other cultivators, not good for young vines.*
ID David Cultivator	*Versatile, with several attachments including mower, weed knife, cultivator, hoe. Slow, and lots of parts to maintain. Good ability to adjust to different row widths, berm heights, slopes. Fairly good sensor. Will handle large weeds, can be mounted on front or mid.*
Omnas Boomerang	*Cultivates with a rototiller head; its mode of articulation around vines permits close cultivation. Useful for young vineyards and on small terraces. It's flexible to adjust to different slopes.*
Spedo (for tillage or mowing)	*This machine has optional attachments for under-vine tillage, a weed knife, rotary hoe, and mower. It offers flexibility. It is distributed by Gearmore, manufactured by Spedo & Figali.*
Kimco In-Row Mower	*Mows vegetation under the vines. This is an option for vineyards that are no-till systems.*
Andros Engineering In-Row Mower (special design)	*This is a hydraulic mower that mows vegatation under the vines; works on a spring system, and is light weight.*
"Perfect" Rotary Mower	*This rotary mower is manufactured in Holland, and it can be initially adjusted for different row sizes. It has options for mowing between the vines, and arms for mowing under the vines.*
Propane Flame Weeders ("Flamers") (see "Contacts" below for listing of distributors of thermal weeders)	*Relies on propane gas burners to produce a controlled and directed flame that passes over weeds. The intense heat sears the leaves, and the weed wilts and dies one to three days later. Needs to be used on young weeds; doesn't work on large weeds. Flame weeders come in various models and can be fitted to tractors, or used in hand-held model. Moves slowly and may be fire risk to use in summer. Liquid propane works best, as it provides more heat than butane.(Lanini, Tom. 2003.) Infrared weeders may reduce fire risk by using a propane-heated radiator, so there are no flames in contact with the ground.*
Other thermal weeders (steam and foam)	*Using steam or foam for weed control has attracted attention in trade journals, and has been used effectively in organic vegetable production, but is not yet well tested in vineyards.*

Contacts: Thermal Weeders *(adapted from Quarles, W. 2004. The IPM Practitioner. May/June. p. 8)*

Handheld Flamers

Atarus Ranger (lease only)
Australian Company
2-6 Raglan Road
AUBURN NSW 2144m
0411-8750379
02 9645-1665 FAX
ianj@batchen.com.au
www.batchen.com.au/index1.htm

BernzOmatic. (#jt850), Available in hardward stores or directly from BernzOmatic
800-654-9011

Flame Engineering, Inc. (Red Dragon)
P.O. Box 577, LaCrosse, KS 67548
888-388-6724
785-222-3619 FAX
flame@awav.net
www.flameeng.com

Peaceful Valley Farm Supply
(Flamers and supplies)
P.O. Box 2209, Grass Valley, CA 94945
530-272-4769
888-784-1722 (toll-free)
530-272-4794 FAX
helpdesk@groworganic.com
www.groworganic.com

Rittenhouse & Sons (Weed Torch)
RR#3, 1402 Fourth Ave
St. Catharines, ON, Canada L2R 6P9
905-684-8122
800-461-1041 (toll-free)
905-684-1382 FAX
prosales@rittenhouse.ca
www.rittenhouse.ca/asp/menu.asp?MID=88

Row Crop Flamers

Flame Engineering, Inc. Two- to eight-row flamers for tractor operation (see above).

Thermal Weed Control Systems, Inc.
(four- to eight-row flamers for tractor operation, hooded models)
N1940 State Hwy 95
Neillsville, WI 54456
715-743-4163
715-743-2921 FAX
jonesconsulting@juno.com

Flame Weeders (push along)
Rt. 76, Box 28, Glenville, WV 26351
304-462-5589
flame-weeders@juno.com
www.flameweeders.cjb.net

Infrared Weeders

Forevergreen (Ecoweeder, push along and handheld)
19974 12 Avenue
Langley, BC, Canada V2Z1W3
604-534-9326
604-530-7129 FAX
info@chemfree-weedcontrol.com
www.chemfree-weedcontrol.com

Rittenhouse & Sons
(Infra-Weeder, push along and handheld; see above)

Steamers

Atarus Stinger (See above.)

Sioux Steamer
One Sioux Plaza
Beresford, SD 57004
605-763-3333
888-763-8833 (toll-free)
605-763-3334 FAX
www.sioux.com

Hot Water

Waipuna USA
715 N Independence
Romeoville, IL 60466
630-514-0364
630-759-8155 FAX
jeffw@waipuna.com

OESCO, Inc. (Aquacide)
P.O. Box 540, Route 116
Conway, MA 01341
413-369-4335
800-634-5557 (toll-free)
413-369-4431 FAX
info@oescoinc.com

Infrared and Hot Water

Sunburst
P.O. Box 21108
Eugene, OR 97402
541-345-2272
info@thermalweedcontrol.com
www.thermalweedcontrol.com/

Grazing Options

Some farmers in California have used pygmy sheep to graze in alleys and under trellises. The following is from an e-mail listserve posting about using sheep in vineyards. (bdnow e-mail archive, 2002)

"I have a friend here in Sonoma County [coastal Northern California] that is running sheep in his vineyard year round with great success. They are pygmy sheep, and they wear a kind of harness that keeps them from getting up into the leaves. Apparently, if they can get at the end of a cane that has drooped down, they will yank the cane down all the way to the trunk. The sheep are Old English Baby Doll South Downs. These are short but not small sheep. The harnesses are dog harnesses for the body and a sheep halter for the face. Tie the two together from chin to chest. Some of the sheep get too big around to fit into the dog harness."

It should be noted that to avoid the potential of contamination by manure, it's required that the sheep be removed from the vineyard at least 90 days prior to grape harvest.

