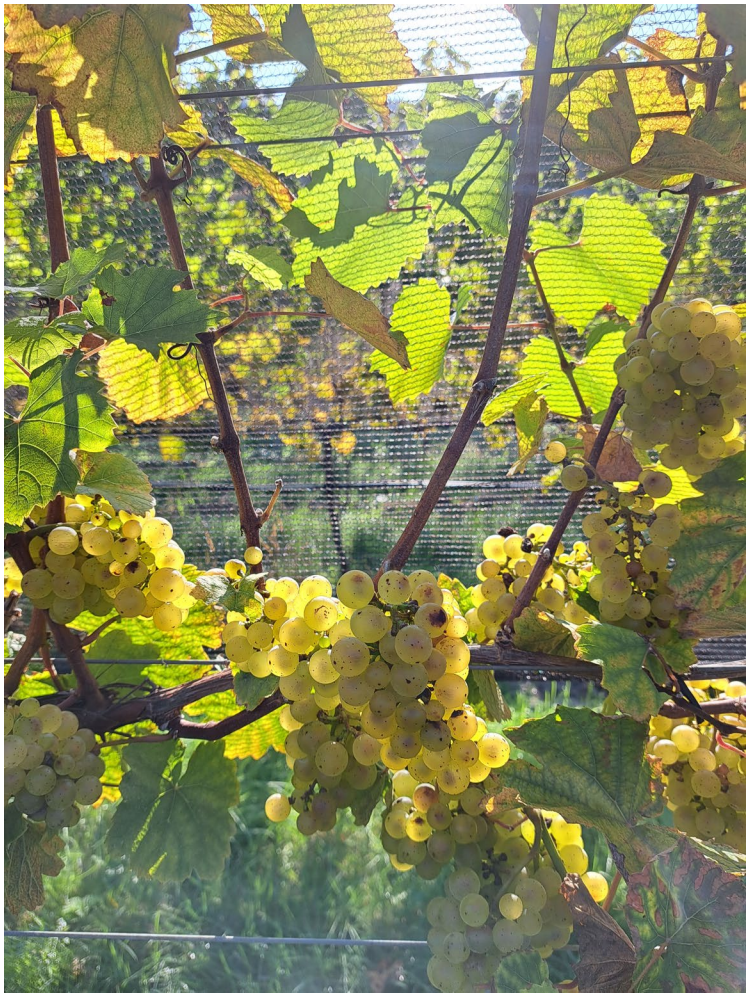


2024
New York and Pennsylvania Pest Management Guidelines for Grapes

Cornell Cooperative Extension

PennState Extension

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

2024 New York and Pennsylvania Pest Management Guidelines for Grapes

Authors

Bryan Brown (NYS Integrated Pest Management Program, Cornell AgriTech, Geneva, NY; *weed management*)

Katie Gold (School of Integrative Plant Sciences, Plant Pathology and Plant-Microbe Biology Section, Geneva, NY; *disease management*)

Bryan E. Hed (Penn State University, North East, PA; *disease management*)

Michael Helms (CCE-PSEP, Cornell University, Ithaca, NY; *pesticide information*)

Greg Loeb (Department of Entomology, Geneva, NY; *entomology*)

Lynn Sosnoskie (School of Integrative Plant Science, Horticulture Section, Cornell AgriTech, Geneva, NY; *weed management*)

Special Appreciation

Special appreciation is extended to the following for their contributions to this publication:

Andrew J. Muza (retired – Penn State Cooperative Extension – Erie County, Erie, PA); Terence R. Bates (Lake Erie Regional Grape Program, Portland, NY); Bruce I. Reisch, (School of Integrative Plant Sciences, Horticulture Section, Geneva, NY); Timothy E. Martinson (Cornell Cooperative Extension, Geneva NY); Alice V. Wise (Cornell Cooperative Extension – Suffolk County, Riverhead, NY); and Hans C. Walter-Peterson (Finger Lakes Regional Grape Program, Penn Yan, NY)

Disease Management: Wayne F. Wilcox (retired – School of Integrative Plant Sciences, Plant Pathology and Plant-Microbe Biology Section, Geneva, NY); David M. Gadoury (School of Integrative Plant Sciences, Plant Pathology and Plant-Microbe Biology Section, Geneva, NY); Amara Dunn (Biocontrol Specialist, NYS Integrated Pest Management Program, Geneva, NY); Timothy H. Weigle (retired - NYS Integrated Pest Management Program, Portland, NY); David Combs (School of Integrative Plant Sciences, Plant Pathology and Plant-Microbe Biology Section, Geneva, NY)

Entomology*:* Michael C. Saunders (retired – Department of Entomology, University Park, PA), Jody Timer (retired – Penn State University, North East, PA); Heather Leach (Department of Entomology, University Park, PA); Timothy H. Weigle (retired - NYS Integrated Pest Management Program, Portland, NY)

Weed Management: Andrew F. Senesac (retired – Cornell Cooperative Extension – Suffolk County, Riverhead, NY); Alice V. Wise (Cornell Cooperative Extension – Suffolk County, Riverhead, NY); Rick Dunst (retired - Lake Erie Regional Grape Program, Portland, NY)

Sprayer Technology: Andrew J. Landers (retired – Department of Entomology, Geneva, NY)

Abbreviations and Symbols Used in This Publication

A.....acre	EC.....emulsifiable concentrate	SP.....soluble powder
AI.....active ingredient	F.....flowable	UDH .....up to day of harvest
AS.....aqueous suspension	G.....granular	ULV.....ultra-low volume
D.....dust	L.....liquid	W.....wettable
DF.....dry flowable	P.....pellets	WDG ....water-dispersible granule
DG.....dispersible granule	PHI.....pre-harvest interval	WP.....wettable powder
DTH.....days to harvest	SC.....suspension concentrate	WSP.....water soluble packet
E.....emulsion, emulsifiable		

* ..... Federal restricted-use pesticide; may be purchased and used only by certified applicators
*[NY] .... Restricted-use pesticide in New York State
† ..... Not for use in Nassau and Suffolk Counties
^ ..... Not registered for use in New York State at press time.

Every effort has been made to provide correct, complete, and up-to-date pest management information for New York State and Pennsylvania at the time this publication was released for printing (April 2024). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available in county cooperative extension offices or from the Cornell Cooperative Extension Pesticide Safety Education Program (CCE-PSEP) (psep.cce.cornell.edu) or from the Pennsylvania Department of Agriculture's Bureau of Plant Industry (www.agriculture.state.pa.us).

Where trade names appear, no discrimination is intended, and no endorsement by Cornell Cooperative Extension or Penn State Cooperative Extension is implied.

These guidelines are not a substitute for pesticide labeling. Always read and understand the product label before using any pesticide.

The guidelines in this bulletin reflect the current (and past) authors' best efforts 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.

Cover photo by: *Jeremy Schuster, Eastern NY Commercial Horticulture Program.*

1 Pesticide Information

1.1 Pesticide Classification and Certification

Pesticides can be classified as general-use or restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides** can only be purchased and used by a certified applicator or used by someone under a certified applicator's supervision. In some cases, the pesticide label may limit use of a restricted-use pesticide to only a certified applicator.

Private applicators use or supervise the use of pesticides to produce agricultural commodities or forest crops on land owned or rented by the private applicator or their employer. If a private applicator wants to use or supervise the use of restricted-use pesticides, they need to be a **certified private applicator**. Certified private applicators are also allowed to purchase restricted-use pesticides. Certification is not needed if a private applicator uses general-use pesticides.

In New York State, a **certified commercial applicator**, **certified commercial technician**, or **commercial apprentice** working under the supervision of a certified commercial applicator is allowed to apply any type of pesticide on property that is not a private application (described above) or is a residential application. (A residential application is the use of general-use pesticides on property owned or rented by the applicator, excluding establishments selling or processing food and residential structures other than where the applicator lives.) Certified commercial applicators are allowed to purchase restricted-use pesticides.

Information on pesticide certification and classification is available from your Cornell Cooperative Extension office (cce.cornell.edu/localoffices), regional NYSDEC pesticide specialist (www.dec.ny.gov/about/558.html), the Pesticide Applicator Training Manuals (www.cornellstore.com/books/cornell-cooperative-ext-pmep-manuals), or the Cornell Cooperative Extension Pesticide Safety Education Program (psep.cce.cornell.edu).

