2019
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.

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Abbreviations and Symbols Used in This Publication

A .....acre	EC .....emulsifiable concentrate	SP.....soluble powder
AI.....active ingredient	F.....flowable	ULV.....ultra-low volume
D .....dust	G .....granular	W .....wettable
DF.....dry flowable	L.....liquid	WDG ....water-dispersible granule
DG .....dispersible granule	P.....pellets	WP .....wettable powder
E.....emulsion, emulsifiable	SC .....suspension concentrate	WSP.....water soluble packet

* ..... 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 (March 2019). Changes in pesticide registrations, regulations, and guidelines occurring after publication are available in county cooperative extension offices or from the Pesticide Management Education Program web site (pmep.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.

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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: Spotted lanternfly adult feeding on a grape cordon in a southeast Pennsylvania vineyard. (*Photo by: Tim Weigle, New York State IPM Program*)

1 Pesticide Information

1.1 Pesticide Classification and Certification

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) created two classifications of pesticides – general-use and restricted-use. **General-use pesticides** may be purchased and used by anyone. **Restricted-use pesticides can** only be purchased by a certified applicator. Restricted-use pesticides must also be used by a certified applicator or someone under their supervision.

The same federal law that classifies pesticides divided applicators into two groups: private and commercial. **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. A farmer must be certified as a private applicator in order to purchase and use restricted-use pesticides on agricultural commodities. (No certification is needed if a farmer does not use restricted-use pesticides.)

A **commercial applicator** uses or supervises the use of pesticides for any purpose or on any property not covered by the private applicator classification. In New York, a commercial applicator must be certified to purchase or use any pesticide whether it is general- or restricted-use.

Information about 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 (https://www.cornellstore.com/books/cornell-cooperative-ext-pmep-manuals), or the Pesticide Management Education Program (PMEP) at Cornell University (psep.cce.cornell.edu).

1.2 Use Pesticides Safely

Using pesticides imparts a great responsibility on the user to protect their health and that of others and to protect the environment. Keep in mind there is more to "pesticide use" than the application. Pesticide use 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 are also regulated by state and federal laws and regulations intended to protect the user, the community, and the environment from any adverse effects pesticides may cause.

1.2.1 Plan Ahead

Many safety precautions should be taken *before* you actually begin using pesticides. Too many pesticide applicators are dangerously and needlessly exposed to pesticides while they are preparing to apply them. Most pesticide accidents can be prevented with informed and careful practices. **Always read the label on the pesticide container before you begin to use the pesticide.** Make sure you understand and can follow all directions and precautions on the label. 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

Carelessness in transporting pesticides can result in broken containers, spills, and contamination of people and the environment. Once pesticides are in your possession, you are responsible for safely transporting them. Accidents can occur even when transporting materials 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 needs depend on the pesticide being handled. ***Required personal protective equipment (PPE) are listed on pesticide labels.*** The required PPE are based on the pesticide's toxicity, route(s) of exposure, and formulation. Label required PPE are the minimum that must be worn during the pesticide's use. Pesticide users can always wear more protection than the label requires.

The type of protective equipment used depends on the type and duration of the activity, where pesticides are being used, and exposure of the handler. Mixing/loading procedures often require extra precautions. Studies show you are at a greater risk of accidental poisoning when handling pesticide concentrates. Pouring pesticide concentrates from one container to another is the most hazardous activity.

Engineering controls are devices that help prevent accidents and reduce a pesticide user's exposure. One example is a closed mixing/loading system that reduces the risk of exposure when dispensing concentrated pesticides. 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 crops, and harm the environment. Choose weather conditions, pesticides, application equipment, pressure, droplet size, formulations, and adjuvants that minimize drift and runoff hazards. See product labels for specific application and equipment requirements.

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 Restricted-Use Pesticides

Restricted-use pesticides recommended in this publication are identified by an asterisk (*). They may be purchased and used only by certified applicators or used by someone under the direct supervision of a certified applicator.

2.2.5 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

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, 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.

