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Production Guide for Organic Grapes

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2010 Production Guide for
Organic Grapes

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The guidelines in this bulletin reflect the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this bulletin does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State at the time this publication was released for printing (January 2010). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available in county Cornell Cooperative Extension offices or from the Pesticide Management Education Program web site (*http://pmep.cce.cornell.edu*).

This guide is not a substitute for pesticide labeling. Always read the product label before applying any pesticide.

Trade names used herein are for convenience only. No endorsement of products in intended, nor is criticism of unnamed products implied.

Updates and additional information for this guide are available at *http://www.nysipm.cornell.edu/organic_guide*

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INTRODUCTION

This guide for organic grape production is an outline of cultural and pest management practices and includes topics that have an impact on improving plant health and reducing pest problems. The guide is divided into sections, but the interrelated quality of organic cropping systems makes each section relevant to the others.

More research on growing perennial crops organically is needed, especially in the area of pest management. This guide attempts to compile the most current information available, but acknowledges that effective means of organic control are not available for many pests. Future revisions to this guide will incorporate new information providing organic growers with a complete set of useful practices to help them achieve success.

This guide uses the term Integrated Pest Management (IPM), which has an affinity to organic production in its emphasis on the use of cultural practices to minimize pest outbreaks. With the limited pest control products available in many organic production systems, IPM techniques such as keeping accurate pest history records, selecting the proper site, and preventing pest outbreaks through use of sanitation, variety selection and biological controls are essential to producing a high quality crop.

1. GENERAL ORGANIC MANAGEMENT PRACTICES

1.1 Organic Certification

Who needs to be certified?

Operations or portions of operations that produce or handle agricultural products that are intended to be sold, labeled, or represented as "100 percent organic," "organic," or "made with organic ingredients" or food group(s). Wines and juices sold as organic have a separate certification process than the crop; when used as an organic ingredient, the processing steps have not been certified.

Who does NOT need to be certified?

Producers and handling (processing) operations that sell less than $5,000 a year in organic agricultural products. Although exempt from certification, these producers and handlers must abide by the national standards for organic products and may label their products as organic. Handlers, including final retailers, that: Do not process or repackage products; Only handle products with less than 70 percent organic ingredients; Process or prepare, on the premises of the establishment, raw and ready-to-eat food labeled organic; Choose to use the word organic only on the information panel; and Handle products that are packaged or otherwise enclosed in a container prior to being received by the operation and remain in the same package. More information can be found at the National Organic Program USDA Agricultural Marketing Service website.

Farming operations that gross more than $5,000 per year in organic products and want to use the organic label must be certified by a USDA National Organic Program (NOP) accredited certifying agency. The choice of certifier may be dictated by the processor or by the target market. A list of accredited certifiers operating in New York can be found on the New York State Department of Agriculture and Markets Organic Farming Resource Center web page. See more certification details in this guide under Section 4.1: Organic Certification Site Requirements.

1.2 Organic Farm Plan

An organic farm plan is central to the certification process. The farm plan describes production, handling, and record-keeping systems, and demonstrates to certifiers an understanding of organic practices for a specific crop. The process of developing the plan can be very valuable in terms of anticipating potential issues and challenges, and fosters thinking of the farm as a whole system. Soil, nutrient, pest, and weed management are all interrelated on organic farms and must be managed in concert for success. Certifying organizations may be able to provide a template for the farm plan. The following description of the farm plan is from the NOP web site:

The Organic Food Production Act of 1990 (OFPA or Act) requires that all crop, wild crop, livestock, and handling operations requiring certification submit an organic system plan to their certifying agent and, where applicable, the State Organic Program (SOP). The organic system plan is a detailed description of how an operation will achieve, document, and sustain compliance with all applicable provisions in the OFPA and these regulations. The certifying agent must concur that the proposed organic system plan fulfills the requirements of subpart C, and any subsequent modification of the organic plan by the producer or handler must receive the approval of the certifying agent.

Find more details at the USDA Agricultural Marketing Service's National Organic Program website. The National Sustainable Agriculture Information Service, (formerly ATTRA), has produced a guide to organic certification that includes templates for developing an organic farm plan. The Rodale Institute has also developed resources for transitioning to organic and developing an organic farm plan.

It is important to note that the USDA National Organic Program requires that applicants for certification must keep accurate post-certification records for 5 years concerning the production, harvesting, and handling of agricultural products that are to be sold as organic. These records must document that the operation is in compliance with the regulations and verify the information provided to the certifying agent. Access to these records must be provided to authorized representatives of USDA, including the certifying agent.

An excellent companion resource available for growers looking into developing a farm plan is the VineBalance, New York State's Sustainable Viticulture Program, the VineBalance Grower Self-Assessment Workbook and VineBalance newsletter series.

2. SOIL HEALTH

Healthy soil is the basis of organic farming. Regular additions of organic matter in the form of cover crops, compost, or manure create a soil that is biologically active, with good structure and capacity to hold nutrients and water (any raw manure applications should occur at least 120 days before harvest). Decomposing plant materials will support a diverse pool of microbes, including those that break down organic matter into plant-available nutrients as well as others that compete with plant pathogens in the soil and on the root surface. The practice of crop rotation to promote a healthy soil should be done in the one or two years prior to vineyard establishment or is limited to row middles in a perennial crop such as grapes. Organic growers must attend to the connection between soil, nutrients, pests, and weeds to succeed. An excellent resource for additional information on soils and soil health is Building Soils for Better Crops by Fred Magdoff and Harold Van Es, 2000. For more information, refer to the Cornell Soil Health website.

3. COVER CROPS

Cover crops are grown for their valuable effect on soil properties, such as organic matter, and, in grapes, on their ability to provide nutrients to the vine, control weeds between the rows, prevent erosion on vineyard slopes and to assist in the manipulation of soil moisture. They can also improve water infiltration into the soil, maintain populations of beneficial fungi, and may help control insects, diseases and nematodes. To be effective, cover crops should be treated as any other valuable crop on the farm, with their cultural requirements carefully considered including susceptibility, tolerance, or antagonism to root pathogens and other pests; life cycle; and mowing/incorporation methods. See Table 3.1 for more information on specific non-leguminous cover crops.

Table 3.1. Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits

Species	Planting Dates	Life Cycle	Cold Hardiness Zone	Heat	Drought	Shade	pH Preference	Soil Type Preference	Seeding (lb/A)	Comments
				--Tolerances--						
Brassicas e.g. mustards, rapeseed	April or late August-early Sept.	Annual / Biennial	6-8	4	6	NI	5.3-6.8	Loam to clay	5-12	+Good dual purpose cover & forage +Establishes quickly in cool weather +Biofumigant properties
Buckwheat	Late spring-summer	Summer annual	NFT	7-8	4	6	5.0-7.0	Most	35-134	+Rapid grower (warm season) +Good catch or smother crop +Good short-term soil improver for poor soils
Cereal Rye	August-early October	Winter annual	3	6	8	7	5.0-7.0	Sandy to clay loams	60-200	+Most cold-tolerant cover crop +Excellent allelopathic weed control

Table 3.1. Non-leguminous Cover Crops: Cultural Requirements and Crop Benefits										
SPECIES	PLANTING DATES	LIFE CYCLE	COLD HARDINESS ZONE	HEAT	DROUGHT	SHADE	pH PREFERENCE	SOIL TYPE PREFERENCE	SEEDING (LB/A)	COMMENTS
				--TOLERANCES--						
										+Good catch crop +Rapid germination & growth +Temporary N tie-up when turned under
Fine Fescues	Mid March-Mid May OR late Aug.- late Sept.	Long-lived perennial	4	3-5	7-9	7-8	5.3-7.5 (red) 5.0-6.0 (hard)	Most	16-100	+Very good low-maintenance permanent cover, especially in infertile, acid, droughty &/or shady sites
Oats	Mid Sept-early October	Summer annual	8	4	4	4	5.0-6.5	Silt & clay loams	110	+Rapid growth +Ideal quick cover and nurse crop
Ryegrasses	August-early Sept.	Winter annual (AR)/ Short-lived perennial (PR)	6 (AR) 4 (PR)	4	3	7 (AR) 5 (PR)	6.0-7.0	Most	14-35	+Temporary N tie-up when turned under +Rapid growth +Good catch crop +Heavy N & moisture users
Sorghum-Sudangrass	Late Spring-Summer	Summer Annual	NFT	9	8	NI	Near neutral	NI	10-36	+Tremendous biomass producers in hot weather +Good catch or smother crop +Biofumigant properties

NI-No Information, NFT-No Frost Tolerance. Drought, Heat, Shade Tolerance Ratings: 1-2=low, 3-5=moderate, 6-8=high, 9-10=very high. AR=Annual Rye, PR=Perennial Rye. Reprinted with permission from M. Sarrantonio. 1994. Northeast Cover Crop Handbook.

A certified organic farmer is required to plant certified organic cover crop seed. If, after contacting at least three suppliers, organic seed is not available, then the certifier may allow conventional seed to be used. Suppliers should provide a purity test for cover crop seed. Always inspect the seed for contamination with weed seeds and return if it is not clean. Cover crop seed is a common route for introduction of new weed species onto farms.

3.1 Goals and Timing for Cover Crops

Cover crops play an important role in a vineyard, especially during the years prior to planting through improvement of soil organic matter, breaking up of compaction layers, erosion control and suppression or elimination of weeds. Cover crops can also be used to manage vine vigor in established vineyards. Goals should be established for choosing a cover crop; for example, the crop can add nitrogen, smother weeds, or increase equipment mobility. The cover crop might best achieve some of these goals if it is in place for an entire growing season prior to vineyard establishment.

Cover crops planted in late summer will suppress annual weed growth, improve soil texture, provide organic matter, and may increase soil nitrogen. The cover crop can be incorporated in late fall or in the spring before planting. Certain cover crops (marigold, sudangrass) will either suppress or resist nematode populations. These should be considered where fumigation is not an option. See Tables 3.1 and 3.2. In addition to producing large amounts of biomass that out-compete other plant species, some cover crops (annual rye, ryegrass) can inhibit weed growth through allelopathy, the chemical inhibition of one plant species by another. Rye provides allelopathic suppression of weeds when used as a cover crop, and when crop residues are retained as mulch. Rye residues retained on the soil surface release chemicals that inhibit germination and seedling growth of many grass and broadleaf weed species. Retention of residue on the soil surface can be accomplished by mowing after seed head formation.

Table 3.2. Suitable cover crops to grow the year before planting grapes

Cover crop	Last day to plant	Seeding rate (lb/a)
Winter Rye	October 1	80-100
Oats*	September 15	60-100
Wheat	September 15	80-100
Vetch	September 1	30-40
Ryegrass	August 15	15
Barley*	August 15	75-100
Sweet Clover	August 15	20
Red clover	August 15	10-20
Buckwheat*	August 1	75
Marigold*	July 1	5-10
Sudangrass*	July 1	50-90

* Will winter-kill.

Use of cover crops in the row middles after vineyard establishment can have both beneficial and detrimental impacts so the choice of cover crop should be carefully considered. Care should be taken in the selection of a cover crop in established vineyards to minimize the competition for water and nutrients during the critical 30-day post bloom period. In a four-year study in Western New York, mowing an orchardgrass sod several times during the growing season only slightly reduced the competition from the cover crop, as compared with an unmown sod.

See Cornell's online decision tool to match goals, season, and cover crop. Although written for vegetable growers it has comprehensive information on various cover crops. Another resource for determining the best cover crop for your situation is *Northeast Cover Crop Handbook*, by Marianne Sarrantonio.

Allowing cover crop residue to remain on the soil surface might make it easier to fit into a crop rotation and will help to conserve soil water. Keep in mind that some of the nitrogen contained in the residue will be lost to the atmosphere, and total organic matter added to the soil will be reduced. Turning under the cover crop will speed up decomposition and nitrogen release from the crop residue.

3.2 Legumes

There has been little research done with legume cover crops in Northeastern United States vineyards. Legumes are looked to as a potential nitrogen source, but work at the Fredonia Vineyard Lab, Cornell University, found that row middle legumes competed more for water with the vines than the vines benefitted from the increased nitrogen availability. Row middles planted to either crown vetch or clover resulted in lower total yield when compared to vines where row middles were cultivated or managed using conventional herbicides. This was especially true in dry years and the effect was lessened or eliminated in wet years. A review of this work can be found in Organic Grape and Wine Production Symposium, 3rd N.J. Shaulis Symposium. Legumes such as red clover and hairy vetch will often benefit from having a nurse crop planted simultaneously, usually a small cereal grain such as wheat or rye. These nurse crops establish faster than legumes and provide soil stability and reduce weed pressure during establishment, and provide support for the newly growing legumes before winter. To receive the full nitrogen benefit from planting legumes, they need to be incorporated into the soil just as they start to bloom, which is usually in late spring. (Source: Bjorkman, T. *Cover Crops for Vegetable Growers*.

3.3 Non-legumes

Buckwheat, rye grass, permanent sod, and natural vegetation can be used as groundcover, depending on the goals that have been established for the row middles.

3.4 Mulching

While technically not a cover crop, use of straw or hay mulch in the vineyard row middles is another option for suppression of weed growth and is an excellent method of water conservation and increasing the soil organic matter. For mulch to be an effective weed management tool it must be applied at a much heavier rate than is needed if only water conservation or improving soil organic matter is desired. In two experiments conducted in Western New York, straw or hay mulch was applied at approximately 5 tons per acre per year in order to provide effective weed control. Hay mulch is typically applied using round bales, which can be rolled out between vineyard rows. Growers have developed simple implements that attach to their tractors to hold these large bales, making the job of applying the mulch much easier. Financial assistance may be available from your county's Soil and Water Conservation District office to help pay for mulch. See section 7.9 for more information on weed management. Organic mulch is typically not used under the row as it can create a more suitable environment for rodents which may feed upon and damage the vines.

4. SITE SELECTION

For organic grape production, the importance of proper site selection cannot be over-emphasized. Grapes are a perennial crop, meaning decisions made on site selection and improvement prior to planting will impact all aspects of production for years to come. Once a vineyard is planted it is very difficult to make major changes to improve soil and air drainage, or to soil tilth, pH, or nutrient status. Improving soil structure or eliminating soil compaction layers in an established vineyard rarely proves successful. Consider that an ideal vineyard soil should have three feet or more of rooting depth and be well drained and conduct needed site improvements prior to vineyard establishment.

Weather plays a critical role in vineyard site selection, as well. The macroclimate, mesoclimate and microclimate of a vineyard site play important roles in variety selection and potential profitability. Of particular importance are the length of the growing season, growing season heat accumulation, potential for spring frosts and winter minimum temperatures. More detailed information on the site selection information presented here also can be found in the Wine Grape Production Guide for Eastern North America, NRAES -145.

A web-based, interactive site selection tool, the New York Vineyard Site Evaluation System, uses specific climate information with a 3 kilometer resolution, based on 30 years of weather data, to determine the suitability of your site for different grape varieties. The map-based system integrates information on climate, topography, soils, and winter low temperatures to evaluate what areas may be suitable, marginally suitable, or unsuitable for Vinifera, Labrusca, hybrid, or cold-hardy 'Minnesota' varieties across the state.

4.1 Organic Certification Site Requirements

The National Organic Program has requirements that affect site selection. Fields must not have been treated with prohibited products for three years prior to harvest of the certified organic crop. If a certified organic grower is replanting, the mandatory 1-year crop rotation out of grapes doesn't apply because harvest is 5 years in the future. However, a 3-4 year roation has the potential to aid in breaking certain pest and disease cycles. For growers planting a new field, adequate buffer zones must exist between certified organic and conventionally grown crops to prevent drift of prohibited materials onto certified organic crops. The buffer zones must be either a barrier (diversion ditch or dense hedgerow) or an area of sufficient size. The buffer zone needed will vary depending on equipment used on adjacent non-certified land. For example, use of high-pressure spray equipment or aerial pesticide applications in adjacent fields will increase the buffer zone size. Check with your certifier for site-specific buffer requirements. Buffer zone sizes commonly range from 20 to 250 ft, depending on adjacent field practices. Buffers can include windbreaks and living barriers such as a dense hedgerow. A dense hedgerow less than 50 ft wide may offer better protection from contamination than a 50-ft-wide open buffer zone. NOFA NY standards prohibit a field's buffer zone to be planted to the same crop, with the exception of hay and pasture fields. Crops grown in the buffer zone may not be marketed as certified organic, or used for feed or bedding for certified organic livestock or dairy cattle.

4.2 Soil and Air Drainage and Soil Depth

Grapes need good internal soil drainage to grow. Wet soils restrict root growth and respiration, resulting in weak growth, reduced yields and small vine size. Coarse-textured and gravelly soils have excellent soil drainage, but heavier soils, or soils with perched water tables often need drainage tiles to remove excess water and improve internal soil drainage. Drainage tile is best installed before planting. Where possible, tile layout should be coordinated with vineyard design, so that tile lines run parallel to rows. Local soil and water conservation districts and private tiling contractors can provide technical assistance in designing a drainage plan, but keep in mind that many base their designs on annual row crops. Vineyards often require more intensive drainage than row crops, particularly in clay soils, where it may be necessary and cost-effective to run lateral tile lines every second or fourth row.

Air drainage is an important consideration in choosing a vineyard site. Cold air, like water, runs down hill, and collects in low areas, or areas where trees or hedgerows obstruct airflow. These 'frost pockets' increase the risk of both mid-winter cold injury and spring or fall frosts. Selecting a site with a gentle slope and good air drainage will reduce the risk of cold or frost injury. Good air drainage will also promote faster drying of foliage which will reduce the duration and frequency of disease infection periods. Good air drainage is essential to an organic disease management strategy.

Although grapes can be grown on a wide variety of soils, shallow soils have less water holding capacity and will limit root development, resulting in small vines with smaller crops. Rooting depth of 2.5 feet or more is considered important for adequate vine growth and cropping levels. Digging test soil pits can help you evaluate potential rooting depth and drainage issues and evaluate what measures to take to address soil management issues before planting.

4.3 Soil Testing

Knowing all you can about the soil of a potential vineyard site will allow for better management decisions prior to planting. Soil testing is recommended to provide information on pH, availability of major and minor nutrients, organic matter and cation exchange capacity. A pH of 5.5 to 6.0 is suggested for Labrusca grapes and 6.0 to 6.5 is suggested for hybrids and Vinifera varieties. See Table 6.2 for soil and tissue testing laboratories and refer to section 6, Vineyard and Nutrient Management, for more information.

5. VARIETY SELECTION

The market destination, bulk juice or wine, premium wine, or table grape is one of the primary factors when making the decision on which variety to plant no matter what management strategy is chosen. Another consideration is whether you are considering conversion of an existing vineyard planting or are planting a new vineyard. In organic grape production the variety's relative resistance or susceptibility to fungal diseases is vital because of the limited number of organic fungicides that are available for vineyard disease management, the potential negative impacts of repeatedly applying copper and sulfur, and the potential for complete crop loss if the primary diseases of grapes are not controlled. The susceptibility to black rot (see Disease Management, section 7.6) should be one of the major considerations when choosing a variety to grow organically.