1.2 Use Pesticides Properly

Using pesticides requires the user to protect their health, the health of others, and the environment. Keep in mind "pesticide use" is more than just the application. It includes mixing, loading, transporting, storing, or handling pesticides after the manufacturer's seal is broken; cleaning pesticide application equipment; and preparing a container for disposal. These activities require thoughtful planning and preparation. They also require you to comply with state and federal laws and regulations intended to protect human health and the environment from the adverse effects pesticides may cause.

1.2.1 Plan Ahead

Many safety precautions should be taken *before* you begin using pesticides. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before using the pesticide.** Make sure you understand and can follow all label directions and precautions. Be prepared to handle an emergency exposure or spill. Know the first aid procedures for the pesticides you use.

1.2.2 Move Pesticides Safely

Transporting pesticides carelessly can result in broken containers, spills, and contamination of people and the environment. Accidents can occur even when transporting pesticides a short distance. You are responsible for a pesticide accident so take every effort to transport pesticides safely. Be prepared for an emergency.

1.2.3 Personal Protective Equipment and Engineering Controls

Personal protective equipment (PPE) needs depend on the pesticide being handled. **Required PPE are listed on pesticide labels.** Any required PPE is based on the pesticide's toxicity, route(s) of exposure, and formulation. Label-listed PPE are the minimum that must be worn when using a pesticide. You can always use more than what's listed!

The type of PPE used depends on the type and duration of the activity, where pesticides are being used, and the user's exposure. For example, mixing/loading procedures often require more PPE than when applying a pesticide. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates is the most hazardous activity.

Engineering controls are devices that help reduce a pesticide user's exposure. An example is a closed transfer system that reduces the exposure risk when dispensing pesticide concentrates. Consult the product label for more information on using engineering controls in place of PPE.

1.2.4 Avoid Drift, Runoff, and Spills

Pesticides that move out of the target area can injure people, damage non-target areas, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants to minimize drift and runoff potential. Product labels may have specific application and/or equipment requirements to reduce issues with drift and runoff.

2 Introduction

2.1 Overview

How do you decide which pest management strategy is right for you? The variety of choices can be daunting: integrated pest management, sustainable, integrated crop management, organic, best management practices, biodynamics, or traditional, just to name a few. However, what it boils down to is that it doesn't really matter what you call your pest management strategy. Consider which practices work best for you in a particular vineyard. Take the best tools from each of the different programs to provide you with the management strategy that fits your needs and pocketbook.

The one component that every successful pest management strategy shares is information. By gathering and compiling the right information, you will be able to make the best choices in putting together your vineyard pest management strategy.

2.2 Specific Fungicide, Insecticide, and Herbicide Information

The following materials have been registered for the control of certain insects, diseases, and weeds affecting grapes. The trade name and (common) name are given, as well as selected uses for each material. The signal word associated with each pesticide indicates its relative level of toxicity. High toxicity indicates that small quantities of the chemical may cause serious illness or death.

2.2.1 Pesticide Toxicity

The toxicity of a chemical typically is measured with a Lethal Dose 50 (LD50) value. This value is the dosage necessary to kill 50 percent of a laboratory population of test animals (rats, mice, or rabbits). These toxicity values may be expressed in terms of a single dosage in milligrams per kilogram of body weight. LD50 values are useful in comparing different pesticides, as the degree of hazard to a person handling a pesticide is directly related to toxicity.

The following classification was established to aid users of pesticide chemicals:

High toxicity: Acute oral LD50 from a trace to 50 mg/kg. From 4 to 100 drops (1 teaspoon) of technical pesticide may be lethal to a 150-pound person. Label must carry signal word DANGER. A skull and crossbones on the label indicates poison.

Moderate toxicity: Acute oral LD50 from 50 to 500 mg/kg. From 1 teaspoon to 1 ounce of technical pesticide may be lethal to a 150-pound person. Label must carry signal word WARNING.

Low toxicity: Acute oral LD50 greater than 500 mg/kg. From 1 ounce to 1 pint of technical pesticide may be lethal to a 150-pound person. Label must carry signal word CAUTION.

2.2.2 Pesticide Compatibility

Some pesticides are unstable or incompatible under alkaline conditions. Well or pond water used to fill sprayers can be alkaline, and pH should be tested and adjusted if over 7.0. Do not apply tank-mix combinations unless your previous experience indicates the mixture is effective and will not result in application problems or plant injury. If tank-mix compatibilities are unknown, the mixture should be combined in the proper proportions using a jar test. CAUTION: Fixed copper formulations and lime should not be used with Captan, Imidan, or Sevin.

2.2.3 Adjuvants with Fungicides and Insecticides

The addition of adjuvants (spreader-stickers, penetrants, etc.) to spray mixtures of fungicides and insecticides is not recommended unless suggested on the pesticide label or supported by reliable data. Many fungicide and insecticide formulations already include an adjuvant; thus, addition of another adjuvant is often counterproductive or a waste of money.

2.2.4 Pesticide Resistance Management

The ability of various fungicides, insecticides, and herbicides to control specific grape pests has been reduced (and, in some cases, eliminated) because pests developed resistance to these materials. Resistance occurs when some individual pests survive treatment with the pesticide. They multiply and pass this resistance on to their young. Because individuals that are controlled by the chemical die, or reproduce poorly, over time the population becomes dominated by individuals that are resistant to it. This process is favored by a number of factors, the most common of which are:

1. Multiple applications of a single product or class of compounds (strobilurin fungicides, organophosphate insecticides, etc.);
2. An exclusive reliance on a single product (or class) to manage the pest;
3. Repeated treatments of large pest populations with the products (e.g., "rescue" treatments); and, in some cases
4. Attempts to manage the pests with very low rates of the products (either intentionally or due to poor spray coverage).

Although it's not possible to guarantee that resistance will never develop to any specific pesticide, ALL growers

site and selecting Grape Forecast models. Used on a regular basis, model information for the various pest models can assist in determining whether the spray interval for these diseases should be tightened or extended. The Grape Diseases forecasts operate like a mini-expert systems with disease management options developed by Wayne Wilcox (Department of Plant Pathology and Plant-Microbe Biology, Cornell University) and Juliet Carroll and Tim Weigle (NYS IPM Program). Being able to choose the current phenological stage of a vineyard, or portion of a vineyard, provides customized results for all the different varieties in a vineyard operation.

The phenology-based degree-day model for grape berry moth found on NEWA was developed as a cooperative effort between research entomologists and extension staff at Cornell, Penn State and Michigan State Universities. This model uses wild grape bloom as a biofix date to start accumulation of degree-days and allows the date of wild grape bloom to be entered for customized results. While the model will provide a default date for wild grape bloom, the ability to enter the actual date wild grape bloom was observed makes the information provided by the model much more valuable.

Using the pest forecast model and weather information found on NEWA a vineyard IPM strategy can be developed that uses resources wisely while managing pest populations to a commercial level. NEWA combines knowledge of the pests' life cycle and how weather conditions affect its development with current and historical weather data to generate infection event and insect development status and predictions or forecasts. Combining the results of models found on NEWA knowledge of pests by individual vineyard blocks, varietal susceptibility, and the materials used for managing the pests provides the basis for implementation a sound vineyard IPM strategy.

Other resources are available online, including:

Network for Environment and Weather Applications
newa.cornell.edu

2024 New York and Pennsylvania Pest Management Guidelines for Grapes:
cropandpestguides.cce.cornell.edu

New York State grape IPM insect and disease fact sheet database:
https://ecommons.cornell.edu/handle/1813/41246/discover?query=%22NYS+IPM+Type:+Fruits+IPM+Fact+Sheet%22&submit=&rpp=10

Cornell Pesticide Safety Education Program:
psep.cce.cornell.edu

Penn State Pesticide Education Program:
extension.psu.edu/insects-pests-and-diseases/pesticide-applicators

2.5 Growth Stages Critical to Grape Pest Management

bud swell

3 Vineyard Disease Management

3.1 Pest Information – Diseases

Several important insects and diseases that occur in New York and Pennsylvania vineyards are described below to help growers manage these pests with practices and pesticides appropriate for their production systems.

