
COMMERCIAL

Muscadine

AND

Bunch Grape

PRODUCTION GUIDE

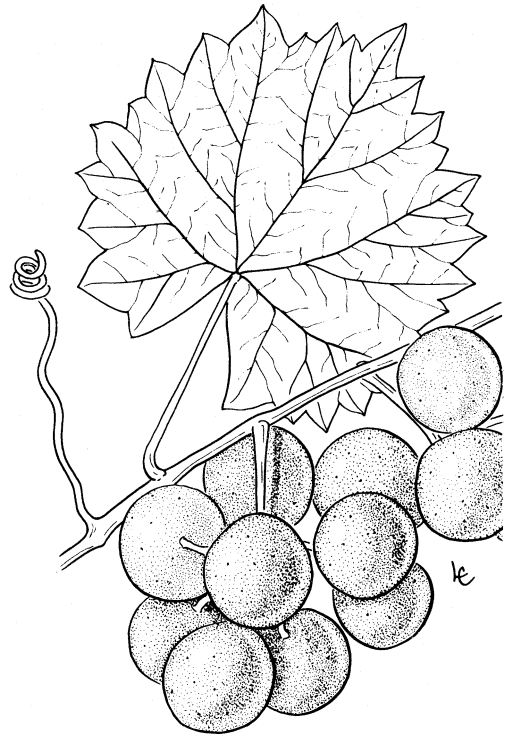
Muscadines

The muscadine grape (*Vitis rotundifolia* Michx.) was the first American grape species to be cultivated. This fruit has a long history in commercial and backyard culture. The oldest and most consistent commercial interest in muscadines has been in wine, but juice and fresh fruit markets have also been developed. Muscadines so differ from "bunch" grapes genetically, anatomically, physiologically, and in taste that they should be considered a separate fruit.

The muscadine industry is currently expanding throughout the southeastern United States as interest in grapes and wine increases nationally. There is particular interest in this fruit for small and part-time farm operations and as an alternative crop for agronomic growers. The current industry includes production for juice, wine, fresh fruit, and pick-your-own operations.

History

For much of the history of muscadines, cultivars were simply wild selections preserved through vegetative propagation. The first recognized muscadine cultivar was a bronze selection found before 1760 by Isaac Alexander in Tyrrell County N.C. This selection is important historically, as well as *viticulturally* (grape culture) as the first American grape cultivar. It was known as The Big White Grape or Hickmans Grape and was later named Scuppernong after the area in which it was found. With time, the name scuppernong became generic for all bronze muscadines, regardless of actual cultivar name. In common usage, scuppernongs are sometimes even thought of as a separate species from muscadines or "bullises," traditional generic names for the dark-fruited types. Bullis and its variants (bullace, bullet grape, bull grape) are very old names for dark-fruited muscadines. It is important to note that all cultivars of this type of grape, regardless of the berry color (bronze, black, red, etc.), are correctly called muscadines. Muscadines are usually considered to be a grape, both in common terminology and in botanical taxonomic classification.





Muscadine grapes are available in a number of fruit colors ranging from bronze and pink to dark red and black.

Marketing

Careful planning about exactly how your fruit will be sold and marketed is essential to commercial success. A marketing strategy should be researched and well developed before the vineyard is planted. The cultivars that are to be planted will be determined by the intended market outlet and end use (Table 1).

In addition to wine production, muscadine grapes are also used in unfermented juice, pies, jellies, and sauces. The distinctive fruity flavor of most muscadine cultivars is retained in fermented and unfermented products. This distinctive flavor and aroma is highly valued by those familiar with the muscadine grape.

Varietal white wines are commonly made from such cultivars as Magnolia, Carlos, and Golden Isles, while Noble produces a deep red wine. If properly fermented, excellent sweet, semi-dry, and dry wines can be produced. In addition to varietals, many white wine cultivars are combined in the production of wines that are labeled as muscadine or scuppernon. The largest portion of the white muscadine production is used in wines that combine other grape species without indicating cultivar or species. Champagne and brandy are also produced from muscadine grapes.

Fruit marketed fresh is primarily sold locally with limited numbers of commercial shipments to cities in the southeastern states. Muscadine grapes have a shorter storage and shipping life than bunch grapes. Rapid cooling following harvest and a cultivar with a dry stem scar such as Summit or Carlos are required for shipment if quality is to remain acceptable for more than a few days. Some growers have built a substantial customer-harvest (pick-your-own) trade. Vineyards of several acres each are located in various areas of the state that grow fruit especially for this local market. If you plan a pick-your-own operation, the site should be close to large population centers with easy access for the public. For example, a pick-your-own site should be near or on a major highway or near an interstate exit to allow for heavy traffic past the operation.

The profitability of existing vineyards has become increasingly dependent upon good management. Prospective growers should seriously consider the marketing opportunities before planting. For wine grapes, a guaranteed contract is desirable. Fresh-market sales potential should be discussed with the intended marketing outlet representatives. An evaluation of potential customers and competing growers should precede a decision to depend upon pick-your-own marketing. After potential markets are identified and realistic selling prices have been projected, your county Extension agent can provide the latest information on vineyard establishment and maintenance costs. With this information and an estimate of yield potential, the grower can reasonably assess the likelihood for financial success or failure.

Vineyard Site Selection

Muscadines are limited in their production to the cotton-belt areas of the southeastern United States that have a moderate climate. Vines should not be planted where temperatures drop below 10 °F, with some

damage and death of vines occurring as temperatures drop below 0 °F, depending on the rapidity of temperature drop, preconditioning, age, cultivar, and condition of the vine.

Air Drainage. Muscadine grapes are not especially cold hardy. Often the vines are injured by cold temperatures, especially when the fluctuation of night and day temperatures is great. On rolling land, plant the vineyard on a site that is elevated from the surrounding area and away from woods or other obstructions that could prevent the normal air drainage. This will allow the cold air, which is heavier than warm air, to flow out of the vineyard. In colder areas where muscadine production is marginal, it is especially important to identify sites with superior air drainage to reduce the possibility of winter freeze injury and vine death.

Do not plant vines lower than 50 feet above the base of a slope. Where there is a thick woods nearby, it is unwise to plant closer than about 75 feet. The woods will harbor cold air as well as compete with the vines for light. Muscadine grapes leaf out late in the spring and are seldom seriously injured by frost.

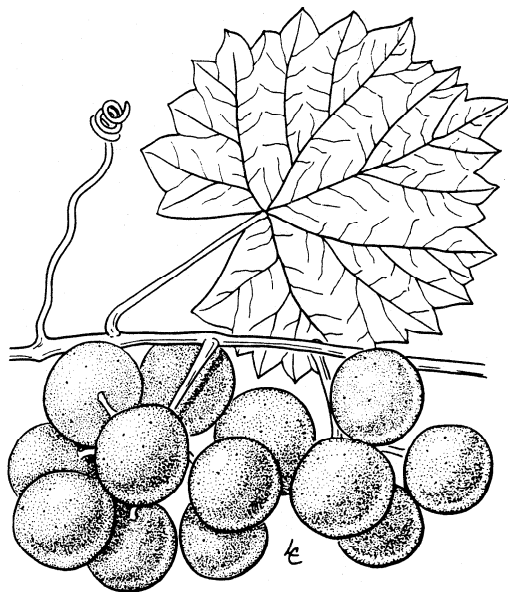
Soil. Although muscadines will survive and produce a crop under a variety of soil conditions, planting is not recommended where soils have poor internal drainage. Never plant where surface water stands more than a few hours even after the most severe storms. If poor drainage may be a problem on an otherwise good site, install a tile drainage system or plant on a raised bed that allows complete surface drainage. Soils that have a hardpan or water table near the surface are not satisfactory.

Other Considerations. Whenever possible, choose a field that lends itself to rows that are long and straight for efficient equipment operation. Plant in straight rows unless the slope is greater than 10 percent. Generally a modified contour on slight slopes allows for straight rows but requires allowance for turn rows.

Growing grapes without irrigation is not advisable. Particle-free water from a well or municipal source is generally suitable. Pond water is not suitable for trickle or micro-irrigation unless extensively filtered.

A vineyard site that will accommodate long straight rows is ideal. If a Geneva double-curtain (GDC) trellis is used on sloping land, straight rows should be oriented perpendicular to the flow of runoff water, otherwise special vineyard floor management practices must be followed to curtail erosion under the trellis row. Contact your local Soil Conservation Service office for assistance. Contoured vineyard plantings are impractical for trellising and mechanical harvesting.

When laying out the vineyard, leave adequate room at the row ends to turn mechanical harvesters. Generally a minimum of 20 feet is required. For greater vineyard efficiency and ease of harvesting, make cross alleys that will accommodate standard-width tractors. In areas with strong prevailing winds, plant rows in the direction of the wind to avoid extra stress on the trellis.



Muscadine leaf, tendril, and fruit cluster.

Table 1. Characteristics Of Muscadine Cultivars.

Variety	Color	Type	Harvest Season	Berry Size	Yield	Disease Resist.	Flavor	Cold Hardiness	Berry Stem Scar	Vine Vigor	Uses	Additional	Comments
Alachua	Blk	SF	M	M-L	H	G	G	F-G	Dry	M	F H C	18.0%	SS, even ripening
Albemarle	Blk	SF	E-M	M	M	G	E	P-G	Dry	M-H	H J F	17.5%	SS, shatters
Big Red	Red	F	M-L	VL	L	G	G	G	Dry	VL	FH tangy		
Black Beauty	Blk	F	M	VL	L-M	G	E	G	Wet	H	F H C	17.0%	SS, edible skin
Black Fry	Blk	F	M	L	H	VG	E	VG	Wet	M	F J C H	14.5%	SS
Bountiful	Blk	SF	L	S	M	G	G	P	Dry	L-M	F	17.5%	SS, shatters
Burgaw	Blk	SF	E	S	M	G	G	G	Wet	M-H	F W	16.0%	SS
Carlos	Brz	SF	E-M	S	H	G	G	E	Dry	VH	W C H F	15.5%	SS
Chief	Blk	SF	M	S-M	M	G E	E	P-F	Wet	M-H	H J	17.5%	SS
Chowan	Brz	SF	E-M	M-L	L	P-F	G	VP	Wet	M-H	H C	17.0%	SS
Cowart	Blk	SF	E-M	M	H	G	G-VG	G-E	Wet	M-H	W C H F	16.5%	SS, shatters
Creek	Blk	F	L	S	M	G	F	G	Wet	M-H	W J	17.0%	SS, tart
Darlene	Brz	F	M-L	VL	H	G E	E	G	Dry	VL	F H C	15.0%	SS
Dearing	Brz	SF	M	S	L	G	G	G	Wet	L	F H	19.0%	SS
Delite	Brz	SF	L	M-L	H	G	F	F-G	Dry	L	F H C	14.5%	SS
Digby	Pk Brz	SF	L	M	L	P	P	P-F	Dry	L-M	H	19.5%	SS, doesn't ripen
Dixie	Brz	SF	M	S	H	P-G	G	F-G	Wet	VH	W J F H	18.5%	SS
Dixieland	Brz	SF	M	M-L	L-M	F	F-G	P-F	Wet	M	F H C	17.0%	SS
Dixiered	Rd Brz	SF	M-L	M	H	G	G	VG	Dry	M-H	F J W	16.5%	SS
Doreen	Brz	SF	L	M	L-M	G	G	G	Dry	H	W J H	17.5%	SS, slow grower
Dulcet	Blk	F	E-M	S-M	M	G	G	G	Wet	L	J F H	17.5%	SS
Duplin	Blk	SF	E	M	M	F-G	F	G	Wet	M	H	14.5%	ss
Excel	Brz	SF	L	L	H	G	F	F-G	Wet	L	F H	14.5%	SS, holds on vine
Farrer	Blk	F	M-L	VL	H	G	E	G	Wet	H	W J F	14.0%	SS
Frv	Brz	F	E-M	L	H	F	E	P-F	Wet	L-H	F H	16.0%	SS
Fry Seedless	Rd Blk	SF	E-M	S	VL	G	G	G	Dry	H	F H	17.0%	SS
Georgia Red	Red	F	M	S	M-H	E	F	G	Wet	H	F		holds on vine
Golden Isles	Brz	SF	M-L	M	M-H	G	P	VG	Drv	M	W J	15.0%	SS
Granny Val	Brz	SF	L	L	H	G	G	P-F	Dry	L-M	F H	16.0%	SS
Higgins	Rd Brz	F	M-L	M-L	H	G	G	P-F	Wet	M	F W H	15.0%	SS
Hunt	Blk	F	E-M	M	M-H	P	G	G	Wet	VH	J F H	16.5%	SS
Ison	Blk	SF	E	M-L	H	E	VG	G	Drv	VH	F H C	14.0%	SS
James	Blk	F	L	L	M-H	G E	FG	G	Dry	M-H	F H C	15.0%	SS
Jane Belle	Brz	SF	M	L	H	G	G	G	Dry	H	FW		
Janet	Brz	SF	M	L	H		VG	G	Wet	H	F	16.0%	SS
Jumbo	Blk	F	L	VL	H	VG	G	F	Dry	M-H	J W F	15.0%	SS
Loomis	Blk	F	M-L	M-L	L	G	E	G	Dry	H	F	15.0%	ss
Magnolia	Brz	SF	M	S-M	H	F-G	G	G	Wet	M-H	H W J	14.5%	SS