Varieties vary widely in their susceptibility to fungal diseases and in their sensitivity to sulfur and copper fungicides that are used to control the disease. Table 7.1, *Relative disease susceptibility and sensitivity to sulfur and copper among grape varieties*, lists the relative disease susceptibility of many of the grape varieties grown in the Northeast. It is generally understood that Concord and Niagara (American or Labrusca varieties) are susceptible to a much smaller complex of diseases than are most Vinifera varieties. Even when powdery mildew is actively growing on Labrusca varieties, the fruit are often more resistant and the leaves are tolerant to the effects of the disease. Hybrid grapes, on the other hand, were often developed to combine disease resistance with good wine quality. They descend from a large number of native American species hybridized with Vinifera grapes, and their disease resistance varies greatly from variety to variety and from disease to disease. Since Labrusca grapes co-evolved with many of the diseases of importance in the Northeast, it should be no surprise that the fungicide programs for Labrusca and hybrid varieties are generally less intensive than those required for Vinifera varieties. Because copper and sulfur are key fungicides in an organic disease management program, prior to choosing a variety, know its sensitivity to injury from either one.

Varieties which have the best potential for organic production across New York State, based primarily on resistance to black rot, bunch rot, and low sensitivity to copper, include:

Labrusca Grapes
- Concord

Hybrid Grapes
- Cayuga White
- Corot noir
- Noiret
- Traminette

Vinifera Grapes
- None

Table Grapes
- None

This is not an inclusive list and does not represent all varieties that are, or have been grown organically in New York State. Ratings for best potential for organic production are based primarily on resistance to black rot, bunch rot and low sensitivity to copper. However, if other varieties are considered, the importance of site, canopy management, sanitation and the selection of proper fungicides and application procedures will increase in accordance to the variety's susceptibility to the complex of diseases. Organic grape growing is challenging in the Northeast climate, and the presence of disease may reduce the maximal level of winter hardiness and could lead to increased bud and/or vine mortality due to winter injury. An excellent resource on the factors involved in cold hardiness and winter injury, as well as the management practices to reduce the risk of winter injury, can be found in Winter Injury to Grapevines and Methods of Protection, Michigan State University Bulletin E2930.

Researchers at Cornell University are developing new hybrid varieties with highly elevated levels of resistance to powdery mildew, downy mildew and black rot. Testing is taking place under "no-spray" conditions, and new breeding program selections are now being sent to cooperating researchers to confirm observations of disease resistance in additional locations. These new selections show great promise in expanding the spectrum of quality varieties that may be more suitable for organic production methods. Information on the process of creating these new selections as well as complete information on grape varieties for cool climates can be found at the Cornell-Geneva Grapevine Breeding and Genetics Program website

Growers must also consider where they obtain their planting stock. According to USDA-NOP regulation §205.202, "the producer must use organically grown seeds, annual seedlings, and planting stock. The producer may use untreated nonorganic seeds and planting stock when equivalent organic varieties are not commercially available, except that organic seed must be used for the production of edible sprouts. Seed and planting stock treated with substances that appear on the National List may be used when an organically produced or untreated variety is not commercially available. Non-organically produced annual seedlings may be used when a temporary variance has been established due to damage caused by unavoidable business interruption, such as fire, flood, or frost. Planting stock used to produce a perennial crop may be sold as organically produced planting stock after it has been maintained under a system of organic management for at least 1 year. Seeds, annual seedlings, and planting stock treated with prohibited substances may be used to produce an organic crop when the application of the substance is a requirement of Federal or State phytosanitary regulations." With the limited availability of organically certified vines, growers will likely be able justify the use of non-organic sources to their certifying agency.

6. VINEYARD NUTRIENT MANAGEMENT

To produce a healthy crop, soluble nutrients must be available from the soil in amounts that meet the minimum requirements for the whole plant. The challenge in organic systems is balancing soil fertility to supply required plant nutrients at a time and at sufficient levels to support healthy plant growth. Restrictions in any one of the needed nutrients will slow growth and can reduce crop quality and yields.

Organic growers often speak of feeding the soil rather than feeding the plant. A more accurate statement is that organic growers focus their fertility program on feeding soil microorganisms rather than the plant. Soil microbes decompose organic matter to release nutrients and convert organic matter to more stable forms such as humus. This breakdown of soil organic matter occurs throughout the growing season, depending on soil temperatures, water availability and soil quality. The released nutrients are then held on soil particles or humus making them available to crops or cover crops for plant growth. Amending soils with compost, cover crops, or crop residues also provides a food source for soil microorganisms and when turned into the soil, starts the nutrient cycle again.

In vineyards, the key considerations when managing vine nutrition organically include filling the trellis without promoting excess vine vigor, meeting crop demand, managing soil pH to optimize the potassium and magnesium balance, understanding carbon to nitrogen ratios in compost, and selecting appropriate rootstocks.

6.1 Fertility—Vine Size, Vigor, and Demand

In vineyards, the goal is to optimize resource use efficiency (land, water, nutrients) to maximize light interception and minimize internal canopy shading. Weak vines with undersized canopies will intercept insufficient available sunlight to ripen the fruit in the current season or to develop buds for the next season. Conversely, over-stimulated vines with excessively large canopies have low water use efficiency and shade the fruit zone, leading to lower fruit quality. Canopy size is strongly influenced by soil water and nutrient availability and the ability of the vine root system to take up water and nutrients. Therefore, organic vineyards should strive to balance soil nutrient availability—organic matter content, cation exchange capacity, soil pH, and microbial activity—with vine canopy growth and vineyard goals. Grapevine rootstocks differ in their ability to take up water and nutrients and can be used in an organic management program to help achieve desired vine canopy growth, see section 6.5 for information on rootstocks.

Research has indicated that the fertilization needs of grapes, can vary greatly depending on whether you are growing Labrusca grapes for juice, hybrids for the bulk wine market, or Vinifera for the premium wine market. Vine nutrient demand is greatest during green shoot and fruit development from about two weeks pre-bloom until veraison. Overall vine size (vegetative growth) and fruit yield are the deciding factors in the need for nutrients during the growing season. Juice and bulk wine vineyards tend to be cropped at a higher level and therefore tend to have a higher nutrient demand than lower cropped premium wine grape vineyards.

The primary challenge in organic systems is synchronizing nutrient release from organic sources, particularly nitrogen, with crop requirements. In cool soils, microorganisms are less active, and nutrient release may be too slow to meet the crop needs. Once the soil warms, nutrient release may exceed crop needs. In a long-term organic nutrient management approach, most of the required crop nutrients would be in place as organic matter before the growing season starts. Nutrients needed by the crop in the early season can be supplemented by highly soluble organic amendments such as poultry manure composts or organically approved bagged fertilizer products (e.g. Chilean nitrate). These products can be expensive, so are most efficiently used if banded. Be sure to review National Organic Program rules that govern use of Chilean nitrate and confirm the practice with your organic certifier prior to field application.

Table 6.1. Annual Nutrient Demand of High-Yielding Concord Vines			
Nutrient	Annual Nutrient Demand (lbs/Acre)	Nutrient Carryover in Vines (lbs/Acre)	Annual Soil Nutrient Demand (lbs/Acre)
N (nitrogen)	160.1	106.7	53.4
K (potassium)	117.8	67.6	50.2
Ca (calcium)	118.2	75.7	42.5
P (phosphorus)	17.9	11.1	6.8
Mg (magnesium)	17.1	11.4	5.7
S (sulfur)	12.8	8.7	4.1
Na (sodium)	4.2	2.6	1.6
Al (aluminum)	3.9	2.4	1.5
Fe (iron)	4.0	2.5	1.5
Mn (manganese)	3.7	2.4	1.3
Zn (zinc)	1.5	1.2	0.3
B (boron)	0.2	0.1	0.1
Cu (copper)	0.2	0.1	0.1

6.2 Managing Fertility

Regular soil testing and petiole testing will help monitor nutrient levels. Choose a reputable nutrient testing lab (see Table 6.2) and use it consistently to avoid discrepancies caused by different extraction methods. It is recommended that regular petiole testing be incorporated into a fertility management program with soil testing to assist in determining the vines' nutrient status and to make sure that what is in the soil is making it into the vines in the proper amounts. It is recommended that soil and petiole tests be completed in each block a minimum of every three years. Petiole testing is especially crucial in getting the information needed to make management decisions in problem areas of the vineyard and should be used on a more frequent basis, if needed.

Table 6.2. Nutrient Testing Laboratories					
Testing Laboratory	Web URL	Soil	Petiole	Compost/ Manure	Forage
Agro One	http://www.dairyone.com/AgroOne/default.htm	x	x	x	x
Agri Analysis, Inc.	http://www.agrianalysis.com/		x	x	
A&L Eastern Agricultural Laboratories, Inc.	http://www.al-labs-eastern.com/	x	x	x	
Penn State Agricultural Analytical Services Lab.	http://www.aasl.psu.edu/DefaultA.htm	x	x	x	
University of Massachusetts	http://www.umass.edu/plsoils/soiltest/	x	x	x	
University of Maine	http://anlab.umesci.maine.edu/	x	x	x	x

Maintaining a soil pH of 5.5 to 6.0 is suggested for Labrusca grapes and 6.0 to 6.5 is suggested for hybrids and Vinifera varieties to maximize the availability of nutrients. It is important to have the soil pH between 5.5 and 6.5 to balance potassium (K) and magnesium (Mg) availability with crop demand. Below 5.5, there is aluminum toxicity, cation imbalance, and lower biological activity (lower N release). Above 6.5, excessive calcium and Mg can inhibit K uptake and lead to K deficiency. However, this situation is more evident in high producing vineyards because of the high K demand by the fruit. This should be true for most grape varieties but is usually only documented in Concord because economics push for high yields. There is usually a conservative range of ideal pH between 5.8-6.2 for vineyard soils.

Table 6.3 gives the target values for soil, bloom petiole, and veraison petiole analysis results for grape production in the Northeast. Regular soil testing helps monitor nutrient levels, in particular phosphorus (P) and potassium (K). The source of these nutrients depends on soil type and historic soil management. Some soils are naturally high in P and K, or have a history of manure applications that have resulted in elevated levels. As described above, additional plant available nutrients are supplied by decomposed soil organic matter or through specific soluble nutrient amendments applied during the growing season in organically managed systems. Many types of organic fertilizers are available to supplement the nutrients supplied by the soil. ALWAYS check with your certifier before using any product to be sure it is approved.

Table 6.3. Sufficiency ranges for nutrient concentrations in vineyard soil and petiole analyses

		Target values (ppm, unless otherwise noted)		
Nutrient	**Symbol**	**Soil Nutrients**	**Bloom Petiole**	**Late-Summer Petiole[1]**
Total Nitrogen	N	— [a]	1.2-2.2%	0.8-1.2%
Phosphorus	P	20-50	0.17-0.30%	0.14-0.30%
Potassium	K	75-100	1.5-2.5%	1.2-2.0%
Calcium	Ca	500-2,000 [b]	1.0-3.0%	1.0-2.0%
Magnesium	Mg	100-250	0.3-0.5%	0.35-0.75%
Boron	B	0.3-2.0	25-50	25-50
Iron	Fe	20	30-100	30-100
Manganese	Mn	20	25-,000	100-1,500
Copper	Cu	0.5	5-15	5-15
Zinc	Zn	2	30-60	30-60
Molybdenum	Mo	— [c]	0.5	0.5
Aluminum	Al	< 100 [b]		
Organic Matter		3-5%		
pH for Labrusca		5.5		
pH for hybrids		6.0		
pH for Vinifera		6.5		

Adapted from: Bates and Wolf (2008) Vineyard Nutrient Management. In: Wine Grape Production Guide for Eastern North America. T. Wolf (ed.). Natural Resource, Agriculture, and Engineering Service. Ithaca, NY.
Note: ppm is parts per million.
[1] (70–100 days after bloom)
[a] Soil nitrogen is not normally evaluated for vineyards in eastern North America.
[b] Calcium level is normally adequate when pH is in the proper range for the grape variety. The same is true for aluminum.
[c] Adequacy of soil molybdenum for grapevines is uncertain.

The carbon to nitrogen (C/N) ratio in compost can provide a guide for nitrogen release into the soil solution. When a decomposing material has a low C/N ratio (a lot of nitrogen) microbes release the excess nitrogen into the soil solution. When a decomposing material has a high C/N ratio (very little nitrogen) microbes will immobilize nitrogen through assimilation until the decomposition process lowers the C/N ratio. Immobilization of nitrogen for high C/N ratio organic matter decomposition can lead to vine nitrogen deficiency. The rule of thumb is that if the C/N ratio is lower than 20 or the material's nitrogen content is above 2.5%, nitrogen will be released. If the C/N ratio is above 20, nitrogen will be immobilized until sufficient decomposition has taken place.

Develop a plan for estimating the amount of nutrients that will be released from soil organic matter, cover crops, compost, and manure. A strategy for doing this is outlined in section 6.3. Submit soil samples for a Cornell Soil Health Test. This test includes an estimate of nitrogen mineralization rate, which indicates the potential release of N from soil organic matter. Test results will provide feedback on how the soil sample compares to other New York soils. The results can also be useful for monitoring changes in nitrogen mineralization rate over time and the transition to organic production.

6.3 Preparing an Organic Nitrogen Budget

Management of N, and insuring adequate supply at the times of crop need, requires some planning. Prepare an Organic Nitrogen Budget to estimate the amount of N released by various organic amendments as well as native soil organic matter. Compost and manure should be tested for nutrient content at an analytical lab, and cover crops can be tested at a forage testing lab (Table 6.2). Knowing these values will help evaluate if the budget plan is providing appropriate amounts of N during the season. Examples of manures and their nutrient content are shown in Table 6.4.

Using the values from your soil test, estimate that 20 lbs. of nitrogen will be released from each percent organic matter in the soil. From the test of total N in any manure applied, estimate that 50% is available in the first year, and then 50% of the remaining is released in each of the next two years. So, for an application rate of 100 lbs. of N as manure, in year one 50 lbs. would be available, 25 lbs. in year 2, and 12.5 lbs. in year 3. Remember to check with your certifier on the days-to-harvest interval when using raw manure and allow a minimum of 120 days between application and harvesting. To prevent run-off, do not apply raw manure to bare ground in established vineyards.

Table 6.4. Estimated Nutrient Content of Common Animal Manures							
	N	P_2O_5	K_2O	N1[1]	N2[2]	P_2O_5	K_2O
	NUTRIENT CONTENT LB/TON			*AVAILABLE NUTRIENTS LB/TON IN FIRST SEASON*			
Dairy (with bedding)	9	4	10	6	2	3	9
Horse (with bedding)	14	4	14	6	3	3	13
Poultry (with litter)	56	45	34	45	16	36	31
Compost (from dairy manure)	12	12	26	3	2	10	23
Composted poultry manure	17	39	23	6	5	31	21
Pelleted poultry manure[3]	80	104	48	40	40	83	43
Swine (no bedding)	10	9	8	8	3	7	7
	NUTRIENT CONTENT LB/1000 GAL.			*AVAILABLE NUTRIENTS LB/1000 GAL FIRST SEASON*			
Swine finishing (liquid)	50	55	25	25*	20+	44	23
Dairy (liquid)	28	13	25	14*	11+	10	23

1-N1 is the total N available for plant uptake when manure is incorporated within 12 hours of application,
2-N2 is the total N available for plant uptake when manure is incorporated after 7 days.
3 –Pelletized poultry manure compost. Available in New York from Kreher's.
* injected, + incorporated.
Adapted from *"Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops"* by Carl Rosen and Peter Bierman and Penn State Agronomy Guide 2007-8.

Estimate that between 10% and 25% of the N contained in compost will be available the first year. It is important to test each new mix of compost for actual amounts of the different nutrients available. Compost maturity will influence how much N is available. If the material is immature, more of the N may be available to the crop in the first year. A word of caution: Using compost to provide for a crop's nutrient needs is not generally a financially viable strategy. The total volume, trucking, and application can be very expensive for the units of N available to the crop. Most stable composts should be considered as soil conditioners, improving soil health, microbial diversity, tilth, and nutrient retaining capacity. Also keep in mind that manure-based composts are potentially high in salts that could become a problem if used yearly. When compost is submitted for testing request a measure of electrical conductivity. This will provide the level of salts present in the finished product.

Add together the various N values from these different organic sources to estimate the N supplying potential of the soil. There is no guarantee that these amounts will actually be available in the season, since soil temperatures, water, and crop physiology all impact the release and uptake of these soil nutrients. If early in the organic transition, a grower may consider increasing the N budget supply by 25%, to help reduce some of the risk of N being limiting to the crop. Remember that with a long-term approach to organic soil fertility, the N mineralization rates of the soil will increase. This means that more N will be available from organic amendments because of increased soil microbial activity and diversity. Feeding these organisms different types of organic matter is essential to helping build this type of diverse biological community and ensuring long-term organic soil and crop productivity.

Additional information on the use of animal manures and organic amendments can be found in the Organic Grape and Wine Production Symposium, 3rd N.J. Shaulis Symposium. For varieties used for juice and bulk wine production, a nitrogen requirements and costs worksheet is available for use in conjunction with soil test results to determine nitrogen needs. This worksheet is just one portion of an integrated assessment that includes visual inspection of the vines for trellis fill, leaf size and pruning weight as well as the results of bloom time petiole sampling.

6.4 Organic Fertilizers

Tables 6.5, 6.6, and 6.7 list some commonly available fertilizers, their nutrient content, and the amount needed to provide different amounts of available nutrients, Adapted by Vern Grubinger from the University of Maine soil testing lab.

Table 6.5. Available Nitrogen in Organic Fertilizers					
	Pounds of Fertilizer/Acre to Provide X Pounds of N per Acre				
Sources	**20**	**40**	**60**	**80**	**100**
Blood meal 13% N	150	310	460	620	770
Soy meal 6% N (x 1.5)*, also contains 2% P and 3% K_2O	500	1000	1500	2000	2500
Fish meal 9% N, also contains 6% P_2O_5	220	440	670	890	1100
Alfalfa meal 2.5% N also contains 2% P and 2% K_2O	800	1600	2400	3200	4000
Feather meal 15% N (x 1.5)*	200	400	600	800	1000
Chilean nitrate 16% N cannot exceed 20% of crop's need.	125	250	375	500	625

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates.

Table 6.6. Available Phosphorous in Organic Fertilizers					
	Pounds of Fertilizer/Acre to Provide X Pounds of P_2O_5 Per Acre				
Sources	**20**	**40**	**60**	**80**	**100**
Bonemeal 15% P_2O_5	130	270	400	530	670
Rock Phosphate 30% total P_2O_5 (x4)*	270	530	800	1100	1300
Fish meal 6% P_2O_5 (also contains 9% N)	330	670	1000	1330	1670

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Should be broadcast and incorporated prior to planting.

Table 6.7. Available Potassium in Organic Fertilizers					
	Pounds of Fertilizer/Acre to Provide X Pounds of K_2O per acre:				
Sources	**20**	**40**	**60**	**80**	**100**
Sul-Po-Mag 22% K_2O also contains 11% Mg	90	180	270	360	450
Wood ash (dry, fine, grey) 5% K_2O, also raises pH	400	800	1200	1600	2000
Alfalfa meal 2% K_2O, also contains 2.5% N and 2% P	1000	2000	3000	4000	5000
Greensand or Granite dust 1% K_2O (x 4)*	8000	16000	24000	32000	40000
Potassium sulfate 50% K_2O	40	80	120	160	200

* Application rates for some materials are multiplied to adjust for their slow to very slow release rates. Should be broadcast and incorporated prior to planting.