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 most likely to become a problem in years when high rainfall occurs between bud break and early summer, especially if this should happen in consecutive years. Riesling appears to be a particularly susceptible cultivar.

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 sharply defined (depending on the cultivar, the margin may be yellow, red, or absent). Lesions are confined by major veins, becoming "angular" or wedge-shaped. They eventually kill the infected tissue, sometimes crossing the major veins in the process and often causing diseased 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 periods of leaf wetness that favor disease development. Destruction of leaf litter by cultivation, before bud break, can also reduce disease pressure. Where needed, effective fungicides applied from the 3-inch stage and continuing through fruit set will provide significant control. Although there are no specific labels for the control of this disease, mancozeb products (e.g., Dithane, Penncozeb) applied according to label directions to control Phomopsis, black rot, and downy mildew also have provided good control of angular leaf scorch in commercial experience. In Europe, the strobilurin fungicides (Abound, Flint, Pristine, *[NY]Sovran) have provided good control of the closely related disease, rotbrenner. However, experience with angular leaf scorch is lacking. The DMI fungicide, difenoconazole (Revus Top, Quadris Top; CAUTION: Quadris Top causes injury to Concord and some other cultivars) is labeled for control of rotbrenner and should provide significant post-infection control of this disease in addition to moderate protective activity (excellent protective activity for Quadris Top). See Table 3.1.1 for varietal susceptibility to this disease.

ANTHRACNOSE is a disease that occurs most commonly in years that are wet during the first half of the growing season, with damage typically limited to a few highly susceptible cultivars. In NY/PA, most outbreaks historically occurred on Vidal Blanc and a few seedless table grape varieties, especially Reliance. In recent years, however, there have been regular outbreaks on some of the newer cold-hardy cultivars that are gaining in popularity and expanding the geographical range of grape production. Marquette appears to be particularly susceptible, although Frontenac and La Crescent also have been affected. Some older cold-hardy cultivars (Edelweiss, Esprit, Brianna, St. Pepin, and Swenson White) also can be problematic. In some Midwestern states, Concord, Catawba, and Leon Millot have been reported as encountering problems, although such occurrences are rare in NY and PA. 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 large dead zones, distortion of the leaf blade, and eventually death of the entire leaf. Infected shoots develop dark, noticeably sunken lesions, typically on the first several internodes near the base of the new shoot. These lesions resemble the internode lesions typical of Phomopsis cane and leaf spot but they usually are more aggressive, expanding farther along the shoot and deeper into its center than those caused by Phomopsis. On berries, spots approximately 0.25-in in diameter develop, with whitish-gray centers surrounded by reddish brown to black margins, sometimes producing an appearance that superficially resembles a bird’s eye. Severely affected berries may shrivel and dry into mummies.

The fungus overwinters primarily on infected canes, although the previous year's berries can also be a source. In spring, spores are produced from the fungal structures on these sources and are dispersed by splashing raindrops to young, susceptible tissues, where they cause infection if wetness persists for a sufficient length of time. Temperatures in the mid-70s to mid-80s Fahrenheit (25-30°C) are optimal and require only 3 to 4 hours of leaf wetness for infection to occur. However, infection can also occur across a much wider range of temperatures, including those that typically prevail during the early growing season in upstate NY, if it remains wet for long enough. Additional spores, which also are splash dispersed, are produced from 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 early and mid-season. Young tissues are most susceptible, becoming resistant as they are mature; for example, berries become relatively resistant by about 7 weeks post-bloom.

Table 3.1.1 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]**
Seyval	++	++	+++	+++	+++	+	++	++	No	+
Steuben	++	+	+	+	?	?	+	++	Yes	?
Traminette	++	++	+	++	?	?	+	?	No	?
Valvin Muscat (NY62.0122.01)	++	+	++	+	?	?	+	?	No	?
Vanessa	+++	++	++	+	+	?	+	?	No	?
Ventura	++	++	++	+	+	?	+	+++	No	?
Vidal 256	+	++	++	+	+	+	++	+	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 in NY and PA. 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 slow-drying conditions (cool or very humid).

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 neutralized by covering the berries with soil through cultivation or, if practical, covering them with mulch. Early-season sprays of mancozeb, captan, or ziram targeted against Phomopsis also provide significant control of anthracnose, although this latter disease is not listed as a target on most labels. Some DMI (Group 3) fungicides, e.g., difenoconazole (Revus Top, Quadris Top, and Inspire Super), myclobutanil (Rally), and tetraconazole (Mettle) are specifically labeled for anthracnose control. A "delayed dormant" application of lime sulfur can be useful in vineyards where the disease has become established and problematic to control and/or in "organic" vineyards where traditional fungicides are not used. This treatment limits the production of infectious spores from overwintered cankers but does not protect new growth from any spores that survive the application or are produced after its effects wear off.

BITTER ROT and **RIPE ROT** are two diseases that are common in states to the south of PA where temperatures are consistently warmer, although they also occur sporadically in NY and PA, especially in the southern regions of our two states. The two diseases are caused by different fungi, but both have similar biologies and respond to the same management practices. Bitter rot is active at somewhat lower temperatures than ripe rot and is the more regular threat in the mid-Atlantic region, although their geographical ranges overlap. In NY, bitter rot has been most problematic on Long Island, primarily in years with wet summer and pre-harvest periods (particularly on Chardonnay). It has also been problematic in southeast PA in some years, and both diseases occur further north on occasion. Usually, bitter rot symptoms first develop after veraison, when the causal fungus moves into the berry from the infected berry stem and turns the diseased portion brown (on white varieties) or a dull purple. Once the berry is completely rotted, it becomes covered with numerous prominently raised black pustules (the fungal fruiting bodies, called acervuli). Within a few days, diseased berries soften and may drop; others shrivel into mummies that resemble those caused by black rot and Phomopsis. This late onset of symptom appearance is one feature that distinguishes bitter rot from black rot (virtually all black rot infections should be apparent by veraison); others include (i) the appearance of the fungal fruiting bodies on infected fruit (those of black rot are relatively small, round and uniform in size, whereas those of bitter rot are larger and much more pronounced, providing a bumpy texture to the berry); (ii) the tendency of black-rot infected fruit to remain attached to the berry stem when pulled gently, whereas those with bitter rot are more easily detached; and (iii) the tendency of fruit infected with bitter rot to leave hands sooty black if handled when wet, whereas those infected with black rot will leave hands clean. Berries infected with Phomopsis also tend to first appear during the preharvest period but are detached very easily when pulled, and the black fruiting bodies produced on rotten berries are relatively few and inconspicuous. Also, significant Phomopsis fruit rot typically occurs in association with significant visible infections of the cluster stem and of the shoots and petioles (leaf stems) near the bottom three to five leaf positions on shoots that bear diseased berries. An

of bunch rots and/or wine spoilage microorganisms. Maintenance programs to protect foliage throughout the summer are necessary for attaining maximum fruit and vine quality on *V. vinifera* and susceptible hybrid cultivars. Good control of foliar infections through Labor Day will contribute significantly to the control of fruit infections the following year, since it will limit the overwintering inoculum needed to produce them.

RIPE ROT (see "Bitter rot")

SOUR ROT develops on injured berries when the weather is wet during the pre-harvest period, particularly if it is relatively warm (above 60°F, with 70s being optimum for disease development) for a significant length of time then. The characteristic vinegar smell from which the disease gets its name results from the activity of a specific group of bacteria, which oxidize the ethanol that wild yeasts produce from the juice of the injured berries. Such berries may also show signs of various "secondary" fungi that colonize decaying fruit, and may further be colonized by certain other yeasts that produce a compound (ethyl acetate) that smells like nail polish remover, which detracts from the quality of finished wines. Numerous fruit flies (sometimes called vinegar flies) – i.e., *Drosophila* spp. – also swarm around decaying berries and multiply by laying their eggs within them. These insects play a central role in the development of the disease and furthermore spread the decay organisms throughout the vineyard once some clusters begin to break down. The sour rot organisms also are spread as diseased berries drip contaminated juice onto nearby healthy berries, which in turn become infected through any wounds that might be available. Rain cracks, bird and insect damage, Botrytis or powdery mildew infections, and mechanical injuries caused as swelling berries pull away from their stems in tightly compacted bunches are among the many injury sites in which sour rot can become established.