Aside from pygmy sheep, other options include geese, which specialize on grasses. Roughly four geese per acre are required for grass weed control in new vineyards. (Lanini, 2003) Any breed will work, but geese in a rapid growth stage will be more aggressive weeders.

Photo by Rex Dufour, NCAT

Economics and Marketing

The Grape Production Cost Resources chart will have more detailed information appropriate to specific regions of the country about establishment and maintenance costs of vineyards. Typical vineyard establishment costs—including soil preparation, plants, irrigation, and trellising system—range from $3,500 to $26,000 or more per acre, excluding land or machinery. Maintenance of the planting may cost up to $2,000 per acre per year (mostly labor for pruning and picking), and it takes three to four years for a new vineyard to begin significant production. (Weber et al., 2005) According to Bob Blue of Bonterra Vineyards in Mendocino County, California, organic weed control runs $100 to $150 more per acre than conventional practices (Cox, 2000), but this is relative to farmer expertise, climate, and farm type. Due to greater moisture available to the alleys, weed control in the East will likely require more time and use of machinery, but it also represents an opportunity to creatively use the resource represented by vegetative growth in the alley.

Organic certification costs will vary according to the certifying agency, but will likely include an inspection fee and an annual certification charge. The inspection fee (generally $150 to $400, though there will be exceptions) will be higher for larger operations, mixed operations that have both organic and conventional ground, and complex operations with several crops and/or several plots of land. There are two programs to help reimburse farmers for the cost of certification: Agricultural Management Assistance Program (AMA), and the National Organic Certification Cost Share Program (NOCCS). Both programs cover 75 percent of cost of certification, not to exceed $500, and the states process applications and distribute funds. The

AMA program is currently only run in the following states: CT, DE, ME, MD, MA, NV, NH, NJ, NY, PA, RI, VT, UT, WV, WY. The NOCCS program expired in October, 2004, but some states may still have money remaining from the federal funds allocated to them for this program. See ATTRA's *Organic Farm Certification and The National Organic Program* for more information about certification costs.

Because of these high establishment and maintenance costs and the long-term nature of a vineyard, it is important that a potential organic grape grower have a realistic marketing plan before planting on a commercial scale. This is particularly true on the West Coast, where production finally exceeded demand in 2002.

A five-year study by Cornell University in New York indicated that growing costs were 69 to 91 percent higher for organic than for conventional growers in New York. (White, 1995) In fact, two of the three cultivars (Seyval, Elvira, and Concord) lost money in the organic system. Only Elvira provided a modest positive return of $35 per acre (compared to about $375 per acre for conventionally grown Elvira). The economics of the system will clearly be different if the grower is also marketing the grapes as wine, as opposed to selling them wholesale. The authors of this study point to high weed control costs as a major factor in the economics of the organic plots. These relative cost data do not apply to organic production on the West Coast, because the Medi-

Grape Production Cost Resources

University of California Cooperative Extension,
Sample Costs To Produce Organic Wine Grape: Chardonnay, 2004
www.agecon.ucdavis.edu/uploads/cost_return_articles/grapeorgnc2004.pdf

The sample costs for organic wine grape production in the North Coast Region (Sonoma County) are presented in this study. The hypothetical vineyard used in this report consists of 30 acres that were established conventionally and then converted to organic production. An additional 5 acres are in farmstead, roads, reservoir, and pumping stations. Two additional studies published in 2005 on conventional grape production in the intermountain region (Shasta and Trinity counties in northern California) and the San Joaquin Valley can be seen at www.agecon.ucdavis.edu/.

The Economics of Wine Production in Virginia
www.ext.vt.edu/pubs/viticulture/463-008/463-008.html

Although this site, maintained by Virginia Cooperative Extension, does not specifically discuss installation of organic vineyards, many of the costs will be the same whether installing a conventional or organic vineyard.

Considerations for Starting a Vineyard,
Texas Cooperative Extension
http://winegrapes.tamu.edu/grow/start.shtml

Although this site by Texas Cooperative Extension does not specifically discuss installation of organic vineyards, many of the costs will be the same whether installing a conventional or organic vineyard.

Cost Estimates for Establishing a Vineyard,
Iowa State University
http://viticulture.hort.iastate.edu/info/costestimate.html
http://viticulture.hort.iastate.edu/info/cost.pdf

Although these sites, maintained by Iowa Cooperative Extension, do not specifically discuss installation of organic vineyards, many of the costs will be the same whether installing a conventional or organic vineyard.

Establishing and Producing Wine Grapes in Hood River County
Oregon State University
http://extension.oregonstate.edu/catalog/pdf/em/em8878-e.pdf

Although this publication, produced by Oregon Cooperative Extension, does not specifically discuss installation of organic vineyards, many of the costs will be the same whether installing a conventional or organic vineyard. Information is up to date, published in September, 2004.

2001 Grape Enterprise Budget French Hybrid and 2003 Table Grape Enterprise Budget
http://aede.osu.edu/People/Moore.301//grape/index.htm

Although this site, maintained by Ohio State University Cooperative Extension, does not specifically discuss installation of organic vineyards, many of the costs will be the same whether installing a conventional or organic vineyard.

Agricultural Management Program (AMA)

This program is administered by USDA's Natural Resource Conservation Service (NRCS). The program is currently only run in the following states: Connecticut, Delaware, Maine, Maryland, Massachusetts, Nevada, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Utah, Vermont, West Virginia, and Wyoming. This program is budgeted at $20 million per year and authorized through 2007. For more information:

Dave Mason, National Program Manager, 202-720-1873, *dave.mason@wdc.usda.gov, www.nrcs.usda.gov/programs/ama*

terranean climate reduces weed production in the (usually) non-irrigated soils of the vineyard alleys. Another important factor is the generally higher prices obtained for *V. vinifera* grapes which dominate West Coast production.