Group 7) and an older phenylpyrrole active ingredient (Group 12), introduced about 25 years ago. In NY and PA trials, ^Miravis Prime has shown excellent activity against powdery mildew and good to excellent activity against black rot and Botrytis. ^Miravis Prime is also labeled for control of anthracnose and Phomopsis cane and leaf spot, but there is little to no local experience with control of these other diseases using this product. The activity against powdery mildew and black rot are primarily from the SDHI component (pydiflumetofen). On the other hand, fludioxonil, also found in another combination product called †Switch, is what provides the Botrytis control. ^Miravis Prime is said to accumulate in the waxy cuticle and "translocate through the leaves". ^Miravis Prime has a 12 hr REI and a 14 day PHI.

NUTROL (dihydrogen potassium phosphate = monopotassium phosphate) - read the label

Signal word: CAUTION

Medical emergency: (800) 424-9300

Chemical/fungicide family: potassium salt

Resistance Group Number: N/A

Resistance risk: low

Physical mode of action: post-infection, antisporulant, limited eradicant

Selected use: powdery mildew

Comments: Monopotassium phosphate (potassium dihydrogen phosphate) is a fertilizer (K and P) that can be applied to both the soil and foliage. Nutrol is a monopotassium phosphate product that also provides moderate control of powdery mildew similar to that provided by the potassium bicarbonate products (^Armicarb, Kaligreen, Milstop) when sprayed onto fruit and foliage, and it is registered for that use. It provides no protective activity but significant post-infection activity when applied up to one week after the start of an infection. However, Nutrol has been relatively ineffective at eradicating well-established powdery mildew infections. It is most effective when used in alternation or tank mixes with traditional powdery mildew fungicides, or with short (7-day) spray intervals if applied two or more times in sequence. NOTE: For best results, Nutrol should be applied with a nonionic surfactant to increase coverage of the leaf and fruit surfaces, since it is not already formulated with one.

OSO (polyoxin D zinc salt) - read the label

Signal word: CAUTION

Medical emergency: (800) 255-3924

Chemical/fungicide family: polyoxins

Resistance Group Number: 19

Resistance risk: moderate

Physical mode of action: protectant (+ some post-infection vs. powdery mildew)

Selected uses: powdery mildew, Botrytis

Comments: Oso contains the active ingredient polyoxin D zinc salt, derived from a natural fermentation product of a soil-inhabiting microorganism, which prevents/inhibits synthesis of a component of fungal cell walls (chitin). As such, it has NO activity against the downy mildew organism, which does not synthesize chitin. Oso and other polyoxin D materials such as Ph-D have provided fair to good activity against powdery mildew and botrytis in limited NY and PA trials. Oso has a 4-hr REI and 0-day PHI.

PH-D (polyoxin D) - read the label

Signal word: CAUTION

Medical emergency: (866) 303-6952

Chemical/fungicide family: polyoxins

Resistance Group Number: 19

Resistance risk: moderate

Physical mode of action: protectant

Selected uses: powdery mildew, Botrytis

Comments: Refer to information provided under the OSO entry.

PHOSTROL, PROPHYT (phosphorous acid = phosphonate = phosphite) - read the label

Signal word: CAUTION

Medical emergency: ProPhyt: (800) 424-9300, Phostrol (877) 325-1840

Chemical/fungicide family: phosphorous acid (phosphite, phosphonate)

Resistance Group Number: 33

Resistance risk: moderate

Physical mode of action: moderate protectant, post-infection, antisporulant

Selected use: downy mildew

Comments: A number of products containing phosphorous acid (also called "phosphite" or "phosphonate") are sold as nutritional supplements and "plant conditioners," but only a few are registered for disease control on grapes; two that have proven efficacy in NY spray trials are ProPhyt and Phostrol, although others (e.g., Rampart, Reveille, Fosphite) have been effective in commercial use. In multiple trials, these products have provided very good to excellent control of downy mildew, but have not controlled any other grape disease. Although very active when applied up to 3-5 days after infection first begins (start of a suitable rainy period), they provide only limited residual protective activity (3-7 days, depending on conditions) against new infections that might occur following an application; hence, spray intervals should not exceed 10 days during periods of wet weather. These products have a 4 hr re-entry interval, 0 day preharvest interval, and are exempt from US-EPA residue tolerances (limits). Although phosphites are popular for midsummer use, it is important to remember that they are at moderate risk for

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.

***HERO** (zeta-cypermenthrin & bifenthrin) – RESTRICTED-USE PESTICIDE – read the label

Signal word: CAUTION

Medical emergency: (800) 331-3148

Selected uses: broad-spectrum, including grape berry moth and Japanese beetle.