Sour rot can increase very rapidly during the pre-harvest period, and it long has been thought to be almost impossible to stop the disease once it has become established if warm and wet conditions persist. However, recent research suggests that disease development can be reduced through a combination of insecticide sprays to control *Drosophila* fly populations and registered broad-spectrum sterilants (e.g., Oxidate) to limit microbial populations on the berries. This program is most effective if started around 15°Brix, as berries become susceptible and before symptoms develop, but it also can reduce further spread if initiated immediately after the disease is noticed through scouting activities. Limiting various causes of injury will also greatly reduce sour rot development. Open canopies and leaf removal around clusters, which allow them to dry once rains have stopped, can lower disease severity significantly. As with Botrytis, practices that loosen cluster compaction can have a major effect on limiting sour rot development; however, most of these practices remain experimental or difficult to employ.

3.2 Fungicide Information

ABOUND (azoxystrobin) – read the label

Signal word: CAUTION

***Medical emergency*:** (800) 888-8372

Chemical/fungicide family: strobilurin [QoI]

Resistance Group Number: 11

Resistance risk: high

Physical mode of action: protectant, variable but limited post-infection, antisporulant

Selected uses: powdery mildew, downy mildew, black rot; modest suppression of Phomopsis and Botrytis

Comments: Azoxystrobin is the active ingredient in Abound. It also is formulated with DMI fungicides, to make two different combination products, Quadris Top (in combination with difenoconazole) and †Topguard EQ (in combination with flutriafol), and with mancozeb to make *[NY]Dexter Max. Abound was the first registered compound in the strobilurin (or "QoI") group of fungicides. It once provided excellent control of both powdery and downy mildew, very good control of black rot, and fair control of Phomopsis and Botrytis. It also provides control of the late season "summer rots" (bitter rot, ripe rot), although it is not specifically labeled for this purpose. However, the powdery mildew fungus has developed resistance to the strobilurin fungicides in multiple vineyards, resulting in poor control of the disease where this has occurred. Resistance to the strobilurins by the downy mildew fungus also appears to have developed in a number of NY vineyards and has been documented as the cause of DM control failures in numerous vineyards elsewhere. Abound is absorbed into the waxy cuticle of the leaves and fruit (hence, it is relatively resistant to wash-off) but works primarily in a protective mode; that is, it is most effective when present before an infection period occurs. However, it does have limited post-infection activity against black rot and modest post-infection activity against non-resistant strains of the powdery mildew fungus. Also, it can limit disease spread by suppressing the production of new spores when applied post-infection, even if applied too late to prevent other symptoms from developing. Abound is labeled for use at 10 to14 day intervals at a rate of 10.0 to 15.5 fl oz/A of the 2SC formulation. ABOUND IS LABELED FOR APPLICATION WITH GROUND EQUIPMENT ONLY, AND CANNOT BE APPLIED WITH AIRBLAST EQUIPMENT IN CERTAIN TOWNSHIPS AND BOROUGHS OF ERIE COUNTY, PA. It has a 4-hour reentry interval and may be applied to within 14 days of harvest.

CAUTION: Abound, Quadris Top, †Topguard EQ, and *[NY]Dexter Max are extremely phytotoxic to many apple cultivars, especially McIntosh and its relatives (e.g.,

Table 3.2.1 Physical modes of action of and resistance risk of fungicides used in management of grape diseases[1].

Fungicide	Protectant[a]	Post-infection[b]	Anti-sporulant[c]	Eradicant[d]	Resistance risk	Resistance group
mandestrobin (*[NY]†Intuity)	+	+?	+?	-	H?	11
mandipropamid (Revus, Revus Top)	+?	+	+?	-	M	40
mefanoxam (Ridomil)	+	+	+	-	H	4
mefentrifluconazole (*[NY]Cevya)	+/-	+	+	-	M	3
metrafenone (Vivando)	+?	+?	+?	-	M/H?	50
myclobutanil (Rally)[e]	+/-	+	+	-	M	3
phosphorous acid (various formulations)	+/-	+	+	-	M	33
potassium bicarbonate (Kaligreen)[h]	-	+	+	+/-	L	N/A[j]
potassium dihydrogen phosphate (Nutrol)[h]	-	+	+	+/-	L	N/A[j]
Pseudomonas chlororaphis strain AFS009 (Howler)	+	-	-	-	L	BM02
pydiflumetofen + fludioxonil (*[NY]†Miravis Prime)	+	+?	+?	-	M	7, 12
pyrimethanil (Scala)	+	+	+	-	H	9
quinoxyfen (Quintec) [h]	+	-	-	-	M	13
spray oil (JMS Stylet, PureSpray)[h]	+/-	+	+	+	L	N/A[j]
sulfur (several formulations) [f]	+	+	+	+/-	L	N/A[j]
tebuconazole (various formulations)[e]	+/-	+	+	-	M	3
tetraconazole (Mettle)	+/-	+	+	-	M	3
trifloxystrobin (Flint Extra)[e]	+	+/-[f]	+	-	H	11
triflumizole (*[NY]Viticure, *[NY]Procure, *[NY]Trionic)[e, f]	+/-	+	+	-	M	3
Ziram	+	-	-	-	L	N/A[j]
zoxamide + mancozeb (*[NY]Gavel)	+	+	+?	-	M	22

[1]These ratings apply only to the diseases against which the products are labeled for control, and assume recommended rates and timings, and good spray coverage.

Key:

+ significant activity
+/- limited activity, or only active against some target pathogens in this mode
- not active in this mode
H = high, M = moderate, L = low

Notes:

a. Active when present before the pathogen begins to infect.
b. Active when applied after infection has begun, but before symptoms appear.
c. Significantly reduces spore production when applied after infection has occurred, although symptoms may develop or persist.
d. Kills all or most of the fungal colony when applied after symptoms appear.
e. Activities diminished or absent against pathogens resistant to the material.
f. Significant post-infection activity against powdery mildew only.
g. Significant post-infection activity against powdery mildew and Botrytis only.
h. Significant activity against powdery mildew only.
i. Modest post-infection activity likely against powdery mildew.
j. N/A = No resistance group designated since resistance is unknown and unlikely; resistance management not required.
* Federal restricted-use pesticide.
*[NY] Restricted-use pesticide in New York State.
† Not for use in Nassau/Suffolk Counties in New York

4 Vineyard Insect & Mite Management

4.1 Pest Information – Insects

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. Subsequent feeding by larger nymphs and adults does not affect cluster development. Economic injury can occur when more than 1 nymph per 10 shoots are present. This injury only occurs in the prebloom stages. Subsequent feeding by nymphs does not reduce berry set. Adults appear to be predaceous and do not cause injury to berries. Look for nymphs on grape clusters and shoot tips prior to the bloom period. They can be recognized by their long, banded antennae.

BROWN MARMORATED STINK BUG (BMSB) is a new invasive species in New York that may present problems for grapes. This stink bug, originally from Asia, was first observed in PA and has spread to many regions and has become particularly abundant in the mid-Atlantic states. It is present in NY and PA grape-growing regions, although at this time at relatively low numbers. BMSB uses its sucking mouthparts to feed on reproductive structures of many different crop plants, including grapes. At high densities, damage can be extensive. BMSB also produces strong odors that have the potential of tainting grape juice. Recent research indicates the offending compounds are not very stable and break down during fermentation. Even without fermentation, odors are relatively unstable and may not be of significant concern except when consumed close to harvest.

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.

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. See the section on pest management schedules for minor insects (4.3) for pesticide recommendations and other comments.

EUROPEAN RED MITES are spider mites. Adult mites are small, dark red, and have eight legs. 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. 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. *Vinifera* and French hybrid varieties appear to be the most susceptible to infestations, although native varieties can also develop large densities under some conditions. Mites may be found on the upper or lower leaf surface. 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. Recent research indicates that frequent use of mancozeb fungicides reduces predatory mite populations, although mancozeb use does not necessarily lead to mite problems.

Selected use: Grape berry moth, climbing cutworm and Japanese beetle adults (use high rate)

Comments: Not registered for use in Nassau, Suffolk, Kings and Queens Counties of New York State. Also in NY, this product cannot be used within 100 feet of water body and aerial application is prohibited. Chlorantraniliprole is in the anthranilic diamide class of insecticides with a new mode of action that is selective against Lepidoptera and some other insect groups.