Two prime examples of successful organic grape production on the West Coast are Bonterra Vineyards (378 acres) and Fetzer Vineyards (2,000 acres), both of which use organically grown grapes as a marketing tool. In addition, Fetzer Vineyards has devoted some of its acreage to Biodynamic production. (For more information about Biodynamic farming practices, see ATTRA's *Biodynamic Farming and Compost Preparation*.) Fetzer announced in late 2002 that it will grow and purchase only organic wine grapes for its wines by harvest 2010. Only about 20 percent of Fetzer's 250 contract grape growers are presently organic. (Horner, 2003) Bonterra winemaker Robert Blue states, "After thirteen years of farming organically, our experience is that vineyards with balanced, fertile soil produce healthier vines and grapes and subsequently better wines...."

One advantage that producers of *vinifera* type grapes have is that these grapes keep longer (one to four months at 32°F) than labrusca types (two to four weeks). The various advantages inherent in organic grape production in the West, combined with a competitive market, may make it difficult for growers outside of California, Oregon, Washington, or Arizona to successfully compete in a *wholesale* organic market dominated by such large producers. Some wholesale buyers and sellers of organic grapes in both the eastern and western U.S. can be found through the Organic Trade Association's Web site at *www.theorganicpages.com/topo/index.html*.

Marketing Labrusca-Type Grapes

Another consideration for the organic grower outside of the West Coast "*V. vinifera* belt" is choosing cultivars that are both adapted to the grower's region and relatively resistant to diseases. The problem is that many cultivars that are both disease-resistant and adapted to a particular region are likely to be seeded labrusca types. Though labrusca grapes can be marketed as both table grapes and as wine grapes, most of the seedless types, preferred by consumers, and which were developed for the East, are not particularly disease-resistant. Mars (seedless) appears to be one of the most resistant, yet it can suffer greatly from black rot in a wet year.

Moreover, most of the seedless varieties, such as Canadice, Interlaken, Himrod, and Lakemont, are subject to major crop losses in many parts of the East due to freeze damage to fruit buds in winter and early spring. The cultivar Reliance is an exception to this last rule, but, again, it is susceptible to most of the major grape diseases.

Some consumers prefer the full, fruity flavor of these American grapes. Many older consumers grew up thinking that grapes were "supposed" to taste the way American grapes taste. Young people exposed to grape jelly (usually made from Concords) and grape-flavored candy and bubblegum are also familiar with the flavor of American grapes. It might behoove the direct marketer to offer a labrusca berry or two as free samples to potential customers at farmers' markets or roadside stands. The seedless white and red grapes from California and Chile have so dominated the table grape market that many consumers don't even know what a labrusca grape is. As a table grape, labrusca has evolved into a

minor, local market niche. It remains one of the primary wine grapes for eastern wineries, however.

Offering recipes and suggestions for a particular cultivar's best use (wine, preserves, fresh eating, etc.) also could be helpful. Because many of the labrusca types have tough, sour, but "slipping" skins, it might even be helpful to show customers how to eat these slip-skin types (the pulp can be squeezed into the mouth and the skin discarded).

Organic Wine

The market for organic wine and wine made from organically produced grapes is growing.

There is a difference between wine made with organically grown grapes and organic wines. Organic wine is made from organically grown grapes, but without added sulfites, although it may contain some naturally occurring sulfites. In addition, the winemaking facility must be certified to ensure compliance with the National Organic Standard. Wine made with organic grapes and containing added sulfites to protect against bacterial spoilage may be labeled "produced from organically grown grapes." Some wineries grow grapes organically or purchase organic grapes, but don't market them as organic wine, either due to the cost of certifying their land and winery or the added expense of cleaning machinery that's required when switching from handling and processing conventional grapes to organic grapes. Other wineries don't seek organic certification for their wines but instead rely on "ecological" or "sustainable" production methods; for example, using composts and cover crops to supply organic matter and increase beneficial insect habitat, yet employing selective pesticides in an IPM program. (Cox, 2000) Most winemakers with experience in ecologically grown grapes feel the quality of the grape, and the resulting wine, is better when soil management is ecologically based.

The market for organic wine and wine made from organically produced grapes is growing. About 5 percent of California vineyards were certified organic as of fall 2000, and organic acreage has grown in that state from about 178 acres in 1989 to some 12,000 acres in 2000. (Cox, 2000) Another source estimated 18,500 acres of organic vineyards in California in 1997. (Greene, 1997) Whatever the true figure, clearly there are many thousands of acres of organically grown grapes in California and the West Coast. Entrepreneurs hoping to find an unexplored niche market in organic grapes or organic wines probably will be disappointed. However, there is increasing public awareness and emphasis on locally-grown and processed foods, and savvy growers producing a good product may be able to market to it. There may be more opportunity for this marketing approach in the East, since there are relatively fewer organic wine producers there.

Given the weaker economics of organic grape and wine production in the East, it would seem even more important that eastern growers receive a premium for their products. A 1990 study (White, 1995) concluded that there was no price premium in the marketplace in 1990 for wine labeled organic. However, in the 15 years since that study, consumer attitudes have changed, and the quality and quantity of organic wines has increased substantially, as have the improved cultivar selections available for planting. These changes, combined with the new pest management tools available to organic growers, will provide additional incentives for eastern vineyardists to examine the market for organically grown grapes.

Wine Making and Sustainable Energy

Winemaking is a highly energy-intensive operation, with some of the main consumers of energy being (1) refrigeration; (2) moving wine in and out of tanks; (3) running motors, drives, and pumps; (4) heating, ventilation, and cooling (HVAC); and (5) lighting.

The first step towards improved energy management is usually some kind of energy audit that tells you how much energy you are using and where the energy is going.