6.5 Rootstocks

Rootstocks have great potential utility in organic grape production. Most commercial rootstocks have some degree of phylloxera resistance. However, they also have different nutrient uptake profiles and impart different vigor to the vine. Selecting the right rootstock for your soil environment and vineyard goals could nearly eliminate the need for supplemental fertilizers. Vigorous rootstocks can also reduce the need for minimizing weed competition in the vineyard. See section 7.9, Weed Management, for additional information. It is important to note that rootstocks should not be viewed as a cure for a poor site but rather as a tool for further improving vineyard practices such as water, weed, and nutrition management.

Table 6.8 Rootstocks Commonly Used in New York and Their Characteristics

	Influence on Scion			Tolerance		
Rootstock[1]	**Scion Vigor**	**Mineral Nutrition[2]**	**Soil Adaptation**	**Drought**	**Wet Soil**	**Lime**
Riparia Gloire	Low-med	N, P: Low K, Mg: Low-med	Med to deep or well drained	Low	Low	Low
SO4	Med-high	N: Low-med P: Med K: Med-high Mg: Med	Moist clay soils	Low-med	Med-high	Med
5BB	Med-high	N: Med-high P, K: Med Mg: Med-high	Shallow dry to deep or well drained	Med	Low	Med-high
420A	Low	N, P, K: Low Mg: Med	Med to deep or well drained	Med	Low-med	Med-high
101-14	Med	N, K: Med-high P, Mg: Low	Shallow moist to deep or well drained	Low-med	Med	Low-med
3309	Low-med	N: Med-high P: Low K, Mg: Med	Shallow dry to deep or well drained	Low-med	Low-med	Low-med

1 The rootstocks listed are highly resistant to phylloxera.
2 Influence on scion mineral nutrition refers to comparative petiole tissue levels of nutritional elements.
Adapted from *"Wine Grape Varieties in California"* by Peter Christensen et al. and *ASEV Rootstock Seminar: A Worldwide Perspective*. (1992). J. Wolpert, M. Ealker and E. Weber.

7. ORGANIC VINEYARD IPM

Organic production of grapes is challenging in New York State given the abundant rainfall during the growing season leading to increased pressure from diseases. However, growers in New York and the eastern United States, through proper variety and site selection, strict attention to canopy management and sanitation, and increased attention paid to scouting vineyards on a weekly basis to catch pest outbreaks early, have succeeded in producing quality organic grapes. In contrast, a failure to appreciate the risk of disease development, and to devise and implement a season-long (and multiyear) management strategy, can lead to serious crop and even vine losses in particular years. Successful disease management is essential to the sustainable production of organic grapes.

7.1 Developing a Vineyard IPM Strategy

1. Examine your vineyard operation closely. Break it down into specific vineyards, or "vineyard blocks."
2. Produce a map of each vineyard (or vineyard block) to record pest outbreaks, nutrient deficiencies, drainage problems, missing vines, and any other abnormalities you find.
3. Develop a record-keeping system for each vineyard or vineyard block.
4. Develop a scouting plan for each vineyard block and record results.
5. Monitor and record weather factors and understand basic weather patterns of the area.
6. Keep accurate records of spray applications, tools, or tactics used to manage pests.
7. Properly maintain your spray equipment, calibrate the sprayer at the beginning of every season at a minimum, select appropriate nozzles, and reduce spray drift. Consult the Pesticide Application Technology website at Cornell University: http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp/
8. Develop a thorough knowledge of the vineyard pests you are likely to encounter during the year. This includes basic pest biology, symptoms or damage, whether they are a primary or secondary pest, scouting thresholds, and the best time to apply management practices.
9. Choose a pest management strategy for the vineyard (or vineyard block) that is based on all of the information you've gathered. Use the options that make the most sense for your operation.
10. Continue your pest management education.

Other resources available online, include:
New York State grape IPM website: http://lergp.cce.cornell.edu/IPM/Home.htm
Grape IPM in the Northeast: http://www.nysipm. cornell.edu/publications/grapeman/
New York State grape IPM insect and disease fact sheet index: http://www.nysipm.cornell.edu/ factsheets/grapes/
Cornell University Pesticide Management Education Program: http://pmep.cce.cornell.edu/
Pesticide Application Technology at Cornell University: http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp/
Elements of IPM for Grapes in New York State http://nysipm.cornell.edu/elements/grapes.asp
Network for Environment and Weather Applications (NEWA) http://newa.nysaes.cornell.edu
VineBalance, New York State's Sustainable Viticulture Program http://www.vinebalance.com/

7.2 Pesticides Labeled for use in Organic Grape Production

At the time the guide was released, the pesticides listed in this guide were allowable for organic production under the National Organic Program Rule and registered for use in New York. The authors relied mainly on the Organic Materials Review Institute OMRI list for pesticides to include. Always check with your certifier before using any new product.

Given the high cost of many products and the limited efficacy data available for many products, the importance of developing an integrated approach based on cultural practices for disease and insect management cannot be emphasized strongly enough. **Pesticides should not be relied on as a primary method of pest control**. Scouting, forecasting, or trapping pests are important for detecting infestations at an early stage. When conditions do warrant an application, proper choice of materials, proper timing, and excellent spray coverage are essential. Thresholds developed using conventional pesticides are often ineffective when using organic approved pesticides, which are often less effective than synthetic pesticides.

7.3 Pesticide Regulatory Considerations

Organic production focuses on cultural, biological, and mechanical techniques to manage pests on the farm, but in some cases organically approved pesticides, which include repellents, are a necessary option. Pesticides mentioned in this organic production guide must be registered and labeled at the federal level for use, like any other pesticide, by the Environmental Protection Agency (EPA), or meet the EPA requirements for a "minimum risk" pesticide, which are exempt from normal registration requirements as described in FIFRA regulation 40 CFR Part 152.25(b).

"Minimum risk" pesticides, also referred to as 25(b) pesticides, must meet specific criteria to achieve the "minimum risk" designation. The active ingredients of a minimum-risk pesticide must be on the list of exempted active ingredients found in the federal regulations (40 CFR 152.25). Minimum-risk pesticides must also contain inert ingredients listed on the most current List 4A published in the Federal Register.

In addition to meeting the active and inert ingredient requirements above, a minimum-risk pesticide must also meet the following:

- Each product must bear a label identifying the name and percentage (by weight) of each active ingredient and the name of each inert ingredient.
- The product must not bear claims to either control or mitigate microorganisms that pose a threat to human health, including, but not limited to, disease-transmitting bacteria or viruses, or claim to control insects or rodents carrying specific diseases, including, but not limited to, ticks that carry Lyme disease.
- The product must not include any false or misleading labeling statements.

Besides registration with the EPA, pesticides sold and/or used in New York State must also be registered with the New York State Department of Environmental Conservation (NYS DEC). However, pesticides meeting the EPA "minimum risk" criteria described above do not require registration with the NYS DEC.

To maintain organic certification, products applied must also comply with the National Organic Program (NOP) regulations as set forth in 7 CFR Part 205, sections 600-606. The Organic Materials Review Institute (OMRI) is one organization that reviews and publishes products they find compliant with the NOP regulations, but other entities also make product assessments. Organic growers are not required to use only OMRI listed materials, but the list is a good starting point when searching for potential pesticides.

Finally, each farm must be certified by an accredited certifier who must approve any material applied for pest management. ALWAYS check with the certifier before applying any pest control products.

Some organic certifiers may allow "home remedies" to be used to manage pests. These materials are not labeled as pesticides, but may have properties that reduce the impact of pests on production. Examples of home remedies include the use of beer as bait to reduce slug damage in strawberries or dish detergent to reduce aphids on plants. Home remedies are not mentioned in these guides, but in some cases, may be allowed by organic certifying agencies. Maintaining good communication with your certifying agent cannot be overemphasized in order to operate within the organic rules.

7.4 Optimizing Pesticide Effectiveness

Information on the effectiveness of a particular pesticide against a given pest can sometimes be difficult to find. Some university researchers include pesticides approved for organic production in their trials; some manufacturers provide trial results on their web sites; some farmers have conducted trials on their own. Efficacy ratings for pesticides listed in this guide were summarized from university trials and are only provided for some products.

In general, pesticides allowed for organic production may kill a smaller percentage of the pest population, could have a shorter residual, and may be quickly broken down in the environment. Read the pesticide label carefully to determine if water pH or hardness will negatively impact the pesticide's effectiveness. Use of a surfactant may improve organic pesticide performance. OMRI lists adjuvants in OMRI Products List, Web Edition – Crop Products, http://www.omri.org/crops_category.pdf. Regular scouting and accurate pest identification are essential for effective pest management. Thresholds used for conventional production may not be useful for organic systems because of the typically lower percent mortality and shorter residual of pesticides allowed for organic production. When pesticides are needed, it is important to target the most vulnerable stages of the pest. Thoroughly cover plant surfaces, especially in the case of insecticides, since many must be ingested to be effective. The use of pheromone traps or other monitoring or prediction techniques can provide an early warning for pest problems, and help effectively focus scouting efforts.

7.5 Disease Management

Managing Diseases Organically—The Basics

An organic disease management strategy must recognize the limitations of organic spray products. Although some of these may play a significant role in the management of certain specific diseases, organic pesticides should be viewed as secondary supplements to a primary disease management program founded on four basic pillars: (1) site selection; (2) variety selection; (3) canopy management; and (4) sanitation. When these cultural tools are not implemented effectively, an organic grower cannot compensate for the omission by simply applying sprays, as growers with access to highly effective "conventional" fungicides often can. Indeed, these four basic tools are the only effective means of managing several of our common and important diseases.

• ***Site selection***. Most disease-causing fungi thrive in damp environments, and require a film of water for their spores to germinate and infect the grapevine. In general, the longer that leaves and fruit remain wet after a rain or dew, and the more humid that it is at other times, the more severe that disease will be. Therefore, disease pressure is reduced significantly at sites where air is allowed to move freely and prevailing breezes blow through the vines to dry them; conversely, pressure is significantly increased at sites where air movement is impeded.

In addition to suffering restricted air movement, sites adjacent to woodlots are also at risk for certain diseases and insects that attack wild grapes that live in these locations. Such locations act as "reservoirs" for these pests, which can then move into the vineyard and damage the vines and crop. To the extent possible, it is useful to avoid or at least minimize situating new vineyards directly next to wood lots.

• ***Variety selection***. There are many reasons to choose specific varieties to plant in addition to their disease susceptibility. For example, businesses that wish to produce wines from Vinifera varieties, or growers who seek to supply them, may decide to plant these varieties despite the fact that all of them are highly susceptible to most fungal diseases. However, where flexibility of variety choice is an option, it is often extremely useful for an organic grower to include disease susceptibility as a major factor in choosing the variety or varieties to plant. For example, black rot is often considered the "Achilles heel" of organic grape production in the eastern half of North America, yet there is a wide range of susceptibilities to this disease among hybrid and Labrusca grape varieties. Over the course of multiple seasons, a grower with a variety that is only slightly susceptible (moderately resistant) to this disease will have a much easier time, and be far less likely to sustain losses in challenging years, than will a grower with a highly susceptible variety.

Similarly, it should be recognized that copper and sulfur are key fungicides in an organic program (sulfur primarily for good control of powdery mildew, copper for good control of downy mildew and modest control of other diseases). However, some Labrusca and hybrid varieties are injured by one or both of these materials. In addition to recognizing relative disease susceptibility, it is very useful to also recognize a variety's sensitivity to sulfur and copper before choosing it for an organic production system. For example, cv. Chancellor—highly susceptible to both powdery and downy mildew, plus injured by both copper and sulfur—would not be a recommended choice for an organic producer. Table 7.1 lists relative susceptibilities to various diseases and sensitivities to copper and sulfur among most varieties grown in New York and surrounding regions.

Researchers at Cornell University are developing new hybrid varieties with highly elevated levels of resistance to powdery mildew, downy mildew and black rot. Testing is taking place under "no-spray" conditions, and new breeding program selections are now being sent to cooperating researchers to confirm observations of disease resistance in additional locations. These new selections show great promise in expanding the spectrum of quality varieties that may be more suitable for organic production methods.

• ***Canopy management***. Good air circulation through vines, to reduce humidity and speed drying, is promoted not only by the choice of a good vineyard site but also by canopy management techniques. In fact, the value of good canopy management in disease control, especially in the absence of highly effective fungicides, cannot be overstated. In addition to providing good air circulation, an open canopy structure that exposes the berries to good sunlight penetration will also allow better coverage of the berries with any sprays that are applied. Furthermore, sunlight itself helps to minimize some diseases (especially powdery mildew), in addition to improving fruit quality. Canopy management techniques can also incorporate aspects of sanitation, as discussed next.

• ***Sanitation***. Disease-causing fungi persist between seasons ("overwinter") within infected vine residue or in the perennial wood of the vine itself, depending on the particular organism and disease that it causes. The first infections of the year ("primary" infections) come from these overwintering sources, then typically spread to other parts of the vine and to neighboring vines throughout the season, as weather and management conditions permit (think in terms of an initial "deposit" in a bank, which then grows over time with interest). Therefore, any technique that reduces the level of overwintering disease-causing fungi—that is, the initial deposit—will help to reduce the amount of disease that develops during the ensuing year. The sanitation procedures—such as removal of diseased clusters, cluster stems, and wood—that will help with specific diseases are discussed, for each, below. For some diseases, such as black rot, sanitation is a critical component of disease management in an organic system.   For diseases that overwinter on or in the bark and wood of the grapevine (powdery mildew, Phomopsis; bitter rot and ripe rot; black rot, occasionally), an application of liquid lime sulfur (calcium polysulfide) near the end of dormancy may help to reduce the numbers of infectious fungal spores produced after growth begins.

Assessing Disease Risk

Disease risk should be assessed on a block-by-block basis. Just as one would not put drainage tile into all vineyards because one site held water throughout the year, so one should not assume that all blocks have the same potential for disease. Disease risk in any given year is determined by that season's weather, the grape variety, and the level of overwintering inoculum present in the vineyard. Therefore, disease risk in a given block is often indicated by the level of disease that was present prior to harvest in the previous growing season. Over time, vineyards, blocks, and varieties will be recognized as being particularly disease-prone or relatively disease-free through a range of weather conditions.

As the vine grows, its tissues become more or less susceptible to various diseases. Different growth stages, combined with the life cycle of the fungus result in changing levels of disease risk during the growing season. Management tactics should be precisely timed to correspond to these changing risk levels. Knowing when primary infections occur and factors that promote disease spread allow the matching of available fungicides to the growth stage and the disease.

Weather conditions impact the development of the grapevine, the pathogen, and the disease. Most diseases are favored by warm, moist conditions. For many, the specific conditions required for infection have been identified, allowing tracking and prediction of infection events. Consult the grape disease models for Phomopsis, black rot, powdery mildew and downy mildew on NEWA for information on infection events.

Table 7.1. Relative disease susceptibility and sensitivity to sulfur and copper among grape varieties[1]

	Disease susceptibility or chemical sensitivity[a]									
Variety	**BR**	**DM**	**PM**	**Bot**	**Phom**	**Eu**	**CG**	**ALS**	**S[c]**	**C[d]**
Aurore	+++	++b	+++	+++	++	+++	++	+++	No	++
Baco noir	+++	+	++	+++	+	++	++	++	No	?
Cabernet Franc	+++	+++	+++	+	?	?	+++	?	No	+
Cabernet Sauvignon	+++	+++	+++	+	+++	+++	+++	?	No	+
Canadice	+++	++	+	++	?	?	++	++	No	?
Cascade	+	+	++	+	++	++	+	?	No	?

Table 7.1. Relative disease susceptibility and sensitivity to sulfur and copper among grape varieties[1]

	Disease susceptibility or chemical sensitivity[a]									
Variety	**BR**	**DM**	**PM**	**Bot**	**Phom**	**Eu**	**CG**	**ALS**	**S**[c]	**C**[d]
Catawba	+++	+++	++	+	+++	+	+	+	No	++
Cayuga White	+	++	+	+	+	+	++	++	No	+
Chambourcin	++	++	+++	+	++	?	?	?	Yes	?
Chancellor	+	+++	+++	+	+++	+++	++	+++	Yes	+++
Chardonel	++	++	++	++	?	?	++	++	No	?
Chardonnay	+++	+++	+++	+++	+++	++	+++	++	No	+
Chelois	+	+	+++	+++	+++	+++	++	+++	No	+
Concord	+++	+	++	+	+++	+++	+	+	Yes	+
Corot noir (NY70.0809.10)	+	++	+	+	?	?	+	?	No	?
DeChaunac	+	++	++	+	+++	+++	++	+++	Yes	+
Delaware	++	+++b	++	+	+++	+	+	+	No	+
Dutchess	+++	++	++	+	++	+	++	+	No	?
Elvira	+	++	++	+++	+	+	+	++	No	++
Einset Seedless	+++	+++	++	+	?	?	+	?	?	?
Foch	++	+	++	+	?	+++	+	+	Yes	?
Fredonia	++	+++	++	+	++	?	+	+	No	?
Frontenac	++	+	++	+	?	?	+	?	?	?
Frontenac gris	++	+	++	+	?	?	+	?	?	?
Gewurztraminer	+++	+++	+++	+++	?	?	+++	+	No	+
GR7	+	++	++	++	+	+	+	?	No	?
Himrod	++	+	++	+	?	?	?	+	No	?
Ives	+	+++	+	+	?	++	+	+	Yes	?
La Crescent	++	++	++	+	?	?	+	?	?	?
Marquette	+	+	++	++	+	?	+	?	?	?
Marquis	+++	++	++	+	+	?	?	?	No	?
Melody	+++	++	+	+	?	?	+	+++	No	?
Merlot	++	+++	+++	++	+++	+++	+++	?	No	++
Moore’s Diamond	+++	+	+++	++	?	++	?	?	No	?
Niagara	+++	+++	++	+	+++	+	++	+	No	+
Noiret (NY73.0136.17)	+	++	+	+	?	?	++	?	No	?
Pinot blanc	+++	+++	+++	++	?	?	+++	?	No	+
Pinot gris	+++	+++	+++	+++	?	?	+++	+++	No	+
Pinot noir	+++	+++	+++	+++	?	?	+++	+	No	+
Riesling	+++	+++	+++	+++	++	++	+++	+	No	+
Rosette	++	++	+++	+	++	++	++	++	No	+++
Rougeon	++	+++	+++	++	+++	+	++	+++	Yes	+++
Sauvignon blanc	+++	+++	+++	+++	?	?	+++	?	No	+
Seyval	++	++	+++	+++	++	+	++	++	No	+
Steuben	++	+	+	+	?	?	+	++	No	?
Traminette	+	++	+	+	?	?	+	?	No	?
Valvin muscat (NY62.0122.01)	++	+	++	+	?	?	+	?	No	?
Vanessa	+++	++	++	+	+	?	+	?	?	?
Ventura	++	++	++	+	+	?	+	+++	No	?
Vidal blanc	+	++	+++	+	+	+	++	+	No	+
Vignoles	+	++	+++	+++	+++	++	++	++	No	?

Key:	+ Slightly susceptible or sensitive	++ Moderately susceptible or sensitive	+++ Highly susceptible or sensitive	No Not sensitive	? Relative susceptibility or sensitivity not established

[1]The relative ratings in this chart apply to an average growing season. Under conditions favorable for disease development, any given variety may be more severely affected.

a. BR=Black rot, DM=Downy mildew, PM=Powdery mildew, Bot=Botrytis, Phom=Phomopsis, Eu=Eutypa, CG=Crown gall, ALS=Angular Leaf Scorch, S=Sulfur, C=Copper

b. Berries only weakly susceptible

c. Slight to moderate sulfur injury may occur even on tolerant varieties when temperatures are 85F or higher during or immediately following the application

d. Copper is most likely to cause injury when applied under cool, or very humid, slow drying conditions

7.6 Diseases of Primary Concern

Several important diseases that occur in the temperate climate of the Northeastern U.S. are described below to help growers manage them with appropriate organic practices.

