Establishment and Production of Muscadine Grapes

The muscadine grape *(Vitis rotundifolia Michx)* is native to the southeastern United States, occurring from Georgia to Texas and northward along the Atlantic coast to Delaware. Muscadines are well adapted to the warm, humid conditions of the Southeast where European and American grapes do not thrive.

The area of adaptation is limited because the muscadine grape is not cold hardy. Muscadine plants can be injured by minimum winter temperatures of 0 ºF and do not need to be grown in regions where temperatures frequently fall below 10 ºF. Some cultivars are more cold hardy than others. "Higgins," "Fry," and "Granny Val" cultivars appear to be the most sensitive to cold injury, while the cultivars "Magnolia," "Carlos," and "Sterling" are more cold hardy than others.

Muscadines grow well in areas of high humidity and are tolerant to pests and diseases that prevent bunch grapes from growing in the Southeast. Muscadines can grow on the west coast, but the lack of sufficient heat produces small berries that are low in sugar.

Muscadine vines are vigorous and deciduous with some significant botanical differences from other grapes. Muscadine vines have a tight, nonshedding bark, warty shoots, and unbranched tendrils. Native muscadines may be dioecious, with male and female flowers on different plants. The small greenish flowers are born in short, dense panicles. Both wind and insects play a role in pollinating the female flowers. Breeding and selection have produced self-fertile cultivars that also are a pollen source for female plants.

Unlike the large, tight bunches characteristic of European and American grapes, muscadine fruit grows in small, loose clusters of 3 to 40 grapes. The round 1- to 1 ½-inch fruits have thick, tough skin and contain up to five hard, oblong seeds. Fruit color ranges from bronze to dark purple. The sugar content varies from 13 to 25 brix. Wild fruit and some of the older cultivars have a musky quality; modern cultivars have a fruity flavor with very little muskiness.

Muscadines were found growing wild by colonists who settled in the southeastern United States. Many older cultivars were selections from the wild. The earliest named variety was Scuppernong, which was found growing wild in northeastern North Carolina along the Scuppernong River about 1810. Breeding programs have developed several improved cultivars that are produced commercially. Large-fruited cultivars, which are suited to the fresh market, can yield 3 to 4 tons per acre. Cultivars suitable for the wine and processing market can be expected to yield 8 to 10 tons per acre. Market demand is high for both fresh and processing-grade muscadines.

Fresh-market muscadines are sold directly to the consumer for immediate consumption and household use. These are usually packed in pint or quart containers for direct sale, and they are sometimes available in 22-pound boxes. Processing-grade fruit is sold in large bulk containers to wineries or food-processing companies for use in wine, juice, jam, jelly, or other similar products. Sale prices for fresh-market fruit are higher than for processing fruit, but more expense is involved in harvesting and packing, and yields are lower.

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Site Selection

Muscadine vineyards produce best in full sun on fertile, well-drained soils with good water-holding capacity. Fruit set and size are smaller in shady areas. Muscadine plants can grow in a wide range of soil types as long as internal drainage is good. Plant death occurs in areas where water stands or where soil remains wet for even short periods after heavy rains. Soils with hardpans tend to become saturated, especially during winter months. As a grower, you must correct this condition or find a more suitable site.

Adjust the soil pH to 6.5 by incorporating dolomitic limestone before planting. Elevated sites with good air drainage and circulation will have fewer diseases and less injury from severe winter temperatures and late spring freezes.

Site Preparation

Begin site preparation the year before planting. Have soil tested and adjust pH and fertility levels accordingly. Eliminate perennial and troublesome weeds since they are easier to control before the vineyard is planted.

Determine row orientation and establish the location of the trellis rows. A north/south orientation is best because it allows both sides of the plant to receive direct sunlight. However, other factors such as erosion control and property layout are also important when determining row orientation.

You also must consider the irrigation system when determining the vineyard layout. There is a limit to the length drip lines can be run and still maintain adequate output. Therefore, consult an irrigation dealer when designing the irrigation system. Generally, driplines can be run for 200 to 300 feet and still maintain adequate pressure; however, slope and elevation affect total capacity. If the main water line is buried in the middle of the field, total row length will be a maximum of 400 to 600 feet.

Another factor in vineyard layout is accessibility and traffic. You need adequate room at the end of the rows for mechanical harvesters and equipment to turn around and operate (a minimum of 30 feet is recommended). In large vineyards, roadways are recommended at various intervals.

Once you have adjusted soil pH and nutrient levels, eliminated troublesome weeds, and determined location of trellis rows, you must thoroughly prepare the soil. Plow the soil to a depth of at least 8 inches. Subsoil as deeply as possible (usually 20 to 24 inches) down the row and across the row where each plant will be set. Do not subsoil when the field is wet as this reduces the effectiveness of this procedure. Harrow the soil to prepare a good planting bed.

The Trellis System

Establish the trellis system before planting the vines into the field. The trellis system is a permanent part of the vineyard and must be strong enough to support a heavy crop and durable enough to last for many years. Number 9 galvanized wire and galvanized metal arms are the best building materials for this project. Treat wood with a nontoxic wood preservative such as copper chromium arsenate (CCA).

Pentachlorophenol (Penta) also is a durable preservative, but if Penta is used, do not place plants at the post, and do not allow them to touch the post. All wood materials used in trellis construction need to be pressure treated according to the American Wood Preservative Association's (AWPA) standard C16. Wood material so treated will last 20 to 25 years under vineyard conditions. Trellis longevity is important because vines that are properly cared for can outlast a trellis, and replacing a trellis in a mature vineyard is a difficult task.

Set posts 20 feet apart in the row with 12 feet between the rows. Set the plants next to each post (182 vines per acre). This helps support the fruit load and protects the plant from damage during severe weather, mechanical harvest, routine mechanical maintenance, and other activities.

Both the Single Wire Trellis (Figure 1) and the Geneva Double Curtain Trellis (Figure 2) are used in vineyards that employ mechanical harvesting and pruning. The Single Wire Trellis is used in sizable vineyards where mechanical harvesting and pruning equipment is used. It is preferred by many growers because of the ease of establishment, pruning, harvesting, and renovation.

Easy, low-cost construction, pruning, and harvesting are the main advantages of the Single Wire Trellis. The major disadvantage is lower yields. Muscadine vines grown on a Single Wire Trellis yield about two-thirds the fruit grown on a Geneva Double Curtain Trellis. However, despite the yield reduction, many ex-perienced muscadine growers prefer the Single Wire Trellis.

The Geneva Double Curtain was developed in New York to train vigorous grape vines. It consists of cross arms at each post and two wires on each row. The Geneva Double Curtain Trellis system gives increased yields by doubling the fruiting wood on each vine to 40 feet of fruiting wood.