A conversation with your utility representative may be the best place to start. As part of this conversation, inquire whether energy audits are available, or whether you can get help in doing your own audit. An audit should also help you identify "low hanging fruit," targets for highly cost-effective energy saving improvements.

Many wineries have found ways to dramatically reduce their energy consumption, while others have incorporated renewable energy into their operations. These improvements often pay for themselves quickly in energy savings while also attracting favorable publicity and public relations benefits. Substantial incentives for energy-saving projects are currently available from numerous federal and state agencies, as well as utilities.

Links to information about Federal and State Energy Incentive Programs

1. The Farm Bill Clean Energy website, from the Environmental Law & Policy Center is at *www.farmenergy.org*. Information about the Energy Title programs of the Federal Farm Bill and "energy efficiency and renewable energy opportunities that benefit farmers, ranchers and rural communities."

2. The Database of State Incentives for Renewable Energy (DSIRE) is "a comprehensive source of information on state, local, utility, and selected federal incentives that promote renewable energy." *www.dsireusa.org*

3. The California Sustainable Winegrowing Alliance provides links to energy efficiency resources. *www.sustainablewinegrowing.org/resources*

Some approaches to energy efficiency and renewable energy projects in vineyards and wineries:

Sutter Home (Trinchero Family Estates, St. Helena, CA)

- Night harvesting takes advantage of off-peak hours and reduces refrigeration needs.
- Better insulation of warehouses, along with roof fans that pull in cool air at night.
- Replaced incandescent lights with fluorescents (payback about ½ year).
- Installed energy-efficient motors on all refrigeration tanks.
- Using 45% recycled glass in bottles.

Simpson Meadow Winery (Madera, CA)

- Installed low-emission engines for two irrigation pumps, reducing fuel use 15%.
- Drip irrigation during off-peak hours in the evening and on weekends, reducing PG&E bills 27% through use of time-of-use rate schedules and reduced evaporation.

Fetzer (Hopland, CA)

- Simple insulated concrete wall separates cold stabilizing wine from warm-fermenting wine, reducing power bills $5,000 per month.
- Computerized and upgraded temperature tank controls allow better control and the ability to completely shut off the system as needed.
- Natural gas-powered co-generation unit produces hot water for barrel washing and electricity for heating, cooling, and lighting.
- Purchasing 100% green power; PV provides 75% of power for Administration Bldg.
- 40% recycled glass in bottles; case boxes 100%.

Sanford Winery (Santa Barbara, CA)

- Winery built from on-site materials: adobe bricks, recycled timbers, indigenous stone, etc.
- High-quality, thermally efficient walls reduce heating and cooling costs.
- Make full use of ambient temperatures for cooling in the aging cellars. Fans draw cool night air into the building.
- Grass cover crops reduce tractor passes for disking of weeds.

Benziger Family Winery (Glen Ellen, CA)

- Changed from incandescent to fluorescent lighting, reducing lighting energy 20-25%.
- Cave excavation for barrel aging avoids power needs for chilling and humidity control.
- Changed electrical service from 240 volts to a more efficient 480 volt service.
- Rewired the crush pad and installed variable speed motors.
- Applied foam insulation to fermentation and storage tanks, roof of the barrel barn.

Summary

As is the case with so many other crops, organic grape production faces different challenges depending on where the vineyard is located. This is reflected in the vast regional differences in the areas under organic grape production. Public concerns reflected by increased regulation of synthetic agrichemicals combined with market pressures for a better quality grape or wine are pushing grape production to develop better, more ecological approaches to vineyard management. At the forefront of this movement are organic and Biodynamic grape growers.

It is clear that in the arid West, producing grapes organically is a profitable and sustainable enterprise, whether for fresh market or wine grapes. Increasing numbers of conventional producers are incorporating sustainable (if not organic) practices into their vineyards to increase the quality of the grapes in an increasingly competitive market. This is a win for the growers, for consumers, and for the environment.

In the humid East, the commercial success of organic grape production is complicated by disease and insect pressure and the types of cultivars adapted to Eastern climates. French hybrids and back crosses with French hybrids will provide a wider range of cold- and disease-resistant cultivars with high quality grapes that are more compatible with organic production systems. Organically acceptable fungicides and insect controls, as well as disease-resistant cultivars, make small-scale organic production of grapes possible in the East, but long-term commercial success may depend on novel marketing techniques, new organically acceptable pest management techniques, and continuing research into innovative methods and techniques of organic production. Improved techniques for organic vineyard management will evolve in the East, as they have in the West, as more research is conducted on organically managed vineyards and more growers gain experience in the science and art of organic grape production.

Those that practice organic grape farming anywhere in the country will benefit from exchanging information. In that spirit, and in order to better protect our nation's resources, please contact the author at *rexd@ncat.org* if you have information you would like to share with other farmers.

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Gempler's
800-382-8473
www.gemplers.com

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www.pacificbiocontrol.com

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Further Resources

Publications and Periodicals

American Journal of Enology and Viticulture
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www.asev.org/Journal/Journal.htm
Refereed scientific journal for wine research. Call or e-mail for cost.

Compendium of Grape Diseases. 1988. Pearson, R.C., and A.C. Goheen (ed.). American Phytopathological Society Press, St. Paul, MN. 93 p.
Comprehensive treatise on this subject. Color plates of symptoms. Highly recommended for the serious grower. $49 plus shipping and handling from:
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800-328-7560 toll-free
651-454-0766 FAX
aps@scisoc.org
www.shopapspress.org/40888.html

Cover Cropping in Vineyards. A Growers Handbook. Westerdahl et al. 1998. University of California Division of Agriculture and Natural Resources. Publication #3338. 162 pp.
This book will be most useful to growers on the West Coast. It covers various cover crops, their histories, uses and management, effects on soil and pest management. It has a very useful section that describes how California grape growers use cover crops.

