



2020 Southeast Regional Muscadine Grape Integrated Management Guide

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Recommendations are based on information from the manufacturer's label and performance data from research and extension field tests. Because environmental conditions and grower application methods vary widely, suggested use does not imply that performance of the pesticide will always conform to the safety and pest control standards indicated by experimental data.

This publication is intended for use only as a guide. Specific rates and application methods are on the pesticide label, and these are subject to change at any time. Always refer to and read the pesticide label before making any application! The pesticide label supersedes any information contained in this guide, and it is the legal document referenced for application standards.

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Pesticide Stewardship and Safety

PESTICIDE EMERGENCIES

1-800-222-1222

This number automatically connects you with a local Poison Control Center from anywhere in the United States.

- **Tightening of the chest, mental confusion, blurred vision, rapid pulse, intense thirst, vomiting, convulsions, and unconsciousness are always serious symptoms! Dial 911!**
- **Pesticides with ‘DANGER’ or ‘DANGER/POISON’ on the product label can cause severe injuries or death very quickly, even with small exposures. Take immediate action!**

- ***Other symptoms of pesticide poisoning:*** headache, fatigue, weakness, restlessness, nervousness, profuse sweating, tearing and drooling, nausea, diarrhea, or irritation of the skin/ eyes/nose/throat. Consult the product Material Safety Data Sheet (MSDS) for symptoms associated with a particular pesticide.

Pesticide on Skin

- **WASH, WASH, WASH!** Immediately wash pesticide from skin as thoroughly as possible with any available water that does not contain pesticides.
- Quickly remove protective clothing and any contaminated clothing.
- *Rewash* contaminated skin with soap and water as soon as possible.
- If the victim experiences *any* symptom(s) of poisoning, get medical assistance immediately. *Take the pesticide label with you*, but do not contaminate vehicles or expose others if you must take the container with you.

Pesticide in Eyes

- Rinse eye(s) gently with *clean* water for *at least* 15 minutes. Be careful of water temperature.
- **If eye remains irritated or vision is blurry after rinsing, get medical attention right away!** *Take the pesticide label with you.*

Pesticide in Mouth or Swallowed

- Provide / drink large amounts of water or milk to drink - *Do not give liquids to a person who is unconscious or convulsing!*
- Consult the label BEFORE vomiting is induced – the label may advise against inducing vomiting. Do not induce vomiting with emulsifiable concentrate (E, EC) formulations.
- *Do not induce vomiting if a person is unconscious or is convulsing!*
- **Seek medical attention.** *Take the pesticide label with you.*
- If the pesticide was not swallowed, *rinse mouth thoroughly with clean water.* If mouth is burned or irritated, consult a physician.

Pesticide Inhaled

- Move victim to fresh air immediately!
- Warn others in the area of the danger.
- Loosen tight clothing.
- Administer artificial respiration if necessary, but try to determine if the person also may have swallowed any pesticide - avoid any pesticide or vomit that may be around the victim's mouth.
- **Seek medical attention.** *Take the pesticide label with you.*

Heat Stress

- Move the victim to a cooler area, remove protective clothing, and pour cool water over the person.

- Give cool liquids to drink – *Do not give liquids to a person who is unconscious or convulsing!*
- **Pesticide poisoning may mimic heat illness!** Get medical attention if the person is unconscious or if the person is not fully recovered within 15 minutes of cooling down and drinking liquids.

Signal Words

The pesticide signal word will appear on the pesticide label. It provides information about the acute risks of the pesticide to people.

- **DANGER/POISON:** *Highly toxic* - less than a teaspoon can kill an adult.
- **DANGER:** *Highly toxic* - pesticide can cause severe eye and/or skin injury.
- **WARNING:** *Moderately toxic* - two tablespoons or less can kill an adult.
- **CAUTION:** *Slightly toxic* - an ounce or more is required to kill an adult.

Understand that the signal word does *not* provide information about long term pesticide exposure risks (*e.g.*, cancer) or allergic effects. Minimize your exposure to *all* pesticides. The signal word does *not* indicate environmental toxicity or other environmental effects.

PESTICIDE SPILLS OR OTHER EMERGENCIES

Spills on public roads (Usually call the state police/state highway patrol. In many cases you can call CHEMTREK at 1-800-424-9300 or 911.)

STATE	AGENCY	PHONE NUMBER
Arkansas		
Georgia	Georgia State Patrol	Cell: call *GSP or 911
Louisiana		
Mississippi	Mississippi Emergency Management Agency	1-800-222-6362
North Carolina	Regional Response Team (RRT) For spills not on public road ways, contact the Pesticide Section of NCDA&CS	911 or your RRT (919) 733-3556 or (800) 662-7956 during non-business hours
South Carolina	South Carolina Highway Patrol ----- South Carolina DHEC Emergency Response Section	Cell: call *HP ----- 1-888-481-0125 (Toll Free)
Tennessee	Tennessee Emergency Management Agency (TEMA) State Emergency Operations Center	1-800-262-3300
Virginia	Virginia Emergency Operations Center	1-804-674-2400

Environmental emergencies (contamination of waterways, fish kills, bird kills, etc.)

STATE	AGENCY	PHONE NUMBER
Arkansas		
Georgia	Georgia Department of Natural Resources Response Team	1-800-241-4113
Lousiana		

Mississippi	Mississippi Emergency Management Agency	1-800-222-6362
North Carolina	North Carolina Div. of Water Quality	1-800-858-0368
South Carolina	South Carolina DHEC	1-888-481-0125 (Toll Free)
Tennessee	Tennessee Wildlife Resources Agency	1-615-781-6643
Virginia	Virginia Emergency Operations Center	1-804-674-2400

PESTICIDE LIABILITY and STEWARDSHIP

Pesticide applicators, supervisors, and business owners may all face severe criminal and/or civil penalties if pesticides are misused – knowingly or accidentally. Read and know the following:

The pesticide label. Federal and state laws require pesticide applicators to follow the directions on the pesticide label exactly. Do not exceed maximum label rates, apply a pesticide more frequently than stated on the label, or apply a pesticide to a site that is not indicated on the label. Labels change; review yours regularly.

Restricted Use Pesticides (RUP). These pesticides are clearly labeled “Restricted Use Pesticide” in a box at the top of the front label. Applicators purchasing, applying, or supervising the application of an RUP, must be certified or licensed through their state pesticide regulatory agency. Some states have mandatory licensing for certain pesticide use categories whether or not RUPs are applied.

Personal Protective Equipment (PPE). Anyone handling or applying pesticides must wear the PPE stated on the pesticide label. The Worker Protection Standard requires applicators to wear the label required PPE and requires agricultural employers to supply the label PPE and ensure that the PPE is worn correctly by applicator employees. Do not wear PPE items longer than it has been designed to protect you. Clean, maintain and properly store PPE. Do not store PPE with pesticides.

Reentry Interval (REI). The REI is the period of time immediately following the application of a pesticide during which unprotected workers should not enter a field.

Pre-Harvest Interval (PHI). The PHI is the time between the last pesticide application and harvest of the treated crops.

EPA Worker Protection Standard (WPS; <http://www.epa.gov/agriculture/twor.html>) Growers who employ one or more *non*-family members must comply with the WPS. This standard requires agricultural employers to protect applicator employees and agricultural worker employees from pesticide exposure in the workplace by 1) providing specified pesticide safety training, 2) providing specific information about pesticide applications made on the agricultural operation, 3) providing and ensuring that applicators wear clean and properly maintained label required PPE, 4) providing decontamination facilities for potential pesticide and pesticide residue exposures, and 5) providing timely access to medical assistance in the event of a suspected pesticide exposure. These protections apply to both Restricted Use *and* general use pesticides used in agricultural plant production.

Pesticide Recordkeeping. You must keep records of all RUP applications for at least two years under the Federal (USDA) Pesticide Recordkeeping Requirement if your state does not have its own pesticide recordkeeping requirements. Some states require records be kept for longer than the federal requirement. Maintaining records of all pesticide applications, not just RUP applications, indefinitely, cannot only help troubleshoot application problems, but also allows you to reference successful applications and can help protect against future liability. Consult your [local Extension Service](#) for details.

Be prepared for emergencies. Store pesticides and clean empty containers securely. Develop and provide written plans and training to prepare your employees, and family members, for pesticide fires, spills, and other emergencies. Assign responsibilities to be carried out in the event of pesticide emergencies. Keep copies of the pesticide labels and MSDS away from the area where pesticides are stored. Provide copies of product MSDSs to your community first responders. Consult your local Extension office and insurance company for assistance.

Properly dispose of clean empty pesticide containers and unwanted pesticides as soon as possible. Containers can often be recycled in a pesticide container recycling program. Unwanted pesticides may pose a risk of human exposure and environmental harm if kept for long periods of time. Consult your local Extension office for assistance.

PESTICIDE APPLICATION

Information on pesticide use is available from the Pesticide Environmental Stewardship website (<http://pesticidestewardship.org>) including information on [sprayer calibration](#), [personal protective equipment](#), [recordkeeping](#), and [resistance management](#).