Comments: REI = 12 hrs, DTH = 30. A broad-spectrum insecticide that combines two different synthetic pyrethroids. Maximum amount of product allowed per season is 10.4 fl ounces. Do not make applications less than 7 days apart.

***[NY]IMIDAN** (phosmet) – Some formulations RESTRICTED-USE PESTICIDE IN NY – read the label

Signal word: WARNING

Medical emergency: (888) 478-0789

Selected uses: Japanese beetle, grape leafhopper, grape berry moth

Comments: Do not apply within 14 days of harvest for rates greater than 1 1/3 lbs per acre or 7 days for rates of 1 1/3 lb per acre or less. Do not enter treated area within 14 days. All hand labor prohibited for 14 days after application. For rates of 1 1/3 lbs or less, mechanical harvesting is permitted 7 days after application. Activity of *[NY]Imidan may be reduced when the spray solution has a pH of 7 or higher. The pH of the spray solution must be corrected by the addition of a suitable buffering or acidifying agent for optimum insecticidal activity. Fixed copper formulations and lime should not be used with *[NY]Imidan.

^INTREPID (methoxyfenozide) – read the label

Signal word: CAUTION

Medical emergency: (215) 592-3000

Selected uses: grape berry moth and other Lepidoptera. NOTE: Only approved use of ^Intrepid in New York is on pome fruit. Although it is not legal to use in New York, it is legal to use in Pennsylvania.

Comments: This is an insect growth regulator that interferes with larval development. It appears to be most effective when applied at the start of egg-laying rather than at egg-hatch. Hence, ^Intrepid should be applied somewhat earlier than broad-spectrum materials such as carbaryl. ^Intrepid has been shown to have long residual (several weeks). Do not apply within 30 days of harvest. Latron B-1956 spreader/sticker is recommended to maximize coverage.

JMS STYLET OIL (aliphatic petroleum distillate) – read the label

Signal word: CAUTION

Medical emergency: (866) 778-9538

Selected uses: spider mites, powdery mildew – see Fungicides

Comments: Has some activity against spider mites, especially with repeated applications. Coordinate use with fungicide program. Multiple applications, starting at 3-inch shoot growth, have been shown to reduce populations of European red mites in a vineyard study conducted in the Finger Lakes. There are legal restrictions on the use of this product and compatibility problems with various nutrient sprays and other pesticides, including Captan, *Vendex, and sulfur. Check the label for details.

NOTE: In controlled tests, two or more applications of JMS Stylet Oil near veraison have resulted in a modest but consistent lowering of Brix values (1° to 2°) at harvest. In contrast, applications before this period have had no effect on Brix values.

KNACK (pyriproxyfen) –

Signal word: CAUTION

Medical emergency: (800) 892-0099

Selected uses: Lepidoptera, sucking insects such as whiteflies, sharpshooters, soft scale.

Comments REI = 12 hrs, DTH = 21 days. This insecticide is an insect growth regulator that affects embryogenesis and molting. It does not directly harm adults though it will suppress egg laying in affected species.

***LEVERAGE 360** (imidacloprid, beta-cyfluthrin) – RESTRICTED USE PESTICIDE –read the label

Signal word: CAUTION

Medical emergency: (800) 334-7577

Selected uses: leafhoppers, grape berry moth, minor insects

Comments REI = 12 hrs, DTH = 3 days. This insecticide contains two active ingredients, the more selective neonicotinoid imidacloprid and the broad-spectrum synthetic pyrethroid insecticide beta-cyfluthrin. Harsh on natural enemies and bees as well as aquatic organisms. A FIFRA 2(ee) recommendation is in place for *Leverage adding Japanese beetle adults in New York State. Maximum use allowed per season is 6.4 fl. ounces/A. An early formulation, *Leverage 2.7, continues to be labeled for use on grapes in NY and PA.