Establishment and Maintenance of Muscadine Vineyards. 1983. Hegwood, C.P. et al. MAFES Bulletin 913. Mississippi State University, Mississippi State, MS. 20 p.
A short but comprehensive treatise on commercial production of muscadines. Valuable discussion of the horticultural traits of cultivars. Cooperative Extension in other southern states also produce materials on muscadines. Free from:
Office of Agriculture Communications
Box 9625
Mississippi State, MS 39762
662-325-7774

Grape Pest Management. 1992. Flaherty, D.L. et al. University of California Publication 3343, Second Edition. University of California, Oakland, CA. 400 p.
This is an invaluable reference for West Coast grape growers. It has hundreds of color pictures, many line drawings and diagrams, and covers nearly all important diseases, nematodes, weed management, and insect, mite, and vertebrate pests. Excellent color plates. $70 plus $7.00 shipping and handling from:
DANR Communication Services
University of California
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Oakland, CA 94608
800-994-8849
510-643-5470 FAX
danrcs@ucdavis.edu
www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_grapes.html

Modern Winemaking. 1985. Jackisch, P. Cornell Univ. Press, Ithaca, NY. 289 p.
$35 plus $3.50 shipping and handling from:
Sales Department
Sage House
Cornell University Press
512 East State Street
P.O. Box 250
Ithaca, NY 14851-0250
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Organic Viticulture in New York. 1995. Pool, Robert (ed.). Organic Grape and Wine Production Symposium. NYSAES Special Report, Number 69. NYAES Communications Services, Cornell University, Geneva, NY.
A useful guide on growing organic grapes in the East. Available on the Web in Acrobat in its entirety at www.nysaes.cornell.edu/hort/faculty/pool/organicvitwkshp/tabofcontents.html
Order as "SpR 69, Shaulis III," $13 ppd., from:
Bulletins, Communications Services
New York State Agricultural Experiment Station
Cornell University
Geneva, New York 14456

The Grape Grower: A Guide to Organic Viticulture. 2002. Rombough, Lon. Chelsea Green Publishing Company, White River Junction, VT. 289 p.
According to the author, "From finding and preparing the right site for your vineyard to training, trellising, and pruning vines, to growing new grapes from seeds and cuttings, The Grape Grower offers thorough and accessible information on all the basics. The chapters on grape species, varieties, and hybrids are alone worth the price of a college course in viticulture. And technical information on the major (and minor) insect pests and diseases that affect grapes, as well as their organic controls, makes this book an invaluable reference that readers will turn to again and again." See the author's full description at www.chelseagreen.com/Garden/GrapeGrower.htm

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Organizations

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Produces an excellent series of fact sheets and other bulletins relevant to eastern grape production, which are listed in their publications catalog.

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Dedicated to enhancing the business of growing wine grapes through research, advocacy, and leadership. Web site features a section on Sustainable Wine Growing, as well as a number of research publications and other resources.

California Table Grape Commission
392 W. Fallbrook, Suite 101
Fresno, CA 93711-6150
559-447-8350
559-447-9184 FAX
info@tablegrape.com
www.tablegrape.com
Grape growers united to promote California table grapes. Conducts research on production. Quarterly grower report.

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www.chinabend.com

Cooperative Extension Service and Land-Grant University System
Every state has a land-grant university and an associated Extension Service. Research and Extension services relevant to viticulture are offered in many states. To contact the county CES, see Yellow Pages under "Government, County."

Department of Fruit Science
Southwest Missouri State University
9740 Red Spring Road
Mountain Grove, MO 65711-9252
mtngrv.smsu.edu
Operates the Missouri State Fruit Experiment Station and the Midwest Viticulture and Enology Center. The department conducts research programs in biotechnology/molecular genetics, entomology, plant pathology, molecular plant virology, pomology/plant physiology, enology, and viticulture, and has advisory programs in fruit production, grapes and wine, and consumer education. The department also conducts the Grape Importation and Certification Program, a USDA quarantine site.

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Consultant for organic production. Also supplier for natural pest control products.

Heller Vineyards
Tasting Room and Offices
P.O. Box 999
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Carmel Valley, CA 93924
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831-659-6226 FAX
heller@redshift.com
www.hellerestate.com
A California vineyard that produces chemical-free grapes without pesticides or herbicides and is certified 100% organic.

Minnesota Grape Growers Association
35680 Hwy. 61 Blvd.
Lake City, MN 55041
651-345-3531
grapes@connect.com
www.mngrapes.com
Source of information for growing grapes in very cold climates. Newsletter and annual "Yearbook."

Munson Memorial Vineyard
Grayson County Community College
6101 Grayson Dr.
Denison, TX 75020
903-786-4382
www.grayson.edu/grayson/
A repository for the cultivars developed at the turn of the 20th century by the prolific grape breeder and botanist T. V. Munson. Munson crossed native and European species for disease resistance and for adaptability to various soils and climates. The Vineyard provides only information and cuttings—no plants.

New York Wine & Grape Foundation
350 Elm St.
Penn Yan, NY 14527
315-536-7442
315-536-0719 FAX
info@newyorkwines.org
www.uncorkny.com/
Grower/processor/retailer group that promotes sales and use of New York grapes and grape products. Also provides marketing information assistance.

North American Fruit Explorers, Inc. (NAFEX)
Rt. 1, Box 94
Chapin, IL 62628
vorbeck@csj.net
www.nafex.org
Amateur and professional fruit afficionados share information in a quarterly journal, Pomona, and in national and regional meetings.

Ohio State University
College of Food, Agricultural, and
Environmental Sciences
http://ohioline.osu.edu/lines/fcrop.html#FRU.8
Provides a number of useful online publications related to grape pests and diseases.