Variety	Color	Type	Harvest Season	Berry Size	Yield	Disease Resist.	Flavor	Cold Hardiness	Berry Stem Scar	Vine Vigor	Uses	Additional	Comments
Magoon	Rd Blk	SF	E-M	S	H	G	VG	P	Dry	L	F	18.5%	ss
Nesbitt	Blk	SF	M-L	L	M	G	VG	F	Dry	M	F H	17.0%	SS
Nevermiss	Brz	SF	M	S	M-H	G	G	G	Wet	H	F H	13.5%	SS
Noble	Blk	SF	E-M	S-M	H	VG	G	VG	Wet	H	J W	15.5%	SS
Pam	Brz	F	M	VL	M-H	G	VG	G	Dry	H	F H C	15.0%	SS
Pamlico	Brz	SF	E	M-L	M-H	F-G	P	F-G	Wet	H	H J	15.0%	SS
Pineapple	Brz	SF	E-M	M-L	H	E	VG	G	Wet	H	F J H C	15.5%	SS
Pride	Blk	F	M	M-L	H	P	G	P	Dry	VL	H	15.5%	SS, long season
Redgate	Red	SF	M-L	S	M	G	F-G	F	Wet	H	F	15.0%	ss
Regale	Blk	SF	M	S	H	F-G	G	E	Wet	H	W J	14.5%	SS
Roanoke	Brz	SF	E-M	M	H	P	F	P	Dry	M-H	H	14.5%	ss
Scuppemong	Brz	F	M-L	M	L	F-G	E	P-G	Wet	M-H	J W F	17.0%	SS, holds on vine
Senoia	Rd Brz	SF	M-L	M	H	G	F	F	Wet	M-H	W	14.5%	ss
Southland	Blk	SF	M-L	M-L	H	G	VG	P	Wet	M	H C F J	17.0%	SS
Sterling	Brz	SF	M	M	H	F-G	G	E	Wet	M	J W	16.0%	SS
Sugargate	Blk	F	E	VL	L	G E	E	P	Wet	M	F H C	18.0%	SS
Sugarpop	Brz	F	L	M-L	H	G	G	G	Dry	H	F H C	16.0%	SS
Summit	Rd Brz	F	E-M	M-L	M-H	FVG	G-E	F	Dry	H	FJ	17.0%	ss
Supreme	Blk	F	M-L	VL	H	G	E	G	Dry	H	F H C	will shatter	
Sweet Jenny	Brz	F	M-L	L	M-H	G	VG	G	Dry	H	H F C	17.0%	SS
Tara	Brz	SF	E-M	L	L	G	G	G	Dry	H	F H C	16.0%	SS
Tarheel	Blk	SF	E-M	S	M-H	P-G	F-G	F-G	Wet	H	J W	17.0%	SS
Thomas	Blk	F	M	S	M	E	VG	E	Dry	M-H	H J	16.0%	SS, thin skin
Topsail	Brz	F	M-L	M	L-M	F-G	VG	P-G	Wet	M	H F	18.5%	SS
Triumph	Rd Brz	SF	E	M-L	M	F-G	G	P	Dry	M	F H	17.5%	SS, shatters
Wallace	Brz	SF	L	S	H	G	G	E	Dry	M	WF		
Watergate	Brz	F	L	VL	M-H	F	F-G	P	Wet	M	W F J	16.0%	SS
Welder	Brz	SF	M-L	S	H	G	-G	P	Wet	H	W J	18.5%	SS
Willard	Brz	SF	M	S	H	G	G	G	Dry	G	WJ		
Yuga	Brz	F	L	S	M	G	G	G	Wet	H	F	17.5%	ss

Color
 Brz = Bronze
 Blk = Black
 Red = Red
 Pk Brz = Pink Bronze
 Rd Brz = Red Bronze
 Rd Blk = Red Black

Type
 SF = Self-fertile
 F = Female

Harvest Season
 E = Early
 M = Mid
 L = Late

Berry Size
 S = Small
 M = Medium
 L = Large
 VL = Very Large

Yield and Vigor
 VL = Very Low
 L = Low
 M = Medium
 H = High
 VH = Very High

Disease Resistance, Flavor, and Cold Hardiness
 P = Poor
 F = Fair
 G = Good
 VG = Very Good
 E = Excellent

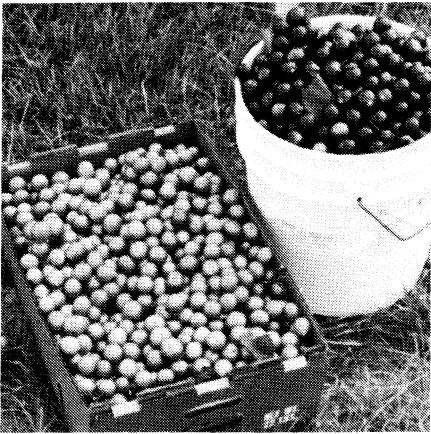
Uses
 H = Home
 C = Commercial
 W = Wine
 J = Juice and Jelly
 F = Fresh market and "Pick-Your-Own"

Comments
 % SS = % Soluble Solids (typical sugar level)

Cultivar Selection

Berry use dictates the choice of cultivars. Table 1 summarizes varietal attributes and shortcomings and usage of several popular muscadine cultivars.

An overriding consideration in the selection of cultivars is whether they have self-fertile flowers or self-sterile pistillate flowers. Self-fertile, perfect-flowered cultivars that have both male and female flower parts do not require pollinizers. Pistillate cultivars have only female flower parts and must be adjacent to pollen producing lines. Pistillate cultivars should be planted with one row of a self-fertile, pollen-producing cultivar between two rows of pistillate cultivars.



If muscadines are being grown for fresh fruit consumption, two characteristics seem to demand greater attention than all others: size and color. Most pick-your-own operators have found a ratio of 80 percent large bronze muscadine cultivars to 20 percent large black muscadine cultivars to be best for fresh sales. This ratio of bronze to black or red cultivars may be different for various localities, so a pre-plant survey of potential customers should be made.

Pick-Your-Own. A brief description of some of the cultivars that are suitable for the pick-your-own production follows (in addition to Higgins):

Black Beauty--Female, black, large berries that ripen early to mid-season, excellent flavor with edible skin, moderate yield, good cold hardiness, high vigor.

Black Fry--Female, black, won't shatter when picked, ripens evenly in mid-season, large berries with dry stem scar, very good disease resistance and cold hardiness, excellent flavor.

Cowart--Self-fertile, black, large berries borne in large clusters that ripen early to mid-season, good disease resistance and cold hardiness, very good flavor, wet stem scars, vigorous plants with high yields.

Fry--Female, bronze, very large fruit borne in large clusters that won't shatter when picked, ripens early to mid-season, fair disease resistance and cold hardiness, excellent flavor, wet stem scars, vigorous vines.

Ison--Self-fertile, black, clusters ripen evenly early in the season, very good flavor, large berries with dry stem scars, very vigorous vines with good cold hardiness, moderate yields.

Loomis--Female, black, medium to large berries ripening mid- to late season with dry stem scar, high vigor, low yield, excellent flavor, good cold hardiness.

Sweet Jenny--Female, bronze, clusters ripen evenly during mid-season, medium- to high-yielding vigorous vines, good disease resistance and cold hardiness, very good flavor, large berries with dry stem scar.

Triumph--Self-fertile, red-bronze, medium to large berries with good flavor and dry stem scar, ripens early in the season, poor cold hardiness, moderate vigor.

Fresh Market--If the grapes are to be shipped or sold at a roadside market or grocery store, choose a cultivar with a high percentage of dry stem scars. Cultivars with dry stem scars have berries that do not tear and separate easily from the cluster. Following are several cultivars good for the fresh market:

Carlos--Self-fertile, bronze, medium-size fruit borne in small clusters that ripen early to mid-season, very vigorous vines, good disease resistance and cold hardiness, good flavor, dry stem scars, high yields.

Granny Val--Self-fertile, bronze, clusters ripen late in the season and won't shatter when picked, good disease resistance, poor to fair cold hardiness, good flavor, large berries with dry stem scars, low vigor plants with high yields.

Nesbitt--Self-fertile, black, large fruit with dry stem scars, clusters ripen mid- to late season, very good flavor, good cold hardiness, vigorous vines with moderate yields.

Summit--Female, bronze, ripens evenly during mid-season, large berries borne in small clusters, dry stem scars, vigorous vines with moderate to high yields.

Wine Production--The most popular cultivars that are being grown for the production of wine are (in addition to Carlos):

Higgins--Female, reddish-bronze, large clusters of large fruit matures late in the season, tough but edible skins, wet stem scars, good disease resistance and cold hardiness, good flavor, vigorous vines, high yields.

Golden Isles--Self-fertile, bronze, medium-size berries with dry stem scars mature in mid-season, good disease resistance and cold hardiness, vigorous vines, high yield.

Magnolia--Self-fertile, bronze, thin skinned, medium to large fruit in medium-size clusters maturing mid- to late season, wet stem scars, good flavor and cold hardiness, vigorous vines, high yields.

Noble--Self-fertile, black, medium-size berries in large clusters that mature early to mid-season, good disease resistance and cold hardiness, good flavor, very vigorous plants, high yields.

Senoia--Self-fertile, red-bronze, medium-size berries maturing mid- to late season, high yield, moderate to high vigor, fair flavor with fair to good cold hardiness.

Welder--Self-fertile, bronze, medium-size fruit maturing mid-season, high vigor and yield, poor cold hardiness.

Jelly And Juice--Some of the cultivars that are grown for making jelly and juice (in addition to Carlos, Golden Isles, Hunt, Magnolia, Noble, and Welder) are:

Albemarle--Self-fertile, black, medium fruit, maturing early to mid-season, excellent flavor, good disease resistance, poor to good cold hardiness, moderate yield, moderate to high vigor, dry stem scars, clusters shatter easily.

