HS763

UF UNIVERSITY of FLORIDA
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The Muscadine Grape[1]

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Introduction

The muscadine grape (*Vitis rotundifolia* Michx.) is native to the southeastern United States and was the first native grape species to be cultivated in North America. The natural range of muscadine grapes extends from Delaware to central Florida and occurs in all states along the Gulf Coast to east Texas. It also extends northward along the Mississippi River to Missouri. Muscadine grapes will perform well throughout Florida, although performance is poor in calcareous soils or in soils with very poor drainage. Most scientists divide the *Vitis* genus into two subgenera: *Euvitis* (the European, *Vitis vinifera* L grapes and the American bunch grapes, *Vitis labrusca* L.) and the *Muscadania* grapes (muscadine grapes). There are three species within the *Muscadania* subgenera (*Vitis munsoniana*, *Vitis popenoei* and *Vitis rotundifolia*). *Euvitis* and *Muscadania* have somatic chromosome numbers of 40 and 38, respectively. Vines do best in deep, fertile soils, and they can often be found in river beds.

Wild muscadine grapes are functionally dioecious due to incomplete stamen formation in female vines and incomplete pistil formation in male vines. Male vines account for the majority of the muscadine grape population. Muscadine grapes are late in breaking bud in the spring and require 100-120 days to mature fruit. Typically, muscadine grapes in the wild bear dark fruit with usually 4 to 10 fruit per cluster. Bronze-fruited muscadine grapes are also found in the wild, and they are often referred to as scuppernongs. There are hundreds of named muscadine grape cultivars from improved selections, and in fact, one that has been found in the Scuppernong river of North Carolina has been named Scuppernong. There are over 100 improved cultivars of muscadine grapes that vary in size from 1/4 to 1 inches in diameter and 4 to 15 grams in weight. Skin color ranges from light bronze to pink to purple to black. Flesh is clear and translucent for all muscadine grape berries.

One reason for the popularity of muscadine grapes is that they are a sustainable fruit crop in the southeastern United States. They are tolerant of insect and disease pests, and homeowners can successfully grow muscadine grapes without spraying any pesticides. The commercial acreage in Florida is small (< 500 acres). The most successful commercial plantings are comprised of large-fruited cultivars that are destined for the fresh market. U-Pick operations are common, and many growers market their product directly to the consumer using roadside markets, farmers markets, local sales and

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other direct-to-consumer marketing strategies. Commercial muscadine vineyards that have been based on juice or wine grapes have generally not been profitable because of low prices offered for muscadine grapes destined for processing.

Cultivars

Two categories of muscadine grapes will be discussed—recommended cultivars, and those that are suggested for trial plantings. The vegetative and reproductive characteristics of recommended cultivars of muscadine grapes have been extensively tested in the southeastern United States and have stood the test of time. Many new cultivars appear to have good potential, but they have not been extensively tested, particularly in respect to consistent yield production. The performance of many grape cultivars in Florida is listed in Tables 1 to 3. The majority of muscadine grape cultivars are not recommended in Florida due to a variety of reasons including low or inconsistent yields, small berry size, poor flavor and/or thick skin, disease susceptibility or a low percentage dry scar. The characteristics of most important muscadine cultivars are summarized in table 4.

A cultivar good for fresh market consumption should be large, sweet, and attractive with a relatively thin skin. Yields should be consistently moderate to high and vine vigor and disease resistance should be satisfactory. Many are female cultivars with imperfect flowers and require a pollenizer. Female cultivars possess stamens that are not completely developed and are non functional. Self-fertile cultivars tend to yield 40–50% higher than female cultivars.

A cultivar adapted for processing into wine, juice or jelly must produce consistently high yields. Berries should contain at least 14 Brix, should have a favorable sugar-acid ratio and should taste good. Berry ripening should be uniform so that multiple harvests are not required. Juice and wine grapes (particularly red-skinned grapes) must have a high degree of color stability. Berry appearance is not critical. Mechanical pruning and harvesting must be employed for large-scale production due to a low return historically (10 to 20 cents/pound) for grapes destined to be processed.

Recommended Cultivars for Fresh Market

Black Beauty: Black Beauty is a pistillate cultivar that is patented. It produces an attractive, very large, black berry grape of high overall quality. Berries are crunchy when ripe. It has a medium-high % dry stem scar. Vine vigor and yield are moderate, and harvest is mid season.