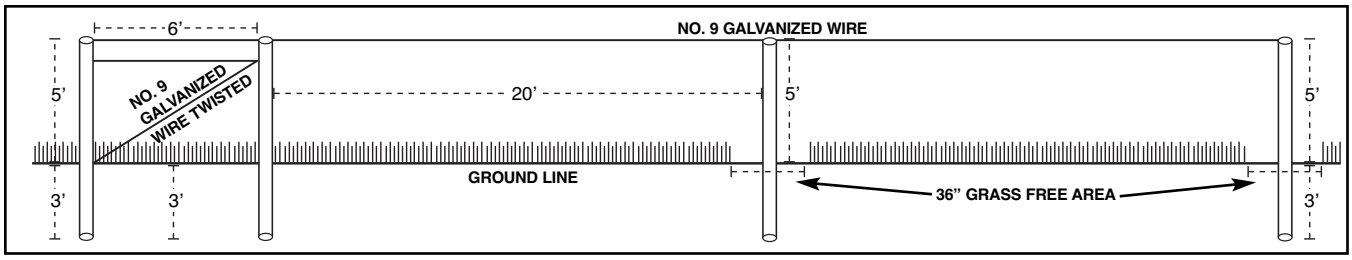


Figure 1. Horizontal and vertical dimensions of a Single Wire Trellis.

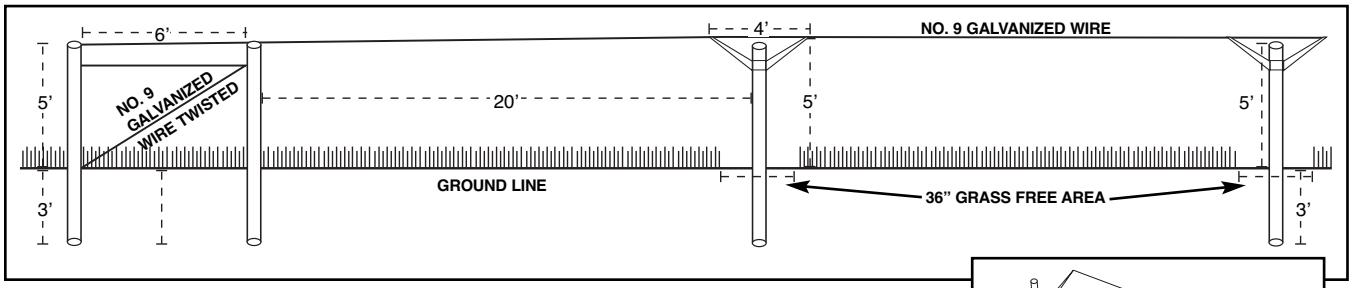
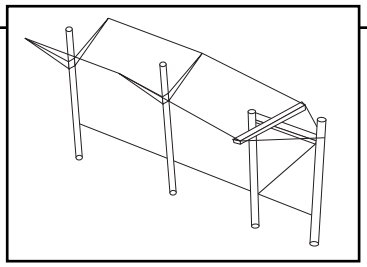


Figure 2. Horizontal and vertical dimensions of a Geneva Double Curtain Trellis system.



Single Wire Trellis

- Make end posts at least 4 inches in diameter and 8 feet long.
- Set the end post 3 feet in the ground so the trellis wire will be 5 feet high.
- Brace – set a post identical in size to the end post 3 feet deep, 6 feet from the outside brace post.
- Position a 4-by-4 timber or post between the tops of the two posts. The horizontal beam must be longer than the posts are tall.
- Run a double 9-gauge wire from the top of the inside post to the bottom of the outside post. Twist the wire to tighten and secure the brace system.
- Set line posts that are 3 to 4 inches in diameter and 8 feet long so that the wire will be 5 feet high. Spacing on the line posts needs to be 20 feet.
- Use number 9 galvanized wire for the trellis. Staple it to the tops of the line posts with 2 ½-inch staples. Leave the staples just loose enough so that the wire is not held rigidly; if the wire is bound too tightly by the staple, it may break.
- Bring the wire over the top of the end post, tighten, wrap it around the post, and staple. Periodic tightening after pruning is needed as the wire stretches over the years. Fence strainers with a ratchet-type gear that tightens the wire are available from livestock supply houses and can be used at one end of the trellis for easy tightening.

Geneva Double Curtain Trellis

- Place line posts 3 feet into the ground and 20 feet apart.
- Make the end brace post 8 feet long with a minimum diameter of 5 inches. Set the end post 3 feet in the ground.
- Brace – set a post identical in size to the end post 3 feet deep, 6 feet from the outside brace post.
- Position a 6-foot 4-by-4 timber or post between the top of the two posts as a brace. The horizontal beam must be longer than the posts are tall.
- Run a double 9-gauge wire from the top of the inside brace post to the bottom of the outside brace post, and twist it to tighten the entire brace system.

Prefabricated galvanized metal cross arms are available to install on each line post to support the two wires. Wooden cross arms also can be fabricated from pressure-treated 2-by-4 lumber, or T-shaped braces can be fabricated from heavy metal pipe and substituted for line posts.

Cultivar Selection and Handling of Plant Materials

There are many factors for growers to consider when selecting the appropriate muscadine grape cultivars.

- ***Reproduction*** – The first factor involves understanding a cultivar's reproductive biology. Muscadine cultivars have one of two different flower types, either perfect flowers having both functional stamens and pistils that produce fruit without cross-pollination, or female flowers requiring cross-pollination from a different cultivar having perfect flowers. Plantings consisting of a female cultivar must have an interplanting of a perfect flower pollenizer cultivar located within about 25 feet of female plants, or at least every third row must be a self-fertile variety. "Ison" and "Granny Val" are examples of large-fruited, perfect-flower cultivars that can be used as pollenizers and can also be sold to the fresh market. Other grape species are not good pollen sources for muscadines.
- ***Purpose*** – Muscadines are produced for different reasons – either for commercial u-pick operations, fresh market, processing, or home gardens. Your purpose dictates which cultivar to grow. The fresh market demands a flavorful, disease-free, large-fruited grape with a dry picking scar, which prolongs shelf life. Market preferences in some areas are for purple fruit, while bronze fruit may be preferred in others. Cultivars providing greater juice yield are most suited for commercial production of juices and jellies. Juice yield, the balance of sugars and acids, and pigment stability determine which fruit is best for commercial wine production. The period of fruit ripening is another factor to consider for market windows, labor, and resource management purposes. Table 1 gives an overview of the horticultural characteristics of currently grown muscadine grape cultivars. (New or nearly obsolete cultivars may not be listed.)
- ***Environment*** – Muscadine cultivars vary in their potential to produce in different environments (locations, soil types, seasons, etc.). Many cultivars are broadly adapted and perform well across the South. Table 2 presents information on relative yield and quality factors of selected muscadine cultivars grown in McNeil, MS. For additional information, cultivar performance trials are conducted in most southern states. Consider results of these studies when selecting the best cultivars for a specific site.
- ***Disease Resistance*** – By design, muscadine grape cultivars are far more resistant to grape diseases than bunch grapes. Most muscadine cultivars are resistant to the bacterial Pierce's Disease. Several bronze-skinned cultivars such as "Triumph" and "Tara" and most dark-skinned cultivars are resistant to ripe rot, a fungal disease. Little resistance exists to other major diseases. Treat all muscadine cultivars with fungicides beginning in the second or third year after planting to ensure best yield and quality.
- ***Ripening Period*** – The ripening period of muscadine grape cultivars also is important in selecting which cultivar to grow. Consider factors such as the length of time ripe fruit is available, marketing strategies that may exploit early fresh fruit markets, and resource/labor management. On the Gulf Coast, early maturing muscadine cultivars generally ripen in middle to late August, while full-season varieties may ripen in middle to late September. Some cultivars bear fruit with a concentrated ripening period. The fruit of other cultivars may ripen over a more extended time period. For home gardens or u-pick operations, choose a cultivar with an extended ripening period. However, for efficiency in commercial juice or wine production, a selection with a concentrated ripening period is better.
- ***Other Factors*** – Other important factors to consider may include a cultivar's ornamental value such as the appealing leaf shape and color of "Southern Home" for use in home gardens, or the nutraceutical value such as the high resveratrol content of "Noble." To decide which cultivar to grow, you need to understand the various characteristics of cultivars and their intended use or market.