BLACK ROT is one of the most serious diseases of grapes in the eastern United States and has the potential to be the "Achilles heel" for organic producers. Fruit rot is the most damaging phase of the disease, but all green tissues of the vine are susceptible to infection. This disease can be especially damaging in organic production because organic-approved fungicides are largely ineffective. Therefore, strict implementation of sanitation practices and other available horticultural techniques is essential, especially on moderately to highly susceptible varieties. Black rot can cause complete crop loss in warm, wet years if it is not properly managed.

Infected leaves develop relatively small, brown circular lesions surrounded by distinct dark margins; black, pimple-like fruiting bodies ("pycnidia") are scattered within these spot-like lesions. Black, elongated lesions on petioles (leaf stems) may cause affected leaves to wilt and drop. Large, black, elliptical lesions on infected shoots may contribute to breakage by wind. The disease is most common and damaging on berries which appear chocolate brown when first infected, but soon become dark brown with numerous black, pimple-like pycnidia on the surface. Berries eventually shrivel into hard, black raisin-like mummies, most of which remain firmly attached to the berry stem. The black rot fungus overwinters primarily in these mummified fruit, either on the vineyard floor or in clusters retained within the vine. It can also overwinter within cane lesions when these develop.

Table 7.2. Hours of leaf wetness required for a black rot infection period at various temperatures following a rain

Temp (°F)	Hours[a]
50	24
55	12
60	9
65	8
70	7
75	7
80	6
85	9
90	12

Source: R. A. Spotts. 1977. The Ohio State University

[a] Hours of continual wetness from rain.

Rain triggers the release of infective spores from all sources, and infection occurs if susceptible tissues remain wet for a sufficient length of time, which depends on temperature (Table 7.2). Spores within cane lesions are available for infection starting at bud break; however, the majority of overwintering spores in most vineyards (those within mummified fruit on the ground) first become available about 2–3 weeks after bud break, reach peak levels about 1–2 weeks before bloom, and are usually depleted within one to several weeks after the start of bloom, depending on the season. However, in years with dry spring weather when only a few rains occur, the fungus does not discharge all of its spores as early as usual, and significant spore discharge may extend several weeks beyond bloom if this is when rains finally develop.

Pycnidia develop within lesions caused by current season infections and release a new crop of spores during the late spring and summer, beginning about 2–3 weeks after infection first occurs. These secondary rounds of spore release and infection are responsible for disease spread and are the cause of most economic loss when it occurs. Fruit are highly susceptible to infection for the first 2–3 weeks after bloom. They become progressively less susceptible as they continue to develop, finally becoming highly resistant about 5–8 weeks after bloom, depending on the variety and year. In general, "Concord" fruit appear to become resistant about 1–2 weeks earlier than those of Vinifera varieties. Thus, the most critical time to control berry infections is during the first few weeks after the start of bloom.

Removal of mummified clusters from the canopy during pruning significantly reduces disease pressure for the coming season; burying mummies on the ground before or soon after budbreak, by cultivation or covering them with mulch, also can contribute to a reduction of inoculum if disease was severe the previous season. **CAUTION:** When mummified fruit are not dropped to the ground during dormant pruning operations, large numbers of spores will be produced within the canopy throughout the period of berry development. Research has shown that this prolonged period of high spore production, combined with the closeness of the spores to newly-developing berries, significantly increases the pressure for berry rot. **Therefore, complete removal of mummies from the canopy is an absolutely critical component of a black rot management program for organic growers.**

All fungicides currently approved for organic production are weak against black rot, although copper has moderate efficacy if applied very regularly. Therefore, growers of organic grapes should pay strict attention to the above sanitation procedures, because they are the most important defenses against this disease, which can be the "Achilles heel" of organic grape production in eastern viticulture. Cultural practices that open the canopy also are beneficial because they promote drying and improve spray coverage. See Table 7.1 for varietal susceptibility to this disease.

IPM fact sheet on Black Rot http://nysipm.cornell.edu/factsheets/grapes/diseases/grape_br.pdf

Black Rot Management Options	
Scouting/thresholds	Severe loss is usually the result of disease spread within and among clusters after it first gets established on a few berries in the early stages of fruit development. Scout for symptoms of black rot regularly beginning 10 days to 2 weeks after cap fall. Remove diseased clusters and/or consider regular copper applications during wet weather periods on varieties where this material can be used, especially if more than a trace level of disease is found.
Slightly susceptible varieties	Cascade, Cayuga White, Chancellor, Chelois, Corot noir, DeChaunac, Elvira, GR7, Ives, Marquette, Noiret, Traminette, Vidal blanc, and Vignoles. (See Table 7.1)
Cultural management	***Sanitation***. Remove all mummies from the canopy and drop to the ground during dormant pruning operations. Around bud break, cultivate beneath the vines to bury mummies or cover them with mulch. ***Canopy management***. Prune and train the vines to promote air circulation and speed drying of the leaves and fruit. Establish new plantings away from wooded areas, where wild grapes can serve as a source of black rot spores.
Chemical treatment	Copper products on varieties not sensitive to this material.

Pesticides Labeled for Management of Black Rot					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Champ WG *(copper hydroxide)*	2-4 lbs/acre	0	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Although all copper products have not been tested, each contains essentially the same active ingredient.
Nu Cop 50 WP *(copper hydroxide)*	2 lbs/acre	0	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Although all copper products have not been tested, each contains essentially the same active ingredient.
OxiDate *(hydrogen dioxide)*	Curative: 128fl /acre Preventative: 40fl /acre	0	0	4	Due to its mode of action, Oxidate is unlikely to provide significant protective activity. When applied to diseased tissues ("curative"), it ***may*** reduce the potential for disease spread; however, this has not been tested. Apply 30-100 gallons of solution/acre.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

BOTRYTIS is a fungus that causes a bunch rot of berries and also may blight blossoms, leaves, and shoots. The bunch rot phase of the disease can cause severe economic losses, particularly on tight-clustered hybrid and Vinifera varieties. Ripe berries are susceptible to direct attack and are particularly susceptible to infection through wounds such as those caused by insects, hail, or rain cracking. Once established, infections can spread rapidly throughout the cluster during the preharvest period, causing extensive loss in yield and quality. This disease can be distinguished from other causes of bunch rot by the characteristic masses of gray “fuzzy” spores produced by the Botrytis fungus on infected plant parts, especially during humid weather.

The fungus overwinters in debris on the vineyard floor or on the vine. Old cluster stems are a particularly important source of carry-over between seasons. Spores are produced throughout the growing season, although their numbers appear to be greatest near bloom and after veraison. Production of spores and subsequent infection are greatly favored by prolonged periods of wetness or very high humidity, particularly at moderate temperatures (60–75°F).

The Botrytis fungus is most capable of attacking injured or senescing tissues; hence, infections usually occur as blossoms wither, as fruit ripens, or through wounds. Wounds caused by the grape berry moth are particularly common sites of infection. Under wet conditions, blossom parts can become infected between cap fall and bunch closing; such infections can lead to latent (dormant) infections of the young berries, which then become active as the berries begin to ripen. Although direct losses from these early infections appear to be modest, they often provide a starting point for sudden and significant disease spread within the clusters if wet weather occurs before harvest. Berries infected by powdery mildew between fruit set and bunch closing also can serve as starting points for a Botrytis epidemic; hence, good control of powdery mildew during this period is an important component of a good Botrytis management program.

In organic production, Botrytis management is best accomplished through cultural practices. In fact, even for growers who use conventional fungicides, consistent control of Botrytis requires the conscientious use of cultural management practices. Any practice that improves air circulation and thereby reduces humidity within the canopy is of significant benefit. Such practices include site selection to avoid fog pockets and heavily wooded areas; management of canopy densities through pruning, shoot positioning, and selectively removing leaves in the cluster zone immediately after fruit have set; and avoiding excessive nitrogen fertilization. Loose clusters also significantly reduce Botrytis development, and the use of clones (e.g., the ‘Mariafeld’ clones of cv. Pinot noir) or viticultural techniques that provide loose clusters can greatly aid in its control.

IPM fact sheet on Botrytis Bunch Rot and Blight http://nysipm.cornell.edu/factsheets/grapes/diseases/botrytis.pdf

Botrytis Bunch Rot Management Options	
Scouting/thresholds	Damaging levels of Botrytis are due to extensive disease spread throughout a cluster and to neighboring clusters after a few berries first become diseased. Regularly scout for the presence of Botrytis starting shortly after veraison, and consider treatment to slow spread of the disease if it is detected.
Slightly susceptible varieties	Cabernet Franc, Cabernet Sauvignon, Cascade, Catawba, Cayuga White, Chambourcin, Chancellor, Concord, Corot noir, De Chaunac, Delaware, Dutchess, Einset Seedless, Foch, Fredonia, Frontenac, Frontenac gris, Himrod, Ives, La Crescent. Marquis, Melody, Niagara, Noiret, Rosette, Steuben, Traminette, Valvin Muscat, Vanessa, Ventura, and Vidal blanc. (See Table 7.1)
Cultural management	***Sanitation***. Remove old cluster stems from the canopy and drop to the ground during dormant pruning operations. Around bud break, cultivate beneath the vines to bury infected debris or cover with mulch. ***Fruit management***. Thin clusters to promote open cluster architecture on tight-clustered varieties. Prevent grape berry moth damage. Protect against powdery mildew infections between fruit set and bunch closure.

Botrytis Bunch Rot Management Options	
Cultural management cont…	***Canopy management***. Prune and train the vines to promote air circulation, reduce humidity, and speed drying of the clusters. On highly susceptible varieties or clones, thin or remove leaves immediately surrounding the cluster zone. This technique is most beneficial if practiced early in the fruiting period, soon after berries have set. ***Vineyard management***. Orient rows to improve air movement within the vineyard. Avoid sites prone to fog or heavily wooded areas.
Chemical treatment	Organically approved pesticides have provided little control under high disease pressure conditions, but some have been beneficial under more moderate conditions. The possible times for application are bloom, bunch closure, veraison, and pre-harvest, depending on the weather and current presence of disease. Wounds caused by grape berry moth are common sites of infection, as are powdery mildew infections occurring on fruit between fruit set and bunch closure. Good management of berry moth and powdery mildew will contribute to a good Botrytis management program.

Pesticides Labeled for Management of Botrytis Bunch Rot

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until solution has dried	4	Apply in 20 to 150 gallons of water per acre.
JMS Stylet Oil *(paraffinic oil)*	1-2gal/ 100gal	14 for Table grapes; 0 for others	4	3	Provides significant control of powdery mildew, and for this reason treated vines will have less Botrytis. Has no direct effect on the Botrytis fungus nor will it control infections that develop through sites other than powdery mildew injuries. Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential.
Milstop *(potassium bicarbonate)*	2-5 lbs/acre	0	1	3	Provides significant control of powdery mildew, and for this reason treated vines will have less Botrytis. Has no direct effect on the Botrytis fungus nor will it control infections that develop through sites other than powdery mildew injuries.
OxiDate *(hydrogen dioxide)*	Curative: 128fl /acre Preventative: 40fl /acre	0	0	3	Provides significant control of powdery mildew, and for this reason treated vines will have less Botrytis. Has no direct effect on the Botrytis fungus nor will it control infections that develop through sites other than powdery mildew injuries. Apply 30-100 gallons of solution/acre.
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	2	
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	2	

Pesticides Labeled for Management of Botrytis Bunch Rot					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Trilogy *(neem oil)*	0.5-1.0% solution	None Listed	4	3	Provides significant control of powdery mildew, and for this reason treated vines will have less Botrytis. Has no direct effect on the Botrytis fungus nor will it control infections that develop through sites other than powdery mildew injuries. Use a minimum of 25 gallons of water per acre.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

DOWNY MILDEW is caused by a fungus-like organism that can infect berries, leaves, and young shoots. Leaf lesions appear as yellow or reddish-brown areas on the upper surface, with corresponding white, downy, or cottony fungal growth directly opposite on the lower surface (note that downy mildew growth appears only on the lower surface of a leaf lesion and looks cottony, whereas powdery mildew can occur on both sides of the lesion and looks more like baby powder). Leaf lesions become brown and dead with age, and severely infected leaves fall prematurely. Young, infected shoots and cluster stems may curl and are characteristically covered with the white, "downy" growth of the fungus on mornings following rain or dew the night before. Berries on infected cluster stems may fail to set or can turn brown and eventually shrivel, depending on the time of infection. Berries that are directly infected while very young may become entirely covered with a fuzzy white fungal growth when wet from evening rain or early morning dew. Cluster infections that occur later in the season cause berries to remain hard, with a mottled light green to brown or red appearance.

Frequent rainfall and high humidity are the most important environmental factors promoting downy mildew epidemics. The downy mildew organism overwinters as dormant spores within infected leaves on the vineyard floor or (more commonly) within the upper soil layer, and first becomes active in the spring about 2–3 weeks before bloom. Infective spores are then produced during rainy periods if temperatures are above 52°F, and are splashed from the soil onto susceptible tissues to cause the season's first (primary) infections. (Note that inoculum for such early-season infections come strictly from within the vineyard.) Epidemic disease development can then result from repeated cycles of new infections, which are caused by new spores produced within the white fungal growth on diseased tissues. These spores are produced only at night when the relative humidity is extremely high (>95%). They can be blown relatively long distances and cause infection when they land on susceptible tissues that remain wet for just a few hours. (Note that such disease spread can also originate from nearby vines outside the vineyard.)

The generation period for the fungus (time from spore germination and infection to the production of a new "crop" of secondary spores) is only 4 to 5 days at optimum temperatures in the mid- to upper-70s, allowing explosive disease development during extended periods of warm, humid weather with periodic rain showers. On some varieties, including all Vinifera varieties, this can be particularly destructive during the several week period before and after bloom, when fruit clusters are highly susceptible to infection. Young leaves remain highly susceptible to infection so long as they continue to be produced, although even older leaves can become diseased under high-pressure conditions. Uncontrolled infections can cause extensive defoliation in wet years, limiting both fruit ripening and vine winter hardiness. Winter kill of buds or even entire vines is not uncommon when spraying stops too early on susceptible varieties in a bad downy mildew season. Disease can develop at a wide range of temperatures, from the low 50s to the mid-80s, although the rate of spread is slower while at these edges of the range.

Downy mildew management programs should focus on (a) preventing early disease establishment and destructive cluster infections during the prebloom and early postbloom periods and (b) limiting secondary spread on the foliage during the summer and early fall. Any practice that improves air circulation and speeds drying within vine canopies will help to control downy mildew.

Because primary infections can first occur 2–3 weeks before bloom, protection may need to start at this time on Vinifera varieties and on highly susceptible hybrid and Labrusca varieties (e.g., Chancellor, Catawba, Niagara) if the weather is wet. This is particularly true if significant disease occurred the previous year which would contribute to high levels of overwintering inoculum within the vineyard. Clusters should be protected on all but the most highly resistant varieties from the immediate prebloom period through the first or second postbloom spray, depending on the weather.

Continued protection against disease spread during the summer should be based on variety susceptibility, the extent of favorable weather conditions, and the amount of disease already in the vineyard (secondary inoculum). Downy mildew has the potential for "explosive" spread if the disease is active and weather conditions favor its development. However, in many years, hot, drier weather causes the downy mildew fungus to become inactive during mid-summer. Thus, it is worthwhile to scout vineyards during this time for the presence of active disease and to determine the need for protective sprays based on such findings. Also, recognize that fruit lose their susceptibility to infection by midsummer, although protection against leaf infections and consequent defoliation may need to continue throughout the summer, depending on weather conditions. See Table 7.1 for varietal susceptibility to this disease.

IPM fact sheet Downy Mildew http://nysipm.cornell.edu/factsheets/grapes/diseases/downy_mildew.pdf

Downy Mildew Management Options	
Scouting/thresholds	Scout vineyards in mid-summer for the presence of sporulating lesions that may spread infections to leaves during warm, wet weather.
Slightly susceptible varieties	Baco noir, Cascade, Chelois, Concord, Foch, Frontenac, Frontenac gris, Himrod, Marquette, Moore's Diamond, Steuben, and Valvin Muscat. (See Table 7.1)
Cultural management	***Canopy management***. Prune and train the vines to promote air circulation, reduce humidity, and speed drying of the leaves and fruit. ***Vineyard management***. Orient rows to improve air movement within the vineyard. Avoid sites prone to fog or heavily wooded areas.
Chemical treatment	Copper products are very effective, although they must be reapplied frequently (7- to 10-day intervals) during periods of wet weather in order to provide continued protection.

Pesticides Labeled for Management of Downy Mildew					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until solution has dried	3	
Champ WG *(copper hydroxide)*	2-4 lbs/acre	None listed	24	1	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
Milstop *(potassium bicarbonate)*	2-5 lbs/acre	0	1	3	
NuCop 50 WP *(copper hydroxide)*	2 lbs/acre	None listed	24	1	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.

Pesticides Labeled for Management of Downy Mildew					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
OxiDate *(hydrogen dioxide)*	Curative: 128fl /acre Preventative: 40fl /acre	0	0	3	Apply 30-100 gallons of solution/acre
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	3	
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	3	
Trilogy *(neem oil)*	0.5-1.0%	None Listed	4	3	Use a minimum of 25 gallons of water per acre.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

PHOMOPSIS CANE AND LEAF SPOT AND FRUIT ROT are most likely to become problems when the Phomopsis fungus is allowed to build up on dead canes or pruning stubs in the vines and effective early-season sprays for this disease are omitted. In conventionally managed vineyards, economic losses have been especially severe on Niagara, and to a lesser extent, Concord, although many other Labrusca, hybrid, and Vinifera varieties are susceptible as well (see Table 7.1).

Infected rachises and shoots develop black lesions that may split the green tissue (shoots) or appear sunken (rachises). Numerous lesions give the shoot surface a blackened, scabby appearance, and may coalesce to girdle the rachises. Severe infection weakens the tissues at these spots and can cause infected shoots to break off during high winds, or infected clusters to break before and during harvest. Small, pinprick-sized lesions, with brown or black centers surrounded by a small and often yellow margin, can be numerous on the leaves early in the season. These infections cause little harm themselves, but provide a good indication that the fungus is present in the vine and capable of causing more serious losses on other organs if not effectively managed.

Infected berries remain symptomless until late summer or preharvest, when they turn brown, often beginning at the point of attachment to the pedicel (berry stem) and become covered with black, pimple-like fruiting bodies. Such berries eventually shrivel up into raisin-like "mummies", at which time they look very similar to berries infected with black rot. On fruit, the two diseases are best distinguished by the initial location, timing, and development of symptoms. Phomopsis lesions typically (but not always) start where the berry is attached to its stem, whereas black rot lesions start at random locations on the fruit. Also, Phomopsis lesions do not appear until late summer or early fall on the fruit, often just before harvest; in contrast, most black rot symptoms appear by late July or early August, and all diseased berries should be evident by veraison. Finally, berries infected with Phomopsis are usually quite easy to detach from their stem by lightly touching them or giving a gentle pull, whereas those with black rot typically remain attached firmly to the berry stem.

Black fruiting bodies of the Phomopsis fungus overwinter in infected wood (diseased canes or pruning stubs) and rachises. During wet periods, spores ooze from the fruiting bodies and are distributed by raindrops onto nearby susceptible tissues. For this reason, young shoots and clusters directly beneath old canes and pruning stubs are at greater risk than those that are trained to grow above these sources.