Black Fry: Black Fry is a pistillate cultivar that is patented. It produces a large, black berry. Berries have a medium % dry stem scar. Vine vigor and yield are in the moderate range. Harvest is early to mid-season. It is reported to have leaf disease problems (Krewer 2000).

Fry: Fry is the most popular muscadine grape cultivar. It is female and produces a very large, bronze grape. Yield, vigor and disease resistance are moderate. The period from first ripening to last ripening can extend to 6 weeks.

Granny Val: Granny Val is patented and produces an extremely heavy yield and extends the harvest season into late September and October. In some years, it can overproduce and stress the vine. Berries are bronze, but are not quite as large or sweet as Fry. It has a high % dry stem scar when fully ripe. Cordon dieback has been a problem. Due to tendency to overcrop, Granny Val should be pruned to 2 node spurs.

Farrer: Farrer is a patented cultivar. It is a female cultivar that has produced well at the NFREC-Monticello. It produces a large, purple grape that is somewhat more elongated and much sweeter than Jumbo.

Pam: Pam is patented. It is a pistillate cultivar that produces a very large, yellowish bronze grape with a mild muscadine flavor. It has a good flavor and is attractive. Yield is moderate and vine vigor is high. Harvest is mid-season.

Pineapple: Pineapple is patented. It is self-fertile and produces a medium-large, bronze grape. Vine vigor and yield are moderate and harvest season is mid- to late-season. It may have a tendency to over-crop. It is reported to have a pineapple flavor, but it was hard for the author to detect.

Polyanna: Polyanna is self-fertile and produces a medium-large, dark purple grape. Yields have been rated moderate to high. Berry flavor is very sweet and berries are attractive. It has a high % dry stem scar. Vigor is medium-high and harvest season is medium to late. Polyanna has potential as a pollenizer for pistillate cultivars.

Southern Home: Southern Home is a patented, interspecific *V. rotundifolia x V. vinifera* hybrid that has considerable ornamental value owing to a bilaterally convex leaf with deeply cut sinuses. It produces a black berry with a cluster size of about 12. Berry size is medium, and berry flavor is non-muscadine. Yield is moderate to high, and ripening period is from August to November.

Summit: Summit is an excellent fresh market bronze cultivar. It is a pistillate cultivar that produces a medium-large grape that is very sweet. Vigor is high and yield is moderate to high. Yields and disease resistance are higher than those for Fry, although berry size is slightly smaller. Summit has a dry stem scar. It has a mid harvest season.

Supreme: Supreme is patented and it is a pistillate cultivar. It produces a very large, dark purple grape that is very sweet. Yields have been high in southern Georgia. It is low in vigor and vine mortality may occur if vines are allowed to over produce. Vines should be pruned to 2 node spurs to avoid overcropping. Harvest is mid- to late-season.

Sweet Jenny: Sweet Jenny is a patented cultivar. It is pistillate and produces a very large, bronze grape early in the season. Vine vigor and yield are moderate. Disease resistance has been reported to be low to moderate, and berry blemishes were more apparent than on other cultivars.

Tara: Tara is a self-fertile cultivar that produces a large, bronze grape. Vine vigor and yield are moderate. It has an early- to mid-season harvest. Tara has a dry stem scar. Tara has potential as a pollenizer for pistillate cultivars.

Recommended Cultivars for Processing into Wine, Juice and Jellies

Alachua: Alachua produces a medium-sized black berry. Vines are self-fertile, productive and medium-high in vigor. Berries ripen uniformly mid-season. Berries have a medium-high % dry stem scar. The fresh market potential of Alachua is limited due to lack of a competitively sized berry.

Carlos: Carlos is an extremely heavy producer of medium-sized, bronze grapes. It is self- fertile and will provide the tonnage and quality required for juice or wine production. Carlos is the number one bronze juice or wine grape in the southeastern United States. In years of heavy production and/or drought or mineral stress, it has shown symptoms of Pierces disease.

Noble: Noble is the most popular red muscadine grape for wine or juice production. It is self-fertile. Yields and disease resistance are high, and berry ripening is fairly uniform. Flavor is less musky than most muscadine grapes. Good color stability. Good wine grape.

Welder: Welder is a bronze grape that also produces a good juice and wine. Yield is moderate, and the berry ripening period can be very extended such that three harvests may be required.