Once you have selected the proper cultivars, locate a certified nursery and place an order early (by late summer) to ensure the availability of 1- or 2-year-old container-grown or bare-root plants. Year-old plants have adequate root systems for transplanting, but the more developed 2-year-old plants are easier to establish. Bare-root plants will move well from nursery to field, but special care must be given during shipping, handling, and transplanting to prevent loss of roots caused by desiccation, excessive breaking, or pruning. Heel in and water bare-root plants that are not planted immediately upon receipt. Then transfer them to the field as needed. As soon as you receive container-grown plants, put them outside and water until they can be transplanted.

Table 1. Muscadine Grape Cultivars and Their Characteristics

Cultivar	Principal Usage	Flower Type	Fruit Color	Berry Size	Flavor	Stem Scar	Yield	Harvest Season	Vine Vigor	Cold Hardiness	Dis. Res.	Sugar Content	Comments
Alachua	**F**CH	SF	Blk	M-L	G	VW	H	M	M	F-G	G	M	even ripen., thin skin
Albermarle	**JlJu**FH	SF	Blk	M	E	D	M	E-M	M-H	P-G	G	H	even ripen., stable pig.
Black Beauty	FCH	F	Blk	VL	E	W	L-M	M	H	G	G	M	edible skin
Black Fry	**P**FJCH	F	Blk	L	E	VW	H	M	M	VG	F	M	large, black fresh fruit cultivar
Bountiful	F	SF	Blk	S	G	D	M	L	L-M	P-G	G	H	shatters, cold tender
Burgaw	FW	SF	Blk	S	G	W	M	E-M	M-H	**G**	G	L	
Carlos	**WJu**FCH	SF	Brz	S	G	VD	H	E-M	VH	E	G	L	even ripen., stable pig., fruit best for producing wine
Chowan	CH	SF	Brz	M-L	G	W	L	E-M	M-H	VP	P-F	M	
Cowart	WFCH	SF	Blk	M	G-VG	W	L-H	E-M	M-H	G-E	F	M	shatters, sus. to berry rot, uneven ripen.
Creek	WJ	F	Blk	S	F	VW	M	L	M-H	G	G	M	tart
Darlene	**P**FCH	F	Brz	VL	E	W	H	M-L	VL	G	F	H	sus. to berry rot
Delite	FCH	SF	Brz	M-L	F	D	H	L	L-M	F-G		L	
Dixie	WJFPH	SF	Brz	S	G	W	H	M	VH	F-G	P-G	H	even ripen., good fresh fruit and can use for wine
Dixieland	FCH	SF	Brz	S-L	F-G	VW	L-M	M	M	P-F	G	M	cold tender, sus. to leaf dis.
Dixie Red	FJuW	SF	Rd Brz	M	G	VW	H	M-L	M-H	**VG**	F	ML	attractive fruit
Doreen	**W**JH	SF	Brz	S-M	G	W	L-M	L	H	G	G	VH	slow grower, res. to leaf dis.
Dulcet	**Jl**FH	F	Blk	S-M	G	W	M	E-M	L-M	G	G	M	
Duplin	H	SF	Blk	M	F	W	M	E	M	G	F-G	L	
Early Fry	**P**J	F	Brz	L	G	W	VH	VE	H	G	G	H	even ripen., very early
Excel	FH	SF	Brz	L	F	D	H	L	L-M	F-G	G	L	holds on vine
Farrer	WJF	F	Blk	VL	E	VW	H	M-L	H	G	G	VL	
Florida Fry	FH	SF	Brz	M	G	VD	H	M-L	M	G	VG	VH	crisp, edible skin, extended ripen., res. to berry rot
Fry	**P**FH	F	Brz	L	E	VW	M-H	E-M	M-H	P-F	F	M	cold tender, sus. to berry rot, excellent fresh fruit
Fry Seedless	FH	SF	Rd Blk	S	G	VD	VL	E-M	H	G	E	VH	res. to berry rot, seedless
Golden Isles	**Wju**	SF	Brz	M	P	D	M-H	M-L	M	VG	G	L	even ripen., stable pigments, mild aroma
Granny Val	FH	SF	Brz	L	G	D	H	L	L-M	P-F	G	VL	cold tender, fruit quality decreases with vine age
Higgins	F**W**H	F	Rd Brz	M-L	G	W	H	M-L	M	P-F	P	VL	cold tender, sus. to berry rot, thick yet tender skin
Hunt	**JlJu**FH	F	Blk	L-M	G	D	M-H	E-M	VH	G	F-G	L	even ripen., stable pig., sus. to leaf dis.
Ison	FCH	SF	Blk	M-L	VG	W	H	E	VH	G	E	L	res. to berry rot, large, black fresh fruit cultivar
Janebell	FW	SF	Brz	L	G	W	VH	M-L	M	G	G	VL	sus to berry rot and leaf dis.
Janet	**P**F	SF	Brz	L	VG	VW	H	M	H	G	F	VH	large fruit, sweet, cold hardy, late maturing

(Table 1 continued)