***LORSBAN ADVANCED, 4E** (chlorpyrifos) – read the label

Signal word: WARNING

Medical emergency: (800) 992-5994

Selected use: grape root borer, climbing cutworm, grape mealybug

Comments: REI = 24 hrs, DTH = 35 days. For grape root borer, apply to the ground just before pest emerges from the soil in mid- to late-summer. Do not allow spray to contact fruit or foliage at this time. For cutworm control, treat in minimum of 50 gallons of water when

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)		Topsin M 70 WSB	3.2 oz/gal water	Apply Topsin M as a paint or directed spray to wounded surfaces after pruning and before the next rain. This recommendation is primarily for large pruning cuts, and has been shown to be beneficial. Application is allowed only in NY, under Special Local Needs (SLN) label # NY-07002. A copy of the SLN label and the federal product label must be in possession of the user at the time of application. There is a 7-day re-entry interval following application.
		Mettle 1ME	5 fl oz/A	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 difrections. Unlike Topsin, 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.
	OR	*Lorsban Advanced	1 qt	Apply no later than late budbreak in at least 50 gallons. Only one application of *Lorsban Advanced allowed per season. Other generic products with this active ingredient (chlorpyrifos) also labeled on grapes for NY and PA (e.g. Vulcan, Warhawk).
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
	OR	*[NY]Sulforix	1-2 gal	

Pest(s)		Materials	Rate per Acre	Comments
5.2.11 MIDSUMMER SPRAYS (July and August, as necessary) (*continued*)				
Botrytis bunch rot *(continued)*				oz) would just about match the recommended minimum dose of fluopyram in Luna Experience (8.0 fl oz) and the recommended dose of trifloxystrobin (3.0 oz) found in Flint for good to excellent Botrytis control needed at this time. Do not apply this product to Concord grapes or injury may occur.
	OR	^Miravis Prime	10.3-13.4 fl oz	^Miravis Prime is a combination of a new succinate dehydrogenase inhibitor fungicide (SDHI, Group 7) and fludioxonil (Group 12), introduced about 25 years ago for Botrytis control. Fludioxonil is also found in another combination product called †Switch for Botrytis control. Most, if not all of the activity against Botrytis comes from fludioxonil. The 10.3-13.4 fl oz rate of ^Miravis Prime delivers the same amount of fludioxonil as the 11-14 oz labe rate range of †Switch.
	OR	†Switch 62.5WG	11-14 oz	
	OR	^Intuity 4SC	6 fl oz	^Intuity is a strobilurin fungicide for control of Botrytis and suppression of powdery mildew. In limited NY and PA trials, ^Intuity provided good to fair control of Botrytis equivalent to current standards like Elevate, Vangard, Scala, and †Switch. Do not use on *V. labrusca, V. labrusca* hybrids or other non-*vinifera* hybrids. Avoid mixing with organosilicone surfactants.
	OR	Botector	6-8 oz	Botector is a preparation of a living yeast-like organism that competes with the Botrytis fungus for colonization sites on the grape flowers and berries. It provides protective activity only and can be killed by some broad-spectrum fungicides used for managing other diseases. Fracture is a fragment of a naturally-occuring plant protein that has activity against some fungi. Both products have provided fair to good control in a limited number of NY trials with moderate disease pressure.
	OR	Fracture	24.4-36.6 fl oz	
Grape berry moth	Treatments in mid-summer targeting offspring from second and subsequent adult flights need to be made to high-risk vineyards. Timing of sprays for offspring from second and third flights is best accomplished using the grape berry moth degree day model available at the Network for Environment and Weather Applications (NEWA): newa.cornell.edu/index.php?page=crop-page-grapes. Low-risk vineyards rarely require this treatment. Sample low- and intermediate-risk vineyards during mid and late season, as well as high-risk vineyards for late season (August), to determine if they need to be treated. . See New York Food and Life Sciences Bulletin no. 138 for GBM risk assessment protocols, or contact the grape IPM program. Most insecticides are incompatible with lime. Check label for incompatibility before tank mixing insecticides with alkaline spray materials. See New York Food and Life Sciences Bulletin no. 118 for information on effects of alkaline hydrolysis on pesticides.			
		Sevin 4F	2 qt	Efficacy of carbaryl products such as Sevin has dropped in recent years, especially in the Lake Erie region, probably due to resistance.
		or ^Sevin 80 Solupak	2.5 lb	
		or Sevin XLR Plus	2 qt	
	OR	*[NY]Imidan 70W	1.33-2.125 lb	
	OR	Dipel DF	read the label	If using Dipel DF, Deliver, or Biobit, proper timing is critical to control. Scout vineyards carefully, apply when larval feeding begins, and repeat after 5-7 days.
	OR	Deliver	0.5-2 lb	
	OR	Biobit	0.5-1 lb	
	OR	*Brigade 2EC	3.2-6.4 fl oz	Maximum of 6.4 fl oz *Brigade 2 EC per season.
		or *Brigade WSB	8-16 oz	
		or *Bifenture 10DF	8-16 oz	

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. 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.