Organic Grapes into Wine Alliance (OGWA)
1592 Union St., Suite 350
San Francisco, CA 94123
415-256-8882
www.organicwine.com
An alliance of wine makers, grape growers, and wine-trades people who support the production of wines made from organically grown grapes through the establishment of production standards, education, cooperation, and leadership.

Organic Wine Guild
Box G
Santa Rosa, CA 95402
707-522-0550
info@organicwineguild.com
www.organicwineguild.com
Founded in 2001 to educate vintners, consumers, vineyard managers, and others about the benefits of converting vineyards to organic and Biodynamically grown grapes.

Minnesota Grape Growers Assoc. 1990. Growing Grapes in Minnesota. MGGA, White Bear Lake, MN. 67 p.
Excellent guide for viticulturists in cold climates. $8.50 ppd. From:
MGGA
35680 Hwy. 61 Blvd.
Lake City, MN 55041
651-345-3531
grapes@connect.com
www.mngrapes.com

Shelburne Vineyard
70 Pierson Drive
Shelburne, VT 05482
802-734-1386
kalbert@shelburnevineyard.com
www.shelburnevineyard.com
An organic vineyard in Vermont. This Web site has some excellent insights into weed and disease management in a Northeastern U.S. setting. Also discusses cultivars used in their vineyard and some cultural practices.

Washington Association of Wine Grape Growers
Box 716
Cashmere, WA 98815
509-782-8234
509-782-1203 FAX
scharlau@televar.com
www.wawgg.org
A grower association committed to representing, educating, and promoting wine grape growers in Washington State.

Yorkville Cellars
25701 Highway 128
P.O. Box 3
Yorkville, CA 95494
707-894-9177
707-894-2426 FAX
yvcellars@pacific.net
www.yorkville-cellars.com/organic.html
Organic estate winery in California.

Web Sites

Controlling Fungal Diseases of Grapevine Under Organic Management Practices. Gadoury, David M. No date. Cornell University. Downloaded December 2005. *www.nysaes.cornell.edu/hort/faculty/pool/organicvitwkshp/newgadoury.pdf*
Aids organic grape growers with controlling major fungal diseases.

Grape Production in New York: Resistant Rootstocks for New York Vineyards. Pool, Robert M. No date. Cornell University. Downloaded December 2005.

www.nysaes.cornell.edu/hort/faculty/pool/rootstocks/nyrootstocks.html

Helps New York grape growers determine whether to use a special rootstock. Topics covered include resistant stocks, hybrid varieties, viticultural factors, and more.

Internet IPM Resources on Grapes and Current
www.ippc.orst.edu/cicp/fruit/grape.html

This is a comprehensive listing of Web-based grape pest management information, organized by topic as well as by source.

Northwest Berry & Grape Information Network
http://berrygrape.orst.edu

A cooperative effort of Oregon State University, University of Idaho, Washington State University, and the USDA Agricultural Research Service, the Network's Web site is a comprehensive information and communications resource for berry and grape production practices, research, and marketing. The primary intended audience is commercial growers, marketers, crop consultants, pest management advisors, educators, and researchers in the Pacific Northwest. It includes information and links related to organic production methods and research.

Organic Wineries—CA
www.cawinemall.com/organic.htm

Identifies and provides links to organic wineries in California.

Sample Costs to Produce Organic Wine Grapes in the North Coast with an Annually Sown Cover Crop. Klonskey, Karen et al. 1990. University of California Cooperative Extension, Davis, CA. Accessed December 2005. *www.sarep.ucdavis.edu/pubs/costs/92/grape1.htm*

Addresses issues that are integral to organic wine grape farming, including the seasonal flow of operations for the production of organic wine grapes, cover crops, pest management, and current status of regulations for organically grown grapes and organic wine. Despite its age, this is a useful publication for farmers and others interested in organic grape production.

The Super Gigantic Y2K Winegrape Glossary by Anthony J. Hawkins
www.wineloverspage.com/wineguest/wgg.html

This Web page has many links to other grape-related pages and contains a comprehensive collection and discussion of various wine grape cultivars, with within-page links to each cultivar discussed.

Plant Suppliers

A list of Grapevine Nurseries is located online at *www.oardc.ohio-state.edu/grapeweb/nurseries.htm*

Boordy Vineyard
12820 Long Green Pike
Hydes, MD 21081
410-592-5015
410-592-5385 FAX
wine-info@boordy.com
www.boordy.com

Wide range of labrusca, vinifera, and French hybrid grapes.

California Grapevine Nursery, Inc.
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707-963-5688
800 344-5688 (toll-free)
707 963-1840 FAX
sales@californiagrapevine.com
www.californiagrapevine.com/

Concord Nurseries, Inc.
10175 Mile Block Rd.
North Collins, NY 14111-9770
800-223-2111 (toll-free)
800-448-1267 FAX
info@concordnursery.com
www.concordnursery.com

Wide range of labrusca, vinifera, and French hybrid grapes.

Double A Vineyards
10277 Christy Road
Fredonia, NY 14063
716-672-8493
vine@rakgrape.com
www.rakgrape.com

Some 75 varieties available, with production of other varieties by request. Catalog available online.

Duarte Nursury
1555 Baldwin Road
Hughson, CA 95326
209-531-0351 (toll-free)
www.duartenursery.com/main.htm

Free delivery in most of California and Oregon. There is a minimum order of 100 vines for shipping. All orders outside of California or Oregon will be shipped UPS at customer's expense. Shipping is approx. $1.00 per vine from Dec. - Feb. Balance of the year is shipped UPS Express, which is estimated at $2.00+ per vine.

Fairacre Nursery
Rt. 1, Box 1068
Prosser, WA 99350
509-786-2974
Wholesale only. Specializes in viniferas.

eVine Grape Sales Listings
www.evine.com/
Online resource that allows users to quickly and easily research and compare products from different growers in one convenient location. Searchable by grape type and variety, as well as region.