Cultivar	Principal Usage	Flower Type	Fruit Color	Berry Size	Flavor	Stem Scar	Yield	Harvest Season	Vine Vigor	Cold Hardiness	Dis. Res.	Sugar Content	Comments
Jumbo	**JlJu**WF	F	Blk	L-VL	G	W	L-H	L	M-H	F-G	VG	L	even ripen., poor flavor when over or under ripe
Late Fry	**PF**	SF	Brz	L	G	VD	H	VL	H	E	E	VH	late season, large clusters
Loomis	FH	F	Blk	M-L	E	D	L	M-L	H	G	G	M	high solids and good flavor
Magnolia	**JlJuW**FH	SF	Brz	S-M	G	W	H	M	M-H	E	VG	L	even ripen., stable pig.,
Magoon	FH	SF	Rd Blk	S	VG	D	H	E-M	L	P	G	VH	cold tender
Nesbit	FH	SF	Blk	M-L	VG	D	M	M-L	M	F-G	VG	L	excel. texture, flavor, size
Noble	**JuW**	SF	Blk	S	G	W	H	E-M	H	VG	E	L	even ripen., stable pig., res. to berry and leaf dis.
Pam	**PF**CH	F	Brz	VL	VG	VW	M-H	M	H	G	F	H	very large clusters
Pineapple	FJCH	SF	Brz	M-L	VG	VW	H	E-M	H	G	P	M	sus. to berry rot, pineapple flavor
Polyanna	JCH	SF	Rd Blk	S	VG	VD	H	L	H	G	E	M	productive, res, to dis.
Pride	H	F	Blk	M-L	G	D	H	M	VL	P	P	L	slow ripen., cold tender
Redgate	FH	SF	Rd	S	F-G	VW	M-VH	M-L	H	F	G	L	
Regale	WJ	SF	Blk	S	G	VW	H	M	H	E	F-G	VL	cold tender, grape root borer tolerance, processing
Roanoke	H	SF	Brz	M	F	D	H	E-M	M-H	P	P	VL	
Rosa	PFJH	F	Pk Rd	VL	G	W	H	M-L	M	G	G	H	vigorous, good red grape
Scarlet	**P**FJHC	F	Rd	VL	VG	D	H	M	M-H	G	VG	H	large fruit, vigorous, productive, res. to dis.
Scuppernong	J**W**F	F	Brz	M	E	VW	L	M-L	M-H	P-G	VG	L	holds on vine, good fruit quality, low yield
Southland	FJCH	SF	Blk	S-L	VG	VD	M-H	M-L	M	P	G	H	cold tender, res. to leaf dis.
Southern Home	H	SF	Blk	S-M	G	D	H	M	H	G	G	M	thin skin, ornamental, dooryard cultivar
Sterling	JW	SF	Brz	S-M	G	W	M-H	M	M	E	VG	M	good for wine in MS, poor in NC
Sugargate	**P**CH	F	Blk	VL	E	W	L	E	M	P	G-E	VH	cold tender, sus. to dis., best on clay soils
Summit	**PF**J	F	Rd Brz	M-L	G-E	D	M-H	E-M	H	F	F-VG	H	res. to leaf dis., uniform ripen.
Supreme	**F**CH	F	Blk	VL	E	W	M-H	M-L	H	G	VG	M	shatters
Sweet Jenny	FCH	F	Brz	L	VG	W	M-H	M-L	H	G	G	H	sweet, large clusters, res. to dis.
Tara	**FH**C	SF	Brz	L	G	VD	L	E-M	H	G	G	H	thin skin, tolerant to most dis. except black rot
Tarheel	JW	SF	Blk	S	F-G	VW	M-H	E-M	H	F-G	P-G	M	sus. to dis.
Triumph	**F**H	SF	Rd Brz	M-L	G	V	M	E	M	P	F-G	H	shatters, cold tender
Watergate	WFJ	F	Brz	M-VL	F-G	VW	M-H	L	M	P	F	L	cold tender
Welder	**WJu**	SF	Brz	S	G	D	H	M-L	H	P	VG	H	even ripen., stable pig.

Uses: Home or dooryard (H), Commercial (C), Wine (W), Juice (Ju), Jelly (Jl), Juice or jelly (J), Fresh market (F), U-pick (P)
(Bold letters Cultivars among most popular for a given usage**).**
Flower type: Self-fertile (SF), Female (F).
Fruit color: Bronze (Brz), Black (Blk), Red (Rd), Pink (Pk).
Berry size: Small (S), Medium (M), Large (L), Very Large (VL).
Flavor, disease resistance, and cold hardiness: Poor (P), Fair (F), Good (G), Very good (VG), Excellent (E).
% Dry stem scar: Very Dry (VD) >85, Dry (D) 71-85, Wet (W) 51-70, Very wet (VW) <50.
Yield (lb/vine): Very high (VH) >80, High (H) 61-80, Medium (M) 46-60, Low (L) 31-45, Very low (VL) <30.
Vigor: Very low (VL), Low (L), Medium (M), High (H), Very high (VH).
Harvest season: Early (E), Mid-season (M), Late (L).
Comments: ripen. = ripening, pig. = pigment, sus. = susceptible, dis. = disease, res. = resistant, excel. = excellent

Table 2. Performance of Muscadine Cultivars Planted at McNeil, Mississippi

Cultivar	Yield (kg/vine)	Dry Scar (% of berries)	Berry wt. (g/berry)	^{0}Brix	Seeds (no./berry)	pH	Seed wt. (g/100 seeds)
Planted in 1990 and Harvested 1992 - 94							
Black Beauty	27	56	13.4	16.2	3.5	3.5	9.4
Carlos	45	85	8.7	14.5	3.9	3.1	8.3
Cowart	29	68	6.5	14.8	3.7	3.3	8.2
Dixieland	23	66	8.7	15.3	3.6	3.4	8.1
Doreen	36	77	4.2	18.1	3.0	3.2	6.8
Fry	25	63	10.8	15.2	3.0	3.4	9.5
Fry Seedless	13	94	2.2	15.6	0.0	3.0	0.0
Higgins	36	63	7.5	13.6	3.3	3.1	10.1
Hunt	29	59	4.5	13.4	3.4	3.1	6.1
Janebell	37	65	8.1	14.5	3.5	3.2	10.0
Jumbo	23	60	10.6	13.6	3.7	3.5	11.0
Magnolia	43	67	5.4	11.9	3.3	3.1	7.5
Nesbitt	35	77	7.4	14.0	3.4	3.1	7.9
Noble	43	62	3.3	13.2	3.8	3.1	5.5
Southland	30	89	5.0	16.6	3.5	3.0	7.3
Sterling	34	64	5.0	18.1	3.5	3.4	6.5
Sugargate	21	63	11.9	17.5	3.3	3.4	8.8
Summit	37	81	9.1	16.2	2.7	3.3	8.5
Supreme	33	63	12.8	14.1	3.1	3.5	10.4
Sweet Jenny	26	66	12.6	16.6	3.3	3.5	11.3
Watergate	35	68	8.9	15.3	3.8	3.2	9.7
Welder	44	73	4.0	15.7	3.1	3.1	6.8
$LSD_{0.05}$	7	12	0.8	1.1	0.3	0.1	0.7
Planted 1992 and Harvested 1998 - 99							
Alachua	35.0	83.0	6.7	14.6	3.1	3.8	12.4
Fry	26.0	72.0	10.7	15.0	2.5	3.8	13.6
Polyanna	48.0	97.0	9.3	16.1	3.3	3.7	8.6
Southern Home	52.0	78.0	5.7	16.5	3.6	3.9	5.8
Tara	28.0	91.0	10.3	17.0	3.5	3.9	11.1
$LSD_{0.05}$	20.0	11.0	0.8	0.9	0.2	0.1	1.5

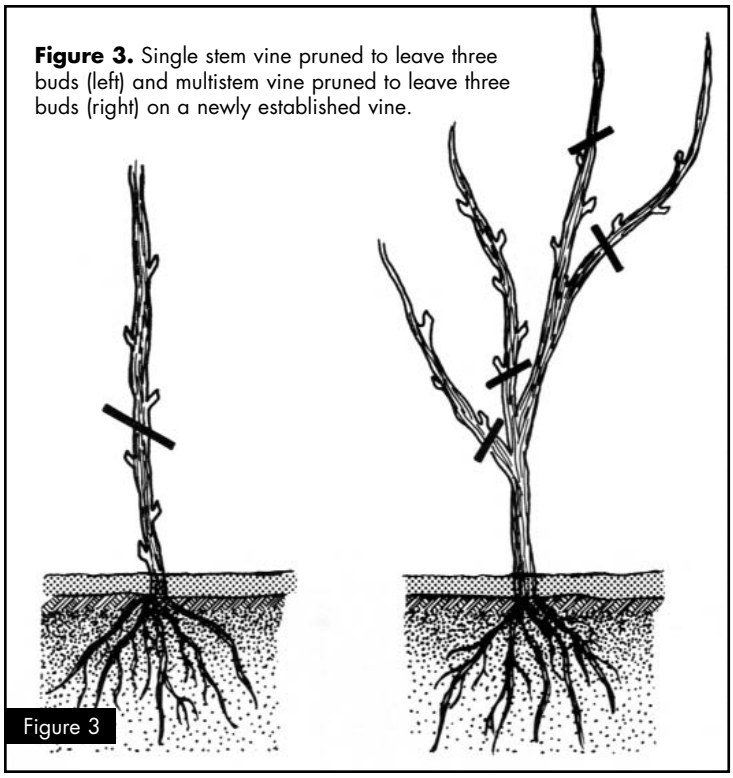


Figure 3. Single stem vine pruned to leave three buds (left) and multistem vine pruned to leave three buds (right) on a newly established vine.