RESISTANCE MANAGEMENT

Insects, weeds, and disease-causing organisms are all capable of developing resistance to pesticides. To minimize the likelihood of resistance development against your material of choice:

1. Only use pesticides when necessary. Pesticide use is not economical unless the damage caused by the pest you are controlling is at least greater than the cost of the pesticide application, and only then when no other practical, effective options are available.
2. Use the appropriate material for the pest.
3. Use the recommended rate of the material. Do not use a higher or lower rate than listed on the label.
4. If more than one treatment is needed when the same pest is present, rotate pesticide mode of action (MOA) between treatments.

The Fungicide Resistance Action Committee (**FRAC**, www.frac.info), Insecticide Resistance Action Committee (**IRAC**, www.irac-online.org), and Weed Science Society of America (**WSSA**, <http://www.wssa.net>) have grouped pesticides into MOA categories, which are listed in this guide to aid in the development of resistance management programs.

POLLINATOR PROTECTION

Before making insecticide applications, monitor insect populations to determine if treatment is needed. If insecticide application is necessary:

1. Use selective pesticides to reduce risk to pollinators and other non-target beneficial insects.
2. Read and follow all pesticide label directions and precautions (the Label is the Law!). EPA now requires the addition of a “Protection of Pollinators” advisory box on certain pesticide labels. Look for the bee hazard icon in the Directions for Use and within crop specific sections for instructions to protect bees and other insect pollinators.

(Continued on next page)



3. Minimize in-field exposure of bees to pesticides by avoiding applications when bees are actively foraging in the crops. Bee flower visitation rate is highest in early morning. Apply pesticides in the late afternoon or early evening to allow for maximum residue degradation before bees return the next morning. Bee foraging activity is also dependent upon time of year (temperature) and stage of crop growth. The greatest risk of bee exposure is during bloom.
4. Minimize off-target movement of pesticide applications by following label directions to minimize drift. Do not make pesticide applications when the wind is blowing towards bee hives or off-site pollinator habitats.

Muscadine Grape Integrated Management Guide

Introduction

The muscadine grape (*Vitis rotundifolia*, syn. *Muscadinia rotundifolia*) is a thick-skinned native grape species found in the southeastern United States. The fruit ripens in late summer/early fall and is generally harvested as single berries rather than in bunches. In the wild, muscadines vines are usually either male or female, while cultivated varieties (cultivars) are usually either female or perfect-flowered (having both male and female flower parts). Most wild vines have dark fruit, while cultivated (improved) cultivars are also available in many shades of bronze, purple or red. Cultivars have been developed for both fresh fruit and for winemaking. As the species name implies, the leaves are round and unlobed, though serrated at the edge.

Diseases – Muscadines can be grown in warm, humid areas where bunch grapes cannot, and have been grown organically for local markets. Muscadines are resistant to the Pierce's Disease bacterium (*Xylella fastidiosa*) that limits bunch grape production, and are not affected by some major fungal diseases like grape downy mildew or botrytis bunch rot. However, muscadines can still suffer extensive losses if diseases like powdery mildew, bitter rot, black rot and ripe rot are left unchecked. Fruit rotting diseases reduce yields and make berries unmarketable for either wine or fresh sales.

Insects – See text in each section below for specific comments. Grape root borers are an important pest of muscadine vines. Aphids occur on new shoots but often do not require control. Grape berry moth occurs sporadically. Japanese beetles may feed on foliage and flowers in early summer. Insects feeding on ripe fruit include June beetles, as well as wasps, yellowjackets and other stinging insects that can pose a risk to pickers. The risk of infestation by spotted wing drosophila (SWD) is considered low due to the thick skins of muscadine grapes; however SWD and other vinegar flies can be found in damaged fruit such as rain-splits.

Weeds—See comments beginning on page 24.

Cultural Practices

Cultivar selection – Most muscadines grown for wine are high-yielding, medium to small size grapes that detach easily and thus are suitable for machine harvest. The cultivar Carlos is the most commonly used bronze muscadine for white wine, and Noble is the most common dark fruited cultivar for red wine. Fresh market and pick-your-own cultivars have grapes that are larger in size, with firmer flesh, and a more edible skin. Examples of fresh-market cultivars include dark-fruited Supreme and Nesbitt, and the bronze-fruited cultivars Triumph, Summit and Fry.

Site selection and establishment – The most productive muscadine vineyards are on sites that have well-drained soils. Soils that stay wet during the winter months or that flood regularly are not satisfactory for muscadines. Sites where tobacco has been grown successfully are generally suitable for muscadines. Where needed to improve drainage, plant in raised rows bedded 4-12 inches high and four feet wide. Provisions for drainage must be made prior to planting.

Land preparation should begin the year before planting; have the soil tested, correct any deficiencies in P and K levels, and adjust the pH to 6.5 with dolomitic limestone. Use contact or systemic herbicides to clean up infestations of johnsongrass, bermudagrass, or nutsedge in the year *before* vines are set. Use a single-wire trellis, space rows 10 to 12 feet apart, and set posts 20 ft apart within rows. Plant one vine beside each post (rather than halfway between posts). This positioning will help protect the vine and minimize fruit loss during harvest, especially if mechanical harvest is planned.

Plant in late April or early May (NC and GA/SC Piedmont) after danger of spring freezes has passed, or during the winter in South GA. Commercial “grow tubes” (24-36 inches long and 3-4 inches in diameter) will accelerate growth and protect vines in the first growing season, but grow tubes may delay the development of vine cold hardiness in the fall, and for this reason they should be removed at the end of each growing season, in late September/early October.

Pruning (training new vines)

Trellising young vines -- During the first two or three years, vines need regular training once a week throughout the growing season. Training establishes the optimal shape and position of the vine. Proper training is accomplished by selecting a single shoot and training it up a bamboo stake or string. Remove any side shoots that appear in the leaf axils by pinching them out as soon as possible, leaving the leaf intact. The objective is to have a single growing point rather than multiple shoots. Plastic vineyard tape is used for attaching vines to the bamboo stake and later to the trellis wire. Train the young vines up the stake or string to the wire, then pinch the tip back to approximately 10-12 inches below the wire. This will encourage a V-shaped branching. Choose two of these lateral branches and begin training them in opposite directions along the wire, as future “main arms” or cordons. Continually remove lateral suckers along the trunk in order to direct all the plant’s growth into the growing tips of the cordons. Until the cordons reach full length, cut back side shoots along the cordon to approximately 4 to 6 inches during the growing season. Likewise, remove all fruit at the earliest possible stage on young vines, in order to direct growth to the desired shoots.

Dormant

Winter pruning – Proper pruning aids in disease management. Hedge or hand prune vines, leaving only 3-4 inch stubs (spurs) of 1-yr-old wood protruding from the main cordon or previous season's wood. Selectively thin these spurs or spur clusters to space them approximately 4-6 inches along the cordon. As the vines age, remove some of the older spur clusters when crowding occurs. Young vines (1-4 yrs old) require special attention to remove grape tendrils that wrap around the new cordon. If not removed, these tendrils will girdle and kill the newly-trained arm. After the 3rd or 4th year, the cordon becomes too thick for tendrils to wrap around it, and this girdling ceases to be a threat. Late winter is the best time to prune muscadines in areas subject to winter injury.

Dieback "dead arm" diseases – Fungal dieback diseases (caused by *Botryosphaeria*, *Phomopsis*, *Fusicoccum*) can quickly kill even mature plants. These diseases are often observed as plants come out of dormancy or following initial fruit swell. Symptoms are rapid death from the growing cordon tips back towards the main trunk. These fungi reside in pruning or other wounds, and are present on all muscadines. Plant stress triggers disease. Any actions to reduce plant stress throughout the year will be helpful (irrigation, proper fertilization). Cold injury can predispose vines to these "dead arm" diseases by causing large, slow-healing wounds to trunks and cordons.

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Fruit rots and foliage diseases	Sanitation and pruning, canopy management		+++				Prune to remove dead wood and old fruit pedicels that can harbor diseases. Control weeds under vines with chemicals or mowing; trim vines if needed, so shoots terminate at least 18-24 inches from the ground. This will promote air movement and drying under vines.
Dieback "dead arm" diseases (Botryosphaeria and other similar organisms)	Sanitation and pruning, canopy management		+++				Prune to remove dead wood. Monitor vines for injury and prune to remove/replace cold-damaged or insect-damaged cordons.
	myclobutanil (Rally 40W)	5 oz	???	FRAC Code [3]	24 hrs	14 days	May be applied in 50 gallons of water per acre to protect pruning wounds. This treatment has not been evaluated on muscadines but has likely shown benefit on other grape species. Apply within 24 hrs of pruning. Do not apply more than 1.5 lb of Rally 40W per acre per year. Interval for repeat applications should not exceed 14 days.

Prebloom (Bud break till bloom)

Angular leafspot is a fungal disease caused by the pathogen *Mycosphaerella angulata*. Leaf spotting leads to premature defoliation. When a muscadine vine defoliates prior to harvest, development of fruit ceases and grapes may fail to ripen. Total crop loss may occur. Fortunately, angular leafspot is easy to control with either mancozeb or captan. In wet seasons, however, control may be expensive due to the need for repeated fungicide applications.