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. 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 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. 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, or directly through the Bulletin Room at the New York State Agricultural Experiment Station, Geneva, NY.

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.

6.3 Effective Use of Herbicides

Most herbicides are degraded in the soil by microbes. Repeated use of the same herbicides, or those with similar chemistry, can lead to a buildup of tolerant weeds, development of resistant biotypes, and more rapid microbial decomposition that can reduce the length of time soil active herbicides are effective. Although herbicide options in vineyards are somewhat limited, weed management programs should not rely on the repeated use of the same herbicide modes of action or weeds will develop resistance. See Table 8.1 for a listing of herbicide mode of action group numbers from the Weed Science Society of America.

SCYTHE (pelargonic acid) - read the label

Signal word: WARNING

Medical emergency: (888) 478-0798

Selected uses: Postemergence burndown of all weeds in bearing and nonbearing vineyards; repeat applications necessary for larger annual weeds and for perennials.

Rate: Use a 3-5% solution for small annual weed burndown. Use a 5-10% solution for larger weeds and burndown of mature perennial weeds. Registered as a sucker control agent as well as a postemergence herbicide. Injury to sprayed weeds is evident within several minutes. Weed control is optimal when weeds are thoroughly covered. To attain this, the recommended spray volume is 75-200 gal per acre sprayed.

Timing: May be applied whenever weeds are actively growing. Repeat applications are necessary for large weeds and perennials that continue to emerge from underground parts.

Comments: Avoid application to any desirable green tissue, as injury will result. Strong odor can linger for several hours or days. Observe applicator precautions carefully.

^SNAPSHOT 2.5 TG (trifluralin plus isoxaben) - read the label

Signal word: CAUTION

Medical emergency: (800) 992-5994

Selected uses: Preemergence control of annual grasses and broadleaf weeds and, at the high use rate, suppression of some perennial weeds (including field bindweed) in nonbearing vineyards only. **^SNAPSHOT IS NOT REGISTERED FOR USE IN NEW YORK STATE.**

Rate: Apply 100-200 lbs per acre surface treated. For use only on nonbearing vines that will not bear fruit for at least one year. Repeat applications of 150 lbs per acre and higher should not be made within 60 days of a previous application.

Timing: Apply prior to weed germination or just after cultivation. The active ingredient, trifluralin, is quite volatile and uniform incorporation by rainfall or cultivation should occur within three days of application, otherwise annual grass control may be erratic. Do not apply within one year of harvesting fruit.

Comments: ^Snapshot is a pre-mix of trifluralin (Treflan) and isoxaben (^Gallery) used more commonly in ornamentals. Where volatility is a concern, or where uniform granular applications are not possible, tank-mix ^Gallery (where legal) with an effective grass herbicide such as oryzalin (Surflan, Oryzalin), pendimethalin (Prowl, ^Pendimax), or Devrinol.

TREFLAN, others (trifluralin) - read the label

Signal word: CAUTION

Medical emergency: (800) 992-5994

Selected uses: Applied and incorporated prior to planting new vineyards for preemergence control of annual grasses and broadleaf weeds.

Rate: Depends on the formulation used and on soil texture and organic matter– consult the label.

Timing: Apply and incorporate within 24 hours of application prior to planting.

Comments*:* Local experience with these products is extremely limited, as other options are more practical.

WEEDZSTOP, BIO-WEED, several others (corn gluten meal)

Signal word: N/A

Medical emergency: N/A

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

Rate: Apply 20 lb per 1,000 sq ft (870 lb per acre surface applied). Can only be applied as a granular material.

Timing: Apply in the spring and the fall.

Comments: An organic product derived from cornmeal production. Contains about 10% soluble nitrogen, so at recommended use rate supplies about 87 lbs. actual nitrogen per acre surface treated. Although herbicidal activity has been observed in some greenhouse studies, little if any weed control efficacy has been observed in trials on turf conducted in New York. For those interested in trying it, a small evaluation trial is advised before large-scale applications are made.