Figure 4. Choose one shoot from the vine trunk and remove all others. As the shoot develops, provide vertical support.

Figure 5. When training the main shoot, pinch off the tips of the side shoots of the young trunk, but leave as much leaf area as possible to nourish the main trunk.

Vineyard Establishment

Transplant muscadines during the winter while plants are dormant. Set bare-root plants about 3 inches deeper than the top roots and spread the roots out. Set container plants about 1 inch deeper than they grew in the nursery. If the rootball is potbound, untwine the roots from the outside of the rootball and spread them in the planting hole. Backfill the hole with topsoil, and firm the soil around the rootball. Water the plants if there is no rain within a few days after transplanting. Do not place fertilizer in the planting hole, and do not make a ground application immediately after planting. Allow the soil to settle around the root system and then fertilize in the spring. Prune the vine to a single stem; remove all of the stem except for three buds (Figure 3).

Training the Vine

Vine training is a very important part of developing a muscadine vineyard and requires perseverance and an understanding of the horticultural goal. When a newly planted vine breaks dormancy, shoots may emerge from the three or four buds left after pruning. Choose one shoot to form the vine trunk, and remove all others (Figure 4). As this shoot develops, provide some type of vertical support. Tie a piece of durable string to a stake driven beside the plant or to a nail driven into the line post. Then tie the twine to the overhead wire using a Y-shaped string attached to the trellis. The Y shape at the top is to guide the two cordons to the wire. As the shoot grows, periodically wrap the new growth around the twine.

While you are training the main shoot, pinch off the tips of the side shoots of the young trunk, but leave as much leaf area as possible to nourish the main shoot (Figure 5). When the main shoot is near the trellis wire, pinch the tip off at about 12 inches below the wire. The point where you pinch is particularly important for muscadines that will be harvested mechanically because the vine trunk may be split by the harvester if the vine is pinched too high. The first branching point must not be above the pivotal point of the trellis arm. Pinching forces shoots to grow from the buds in the leaf axils just below the pinch.

Select two shoots to grow up to the trellis wires. On a Single Wire Trellis, these shoots will become the permanent cordons or main fruiting arms of the vine. On the Geneva Double Curtain Trellis, these shoots will be pinched again when they reach the wires, and two shoots from this pinch will be trained down the wires to form the permanent cordons (Figure 6). These stems will be trained down the wire for 10 feet in each direction, at which point they will meet the stem from the neighboring vine. Check this growth weekly and tie it loosely to the wire. These stems on the wire will become the permanent cordons, and from these will arise the fruiting wood on which the muscadines will be produced. Once the cordons are established on the wires, trim all lateral branches from the main trunk. Allow all lateral branches to develop along the cordons as these will develop into fruiting spurs (Figure 7).

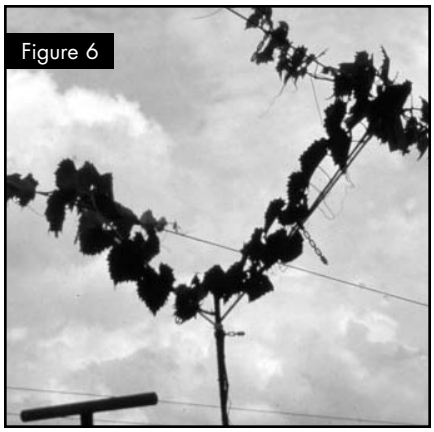


Figure 6. When the main trunk is near the trellis wire, pinch the tip off at about 12 inches below the wire. Pinching forces the shoots to grow from the buds in the leaf axils just below the pinch. Select two shoots to grow up on the trellis wires. On a single wire trellis, these shoots will become permanent cordons. On a Geneva Double Curtain trellis, these shoots will be pinched again when they reach the wires.

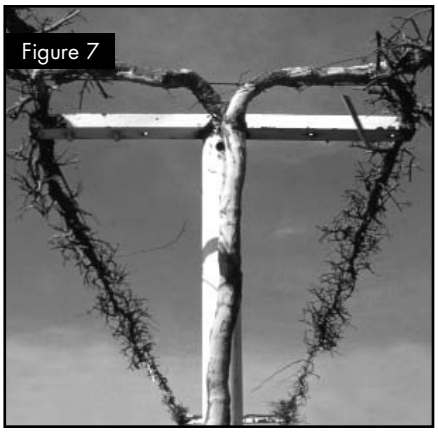


Figure 7. When the cordons are established on the wires, allow lateral branches to develop along the cordons as these will develop into fruiting spurs.

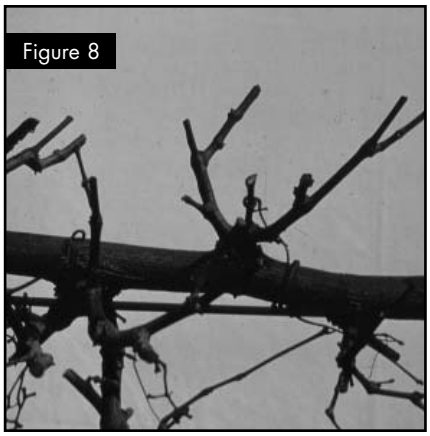


Figure 8. Spurs are developed from side shoots that arise from the cordons during the growing season. Select side shoots spaced about 6 inches apart and then cut them back to two to four buds. Fruiting wood will arise from these buds the following spring. Prune each of these shoots back to two to four buds during the winter. Repeat this pruning procedure every winter.

Check the cordons periodically where they are tied to ensure the tying material is not girdling them.

Development of Fruiting Spurs and Dormant Pruning of Cordons

Annual pruning develops fruiting spurs and provides optimal yields. Muscadine vines are trained to a system of cordons and spurs. The cordons are the main arms on the trellis wire along which a row of spurs arises. From this, fruiting wood arises each year (Figure 7). Muscadine fruit grows on new growth produced from buds on the previous season's growth. Therefore, a certain number of buds from the previous season's growth are left on the plant each year so that the optimum amount of high quality fruit will be produced each season.

Spur establishment begins the first winter after cordons are established on the wire. The spurs are established from side shoots that have arisen from the cordons during the growing season. Select side shoots that are spaced about 6 inches apart and cut them back to two to four buds. The fruiting wood will arise from these two to four buds the following spring. Flowers will arise in the axils of the third, fourth, and fifth leaves, and the fruit will be borne at this site. Prune each cane that arises from these buds to two to four buds during the dormant season (Figure 8). Repeat this pruning procedure every winter for optimal production. Prune as late in the dormant season as possible. Do not begin pruning until mid-January. Earlier pruning can result in considerable winter injury and vine death. Although late pruning results in heavy bleeding, there is no evidence that this is harmful to the plant.

As the vine gets older, each spur becomes a spur cluster. You will need to thin the spur cluster after a few years to reduce the amount of fruiting wood and make pruning more manageable. As spur clusters expand, remove spurs that grow straight down from the cordon since they are in the poorest position to produce high quality fruit. Remove all spurs arising from the main trunk and crotch. This will make it easier to manage the vineyard, to prune, and to maintain vigor at the end of the cordons.