Black rot is a fungal disease caused by the pathogen *Guignardia bidwellii* f. sp. *Muscadinii*. Black rot can cause numerous necrotic round (ca, 10 mm) leaf spots early in the season beginning in May-June, and also causes scabby black lesions on fruit that do not penetrate the skin. Fungicides applied prior to, during and after bloom are effective in controlling black rot.

Aphids in muscadines are typically cool-season, spring pests. Natural enemies often moderate aphid numbers as the weather warms. Treat only if aphids are abundant and new shoot tips or foliage are becoming malformed.

Grape leafhoppers are sucking pests that may be very abundant, causing colorless, cleared stippling on leaves; heavy infestations can cause defoliation. Leafhoppers may be present through much of the growing season, but often in numbers that appear to do no harm. Provisional treatment thresholds are 10 leafhopper nymphs or adults per leaf based on samples from 10 vines per acre, or when leafhoppers and injury are seen (stippling and weak, unthrifty growth).

Flea beetles and Scarab beetles are occasional bud and foliage feeders. The primary concern is Spring bud and shoot damage. Treat if beetles are abundant and injury is evident. Suggested treatment threshold is 5% damaged buds in a sample of 10 vines per acre. Less than 10% foliar injury is unlikely to be harmful. Scarab beetles often feed at dusk or at night, and may not be present during the day.

Prebloom (Bud break till bloom)

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Black rot Bitter rot Angular leaf spot Powdery mildew	myclobutanil (Rally 40W)	3-5 oz	++++	FRAC Code [3]	24 hrs	14 days	Do not apply more than 1.5 lb of Rally 40W per acre per year. Interval for repeat applications should not exceed 14 days.
(Continued on next page)	thiophanate-methyl (Topsin M 70WSB)	0.75-1.5 lb	+++	FRAC Code [1]	2 days	7 days	Apply when foliage first develops and repeat at 14 to 21 day intervals or as needed. Do not apply more than 4 lb. product (2.8 lb ai)/acre/season. Use only in combination or alternation with a labeled non-benzimidazole fungicide.

Prebloom (Bud break till bloom) -- *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Black rot Bitter rot Angular leaf spot Powdery mildew (<i>continued</i>)	azoxystrobin (Abound 2.08SC)	10-15.5 fl oz	+++++	FRAC Code [11]	4 hrs	14 days	Do not make more than four applications of Abound per acre per year, or more than two sequential sprays before alternating with other fungicides having a different mode of action.
	trifloxystrobin (Flint 50WG)	2-3 oz	+++++	FRAC Code [11]	12 hrs	14 days	Do not apply more than 24 oz of Flint per acre per season, or more than six times per season. Do not apply more than two applications of Flint before switching to a non-strobilurin fungicide. DO NOT APPLY to CONCORD GRAPES or crop injury may occur.
	pyraclostrobin + boscalid (Pristine WG)	8-12.5 oz	+++++	FRAC Code [11+7]	12 hrs (5 days for vine turning, tying)	14 days	Do not make more than three applications of Pristine or related fungicides (strobilurin or carboxamide) per season. Do not make more than two sequential applications before alternating with a fungicide with a different mode of action. Do not use on CONCORD and related grapes (Worden, Fredonia, Niagara).
	kresoxim-methyl (Sovran 50 WG)	3.2-4.8 oz	++++	FRAC Code [11]	12 hrs	14 days	Do not make more than four applications of Sovran per acre per year, or more than two sequential sprays before alternating with other fungicides having a different mode of action.
	EBDCs (ethylene-bis-dithiocarbamates) Mancozeb, Dithane M45 Manzate ProStick Maneb 75DF Penncozeb 75DF	1.5-4 lb	+++	FRAC	24 hrs	66 days	Do not apply more than 24 lb of Dithane M45, Manzate 200DF, Maneb 80WP or Penncozeb 75DF per acre per season. Repeat applications at 7 to 10 day intervals.

(*continued on next page*)

Prebloom (Bud break till bloom) – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Black rot Bitter rot Angular leaf spot ONLY	Ziram 76 DF	3-4 lb	+++	FRAC Code [M3]	48 hrs	21 days	Repeat Captan applications at 7 to 14 day intervals. Do not apply 50WP by air.
	captan (Captan 50WP)	4 lb	+++	FRAC Code [M4]	48 hrs	0 day	
	captan (Captan 4L)	0.75-2 qt	+++		48 hrs	0 day	
Powdery mildew ONLY	wettable sulfur (Microthiol, various brands, 80 to 92% S)	3 to 10 lb	++++	FRAC Code [M2]	24 hrs	--	Must be applied every 7-10 days. Dilute in 100 gal of water per acre. Corrosive to sprayers and trellis wires. OMRI listed for organic growers. Do not apply within two weeks of oil or oil-based products, or at temperatures above 90 F. May injure Concord and other <i>Vitis labrusca</i> cultivars.
Aphids	malathion 57EC	1.5 pt	++++	IRAC Code [1B]	24 hrs (72 hrs for vine tying)	3 days	Treat if aphids are abundant and terminals or foliage are becoming malformed. Aphids rarely reach damaging levels.
	imidacloprid (Admire Pro)	7 to 14 fl oz (soil) 1 to 1.4 fl oz (foliar)	++++	IRAC Code [4A]	12 hrs	30 days (soil) 0 days (foliar)	If a soil application of a Group 4 is made, at least one foliar application of a different mode of action should be made before a foliar application of a Group 4A material is made.
(continued on next page)	malathion 57EC	1.5 pt	++++	IRAC Code [1B]	24 hrs (72 hrs for vine tying)	3 days	Grape leafhopper injury is seen as colorless, cleared stippling on leaves; heavy infestations can cause defoliation. Provisional treatment thresholds suggest treating for 10 leafhopper nymphs or adults per leaf or when grape leafhoppers and injury are evident (weak, unthrifty growth.)
	carbaryl (Sevin 80S)	1.25 to 2.5 lb	+++	IRAC Code [1A]	12 hrs	7 days	
	phosmet (Imidan 70W)	1.33 to 2.12 lb	++++	IRAC Code [1B]	14 days	14 days	

Prebloom (Bud break till bloom) – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-Iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Grape leafhoppers (<i>continued</i>)	fenpropathrin (Danitol 2.4EC)	5 to 10 fl oz	+++	IRAC Code [3A]	24 hrs	21 days	
	imidacloprid (Admire Pro)	7 to 14 fl oz (soil) 1 to 1.4 fl oz (foliar)	++++	IRAC Code [4A]	12 hrs	30 days (soil) 0 days (foliar)	If a soil application of a Group 4 is made, at least one foliar application of a different mode of action should be made before a foliar application of a Group 4A material is made.
	thiamethoxam (Platinum) (Actara)	8 to 17 oz 1.5 to 3 oz	+++	[4B]	12 hrs	60 days 5 days	Platinum is soil applied, Actara by foliar spray. Actara can be applied by ground or air.
	dinotefuran (Venom)	5 to 6 oz soil 1 to 3 oz foliar	+++	IRAC Code [4A]	12 hrs	28 days 1 day	Only one soil application allowed per season.
Grape flea beetles	carbaryl (Sevin 80WSP)	1.25 to 2.5 lb	++++	IRAC Code [1A]	12 hrs	7 days	Flea beetles chew holes in the foliage. Less than 10% foliar injury is unlikely to be harmful. Treat if flea beetles are abundant and injury is evident.
	Malathion 57EC	1.5 pt	+++	IRAC Code [1B]	12 hrs	3 days	Grape flea beetle larvae also feed on buds. Treatment is recommended if 5% of vines exhibit bud damage.
	cyfluthrin (Baythroid 2 EC)	2.4-3.2 fl oz	+++	IRAC Code [3A]	12 hrs	3 days	
	phosmet (Imidan 70-W)	1.33-2.125 lb	+++	IRAC Code [1B]	14 days	14 days	The 14-day REI may make this product impractical to use for most growers.

Prebloom (break till bloom) – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-Iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Climbing Cutworms (<i>continued</i>)	cyfluthrin (Baythroid 2EC)	2.4-3.2 fl oz	+++	IRAC Code [3A]	12 hrs	3 days	
	methoxyfenozide (Intrepid 2F)	12-16 fl oz	+++	IRAC Code [18]	4 hrs	30 days	
	spinetoram (Delegate 25 WG)	3-5 oz	+++	IRAC Code [5]	4 hrs	7 days	
	flubendiamide + buprofezin (Tourismo 12.5)	10-14 fl oz	++	IRAC Code [16+28]	12 hrs	7 days	
	spinosad (Entrust 80W)	1.25-2.5 oz	+++	IRAC Code [5]	4 hrs	7 days	OMRI approved.
	<i>Bacillus thuringiensis</i> [Bt] (Dipel DF and others)	0.5-1 lb	++	IRAC Code [11]	4 hrs	0 days	OMRI approved.
	rynaxypyr (Altacor)	3.0-4.5 oz	+++	IRAC Code [28]	4 hrs	14 days	Use between 100-200 gallons per acre total spray volume.