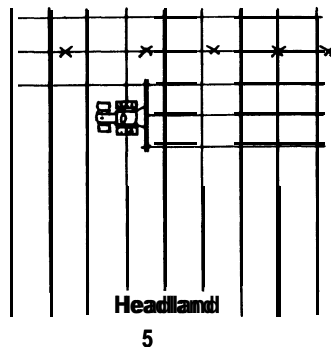
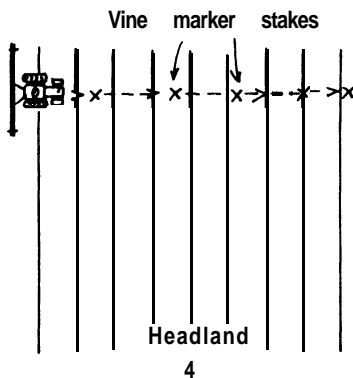
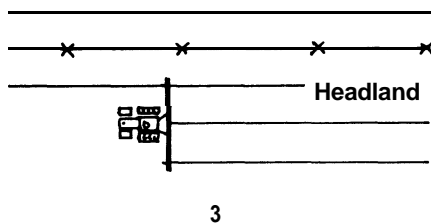
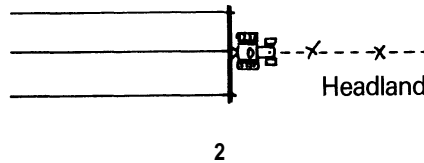
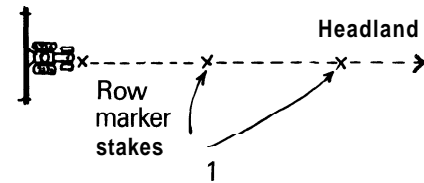
Jumbo--Female, black, very large berries maturing late in the season, dry stem scars, good disease resistance and cold hardiness, very good flavor, thick skin, high vigor and yields.

Nevermiss--Self-fertile, bronze, medium-size fruit, high vigor, moderate to high yield.

Pamlico--Self-fertile, bronze, medium to large fruit maturing early the season, vigorous vines, moderate to high yields.

Site Preparation

Prior to preparing the site, be sure to check the pH of the soil. If soil pH is out of the desired range, apply lime, following soil test recommendations. Dolomitic lime is preferred because of its higher magnesium content. During the summer or autumn prior to planting, eliminate all perennial weeds from the vineyard site, using a systemic herbicide such as Roundup. If erosion is a concern on a sloping site, weeds may be eliminated in strips where the rows will be located. However, if this is done, a constant battle will be waged each season with those perennial weeds present on the site. After weeds have been eliminated, the site should be deep plowed to 6 to 8 inches and thoroughly disked. If a hard-pan exists near the surface, the soil should be chisel-plowed to a depth of about 2 feet, to ensure good root penetration and good water drainage.



Marking the vineyard. 1. Stakes set to determine second row of grapevine. 2. Rows 1, 2, and 3 marked as tractor follows row of stakes. 3. Other rows marked using last-marked row as a guide. 4. Stakes set to determine second vine position in rows. 5. Vine positions marked like row positions.

Vineyard Layout

Before planting, establish the layout of the vineyard. Row width and spacing of plants will be determined in part by the trellising system used. Several trellising systems may be used for muscadine production. The most important consideration is fitting the trellis to the available machinery and working capital. Row width is determined largely by tractor size. If custom mechanical pruning or harvesting will be done by outside sources, the vineyard must be able to accommodate the available machinery.

The simplest system is the single-wire Bilateral Cordon (BC) system. If the grower can invest more money initially, the Geneva double-curtain (GDC) system generally produces a higher yield than other trellising systems and makes better use of available land. Distances between rows is slightly greater for the GDC than the BC. Because of various drawbacks, other trellising systems that are used are not recommended.

Make your vineyard layout using a steel measuring tape on a calm (wind-free) day. Stakes or plastic straws are needed to mark post and plant location. Pinpoint the location of three of the four corners of the vineyard and use triangulation to ensure correct alignment. Post placement should be 24 feet within rows and 10 to 12 feet between rows. End posts should be 3 to 5 inches in diameter. All posts should be guaranteed pressure treated. Rows should be well anchored or braced by any of several methods.

Plant locations should be marked at the same time as post location. Within-row planting distances for muscadines should be about 12 feet. Greater planting distances of 20 feet between vines have two distinct disadvantages: longer time of recovery of investment and greater impact of loss of plants within a vineyard. Plants are the cheapest part of the investment in a vineyard. If plants are spaced at 20 feet, they should be 10 feet from posts, spaced 20 feet apart in the row for efficient hand harvest with catch-frames.

Following measurement for post and plant location, but before actual planting is done, install the irrigation system (drip or micro-jet). Row length should be maintained between 200 to 300 feet to ensure adequate pressure within low-pressure tubing. Controls for the system should be placed underground in valve boxes to prevent damage to the system.

Use either drip emitters or micro-jet emitters. If soils are sandy and irrigation water is abundant and cheap, micro-jet emitters are preferred as they provide more thorough coverage of the soil.

Trellis wires should be g-gauge, high-tensile steel wire, smooth or crimped. Wire should be permanently attached to one end and loosely stapled to interior posts. Attachment at the far end should be amenable to loosening as wires must be stretched each year following pruning.

Planting And Training

Planting should be done in the spring using dormant plants or during the growing season using potted plants. Holes should be dug by hand or by using a tractor-driven auger. Augured holes may have hardened sides in some soils. Depth of the hole should be about 8 inches with a diameter of 6 to 8 inches. Under dry conditions, pour about a gallon of water into the planting hole before planting. To encourage vigorous growth of the new plant, prune off all branches and suckers, leaving only two to four buds on the main stem. If roots of a plant will not fit within the hole, prune off the excess length. Excessively long roots should not be placed within the hole. Care should be taken to untangle roots if plants are pot-bound. Do not cut roots of actively growing plants. Plants should be planted 1 to 2 inches deeper than they were growing in the nursery or pot and buds should be visible above the soil line. Plants should be watered in immediately. Do not use fertilizer in the hole at planting.

Training Newly Planted Vines. Proper training of the newly set vineyard and pruning of mature vines are extremely important operations. Young vines properly trained and cared for will usually bear an economical crop the third year. If training is neglected, a year's growth or more will be lost even though all other operations are performed.

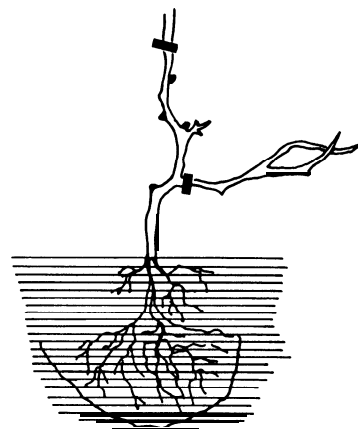
When training young muscadine grapevines, follow as closely as possible the step-by-step procedure listed below:

1. After planting, prune to a single stem and cut the vine back, leaving two to four buds. This step is most important because it balances the root system with the top, limits the number of growing points, and forces new, strong wood that will rapidly develop into a permanent trunk.

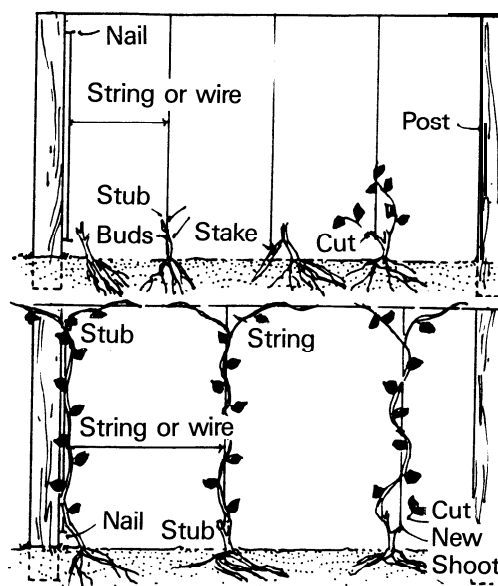
2. Tie a durable string such as nylon or binder twine from the stub of the new plant to the trellis. A soft, small-diameter wire may be used instead of the string. Using bamboo stake instead of the training wire or string is an excellent system that promotes straight trunk development without additional training time.

3. After new growth is about 1-foot long, select the strongest shoot and train it to the string or wire by tying it loosely to the training cord. Remove all the other shoot growth from the plant. Note: some growers prefer to keep two shoots to develop into double trunks. This practice, if done properly and if the tendrils of one trunk are not allowed to girdle the other trunk, offers insurance in later years against winter trunk kill or other injury.

4. As the new trunk grows, tie it loosely to the training cord. Pinch or clip side shoots that develop in the leaf axils. Do not remove leaves growing on the main trunk until it reaches the trellis wire. This training process must be repeated once every 2 or 3 weeks throughout the first



Plant pruned to four buds at planting time.



Methods of training a young vine.

summer. If the trunk does not reach the wire the first summer, cut it back during the dormant season (early spring) and start again with step 1.

5a. Steps For Vertical One-Wire Trellis Training: When the new trunk reaches the trellis wire, pinch it back to 4 inches below the wire to encourage branching. Tie a string from the top of the vine to the wire and place enough tension on the string to straighten the trunk. Train one new branch to each trellis wire to form the permanent fruiting arm.

5b. Steps For GDC Training: When the trunk shoot reaches 18 to 24 inches below the trellis wires, pinch it to force branching. To support the developing trunk shoot and lateral shoots from the head of the vine until they reach outer trellis wires, position a 1-foot stake 3 to 5 inches from the base of the vine with a small nail driven into the side. A string fastened to the two top wires of the trellis can be attached to a second string originating from the stake below to make a support string in the shape of a Y (be sure to leave enough slack in the upper horizontal string so that the junction of the Y will be 18 to 24 inches below the top wires). A bamboo stake can be used for the tail of the Y with string attached to the top of the stake and tied to the trellis wires.

The point of pinching is particularly important for muscadines that are to be harvested mechanically because the vine trunk may be split by the harvester if the trunk shoot is pinched too high. The first branching point must not be above the pivotal point of the trellis arm.

Select two shoots to grow up to the trellis wires (cordon wires). When this growth stage is reached, pinch the shoots 2 to 3 inches below the wires to force lateral shoots. Select two shoots for training to each trellis wire to form permanent fruiting arms. You will be selecting a total of 4 shoots to form the vine's four permanent arms.

6. Train the fruiting arm along the wire by tying it loosely to the cordon wire as it grows. Do not prune back side shoots on the permanent fruiting arms until the dormant season.

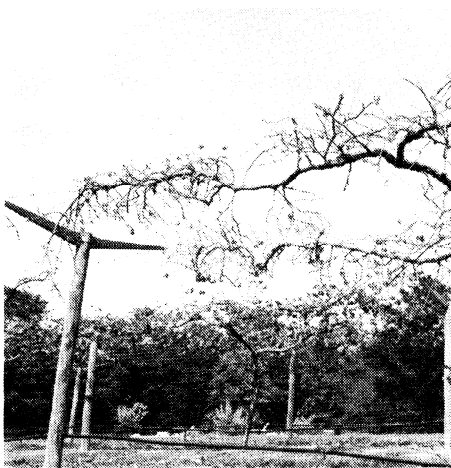
7. Allow the fruiting arms to meet halfway between the vines and pinch each shoot tip when it reaches 10 feet in length (usually the second year) to form the permanent cordon fruiting arms.

Fertilizer should be applied to the plants about 2 weeks after vine growth starts at the rate of 1/4 pound of 10-10-10 banded in a circle 6 inches from the plant. A second and third application may be made at the same rate 6 and 12 weeks later.

Pruning

Pruning of the past season's growth must be done each winter between December and March to ensure a high-quality crop and vigorously growing vines. Pruning is done to balance vine vigor (growth) with fruit production. The goal of the grape grower is to maximize production without compromising fruit quality. Failure to prune for even 1 year makes production difficult. Farmers may be tempted to prune very little, but although this will result in the largest crops, the quality of the fruit will suffer, and management becomes more difficult.

An unpruned muscadine vine eventually becomes a mass of tangled, unproductive, and diseased growth that is impossible to manage and har-



Muscadine vine trained to a double-curtain system. Single curtain systems are usually easier to manage

vest. A vine that is fully established and trained to a trellis system requires annual pruning, usually in late February or March, to maintain productivity. The objectives of pruning include removal of dead, damaged, or otherwise undesirable wood. Pruning also regulates vegetative growth and maintains the quality and quantity of the crop.

Pruning consists of three distinct operations: (1) pruning the previous season's growth (1-year-old) to fruiting spurs; (2) spur thinning (removing parts of some spurs and, in some instances, all of others to lessen crowding); and (3) removal of tendrils to prevent girdling.