Extended periods of wet weather are particularly favorable for disease development. Shoot and leaf infections can occur anytime between bud break and early summer, although they are most common during the first few weeks of growth. Shoot and leaf lesions appear within 3 to 4 weeks after infection, but they do not serve as a source of disease spread during the current season. Rachises can be infected anytime after the young clusters first emerge until fungal spores are depleted in early summer, although infections that occur soon after cluster emergence in the early growing season are the most damaging. Infections that occur on the pedicels (berry stems) during this period can also move into the fruit, causing them to rot before harvest.

Fruit appear to be most susceptible to direct infection from bloom through pea-sized berries, after which few spores are available for new infections. Fruit infection occurs sporadically, since it requires extended periods of rain and wetness; however, serious losses can result if the growing season is excessively wet and protection is not maintained with an effective Phomopsis fungicide from the early shoot growth period through fruit set.

Diseased canes should be removed during pruning to reduce inoculum. Research has shown that dead canes and pruning stubs can produce extremely high levels of Phomopsis spores, and these sources should be specifically targeted for removal as part of a Phomopsis management program. Recent research from Ohio suggests that when inoculum is present, moderately-severe infection can develop after about 26 hr. of wetness at an average temperature of 48°F, 16 hr. at 54°F, and 12 hr. at 60–68°F (shorter and longer periods of wetness should reduce and increase disease severity, respectively).

Copper and sulfur are only weakly effective; thus, organic growers should pay strict attention to the removal of infected wood from within the canopy.

IPM fact sheet Phomopsis Cane and Leaf Spot http://nysipm.cornell.edu/factsheets/grapes/diseases/phomopsis.pdf

Phomopsis Management Options	
Scouting/thresholds	Note "hot spots" of disease activity within individual vines; try to identify the likely source of the fungus causing these infections (pruning stubs, dead canes) and target for removal.
Slightly susceptible varieties	Baco Noir, Cayuga White, Elvira, GR7, Marquette, Marquis, Vanessa, Ventura, and Vidal blanc. (See Table 7.1)
Cultural management	***Sanitation***. Remove all dead wood, infected wood and pruning stubs from the canopy during dormant pruning operations. ***Canopy management***. Prune and train the vines to promote air circulation and speed drying of the shoots and clusters. In some instances performing "cane pruning" rather than "spur or cordon pruning" in vinifera and hybrids will result in ensuring new wood is laid down on the fruiting wire every year. ***Vineyard management***. Orient rows to improve air movement within the vineyard.
Chemical treatment	Copper and sulfur are weakly effective and may cause injury on sensitive varieties. Early-season copper use may also injure more tolerant varieties if applied under cool and/or humid, slow-drying conditions.

Pesticides Labeled for Management of Phomopsis					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Champ WG *(copper hydroxide)*	2-4 lbs/acre	None listed	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
Kumulus DF *(sulfur)*	2-10 lbs/acre	None Listed	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.

Pesticides Labeled for Management of Phomopsis					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Micro Sulf *(sulfur)*	3-10 lbs/acre	None Listed	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Miller Lime Sulfur Solution *(Calcium Polysufide)*	15-20 gal/acre	None listed	48	2	Dormant application. Apply in sufficient water for coverage. Spray to runoff. Label states 100 gallons of water per acre unless otherwise noted.
Milstop *(potassium bicarbonate)*	2-5 lbs/acre	0	1	3	
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	4	
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	4	

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

POWDERY MILDEW is a fungal disease that affects all green tissues. Diseased tissues appear to be covered with a white to grayish-white powder. Severe leaf infection can result in cupping and drying of leaves and premature leaf drop. Infected berries may fail to ripen properly; remain covered with a dusty mass of the fungus; turn dark brown; and/or shrivel and split, depending on the time and severity of infection. Fruit infection may promote growth of spoilage microorganisms and reduce wine quality on grapes intended for that use, even when symptoms are relatively mild.

The powdery mildew fungus overwinters on the bark of the vine as tiny black fruiting bodies ("cleistothecia"). Spores ("ascospores") contained in the cleistothecia are released during rains of approximately 1/10-inch or more, from bud break until shortly after bloom. They are wind-dispersed to young leaves and clusters, and can infect wet or dry tissue at temperatures of 50°F or higher. These primary mildew colonies produce masses of white, powdery secondary spores ("conidia"). Conidia are wind-dispersed throughout the vineyard and do not require rain for release or infection, although humid conditions particularly favor disease development. New colonies that result from these secondary infections produce additional conidia, which can continue to spread the disease.

This repeating cycle of infection, spore production, spore dispersal, and re-infection continues throughout the season if susceptible tissue is present, at a rate that is driven by temperature (Table 7.3). Thus, at optimum temperatures in the mid-60s to mid-80s (°F), a new generation of the fungus can multiply every 5–7 days, resulting in an epidemic of powdery mildew unless it is managed efficiently. Disease development also is strongly favored by high humidity and cloudy weather. Therefore, management programs may need to be intensified (e.g., shorter spray intervals, higher fungicide rates, more effective materials) during periods when such conditions occur. Conversely, the harmful impact of sunlight on the powdery mildew fungus can be exploited by pruning and training practices that promote good light exposure throughout the canopy, thereby utilizing this natural "fungicide" to help manage the disease.

Berries are highly susceptible to infection from the immediate prebloom stage until about two to three weeks after fruit set. Severe fruit damage observed later in the season almost always is the result of infections that occurred during this peak period of susceptibility. Berries of Concord become almost completely resistant to infection after this time (about 1/4-inch diameter fruit). Concord rachises remain susceptible until harvest, but the economic importance of mid- or late-summer rachis infections on processing fruit is questionable. On berries of Vinifera and certain hybrid varieties, infections can continue to occur until bunch closure or slightly thereafter. Such midsummer infection usually results in the development of sparse, inconspicuous infections that can be especially important as entry points for Botrytis and sour rot organisms that become apparent at harvest, or for spoilage microorganisms (e.g., *Brettanomyces*) that reduce wine quality.

Leaf infections that occur beyond the fruit set period are much less serious on Concord and similar varieties than on Vinifera and susceptible hybrids. On low to moderately cropped Concord vines, such infections appear to have relatively little effect on yield and Brix levels. However, on more heavily cropped Concord vines they can suppress both Brix levels and yield, particularly in years with poor ripening conditions. Thus, on this variety, the need for fungicide sprays after fruit set should be heavily influenced by both crop size and weather factors. On Vinifera and highly susceptible hybrid varieties, continued suppression of foliar mildew is required throughout the summer to avoid poor ripening, premature defoliation, and reduced winter hardiness.

Good management of leaf infections throughout the season significantly reduces disease pressure the following year, by limiting the number of cleistothecia (fungal fruiting structures) that form, overwinter, and initiate infection in the spring. Limiting the level of overwintering inoculum has been shown to have a particularly positive impact on the control of cluster infections the following season.

Table 7.3. Approximate generation period for powdery mildew (time from infection by a spore until production of a colony with new spores) at different constant temperatures[a]

Temp (°F)	Days
44	32
48	25
52	16
54	18
59	11
63	7
74	6
79	5
86	6
90	--[b]

a. Data of C.J. Delp (University of California, Davis; 1954)
b. Little or no disease development while temperatures remain above 90 degrees.

To protect against powdery mildew infections of the fruit, management programs should be at their peak from just before bloom through fruit set, emphasizing the use of effective fungicides, full rates, appropriate spray intervals, and superior spray coverage (every row, proper speed, sufficient gallonage). The risk of berry infection is particularly high when days and nights remain warm during this period (see Table 7.3) and/or weather is cloudy and wet, and spray programs may need to be especially “tight” under these circumstances. Protection of Concord berries is not required after fruit are 1/4-inch in diameter, although continued foliar protection may be beneficial under high-crop-load or poor-ripening conditions. For Vinifera and susceptible hybrids, it is important to maintain excellent protection of the clusters through the bunch closure period, since powdery mildew infections at this time can promote the later development of bunch rots and/or wine spoilage.

Maintenance programs to protect foliage throughout the summer are necessary for attaining maximum fruit and vine quality on Vinifera and susceptible hybrid varieties. In years or locations where several weeks may elapse between harvest and frost, additional postharvest protection of the foliage may benefit vines of highly susceptible Vinifera varieties, especially if disease is active in the vineyard and the weather is reasonably warm. See Table 7.1 for varietal susceptibility to this disease.

IPM fact sheet Grapevine Powdery Mildew http://nysipm.cornell.edu/factsheets/grapes/diseases/grape_pm.pdf

Powdery Mildew Management Options	
Scouting/thresholds	Scout foliage shortly before bloom and apply eradicative fungicide if disease is observed. Continue to scout foliage and young berries soon after fruit set and apply eradicative fungicide if disease is observed.
Slightly susceptible varieties	Canadice, Cayuga White, Corot noir, Ives, Melody, Noiret, Steuben, and Traminette. (See Table 7.1)

Powdery Mildew Management Options	
Cultural management	***Canopy management***. Prune and train the vines to maximize sunlight exposure, promote air circulation, reduce humidity, and speed drying of the leaves and clusters. ***Vineyard management***. Orient rows to maximize sunlight exposure and reduce humidity within the vineyard. Avoid sites prone to fog or heavily wooded areas. On highly susceptible varieties, thinning or removing leaves around clusters soon after fruit set will help to control this disease by exposing them to sunlight and, furthermore, will improve spray coverage of the fruit.
Chemical treatment	Unlike other fungal diseases of grapes, the powdery mildew fungus lives almost entirely on the ***outside*** of diseased tissues. Therefore, it is sensitive to topical applications of many products—oils, potassium salts (e.g., Kaligreen, Milstop), hydrogen dioxide (Oxidate), etc.—that have no effect on other diseases, whose causal fungi live ***within*** diseased tissues, where they are protected from these materials. (This is also the likely reason that sulfur is so much more effective against powdery mildew than any other disease). With the exception of sulfur, these other materials have relatively little residual activity, and must be reapplied frequently, even if it does not rain. Sulfur washes off in rains and must be reapplied frequently in wet weather, but persists during dry periods.

Pesticides Labeled for Management of Powdery Mildew

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1	2	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Champ WG *(copper hydroxide)*	2-4 lbs/acre	None Listed	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
JMS Stylet Oil *(paraffinic oil)*	1-2gal/ 100gal *See Comments	14 for Table grapes; 0 for others	4	1	*Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential. Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Kumulus DF *(sulfur)*	2-10 lbs/acre	0	24	1	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Sulfur washes off in rains and must be reapplied frequently in wet weather, but persists during dry periods.
Miller Lime Sulfur *(Calcium Polysufide)*	Dormant 4-10 gal/acre 4-6 in shoot: 2 qts/acre Post Harvest: 10-20 gal/acre	0	48	2	Lower rates may cause injury during the growing season. Do not use higher rates (4-20 gal) except during dormancy, or injury is likely.
Micro Sulf *(sulfur)*	3-10 lbs/acre	None Listed	24	1	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Sulfur washes off in rains and must be reapplied frequently in wet weather, but persists during dry periods.

Pesticides Labeled for Management of Powdery Mildew					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Milstop *(potassium bicarbonate)*	2-5 lbs/acre	0	1	1	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
NuCop 50 WP *(copper hydroxide)*	2 lbs/acre	None Listed	24	2	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
OxiDate *(hydrogen dioxide)*	Curative: 128fl /acre Preventative: 40fl /acre	0	0	2	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain. Apply 30-100 gallons of solution/acre
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	2	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	2	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Sonata *Bacillus pumilis*	2-4 qts/acre	0	4	2	Has relatively little residual activity, and must be reapplied frequently, even if it does not rain.
Sporan EC *(rosemary oil)*	0.75-1.5 qts/acre	0	0	4	
Thiolux Jet *(sulfur)*	6 lbs/acre	None Listed	24	1	May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity. Sulfur washes off in rains and must be reapplied frequently in wet weather, but persists during dry periods.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.7 Other Diseases of Note

ANTHRACNOSE is a disease that occurs primarily in very wet years, with damage typically being limited to a few highly susceptible cultivars. In NY, most outbreaks have occurred on Vidal blanc and a few minor seedless table grape varieties, especially Reliance. There is also some indication that the new cold-hardy cultivar, La Crescent, may be in this category. Symptoms occur on leaves, green shoots, and clusters. On leaves, numerous small, circular brown spots appear, which later turn gray in the center and develop dark brown to black margins. In severe attacks, lesions may coalesce and cause distortion of the leaf blade and eventually death of the entire leaf. Infected shoots develop dark, noticeably sunken lesions; a slightly raised area may form around the margins of the lesions, whose centers may extend into the pith of the shoots. Severely infected shoots are often stunted. On berries, spots approximately 1/4-in in diameter develop, with whitish-gray centers surrounded by reddish brown to black margins, producing an appearance that superficially resembles a bird's eye. Sometimes, severely affected berries may shrivel and dry into mummies.

The fungus overwinters primarily on infected canes. In spring, spores are produced from the overwintering fungal structures and are dispersed by splashing raindrops to young, susceptible tissues. Infection can occur across a wide range of temperatures, but temperatures in the mid-70's to low 80's (°F; 24-27°C) are optimal. Additional spores, which also are splash-dispersed, are produced upon new infections, and these can rapidly spread the disease through multiple repeating cycles of new infection and additional spore production. Hence, outbreaks occur most frequently in years with multiple rain events throughout the season.

Fungal inoculum to start the disease cycle comes primarily from infected canes. Diseased canes should be pruned during the dormant season and removed from the vineyard or destroyed. If numerous infected berries remain on the vineyard floor, the spores originating from them can be largely negated by covering the berries with soil through cultivation or, if practical, covering them with mulch. A "delayed dormant" application of lime sulfur can be useful in organic vineyards to limit production of infectious spores from overwintered cankers in susceptible varieties or where the disease has become established.

ANGULAR LEAF SCORCH was first described in 1985. Symptoms of this fungal disease are similar to those of rotbrenner, a disease of grapevines found in the cool grape-growing regions of Europe, which is caused by a very closely related fungus. Angular leaf scorch occurs sporadically and is seldom destructive, but is most likely to become a problem in years when high rainfall occurs during early shoot growth.

Disease symptoms occur mainly on the leaves and first appear as faint chlorotic spots. As these lesions grow larger, they change from yellow to reddish-brown and the margin often becomes pronounced (depending on the variety, the margin may be yellow, red, or absent). Lesions are confined by major veins, becoming "angular" or wedge-shaped. They eventually kill the tissue, often causing infected leaves to fall prematurely.

The fungus survives winter in infected leaves on the vineyard floor. Mature spores are ready for discharge in spring when grape buds begin to grow. During rainfall, spores are released into the air from fruiting structures, and susceptible tissue is infected.

Cultural practices that increase air circulation through the canopy can shorten the periods of leaf wetness that favor disease development. Destruction of leaf litter by cultivation, before bud break, can also reduce disease pressure. Conventional fungicides applied before rainfall, beginning about the 3-inch stage and continuing through fruit set have provided good control, but there are no data on the efficacy of organically approved products. See Table 7.1 for varietal susceptibility to this disease. Varieties with the least susceptibility include Catawba, Concord, Delaware, Dutchess, Foch, Fredonia, Gewurztraminer, Himrod, Ives, Niagara, Pinot Noir, Riesling, and Vidal blanc.

IPM fact sheet Angular Leaf Scorch of Grape http://nysipm.cornell.edu/factsheets/grapes/diseases/leaf_scorch.pdf

Pesticides Labeled for Management of Angular Leaf Scorch					
Trade Name (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[1]**	**Comments**
Actinovate-AG *(Streptomyces lydicus)*	3-12 oz/acre	0	1 or until solution has dried	4	"other foliar fungi" listed on the label

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

CROWN GALL is a bacterial disease whose characteristic symptom is fleshy galls produced mostly on the lower trunk, but which may form anywhere on the trunks where injuries occur. Large galls may develop rapidly and completely girdle young vines in one season. Galled vines frequently produce inferior shoot growth, and portions of the vine above the galls may die. Current-season galls are first apparent in early summer as white, fleshy, callus growth. Galls turn brown by late summer, and in the fall, become dry and corky.

The crown gall bacterium is systemically present in the vast majority of grape vines, but seldom causes disease unless the vine is injured. Budding and grafting cause injuries that occasionally elicit disease development at those wounding sites, as does "tractor blight", but cold injury is by far the most important factor in the Northeast. Therefore, management practices that minimize the risk of cold injury are currently the only practical technique for managing the disease. These include careful site selection for cold-sensitive varieties and cultural practices that promote winter hardiness. Hilling above the union of grafted vines protects buds from freezing and ensures the development of new scion shoots that may be needed for trunk renewal. The use of multiple-trunk vines and regular replacement of diseased or dead trunks with renewals helps to manage the disease at a tolerable level. See Table 7.1 for varietal susceptibility to this disease. Varieties with the least susceptibility include Cascade, Catawba, Concord, Corot noir, Delaware, Elvira, Einset Seedless, Foch, Fredonia, Frontenac, Frontenac gris, GR7, Ives, La Crescent, Marquette, Melody, Steuben, Traminette, Valvin Muscat, Vanessa, and Ventura.

IPM fact sheet Grape Crown Gall http://nysipm.cornell.edu/factsheets/grapes/diseases/crown_gall.pdf

EUTYPA DIEBACK is a fungal disease appearing as cankers on trunks and arms of infected grapevines. New shoots above cankers often appear stunted, with shortened internodes and small, cupped, greenish-yellow leaves in the spring. (Such symptoms on new shoots superficially resemble those caused by Roundup and similar herbicides.) Healthy shoots usually overgrow and obscure affected shoots by early- to midsummer. Shoot and leaf symptoms become progressively worse each season until, eventually, the entire portion of the trunk or arm above the canker dies.

In winter or early spring, during rainfall or snowmelt, fungal spores are released from fruiting structures on the dead, infected wood of the cankers. Spores are dispersed by the wind and infection occurs when they enter fresh pruning wounds. Cankers and foliage symptoms are not evident until 2 to 4 years after infection; then, vine deterioration continues until the trunk or arm is finally killed.

Infected arms or trunks should be removed in late spring when foliar symptoms are noticeable and the resultant wounds remain susceptible for a more limited period of time than if made earlier. Pruning should be at least 6 inches below any dead or discolored wood associated with the canker. Any infected wood or stumps should, at the very least, be removed from the vineyard, and burned or buried if practical. See Table 7.1 for varietal susceptibility to this disease. Varieties with the least susceptibility include Catawba, Cayuga White, Delaware, Dutchess, Elvira, GR7, Niagara, Rougeon, Seyval, and Vidal blanc.

IPM fact sheet Eutypa Dieback http://nysipm.cornell.edu/factsheets/grapes/diseases/eutypa.pdf

Pesticides Labeled for Management of Eutypa Dieback

Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Serenade ASO *(Bacillus subtilis)*	2-5% solution applied to pruning wounds	0	4	4	Major pruning wounds are susceptible to infection during rains that occur soon after they are made. The efficacy of organically-approved products to protect these wounds from infection is not known.
Serenade MAX *(Bacillus subtilis)*	2-5% solution applied to pruning wounds.	0	4	4	Major pruning wounds are susceptible to infection during rains that occur soon after they are made. The efficacy of organically-approved products to protect these wounds from infection is not known.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

SOUR ROT develops on injured berries when the weather is wet during the pre-harvest period. Affected berries typically are colonized by a mix of various wound-invading fungi and bacteria and can give off a strong smell of vinegar, the result of infection by a specific group of bacteria. Diseased berries drip juice and spores or cells of the sour rot microorganisms onto nearby healthy berries, which in turn become infected through any wounds that might be available (rain cracks, bird or insect damage, Botrytis or powdery mildew infections, etc).