If a cordon becomes weak or diseased, remove part or all of it as needed and train a shoot to take its place. Remove any tendrils that become wrapped around cordons or spurs to prevent girdling. Inspect ties that attach cordons to the trellis wire to prevent them from becoming too tight and girdling the cordon.

Many vineyards use mechanical pruning. Growers who have enough acreage to justify the cost of equipment use a tractor-mounted sickle bar pruner. Many vineyard managers use gasoline-powered hedgers. Most of the pruning can be done in this operation; however, be careful not to cut too deeply and cut past the current season's wood. After completing the mechanical pruning, hand pruning is required to cut the current season's wood to two to four buds (Figure 9). This process is much faster than only using hand pruning.

In neglected or improperly pruned vineyards, rejuvenation training must be used. If no cordons were initially established, prune the plant back, and select major vigorous shoots from the new growth to establish

Figure 9. Pruning is required to cut the current season's wood to two to four buds during the dormant season.

new cordons. If vigorous cordons exist but pruning has been neglected, cut spurs back severely and allow the new shoots to begin the new spur clusters. Both methods will result in a fruitless season but will get the vines back into optimum production.

Fertilization

Before planting, follow fertilizer recommendations on soil test results to adjust pH and fertility. During the first 2 years of vineyard development, apply fertilizer soon after growth starts in the spring with additional applications each sixth week. Do not apply fertilizer after mid-July. The first season, apply 3 ounces of 10-10-10 fertilizer evenly in a circle 2½ feet in diameter around the vine, starting after growth begins in the spring. Do not place fertilizer within 6 inches of the trunk. Repeat this application every 6 weeks through the middle of July. During the second year, keep the timing and application method the same, but enlarge the diameter of the broadcast circle to 4 feet and increase the rate to 6 ounces per application.

Fertility needs increase once the plants begin bearing a sizeable crop. If the vines are into production the third year, apply 2 pounds of 10-10-10 fertilizer per vine in March, plus 1 pound of 10-10-10 fertilizer per vine in May. Broadcast this beneath the vines in a 6-foot diameter circle around each vine.

Established, mature vineyards are fertilized more heavily early in the season. Apply 3 to 5 pounds of 10-10-10 fertilizer per vine in March of each year. Apply one-half pound of ammonium nitrate fertilizer per vine after fruit set. The nutrient/water requirements of a producing vineyard diminish as the season progresses. Nutrient and water requirements are highest from bud break to flowering (about June 1) to support vigorous growth and development of the vine, shoots, and flower parts. After flowering, limit nutrients and water to that required for maintaining the plant without stimulating vigorous shoot growth. Vigorous vegetative growth throughout the summer diminishes good sugar/acid ratios in the fruit and can lead to undesirable hardening of shoots.

Check soil pH every 2 years. If lime is recommended, apply the dolomitic form since grapes have a high magnesium requirement. Magnesium deficiency often shows up later in the season and, in severe cases, may cause fruit to shatter prematurely. A symptom is yellowing between veins of older leaves that progresses up the shoots as other leaves mature. If symptoms are evident and the soil pH is too high to add dolomitic lime, use a soluble form of soil-applied magnesium such as magnesium sulfate (Epsom salts) at 100 pounds per acre.

Boron deficiency can result in poor fruit set. If a boron deficiency is determined by a tissue analysis, apply 5 pounds of Borax (10% boron) per acre to the soil surface, or spray the vines with 1 pound of Solubor (20% boron) per acre just before bloom. Do not exceed the recommended rates as excessive boron will kill or injure plants.

Monitor the nutritional status of producing vineyards by both soil and tissue analysis. Take soil samples in the fall, and be sure to request a test for magnesium. Take tissue samples in June, consisting of at

least 100 petioles. Take only basal leaves on fruiting shoots, preferably those opposite fruit clusters. Do not sample end vines, vines on outside rows, or shaded vines. Sample each cultivar separately.

Irrigation

Irrigation is important in establishing a new muscadine vineyard. Supplemental irrigation water during the first 2 years will allow young vines to grow rapidly and become established on the trellis. Irrigation is also important to fruit production. The availability of irrigation water will allow the grower to control soil moisture and maximize yields. Drip irrigation is the preferred method because initial cost of installation and total water usage is considerably less than overhead irrigation. Also, vines can be irrigated without wetting the foliage and fruit. Irrigation tubing is usually attached to a wire attached to the line post 12 inches off the ground. Suspending the tubing prevents rodent damage, allows the grower to monitor the rate of dripping from the emitters, and makes maintenance easier.

Most systems use 1 gallon per hour emitters. Initially, one emitter per plant is installed 2 feet from the trunk of the vine. During the first year, a spaghetti tube channels the water to the base of the vine. After the first year, the spaghetti tube can be removed. When the vine is 3 years old, a second emitter is installed on the opposite side of the vine. Irrigate regularly to replace water lost to evaporation and plant use. Research in Georgia has shown that 6 to 8 gallons of water per vine per day result in maximum yields on single-trellised vines. At a planting density of 181 plants per acre, this application rate would use 1,500 gallons of water per acre per day.

After harvest, reduce the amount of supplemental water applied to the muscadine vineyard. Apply only enough water to keep the vines healthy and maintain foliage. In October, discontinue irrigation so that the vines can harden off in preparation for winter.

Weed Control

Maintain a weed-free strip 4 feet wide under muscadine vines. Use herbicides to keep the strip clean of vegetation. Most weed-control programs include glyphosate for broad spectrum weed control. Be careful to avoid contact with green tissue. Crimson clover or subterranean clover can be planted in the fall and allowed to reseed before mowing the following spring. Clover will reduce competition from weeds, provide erosion control, and increase nitrogen levels. Herbicide recommendations specific for different weeds and soil types are available at your county Extension office.

Diseases

Fungi cause the important muscadine diseases. Some diseases primarily affect foliage, and others primarily affect fruit. Although foliage diseases can cause yield reduction, fruit rots are generally more destructive. Several species of fungi cause leaf spots and fruit rots in muscadine. The usual diseases observed are black rot, bitter rot, ripe rot, macrophoma rot, and angular leaf spot.

Rainfall brings moisture that encourages muscadine grape diseases. Lush muscadine leaf canopies increase diseases and prevent foliage and berries from drying because of slower air movement. Most of these diseases become more prevalent as the growing season progresses to berry maturity. The following disease descriptions provide the most significant symptoms observed on muscadine:

- ***Bitter Rot*** – The most common disease on muscadines in Mississippi is bitter rot. The bitter rot fungus causes a severe disease on muscadine grapes. The fungus, Melanconium fuligineum, mainly affects berries but can be found on other plant parts. The fungus usually invades the berry from the pedicel. A brownish, water-soaked spot is the first symptom on berries. The spots enlarge and completely destroy the berry, causing it to turn black and shrivel. Tiny, black-fruiting bodies (acervulii) of the fungus appear on the surface of rotted berries. As berries mature they become more vulnerable to the fungus.