Ison's Nursery & Vineyards
P.O. Box 190
Brooks, GA 30205
770-599-6970
info@isons.com
www.isons.com
Specializes in muscadines.

King Estate Winery
80854 Territorial Road
Eugene, OR 97405
541-942-9874
541-942-9867 FAX
info@kingestate.com
www.kingestate.com
A certified nursery that produces premium grafted and non-grafted (dormant and green-growing) grapevines. Offers a fine selection of both certified and non-certified material.

Owens Vineyard & Nursery
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Specializes in muscadines.

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Aurora, OR 97002
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lonrom@bunchgrapes.com
www.hevanet.com/lonrom
Private grape breeder and consultant for grapes. Maintains a large collection of grape cultivars; sells cuttings. Enclose SASE with inquiries.

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Minimum order: 50 vines

Dave Wilson Nursery
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Wholesale only. Specializes in viniferas.

Vineyard Supplies

A. M. Leonard Inc.
241 Fox Drive
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www.amleo.com/textproducts.html
Carries a wide range of horticultural tools.

Green Hoe Co., Inc.
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Portland, NY 14769
716-792-9433
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Hydraulic grape hoes, end-post anchors, more.

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Irrigation supplies, organic fertilizers, ecological pest controls.

Oregon Vineyard Supply
2700 St. Joseph Road
McMinnville, OR 97128
503-435-2700
1-800-653-2216 (toll-free)
503-474-0476 FAX
www.ovs.com
Complete range of vineyard supplies and organic nutrients, as well as tractors, power equipment, and more. Web site includes a vineyard Q&A section.

Pacific Biocontrol Corp.
14615 NE 13th Court, Suite A
Vancouver, WA 98685
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360-571-2248 FAX
jackjenkins@qwest.net
www.pacificbiocontrol.com/
Pheromone disruption system for grape berry moth.

Peaceful Valley Farm Supply
P.O. Box 2209
Grass Valley, CA 95945
1-888-784-1722 (toll-free)
530-272-4769
helpdesk@groworganic.com
www.groworganic.com
Organic pest controls and fertilizers.

Appendix I

Disease Resistance Rating Chart for Grape Cultivars

Compiled by Guy Ames & Ric Lancaster October 1999, Revised by Rex Dufour 2006

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomop-sis**	**Anthrac-nose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
Abouriou			MR						
Alicante Bouschet			MR						
Alicante Ganzin			HR						
Alwood	R	S				S			
America		MR							
Angur Kalan			HR						
Aramon			MR						
Athens		HS							
Aspiran			HS						
Aubun			HR						
Aurore	HS	MS	MS	HS	SS		HS	No	MS
Babeasca Neagra			HR						
Bacchus			HS						
Baco Noir	HS	MS	MS	MR	SS	SS	MS	No	
Barbera			MR						
Baroque			HR						
Bath		MR							
Belcan			MR						
Black Corinth			HS						
Bouteillan			HS						
Brighton	HS	MS							
Buffalo	MS	MR	MR	MR					
Cabernet Franc	HS	HS	HS	SS				No	
Cab. Sauvignon	HS	HS	MS	SS	HS		HS	No	SS

HR=Highly Resistant **MR**=Moderately Resistant **SR**=Slightly Resistant **R**=Resistant **SS**=Slightly Susceptible **S**=Susceptible **MS**=Moderately Susceptible **HS**=Highly Susceptible

+=Fruit of Vignoles is highly susceptible to anthracnose while foliage and shoots are only slightly susceptible

*=Fruits not susceptible

1=Slight to moderate sulfur injury may occur–even on tolerant cultivars–when temperatures are 85 degrees F or higher during, or immediately following, the application

2=Copper applied under cool, slow-drying conditions is likely to cause injury.

Disease Resistance Rating Chart for Grape Cultivars

continued from pg. 38

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomop-sis**	**Anthrac-nose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
Campbell		HS							
Campbells Early	MS	HS							
Canadice	HS	HS	MS	MS				No	
Cardinal			HS						
Carignane			HS						
Cascade	MR	MR	MS	MR	MS		MS	No	
Castor			HR						
Catawba	HS	HS	MS	SS	HS	MS	SS	No	MS
Cayuga White	MS	MS	MS	SS	SS	HS	SS	No	SS
Caywood		MR							
Challenger	HS	HS	MS			HS		No	
Chambourcin	MS	SS	MS	MS		SS		Yes	
Champanel		MR	MR						
Chancellor	MS	HS	HS	SS	HS	MS	SS	Yes	HS
Chardonnay	HS	HS	HS	HS	HS		MS	No	SS
ChardonnayNY	MS	HS	HS	HS				No	
Chardonel	MS	MS	MS	MS				No	
Chelois	SS	SS	MS	SS	HS	SS	SS	No	SS
Chenin Blanc			MS						
Clairette			HS						
Claverie			HS						
Clinton		MR	HR						
Concord	HS	MS	MS	SS	HS	SS	HS	Yes	SS
Cottage		R							
Cynthiana/Norton	MR	MS	SS	SS	SS	SS		Yes	
DeChaunac	MS	MS	MS	MS	HS	MS	HS	Yes	
Delaware	HS	HS*	MS	MS	HS	MS	SS	No	
Diamond	HS	MS	HS						
Durif (Petite Sarah)			MR						
Dutches	MS	MS	MS	MS	MS	MR		No	
Einset seedless	HS	MS	HS	SS					
Elviria	MR	MR	MS	MS	SS		SS	No	MS
Emperor			HS						
Erie		S							
Flame Tokay			HS						