7 Sprayer Technology

7.1 Preparing the Airblast Sprayer for Work

7.1.1 Checking the Sprayer

Surveys have shown that many farmers are using inaccurate sprayers. Faulty sprayers contribute to increased drift levels and waste money through inefficiency and overuse of chemicals. For example, the cost of replacing a faulty pressure gauge that has been indicating at 15% below the actual pressure is recouped in around two hours' operation. Maintenance measures such as fitting a new set of nozzles at the beginning of each season also save money. Even when overdosing occurs by as little as 5%, the cost of a new set of nozzles would be recovered in less than a day's work. Sprayers must be checked over regularly to ensure that proper maintenance has been carried out and that no outstanding repairs need to be done. Before attempting any work on a machine, make sure that it is fully supported on stands and that all necessary protective clothing is on hand.

7.1.2 Fitting the Sprayer to the Tractor

The selected tractor must always be powerful enough to operate the sprayer efficiently under the working conditions that will be encountered. All its external services - hydraulic, electrical, and pneumatic - must be clean and in working order. Tractors fitting with cabs must have efficient air filtration systems. All protective guards must be in place. Trailed sprayers are often close-coupled to the tractor, so it is essential that the drawbar and the PTO shaft are correctly adjusted for turning. PTO shafts must be disengaged when making very tight turns.

CAUTION

- Take great care when adjusting a sprayer while the tractor engine is running.
- Always ensure that the fan is stationary before approaching the rear of the sprayer.
- Engage the handbrake when leaving tractor seat.

7.1.3 Checking the Operation of the Sprayer

Partially fill the tank with clean water and move the sprayer to uncropped waste ground. Remove the nozzles. Although you are not using any chemical at this point, get into the habit of wearing a coverall, gloves and a face visor when working with the sprayer. Engage the PTO and gently turn the shaft, increasing speed slowly to operating revs. Test the on/off and pressure relief valves, and check the agitation system. Flush through the spray lines, and then switch off the tractor. Refit the nozzles and check the liquid system again for leaks.

It is a valuable exercise to assess the spray deposits at various points in the canopy and on upper and lower leaf surfaces of the vines to be sprayed. This is particularly important if the foliage is dense or if the vines are grown in beds of three or more rows. Water-sensitive papers or fluorescent tracers are available for this purpose. An increase in spray volume or adjustment of the nozzles and their locations may be necessary in order to achieve the correct deposits.

7.1.4 Pre-season Maintenance

Use the following checklists before you begin spraying**:**

Hoses

- ✓ for splits and cracks
- ✓ connections to ensure they are water-tight
- ✓ for hose chafe, particularly in routing clips

Action:
Replace damaged hoses.

Filters

- ✓ for missing filter elements and seals
- ✓ for leakage
- ✓ for blocked or damaged filters

Action:
Replace any damaged or blocked filters.

Tank

- ✓ for fractures and any other damage
- ✓ that the tank sits firmly in its mount
- ✓ that the securing straps are correctly adjusted
- ✓ that the agitation is working
- ✓ that the tank is clean

Action:
See the supplier/manufacturer now about fractures and any other repairs.

Controls

- ✓ the control circuitry (electrical, hydraulic or air) for correct operation
- ✓ valves for both internal and external leaks

Action:
Replace leaky valves, which waste money and are potentially dangerous to operators and the environment.

Pump

- ✓ lubrication levels
- ✓ for leaks
- ✓ that the air pressure in the pulsation chamber (if fitted) is at the recommended level
- ✓ that the pump rotates freely without friction or noise. (Do so by rotating manually or starting at low speed, as corrosion may cause seizing up)

Pressure Gauge

- ✓ The pressure gauge is vital for indicating whether the nozzles are delivering the correct amount of chemical

Hardi Air Induction nozzles are similar in construction to Spraying Systems AI nozzles. They are one-piece plastic nozzles.

Albuz nozzles are similar in construction to Spraying Systems AI nozzles. They are one-piece plastic nozzles with a ceramic tip.

Current research
Trials are underway at Cornell University to compare air induction nozzles. Although the nozzles physically reduce drift, we need to see how effective they are at delivering materials used to control disease and insects. They certainly work well at delivering materials used to control weeds.

7.4 Sprayer Calibration

A simple vertical patternator can be constructed in the farm workshop using readily available materials; a build list and photographs can be found online at: www.nysaes.cornell.edu/ent/faculty/landers/pdf/Patternator.pdf.