  The fungus overwinters on fallen berries and on mature leaves and may start early in the season immediately after flowering. It invades the pedicel tissue and moves into berries as they approach maturity. Any injury to berries, such as insect or bird damage, increases chances of infection. “Higgins” and “Fry” varieties are at very high risk for this fungus.
- ***Black Rot*** – *Guignardia bidwelli* causes black rot. The fungus can affect all of the new season’s growth. On leaves, small, reddish-brown spots develop on the upper leaf surface. A black band surrounding the brown spots will usually border these spots. You may see a sunken, dark canker on stems. Symptoms on fruit appear as small, black scabby spots. Infected young berries may drop or mummify. The disease can occur anytime before maturity, but it usually occurs by the time berries are half grown.

  The fungus overwinters in infected canes and fallen, mummified berries. Fruiting bodies (pycnidia) produced by the fungus on infected fruit produce spores that cause initial infections in the spring. The fungus then spreads to young berries. Berries of “Higgins,” “Hunt,” and “Scuppernong” varieties are especially at risk.

- ***Angular Leaf Spot*** – This fungus disease primarily affects foliage of muscadine grapes in the southeastern United States. The causal fungus is *Mycosphaerella angulata (Cercospora)*. Damage from this disease results from premature defoliation, which causes lower plant vigor and yields.

  Initial symptoms begin as tiny, brown spots on the upper leaf surface. Lesions increase in size and become angular to irregular in shape. Severely affected leaves may drop from the plant. The fungus survives over the winter on infected leaves and produces spores that are wind-blown in the spring. "Magnolia" is more prone to leaf spot than "Carlos."
- ***Macrophoma Rot*** – This berry rot disease is caused by the fungus *Botryosphaeria dothidea*. Circular, light brown spots that turn black and appear slightly sunken are initial symptoms occurring as berries reach maturity. A soft rot develops from the initial infection and eventually spreads over the entire berry. Affected berries usually drop from the vine and become dry and shriveled. Fruiting bodies of the fungus form on the dry, fallen berries.
- ***Ripe Rot*** – This fungus disease is primarily observed on ripe berries at harvest time. The causal fungus, *Glomerella cingulata*, initially causes circular, reddish-brown spots of decay on fruit. The disease resembles bitter rot, but it occurs closer to maturity. The fungus spreads rapidly from berry to berry in wet weather. Pink masses of spores usually appear on the surface of rotting fruit. "Higgins" and "Fry" are highly susceptible varieties.
- ***Crown Gall*** – This bacterial disease was first observed in Mississippi in 1985. The causal organism is *Agrobacterium tumefaciens*. The primary symptom observed on muscadine grapes is the formation of swollen, galled tissue on the trunk just above the soil line. The growth above the galled tissue is generally stunted, and in many cases, the vine dies. A wound is necessary before infection can occur. In muscadine grapes in Mississippi, this is often associated with freeze damage. Injury from insects, mechanical tools, and grafting may also lead to infection.

Disease Control

Most diseases of muscadine occur during mid- to late-season, and particularly on berries as they approach maturity. Since fungus diseases of muscadine can spread rapidly during periods of wet weather, prevention is best.

To prevent disease, select vineyard sites that maximize air flow through the canopy and provide adequate water drainage to reduce the possibility of freeze damage. Vines that are delayed going into dormancy are most likely to be affected by freeze damage. Other cultural practices such as proper fertility, pruning, and weed control will provide conditions for healthy vine growth. Avoiding trunk injury from mechanical operations or insect feeding will prevent diseases such as crown gall.

Develop a disease-prevention program with the use of fungicides. Most fungal diseases of muscadine grapes can be prevented and/or controlled by using fungicides. Table 3 suggests a preventive spray program for use in muscadines.

Insect Control

This guide is intended to help Mississippi muscadine producers manage common vineyard pests. Always check the legal status of all agro-chemicals used on muscadines at specific times of the growing season. Trade names and brand names listed in Table 4 are products that can be legally applied to muscadines in Mississippi. Their mention is not an endorsement of one product over any others. Many pesticides registered for use in muscadine vineyards are infrequently applied, but most are broad-spectrum, and one or two cover applications for one pest can also suppress other pest species present during that time of the growing season.

Always read and fully understand the pesticide label, instructions, safety guidelines, restrictions, warnings, and precautions before opening and handling a pesticide. Label information will also help you choose the most effective and legal product for pest control. Consult with a local expert if you are unsure of the pest's identification or the type of damage the insect pest is doing to your crop. When you have identified the pest problem, and if nonchemical pest control is impractical, first refresh your memory of the best product and its proper rate to legally control that pest in your area, especially if the product is applied infrequently. Always consider how chemicals will react with one another when mixing them in the same tank.

Table 4 gives the relative effectiveness of the pesticides used for specific grape pests.

- ***Grape Flea Beetles*** – shiny, dark blue beetles, oval in shape, and about one-fourth of an inch long. Larvae are dark brown and about one-third of an inch long. Apply insecticides when adult beetles and larvae are damaging muscadine leaves. Damage appears as shotgun-like holes throughout the leaf, especially on border vines. This is one of the most common prebloom pests of muscadine grapes in Mississippi. One cultural control method is the removal of any Virginia creeper vines, which serve as an alternative host for grape flea beetles. Wherever possible, clean up any wild areas around

Table 3 - Muscadine Grape Disease Spray Program

Application Time	Fungicide*	Amount/Acre	Remarks
First, just before bloom	Mancozeb or Captan 50WP	2 - 3 lb 3 lb	
Second, just after bloom and fruit set	Nova 40W or Abound	1.2 - 2 oz 11 - 15 oz	Do not omit application. Important for reducing bitter rot and other fruit infections.
Continue at 14-day intervals	Nova 40W or Abound	Above Rates	Use shorter application intervals during rainy periods. Extend application interval if conditions do not favor disease development.
Preharvest sprays beginning 6 to 8 weeks before harvest	Captan 50WP or Nova 40W or Abound	3 lb Above Rates	Necessary for berry rot control. Shorten application interval to 7 to 10 days if rainy conditions exist during berry maturation. Pay attention to days until harvest.

Minimum days from last application until harvest:
Nova – (14); Captan – (0); Mancozeb – (66); Abound – (14)

Note: The addition of a spreader/sticker product to fungicide sprays will improve the pattern in which fungicide is deposited and weatherability. Read and follow all label directions.

*Other products are labeled for disease control in muscadine, and not all products are listed here.

the vineyard to help reduce overwintering sites. Frequent hoeing or disking to control weeds between grape rows can destroy pupae.

- ***Aphids*** – very small, soft-bodied insects that form colonies on the underside of grape leaves and along green stems. They come in several different colors: green, pink, black, or yellow. They remove sap from leaves, terminals, or stems. Leaves begin to curl and turn yellow, stunting terminal stem growth. Aphids secrete excess sap called honeydew that produces a sooty mold harmful to leaves and fruit. Aphids are seldom a problem on grapes because parasitoids and predators keep their numbers in check, especially in autumn. However, if they do reach harmful levels, apply one or two prebloom cover sprays before the onset of bloom and when shoots are about 6-10 inches long.
- ***Grape Root Borers*** – very serious muscadine grape pests. These moths closely resemble red wasps in appearance, but they cannot sting. Females lay their eggs on foliage or trunks of muscadines in June, July, and August. Larvae drop from the leaves to the soil where they burrow down, eventually tunneling into the roots where they reside for almost 2 years. Larvae are whitish grubs that are 1½ inches long when fully grown. They then exit the roots and pupate in cocoons near the soil surface in June. A larva feeding near the crown of the plant can cause a gradual and noticeable yield reduction over a 2- to 3-year period. Monitor plants in May and June for poor leafing, wilting, or dying leaves. One cultural-control method is to mound soil over the base of vines in infested areas, preventing larvae from entering roots. Mounding also helps smother pupae. Lorsban (chlorpyrifos) is the only chemical control available but is no longer being manufactured and will soon be unavailable for use on muscadines.