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Disease Resistance Rating Chart for Grape Cultivars

continued from pg. 39

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomop-sis**	**Anthrac-nose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
Foch	MS	SS	MS	MS		MS	HS	Yes	
Fredonia	MS	HS	MS	MR	MS			No	
French Colombard			MR						
Frontenac	MS	SS	MS	MS	SS			No	
Gewürztraminer	HS	HS	MS	HS				No	SS
Glenora	HS	HS	HS			HS			
Goeth									
Golden Muscat	HS	MS	HS						
Greek Perfume		S							
Grenache		MR	MR						
Grignolino			MR						
Himrod	HS	MS	HS	SS		HS		No	
Island Belle		S							
Isabella		MR							
Italia		S							
Ives	MR	HS	MR	MR			MS	Yes	
Janjal Khara			HR						
Jupiter	MS	SS	HS	SS	SS				
Kendaia									
Kerner			MS						
LaCrosse	HS	MS	MS	HS	MS				
Lady Patricia		R							
Lakemont		S							
Leon Millot	MS	MS	HS	SS	SS	SS	SS	Yes	
Limberger	HS	HS	HS	SS	HS			No	
Lomanto		MR							
Long John		MR							
Loretto		R							
Lutie		R							
McCampbell		MR							
Maccabeu			HR						
Malbec			MR						
Manito		S							
Marechal Foch	MS	SS	MS	SS		MS	HS	Yes	
Mars	SS	SS	HR	SS	SS				

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2=Copper applied under cool, slow-drying conditions is likely to cause injury.

Disease Resistance Rating Chart for Grape Cultivars

continued from pg. 40

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomop-sis**	**Anthrac-nose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
Marsanne			MR						
Mataro			MR						
Mauzac			HR						
Melody	HS	MS	SS	SS				No	
Merlot	MS	HS	HS	MS	HS		HS	NO	MS
Meunier			HR						
Mid-South		R							
Missouri Riesling	SS	HS	HS	MS					
Moored		S							
Moore's Diamond	HS	SS	HS	MS			MS	No	
Muscadel			HS						
Muscat Alexandra			HS						
Muscat Ottonel	HS	HS	HS	MS			HS	No	
Niabell			HR						
Niagara	HS	MS	MS	SS	HS		SS	No	SS
Oberlin 595		R							
Ontario		MR							
Optima			HS						
Orion			MR						
Patricia		R							
Pearl		S							
Perlette			HS						
Petite Bouschet			MS						
Phoenix			HR						
Pinot Gris	HS	HS	HS	MS			HS	No	
Pinot Blanc	HS	HS	HS	MS				No	SS
Pinot Meunier	HS	HS	HS	HS			HS	No	
Pinot Noir	HS	HS	HS	HS				No	SS
Pollux			MR						
Portland									
Rekasetali			HR						
Reliance	HS	HS	SS	SS	MS	HS		No	SS
Riesling (gray)			HR						
Riesling (white)			MR						
Riesling			MS						

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2=Copper applied under cool, slow-drying conditions is likely to cause injury.

Disease Resistance Rating Chart for Grape Cultivars

continued from pg. 41

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomopsis**	**Anthracnose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
RieslingNY	HS	HS	HS	HS	MS		MS	No	SS
Rubired			HR						
Rish Baba			HS						
Rosette	MR	MR	HS	MR	MS		MS	No	HS
Rougeon	MR	HS	HS	MR	HS		SS	Yes	HS
Royalty			MR						
Rubired			HR						
Saint Croix		MS	MS	MS					
Saturn		S							
Sauvignon blanc	HS	HS	HS	HS				No	
Schuyler		S							
Semillon			MR						
Seneca		S							
Seyval	MS	MS	HS	HS	MS			No	
Seyval Blanc	HS	SS	HS	MS		SS		No	
Silva			HR						
Sirius			MR						
Sovereign Coronation		S							
Steuben	HS	MS	MS	MR				No	
Suelter		R							
Sylvaner			MS						
Tampa			HR						
Terret Noir			HR						
Thompson Seedless			HS						
Tinto Cao			HR						
Traminette	SS	MS	SS	SS					
Ugni Blanc			MS						
Urbana	MS	HS							
Valdiguier			HR						
Vanessa	HS	MS	MS	MR	MR				
Vanessa Seedless		MR							
Ventura	MS	MS	MS	SS	SS			No	
Venus	HS	HS	HS			MS			
Verdelet	MS	MR	MS						

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Disease Resistance Rating Chart for Grape Cultivars

continued from pg. 42

	Sensitive to:								
Cultivar:	**Black Rot**	**Downy Mildew**	**Powdery Mildew**	**Botrytis Rot**	**Phomop-sis**	**Anthrac-nose**	**Eutypa**	**Sudlfur** [1]	**Copper** [2]
Vernaccia			MR						
Vidal			HR						
Vidal Blanc	MS	SS	HS	SS	SS	HS	SS	No	
Vignoles	MS	MS	MS	HS	MS	HS+	MS	No	
Villard Blanc	HS	SS	HS	SS		HS			
Villard Noir		SS	HS	SS					
Vinered	HS	HS	MS	SS		HS			
Westfield		S							
White Riesling	HS	HS	HS	HS					
Worden	MS	HS							
Yates		S							
Zinfandel			MR						

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2=Copper applied under cool, slow-drying conditions is likely to cause injury.

References: *(The information for this chart was taken from the following sources. Please consider that the disease reaction of a particular cultivar depends on several factors, especially the climate in which it is grown.)*

Anon. 1987. Relative disease susceptibility under Missouri conditions and sulfur sensitivity of grape cultivars. Missouri Grape Pest Control Guide. State Fruit Experiment Station, Mtn. Grove, MO.

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By Rex Dufour
NCAT Agriculture Specialist

Paul Driscoll, Editor
Amy Smith, Production

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or
www.attra.ncat.org/attra-pub/PDF/grapes.pdf

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