Bloom (*Do Not Apply Insecticides During Bloom*)

[illegible]

Bloom (Do Not Apply Insecticides During Bloom) – continued from previous page

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-Iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
The disease Ripe rot (caused by <i>Colletotrichum</i> sp. fungi) is one of the most difficult fungal pathogens to control on muscadine grapes. Most bronze-fruited cultivars are susceptible, while most purple-fruited muscadines are resistant. Fungicidal control has been most successful when strobilurin-type fungicides [FRAC code 11] are combined or alternated with fungicides having a different mode of action. Sprays should begin at bloom or immediately following bloom (first cover). Ripe rot is most severe in wet harvest seasons and when fruit is left hanging too long on the vine. Timely harvest and rapid cooling of harvested fruit aids in control.							
Black rot Bitter rot Ripe rot Angular leaf spot Powdery mildew (continued)	EBDCs (ethylene-bis-dithiocarbamates) Mancozeb, Dithane M45 Manzate ProStick Maneb 75DF Penncozeb 75DF	1.5-4 lb	+++	FRAC Code [M3]	24 hrs	66 days	Do not apply more than 24 lb Dithane M45, Manzate 200DF, Maneb 80WP or Penncozeb 75DF per acre per season. Repeat applications at 7 to 10 day intervals.
	Ziram 76 DF	3-4 lb	+++	FRAC Code [M3]	48 hrs	21 days	
	captan (Captan 50WP)	4 lb	+++	FRAC Code [M4]	48 hrs	0 day	Repeat Captan applications at 7 to 14 day intervals. Do not apply 50WP by air.
	captan (Captan 4L)	0.75-2 qt	+++		48 hrs	0 day	
Powdery mildew ONLY	wettable sulfur (Microthiol, various brands, 80 to 92% S)	3-10 lb	++++	FRAC Code [M2]	24 hrs	--	Must be applied every 7-10 days. Dilute sulfur in 100 gal of water per acre. Sulfur is corrosive to sprayers and trellis wires. Do not apply within two weeks of oil or oil-based products, or at temperatures above 90 F. May injure Concord and other <i>Vitis labrusca</i> cultivars.

First Cover (post-bloom)

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Acton Code	REI	PHI	Comments and Precautions
Aphids Leafhoppers Flea beetles	Same as sprays for Prebloom						Base treatments on scouting and scout regularly in areas with a history of injury.
Black rot Bitter rot Ripe rot Angular leaf spot Powdery mildew <							

First Cover (post-bloom) – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Black rot Bitter rot Ripe rot Angular leaf spot Powdery mildew (<i>continued</i>)	kresoxim-methyl (Sovran 50 WG)	3.2 to 4.8 oz	++++	FRAC Code [11]	12 hrs	14 days	Do not make more than four applications of Sovran per acre per year. Do not apply more than two sequential sprays of Sovran. Alternate applications with other fungicides which have a different mode of action.
	EBDCs (ethylene-bis-dithiocarbamates) Mancozeb, Dithane M45 Manzate ProStick Maneb 75DF Penncozeb 75DF	1.5 to 4 lb	+++	FRAC Code [M3]	24 hrs	66 days	Do not apply more than 24 lb Dithane M45, Manzate 200DF, Maneb 80WP or Penncozeb 75DF per acre per season. Repeat applications at 7 to 10 day intervals. <u>**Note PHI of 66 days – cannot be used post-bloom for early-ripening cultivars.</u>
	Ziram 76DF	3 to 4 lb	+++		48 hrs	21 days	
	captan (Captan 50WP)	4 lb	+++	FRAC Code [M4]	48 hrs	0 day*	Repeat Captan applications at 7 to 14 day intervals. Label allows application up to day of harvest; however; note 48 hr re-entry interval.
	captan (Captan 4L)	0.75 to 2 qt	+++		48 hrs	0 day*	
Powdery mildew ONLY (<i>Sulfur will not control other diseases</i>)	wettable sulfur (various brands, 80 to 92% S)	2 to 5 lbs	++++	FRAC Code [M2]	24 hrs	--	Must be applied every 7-10 days. Dilute sulfur in 100 gal of water per acre. Sulfur is corrosive to sprayers and trellis wires. Do not apply within two weeks of oil or oil-based products, or at temperatures above 90 F. May injure Concord and other <i>Vitis labrusca</i> cultivars.

First Cover (post-bloom) – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Sooty blotch (Primarily seen on the cultivar 'Fry')	captan (Captan 50WP) (Captan 4L)	2.0 to 4.0 lb 0.75 to 2.0 qt	+++	FRAC Code [M4]	48 hrs	0 days	*Label allows application up to day of harvest; however; note 48 hr re-entry interval.
	azoxystrobin (Abound 2.08SC)	10.0 to 15.5 fl oz	+++++	FRAC Code [11]	4 hrs	14 days	Do not make more than four applications of Abound per acre per year. Do not apply more than two sequential sprays of Abound. Alternate applications with other fungicides which have a different mode of action.
	trifloxystrobin (Flint 50WG)	2 to 3 oz	+++++	FRAC Code [11]	12 hrs	14 days	Do not apply more than 8 oz Flint per acre per season. Do not make more than four applications of Flint per season. Do not apply more than two applications of Flint before switching to a non-strobilurin fungicide.
	pyraclostrobin + boscalid (Pristine)	8.0 to 12.5 oz	+++++	FRAC Code [11+7]	12 hrs (5 days for vine turning, tying)	14 days	Do not make more than five applications of Pristine or related fungicides (strobilurin or carboxamide) per season. Do not make more than two sequential applications of Pristine before alternating with a fungicide with a different mode of action (neither strobilurin or carboxamide).

Summer cover (post-bloom) sprays until harvest

Fruit rots: Bitter rot and black rot – These rots are usually controlled by fungicide applications pre-bloom to first cover. Proper pruning and removal of infected berries, leaves and old fruit stems from the previous winter may reduce disease. If bitter rot is very heavy, fungicides can be applied at shoot emergence, 3-5 inches, 8-10 inches and at 7-10 day intervals until fruit set. Black rot-susceptible cultivars can be sprayed with a fungicide every 14 days from the start of new growth until after bloom. Black rot control is particularly needed on highly susceptible cultivars such as Carlos and Cowart. **Ripe rot** – Ripe rot can be particularly severe on susceptible cultivars such as Higgins, Magnolia, Summit, Watergate, Carlos, Fry, Dixieland, and Scuppernong. Abound and other QoI fungicides are the materials of choice in vineyards where ripe rot is a problem. However resistance is likely developing to these chemicals. **Sooty blotch** causes a dark, superficial discoloration on the surface of otherwise healthy fruit; the disease is common on unsprayed vines of the cultivar Fry. **Macrophoma rot** – control can be improved with early cover sprays of Captan, particularly on susceptible cultivars such as Cowart, Fry, Higgins, Summit and Triumph.

Cover spray insecticides are often not needed in muscadines due to moderate insect pressure. Growers should rely on “as-needed” applications, while using the IPM approach of scouting frequently for insect damage, including detailed plant examination of 10 vines per acre for insect or mite pests.

Grape berry moth is somewhat sporadic, but if present can be very damaging. This moth has several generations per season, beginning around bloom. In muscadines, grape berry moth is normally a mid- to late-season pest. Eggs are laid on the berry clusters, and young larvae enter berries at the stem end; their feeding, webbing and frass can damage multiple berries within a cluster. Spray promptly if infested clusters are seen or if a vineyard has a history of grape berry moth infestations.

Grape curculio is a small weevil (snout beetle) that typically emerges in mid-June (in GA). Grape curculio initially feeds on the underside of leaves in a shallow zigzag pattern before beginning to lay eggs in the berries. Spray if grape curculio are present or if either foliar or fruit injury are seen. This is a sporadic pest that is sometimes a problem in unmanaged vineyards where weeds and wild hosts thrive.

Green June beetle and **Japanese beetle** populations can get out of hand rapidly. Moderate defoliation by Japanese beetles is seldom damaging, but in some years these insects can be found feeding on flowers, and this can greatly reduce the crop. Fruit feeding by green June beetle is serious, so do not allow these pests to feed heavily on and become abundant in blocks with ripe fruit. Beware of heavy emergence and migration to blocks with ripe fruit after rains. Multiple applications are often necessary to maintain control if populations are allowed to build up. Ripening fruit and aggregation pheromone may quickly attract ‘new’ beetles to your vineyard after successful applications.

Wasps, hornets, yellowjackets and imported fire ants may be attracted to ripening fruit. Feeding injury or the presence of insect debris in harvested fruit can be damaging, and stinging insects discourage pick-your-own customers. Pre-harvest insecticide options are limited; monitor and treat only as needed.

Spider mites and others – Mites are capable of explosive population growth. Treat if more than 10 mites per leaf are found or if mites are present and leaves are webbed or bronzed. Drought and heavy crop load aggravate mite injury, especially early in a growing season. Two treatments at 1 week intervals may be needed if using a material that only kills adult mites. **Brevipalpis** mites (flat mites) cause russetting around leaf veins and at the stem end of berries in NC, and this mite may occasionally warrant control.

Stink bugs – The impact of stink bugs and other piercing/sucking insects in muscadine grapes is unclear, but their feeding may cause fruit to shrivel, spot or abort. No threshold has been developed for these pests.