***[NY]ASSAIL** (acetamiprid) – read the label

***Signal word**:* CAUTION

Medical emergency: (866) 673-9300

Selected uses: leafhoppers, plant bugs, grape phylloxera, mealybug, Japanese beetle and rose chafer

Comments: The active ingredient is particularly effective against sucking insects such as leafhopper, but also has activity against some beetles such as Japanese beetle and rose chafer.

AVAUNT (indoxacarb) – read the label

Signal word: CAUTION

Medical emergency: (800) 331-3148

Selected use: Japanese beetle, grape berry moth

Comments: REI = 12 hrs, DTH = 7 days. Avaunt has activity against a number of chewing insects including Japanese beetle and grape berry moth. It will help suppress leafhoppers. Conserves some beneficial arthropods. Two applications per season with minimum of 21 days between applications. A new formulation of Avaunt, called Avaunt eVo (WDG), has recently been approved for use on grapes. It has similar uses as Avaunt and similar restrictions but it is reported to be easier to mix and handle. It will eventually fully replace Avaunt.

***BAYTHROID XL** (beta-cyfluthrin) – RESTRICTED-USE PESTICIDE – read the label

Signal word: WARNING

Medical emergency: (800) 334-7577

Selected uses: leafhoppers, grape berry moth, minor insects

Comments REI = 12 hrs, DTH = 3 days. This is a broad-spectrum insecticide in the same chemical class as fenpropathrin and bifenthrin. Harsh on natural enemies and bees as well as aquatic organisms. Maximum use allowed per 14-day interval is 3.2 fl. ounces/A and maximum allowed per crop season is 12.8 fl. Ounces/A. *Tombstone Helios insecticide is a generic pyrethroid that contains cyfluthrin as its active ingredient.

BIOBIT, DIPEL, DELIVER, BT NOW, OTHERS (biological insecticides, active ingredient – *Bacillus thuringiensis* var. *kurstaki*) – read the label

Signal word: CAUTION

Medical emergency: (800) 892-0099 (Biobit and Dipel), (800) 255-3924 (Deliver), (800) 222-1222 (BT NOW)

Selected use: grape berry moth

Comments: These Bt products are highly selective insecticides. Larvae must eat deposits of the insecticide to be affected. Close scouting with early attention to infestation is recommended. Apply when larvae are young. Thorough coverage is needed to provide a uniform deposit at the site of larval feeding. Larvae stop feeding after eating a lethal dose of the insecticide and will die within several days. Consult the label for information concerning active ingredient, application, and tank-mix compatibility.

***BRIGADE 2EC** (bifenthrin) – RESTRICTED-USE PESTICIDE – read the label

Signal word: WARNING

Medical emergency: (800) 331-3148

Selected uses: leafhoppers, grape berry moth, minor insects

Comments: REI = 12 hrs, DTH = 30 days. This is a broad-spectrum insecticide in the same chemical class as fenpropathrin and cyfluthrin. Replaces *Capture 2 EC. There is also a WSB formulation. Harsh on natural enemies and bees as well as aquatic organisms. Maximum use allowed per acre per season is 6.4 fl oz (.1 lb ai). [*Bifenture EC, *Bifenture 10DF, and *Sniper are generic products that have bifenthrin as active ingredient]

***BRIGADIER** (bifenthrin + imidacloprid) – RESTRICTED-USE PESTICIDE – read the label

Signal word: WARNING

Medical emergency: (800) 331-3148

Selected uses: leafhoppers, grape berry moth, minor insects

Comments: REI = 12 hrs, DTH = 30 days. This insecticide combines two active ingredients. Imidacloprid is a narrower spectrum insecticide in the neonicotinoid group that is particularly effective against sucking insects such as leafhoppers. Bifenthrin is a broad-spectrum pyrethroid insecticide in the same chemical class as fenpropathrin and cyfluthrin. Harsh on natural enemies and bees as well as aquatic organisms. Maximum use allowed per acre per season is 12.8 oz of product (0.1 lb ai for bifenthrin and 0.1 lb ai for imidacloprid). *Swagger is a generic product that includes both these active ingredients.

***[NY]†CYCLANILIPROLE 50SL** (cyclaniliprole) – RESTRICTED-USE PESTICIDE IN NY – read the label

Signal word: CAUTION

Medical emergency: (888) 484-7546

Selected use: Lepidoptera, Japanese beetle, thrips, spotted-wing drosophila

Table 4.2.1 Effectiveness of insecticides for management of grape insects and mites. *(continued)*

Key to pests:

BGB = banded grape bug	CW = cutworms	GBM = grape berry moth	GCGL = grape cane gallmaker
GCGR = grape cane girdler	GE = grapevine epimenis	GFB = grape flea beetle	GP = grape phylloxera
GR = grape rootworm	JB = Japanese beetle	LH = leafhoppers	M = mites
RBLR = redbanded leafroller	RC = rose chafer	SB = steely beetle	SF = 8 spotted forester

Key to ratings:

+++ = highly effective ++ =moderately effective + =slightly effective effective or not labeled 0 =not ? =effectiveness not known

* Federal restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.

*NY Restricted-use pesticide in New York State

† Not for use in Nassau/Suffolk Counties

Table 4.2.2 Insecticides for use in New York and Pennsylvania vineyards

Insecticide	IRAC Number[1]	Control method	Longevity	GBM	Leafhopper	Japanese Beetle	Toxic to Natural Enemies
Delegate	5	C, I	**	+++	+	+	Moderate
Entrust	5	C, I	**	++	+	0	Moderate
Biobit, Dipel, Deliver, Javelin	11	I	*	++	0	0	Safe
*NY†Intrepid	18	I	****	+++	0	0	Safe
Movento	23	S, C, I	***	Phylloxera, mealybug, and tumid gall midge control only			Moderate
*NY†Altacor	28	C, I	***	+++	0	+++	Moderate
*NY†Voliam Flexi	28 + 4A	S, C, I	****	+++	+++	+++	Moderate
*NY†Cyclaniliprole	28	C, I	***	+++	0	+++	Moderate
*NY†Verdepryn	28	C, I	***	+++	0	+++	Moderate
Sevin	1A	C	**	++	+++	+++	Toxic
*NYImidan	1B	C	***	+++	++	+++	Moderate
Avaunt	22A	C, I	**	++	+	++	Moderate
Evergreen	27A + 3A	C	*	+	+	+++	Moderate
Grandevo		C, I	**	++	+	++	Safe
*Baythroid	3A	C	***	+++	++++	+++	Toxic
*Brigade	3A	C	***	+++	++++	+++	Toxic
*Danitol	3A	C	***	+++	++++	+++	Toxic
*Mustang Maxx	3A	C	***	+++	++++	+++	Toxic
*Hero	3A	C	***	+++	+++	+++	Toxic
Pyganic	3A	C	*	+	+	++	Moderate
*NY†Actara	4A	S, C, I	****	++	+++	+++	Moderate
*NY†Admire Pro-foliar	4A	C, I	****	0	+++	++	Moderate
*NY†Admire Pro-soil	4A	S, C, I	****	0	+++	++	Moderate
*NYAssail	4A	S, C, I	***	0	+++	+++	Moderate
^Venom, ^Scorpion	4A	S, C, I	****	++	++++	+++	Moderate
*Brigadier	4A + 3A	S, C, I	****	+++	+++	+++	Toxic
*Leverage 360	4A + 3A	S, C, I	****	+++	+++	+++	Toxic?
*NY†Sivanto Prime	4D	S, C, I	****	0	+++	0	Toxic?

5 Pest Management Schedules for Diseases and Major and Minor Insects

5.1 Introduction

This section provides guidelines pertaining to management programs for control of diseases and major insects in vineyards of New York and Pennsylvania. Although this section is organized along a phenological schedule to reflect important events during the growing season, there is no implication that every spray listed will be necessary. Rather, this is a schedule of the various times when individual diseases and insects might require that sprays be integrated into a management program; refer to the notes to help determine which sprays are generally necessary and which ones apply only to certain conditions. Refer to the pictures in the front of this publication for help in identifying critical growth stages during the season. Note comments in right-hand column address precautions or considerations necessary for use of particular methods or materials. Be especially alert to the notations that certain chemicals may not be approved for your state or for certain growing areas within a state.