Although it is almost impossible, under wet conditions, to stop sour rot once it has become established, controlling other causes of injury beforehand will greatly reduce the probability of the disease getting started in the first place. Experience has shown that excellent control of powdery mildew and, especially, Botrytis are two measures that significantly minimize sour rot development.

Pesticides Labeled for Management of Sour Rot

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
OxiDate *(hydrogen dioxide)*	Curative: 128fl /acre Preventative: 40fl /acre	0	Until sprays have dried	3	Apply 30-100 gallons of solution/acre
Serenade ASO *(Bacillus subtilis)*	2-6 qt/acre	0	4	2	
Serenade MAX *(Bacillus subtilis)*	1-3 lbs/acre	0	4	2	

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

SUMMER ROTS is a name sometimes used for two similar diseases (ripe rot and bitter rot) common in more southern, humid production regions, although they occasionally occur in NY and PA (especially southeast PA). Bitter rot is the more regular threat in the mid-Atlantic region, but appears to occur only sporadically in NY, presumably due to the somewhat cooler temperatures farther north.

Bitter rot symptoms usually first occur after veraison, as the bitter rot fungus moves into the berry from the pedicel and turns the diseased portion brown (on white varieties) or a dull purple. Once the berry is completely rotted, it becomes covered with numerous raised black pustules (the fungal fruiting bodies, called acervuli). Within a few days, diseased berries soften and may drop; others shrivel into firmly attached mummies that resemble those caused by black rot and Phomopsis.

Bitter rot and black rot can be distinguished by (i) fungal fruiting bodies of bitter rot are irregular and variable in size, often larger and more pronounced, whereas those on black-rot-infected fruit are relatively small, round and uniform in size; (ii) the tendency of fruit infected with bitter rot to leave hands sooty black if handled when wet (whereas those infected with black rot will leaves hands clean); and (iii) bitter rot infections develop after veraison, those of black rot before veraison.

Berries infected with Phomopsis also tend to appear during the preharvest period rather than after veraison. And, compared to bitter rot, significant Phomopsis fruit rot typically occurs in association with significant infections of the rachis, and of the shoots and petioles (leaf stems) near the bottom three to five leaf positions on the shoots bearing the diseased berries. An absence of these other symptoms suggests that Phomopsis is not the cause of multiple berry infections.

The bitter rot fungus colonizes dead tissues of the grapevine (fallen leaves and berries, damaged shoots, necrotic bark), where it overwinters and produces spores the following spring. After flowering, some spores are moved by splashing raindrops onto the pedicels (stems) of the developing berries, where they germinate and cause latent (dormant) infections. When the berries mature, the fungus grows into them, causing the fruit to rot. The acervuli that cover the diseased berries contain abundant, black spores, which are spread to and infect healthy berries during subsequent rains. Infection occurs through any type of injury, including rain cracking, insect damage, or bird injury. Temperatures of approximately 82 to 86°F are optimal for infection.

Ripe rot tends to predominate further south, although it has been documented as far north as New England. Symptoms do not develop until after veraison and become increasingly prevalent by harvest. Infected fruit initially develop circular, reddish brown lesions on their skin, which eventually expand to affect the entire berry. Under humid conditions, small "dots" of slimy, salmon-colored spores may develop across the rotten berry, and serve to spread the disease to healthy fruit if rains continue. Infected fruit shrivel and mummify, and may either remain attached or fall to the ground. No foliar symptoms are produced.

The ripe rot fungus overwinters in mummified fruit, infected pedicels, and dead bark and cankers. Spores are produced from these sites in the spring and are distributed by splashing and blowing rain. Fruit may be infected at any stage of their development, but infections remain latent until the berries begin to ripen. During warm rainy periods (77 to 86°F is optimum), the salmon-colored spores produced upon diseased fruit can spread the disease to healthy berries, which become increasingly susceptible to infection as they ripen. Frequent rains during the pre-harvest period can result in severe crop loss once the disease becomes active, especially if it is not managed.

Summer rots are favored by abundant, warm rains (77° to 86°F is optimum) between veraison and harvest, although initial infections can occur much earlier and remain latent until this time. Cultural practices, such as pruning out dead spurs, removing overwintered mummies, and removing weak or dead cordons, are important to help reduce the inoculum in the vineyard. Sanitation through removal of mummies from the vine during dormant pruning, as for black rot, helps in their management. Susceptibility to both diseases increases with fruit maturity, so fruit become especially vulnerable when harvest is delayed. Timely harvest of ripe fruit is an essential component of disease management. Hybrids are generally more resistant to bitter rot than are varieties of Vinifera. There is little information on the relative susceptibility of specific varieties of Vinifera, Labrusca, or hybrids to ripe rot.

Both diseases are frequently controlled in the early- to mid-summer by fungicide sprays targeted against other diseases, such as downy mildew. Sprays targeted against bitter rot and/or ripe rot may be needed in the late season if the weather is warm and wet, especially if the diseases are observed in the vineyard or have occurred there in the past. In southerly regions where the diseases are consistent problems, it is typically necessary to apply protectant fungicides on a 2-week schedule from bloom until harvest, except during periods of drought. Because fruit are especially vulnerable in their final stages of ripening, pre-harvest sprays are particularly important where these diseases are active.

Pesticides Labeled for Management of Summer Rots

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Milstop *(potassium bicarbonate)*	2-5 lbs/acre	0	1	4	No data available, but mode of activity is inconsistent with control of these types of diseases.
Trilogy *(neem oil)*	0.5-1.0% solution	None Listed	4	4	No data available, but mode of activity is inconsistent with control of these types of diseases. Use sufficient water per acre to ensure thorough coverage.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.8 Insect and Mite Management

Many insects found in the vineyards of New York, while having the capacity to cause economic damage, do not occur on a yearly basis at damaging levels and therefore are considered minor pests. The several species that are considered major pests also vary both from year to year and from vineyard site to vineyard site. For these reasons it is important to be familiar with the life cycle of the pest to assist in developing a scouting program that will ensure a pest problem can be discovered and dealt with before it becomes an outbreak. Alternatively, its important to know when a potential pest is not causing significant economic damage so that unnecessary controls can be avoided. Applying an organically approved broad-spectrum insecticide such as PyGanic EC (a pyrethrum) when not necessary, for example, is not only a waste of money but also has the potential to disrupt biological control by beneficial organisms. This illustrates the need to take potential biological control agents (predators, parasitoids, parasites, microbes) into account when making management decisions. Following are descriptions of the most commonly found insect pests in vineyards.

7.9 Insects and Mites of Primary Concern

GRAPE BERRY MOTH is one of the most serious insect pests affecting grapes in New York and Pennsylvania as well as other grape growing areas in the Eastern USA. There are two to four generations of moths per season. Overwintered pupae emerge as adult moths in late May and lay eggs among the grape clusters. The larvae are small (up to 4/10-inch long) and feed internally in grape berries. External signs of moth feeding are the silk webs that tie several berries together. The larvae pupate inside pieces of leaf material generally under the vine, emerging as adult moths (wingspan is 1/2 inch). Bulletin 138 covers the risk assessment protocol in detail.

IPM fact sheet Grape Berry Moth http://nysipm.cornell.edu/factsheets/grapes/pests/gbm/gbm.pdf
Grape berry moth scouting form http://nysipm.cornell.edu/publications/grapeman/files/mothform.pdf
Value of scouting for grape berry moth and grape leafhopper
http://nysipm.cornell.edu/publications/grapeman/default.asp?metatags_Action=Find('PID','12')

Grape Berry Moth Management Options	
Scouting/thresholds	Follow guidelines in Bulletin 138 http://nysipm.cornell.edu/publications/grapeman/files/risk.pdf. Scouting form http://nysipm.cornell.edu/publications/grapeman/files/mothform.pdf.
Resistant varieties	None, but damage from grape berry moth can promote bunch rot and other diseases and this can be more severe in tight-clustered varieties.
Cultural management	***Mating disruption***. May prove effective in low-pressure situations. See Bulletin 135 http://nysipm.cornell.edu/publications/grapeman/files/phercon.pdf. ***Vineyard management***. Avoid sites prone to heavy snowfall or those surrounded by wooded areas. Where possible, plant rows parallel to wooded edges to allow for spot treatment of outside 6 rows.
Chemical treatment	Bt and some other organic insecticides typically have relatively short residual activity and hence, may work better if applied twice per generation, space about 7 days apart.

Pesticides Labeled for Management of Grape Berry Moth

Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	1	“Caterpillars” listed on label

Pesticides Labeled for Management of Grape Berry Moth					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Biobit HP *(Bacillus Thuringiensis)*	.5-1 lbs/acre	0	4	1	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	2	"Caterpillars" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Entrust *(spinosad)*	1.25 – 2.5 oz/acre	7	4	1	Target eggs at hatch or small larvae.
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	"Lepidopteran eggs" listed on label
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	2	"Caterpillars" listed on label

[1]At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

GRAPE LEAFHOPPERS overwinter in leaves and litter and enter vineyards in the spring and feed on sucker leaves. These overwintered adults generally do not cause serious damage. Depending on degree-day accumulations, one to two generations occur. Rapid population increases are most likely in hot, dry years. Both the adults and nymphs feed on the underside of grape leaves by piercing the tissue and sucking out the plant juices. Damaged leaves become mottled with yellow dots. A moderate infestation of grape leafhopper does not affect yield and quality significantly.

The species of leafhopper found on Labrusca-type varieties differs from those found on hybrids and Vinifera grapes. The Eastern grape leafhopper, *Erythroneura comes*, is found on Labrusca varieties such as Concord, Niagara, Catawba, Delaware, and other Labrusca varieties. Hybrids and Vinifera grapes are infested by other Erythroneura leafhopper species, principally *E. bistrata*.

IPM fact sheet Grape Leafhopper http://nysipm.cornell.edu/factsheets/grapes/pests/glh/glh.pdf
Leafhopper scouting form http://nysipm.cornell.edu/publications/grapeman/files/hpprform.pdf
Value of scouting for grape berry moth and grape leafhopper
http://nysipm.cornell.edu/publications/grapeman/default.asp?metatags_Action=Find('PID','12')

Grape Leafhopper Management Options	
Scouting/thresholds	Follow guidelines in Bulletin 138 http://nysipm.cornell.edu/publications/grapeman/files/risk.pdf Scouting form http://nysipm.cornell.edu/publications/grapeman/files/hpprform.pdf.
Resistant varieties	None.
Cultural management	None.
Chemical treatment	No research data available.

Pesticides Labeled for Management of Leafhoppers					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (see comments)	4	4	For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG repellent *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
JMS Stylet Oil *(paraffinic oil)*	1-2 gal/ 100gal	14 for Table grapes; 0 for others	4	4	Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	Up to day of harvest	4	4	
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None listed	12	4	
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None listed	12	4	
Surround WP *(kaolin)*	12.5-50 lbs/acre	Up to day of harvest	4	4	For suppression only. Table grapes cannot be sprayed from first bloom until after harvest.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

JAPANESE BEETLES are distinguished by a metallic green abdomen and copper outer wings. Tufts of white hairs are arranged along the side of the 1/2-inch body and behind the wing tips. Adults cause damage by feeding on the foliage and occasionally the berries. There is one generation per year, with the peak of adult activity occurring in midsummer. Vines with smooth, thin leaves are most susceptible to Japanese beetle attack, as are vineyards adjacent to pasture or sod fields. Young vines, especially those in grow tubes, should be monitored closely to prevent excessive damage.

Japanese Beetles Management Options	
Scouting/thresholds	Young vines, especially those in grow tubes, should be monitored closely to prevent excessive damage.
Resistant varieties	Varieties with smooth, thin leaves are most susceptible to Japanese beetle attack.
Cultural management	***Vineyard management***. Avoid sites adjacent to pasture or sod fields.
Chemical treatment	No research data available.

Pesticides Labeled for Management of Japanese Beetles					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Beetles" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Beetles. Use sufficient water per acre to ensure foliage is thoroughly wetted.
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	"Beetles" listed on label
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	"Beetles" listed on label
Surround WP *(kaolin)*	12.5-50 lbs/acre	0	4	4	For suppression only. Table grapes cannot be sprayed from first bloom until after harvest. Infestations can be sprayed up to first bloom and again after harvest.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

POTATO LEAFHOPPERS are a sporadic but sometimes locally serious pest of grapes. Unlike grape leafhoppers, potato leafhoppers cannot overwinter in northern latitudes due to the cold winters. Each spring, however, large numbers of adults migrate north and colonize a number of different plant species, including grapes. Adult potato leafhoppers are wedge-shaped and iridescent green, while the nymphs are usually bright green. The nymphs, generally found on the undersides of leaves, walk in a sideways manner that helps distinguish them from other leafhopper species.

Both adults and nymphs feed by sucking sap from the vascular system of grape leaves. They also inject a salivary toxin that produces characteristic symptoms including leaves with yellow margins that are cupped downwards. A low infestation of potato leafhopper does not affect fruit quality or yield.

Potato Leafhopper Management Options	
Scouting/thresholds	None.
Resistant varieties	Observations indicate thin-leafed varieties including Cayuga White and Vinifera varieties develop obvious symptoms and may be more susceptible.
Cultural management	Vines adjacent to alfalfa more prone to problems, especially after alfalfa is cut.
Chemical treatment	No research data available.

Pesticides Labeled for Management of Leafhoppers

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
JMS Stylet Oil *(paraffinic oil)*	1-2 gal/ 100gal	14 for Table grapes; 0 for others	4	4	Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	0	4	4	
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	
Surround WP *(kaolin)*	12.5-50 lbs/acre	0	4	4	Do not apply to table grapes from first boom to harvest. Infestations can be sprayed up to first bloom and again after harvest.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

SPIDER MITES—European red mites and two-spotted spider mite—Spider mites are small, eight-legged, plant-feeding arthropods related to spiders. Two species of spider mites can be encountered in New York vineyards. The European red mite is the more common species. Adult mites are dark red in color. When viewed with a hand lens, the mites appear hairy because they have white spines called "setae." Nymphs range in color from pale to dark orange. Both adults and nymphs pierce the leaf cells and extract plant juices. This leads to the characteristic bronze coloration, which impairs the photosynthetic capacity of the leaf. The European red mite overwinters in the egg stage, generally located in crevices in bark on two-year old and older wood. Two-spotted spider mites are often found in mixed populations with European red mites. Two-spotted spider mites are light in color with two black spots on their backs. They overwinter as adult females off of the grapevine and therefore must colonize vines each year.

Vinifera and hybrid varieties appear to be the most susceptible to infestations, although Amercian varieties can also develop large densities under some conditions. European red mites may be found on the upper or lower leaf surface while two-spotted spider mites are normally found on the underside of the leaf. Four to nine generations occur in a season. Susceptible vineyards in production areas prone to damaging infestations should be monitored, starting at the bud break stage, for presence of this pest. Although problems can develop at any time after bud break, pay particular attention to the 1- to 4-inch growth stage and the postbloom period, especially after early July. Given a head start, the vine can tolerate a fair amount of feeding damage on lower leaves. Heavy mite infestations early in the season can cause stunted, chlorotic shoots with small leaves and pinpoint necrotic areas on leaves. Later in the season, as shoot growth rate declines and the vine allocates more resources to fruit, mites may also have an increased capacity to cause damage. Infestations can be severe on Long Island and in southeastern Pennsylvania vineyards. Serious infestations in the Finger Lakes region have occurred more frequently in recent years. Problems with spider mites in the Lake Erie region are uncommon. Predatory mites, when present in the vineyard at sufficient densities, can provide excellent biological control of spider mites.

Spider Mite (European red mite and two-spotted spider mite) Management Options	
Scouting/thresholds	At bud break, start monitoring vineyards prone to infestations for presence of mites, especially European red mite. Monitoring is especially important at the 1- to 4-inch growth stage and the post-bloom period. Note presence or absence of predatory mites.
Resistant varieties	None.
Cultural management	Encourage the development of predatory mite populations in the vineyard.
Chemical treatment	Research has shown that early-season use of oils can suppress mite populations.

Pesticides Labeled for Management of Spider Mites

Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
JMS Stylet Oil *(paraffinic oil)*	1-2 gal/ 100gal	14 for Table grapes; 0 for all other uses	4	1	Studies show early-season use can suppress mite populations. Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential.

Pesticides Labeled for Management of Spider Mites					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Kumulus DF *(sulfur)*	2-10 lbs/acre	None Listed	24	2	Labeled only for use against bud mite, red spider mite and blister mite. Sulfur can suppress mites, but efficacy is not high and can reduce populations of some beneficial mites. May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
Micro Sulf *(sulfur)*	3-10 lbs/acre	None Listed	24	2	Sulfur can suppress mites, but efficacy is not high and can reduce populations of some beneficial mites. May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
Thiolux Jet *(sulfur)*	6 lbs/acre	None Listed	24	2	Sulfur can suppress mites, but efficacy is not high and can reduce populations of some beneficial mites. May cause injury on sensitive varieties. See Table 7.1 for varietal sensitivity.
Trilogy *(neem oil)*	0.5-1.0%	None Listed	4	4	Use sufficient water per acre to ensure thorough coverage.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.10 Minor and Sporadic Insect Pests

BANDED GRAPE BUG and *LYGOCORIS INCONSPICUOUS* These two insects are true bugs in the family Miridae.

Banded Grape Bug is a sporadic pest of grapes in the Finger Lakes and Lake Erie regions and does not require treatment in most years. Nymphs of this insect emerge in the spring and feed on flowers and young berries, using their sucking and piercing mouth parts. The nymphs range in size from 1/8- to 1/2-inch in length, depending on the stage. Injury by small nymphs, occurring between 3- to 5-inch shoot growth (around May 15) and early June, results in floret drop, reduced berry set, and fewer clusters. Adults, which appear at about bloom, are predaceous and do not cause damage. Economic injury can occur when more than 1 nymph per 10 shoots are present. This injury only occurs prior to bloom (between 5- and 10-inch shoot growth). Look for nymphs on grape clusters and shoot tips prior to the bloom period. They can be recognized by their long, banded antennae.

Lygocoris inconspicuous has a similar life cycle as the banded grape bug. Nymphs emerge from overwintering eggs shortly after bud break and begin feeding on shoot tips, flower buds, pedicels, and the cluster rachis. This feeding activity results in floret drop, reduced berry set, and reduced cluster number. The nymphs are light green in color with threadlike antennae that are not banded. They pass through five growth stages and become adults shortly before bloom. For a given growth stage, they are considerably smaller than the banded grape bug. Scout for these insects on clusters and shoot tips. Because of their small size, green color, and habit of hiding when disturbed, they can be very difficult to see on the cluster. This pest is sporadic and does not require treatment in most years. When present, however, it can cause considerable economic damage.

Pesticides Labeled for Management of True Bugs					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	For application day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	0	12	4	

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

CLIMBING CUTWORMS are known to feed on grapes. Larvae hide in the soil litter below the grape trellis and climb onto vines on warm nights to feed on developing primary buds. Only during bud swell are cutworms able to inflict serious damage to a vineyard. To examine vines for cutworms, search under the bark and in the soil litter beneath a vine with damaged buds, or search the vine with a flashlight after dark. Weeds under vines may provide shelter for cutworms.