Removal Of Previous Season's Growth. A short spur has two or three buds and a long spur has four or more buds. Varieties such as Fry that exhibit low vigor generally should be pruned to short spurs. High-vigor varieties such as Carlos, Tarheel, or Regale and irrigated vineyards on good sites may be pruned to long spurs. Typically spurs are pruned to 4 to 5 inches in length.

Theoretically, vines with longer spurs (canes) yield more, but they must have the capacity to support the increased shoot growth and adequately mature—the greater fruit load that results from leaving the spurs longer. Vines that are pruned to long spurs must also be grown in good, high-fertility soils and must never be subjected to drought stress.

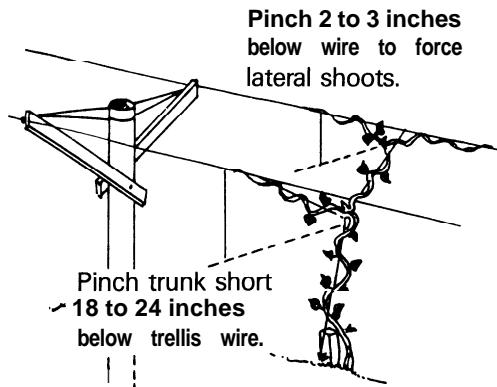
Spur Thinning. Spur size is compounded with each annual pruning, and the cordons begin to crowd after 4 or 5 years. Gradual thinning of spurs each year after the third bearing season will minimize yield reductions caused by the spur wood removal. Removal of spur clusters in an alternating pattern each year allows for thinning and spacing without excessive yield loss.

Removal Of Tendrils. It is essential that all tendrils that are wrapped around permanent vine structures such as cordons or spurs be removed to prevent girdling and death of important plant parts. Tendrils are difficult to cut. A sharp knife is the best instrument for the job. Tendrils also are difficult to see; take care to assure that they are not overlooked.

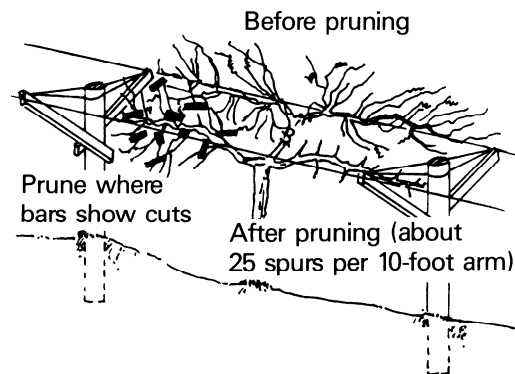
The three pruning operations should be done sequentially: first, prune to the desired spur length; second, thin the spurs; then remove the tendrils.

Season One Pruning, Season Two Growth

If the vines grow enough in the first season to establish cordons, pruning to spurs along the cordons may be done. New growth occurs primarily from buds on the previous season's growth, so each bud has the capacity to produce a new stem and possibly one to four flower clusters. To ensure good vine structure, the lateral stems growing off the cordons should be pruned to spurs of no more than three buds. In the spring of the second growing season, as these buds break and produce new shoots, all flower clusters should be removed. This will allow the young vines to put all of their resources into producing the largest vine possible. Fruiting in the second year is futile and can stunt a vine. Vines that did not reach the trellis wire should be pruned off to two buds and retrained to the wire in the second year. Stretch trellis wires if they are not taut and are beginning to sag.



Training vine on a Geneva double curtain trellis.



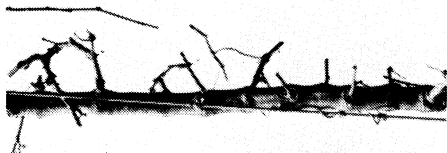
Pruning a mature muscadine grape vine.

At bud break in the second year, plants should be fertilized at the rate of 1/2 pound of 10-10-10 per plant, banded along the row. Repeat this application at 6 and 12 weeks later. Irrigate and maintain weed control as before.

Season Two Pruning, Season Three Growth

Prior to bud break, canes should be pruned back to three buds per cane with a maximum of three spurs per node. At bud break, apply 3/4 pound of 10-10-10 fertilizer, side banded. Two more applications at the same rate should be made 6 and 12 weeks later. Irrigate and control weeds as needed. Some fruit may be harvested in the third year.

a.



b.



c.



Spur-pruned vines. a. Young cordon; b. old cordon; c. close up of three bud spurs.

Season Four Onward

Prune the vines after the third season of growth as before. Fertilizer application should follow the same timing, increasing to about 1 pound per application. For best results, leaf samples should be taken from the vineyard in alternate years and sent off for laboratory nutrient analysis. This is done by taking about ten leaves (blade and petiole) from ten to fifteen healthy plants throughout the vineyard. Follow lab recommendations for increasing or decreasing fertilization and liming.

Beginning in the first season of growth, it is safe to use some pre-emergence herbicides. These herbicides will save you money and effort by preventing the growth of annual weeds. Incorrect use of some pre-emergence herbicides may result in damage to muscadine roots. Some pre-emergence herbicides may not be used in the first two seasons. Care should be taken with all herbicides. Read and follow the instructions on all pesticide labels.

Pruning Neglected Vines

Unless a vine is pruned yearly, fruit-bearing wood develops farther and farther away from the main trunk. Eventually there is only a thin layer of new growth over a mass of tangled, nonbearing wood. The objective is to get this fruiting wood back near the original fruiting arms and trunk. This will promote greater annual yields, better disease and insect control, easier management of the trellis, and easier harvesting.

Neglected vines can be brought back into production by cutting away most of the permanent fruiting arm and leaving only a 6-inch cordon renewal spur at the head of the trunk for each arm of the vine that requires renewal. Use one of the new shoots that will arise from the renewal spur area for training into a new fruiting arm (follow step 6 under Training Newly Planted Vines).

An arm can also be renewed with a vigorous shoot that originated near the head of the trunk. By selecting this shoot before the vine is pruned, a 3- to 6-foot length of new arm can be attached to the wire after the old arm is removed. This renewal procedure reduces the amount of training required during the following summer and should hasten the return to full production.

If more than one vine is involved, cut back half the vines the first year and the remainder the second year to avoid losing the entire crop. In many instances, setting new vines may be preferable to renovating arms of

vines that have been poorly trained and do not have good trunks and fruiting arm structures.

Propagation

In the past, muscadines were propagated by the technique of layering. Layering can be done in the vineyard in the spring before muscadines leaf out by digging a 4- to 5-inch-deep trench close to a healthy vine and pegging down an unpruned cane. As the buds break and new shoots emerge, gradually cover the bases of the new shoots. Roots will form at the base of each of these new shoots. In the fall or winter, separate the plants by using a sharp-pointed shovel, digging in between each new plant. Vine replacement can also be achieved in such a manner. Dig a trench where the replacement is needed, covering all but the tip of the cane. It is very important that missing vines are replaced as quickly as possible to achieve maximum yields in a vineyard.

Muscadines can also be propagated using softwood cuttings taken after flowering in the early summer. This requires the use of a mist bed system and a partially shaded site.

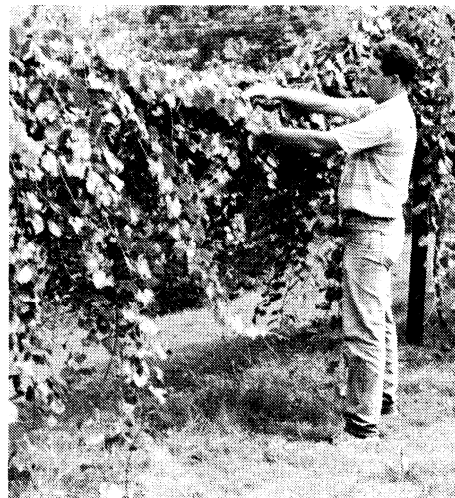
Harvesting

Characteristics That Affect Harvesting. Muscadine clusters are small, usually containing six to twenty-four berries. Mature berries of most cultivars do not adhere to the stems as do those of bunch grapes, and berry fall or shattering of early ripening berries results in crop loss.

The muscadine's long flowering period, from early May until mid-June, often results in uneven berry ripening. The main crop is set over 3 to 4 weeks. Individual clusters may contain flower buds, flowers, and small berries at the same time. Clusters bloom in order beginning with the cluster nearest the base and progressing outward to the cluster at the tip of the shoot. Another characteristic that affects harvesting is berry tear (wet stem scars). Berries often tear at the point of attachment to the cluster. Berry maturity affects the amount of tear. Fully mature berries usually fall with dry stem scars. Berries harvested before they are fully ripe have wet stem scars. The percentage of berries with dry stem scars is higher for some cultivars; for example, Carlos and Southland. If a vineyard is being established for fresh market sales other than pick-your-own or roadside stands, consider planting varieties with the highest percentage of dry stem scars; otherwise, harvesting whole clusters may be necessary.

Harvesting Determination. Optimum quality, yield, and pack out can only be achieved by carefully monitoring your crop's maturity to insure timely harvest. Maturity for fresh market and processing is determined by analyzing the juice of sample berries for pH, total acidity, and Brix (sugar content).

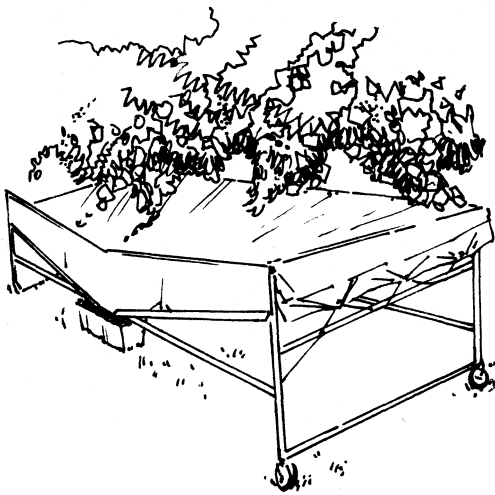
Harvest berries when juice pH ranges from 3.2 to 3.4. At this pH, total acidity values for most varieties range from 0.3 to 0.5. Soluble solids (sugars) usually range from 15 to 19 percent. At this point let your processor know--if you are dealing with a processor--that your muscadine crop is approaching proper maturity and arrange to harvest when delivery can be accepted. If the processor is more than 6 hours from the vine-





This home-made catching frame can be hung on the wires and each arm jerked to loosen berries. A 10 x 20-foot burlap or canvas sheet spread under the vines on each side can also be used to catch the berries. Motor-driven machines with hand-held rubber-finger shakers and catching frame are available for limited acreage. Over-the-row mechanical harvesters are used for large commercial acreage.

(Source: University of Arkansas)



This portable catch frame can be rolled under vines. Berries are caught and then released through a shuttle into a bucket under the frame.

yard and the berries cannot be transported in a refrigerated vehicle, harvest at night so that the berries can be transported with a minimum of field heat.

Sample each variety separately. Collect one cluster from each tenth vine of each variety. Sample only primary set clusters, the first or second clusters from the base of the shoot. Select sample clusters from different positions along the trellis wires. Do not sample end vines, vines on outside rows, or vines near trees.

Harvesting For Fresh Market. Flavor and attractiveness are the key determinants of harvesting for fresh market. Fruit of high quality can be obtained with hand harvesting. Prolonged ripening of berries permits harvesting of top quality berries over a longer period. If acreage or time constraints make once-over harvesting necessary, recognize up front that this practice is at best a compromise for fresh market. Some fruit will not be at the optimum stage of maturity and a grading line will be necessary to remove the under- and overripe fruit.

Grapes for the fresh market should be cooled to 33 to 36 °F immediately after harvesting and maintained at that temperature. Proper refrigeration can maintain muscadine quality for up to 14 days.

Catch-Frame Harvesting. Catch-frame harvesting is practical in vineyards that are too small to justify the investment in a mechanical harvester. Frames have been designed for muscadines grown on the GDC or on the two-wire vertical and single-wire trellis types.

The catch-frames fit beneath the vines and collect the berries as they fall. Berries usually are shaken from the vine by striking the trellis wire with a padded club. The catch-frame funnels them into a suitable container. Catch-frame harvesting is labor intensive and requires four or five people for maximum efficiency. Average time required for one vine ranges from 3 to 7 minutes.