5.2 Pest Management Schedules for Diseases and Major Insects

Pest(s)		Materials	Rate per Acre	Comments
5.2.1 DORMANT				
Canker diseases (Eutypa, Botryosphaeria)		Mettle 1ME	5 fl oz	Mettle is labeled in all states for spray application in 25 to 50 gpa within 24 hr after pruning, with a 12-hr REI. Consult the label for further use directions. No trials have been conducted in NY or PA to evaluate the efficacy of Mettle for this purpose.
5.2.2 DELAYED DORMANT				
Soft scale insects and mealybugs		petroleum oil	2.5%	**Apply early in the spring at bud swell but before any leaf tissue is exposed.** Apply in 250 to 300 gallons of water. Thorough coverage is essential for good results. Avoid use with captan or sulfur due to phytotoxicity. Also avoid use within 24 hours before or after freezing temperatures. Field data indicate only short-term benefits for reducing mealybug populations. Oil more effective against soft scale.
	OR	Knack	16 fl oz	Only labeled for lecanium scale. Can use oil with Knack at this time (delayed dormant). Not to exceed 32 fl oz/A for season.
Anthracnose, black rot, Phomopsis, powdery mildew		*[NY]Miller Lime Sulfur	1 gal/10 gal water	This spray is most likely to be beneficial on cultivars highly susceptible to anthracnose (e.g., Marquette, Reliance), where it can be important in blocks with a history of the disease, or in blocks where black rot and/or Phomopsis control is regularly problematic and conventional fungicides will not be used during the growing season. Otherwise, it is unlikely to be cost effective. THOROUGH coverage of the vines is essential for acceptable results. If practical, application to individual vines with a handgun or using some other system that minimizes loss of these expensive materials to non-grapevine surfaces (e.g., hooded-boom, recirculating sprayer such as the Lipco) is desirable. The low per-acre rate of *[NY]Sulforix is unlikely to be effective unless loss to non-target surfaces is minimal. Use of more than 15 gal/A of *[NY]Miller Lime Sulfur is prohibitively expensive. For NYS users: note that *[NY]Sulforix is only labeled for use against powdery mildew and Phomopsis and that*[NY]Miller Lime Sulfur is only labeled for control of Phomopsis, powdery mildew and anthracnose.
	OR	*[NY]Sulforix	1-2 gal	

6 Vineyard Weed Management

6.1 Introduction

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. 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. Weed management practices can have negative impacts on grapes if those strategies cause direct damage to the vines.

This portion of the guide primarily addresses chemical methods to control weeds in vineyards. We have attempted to include all herbicides labeled for use in grapes even though some are not commonly used in eastern United States vineyards. Not all products or use patterns are labelled for use in each state or in every region of the same state. Registrations may change, so product users should always rely on the most up to date labels for use recommendations. Herbicides are listed in the sections, "preemergence herbicides," "postemergence herbicides," and "herbicides for nonbearing vineyards." Herbicides that are registered for vineyard use and may have applicability under specific circumstances are listed in the section, "specialty use herbicides."

Cultivation is sometimes used as a weed management tool in vineyards. Low vine size restricts productivity of own-rooted *Vitis labruscana* varieties such as 'Concord' that generally have shallow root systems. Effective herbicide use has been shown to increase vine size and subsequent yields as compared with under-the-row cultivation, but this may be less of a concern when deep-rooted rootstocks are used, when vines are overly vigorous, or when maximum yields are not desired. Under trellis mowing and growing cover crops under the row are currently being researched in New York and Virginia. These methods might also be considered where vine growth is overly vigorous.

Cultivation and organic mulches can also be used as tools for row middle management. 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. Recently cultivated soil can restrict equipment mobility needed for critical vineyard operations such as timely pesticide applications and mechanical harvest. 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 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. Organic mulches are most effective where soil moisture and fertility are low and where low vine size restricts vineyard productivity.

6.2 Resources

Several resources are available to aid in determining and addressing vineyard weed management goals. The concepts and tools for weed management are covered in the Cornell vineyard weed management fact sheets, listed below and at the back of this guide. They are available online at www.nysipm.cornell.edu/publications/grapeman/index.html (table of contents for Grape IPM in the Northeast), through Cornell Cooperative Extension offices.

The fact sheets in this series are:

- Choosing a weed management program, which discusses goals and management options, including cultivation, mowing, mulching, and the use of chemical weed control agents (herbicides);
- Chemical control of vineyard weeds, which discusses weed types, herbicide types, and factors to consider in using herbicides effectively;
- Pre-emergence herbicides, which discusses all the available residual herbicide options, including their behavior in soil, persistence, and means of loss from the soil;
- Post-emergence herbicides, which discusses available contact and systemic herbicides and how they affect plants and soil; and
- Managing vineyard floors using no-tillage, which discusses the reasons for avoiding tillage and practical factors to consider in using no-tillage as a weed management tool.

Additionally, ***Weeds of the Northeast*** is an excellent resource covering weed identification and aspects of weed biology and ecology that relate to weed management. ***Weeds of the Northeast*** is available through Cornell University Press and the Lake Erie Regional Grape Program office in Portland, NY. Another valuable resource is the ***Manage Weeds on your Farm*** e-book available at www.sare.org/resources/manage-weeds-on-your-farm/.

6.3 Effective Use of Herbicides

Repeated use of the same herbicides, or those with similar chemistry, can lead to a buildup of tolerant weeds, development of resistant biotypes, shifts in microbial communities that can facilitate rapid decomposition, which can reduce the length of time soil active herbicides are effective. Although herbicide options in vineyards are somewhat limited, weed management programs should not

species including velvetleaf, and will provide some suppression of yellow nutsedge, plantains, and perennial grasses. *[NY]†Solicam is relatively weak in controlling common annual broadleaf weeds such as pigweed and smartweed species and common lambsquarters. Apply to weed-free soil. Tank mixes with another preemergence herbicide such as Prowl H_2O, simazine, diuron, oxyfluorfen, or oryzalin are needed to attain season-long, broad-spectrum weed control. Note that *[NY]†Solicam is not registered for use in Nassau and Suffolk counties in New York.

SURFLAN A.S. (oryzalin) – read the label

Signal word: CAUTION

Medical emergency: (866) 673-6671

Selected uses: Preemergence control of annual grasses and control or suppression of some annual broadleaf weeds in bearing and nonbearing vineyards.

Rate: Apply 2-6 qt per acre surface sprayed. Length of control depends on the rate applied. The total amount allowed per year is 12 qt per acre surface sprayed with a minimum of 2.5 months between applications.

Timing: Apply in the fall or spring prior to weed germination. Do not apply to newly planted vines until soil has settled.

Comments: Oryzalin may be applied safely to coarse-textured, low organic matter soils where other residual herbicide options are limited. It is not recommended for use on soils with an organic matter content of greater than 5 percent. Apply to weed free soil; residues on the soil surface can also reduce its effectiveness. Oryzalin is very weak in controlling some broadleaf weeds including ragweed and mustard species. Tank mix with *[NY]†Solicam, diuron, simazine, or oxyfluorfen for broad-spectrum season-long weed control. Note: the product "Surflan A.S. Specialty Herbicide" is only registered for use in non-bearing vineyards.

NOTE: Oryzalin is also registered for use during vineyard establishment. That use is discussed in the section "Herbicides for nonbearing vineyards."

6.5 Postemergence Herbicides

AIM (carfentrazone-ethyl) – read the label

Signal word: CAUTION

Medical emergency: (800) 331-3148

Selected uses: Postemergence control of certain susceptible broadleaf weeds and burn down of grapevine suckers

Rate: For broadleaf weed control, apply up to 2 fl. oz. per acre surface sprayed. Lower rates can be used to control small seedling weeds at the 2 to 3-leaf stage; higher rates are needed for larger weeds up to the 6-leaf stage. Applications to weeds beyond the six-leaf stage may result in only partial control. For burn down of grapevine suckers, apply at the maximum use rate (2 fl. oz.) per acre surface sprayed. Add a non-ionic surfactant (NIS) containing at least 80% active ingredient at 2 pt. per 100 gallons, or a crop oil concentrate (COC) at one gallon COC per 100 gallons, or methylated seed oil (MSO).