Videos showing calibration and nozzle selection may be found on the internet at: www.youtube.com. Type in: "Calibration of airblast sprayers for orchards part 1 selecting and changing nozzles" or "Calibration of airblast sprayers for orchards part 2 measuring liquid flow"

7.4.1 Travel Speed Calibration

Sprayer travel speed will influence spray deposition and is a critical factor in maintaining accurate application rates. Although results of studies to determine the effect of travel speed on average spray deposition have been inconsistent, all studies have been in agreement 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 that will affect 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._____

$\frac{\text{\_\_\_\_ft.}}{\text{\_\_\_\_sec}} \times \frac{60}{88} = \text{\_\_\_\_MPH}$

7.4.2 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
a. 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 7.4.1.
b. Replace all nozzle tips which are more than 5% inaccurate.
c. 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: $\frac{\text{\_\_\_\_GPM X 495}}{\text{\_\_\_\_mph X \_\_\_\_ft.}} = \text{GPA}$

7.4.3 Calibrating a Kinkelder Sprayer

-use clean water

Rate of spray **Forward speed** **Row spacing**

$\frac{\text{Gals/acre} \times \text{mph} \times \text{ft} \times 60}{500}$ = gals/hr delivery or index setting

e.g.
50 gals/acre x 3 mph x 9 ft x 60 = 162 gals/hr delivery or index setting

Your figures:

$\frac{\text{gallons/acre} \times \text{mph} \times \text{ft} \times 60}{500}$ = gals/hr delivery or index setting

This figure should be set on both scales.

8 Pesticides for New York and Pennsylvania Vineyards

8.1 Herbicides

Common Name	Trade Name	Formulation	WSSA Group Number (Resistance Management)	Days to Harvest	Reentry Interval	EPA Number
carfentrazone-ethyl	Aim EW	EC	14	3	12	279-3241
clethodim	*[NY]Select 2EC[a]	2EC	1	1 year	24 hr	59639-3
	^Volunteer	2 EC	1	1 year	24 hr	59639-3-55467
	*[NY]Select 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	Karmex, Direx, and others	80DF	7	0	12 hr	^1812-362
	Direx, others	4L	7	0	12 hr	^1812-257
	Direx 4L	4L	7	0	12 hr	66222-54
	Karmex DF,	80 DF	7	0	12 hr	66222-51
	^Karmex XP	80 DF	7	0	12 hr	352-692
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	1EC	10	14	12 hr	264-652
	†Rely 280	2.34 EC	10	14	12 hr	264-829
glyphosate	^Roundup Ultra	4L	9	14	4 hr	524-475
	^Touchdown Herbicide	3EC	9	14	12 hr	100-1117
	Touchdown Total, Traxion	4.17L	9	14	12 hr	100-1169
	Touchdown HiTech	5F	9	14	12 hr	100-1182
	^Roundup Ultramax	5L	9	14	4 hr	524-512
indaziflam	*[NY]†Alion	SC	29	14	12 hr	264-1106
isoxaben	^Gallery	75DF	21	1 year	12 hr	62719-145
napropamide	Devrinol	50DF	15	35	12 or 24 hr (see label)	70506-36
norflurazon	†Solicam	80DF	12	60	12 hr	61842-41
oryzalin	Surflan	4AS	3	0	24 hr	70506-43
	Oryzalin	4AS	3	0	24 hr	66222-138
oxyfluorfen	Goal 2XL	2EC	14	b	24 hr	62719-424
	GoalTender	4 EC	14	b	24 hr	62719-447
paraquat	^*Gramoxone Max	3L	22	0	24 hr	100-1074
	*Gramoxone SL 2.0	2L	22	0	24 hr	100-1431
pelargonic acid	Scythe	4.2EC	unclassified	0	12 hr	10163-325
pendimethalin	^Pendimax	3.3L	3	1 year	24 hr	68156-6-62719
	Prowl	3.3EC	3	1 year	24 hr	241-337
	ProwlH_20	3.8EC	3	90	24 hr	241-418
pronamide	*Kerb	50W	3	c	24 hr	62719-397
rimsulfuron	Matrix FNV	25DF	2	14	4 hr	352-671
sethoxydim	Poast	1.5EC	1	50	12 hr	7969-58