Summer cover (post-bloom) sprays until harvest– *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Black rot Bitter rot Ripe rot Macrophoma rot Angular leaf spot Sooty blotch	Same as sprays for First Cover						Manzate products can only be used in early season applications. These products are very effective, but use is limited by the 66 day preharvest interval. Other effective cover sprays should include tank mixes of Topsin M or Rally with Captan or Captec, OR an alternation of Topsin M or Rally with Abound, Pristine or Flint.
Stink bugs	phosmet (Imidan 70W)	1.33 to 2.125 lb	+++++	IRAC Code [1B]	14 days	14 days	Imidan seldom prompts outbreaks of secondary pests such as mites. The 14-day REI may make this product impractical to use for most growers.
	fenpropathrin (Danitol 2.4EC)	10 to 21 fl oz	+++++	IRAC Code [3A]	24 hrs	21 days	Danitol is effective against a broad array of insects and is the material of choice for stink bugs. Danitol is a pyrethroid, its use may prompt rebound of mite numbers later in the season.
Japanese beetle	carbaryl (Sevin 80WSP)	1.25 to 2.5 lbs	++++	IRAC Code [1A]	12 hrs	7 days	Use of Sevin may encourage mites. Do not concentrate spray on clusters or visible residue may result. Do not apply more than 12 ½ lb/acre per year.
	carbaryl (Sevin XLR Plus)	1 to 2 qt	++++		12 hrs	7 days	Repeat applications as necessary up to a total of 5 times but not more often than once every 7 days. Do not apply more than 10 qt/acre per year.
	fenpropathrin (Danitol 2.4EC)	10 to 21 fl oz	+++++	IRAC Code [3A]	24 hrs	21 days	Danitol is a pyrethroid, its use may prompt rebound of mite numbers later in the season.
	acetamiprid (Assail 30SG)	2.5 oz	+++	IRAC Code [4A]	12 hrs	7 days	Do not make more than two applications per season.
	imidacloprid (Admire Pro)	1.3 to 1.4 fl oz	++++		12 hrs	0 days	Do not apply by air.
	clothianidin (Clutch 50WDG)	3 oz	+++		12 hrs	0 days	Do not make more than two applications per season.

(continued on next page)

Summer cover (post-bloom) sprays until harvest – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
<i>(continued)</i> Japanese beetle	Surround	25 to 50 lbs	+++	none	4 hrs	0 days	Surround coats leaves and fruit, rendering them unattractive to Japanese beetles. Surround may also decrease other pest activity. Surround is OMRI listed for use by organic growers. Visible residue may persist on fruit at harvest.
Grape berry moth	carbaryl (Sevin 80WSP)	2.5 lbs	++++	IRAC Code [1A]	12 hrs	7 days	Use of Sevin may encourage mites. Do not concentrate spray on clusters or visible residue may result. Do not apply more than 12 ½ lb/acre per year.
	carbaryl (Sevin XLR Plus)	2 qt	++++		12 hrs	7 days	Repeat applications as necessary up to a total of 5 times but not more often than once every 7 days. Do not apply more than 10 qt/acre per year.
	clothianidin (Clutch 50 WDG)	3 oz	+++	IRAC Code [4]	12 hrs	0 days	
	spinosad (Entrust 80W) (Entrust 2SC)	1.25 to 2.5 oz 4 to 8 fl oz	+++	IRAC Code [5]	4 hrs	7 days	Treatments should be timed to egg hatch. Entrust is OMRI listed.
	spinetoram (Delegate)	3-5 oz	+++		4 hrs	7 days	
	methoxyfenozide (Intrepid)	4 to 8 fl oz	+++	IRAC Code [18]	4 hrs	30 days	Treatments should be timed to egg hatch.
Spider mites	fenbutatin-oxide (Vendex 50WP)	1 lb	+++	IRAC Code [12B]	48 hrs	28 days	Do not retreat with Vendex for 21 days. Restricted Use Pesticide.
<i>(continued on next page)</i>	pyridaben (Nexter 75WP)	4.4 oz	++++	IRAC Code [21]	12 hrs	7 days	Nexter is an excellent miticide for European red mite.

Summer cover (post-bloom) sprays until harvest – *continued from previous page*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
(continued) Spider mites	bifenazate (Acramite 50WS)	0.75-1 lb	+++++	IRAC Code [UN]	12 hrs to 5 days	14 days	Acaramite provides excellent twospotted spider mite control. Fujimite and Acramite kill eggs, larvae and adult spider mites. After one week, scout before considering a second application.
	abamectin (Abba 0.15 EC, Agri-Mek 0.15EC and others)	8 – 16 fl oz	+++++	IRAC Code [6]	12 hrs	28 days	Abamectin products are long residual miticides. They should be applied with a non-ionic surfactant. Test for possible cultivar-specific phytotoxicity prior to spraying entire blocks. Do not reapply within 21 days of initial application. Do not apply by air. Do not make more than two applications per season. abamectin is an adulticide and will not impact eggs or larvae. Restricted Use Pesticide.
	fenpyroximate (Portal)	2 pt	++++	IRAC Code [21]	12 hrs	14 days	Portal and Acramite kill eggs, larvae and adult spider mites. After one week, scout before considering a second application. Do not make more than two applications per season.

Grape root borer control

Grape root borers – Left unchecked, borers can kill grapevines. Borers tunnel inside vines at or below ground level, weakening or killing the vines. All grapes (including labrusca, muscadine and vinifera) are susceptible. There are three control options. Mounding (cultural control), Lorsban (chemical control), and Isomate GB (mating disruption). **Mounding** uses layers of soil to make it more difficult for young larvae to reach the roots or adults to emerge. Use clean cultivation, and mound soil 1 foot high and 1½ feet out from the base of each vine to cover the entire area around the base of each vine. This practice (when well timed) will inhibit adult emergence from the soil; the time for this function will vary by location (early to mid-June for Georgia but 1 August for North Carolina, as examples), so check with your county agent for the appropriate time for your location. It is equally important to knock these mounds back down between early November and late December. **Alternatively, one may use plastic mulch to cover the soil.** To determine whether to use **Lorsban treatment**, examine vines on a block by block basis during September or October for damage, borers or cast pupal skins. Look at 100 vines in each vineyard block. **Treat the following year if 2% or more of the vines are infested or damaged. If possible, treat before adult borers emerge, at least 35 days before harvest.** Mating disruption is effective but expensive and is only one part of an integrated approach to pest management. *(Continued on next page)*

Pest/Problem	Management Options	Amount of Formulation per acre	Effect-iveness (+)	Mode of Action Code	REI	PHI	Comments and Precautions
Grape root borer	Mounding		+++				Mounding is an organically acceptable practice.
	Isomate GRB	100 Dispensers	++++	Mating dis-ruption			Pheromone-based mating disruption has provided 90% reduction of pupal counts on bunch grapes in Virginia. Growers in NC have reported near 100% disruption (based on reduced trap catches of adult males) in muscadine vineyards.
	chlorpyrifos (Lorsban 4E)	4.5 pt/100 gals water, apply 2 qt of mixture/ vine	++++	IRAC Code [1B]	24 hrs	35 days	Apply 2 qt. of the dilute spray mixture to the soil surface on a 15 square foot area around the base of each vine or apply in strip as for herbicide. Do not allow spray to contact fruit or foliage. Apply Lorsban before the pest emerges, but at least 35 days prior to harvest. Application can be made with flood nozzles and low pressure (40 to 60 psi).

Fire ant control

Fire ants – Fire ants may be controlled through the use of bait products. These products are often not fast-acting, but operate by sterilizing the colony (the queen lays sterile eggs). They must be applied when the ants are actively foraging -- test for foraging behavior by placing food (hot dog pieces, potato chips, sardines, etc.) and checking 30 min later for ant activity. Apply during dry weather; moisture reduces the effectiveness of bait products.

Insecticides applied for control of other insect pests will also aid in suppression of fire ants. Fire ant populations are at their highest in young vineyards, but the number of mounds drops rapidly after the vines develop a mature canopy that shades the vineyard floor

Imported Fire Ant	pyriproxyfen (Esteem Ant Bait)	1.5-2.0 lbs	++++	IRAC Code [7C]	12 hrs	1 day	For grapes do not exceed 0.22 lbs active ingredient (ai, pyriproxyfen) per season.
	methoprene (Extinguish Professional Fire Ant Bait)	1.0 to 1.5 lbs	++++	IRAC Code [7A]	4 hrs	0 day	Labeled for use on “cropland”

Efficacy of selected fungicides against diseases of muscadine grape¹

Fungicide	PHI (Pre-Harvest Interval)	Mode-of- Action (MOA) Grouping ₂	FRAC code ³	Bitter rot	Powdery mildew	Ripe rot	Macro- phoma rot	Black rot	Sooty blotch	Dead arm	Angular leaf spot
Myclobutanil (Rally)	14 days	G	3	++ ²	++++	NA	+	++++	+++	???	++++
Thiophanate-methyl (Topsin- M)	7 days	B	1	++	+++	+	+	+++	+++	++	+++
Wettable Sulfur (Microthiol and other trade names)	1 day (re-entry)	Multi-site	M 2	NA	++++	NA	NA	NA	???	NA	NA
Pyraclostrobin + boscalid (Pristine)	14 days	C	7+11	+++	++++	++++	+++++	++++	+++++	++	++++
Kresoxim-methyl (Sovran)	14 days	C	11	+++	+++	+++	++	+++	+++	++	+++
Azoxystrobin (Abound)	14 days	C	11	+++	++++	++++	++++	++++	++++	++	++++
Trifloxystrobin (Flint)	14 days	C	11	+++	++++	++++	+++++	++++	+++++	++	+++
Ziram (Ziram)	21 days	Multi-site	M 3	++	++	+++	++	+++	+++	++	+++
Captan (Captan, Captec)	0 days (72 hrs re-entry)	Multi-site	M 4	++	++	++++	+++	+++	+++	++	+++
EBDCs (includes Maneb, Manex, Penncozeb, Manzate, Dithane M-45)	66 days	Multi-site	M 3	+++	++	NA	++	+++	++	++	+++

¹ NA = no significant activity, ??? = unknown activity; + = very limited activity, ++ = limited activity, +++ = moderate activity, ++++ = good activity, +++++ = excellent activity.