Timing: Aim may be applied at any time during the season, but do not allow spray mist to contact desirable fruit, foliage, or green bark. Suckers and other undesirable growth must be treated when the tissue is young (not mature or hardened off). Multiple applications per season are allowed, but do not apply more than 7.9 fl. oz. per season. Do not make applications less than 14 days apart or within 3 days of harvest.

Comments: Aim is very effective in controlling grapevine suckers, and also controls some small broadleaf weeds. Treated suckers turn brown within 1-2 days of application, but multiple applications may be necessary to obtain season-long sucker control. Refer to the label for a list of susceptible broadleaf weeds. Aim may be tank-mixed with other preemergence and postemergence herbicides; observe the other product's label restrictions.

***GRAMOXONE SL 2.0** (paraquat) – RESTRICTED-USE PESTICIDE – read the label

Signal word: DANGER

Medical emergency: (800) 888-8372

Selected uses: Postemergence burn down of all weeds in new or established vineyards and burn down of grapevine suckers up to 8 inches long.

Rate: See labels as multiple products are registered. *Gramoxone SL 2.0 contains 2 lb. of the active ingredient, paraquat, per gallon. Apply 2.5-4 pt per acre surface sprayed. Always add a nonionic surfactant (NIS) or crop oil concentrate (COC). Add NIS at 1 pt per 100 gal (75% or more surface-active agent), or NIS at 2 pt per 100 gal (50-74% surface-active agent), or COC at 1 gal per 100 gal. The label permits applications in as low as 10 gal per treated acre, but spray volume should be increased as necessary to obtain complete coverage of target weeds or suckers without runoff from the target foliage.

Timing: *Gramoxone should be applied to emerged weeds when they are small and succulant. Weeds 1-6 inches tall are easiest to control. Contacted plant foliage wilts and desiccates within hours of application, with complete necrosis in 1-3 days. For burndown of grapevine suckers, treat when sucker growth is no more than 8 inches long. For mature woody weeds, perennial weeds, late-germinating weeds, and green suckers, retreatment or spot -treatment may be necessary. Late season applications to weeds should be made to avoid contact with desirable foliage. Contact of spray or mist with fruit is expressly prohibited on the label and is not a legal use of the product. *Gramoxone applications are most effective under cool, cloudy conditions when

Table 6.7.1 Herbicides and their basic characteristics for New York and Pennsylvania vineyards. (Read the label for potential tank mixes and specific use, rate and timing of each product.)

Common Name	Herbicide Trade Name	(C)ontact or (S)ystemic	Young Vine Use	Non-bearing Only	Application Timing		Weeds Controlled			Sucker Control
					Pre-emergent	*Post-emergent*	*Broad-leaves*	*Grasses*	*Broad Spectrum*	
paraquat	*Gramoxone	C	x	–	–	x	–	–	x	x
pelargonic acid	Scythe	C	x	–		x	–	–	x	x
pendimethalin	Prowl 3.3 EC	–	x	x	x	–	–	x	–	–
	Prowl H_2O	–	–	–	x	–	–	x	–	–
rimsulfuron	Matrix	–	x[d]	–	x	x	–	–	x	–
simazine	*[NY]†Princep	–	–	–	x	–	x	–	–	–
trifluralin	Multiple	–	x[e]	–	x	–	–	x	–	–
trifluralin + isoxaben	^Snapshot	–	x	x	x	–	–	–	x	–

* Federal restricted-use pesticide; may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.

*[NY] Restricted-use pesticide in New York State.

† Not for use in Nassau/Suffolk Counties

^ Not registered for use in New York State at press time

[a] Primarily contact, limited systemic activity

[b] Note maximum annual use rate restriction for Long Island

[c] Do not apply within 4 weeks of planting

[d] Vines must be established one full growing season

[e] Usually used pre-plant incorporated

7 Sprayer Technology

7.1 Solutions for Safer Spraying – Engineering Controls

Keeping pesticide exposure to a minimum should be a chief concern of any pesticide applicator. To reduce the risks associated with handling and applying pesticides, devices known as **engineering controls** can be used that help to reduce or practically eliminate exposure to hazardous chemicals.

7.1.1 Areas of Exposure

1. Loading the Sprayer

Closed transfer systems. Closed transfer systems allow concentrated pesticide to be moved from the original shipping container to the sprayer mix tank with minimal or no applicator contact. Many systems provide a method to measure the concentrated pesticide. Some systems also include a container rinsing system. Currently available closed transfer systems use a probe inserted into the pesticide container, a connector on the container that mates to a similar connector on the application equipment, or a vacuum-type (venturi) system that uses flowing water to transfer the chemical from the container.

Induction bowls. Induction bowls are metal, plastic or fiberglass hoppers attached to the side of the sprayer or the nurse tank that allow pesticides to be added to the mix tank without the applicator climbing onto the spray rig. Pesticides are poured into the bowl and water is added to flush out the bowl and carry the pesticide to the spray tank. Often a rinse nozzle is mounted inside the bowl for rinsing out empty pesticide containers. Typically, induction bowls are raised out of the way during spraying and lowered to about 3 feet above ground when the sprayer is being loaded.

Direct pesticide injection system. Direct pesticide injection systems allow pesticides to be mixed directly with water in the sprayer plumbing system rather than in the main spray tank. The pesticide is pumped from its container and mixed with the water either in a manifold or at the main water pump. Only clean water is held in the main tank of the sprayer. An electronic controller and up to four pumps adjust the amount of concentrated pesticide that is injected into the water stream, allowing for variable application rates.

Container rinse system. Container rinse systems consist of a rinse nozzle and a catch bowl that traps the container washings (rinsate). The empty container is placed over the rinse nozzle and a jet of water cleans the inside of the container. The rinsate caught in the bowl is pumped into the spray tank to be used along with the spray mixture. Often rinse nozzles are installed in chemical induction bowls. Most closed transfer systems also provide a way of rinsing containers and piping the rinse water into the spray tank.

2. Reducing Exposure at the Boom

Boom folding/extending. Manually folding booms can be a source of operator contamination because the boom can be covered with pesticide from drift or dripping nozzles. Consider the use of hydraulic or mechanical folding methods.

Diaphragm check valves. Typically, when a sprayer is shut off and as the system pressure drops, any liquid remaining in the boom piping drips from the nozzles, possibly dripping onto the boom or even the operator. Diaphragm check valves installed at each nozzle prevent this by using a spring-loaded rubber diaphragm to close off the flow of liquid once the system pressure drops below about 10 pounds per square inch. When the sprayer is switched on and system pressure builds up, the valve opens and allows the liquid to flow through the nozzles.

Multiple nozzle bodies. Contamination can occur when operators change or unclog nozzles during an application. Multiple nozzle bodies (or turret nozzles) allow operators to switch between nozzles with a turn of the nozzle body rather than having to unscrew or undo a threaded or bayonet fitting.

Hand wash water supply. Providing adequate wash water is essential (and often required). A simple container with a hand-operated valve can be mounted on the side of the sprayer to provide clean water for hand washing and personal hygiene.

3. Drift and Contaminated Clothing in Cabs

Cab filtration using carbon filters. Carbon filtration systems are used to remove pesticide odor and pesticide-laden mist from fresh air used in a tractor or self-propelled sprayer cab. Carbon filtration systems are often a standard feature on self-propelled sprayers. Many factory installed tractor cabs offer optional filtration systems.

Protective clothing lockers. To prevent contamination of the tractor or sprayer cab interior, protective clothing should be removed before entering the cab. A few sprayer companies offer a simple compartment (or locker) mounted to the side or front of the sprayer where protective clothing can be stored.

4. Controlling Drift

Low-drift nozzles. Low-drift nozzles create larger-size droplets than conventional nozzles. The larger droplet sizes are less prone to drift, reducing environmental and operator contamination.

Air induction (twin fluid) nozzles. These nozzles allow air to mix with the spray liquid, creating large, air-filled droplets that have virtually no fine, drift-prone droplets. The droplets explode when they contact their target and offer similar coverage to droplets from conventional, finer-spray nozzles.

7.3.1 Travel Speed Calibration

Sprayer travel speed influences spray deposition and is a critical factor in maintaining accurate application rates. Studies to determine the effect of travel speed on average spray deposition agree that the higher the travel speed, the greater the variability in spray deposit. This variability is an important factor where uniformity of spray coverage throughout the canopy is required. Conclusions from research were drawn using travel speeds of 1-4 mph.