Machine Harvesting. Several mechanical harvesters are adaptable for harvesting muscadines grown on the GDC or the two-wire vertical trellis or the single-wire trellis. These machines can harvest without excessive berry damage. However, harvesters are very expensive and are practical only for large acreages.

Diseases And Insect Pests

Muscadines have a high degree of resistance to pests and diseases, especially Pierce's disease, which severely limits production of bunch grapes in the South. Primary disease problems of muscadines are fruit rots, especially black rot, bitter rot, ripe rot, and macrophoma rot. If severe, angular leaf spot may cause leaf abscission (shedding), resulting in smaller berries and lower sugar content than from healthy vines. Powdery mildew has also been reported as a problem on certain cultivars. Eutypa dieback can also be a problem in certain vineyards. These diseases have been controlled with cultural practices and fungicides, although the number of fungicides registered for use on muscadines has decreased in recent years.

Insect control is primarily limited to grape root borer. Control of this pest is extremely difficult because of the subterranean feeding of larvae on root and the lack of distinct early symptoms. Early claims that muscadines were immune to grape root borer have been shown to be erroneous. No complete control strategy has been developed, but partial control is

achieved with a soil drench of chlorpyrifos insecticide (Lorsban-4E) around the trunk, in combination with cultural practices such as weed control and temporary soil mounding. Pierce's disease is carried by sharpshooter leafhoppers, but control of these insects is difficult. Other pests, such as mites, aphids, grape flea beetles, grape curculios, and grape berry moths are occasional problems and are controlled only if significant injury is observed.

Growers should obtain the current issue of Circular ANR-478, "Small Fruit Integrated Pest Management," recommendations for insect, disease, and weed control for Alabama.

Bunch Grapes

The principal factor limiting bunch grape production in Alabama is Pierce's disease. This disease is caused by a bacterium that occurs naturally in weeds in the vineyard and is transferred to grapevines by leafhoppers and spittlebugs. **DO NOT** attempt to grow most bunch grapes south of Birmingham because of the very high probability that they will be killed by this-disease. South of Birmingham plant only the Pierce's-disease-resistant cultivars listed in Table 2.

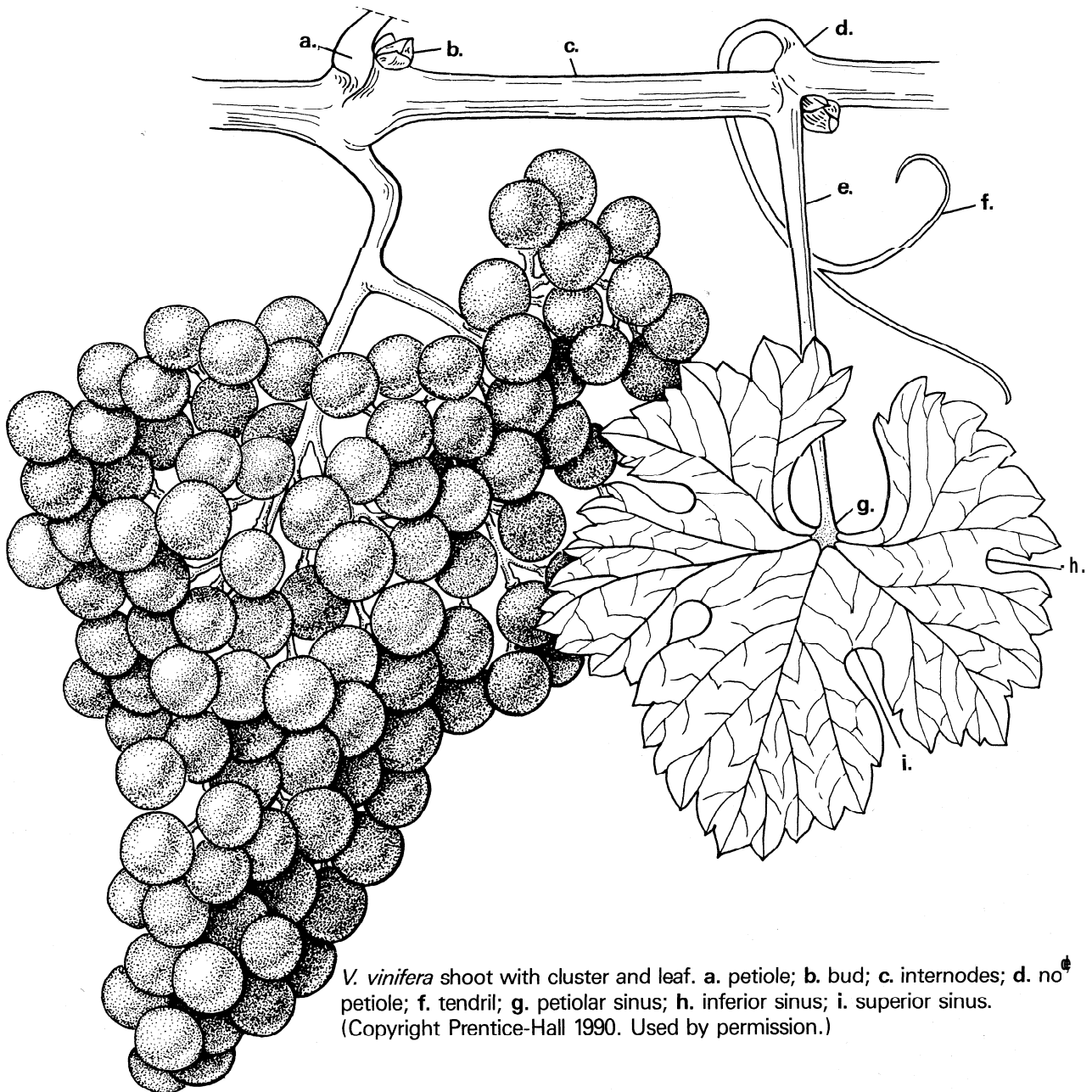
The American bunch grape cultivars such as Concord or Niagara are often thought to be derived mostly from the native *Vitis labrusca* L. species commonly known as the "fox grape." However, most American cultivars are hybrids among a number of native species. Many of these also contain some of the European type *Vitis vinifera* L. germplasm. The term bunch grape refers to the fact that these cultivars have berries that are borne in a cluster and have a concentrated harvest period during which the entire cluster, or bunch, is harvested as a uniformly ripe intact unit. In contrast, muscadine cultivars are harvested as individual berries that ripen over an extended harvest period.

Table 2. Self-Fertile Bunch Grape Cultivars Worthy Of Trial In Areas Affected By Pierce's Disease

Variety	Color	Expected Uses					
		White Wine	Red Wine	Pick-your-own Blue	Pick-your-own White	Fresh Market	Juice, Jelly
Blanc du Bois	white	X					
Blue Lake	blue						X
Conquistador	blue		X	X		X	X
Lake Emerald	white	X					
Lenoir (Black Spanish)	blue		X				X
MissBlanc	white	X					
MissBlue	blue		X				
Orlando Seedless	white				X	X	
Stover	white	X			X		
Suwanee	white	X			X		X

The Vinifera

The various forms of the vinifera, European, or Old World, grape, which have been grouped under the species *V. vinifera* L., is of somewhat uncertain lineage. This species is believed to have originated in the region south of the Caspian Sea in Asia Minor, from where it has been widely disseminated. *V. vinifera* L. grapes not only furnish the major world production, but they have also played a vital part in the improvement of native American types. There are an estimated 5,000 named cultivars, such as Cabernet sauvignon, Pinot noir, Thompson Seedless, and the 41 B rootstock. The cultural range of *V. vinifera* L. grapes is limited mainly by climatic factors. In general, they require a long growing season, relatively high summer temperatures, low atmospheric humidity, a ripening season free from rain, and mild winter temperatures (Table 3).



V. vinifera shoot with cluster and leaf. a. petiole; b. bud; c. internodes; d. node; e. petiole; f. tendril; g. petiolar sinus; h. inferior sinus; i. superior sinus.
(Copyright Prentice-Hall 1990. Used by permission.)

French-American Hybrids

Hybridization of native American species assumed importance in France when the devastations by the grape phylloxera insect made necessary the grafting of *V. vinifera* L. onto resistant roots in the last quarter of the nineteenth century. To combine the most desirable characteristics of different species, interspecific crosses were made between various native American species and between *V. vinifera* L. and the American species. An extension of the early work resulted in the production through breeding of the so-called “direct producers” or “French hybrids,” which would combine the resistance of the American species with the fruit qualities of *V. vinifera* L. As a result of these crosses, many of the French hybrids combine the excellent wine quality of the European *V. vinifera* L. with the hardiness and insect and disease resistance of the wild American species, making them a versatile choice in many geographical areas. In regions where early spring frosts are common, French hybrids exhibit an important advantage over American cultivars. They have the ability to produce a commercial crop from secondary and even tertiary buds if the primary bud, or its developing shoot, is destroyed by cold weather. However, the high degree of fruitfulness of primary shoots along with the growth of fruitful adventitious (unplanned) shoots typically poses a problem of overbearing. Some of the best performing cultivars in the South have been Villard blanc, Chancellor, Chelois, and Cascade.

Rootstocks

The use of rootstocks is a standard practice for grape propagation in most areas of the world where *V. vinifera* L. grapes are grown. The resistance of grape rootstocks to pests or environmental stresses is relative. Injury is simply less with resistant or tolerant rootstocks than would typically be experienced by *V. vinifera* L. roots. With several factors influencing the performance of rootstocks, they need to be examined in many different situations before a final judgment is made on their ability to perform. It should be recognized that no universal rootstock is good for all conditions. There are several reasons for using rootstocks for *V. vinifera* L. cultivars. Primary among them are the extreme susceptibility of the roots to the attack of phylloxera and nematodes. Other important characteristics for rootstocks may include the following:

- Drought, salt, limestone, and soil flooding (wet feet) tolerance.
- Iron chlorosis resistance.
- Resistance to diseases such as oak root fungus and cotton root rot and to viruses such as fanleaf, stem pitting, corky bark, and tomato ringspot.

Rootstocks are also used to impart or decrease vigor in scion cultivars along with hastening or delaying fruit and vine maturity. Vigor control is a very important vineyard management concept and may affect such wide-ranging elements as yield and fruit quality to winter hardiness and vine survival. Other factors, such as cold tolerance, soil type performance, ease of rooting of the cuttings, and budding and grafting compatibility, are also important.

Table 3. Characteristics Of Eastern Bunch Grape Cultivars.