Fresh Market Cultivars Recommended for Trial:

African Queen: African Queen is patented. It is a pistillate cultivar that produces a large, black grape. Quantitative yield data are lacking for Florida, although yield has been erratic in southern Georgia. It ripens mid season and has a dry scar.

Big Red: Big Red is patented. It is a female cultivar that produces a very large, red grape. Quantitative yield data are lacking for Florida, although yields have been erratic in southern Georgia. Vigor is very low. It ripens mid to late season and percentage dry scar is high.

Creek: Creek produces a small, purple berry that is higher in acid than most muscadine grape cultivars. Berries have a low % dry stem scar. Vine vigor and yield are moderately high and ripening season is late.

Color stability for juice or wine has not been tested to our knowledge.

Darlene: Darlene is a patented cultivar. It is a pistillate cultivar that produces a very large, pink grape. It ripens early to mid season and vine vigor is high. Quantitative yield data are lacking for Florida, although yields have been erratic in southern Georgia.

Doreen: Doreen is a self-fertile cultivar that produces a large crop of small to medium-sized berries. Harvest season is late. Quantitative yield data are lacking for north Florida. Doreen is reported to be one of the best cultivars for juice production.

Early Fry: This is a patented cultivar that resembles Fry, but ripens earlier. It is a pistillate cultivar that produces a dark bronze fruit. Vine vigor and yield were rated low in north Florida, although yield estimates appear high in southern Georgia (Krewer 2000).

Florida Fry: Florida Fry is self-fertile and produces a medium-large, bronze grape. It is sweet and has a dry stem scar. Harvest season is mid- to late-season. Vine vigor is moderate. Yield is expected to be moderate to high, but quantitative yield data are lacking.

Golden Isles: Golden Isles is a self-fertile cultivar that ripens mid season. Berries are small to medium in size and taste is non muscadine for a muscadine grape. Quantitative yield data has not been collected for Florida.

Ison: Ison is a patented, self-fertile cultivar that produces a moderate to large, black grape. Yields are said to be high, although we have not seen quantitative data. Harvest season is early and vine vigor is high.

Nesbitt: Nesbitt produces a black grape that is medium-large in size. Yields are high and crop is late to mid season. This is a multi-use grape for fresh market or processing.

Propagation

In the wild, muscadine grapes are propagated sexually from seed and asexually by a natural tendency of shoots that make contact with the ground to form roots. Muscadine grapes are very easy to propagate asexually. Asexual propagation produces a plant that is genetically identical to the mother plant. Propagation from seed will produce plants that vary genetically and that are not true to type. The most common propagation method is to make 2- to 3-node-long cuttings from shoots 1/4 to 3/8 inches in diameter in June or July. Simply insert the basal end of the cutting in a light textured soil or potting media. Keep the roots and leaves moist until roots have formed (usually about 2 weeks). A mist bed can be inexpensively constructed for this purpose. The buds in the leaf axils will break and form shoots shortly thereafter. Dipping the basal ends of the cuttings in Rootone® or other formulations of napthelene acetic acid can enhance rooting percentages, but is not required.

Another method to asexually propagate muscadine grapes is called pegging. To use this method, wound a low growing shoot by making successive cuts in the bark and then cover it with moist soil. Leave the shoot tip exposed. After about a month, roots should have formed, and the shoot may be severed from the mother vine. Pegging can be done in the summer months and is most useful to propagate a few vines. For mass propagation, stem cuttings are preferable. Virtually hundreds of cuttings can be rooted from a single mother vine.

Planting

Muscadine grapes are adapted to a wide range of soil conditions. Ideal soils are loamy sands and sandy loams, although clay soils and sandy soils are also satisfactory with proper irrigation and drainage inputs. In sandy soils, muscadine grapes will require more frequent irrigation because of the reduced water-holding capacity of the soil. Low-lying areas should be avoided because they are associated with poor air circulation and water drainage that contribute to increased probability of frost injury and waterlogging, respectively. The most critical elements to success of newly planted and young vines is irrigation and weed control. Bare-root vines should be planted December through February, whereas container-grown vines can be planted throughout the year provided that they receive adequate irrigation.

A hole should be dug to accommodate the entire root system: usually about 2 feet deep and 2 feet wide. Commercial growers often subsoil to a depth of 1 to 2 feet prior to setting the posts. Several nursery growers recommend planting muscadine roots in 3-feet-long, 1-foot-deep trenches. In the case of extremely long roots, it is probably preferable to cut them rather than have them circled around extensively in the planting hole. Planting distances and configurations are dependent on vineyard design.