  An alternative control method is to carefully time **diazinon drenches** when adult crown borers are in the vineyard. Several drenches are needed to ensure larvae never enter the root zone alive. Another product that may be effective is the **insect-killing nematode**. Nematodes are microscopic worms that burrow through the soil, parasitizing

and killing soft-bodied grubs such as the root borer larvae.

- ***Grape Leafhoppers*** – begin laying their eggs in the leaves and leaf petioles of muscadines during spring. Adults and juveniles feed throughout the year on leaves, causing white spots, yellowing, and eventually necrosis and leaf drop. Leafhoppers can also produce excessive honeydew on foliage and fruit. Spray for grape leafhoppers when you see about 15-20 juveniles per leaf, or before 20-percent leaf loss occurs.
- ***Moths*** – Apply insecticides when you see **leafrolling moth** adults, larvae, and damage between bud break and 6-8 weeks before harvest. Female leafrolling moths lay about 200 iridescent eggs along leaf veins. Home gardeners who do not want to use insecticides to control leafrollers may get good results by crushing larvae (caterpillars) by hand. The insect overwinters as a pupa in fallen leaves, so it is important to rake up any leaves and then promptly destroy them. **Grape berry moth** is sometimes a serious muscadine pest, and larvae create large entrance holes in the fruit near the stem. They produce light webbing and frass around infested areas, usually in middle or late summer.
- ***Wasps*** – insects beneficial to grape production. Take necessary precautions to ensure their safety. Immediately remove rotting or fallen fruit from under the vines. Fungicides that reduce fruit disease will also help reduce the number of wasps and bees feeding on softer fruit in the vines. **Use insecticides only when wasps pose a serious stinging hazard.** PHI intervals must be adhered to.
- ***Stink Bugs*** – large green or brown bugs. You will see adults and immatures in the summer feeding on fruit, and they emit a repugnant odor. The bugs have long piercing mouthparts through which they feed on muscadine fruit juices and seeds. This feeding causes fruit pitting, abortion, and shattering. Apply a spray when a large number of stink bugs suddenly appear and fruit damage and shattering are apparent.
- ***Other Muscadine Pests*** – Serpentine leafminers are small fly maggots that burrow small tunnels between the upper and lower surfaces of leaves. Flower thrips are minute, yellow or brown insects that damage flowers and scar fruit. Grape curculio is a beetle whose larvae feed on berry pulp and seeds. Leaf damage by adult curculios is very noticeable as a zigzag pattern of necrosis on the underside of leaves and petioles. Thoroughly clean up leaf litter and fallen berries to reduce populations of grape curculios.

Table 4. Prebloom and Up-to-Bloom (1st and 2nd Covers)

Pest	Effect-iveness	Pesticide	Application Rate	Reentry Interval	Preharvest Interval	IPM Remarks
Grape Flea Beetle	+++	Sevin 50% WP	2 – 4 lb per acre	12 hr	7 days	To protect native bees and honeybees from any toxicity, do not spray pesticides that have residues harmful to bees for more than 8 hours anytime during bloom. Bees are important for muscadine pollination. The most important and abundant pollinators are bumble bees, honeybees, and sweat bees. Bloom is also when beneficial insects such as parasitoids and predators begin their life cycles. Predatory and parasitoid insects can be effective biological control organisms of many muscadine pests.
	+++	Sevin 80% WP	2 lb per acre	12 hr	7 days	
	+++	Sevin XLR	1 – 2 qt per acre	12 hr	7 days	
		Diazinon AG500	1 – 2 pt per acre in a minimum of 100 gal of water	24 hr	28 days	
Aphids	+++	Malathion 57%EC	1 – 1.5 pt per acre	12 hr	3 days	To minimize harm to pollinating bees and beneficial insects, use the safest and most effective formulations possible. If at all possible, spray prebloom insecticides in late afternoon, in the evening, or during cool, cloudy days with a still wind and when bees are not present anywhere within the coverage area. Many insect pests have nocturnal feeding habits.
		Diazinon AG500	1 – 2 pt per acre in a minimum of 100 gal of water	24 hr	28 days	
			Preharvest-Harvest Period			
Grape Root Borer	++	Lorsban 4E ***While supplies last	4.5 pt per 100 gal	24 hr	35 days	Apply 2 quarts of mix to a 15 square-foot area around the base of each vine just before the pest emerges (normally late June). Do not allow Lorsban to contact developing fruit or foliage. Apply Lorsban once per season.
Grape Leafhoppers	+++	Sevin 50% WP	2 lb per acre	12 hr	1 day	
	+	Thiodan 3EC	0.67 qt per 100 gal water	24 hr	7 days	
Moths						
Grape Leafrolling Moth	++	Sevin 50% WP	2 lb per acre	12 hr	7 days	*Bacillus thuringiensis* is a bacteria-based insecticide that can be used to control moth larvae. Use *B.t kurstaki* as moth larvae are seen rolling and feeding on leaves and serious defoliation occurs. This product can be used in the field and inside greenhouses and indoor nurseries. Bt is a stomach poison that must be ingested before moth larvae get sick and die. Therefore, Bt is more effective when larvae are small.
Grape Berry Moth	++	Sevin XLR	1 – 2 qt per acre	12 hr	7 days	
Grapeleaf Skeletonizer	+	Malathion 57% EC	1 – 1.5 pt per acre	12 hr	3 days	
		Diazinon AG500	1 – 2 pt per acre in minimum of 100 gal of water	24 hr	28 days	
	N/A	*Bacillus Thuringiensis* (Bt)	0.5 – 1.0 lb/acre	0 hr	0 days	
		Dipel 2X	0.5 – 1.0 lb/acre		0 days	
		Biobit				
Stink Bugs Feeding on healthy fruit	++	Sevin 50% WP	2 – 4 lb per acre	12 hr	7 days	
	++	Sevin 80%WP	2 lb per acre	12 hr	7 days	

Table 4 continued...

Table 4 continued...

Pest	Effect-iveness	Pesticide	Application Rate	Reentry Interval	Preharvest Interval	IPM Remarks
Other						
Grape Curculio	++	Sevin XLR	1 – 2 qt per acre	12 hr	7 days	
	++	Malathion 57% EC	1 – 1.5 pt per acre	12 hr	3 days	
	N/A	Thiodan	0.67 qt per 100 gal water	24 hr	7 days	
Wasps	+	Sevin 50% WP	2 – 4 lb per acre	12 hr	7 days	
Feeding on damaged or fallen fruit (during harvest)	+	Sevin 80%WP	2 lb per acre	12 hr	7 days	
	+	Sevin XLR	1 – 2 qt per acre	12 hr	7 days	
	+ +	Malathion 57% EC	1 – 1.5 pt per acre	12 hr	3 days	

N/A denotes chemicals where no data on effectiveness are available. Highly effective insecticides are indicated by +++; effective sprays are indicated by ++; and + indicates an insecticide that is only slightly effective in controlling the specific pest listed.

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