Cultivar	Ripening Seasona	Colorb	Principal UseC	Winter Hardiness
American Hybrids				
Alden	M	B	D	Fair
Alwood	V E	B	D	Fair
Beta	E	B	DJ	Very good
Blue Bell	E	B	D	Good
Buffalo	E	B	D	Fair
Caco	L	R	D	Good
Catawba	L	R	W	Good
Cayuga White	M	W	W	Good
Concord	L M	B	DJ	Good
Cynthiana	VL	R	W	Good
Delaware	M	R	W	Good
Diamond	M	W	W	Good
Dutchess	L M	W	W	Fair
Edelweiss	V E	W	D	Very good
Elvira	M	W	W	Good
Festivee	L M	B	D	Poor
Fredonia	V	B	DJ	Good
Isabella	E M	B	W	Fair
Ives	L	B	W	Good
Kay Gray	V E	W	D	Very good
Monticello	E	B	D	Fair
Moored	L	R	D	Fair
New York Muscat	E	B	D, W	Fair
Niagara	L M	W	W, J	Good
Norton	VL	R	W	Good
Ontario	V E	W	D	Good
Price	V E	B	D	Good
St. Croix	V E	B	D, W	Very good
Schulyer	V E	B	D	Fair
Seneca	V E	W	D	Poor
Sheridan	L	B	D	Good
Steuben	L	B	D	Good
Swenson Red	V E	R	D	Very good
Urbana	L	R	D	Good
Valiant	V E	B	D	Very good
Van Buren	V E	B	DJ	Good
Veeblanc	M	W	W	Good
Ventura	L M	W	W	Good
Vinered	L	R	D	Good
Worden	V E	B	D	Very good
Yates	L	R	D	Good
French-American Hybrids				
Aurore (Seibel 5279)	V E	W	W	Good
Baco Nor (Baco 1)	E M	B	W	Fair
Cascade (Seibel 13053)	V E	B	W	Good
Chambourcin (J. Seyve 26-205)	L	B	W	Poor
Chancellor	L M	B	W	Good

Cultivar	Ripening Seasona	Colorb	Principal UseC	Winter Hardiness
	French-American		Hybrids	(cont.)
Chardone1 (Seibel 7053)	L	W	W	Good
Chelois (Seibel 10878)	M	B	W	Fair
Colobel (Seibel 8357)	L M	B	W	Poor
De Chaunac (Seibel 9549)	M	B	W	Good
Horizon	M	W	W	Good
Leon Millot (Kuhlman 194-2)	V E	B	W	Good
Marechal Foch (Kuhlman 188-2)	V E	B	W	Very good
Melody	L M	W	W	Fair
Rayon d'Or (Seibel 4986)	M	W	W	Good
Rosette (Seibel 1000)	L M	B	W	Very good
Rougeon (Seibel 5898)	M	B	W	Good
Seibel 10868	M	W	W	Fair
Seyve-Villard 23-512	M	W	W	Fair
Seyval (Seyve-Villard 5-276)	M	W	W	Fair
Verdelet (Seibel 9110)	M	W	W	Poor
Vidal blanc (Vidal 256)	L	W	W	Fair
Vignoles (Ravat 51)	M	W	W	Fair
Villard blanc (Seyve-Villard 12-375)	L	W	W	Fair
Villard noir (Seyve-Villard 18-315)	L M	B	W	Fair

aRipening Season: = VE = very early; E = early; M = mid; L = Late.

bColor: B = blue, black; R = red; W = white, green.

cPrincipal Use: D = dessert; J = juice; W = wine.

Row And Vine Spacing

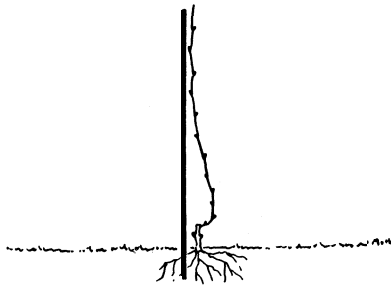
Numerous arbitrary formulas have been recommended in the past for the spacing of vines and rows in commercial vineyards. The most efficient and practical spacing depends on many factors and may change dramatically with climate, site, cultivar, and equipment. The row spacing is determined by equipment size, particularly tractor widths. As a general rule, row spacing has been governed by machinery width, while vine spacing has been governed by cultivar vigor.

The relative spacing of vines in the row has traditionally been determined by the expected vine size and vegetative vigor of a particular cultivar. For example, *very* weak *V. vinifera* L. cultivars such as Muscat Ottonel may only successfully support about twenty buds, and such vines may be planted about 3 feet apart. Moderately weak vines such as Gewurztraminer will support twenty-five buds and could be planted 4 feet apart. Cultivars of medium vigor such as Muller-Thurgau could be allowed thirty-five

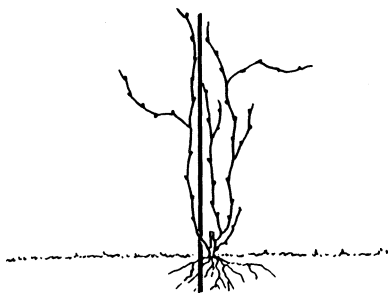
buds and planted 5 feet apart, while the vigorous Cabernet Sauvignon may support fifty buds and might be planted 6 feet apart in many areas. The number of buds per unit length of row for each of the examples above is about the same at six to eight buds per foot. In the case of American and French hybrid vines, the number of buds retained per foot of row typically ranges from three to eight depending on vine size and cultivar fruitfulness. For example, a moderate-sized Concord or Catawba vine might optimally support six buds per foot, while Aurore or Seyval of similar size vine may only adequately sustain five buds per foot.



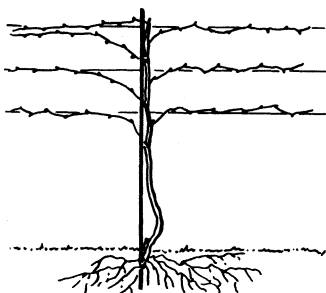
At planting



First season's growth



Spring, second season



Second season's growth

The close spacing of vines increases the number of nodes (buds) per unit area of land. This trend will produce a yield increase up to a point where shoot crowding and shading begin to reduce the fruitfulness of the vines. Early work in Michigan showed that Concord vines with a vigor greater than 2 1/2 to 3 1/2 pounds of pruning weight per vine became overly vegetative and unfruitful using the spacing and training systems of that era. Even though this extra wood production has the potential for increasing the yield, the poor-quality buds being produced in the shaded canopy had fewer and smaller clusters.

Row spacing depends in part on the proposed training and trellising system and, in part, on the equipment to be used in the vineyard, including the possible use of a mechanical harvester. An 8-foot row spacing is satisfactory for small plantings but is considered too restrictive for most commercial operations. In the eastern United States a 9-foot spacing between rows is common and generally ample, but 10 to 11 feet between rows may be needed to accommodate large equipment on steep slopes.

Managing Young American And French Hybrid Vines

First Year. Putting fertilizer in the furrow during planting is not advisable because of the danger of injuring roots. It is unnecessary if the soil was properly prepared. If needed, approximately 4 ounces of 10-10-10 fertilizer, or an equivalent, can be applied to the soil surface around each vine immediately after planting. However, the hazard of overfertilization and stimulation of later summer growth with increased susceptibility to winter cold damage is greater than the hazard of inadequate growth during the first year.

As soon as bud break occurs, the newly set vines, if not pruned before planting, should be pruned to the best single cane. If a trellis is to be constructed early in the first growing season, as recommended, this best single cane should be tied to the lower wire of the trellis. When the new shoots are an inch or less in length, all but two to four strong shoots near the top of the cane should be rubbed off to promote growth in height and to avoid the growth of unwanted shoots along the trunk.

As the season progresses, the retained shoots should be tied loosely to the trellis for better light exposure, to avoid damage by equipment, and to facilitate pest control. Flower clusters that develop should be removed as early as possible through mid-summer. Timely flower-cluster removal, tying, and shoot removal will require two or more trips through the vineyard during early and mid-summer, depending on the cultivar.

If no trellis is to be constructed for several months or excess shoot and flower-cluster removal cannot be accomplished in a timely manner, the best cane should be pruned to two buds immediately before or after planting. Preventing weed competition close to the vines during the first two growing seasons is critical for early profitable vineyard production.

The primary objectives in training a young vine in the first year are the development of a large, healthy root system and straight, semipermanent trunks. The shaping of the aboveground parts of the vine, according to a particular training system, is of secondary importance. During the first and second growing seasons, these objectives can be accomplished by eliminating or reducing the crop and increasing the leaf area. The same treatment rejuvenates very weak vines of any age.

Second Year. During the dormant period following the first growing season, the best cane should be retained to form one trunk and to take it to the top wire if possible. At the time of bud burst, six to ten shoots should be retained on the upper portion of this single trunk if training systems such as GDC, single-curtain cordon, or umbrella Kniffin are being considered, or at the proper position for arms of other training systems. All other shoots should be removed so that the growth will be concentrated in shoots located in positions most useful for 'future training. During the second growing season, all the flower clusters should be removed from the growing shoots as soon as they develop. This, of course, eliminates the crop for the year but ensures greater development of the vine's roots and top.

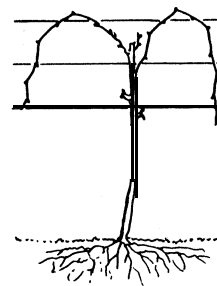
Third Year. Vines that have grown enough to produce $\frac{3}{4}$ pound or more of prunings during their second year should be balanced pruned (see pages 28-29) and fruited in the third year. However, it is important that these immature vines have the flower clusters thinned to prevent overcropping.

In areas where trunk injury is a problem, a second cane, preferably a sucker, should be pruned to the bottom wire. All but two or three shoots near the top of this cane should be removed shortly after shoot growth begins; this cane will become the second trunk. The double trunk training system can also be established earlier by allowing two main shoots to develop from the crown (near ground level) after the first year of growth.

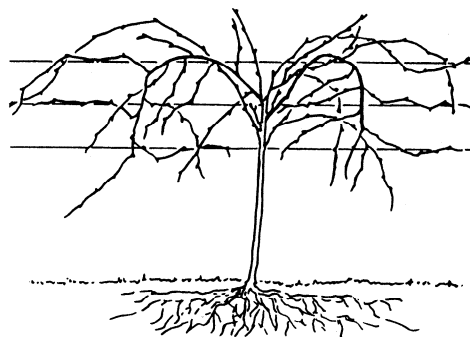
When vines produce less than $\frac{3}{4}$ pound of prunings in their second or subsequent growing seasons, the second-year treatment should be repeated: flower clusters should be removed to promote greater vine growth.

Trellis Systems

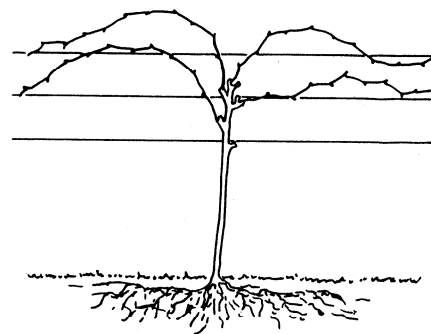
Eastern United States. Most vertical trellises for commercial vineyards in the eastern United States are of the same general type: two or three wires, one above the other, stretched tightly on firmly set posts. Two wires are adequate for single-curtain cordon, umbrella Kniffin and four-arm Kniffin, the most common systems; but three wires are necessary for some other training systems. For average-sized vines the top wire of the trellis should be $5\frac{1}{2}$ to 6 feet above the ground. This permits cane distribution that encourages good exposure to sunlight and facilitates insect and disease control. The bottom wire should be approximately 3 feet above the ground to facilitate mechanical harvest.



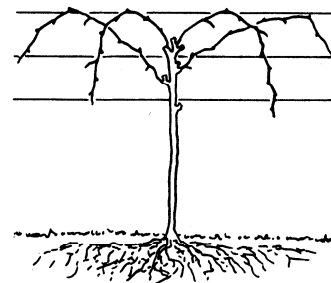
Spring, second season



Winter, third season

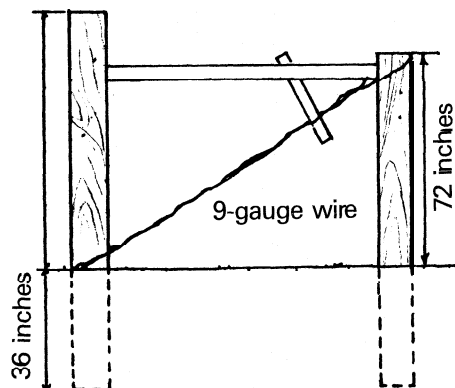


Spring, fourth season



Spring, fourth season

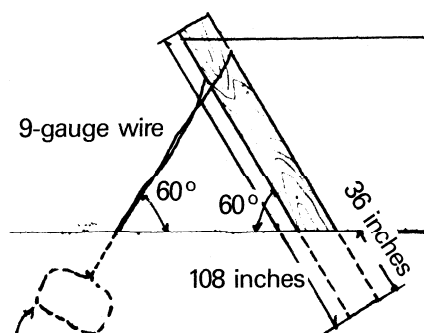
GDC training requires one trunk-support wire plus two horizontal and parallel cordon-support wires, positioned 4 feet apart (for 9-foot rows) and 6 feet above the vineyard floor on metal or wood arms attached to line posts. The arms are usually bolted to the line posts, inclined upward at about a 35° angle, and are free to move vertically up at their outer ends for mechanical harvesting. Row spacings of less than 9 feet will necessitate reduced space between cordons to permit harvester and other equipment use without excessive damage.



The H end post bracing.