² Alternation of fungicides with different modes of action helps prevent the development of pest resistance to a particular class of fungicide. There is no benefit to alternating or tank-mixing fungicides with the same mode of action. Fungicides listed as “multi-site” are the least likely to be overcome by a resistant strain of a pathogen.

³ In addition to MOA grouping, the FRAC code also indicates fungicides that can be alternated to discourage pest resistance; alternate or tank-mix only those products having different FRAC codes.

Weed Management

Grape Vineyards

The primary goal of any weed management program is to minimize competition in order to direct as much resources, like water, nutrients, and light, as possible toward crop growth. It is essential to minimize or eliminate competition in newly planted and young vineyards so that vine growth can be maximized to bring that vineyard into productivity as soon as possible. Research has shown that failure to control weeds through July in newly planted vineyards will reduce vine growth and may increase vine mortality due to water stress. In older, established vineyards competition will reduce grape yields. The weed management programs outlined in this publication are designed to control weeds at levels to prevent competition and maximize fruit yields.

Herbicide Resistance Management

The development of herbicide resistant weed species has increased significantly across the Southeast during the past few years. Lately weed resistance to glyphosate has been the most common resistance development which is largely related to the widespread planting of glyphosate resistant crops. The utilization of herbicides have differing modes of action (MOA) during the growing season or tank mixing herbicides with differing MOA are strategies that can be utilized to prevent the development of herbicide resistant weeds. As a means to assist growers with identifying herbicides having like MOA a number system identifying herbicides by MOA has been developed and is being utilized. In the table below there is a MOA number for each herbicide active ingredient to aid growers in making management decisions that will prevent the development of herbicide resistance or address options for managing a known resistant weed population that may be in or near the vineyard.

Additionally growers are encouraged to find at least two herbicide programs containing different herbicides to rotate on an annual basis. By rotating herbicide programs growers not only minimize the risk of herbicide resistance developing but they also minimize the likelihood of selecting for weeds that one herbicide program may not be particularly effective at controlling.

Vineyard Herbicide Options

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
PREPLANT/ SITE PREPARATION	Glyphosate, MOA 9 Various brands and formulations	See label	Apply 30 days prior to planting for control of emerged weeds.	12	Use to kill strips through vineyard prior to planting. Generic formulations may require the addition of a surfactant. See label for details on controlling specific perennial weeds.
PREEMERGENCE Annual grasses and small seeded broadleaf weeds	Oryzalin, MOA 3 Surflan 4 AS or Oryzalin	2 to 6 qt	Newly Planted (once soil has settled after transplanting) and Established Vineyards.	12	Oryzalin may be tank mixed with paraquat, glyphosate, or Rely for postemergence weed control. In established vineyards tank mix with simazine for expanded residual control of annual weeds.
<i>(Continued on next page)</i>	Pendimethalin MOA 3 Prowl H ₂ O	2 to 6 qt	Newly Planted (once soil has settled after transplanting) and established vineyards.	12	In newly planted vineyards Prowl may only be applied once soil has settled after transplanting but prior to bud swell. In established vineyards Prowl may be used any time after harvest, through winter, and in the spring. Use rate cannot exceed 6 qt per acre per year. Prowl has a 90 day PHI. Prowl should be tank mixed with paraquat, glyphosate, or glufosinate for postemergence weed control.

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
PREEMERGENCE Annual grasses and small seeded broadleaf weeds (<i>Continued</i>)	Pronamide, MOA 3 Kerb 50 WP or Kerb SC	2 to 8 lb 2.5 to 9.5 pt	Fall or winter transplanted grapes established at least 1 year or spring transplanted grapes established at least 6 months.	12	Apply in fall after harvest for cool season perennial grass and small seeded broadleaf weed control. Apply when temperatures do not exceed 55° F. The need for activation is tied directly to air temperature. Under warmer conditions more degradation and herbicide loss occurs until activated by rainfall or overhead irrigation.
PREEMERGENCE Annual weeds and some perennial weeds	Dichlobenil, MOA 20 Casoron 4G Or Casoron 1.4 CS	100 to 150 lb 1.4 to 2.8 gal	Newly planted (4 wks after transplanting) and established vineyards.	12	Apply in January or February for best results. Warm temperatures increase volatilization therefore overhead irrigation may be use for activation when applied in early spring. The Casoron CS formulation should only be used under well-established vines (1 year or older). The Casoron 4G formulation may be used as early as 4 weeks after transplanting young vines.
PREEMERGENCE Broadleaf weeds	Oxyfluorfen, MOA 14 Goal or Galigan or OxiFlo 2 EC	2 to 8 pt	Newly planted (once soil has settled after transplanting) and established vineyards.	24	DO NOT apply after bud swell. Use in newly planted vineyards that are trellised and once soil has settled after transplanting.
	Rimsulfuron, MOA 2 Grapple 25 WG Matrix 25 WG Pruvin 25 WG Solida 25 WG	4 oz	Vines established at least 1 year.	4	Tank mix with oryzalin, diuron, or simazine to broaden spectrum of residual control. DO NOT apply within 14 days of harvest. Rimsulfuron will provide POST weed control of certain species like horseweed, wild radish, pigweed, chickweed, and henbit. Tank mix with glufosinate, glyphosate, or paraquat for non-selective POST weed control. Tank mixes with glyphosate will provide partial control of yellow nutsedge (2 to 3" tall).

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
PREEMERGENCE Broadleaf weeds and some annual grasses	Diuron, MOA 7 Karmex 80 XP Or Direx 80 DF	2 to 3 lb	Vines established at least 3 years.	12	Heavy rainfall soon after application to grapes planted in soils low in clay and <2% organic matter may result in severe injury and this risk is assumed by the user. Apply with glyphosate, paraquat or glufosinate for postemergence weed control.
PREEMERGENCE Broadleaf weeds and some annual grasses	Simazine, MOA 5 Princep 4 L or Princep Cal 90 or various generic formulations	2 to 4 qt 2.2 to 4.4 lb	Vines established at least 3 years.	12	Tank mix with glyphosate, paraquat, or glufosinate for postemergence weed control. The addition of oryzalin (Surflan) or norflurazon (Solicam) or pendimethalin (Prowl H ₂ O) with simazine will extend residual grass control several weeks.
PREEMERGENCE Annual broadleaf and grass weeds (Continued on next page)	Flumioxazin, MOA 14 Chateau 51 SW Tuscany 51 WDG Tuscany SC	6 to 12 oz 6 to 12 fl. oz	Newly planted and established vineyards	12	Apply with hooded or shielded application equipment. Grapes established less than 2 years must be shielded with grow tubes. Flumioxazin may only be used in table grapes after completing harvest and before bud break. Flumioxazin may be applied in vineyards producing grapes used for wine or juice after bud break so long as hooded application equipment is used. DO NOT tank mix with glyphosate after bud break. DO NOT apply more than 6 oz per acre to vines established less than 3 years planted on soils having a sand plus gravel content that exceeds 80% . Flumioxazin formulations have a 60 day PHI.
	Indaziflam, MOA 29 Alion 1.67 SC	5 oz	Vines established at least 5 years	12	DO NOT apply to grapes grown in Georgia or Florida. Alion may be used on soils having a texture of sandy loam or finer and less than 20% gravel content. Tank mix with paraquat, glyphosate, or glufosinate for non-selective POST weed control. DO NOT exceed 5 oz of Alion per acre within a 12 month period. If making more than one application per year allow at least 90 days between applications. Tank-mix with glufosinate, glyphosate or paraquat for non-selective POST weed control.