IPM fact sheet Climbing Cutworms http://nysipm.cornell.edu/factsheets/grapes/pests/cc/cc.pdf

Pesticides Labeled for Management of Climbing Cutworms					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	"Caterpillars" listed on label
Deliver *(Bacillus Thuringiensis)*	.5-1.5 lbs/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Caterpillars" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.

Pesticides Labeled for Management of Climbing Cutworms					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Entrust *(spinosad)*	1.25 – 2.5 oz/acre	7	4	4	
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	Labeled for black and citrus cutworm only.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

EUROPEAN CORN BORER is an important lepidopteran pest of corn, but it is also known to feed on over 200 other plant species, including grapes. Corn borer problems are rare, but under some circumstances, may require management. They are usually found in Vinifera varieties, especially vines with excessive foliage or where vineyards are weedy or surrounded by corn, sorghum, sudan grass, or related crops. Young vineyards or nursery stock may be more seriously affected by borer injury than mature vines. The larvae vary in color, ranging from creamy to light gray to faint pink, with very small, round, dark brown spots on each segment and a dark-colored head capsule. After initially feeding on young leaves, larvae bore into canes. This weakens or kills shoots, especially when the larvae enter the middle or lower sections. Adult moths are a creamy yellowish-brown and approximately one inch long. Eggs are white and laid in masses resembling overlapping fish scales on the underside of leaves. Egg laying can occur in late May, late June to early July, or early August, depending on the genetic race of corn borer present.

Pesticides Labeled for Management of European Corn Borer					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	"Caterpillars" listed on label
Deliver *(Bacillus Thuringiensis)*	.5-1.5 lbs/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Caterpillars" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	

GRAPE CANE BORER is a small (3/8-inch), cylindrical brown beetle that bores into canes, leaving round entrance holes that are about 1/8-inch in diameter. Immature cane borers feed only on dead or dying wood, but adults can enter vigorous, live canes starting in late August. Tunneling can weaken canes causing them to break or die back. It can be particularly problematic when training young vines. Damage has been reported primarily in vineyards surrounding Keuka and Seneca Lakes in the Finger Lakes region of New York. Research in New York and Europe indicates that problems with grape cane borer are reduced if wood from pruning is removed and destroyed each year. Destruction of burn piles before late summer is recommended.

IPM fact sheet Grape Cane Borer http://nysipm.cornell.edu/factsheets/grapes/pests/gcb.pdf

GRAPE PHYLLOXERA are small, aphid-like insects with a complex life cycle. Two forms of grape phylloxera occur within the same species, and several generations of each may occur in any given year. The root gall form feeds on the outside of galls or on swellings on the roots of some grape species and varieties. Loss due to this form can be substantially reduced by grafting to a phylloxera-resistant rootstock (see Table 6.8). This grafting will not affect injury caused by the leaf gall form of the phylloxera. The leaf gall form lives inside galls on the underside of grape leaves of some grape species and varieties. There is a wide range in the susceptibility of grape varieties to both forms of phylloxera. Although Vinifera roots are especially vulnerable to phylloxera, research indicates phylloxera can also feed on Labrusca roots and reduce vine vigor. Vinifera and Labrusca leaves rarely develop leaf galls but some hybrids like Aurore , Baco Noir, and Seyval blanc as well as the newer cold hardy varieties Frontenac, Frontenac gris and La Crescent seem particularly prone to leaf galls. Examine foliage on a weekly basis before and after bloom. Many varieties can withstand extensive galling.

Pesticides Labeled for Management of Phylloxera					
Trade Name (*active ingredient*)[1]	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

GRAPE ROOTWORM is a beetle that feeds on grape foliage as an adult, producing chain-like feeding patterns on the leaves. Immature stages, however, feed on grape roots, and if left untreated, can cause serious damage and vineyard decline over a period of years. Grape rootworm adults begin appearing in vineyards in mid- to late May. They lay eggs on the vine trunk. After the eggs hatch, the larvae crawl into the soil and attach themselves to grape roots. They remain there for 1–2 years while completing their development. An insecticide application made when chain-like feeding symptoms appear throughout a vineyard will control adults before they lay eggs. This pest appears sporadically and does not require treatment every year.

IPM fact sheet Grape Rootworm http://nysipm.cornell.edu/factsheets/grapes/pests/grw/grw.pdf

Pesticides Labeled for Management of Grape Rootworm					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Beetles" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.

Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Beetles. Use sufficient water per acre to ensure foliage is thoroughly wetted.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	0	4	4	"Beetles" listed on label
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	"Beetles" listed on label
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	"Beetles" listed on label

[1] At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

GRAPE ROOT BORERS are clear-wing moths that strongly resemble paper wasps. At present, in this region they occur only in southern and eastern Pennsylvania. Larvae feed on grape roots for a 2-year period. Mature larvae burrow to just below the soil surface, spin a dirty brown silk cocoon, and pupate. Adults emerge in mid- to late summer, mate, and lay eggs beneath vines. The eggs hatch and reenter the root system. Careful monitoring for pupal cases on the soil surface beneath vines will reveal when pupation is occurring. Good under row weed control is important in limiting the number of sites available for ovipositioning (egg-laying). Mounding soil beneath vines after borers have pupated, and then leveling the ridges in the fall or spring creates an environment where adults are unable to dig to the surface after leaving their cocoons. Timing is important because if mounding is done too early the larvae merely tunnel up into the ridge before pupating

GRAPE FLEA BEETLES OR STEELY BEETLES are small (3/16-inch) bluish-black beetles that damage vines by feeding on small grape buds. Larvae feed on the upper surface of the leaves. If adult beetles are present in damaging numbers in the early season, they should be controlled with an insecticide application at bud swell. They tend to be more abundant on the vineyard edge near woods.

IPM fact sheet Grape Flea Beetle http://nysipm.cornell.edu/factsheets/grapes/pests/gfb/gfb.pdf

Pesticides Labeled for Management of Grape Flea Beetles

Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Beetles" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	"Beetles" listed on label. Use sufficient water per acre to ensure foliage is thoroughly wetted.
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	"Beetles" listed on label

Pesticides Labeled for Management of Grape Flea Beetles					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	"Beetles" listed on label
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	"Beetles" listed on label

[1]At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

GRAPE CANE GALLMAKERS are small (1/8-inch) brown weevils that form scars in shoots, typically beyond the last grape cluster. The 3/4-inch reddish swelling is quite noticeable on green shoots. Berry size and percentage of sugar are not affected, and the scars are easily found and removed during winter pruning.

IPM fact sheet Grape Cane Gallmaker http://nysipm.cornell.edu/factsheets/grapes/pests/gcgm/gcgm.pdf

GRAPE CANE GIRDLERS are small (1/8-inch) black weevils that girdle grape canes by chewing 2 series of holes several inches apart. The girdles are generally beyond the last grape cluster, so there is usually no loss of fruit. Cultural control of grape cane girdler involves cutting off and burning the infested part of the canes. This must be done before adults emerge from the canes in late summer.

IPM fact sheet Grape Cane Girdler http://nysipm.cornell.edu/factsheets/grapes/pests/gcg/gcg.pdf

MEALYBUGS AND SOFT SCALES have received attention recently due to their ability to vector leafroll virus in grapes. There are several species of soft scales present in our area and at least one species of mealybug, the grape mealybug. In survey work in the Finger Lakes from 2006-2008 we found low levels of both mealy bugs and soft scale. Some of these individuals have tested positive for two viruses that cause leafroll disease. At this point we do not know whether they are playing a role in spreading the virus in eastern vineyards but because of their low numbers, we believe it is minimal. Research is ongoing to clarify this situation. In the event that moderate to high populations develop, dormant oils can be applied prior to budbreak and may provide some control. Insecticides applied during the season should be timed to coincide with production of crawlers. These pests rarely reach population levels which require treatment and treatment will not stop virus transmission.

IPM fact sheet Grape Leafroll Disease http://nysipm.cornell.edu/factsheets/grapes/diseases/grape_leafroll.pdf

Pesticides Labeled for Management of Mealybugs					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	

Pesticides Labeled for Management of Mealybugs					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
Golden Pest Spray Oil *(soybean oil)*	2 gal/acre	None Listed	4	4	See label for dilute spray instructions. Apply when grapes are dormant.
JMS Stylet Oil *(paraffinic oil)*	1-2 gal/ 100gal	14 for Table grapes; 0 for all other uses	4	4	Suggested rate of application is 25 – 150 gallons of dilute spray emulsion per acre depending on plant size. Thorough coverage is essential.
Miller Lime Sulfur Solution *(Calcium Polysufide)*	Dormant: 4-10 gal/acre 4-6 in shoot: 2 qts/acre	None Listed	48	4	Use sufficient water for coverage. Label states that 100 gallons of water per acre should be used unless otherwise specified.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	0	4	4	
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None listed	12	4	
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None listed	12	4	
Trilogy *(neem oil)*	0.5-1.0% solution	None Listed	4	4	Use sufficient water per acre to ensure thorough coverage. Do not use after bloom on table grapes or following bunch closure on wine grapes.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

MULTICOLORED ASIAN LADY BEETLE (MALB) is an important predator of aphid pests on a number of different crops. However, near harvest it can become a problem for grape growers (both for wine and sweet juice). After a sufficient cold period in the fall the adult beetles begin searching for overwintering sites and this can bring them into vineyards where they may feed on ripe or damaged grapes. Injury to fruit, however, is not the real concern. When disturbed, by harvesting of grapes, for example, the beetles produce a noxious smelling liquid from their joints that contaminates the fruit and causes a severe off-flavor in juice or wine. This problem has been most severe on the Niagara Peninsula and the southeastern shore of Lake Erie, but has also been reported in the Finger Lakes. We currently do not have a good estimate of economic threshold, but it may be as little as 15 beetles per grape lug. During the summer MALB feed on a number of different aphid species, including the introduced soybean aphid. When soybean aphids are abundant, this probably leads to an abundance of MALB and potentially to greater problems in vineyards.

Pesticides Labeled for Management of Beetles

Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Aza-Direct *(azadirachtin)*	1 – 2 pt/acre	0	4	1	"Beetles" listed on label
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Beetles" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG repellent *(garlic juice)*	1-2%	None Listed	None Listed	4	"Beetles" listed on label. Use sufficient water per acre to ensure foliage is thoroughly wetted.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	0	4	4	"Beetles" listed on label
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	"Beetles" listed on label
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	"Beetles" listed on label

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

PLUME MOTH larvae can cause injury to young shoots and grape clusters early in the growing season. In most years, this injury is not significant. The light green larvae hatch at, or near, bud break. They fold young, terminal leaves together to form a shelter in which they feed on leaf tissue (the leaves are held together with webbing). This, in itself, is generally not a serious problem because the shoot can recover after the larvae complete development (in early June). When present in very high densities, the larvae sometimes accidentally enclose young flower clusters within their leaf shelters; if this happens, they will feed on the florets. Infestations are often limited to vineyard edges. This pest does not require treatment in most years.

Pesticides Labeled for Management of Moths					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	0	12	4	"Moths" listed on label

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

ROSE CHAFERS are clumsy, light-brown beetles about 5/8-inch long. They damage leaves and flower clusters around the bloom period. Populations are usually highest on light, sandy soil.

Pesticides Labeled for Management of Chafers					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	"Beetles" listed on label. For applications the day of harvest, crop can be harvested as soon as spray has dried.
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Chafers. Use sufficient water per acre to ensure foliage is thoroughly wetted.
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	"Beetles" listed on label
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	"Beetles" listed on label
Surround WP *(kaolin)*	12.5-50 lbs/acre	0	4	4	Suppression only. Do not spray table grapes from first bloom to harvest. Infestations can be sprayed up to first bloom and again after harvest.

THRIPS are small (1/25-inch) yellowish or brownish insects that rarely cause significant injury to grapes in our area. The adults are winged and more brownish, while immature thrips are more yellowish and have a worm-like appearance. They use their rasping/sucking mouth parts to feed on leaf tissue. When populations are high, during the early part of the season, their feeding activity can result in small, deformed leaves and stunted shoots. Later in the season, the vines are much better able to tolerate thrips feeding. It is rarely necessary to treat for this pest. Aurore and DeChaunac varieties appear to be most susceptible to shoot stunting. Concord and other Labrusca varieties tolerate feeding with no apparent injury.

Pesticides Labeled for Management of Thrips					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
Aza-Direct *(azadirachtin)*	1-2 pts/acre	0	4	4	
Ecozin-Plus 1.2 ME *(azadirachtin)*	15-30 oz/acre	0 (See Comments)	4	4	For applications the day of harvest, crop can be harvested as soon as spray has dried.
Entrust *(spinosad)*	1.25 – 2.5 oz/acre	7	4	1	
Garlic Barrier AG *(garlic juice)*	1-2%	None Listed	None Listed	4	Use sufficient water per acre to ensure foliage is thoroughly wetted.
Mycotrol O *(Beauveria bassiana strain GHA)*	.25-1 qt/acre	0	4	4	
Naturalis L *(Beauveria bassiana ATCC 74040)*	10-15 fl oz/acre	None Listed	4	4	
Neemix 4.5 *(azadirachtin)*	7-16 oz/acre	None Listed	12	4	Only labeled against *thrips palmi*
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz/acre	None Listed	12	4	
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz/acre	None Listed	12	4	
Surround WP *(kaolin)*	12.5-50 lbs/acre	0	4	4	Do not spray table grapes from first bloom to harvest. Infestations can be sprayed up to first bloom and again after harvest.
Trilogy *(neem oil)*	0.5-1.0% solution	None Listed	4	4	Use sufficient water per acre to ensure thorough coverage.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

TUMID GALLMAKER is a small (1/10-inch) brown to reddish fly with plume-like antennae. From early May to mid-September, it lays its eggs in masses between developing tissues at the bud or shoot tips. After hatching, the larvae cause injury by boring into vine tissue and causing a round, reddish gall to form. These galls can develop on leaf tissue or petioles, where they probably do little actual damage to the vine, or in grape clusters, where there is more concern about economic injury. Hence, the greatest concern for this pest is in the early part of the season. Tumid gallmaker is generally not as prevalent in the western and central grape-growing regions as in the southeastern areas. Aurore and Rougeon appear to be particularly susceptible.

IPM fact sheet Grape Tumid Gallmaker http://nysipm.cornell.edu/factsheets/grapes/pests/gtg/gtg.pdf

7.11 Weed Management

Weeds are part of the vineyard ecosystem. Weed management decisions are based on balancing the positive and negative aspects of weed growth in the vineyard. Weeds can compete for water and nutrients, reducing vine growth; contaminate mechanically harvested fruit; provide alternate hosts for vineyard pests; and interfere with vineyard operations. Weed growth can also alter the microclimate around vines, leading to higher disease pressure and increasing the risk of spring frost. However, managing weed or cover crop growth in row middles can be a powerful tool for managing overly vigorous vines, minimizing erosion, and improving equipment access in wet seasons.

Minimizing weed competition during vineyard establishment is critical to achieve optimal vine growth and yields. In mature vineyards, the need to minimize weed competition depends on several factors. Productivity of shallow-rooted vines such as Concord can be severely limited due to weed competition. The critical period of weed competition is from bloom until veraison, when days are long, grapevine leaf area is maximized, and when soil moisture may be limiting. On the other hand, growth of overly vigorous vines can be reduced with weed competition, and limiting soil moisture post-bloom may reduce berry size and lead to concentrated flavors and higher wine quality. In any case, some level of weed control is usually necessary to limit weed growth into the vine canopy which can interfere with sunlight penetration into the fruit zone and lead to higher disease pressure.

Cultivation is sometimes used as a row middle weed management tool in vineyards. Low vine size restricts productivity of own-rooted Labrusca varieties such as Concord that generally have shallow root systems and cultivation has been used to minimize weed competition is such vineyards. However, there are negative aspects to continuous cultivation. Excessive cultivation can lead to undesirable consequences such as soil erosion, reduced soil organic matter, and breakdown in soil structure resulting in compaction and reduced permeability. If cultivation is used for row middle management it is suggested that negative effects be limited by not cultivating more often than necessary to suppress weed growth, to shallow (1-2") depths only, and with the goal of reducing, rather than completely eliminating, weed or cover crop growth. Fall planting of ryegrass or other cover crops can be used in conjunction with cultivation to provide winter cover. See section 3 for more information on cover crops.

Organic mulches can also be used as tools for row middle management. They are most effective where soil moisture and fertility are low and where low vine size restricts vineyard productivity. Use of organic mulches can lead to excessive vine vigor by increasing the soil water content and through release of nutrients. In one study in Western New York, application of 5 tons of straw mulch for two consecutive years increased petiole potassium levels which led to foliar symptoms of magnesium deficiency.

Rootstock choice can influence the amount of weed competition that grapevines can tolerate. In an experiment at the Vineyard Lab in Fredonia, NY, Concord vines grafted to 3309 achieved optimal vine size without row middle cultivation or supplemental nitrogen, whereas own-rooted vines required cultivation and 100 lb. nitrogen to achieve the desired vine size. Note that conventional herbicides were used to control in-row weed growth.

In-row weed management may be one of the most difficult tasks in the production of organic grapes. The yearly hilling up and taking down of a soil ridge to protect the graft union of cold tender varieties grown on a rootstock can be useful in managing weeds and pests if timed correctly. Pulling the soil ridge down in the spring covers newly emerged weed seedlings as well as over-wintering inoculum of black rot and downy mildew and pupae of grape berry moth. However, a single “take down” in the spring, followed by hilling up in the fall, should not be counted on as the sole means of weed control in most vineyards, as annual and perennial weeds are likely to proliferate during the summer months.

There are a number of mechanical, thermal and animal measures that can be used to limit the effects of weeds under the row. Mechanical and thermal options include fixed hoes, rotary cultivators, flamers, steamers, and hot water applicators. A good list of available options is found on the National Sustainable Agriculture Information Service website. Animal weeders have also been used with some success in organic vineyards across the United States. The use of weeder geese and sheep have some effectiveness, but due to food safety concerns regarding microbial contamination of food crops from manure they must be removed from the vineyard 90 days prior to harvest.

Another potential approach to under-row weed management is use of an under trellis mower, using commercially available equipment and currently being investigated at the Long Island Horticultural Research and Extension Lab. Initial results indicated no difference between under-row mowing and conventional herbicide treatments in terms of yield or fruit quality, but mowing is more labor intensive and expensive. Mowing shifted the spectrum of weeds strongly toward summer annual grasses.

Organic mulches are generally discouraged for under-row weed control in vineyards due to concerns about harboring rodents that may feed on the vines. Possible materials include straw, hay, sawdust, and wood chips. Inorganic mulches like plastic can be used in organic production, but only if they are removed from the soil annually. There has been some recent research in Italy with the use of biodegradable mulch films that do not need to be removed from the soil. These materials have not been evaluated in New York vineyards.

For more information on weed management consult:
Grapes: Organic Production. Dufour, R. 2006. The National Sustainable Agriculture Information Service, pub. IP031.
http://attra.ncat.org/attra-pub/grapes.html#weeds.
Managing Weeds in Vineyards. I. Choosing a weed management program
http://nysipm.cornell.edu/publications/grapeman/files/weedman.pdf

Organic Herbicides Labeled for Management of Vineyard Weeds					
Trade Name[1] **(*active ingredient*)**	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy**[2]	**Comments**
Cinnamon oil *(cinnamon oil)*	Consult label	?	?	3	25(b) active ingredient. Trials on Long Island indicate very little efficacy, even when organic surfactants were used.
GreenMatch *(citrus extract (d-limonene))*	14% solution	7	4	4	There are reports of some efficacy on some broadleaves such as *Brassica* species. The manufacturer suggests using 60 or more gallons per acre sprayed, and inclusion of an organic surfactant such as Surfact 50.
Matran EC *(clove oil)*	5 – 8% solution	None listed	0	3	25(b) active ingredient. Trials on Long Island indicate very little efficacy, even when organic surfactants were used.