Line Posts. Line posts should be 8 feet long with a minimum top diameter of approximately 3 inches. They should be driven or set 24 to 30 inches in the ground, depending on the trellis height desired. Tractor-powered posthole augers and post drivers are used for installing posts. Line posts are usually spaced so that there are three or four vines between posts; the exact distance between posts varies, depending on vine spacing, but should not exceed 24 feet if excessive sagging of the crop-supporting or cordon wire is to be avoided.

End Structures. End structures should not move when the trellis is subjected to the stress of large crops, wind, and wire contraction in cold weather. If movement occurs, the result will be crooked trunks, sagging cordons, less-efficient mechanical harvest, and the need for retensioning trellis wires. Therefore, end posts should be larger than line posts and preferably longer so that they can be set 3 to 4 feet in the ground, and endposts should be anchored or braced. Eight-foot, round, pressure-treated posts with a top diameter of 4 inches have been satisfactory for single-curtain-trained vines when secured to an external anchor. However, if GDC training is a possibility, larger posts are advised.



Rock, concrete deadman, or screw anchor
The inverted V bracing system for end posts.

The stability of an end post is increased by driving or setting the post so that the aboveground part is angled away from the vineyard at about 30° from the vertical, reducing the height of the top wire at the end post, and bracing or, preferably, anchoring it. A common method of bracing uses an extra line post to extend obliquely from a point midway up the end post to the base of the first line post. The outside angle formed by the end post and the brace should be at least 135° to avoid a lever effect, which may lift the end post from the ground when the top trellis wire is tightened. The brace should be spiked or otherwise secured in place, or mechanical harvesting is likely to dislodge it. Braces are advantageous if headland is limited, but sometimes braces will interfere with mechanical-harvester collector plates.

Even though they are susceptible to damage by equipment, anchors are generally superior to bracing. Screw-in anchors, a metal plate welded to a steel shank, and a concrete dead-man attached to a steel shank or heavy wire are all common anchors. Buried railroad ties and old gas or oil line pipe have also been used successfully. Screw anchors of 4 to 6 inches in diameter are the most popular and, with a simple adapter, can be screwed in with tractor-mounted posthole augering equipment in most soils. Anchors that require augering holes or ditching should be installed before the ground freezes in the fall. The soil is permitted to settle and pack before the connecting guy wire, cable, or rod is attached to the post, and the trellis wire is tensioned the following spring.

The anchor should be installed 4 feet away from the base of the post. With straight, vertical end posts, anchors should be placed at about a 45° angle toward the end post and aligned with the row to minimize interference with equipment entering and leaving. The holding resistance of the anchors will vary by type, size, depth, soil type, and other factors. A minimum depth of 4 feet should be the goal and has generally been adequate.

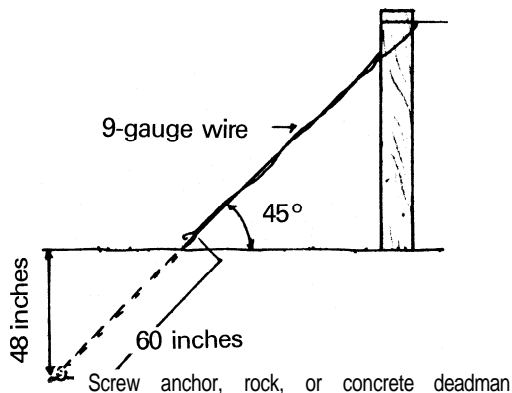
Wire. The most generally used crop-support wire has been No. 9 (steel wire gauge) black annealed wire. However, the increased use of GDC training and other cordon training systems, as well as the need to reduce labor, require a more durable wire. The wire must retain its tension without annual tightening, provided that the end structures do not move. A No. 11, crimped, high-tensile (210,000 psi) steel wire, with class III galvanizing, meets this need most economically. The larger No. 10 wire of the same type is also available and widely used, but No. 11 is adequate.

The lower wire on the trellis is an aid in maintaining straight trunks, tying up trunk renewal canes and shoots, and securing (tying) the ends of canes to enhance cane distribution on the trellis. The stress on this wire is much less than on the crop-supporting wires, so it can be of lower tensile strength and cost. No. 9 black annealed wire is satisfactory for the lower wire; however, uncrimped (straight) No. 11 or 12 galvanized fence wire is more durable and is recommended because it reduces wire chafing on 1- to 3-year-old trunks.

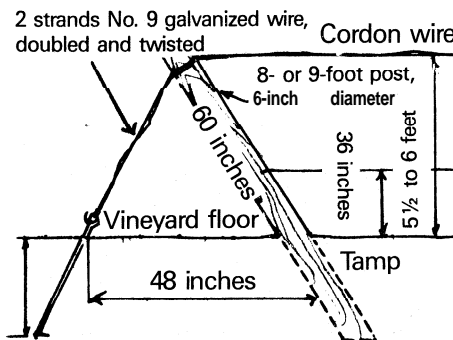
The weight of wire needed for an acre depends on wire size, row number, row spacing, and the amount of waste. For a 9-foot row spacing, approximately 4,900 feet of wire is needed per acre for each trellis wire. Thus a two-wire trellis will require about 9,800 feet of wire. The weight of wire of various sizes required for one strand per acre is given in Table 4.

Wire Installation. The high-tensile No. 11 or No. 10 crimped crop-support wire should be installed 5½ to 6 feet above the vineyard floor. For nondivided training systems on well-drained soils where heaving of posts is unlikely, this wire can be stapled loosely to the top of the line posts with 1¼ to M-inch fence staples. On poorly drained soils, freezing and thawing usually cause heaving, which necessitates periodic repounding of the posts. Here, wire can be stapled in a groove in the top of the post or should be stapled loosely to the windward side and 2 to 3 inches below the top of each line post with 1 to 1¾-inch fence staples. Staples should be driven into the posts far enough to hold the wire close but not so tight as to prevent drawing the wire through the staples for tensioning or retensioning, in the event that end structures move or the wire stretches. The lowest wire of a nondivided trellis is similarly stapled to the line posts at a height of 30 to 36 inches from the vineyard floor. If there is a third wire, it is typically located midway between these two.

For GDC training, the two cordon and crop-support wires are attached at the ends of the supporting arms by metal clips, hooks, or chain links, depending on arm design. First, however, the arms should be secured to the line posts at a height that will position the taut wires 6 feet above the vineyard floor. A lower wire height will reduce training and pruning



Vertical end post with anchor screw and wire.

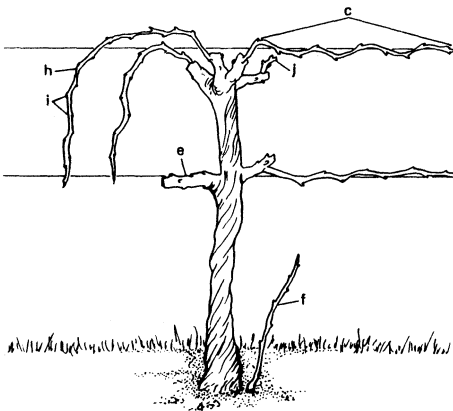


Specifications for a recommended end-post anchoring system.

options and result in machinery damage to cordons and vertical arms. A higher wire will reduce the harvesting efficiency of current mechanical harvesters. The trunk-support wire should be loosely stapled to the line posts, either just above or just below the point of arm attachment. Vine trunk training for efficient pruning mechanization and vertical movement of the arms during mechanical harvesting requires this high trunk-support wire.

Table 4. Description Of Gauges Of Wire Typically Used In Trellis Construction,

Wire Gauge No	Approximate ft./100 lb.	Approximate lb./acre for one wire with 9 foot rows
12 straight	3436	143
11 straight	2632	186
11 crimped	2584	190
10 straight	2079	236
10 crimped	2000	245
9 straight	1730	283
8 straight	1443	340



Pruning

Pruning refers to removal of canes, shoots, and other vegetative parts with the following objectives:

- Establishing and maintaining the vine in desired shape and form.
- Distributing the bearing units over the vine for economic production.
- Controlling the crop.
- Concentrating the growth of the vine into its permanent arms and bearing units.

A vine can properly nourish and ripen only a certain number of clusters and canes. Pruning is done according to the capacity of the vine (potential for bearing a crop) and its vigor (rate of growth).

Terminology Of Pruning. The following terminology of parts of a vine is used in relation to training and pruning.

Arms: The main branches of the trunk.

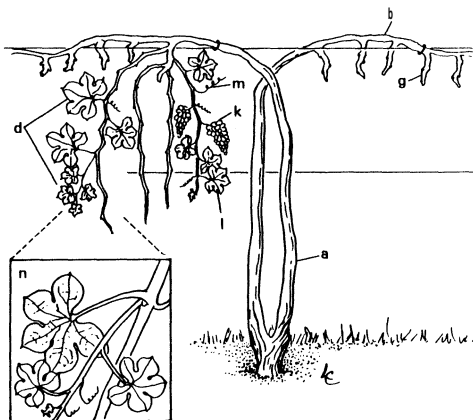
Base bud: A bud in the axil of a bract at the base of a cane that is not borne at a clearly defined node on the cane. Shoots that arise from these buds are often unfruitful.

Base shoot (also referred to as a watersprout): A shoot from a bud at the base of a cane or previously removed shoot or cane. The base shoot may be found on trunks, cordons, arms, and at the base of canes. The base shoot is often extraneous and, unless needed for renewal or fruiting, should be removed during the process commonly referred to as “suckering.”

Bud: A compressed shoot. In the axil of each leaf is the compound bud or eye containing the primary, secondary, and tertiary buds.

Cane: The lignified, brown, mature shoot that has become woody.

Canopy: The entire shoot-leaf complex of the vine; it can be defined in terms of its height, width, and division.



General structure of a grape vine: a. trunk; b. cordon; c. cane; d. shoot; e. arm; f. sucker; g. spur; h. cane; i. internode; j. renewal spur; k. cluster; l. leaf; m. tendril; n. summer lateral shoot.

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Capacity: The quantity of total growth and total crop of which the vine or part of the vine is capable of producing.

Cordon: Extension(s) of a trunk, usually horizontally oriented and trained along a wire. Fully developed cordons can bear arms, spurs, base shoots, and canes. The cordon can be unilateral or bilateral (that is, it can extend from the trunk in either one or two directions).

Curtain: A length of canopy that may be shoot positioned. The curtain can constitute a portion of the canopy as for GDC training or can be synonymous with the canopy as for nondivided cordon-training systems (single-curtain).

Fruiting spur: The basal portion of a cane normally pruned to one to two buds.

Head: The top of the trunk and short upper arms.

Internode: The portion of a cane or shoot between nodes.

Laterals: The side branches of a shoot or cane.

Node: The thickened part of the shoot or cane where the leaf and its compound bud are attached.

Renewal spur: A cane cut back to one to two buds at a place on the arm close to the spur that will be replaced, or where the growth of shoots for a fruiting cane for the subsequent year is desired.

Shoot: The leafy growth (leaves and stem) developing from the bud in spring.

Spur: A cane pruned to one to four nodes.

Sucker: A shoot from a bud below ground.

Trunk: The main unbranched stem of the grapevine.

Vigor: Rate of growth, quality, or condition that is expressed by parts of the vine.

Vine size: Often expressed as the weight of cane prunings on a vine.

Watersprouts: Shoots arising from buds on the trunk.

Pruning Principles

Aspects Of Pruning. Pruning is simply the act of removing unwanted parts of the vine. The objective of pruning is to produce the maximum yield of good-quality mature grapes while maintaining adequate vine size, vigor, and fruiting wood quality for the following year. In many cases, this involves removing 70 to 90 percent of last year's vine growth during the winter pruning operation. Proper pruning of the vine in the dormant season is essential in matching cropping level to vine vigor (size). Careful selection of high-quality canes and the retention of proper bud numbers directly influences yield, fruit quality, vine vigor, and bud and trunk hardiness. Two basic aspects of pruning are vine shaping and growth regulating. Vine shaping involves pruning so that the vine can be arranged on the trellis for maximum exposure of the leaves to light and to aid in other operations, such as insect and disease control, cultivation, and harvesting. The second aspect of pruning is used in crop regulation, which controls not only size, but to a large extent the quality of the crop.