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
PREEMERGENCE Annual broadleaf and grass weeds (Continued)	Indaziflam, MOA 29 Alion 1.67 SC	5 oz	Vines established at least 5 years	12	DO NOT apply to grapes grown in Georgia or Florida. Alion may be used on soils having a texture of sandy loam or finer and less than 20% gravel content. Tank mix with paraquat, glyphosate, or glufosinate for non-selective POST weed control. DO NOT exceed 5 oz of Alion per acre within a 12 month period. If making more than one application per year allow at least 90 days between applications. Tank-mix with glufosinate, glyphosate or paraquat for non-selective POST weed control.
PREEMERGENCE Annual broadleaf, some grass weeds, and yellow nutsedge	Carfentrazone + Sulfentrazone, MOA14 Zeus Prime	7.7 to 15.2 fl. oz	Vines established 2 years or more	12	DO NOT allow spray solution to contact green bark or desirable foliage. Zeus Prime XC should be tank mixed with oryzaline for broadspectrum residual control of annual grass weeds. Sequential applications can be made so long as the herbicide strip width is 50% or less of the vineyard floor. Allow 60 days between applications. DO NOT tank mix with flumioxazin. A ½ inch of rainfall is needed within 14 days of application to insure herbicide activation. Tank mix with glyphosate, glufosinate or paraquat for non-selective POST weed control.
POSTEMERGENCE DIRECTED Non-selective control (Continued on next page)	Glyphosate, MOA 9 Various Brands and Formulations 4 SL	See Label	Vines established 1 year or more.	12	DO NOT allow spray solution to contact green bark, foliage, or suckers. Tank mix with preemergence herbicides for residual control. Do not apply within 14 days of harvest. Generic formulations may require the addition of a surfactant. Refer to label for application directions for hard to control perennial species.
	Glufosinate, MOA 10 Cheetah Lifeline, Reckon 280 Rely 280 Surmise	48 to 82 oz	Newly planted (shielded) and established vineyards	12	Do not allow herbicide to contact desirable foliage or immature, uncallused bark. Apply in a minimum spray volume of 20 gal./A. Do not apply within 14 days of harvest.

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
POSTEMERGENCE DIRECTED Non-selective control <i>(continued)</i>	Paraquat, MOA 22 Firestorm, Parazone, or Paraquat Concentrate 3SL	1.7 to 2.7 pt	Newly planted (shielded) to established vineyards	12	Do not allow herbicide to contact desirable foliage or immature, uncalled bark. Young vines must be shielded. Apply in a minimum spray volume of 20 gal./A with non-ionic surfactant at 0.25 % v/v (1qt per 100 gal. of spray solution).
	Gramoxone SL	2.5 to 4 pt			
POSTEMERGENCE DIRECTED Certain broadleaf weeds	Carfentrazone MOA 14 Aim	1 to 2 fl. oz	Vines established 1 year or longer.	12	Do not allow herbicide to contact desirable fruit or foliage. The addition of a non-ionic surfactant at 0.25 % v/v (1 qt per 100 gal of solution) or crop oil concentrate at 1% v/v (1gal per 100 gal. of solution) is necessary for optimum herbicide performance. Ammonium sulfate may be used in addition to a non-ionic surfactant, refer to label for details. Aim may be tank mixed with glyphosate or Rely or various preemergence herbicides. For chemical removal of suckers use the maximum rate and refer to label for details. Aim has a 3 day PHI.
POSTEMERGENCE Annual and perennial grasses <i>(Continued on next page)</i>	Clethodim, MOA 1 Select, Volunteer, Intensity, and others 2EC	6 to 8 oz	Newly planted or non-bearing vineyards	12	Sequential applications are for perennial grasses (bermudagrass or johnsongrass). The addition of a non-ionic surfactant at 0.25 % v/v (1 qt/100 gal. of spray solution) is required. Do not apply within 1 year of harvest.
	SelectMax, Intensity One	12 to 16 oz			

Weed/Timing	Material	Amount of Formulation per Acre	Crop Age Restrictions	REI (hrs)	Comments
POSTEMERGENCE Annual and perennial grasses (<i>continued</i>)	Fluazifop, MOA 1 Fusilade DX	12 to 24 oz	Newly planted and non-bearing vineyards	12	Sequential applications will be necessary for perennial grass (bermudagrass, etc.) control. The addition of a non-ionic surfactant (1 qt/100 gal of spray solution) or crop oil concentrate (1 gal./100 gal. of spray solution) is necessary for optimum results. Do not apply within 1 year of harvest.
	Sethoxydim, MOA 1 Poast	1 to 2.5 pt	Newly planted and established vineyards	12	Sequential applications will be necessary for perennial grass (bermudagrass, etc.) control. The addition of a non-ionic surfactant (1 qt/100 gal of spray solution) or crop oil concentrate (1 gal./100 gal. of spray solution) is necessary for optimum results. Do not apply within 50 days of harvest. Total use cannot exceed 5 pt/A per year.

Suggested Herbicide Programs for Grape Vineyards

Crop Age	Fall	Winter	Spring	Summer
Newly Planted	Glyphosate (Pre-Plant to kill weeds in herbicide strip)		Oryzalin	Oryzalin + Paraquat (May or June); Fusilade, or Poast, or Clethodim (as needed).
			Flumioxazin (Once soil settles after transplanting)	Flumioxazin + Paraquat (June or July); Fusilade, or Poast, or Clethodim (as needed).
Vines Established 1 to 2 years or more	Glyphosate (spot treat for perennial weeds)	Glyphosate (Mid March)	Oryzalin + Rimsulfuron + Paraquat, Glyphosate, or Glufosinate (Early May)	Paraquat or Glufosinate (multiple applications as needed)
	Glyphosate (spot treat for perennial weeds)	Flumioxazin + glyphosate, paraquat or Glufosinate (mid to late March)	Flumioxazin* + Paraquat or Glufosinate (early June)	Poast (as needed for POST grass control) *See Flumioxazin restrictions for applications made after bud break.
	Glyphosate (spot treat for perennial weeds)	Zeus Prime + Oryzalin (vines est. 2 yrs) + glyphosate, paraquat, or Glufosinate	Zeus Prime + Oryzalin + glyphosate, paraquat, or Glufosinate	Glyphosate, Paraquat, Glufosinate, or Poast (as needed)
	Glyphosate (spot treat for perennial weeds); Flumioxazin + Glufosinate (after harvest)		Flumioxazin* + Paraquat, or Glufosinate (late May)	Glufosinate or Paraquat or Poast (as needed) *See Flumioxazin restrictions for applications made after bud break.
	Glyphosate (spot treat for perennial weeds)	Flumioxazin + Glyphosate (prior to bud break)		Glufosinate or Paraquat or Poast (as needed)
Vines Established at least 3 years or more	Glyphosate (spot treat for perennial weeds)	Glyphosate (mid March)	Simazine + Oryzalin + Glyphosate, or Karmex + Glyphosate	Paraquat, Glufosinate, or Poast (as needed)

Weed Response to Vineyard Herbicides

Herbicides	Annual Grasses					Annual Broadleaf Weeds															Perennial Weeds						
	Crabgrass	Foxtails	Goosegrass	Panicum, Fall	Ryegrass, Annual	Chickweed	Dock	Galinsoga	Geranium, Carolina	Groundsel, Common	Henbit	Horseweed	Lambsquarters	Mornnigglory, Annual	Nightshades	Pigweed	Radish, Wild	Ragweed	Sida, Prickly	Smartweed	Spotted Spurge	Bermudagrass	Dandelion	Johnsongrass	Nutsedge, Yellow	Virginia Creeper	
Preemergence																											
Alion	E	E	E	G	G	E		E	E		E	G	E	E	E	E	G	E	G	G	E	N	G		P	N	
Casoron	G	G	G	G	G	G	G	F	G	G	G	G	G	F	F	G	G	G		G	G	N	G		N	N	
Flumioxazin	E	E	E	G	G	E		G	G		E	G	E	E	E	E	G	G	E	G	E	N	G		N	N	
Diuron	G	G	G	F	G	G		G	F		G	G	G	G	G	G	G	G	G	G	N	N	N		N	N	
Kerb	G	G	G	G	G	G		P			G		F	F	F	P	F	F		F			P		P	N	
Rimsulfuron	F	F	P	P	P	G				G	G	E	G	G	F	E	G	F			G		F		F		
Oryzalin	E	E	E	G	G	G	N	N		F	F		E	F	P	E	P	P	P	P	F	N	P		N	N	
Prowl H ₂ O	E	G	G	G	G	G			G		G		G	F	F	E	G			G	G						
Simazine	F	G	G	F	G	G		G	F	F	G	G	E	F	G	G	E	G	F	G	P	N	P		N	N	
Zeus Prime	F	F	F	F	F	G	G	G	G	G	G	F	E	E	E	E	E	F	E	E	E	N		N	E	N	
Postemergence																											
Aim	N	N	N	N	N							P	G	E	G	G	F			G		N	N	N	N	N	
Clethodim	E	E	E	E	E	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E	N		N	N	
Fusilade	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E	N		N	N	
Glyphosate	E	E	E	E	E	E	G	G	G	E	F	E	E	G	E	E	G	E	G	F	G	F	G		F	G	
Paraquat	G	G	G	G	G	G		G	F	F	F	P	G	G	G	G	F	G	G	G	G	P	P		P	P	
Poast	E	E	E	E	G	N	F	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E	N		N	N	
Glufosinate	F	G	G	G	G	G	N	F	F	F	F	E	G	E	G	G	G	G	F	G	G	F	G		F	P	

E = excellent, G = good, F = fair, P = poor, N = no activity

Postemergence Control of Bermudagrass and Johnsongrass

Perennial grasses like bermudagrass and Johnsongrass can be controlled with Poast, Fusilade, and clethodim. Successful use of grass-specific herbicides (Poast, Fusilade DX, clethodim) depends on several factors however the most critical is application timing relative to weed growth stage. Application timing varies with grass species and somewhat with the herbicide choice which is outlined in table below. Additional factors influencing the performance of these herbicides on perennial grasses include spray volume and soil moisture. Graminicides are systemic herbicides, they enter the plant and move through the vascular system to their targeted site of action. Systemic herbicides need to be applied in spray volumes that do not exceed 25 gal. of spray solution per acre. Higher volumes dilute the herbicide and may reduce their effectiveness. Weeds free of stress (drought, etc.) also respond best to systemic herbicides because the herbicide moves into plant and through its vascular system more readily. All of these herbicides require a second application for them to be effective. It is important that the second application be timed appropriately and when the weed has regrown from the initial herbicide application. The time between the first and second application can vary depending upon environmental conditions so this requires monitoring in order to get the second application applied timely.