Factors affecting travel speed include**:**

- weight of sprayer to be pulled.
- slope of terrain.
- ground conditions traveled over (wheel slippage).

The best way to measure travel speed is to pull a sprayer half full of water over the same type of terrain on which the actual sprayer will be operated.

Using a tape measure, set up a test course at least 100 feet long. Do not pace the distance. The longer the course, the smaller the margin of error.

Run the course in both directions. Use an accurate stopwatch to check the time required to travel the course in each direction. Average the two runs and use the following to calculate the speed in MPH.

Formula $\frac{\text{Ft. traveled}}{\text{Sec. traveled}} \times \frac{60}{88} = \text{MPH}$

Your figures:

Tractor gear_____ Engine revs._____

$\frac{\text{ft.}}{\text{sec}} \times \frac{60}{88} =$ ____MPH

An alternative to using the above method is to purchase a hand-held GPS receiver. A number of systems are available from electronics stores, hunting equipment suppliers, and online. Costing ranges from $80-150. The small device is portable so can be used in all tractors to determine forward speed in specific tractor gears at known engine RPM.

7.3.2 Airblast Sprayer Calibration

- use clean water

1. Pressure check
Place the pressure gauge on the nozzle fitting farthest away from the pump and turn the sprayer on. If pressure is lower at the nozzle than specified, increase pressure at the regulator.

Pressure at nozzle _____psi

Pressure at sprayer gauge _____psi

2. Nozzle output
Use a flow meter (obtainable from Gemplers, Spraying Systems, etc.) attached to individual nozzles OR connect hoses to each of the nozzles and measure the flow from each nozzle into a calibrated jug. Record and total your results using Figure 7.3.1.

Calculate gallons per acre using the following formula.

Formula: $\frac{\text{Total GPM X 495}}{\text{mph X row spacing (ft.)}} = \text{GPA}$

Your figures: $\frac{\text{GPM X 495}}{\text{mph X ft.}} = \text{GPA}$

Replace all nozzle tips which are more than 5% inaccurate.

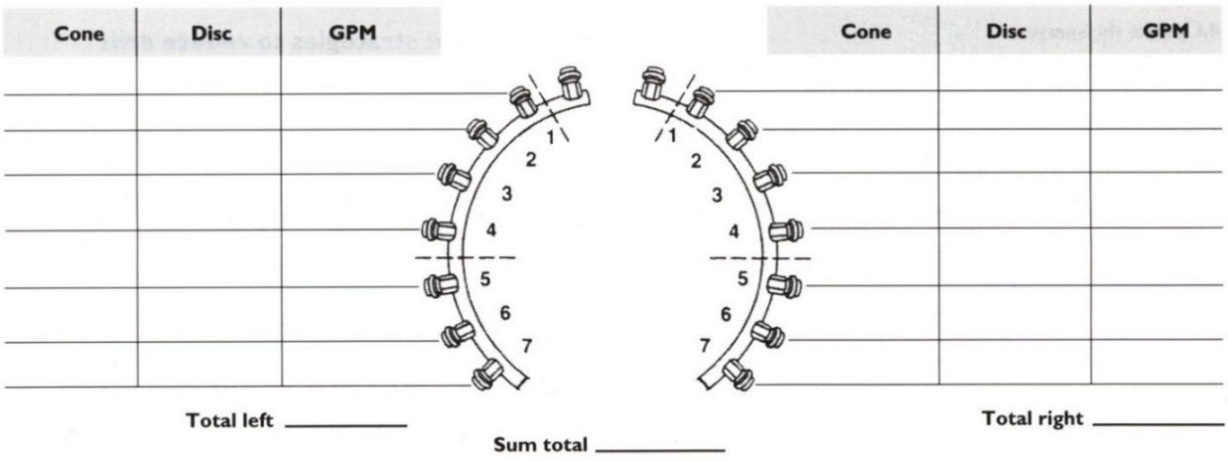


Figure 7.3.1. Airblast Sprayer Calibration

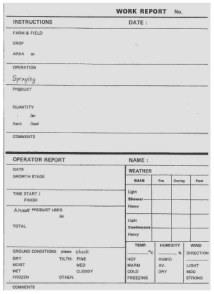
7.10 Going Spraying!

Mixing Procedures

Safety and the Law

- Always remain alert; pesticides are potentially dangerous to the operator and the environment.
- Tractors and sprayers are dangerous machines and care should be taken when operating them.
- Always follow Federal and State laws concerning licensing of operators and handling, application and disposal of pesticides.

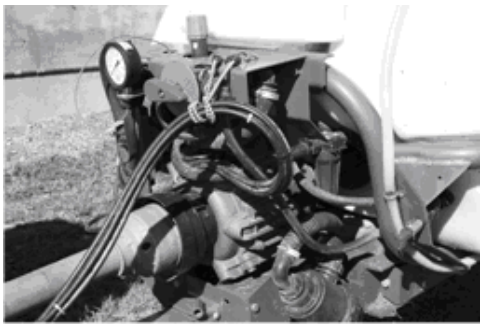
Always read the label for detailed application information and keep a record.



The seven P's of machinery management.

Proper prior planning prevents poor performance.

- Fill the tank on level ground per label instructions. If none are given, fill the tank half full with clean water.



- Prime the pump with water, if needed.

8 Pesticides for New York and Pennsylvania Vineyards

8.1 Herbicides

Common Name	Trade Name	Formulation	WSSA Group Number (Resistance Management)	Days to Harvest	Restricted Entry Interval (REI)	EPA Reg. Number
carfentrazone-ethyl	Aim EC	EC	14	3	12	279-3241
clethodim	*NYSelect 2EC[a]	2EC	1	1 year	24 hr	59639-3-1381
	^Volunteer	2 EC	1	1 year	24 hr	59639-3-55467
	*NYSelect Max	0.97 EC	1	1 year	24 hr	59639-132
dichlobenil	Casoron 4G	4G	20	0	12 hr	400-168
	Casoron CS	1.4 L	20	0	12 hr	400-541
diuron	Direx 4L	4L	7	0	12 hr	66222-54
	Karmex DF	80 DF	7	0	12 hr	66222-51
fluazifop-P-butyl	†Fusilade DX	2EC	1	50	12 hr	100-1070
flumioxazin	Chateau SW	51 WDG	14	60	12 hr	59639-99
glufosinate-ammonium	†Rely 280	2.34 EC	10	14	12 hr	7969-448
glyphosate	Multiple	Multiple	9	See label	See label	Multiple
indaziflam	*NY†Alion	SC	29	14	12 hr	264-1106
isoxaben	^Gallery	75DF	21	1 year	12 hr	62719-145
napropamide	Devrinol DF-XT	50DF	15	70	24 hr	70506-36
norflurazon	*NY†Solicam	80DF	12	60	12 hr	61842-41
oryzalin	Surflan	4AS	3	0	24 hr	70506-43
oxyfluorfen	Goal 2XL	2EC	14	b	24 hr	62719-424
	GoalTender	4 EC	14	b	24 hr	62719-447
paraquat	*Gramoxone SL 2.0	2L	22	0	24 hr	100-1431
pelargonic acid	Scythe	4.2EC	unclassified	0	12 hr	10163-325
pendimethalin	Prowl	3.3EC	3	1 year	24 hr	241-337
	Prowl H_20	3.8EC	3	21	24 hr	241-418
rimsulfuron	Matrix FNV	25DF	2	14	4 hr	352-671
sethoxydim	Poast	1.5EC	1	50	12 hr	7969-58
simazine	*NY†Princep Caliber 90 and others	90WDG	5	0	12 hr	100-603
	*NY†Princep 4L and others	4L	5	0	12 hr	100-526
trifluralin	Multiple	various	3	[c]	See label	Multiple
trifluralin + isoxaben[b]	^Snapshot	2.5TG	3, 21	1 year	12 hr	62719-175

Notes: a Note annual use rate restriction for Long Island
b Do not apply after bud swell
c Apply and incorporate before planting

* Federal restricted-use pesticide.
*NY Restricted-use pesticide in New York State
† Not for use in Nassau/Suffolk Counties in New York
^ Not registered for use in New York State at press time