Bud Quality, Number, And Distribution. When selecting the best possible canes and buds to be retained after pruning, consider bud quality, bud number, and bud distribution. Bud quality of the dormant canes is determined by the sunlight exposure of the leaves that subtended (surrounded) those buds the previous summer. The leaves that originate from shoots on the outer layer of the canopy intercept most of the light striking the vine. Those buds that occupied the best light-exposure position are the most fruitful, so the best fruiting canes should be selected from the outside of the canopy (the top and sides of the trellis). Unless the vine was shoot positioned, interior canes are inferior because they were partially or completely shaded by the leaves of shoots growing outside or above them. In addition to having the highest fruiting potential, these “sun canes” also mature earlier and more completely than canes in the interior of the canopy, making their buds somewhat more winter hardy.

The best-quality canes also have darker cane color and thicker diameters. In general, normal canes with the largest diameters have the greatest fruitfulness. Very large “bull canes,” which made excessive growth the previous summer, are usually not fruitful. However, if they have well-developed lateral branches, fruitful buds can be retained on these laterals.

In regard to cold hardiness, observations suggest that the largest canes of cold-tender cultivars are more susceptible than medium-sized canes to winter injury. As a general rule, wood that is the diameter of a pencil is a good choice for selecting buds with maximum winter hardiness. When comparing canes of the same cultivar, diameter, and color, the shorter or medium-size internode lengths have higher quality buds. The internode length is a direct reflection of good or poor sunlight exposure during the previous growing season. This same effect is seen in the long spindly growth of house plants that are kept in low-light conditions. Certain cultural practices (including balanced pruning to 30 + 10) that favored vine size maintenance and consistent production of ripe fruit also favored cold hardiness of the primary bud of Concord.

The number of buds retained at pruning will be determined by vine size and vigor as evidenced by the weight of 1-year-old canes on the vine and by the cultivar. In balanced pruning, the grower is striving for maximum yields of acceptable quality fruit without a reduction in cane maturity, vine vigor, or winter hardiness in succeeding years. In pruning, it is important to be looking ahead at least 2 years.

The final consideration in effective pruning is bud distribution. It is important to provide a systematic and uniform distribution of the fruiting wood that we retain. This is of primary importance in maximizing light exposure on the developing shoots as well as affecting fruit and vine maturity, insect and disease control, and harvesting. The goal is to distribute the buds uniformly so as to occupy as much of the trellis space allotted for each vine as possible. Various training systems contribute to the distribution of buds, with each having its own advantages and disadvantages.

Balanced Pruning. A system called balanced pruning relates the capacity of the vine to bear fruit with the number of count nodes (buds) to be retained on canes and spurs on the vine. Vines pruned in this man-

ner are called balanced because the process of economic importance to the grower (fruit yield and quality) is in balance with the process of biological importance to the vine (shoot and root growth and carbohydrate storage in the plant). Balanced pruning involves removing a portion of a vine and leaving a calculated number of buds for fruit based on the amount of 1-year-old wood produced during the previous growing season.

Under vineyard conditions this is accomplished by leaving buds slightly in excess of the estimated final number on the vine, while all other 1-year-old wood is cut into manageable lengths and bundled for weighing. It is important to note that no 2-year or older wood is included in the calculation, so 1-year-old canes must be weighed separately from all other prunings. The bundle of canes is weighed with a small hand scale to determine how many pounds of wood were produced by the vine during the previous growing season. For example, using the 30 + 10 system, a bundle weighing 3 pounds would indicate the need to leave a total of 50 buds for fruit production the next season. Thirty buds are retained for the first pound of prunings plus 10 additional buds for pounds number 2 and 3, for a total of 50 buds. For example, if a vine were estimated to have 2 pounds of prunings, it would require 40 buds. Seventy-five buds might be left on the vine and the rest pruned off. If, in this instance, the canes actually weighed 2 pounds, then the pruner would remove 35 of 75 buds remaining on the vine, leaving a total of 40. If, however, the canes weighed 3½ pounds, then 55 buds would be retained. In areas where high light intensities prevail, a pruning formula of 50 plus 10 with a maximum of 90 buds is typically used.

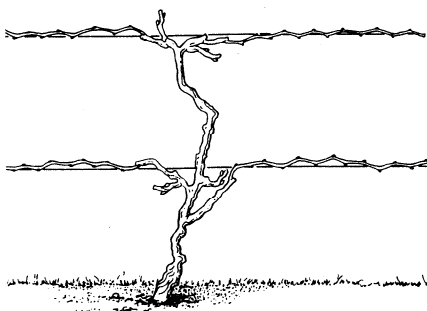
The average grapevine may have 200 to 300 buds on mature canes capable of producing fruit. Typically only 40 or 50 buds may be left for fruiting, as dictated by the balanced pruning formula. Pruning too lightly (leaving too many buds) will lead to excessive shoot numbers, shading and poor shoot development, excessive crop levels and reduced fruit quality, soluble solids, winter hardiness, and vine vigor. On the other hand, excessively severe pruning that leaves too few buds is undesirable because it leads to unnecessarily low yields, limited leaf area, excessive shoot vigor, and potential wood maturity and winter hardiness problems along with decreasing vine size.

Overcropping leads to delayed or inadequate fruit maturation, reduced vine size (hence reduced yield potential), and reduced wood maturity. The latter consequence is especially significant in regions where low winter temperatures occur. Although the wood may appear well matured, the starch reserves in crop-stressed vines can be so low that vegetative growth the following season may be severely depressed. Extreme cases of overcropping may produce symptoms such as tendril abortion, lack of continued shoot growth, and possibly poor foliage condition and premature leaf fall. Undercropping has an obvious direct economic disadvantage, but more subtle vine responses are also encountered. As a crop is reduced below vine capacity vegetative development is enhanced. Excessive vegetative development leads to intracanalopy shading, which further reduces vine productivity. The combination of shade and prolonged shoot elongation precludes adequate wood maturation.

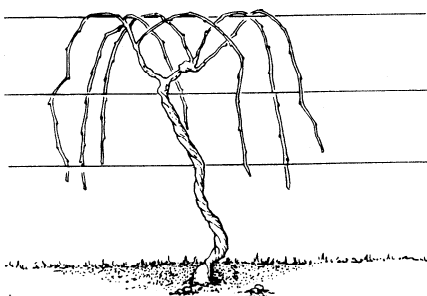
Training Systems For American And French

Hybrid Grapes

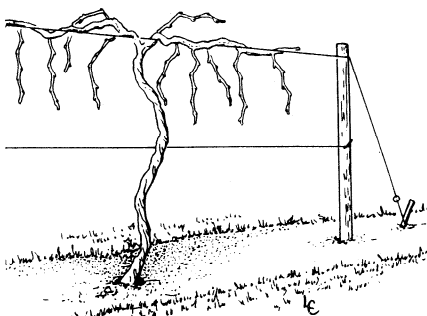
Conventional training of eastern grapevines has been to the Kniffin system. The three modifications of this system that are in use are: four-arm Kniffin, six-arm Kniffin, and umbrella Kniffin. With the development of new knowledge about the fruiting habit of the grape and the use of the mechanical harvester, other systems have been developed and widely adopted. These include the fan and GDC and single-curtain cordon systems. The selection of the best system depends on the cultivar being grown, type of harvester to be used, condition of the trellis, fertility of the soil, and personal preferences.



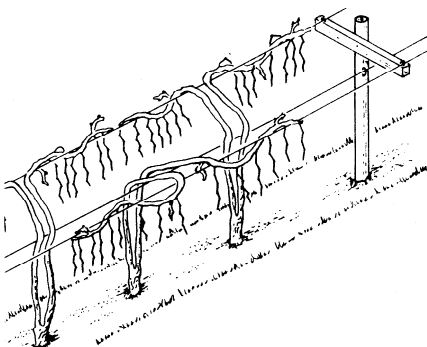
a.



b.



c.



d.

Common grapevine training systems: a. four-arm kniffin; b. umbrella kniffin; c. single-curtain cordon; d. Geneva double curtain (GDC).

Four-Arm Kniffin. This system is characterized by the four short arms from which the fruiting shoots arise. The arms, two on each side of the trunk, are developed from the trunk extensions and renewal spurs and provide fruiting wood for the following year. All surplus wood is pruned away each year. If the vine can support more than four canes, the canes should be left on the top wires because they will be more productive than those arising lower on the trunk.

Six-Arm Kniffin. This system differs only slightly from the preceding one. It permits more canes to remain on the vine by tying them to each of the three trellis wires. In general, both of these systems tend to standardize the training procedure for routine pruning and handling of the vines.

Umbrella Kniffin. The mature vine trained according to this system consists of a single trunk trained to the top trellis wire, then headed out at this point or from 4 to 5 inches below the wire. All canes used in training originate near the head of the vine near the top wire, are allowed to droop down, and are tied to the lower wire or wires. With care, the canes are bent rather sharply, just enough so that the outer bark cracks. The purpose of cracking the bark is to induce more vigorous growth from the buds behind the bend rather than allowing growth to develop at the cane tip. Overall fruitfulness is presumably increased. The number of canes will vary from four to six, depending upon the size of the vine.

Fan System. In the colder climates where trunk injury is more likely to occur, a multiple-trunk system is still found in some vineyards. In the fan system, three or four trunks are tied to the lower wire, which makes it possible to detach the trunks easily from the trellis for burying in winter for cold protection. Greater labor requirements for tying, untying, burying, and suckering on multiple trunks are the disadvantages of this system.

GDC (Geneva Double-Curtain). This system, developed at the New York Agricultural Experiment Station at Geneva, represents one of the best methods of training Concord and other cultivars. It is especially adapted to mechanical harvesting and the utilization of high vine vigor. This system can increase vine productive capacity and at the same time maintain or even improve fruit and vine maturation. Better maturation and increased yields are made possible by shoot and leaf positioning, which exposes a greater proportion of the leaf area to sunlight. Vine vigor and the principles involved in balanced pruning are also fundamental concepts of this system.

Single-Curtain Cordon. The single-curtain cordon training system is also known by other names, such as Hudson River umbrella, top wire cordon, bilateral cordon, and the no-tie system. In this system, the trunk is extended up to the top wire and horizontal arms are established on the top wire. There may be some variation in the number and lengths of canes, renewal spurs, and the amount of tying required. This system incorporates many of the same pruning and training features as the GDC system, except that it is developed on a standard two- or three-wire trellis and, as the name indicates, has only a single-curtain of foliage. The trunk of the single-curtain cordon trained vine is attached to the top trellis wire and is approximately 6 feet high. Two horizontal cordons are then developed along the top wires and extended 4 feet in each direction. If the vineyard is converted from one of the Kniffin training systems, 1-year-old canes are positioned along the top wire to develop into cordons in future years. Extra canes should be retained during this transition year to maintain the balanced pruning concept.

Secure the cordons to the top wire by plastic ties or other similar material. Care must be taken to see that the cordon is not girdled by the ties as it increases in size. One advantage of the single-curtain system compared to the Kniffin systems is a reduction in tying time.

Like the GDC system, five-bud canes are selected from the cordon, plus adequate single-bud renewal spurs. Shoots are later positioned downward for maximum exposure to sunlight during the growing season and also to facilitate the pruning operations.

This system is suitable for low- to moderate-vigor vineyards. For high-vigor vineyards, the GDC system is recommended because it allows essentially twice the amount of surface area per vine as the single-curtain system—8 feet per cordon as compared to 4 feet. Modifications of this system are known by other names. The Hudson River umbrella system, for example, uses long canes (8 to 12 buds instead of 5 buds), which are tied to the bottom wire.

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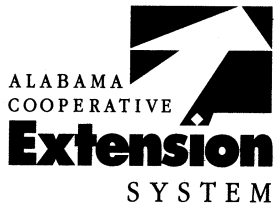
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This publication was written by David G. Himelrick, *Extension Horticulturist*, Associate Professor, and W. A. Dozier, Jr., Professor; both in Horticulture at Auburn University.

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