Appropriate Application Time for Perennial Grass Control

Herbicide	Bermudagrass		Johnsongrass	
	1 st Application	2 nd Application	1 st Application	2 nd Application
Poast	6 inches	4 inches	25 inches	12 inches
Clethodim	3-6 inches	3-6 inches	12-24 inches	6-18 inches
Fusilade	4-8 inches	4-8 inches	8-16 inches	6-12 inches

Refer to product label for spray additive recommendations.

Wildlife Damage Prevention	
Pest/Problem	Management Options
Efforts to control birds and other wildlife that damage fruit crops should be focused on the perimeter of the planting first, especially on the side(s) facing favorable wildlife habitat. This is where the first damage will be observed and, in some cases, it may be sufficient to head off the problem. However, don't discontinue monitoring for wildlife damage throughout the planting.	
Birds	<p>Crop losses to birds appear to be increasing in small fruit crops. Not only do birds consume fruit, but the damage they cause can result in increased problems with fruit rots and other pests such as bees and yellow jackets. Several different types of birds can cause problems. Robins, starlings and mockingbirds are among the more common ones, but orioles, cedar waxwings and finches may also feed on small fruit crops.</p> <p>Feeding pressure will be heavier in fields that are close to roosting or nesting sites such as woodlands, hedgerows, grassy fields, power lines and individual trees. Birds may feed, fly to these resting sites, and then return to the crop later in the day. While birds can and do fly fairly long distances to feed, the further they have to fly, the more apt they are to not find the fruit crop or to be distracted by another food source. The presence of a pond, creek or other water source nearby is another factor that may lead to increased feeding pressure. Typically, bird damage tends to be more severe in the earlier parts of the growing season, and damage lessens as the season progresses.</p> <p>There are several control techniques which may be of value in decreasing losses to birds. They include visual, auditory and chemical repellents and exclusion (netting). For any method to be successful, it must be instituted before birds establish a feeding pattern, which generally means that they should be in place and operating at the time that color change occurs in the fruit. With the exception of exclusion, no one method should be relied on for control.</p> <p>Auditory repellants Auditory scare devices such as propane cannons, noise makers or distress calls may offer temporary relief for some types of birds. Regardless of which one or ones is/are used, the following points should be considered to attain the best results:</p> <ul style="list-style-type: none"> - Assess the potential for objections to the noise from your neighbors. - Start before birds establish a feeding pattern. - Operate control devices beginning shortly before sunrise and continuing until just after sunset, as early and late in the day may be the most intense feeding times. - Vary the frequency, the direction and the timing in which auditory devices are operated. Propane cannons should not be fired at intervals

<p>Birds (Continued)</p>	<p>closer than 3 minutes.</p> <ul style="list-style-type: none"> - Consider using more than one type of auditory device and possibly combine them with visual repellents. - If using distress calls, it is essential to identify the type(s) of birds you want to discourage and get distress calls specific to them. - Reinforce the sense of danger by shooting (if allowed). <p>Visual repellants</p> <p>Visual repellents include such things as scare eyes suspended above the crop, mylar tape on the canopy of the crop, aluminum pie pans, plastic owls and plastic snakes. These range from ineffective to moderately effective for a short period of time. Birds will get used to them quickly if they are not moved around or if another type of repellent is not used along with it. Yellow scare eyes suspended above the crop and allowed to move freely have been reported to have some impact on blackbirds, however, robins do not seem to be affected.</p> <p>Chemical repellants</p> <p>Methyl anthranilate is registered as a bird repellent. While it is sometimes advertised as a taste repellent, this is not exactly correct. When sprayed on a crop, it causes an unpleasant sensation in the bird's mouth. Methyl anthranilate is a naturally occurring material used in the food service industry. Early reports have been inconsistent in regards to its effectiveness. It has also been reported to impart an undesirable foxy flavor to certain grape varieties. Methyl anthranilate has a short residual, so frequent reapplication will be necessary to achieve lasting results. Results may vary depending on the type of birds. Combining with another type of deterrent may result in greater effect than when used alone. As with other types of deterrents, applications need to start before birds establish feeding patterns.</p> <p>Exclusion</p> <p>Exclusion (netting) is the only consistently effective method of reducing bird damage. Netting is more expensive than other types of deterrents and can require fair amounts of labor, so it may not be an economically viable alternative in all situations. Nets are either laid on the canopy of the crop or suspended from a framework over the crop. The fruiting area of the plant needs to be completely protected. Birds will enter the canopy of the plant from below the net if it is open under the plant. If used with care, nets can be maintained for use over several years. For crops requiring multiple harvests such as blueberry, suspending the netting over the crop and around the sides of the field will allow easier access to the crop. If nets are placed directly on the crop canopy, birds can perch on it and feed on berries below them.</p> <p>Wild turkeys are becoming more of a problem in many areas of the country. While there is no doubt that they do consume some fruit, some research has shown that the turkeys are often after insects instead of the fruit. They do not appear to like loud and/or distressing sounds. While netting will work, turkeys can tear holes in it for access to the fruit.</p>
<p>Deer</p>	<p>Deer can damage small fruit plantings by foraging on succulent new growth during the growing season or by eating fruit. In fall, bucks can damage plants by rubbing. This is more of a problem in tree fruits than small fruits. Deer can also puncture plastic mulch and possibly the irrigation tape underneath, resulting in loss of weed control. Deer numbers are increasing and incidents of deer damaging crops are also increasing. Deer populations vary from year to year as a result of weather conditions, food supply and possibly hunting pressure.</p> <p>Locating the planting away from favorable habitat for deer will help to lessen losses. However, this is not always possible. Several control options do exist. Determining which one or ones to use depends on the deer population, availability of other food sources, location of favorable habitat, the duration for which protection is needed, and the value of the crop to be protected.</p>

Deer <i>(Continued)</i>	<p>Repellants Both taste and smell repellents exist. Smell repellents include commercially available products or materials such as tankage, blood, putrified egg solids, certain soaps and human hair. Repellants will not provide long-term control and will not provide control when populations are high or alternate food sources are scarce.</p> <p>Exclusion Exclusion (fencing) is the only truly effective long-term control for deer damage prevention. Fences can be electrified or not. Deer will try to go under a fence, through a fence, or over it. For non-electrified fences, the lowest wire needs to be within 10 inches or less of the lowest point in the ground around the fruit crop planting and tight enough to prevent deer from pushing under it. Do not neglect ditches or other low spots in the ground around the field, because the deer will find them. The fence needs to be at least 8 feet high or higher, as deer can easily clear this height. Wire mesh fences are more desirable than multiple strands of barbed wire.</p> <p>For electric fences, several different designs have been used and, under certain conditions, each can be effective. The simplest and least expensive electric fence uses a single high-tensile wire at about 30 inches above ground level. A solar charger can be used if access to electricity is not an option. Peanut butter can either be smeared on the wire or on aluminum foil strips which are then draped over the wire. Plastic flagging may also be tied to the fence to make it more visible to the deer. Deer are curious animals and will investigate the fence if they are not being chased. Touching the fence results in getting shocked and turning the deer away from the field being protected. The single-wire, baited fence is relatively inexpensive, easy to construct and often adequate to protect the crop. With high deer populations, when available alternate food sources are scarce or when deer have already established a feeding pattern in the area being protected, this fence may not be adequate.</p> <p>More substantial electric fences for deer control have multiple wires with the alternate wires being electrified. One design uses 5 wires and is constructed at a 45 degree angle facing away from the area to be protected. The bottom wire is within 10 inches of the ground and is electrified to keep deer from going under the fence. The middle wire is also electrified to prevent deer from going through the fence and the top wire, which may be only about 5 feet above ground is electrified to keep deer from going over the fence. A fence constructed in this manner presents a barrier to the deer that has height and depth, a combination that generally will discourage the deer from trying to enter the field. Poly Tape electric fence often used to contain cattle and horses works well for deer fences.</p> <p>Numerous other fence designs exist including a non-electrified mesh fence with a hot wire on top. If electric fences are used, it is important to keep weeds, grasses and other materials away from the fence to prevent it from shorting out and to increase its visibility.</p>
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