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[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

7.12 Wildlife Management

Deer and birds have the potential to be economically destructive in a short period of time. Deer browse on young shoot growth early in the year and can destroy a training system if not caught early. Fencing and dogs are the two most reliable options of keeping deer out of the vineyard. Repellents can be used but they must be put in place prior to the deer discovering the presence of "food" as deer are much harder to deter once they have enjoyed a meal. Because much of the deer damage to vines occurs during the dormant season, repellent applications may be limited by cold temperatures or snow cover. Nuisance permits for shooting of deer causing substantial damage may be available to reduce the population in some areas. Contact your regional Department of Environmental Conservation wildlife office for technical advice and a permit application.

Flocking birds can destroy a crop in a matter of days. Netting is the best option to exclude birds from feeding on ripening grapes but is a costly option for all but the more expensive grape varieties. Repellent and scare tactics such as mylar tape, scare eyes, distress calls, cannons and human activity in the vineyard have provided short-term success against birds. Birds quickly adapt to the noises and scare tactics as they learn they will not be hurt. Frequently moving noisemakers to different locations in the vineyard can increase the time frame of effectiveness from days to weeks.

There are no chemicals registered for vertebrate control in New York State vineyards.

Table 7.4. Vertebrate Damage Mitigation Practices	
Animal Pest	**Management Practices[1]**
Birds	Netting; visual scare devices (eye-spot balloons, silhouettes, reflective tape); auditory frightening device (recorded alarm calls, pyrotechnics, propane cannon). Population reduction through shooting by licensed hunter of game species in appropriate season (crows, turkeys); or unprotected species (European starlings, English sparrows, pigeons). All state and local firearms laws or regulations must be followed*.
Mice and voles	Wire trunk guards; close mowing of vineyard middles; vegetation reductions (<40% ground cover) under vines; removal of dropped fruit and prunings; habitat manipulations including elimination of unmowable areas within vineyards; monitor to determine the need for management. Population control through trapping by landowner.
Raccoons	Electrified exclusion fencing. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
Red and gray foxes	Manipulation including elimination of protective cover within vineyards. Population reduction through shooting by licensed hunters or landowners in appropriate seasons; through trapping by landowner, by licensed trapper, or by licensed nuisance wildlife control agent.
White-tailed deer	Exclusion fencing (8 ft. (244 cm) high-tensile woven wire or 5 to 6 ft. (152 to 183 cm) electric exclusion fencing; peanut-butter baited electric fences; invisible fencing with dogs); habitat manipulation including elimination of protective cover within vineyards. Population reduction through shooting by licensed hunters, landowners or their agents with nuisance deer permits.
Woodchucks	Exclusion fencing (electrified exclusion fencing); habitat manipulation including removal of brush piles within vineyards. Population reduction through shooting by licensed hunters or landowners; through trapping by landowner or by licensed nuisance wildlife control agent.

[1] Conduct shooting and trapping only as defined by New York State Department of Environmental Conservation regulations. Shooting for nuisance wildlife control is allowed only when neighboring occupied buildings are >500 ft. distant; shooting when neighboring buildings are less than 500 ft. distant requires neighbor permission. Also check local ordinances, as shooting and trapping are prohibited in some areas.

7.13 Harvest & Nuisance Pests

During harvest operations some pests can contaminate the grapes, reducing their quality, e.g. the striped snail, wasps and yellow jackets, multicolored Asian lady beetles (MALB), and mice. Wasp and yellow jacket nests can be destroyed during the growing season as they are found in the vineyard. Snails can be managed with Sluggo bait (follow label directions) or with copper band barriers (100% effective) placed around trunks. See the 2000 NYS IPM Project Report, Demonstration and Evaluation of Pest Management Alternatives in Finger Lakes Grapes, by T. Martinson and T. Weigle for more information on managing the striped snail. To manage MALB, refer to the section on Secondary Insect Pests. In years with high mouse populations, trap prior to harvest.

Pesticides Labeled for Management of Nuisance Pests					
Trade Name[1] (*active ingredient*)	**Product Rate**	**PHI (days)**	**REI (hours)**	**Efficacy[2]**	**Comments**
PyGanic EC 1.4 II *(pyrethrins)*	16-64 fl oz	0	12	4	Wasps & yellow jackets
PyGanic EC 5.0 II *(pyrethrins)*	4.5-18 fl oz	0	12	4	Wasps & yellow jackets

Pesticides Labeled for Management of Nuisance Pests					
Trade Name[1] (*active ingredient*)	Product Rate	PHI (days)	REI (hours)	Efficacy[2]	Comments
Sluggo *(iron phosphate)*	44 lbs/acre 1 lb/ 1,000 sq ft	0	0	1	Snails

[1]At the time this guide was produced, the following materials were labeled in New York State for managing this pest and were allowable for organic production. Listing a pest on a pesticide label does not assure the pesticide's effectiveness. The registration status of pesticides can and does change. Pesticides must be currently registered with the New York State Department of Environmental Conservation (DEC) to be used legally in NY. Those pesticides meeting requirements in EPA Ruling 40 CFR Part 152.25(b) (also known as 25(b) pesticides) do not require registration. Current NY pesticide registrations can be checked on the Pesticide Product, Ingredient, and Manufacturer System (PIMS) website http://magritte.psur.cornell.edu/pims/. **ALWAYS CHECK WITH YOUR CERTIFIER** before using a new product.

[2] Efficacy: 1-effective in some research studies, 2- inconsistent efficacy results, 3-not effective, 4-no data found.

8. SPRAYER TECHNOLOGY

8.1 Spraying Small, Organic Vineyards:

On many small-scale organic vineyards spraying often requires special attention to calibrating sprayers, calculating amounts of pesticide to use, and measuring pesticide products.

To ensure even distribution throughout the canopy, a systematic approach to spraying the whole canopy is essential. Take particular care to cover the top of the canopy as well as ensuring adequate penetration into the inside and middle of the canopy and the fruiting zone. Spray from both sides of the row. Water sensitive cards (Syngenta) or Surround, kaolin clay, (Engelhard) may be used as tracers to monitor spray distribution.

PRIOR TO SPRAYING—CALIBRATING SPRAYERS

• ***Calibration of backpack sprayers—for canopy spraying***

1. Fill the spray tank with a known quantity of clean water (e.g. 2 gallons)
2. Determine the number of vines that you can spray on both sides with the spray tank (e.g. 48 vines covered)
3. Determine the total number of vines per acre (e.g. 968 vines per acre)
4. Calculate the spray volume required per acre:

   Spray volume/acre = (vines per acre ÷ vines covered per spray tank) **x** volume applied in spray tank

   e.g Spray volume/acre = (968 ÷ 48) **x** 2 = 40 gallons per acre

• ***Calibration of backpack sprayers—in general***

Use clean water

DYNAMIC CALIBRATION

1. Select correct nozzle and pressure.
2. Measure and mark off an area 10 feet x 10 feet on concrete.
3. Fill sprayer to a known level, mark the fill level.
4. Spray the area on the concrete.
5. Refill sprayer to the fill mark.
6. Compare quantity collected with nozzle chart and desired amount.

STATIC CALIBRATION

1. Select correct nozzle and pressure.
2. Measure and mark off an area 10 feet x 10 feet on concrete.
3. Spray the area and record time taken.
4. Carry out stationary run of same time duration, catching liquid in a graduated measuring jug.
5. Compare quantity collected with nozzle chart and desired amount.

CALCULATING THE AMOUNT OF PESTICIDE TO USE

Some organically approved pesticides are typically sold for large-scale vineyards and give application rates on a per acre basis, or an amount per 100 gallons of spray mix. When converting a known quantity per acre to spray a smaller area, the first step is to measure the area to be sprayed using a tape measure. Divide the number of square feet you have measured by 43,560 to obtain the acreage (in decimal form).

Example:

1. If you are going to spray 20,000 sq. ft,
   20,000 divided by 43,560 = 0.459 acre
2. The label states 3 pints of product per acre
   Multiply the label rate per acre by the decimal for you area
   3 pints multiplied by 0.459 = 1.38 pints
3. Remember there are 16 fl oz in 1 pint.

MEASURING SMALL AMOUNTS OF PESTICIDE

The following tables and examples provide information on converting pesticide rate amounts for smaller areas.

Table 8.1. How much powder or granules should I use?

Volume of liquid	*100 gallons*	*25 gallons*	*5 gallons*	*1 gallon*
Amount of powder or granules to use	4 oz	1 oz	$^{3}/_{16}$ oz	½ tsp
	8 oz	2 oz	$^{3}/_{8}$ oz	1 tsp
	1 lb	4 oz	$^{7}/_{8}$ oz	2 tsp
	2 lb	8 oz	1 ¾ oz	4 tsp
	3 lb	12 oz	2 $^{3}/_{8}$ oz	2 Tbsp
	4 lb	1 lb	3 ¼ oz	2 Tbsp + 2 tsp

• Powders and granules

Example: The label states 3 lbs of powdered product per 100 gallons but you only wish to use a backpack sprayer with a 5-gallon tank. Table 8.1 shows you need to mix in 2$^{3}/_{8}$ oz of powder. Use clean weighing scales to provide the correct amount of powder, NEVER use a volumetric measure, e.g. a measuring cup, because the bulk density of different products varies.

Table 8.2. How much liquid should I use?

Volume of liquid	*100 gallons*	*25 gallons*	*5 gallons*	*1 gallon*
Amount of liquid to use	1 gal	2 pts	6 ½ oz	1 ¼ oz
	4 pts	1 pt	3 ¼ oz	$^{5}/_{8}$ oz
	2 pts	½ pt	1 $^{9}/_{16}$ oz	$^{5}/_{16}$ oz
	1 ½ pt	6 oz	1 ¼ oz	¼ oz
	1 pt	4 oz	$^{7}/_{8}$ oz	$^{3}/_{16}$ oz
	8 oz	2 oz	$^{7}/_{16}$ oz	½ tsp
	4 oz	1 oz	¼ oz	¼ tsp

• Liquids

Example: The label states 4 pts of a liquid product per 100 gallons of spray but you only wish to use a backpack sprayer with a 5-gallon tank. Table 8.2, below, shows you need to mix in 3¼ fl oz of liquid product. Use a clean measuring cylinder or vessel to provide the correct amount of liquid.

Table 8.3. Dilution of liquid products to various concentrations

Dilution rate	*1 gallon*	*3 gallon*	*5 gallon*
1 in 100	2 Tbsp + 2 tsp	½ cup	¾ cup + 5 tsp
1 in 200	4 tsp	¼ cup	6 ½ Tbsp
1 in 800	1 tsp	1 Tbsp	1 Tbsp + 2 tsp
1 in 1000	¾ tsp	2 ½ tsp	1 Tbsp + 1 tsp

• Measuring equipment*.*

Always use measuring equipment that is dedicated only for pesticide use. For very small quantities of liquids, a syringe can be useful. For powder or granular products use weighing scales, do not rely on a measuring cup as the bulk density of products varies.

• ***Safety***. Be sure to wear the proper protective clothing and equipment as required on the pesticide label. Always be aware of watercourses, neighboring properties and changes in the weather.

8.2 Selecting a Small Sprayer for the Small, Organic Vineyard

There are many important points to consider before purchasing a sprayer, not the least of which is the area to spray, the proximity of the local supplier, standard of manufacture etc. There are many growers with small vineyards who don't require airblast sprayers and have a need for spraying equipment ranging from backpack sprayers to small truck- or ATV-mounted machines.

CANOPY SPRAYERS

Backpack sprayers

Small capacity (4-5 gallon) sprayers will produce up to approximately 100 psi pressure. Weight is an important consideration and growers should select a sprayer with good, wide, padded straps to ease the load on your shoulders. Correct nozzle selection according to the target is very important to ensure even coverage. A good-sized filling hole at the top is also important.

There are three factors affecting application rate - forward speed, pressure, and nozzle tip size. Unfortunately most inexpensive backpack sprayers have no pressure gauge. Pay more money and purchase a backpack sprayer with a pressure gauge or, better still, purchase a spray management valve as standard or as an option. Normally output increases or decreases according to the pressure in the system, (which is dependent upon how vigorous you are in pumping the handle up and down). A spray management valve, such as a CF valve, will ensure a constant output irrespective of hand pump action. The CF valve evens out fluctuations in pressure, e.g. will only allow a maximum and minimum pressure thus ensuring even flow. The Fountainhead Group also sell a backpack sprayer with a simple valve which ensures the correct pressure is not exceeded.

An alternative to the hand-operated backpack sprayer is an electrically-operated backpack sprayer, which utilizes a small rechargeable battery. Maximum pressure is relatively low and it is easier than using a traditional hand pump system, particularly if you have many rows of vines to spray. Similarly a small back pack sprayer fitted with a small gas engine is available. The electric version is quieter to use, but you must remember to recharge the batteries otherwise spraying will be delayed.

Portable mist and air blower backpacks

These are ideal for vineyards where canopy penetration is required, e.g. denser, less manicured canopies. A small gas engine drives a fan blower which creates an airstream which passes along a hand-held tube (similar to a leaf blower). The tube has a nozzle situated at the end so that liquid spray can be squirted into the airstream. The operator directs the spray cloud towards the canopy by pointing the hand-held tube. It is preferable to point the tube backwards to avoid walking into the spray cloud. Engine speed can be reduced which enables a slower airspeed to match a smaller canopy in early season. They are very good at rustling the canopy and getting good penetration and deposition. They are heavy! Noise is a problem, so ear protection must be worn.

Portable engine-driven gas sprayers

If weight is a problem, and ground conditions are relatively smooth, a number of manufacturers offer a sprayer with a small gas engine and a 10 to 12 gallon tank. Larger capacity tanks (14 to 100 gallons) are often trailed and can be pulled by a lawn tractor, ATV, Gator, or small tractor.

Small, mounted sprayers

Ideal for mounting onto the carrier rack of an ATV, 15 to 25 gallons, they use a small electric pump to provide up to 70 psi. When used with a hand wand and a hose, they can be used to spray short lengths of vine rows. The same system is ideal for weed control and spot spraying of weeds.

Large, skid mounted sprayers

Ideal for fitting into the back of a pick-up truck, these sprayers have a tank capacity of 35 to 200 gallons, and an electric-start gas engine.

Small, trailed airblast sprayers

Very small airblast sprayers, with tank capacities up to 110 gallons and a 5.5 to 20 hp gas engine, can be towed by an ATV or a small tractor. Larger tank capacities up to 300 gallons are also available but require larger tractors with weights and brakes for safe operation. Remember, the larger the gas engine, the more important it is to buy an electric start option. Small airblast sprayers are ideal in smaller vineyards but suffer from a lack of air direction, therefore purchase sprayers with deflectors or towers to direct the air into the canopy.

Small, mounted airblast sprayers

Three-point hitch, PTO-driven models with a 22- or 24-inch fan, for fitting onto 25 plus hp tractors are available. Beware of drift, again consider models which direct the air via deflectors or towers.

HERBICIDE OR GROUND APPLICATION SPRAYERS

Backpack, small ATV-mounted tank, and hand-lance sprayers

These sprayers can be used for herbicide application **BUT** be very careful that there is no carry-over from herbicide residues in the sprayer, therefore wash them out very thoroughly before using them to apply materials other than herbicides.

Controlled Droplet Applicators (CDA)

The use of CDA's will considerably reduce the need to carry vast amounts of water. A spinning disc (battery powered) will produce 95% of the same-size droplets, thus reducing herbicide rates by at least 50% and water rates by 75%. Herbi and Mantis (trade names) are both hand-held CDA sprayers. ATV- or tractor-mounted shielded CDA sprayers such as the Environmist also reduce spray rates while shielding the vines from the spray.

Wick wipers

Where occasional weeds and access over wet land are a problem, the use of a hand-held wick wiper is an easy-to use, effective option. A small tank, usually contained in the handle, holds the liquid, which soaks a rope wick or a sponge. The rope or sponge can then be wiped against the weeds.

For further information on pesticide application technology visit http://www.nysaes.cornell.edu/ent/faculty/landers/pestapp and consult Chapter 7, Sprayer Application Technology, in the New York and Pennsylvania Pest Management Guidelines for Grapes http://ipmguidelines.org/grapes/.

9. PESTICIDES MENTIONED IN THIS PUBLICATION

Table 9.1 Fungicides and Bactericides

Trade Name	Active Ingredient	EPA Reg. No.
Actinovate-AG	*Streptomyces lydicus*	73314-1
Champ WG	copper hydroxide	55146-1
Kumulus DF	sulfur	51036-352-66330
Micro Sulf	sulfur	55146-75
Miller Lime-Sulfur Solution	calcium polysulfide	66196-2-72
Milstop	potassium bicarbonate	70870-1-68539
Nordox 75 WG	copper oxide	48142-4
NuCop 50 WP	copper hydroxide	45002-7
Organic JMS Stylet Oil	paraffinic oil	65564-1
OxiDate Broad Spectrum Bactericide/Fungicide	hydrogen dioxide	70299-2
Serenade ASO	*Bacillus subtilis*	69592-12
Serenade MAX	*Bacillus subtilis*	69592-11
Sonata	*Bacillus pumilis*	69592-13
Sporan EC	rosemary oil	exempt from registration
Thiolux Jet	sulfur	100-1138
Trilogy	neem oil	70051-2

Table 9.2. Insecticides and Miticides

Trade Name	Active Ingredient	EPA Reg. No.
Aza-Direct	azadirachtin	71908-1-10163
Biobit HP Biological Insecticide	*Bacillus Thuringiensis*	73049-54
Deliver Biological Insecticide	*Bacillus Thuringiensis*	70051-69
Ecozin-Plus 1.2 ME	azadirachtin	5481-559
Entrust	spinosad	62719-282

Table 9.2. Insecticides and Miticides		
Trade Name	**Active Ingredient**	**EPA Reg. No.**
Garlic Barrier AG repellent	garlic juice	exempt from registration
Golden Pest Spray Oil	soybean oil	57538-11
Kumulus DF	sulfur	51036-352-66330
Miller Lime-Sulfur Solution	calcium polysulfide	66196-2-72
Mycotrol O	*Beauveria bassiana* strain GHA	82074-3
Naturalis L	*Beauveria bassiana* ATCC 74040	53871-9
Neemix 4.5	azadirachtin	70051-9
Organic JMS Stylet Oil	paraffinic oil	65564-1
PyGanic EC 1.4 II	pyrethrins	1021-1771
PyGanic EC 5.0 II	pyrethrins	1021-1772
Surround WP	kaolin	70060-14
Thiolux Jet	sulfur	100-1138
Trilogy	neem oil	70051-2

Table 9.3. Herbicides		
Trade Name	**Active Ingredient**	**EPA Reg. No.**
Cinnamon Oil	cinnamon oil	exempt from registration
GreenMatch	citrus extract (d-limonene)	82052-4
Matran EC	clove oil	exempt from registration

Table 9.4. Mollusk Control Chemicals		
Trade Name	**Active Ingredient**	**EPA Reg. No.**
Sluggo-AG	iron phosphate	67702-3

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