Vineyard Design

Muscadine grapes can also be planted in an arbor configuration for home fruit production, or in a traditional post-and-wire configuration. A multitude of customized designs can be employed for an overhead arbor, typically with a 7- to 10-feet height requirement. The arbor can include sides or sides down to a certain height. Archways can also be included. Muscadine grapes are fast growers, and after only three years, a grape can easily cover a 6-foot by 15-foot horizontal area. Several cultivars could be planted together to enhance the duration of ripening period and also to provide a variety of grape sizes, colors and flavors.

The three most common vineyard designs are: 1) a single-wire design for vines destined to be trained to a bilateral training system 5 to 6 feet above the ground; 2) a two-wire vertical design with two wires at a height of approximately 3 and 6 feet, and; 3) a two-wire horizontal design whereby vines are trained to two wires two feet to either side of the post at a height of about 5 to 6 feet. This last system is known as a Geneva double curtain system. Plant spacing is dependent on vineyard design but is typically 12 to 20 feet within a row and 10 to 15 feet between a row for bilateral cordon training and two-wire vertical training systems. For vineyards destined to be a Geneva double curtain, the minimum between-row spacing is 12 feet, but 14 to15 feet may be more practical for use of standard farm machinery. The most efficient distance between posts located within a row is about 15 to 20 feet. Establishment costs increase below this post density, and above 20 feet there is too much sagging in the wire. Plant and post density should be the same, and it is advisable to plant vines 1 to three feet away from each post to further minimize wire sagging.

End posts should be 10 feet long and at least 6 to 7 inches in diameter. In-row posts should be a minimum of 8 feet in length and at least 4 to 5 inches in diameter. In-row posts should be planted two feet in the ground, while end posts should be planted to a depth of 3 to 4 feet. End posts should be slanted at angle of 15 to 30 degrees from the vertical away from the vineyard and supported with heavy-duty screw anchors or dead man anchors. Smooth galvanized number 9 wire should be used. Row length should not exceed 600 feet due to maximum load requirements and stretching of the wire. Sixteen- to 24-inch turnbuckles can be placed at various locations to take up wire slack as it occurs over time. This may be preferable to removing and stretching wire every year. Heavy-duty wire staples can secure the wire to the top or the sides of the posts. Grounding rods should ground the wire every 100 feet to minimize losses due to lightening strikes, otherwise the lightening bolt will travel along the entire wire, potentially killing every vine in the row. The three training systems will next be discussed in more detail.

Training

The most simple training system to establish and maintain is the single-wire bilateral cordon training system. After planting, a single, vertical shoot is trained to the wire. Normally at least 3 or 4 competing shoots will emerge from the young plant. Simply select the strongest and straightest. The upward growth of the shoot is supported by a stake or string attached to the wire. Prune off side shoots as they emerge, but do not remove the leaves growing directly on the trunk. During the early summer, the shoot should reach the 5- to 6-foot wire. Promote the formation of straight shoots, since the shoot will harden and become inflexible as it matures. As it reaches the wire, prune the tip of the shoot to facilitate the growth of two side branches to either side of the wire. The upward-growing shoot will become the trunk, and the shoots growing along the wire will become the cordon. Cordon establishment should be completed during the first growing season. Be sure to remove the string from the trunk or any

tags that may girdle the vine. Keep lateral shoots no longer than 1 foot from the cordon to ensure that enough growth goes into cordon formation.

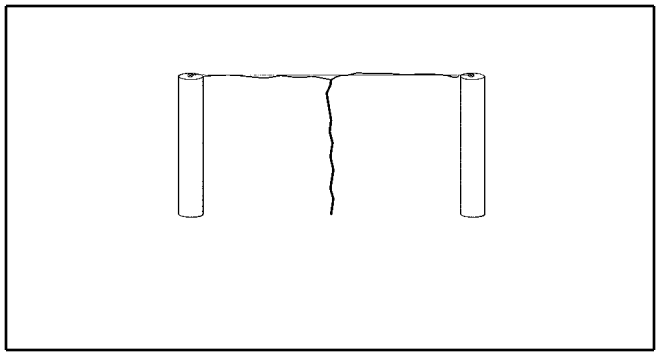

Figure 1. Bilateral cordon training system.

A two-wire vertical system was common about 20-40 years ago but has declined somewhat in popularity because of higher maintenance costs and the extreme difficulty in controlling weeds. With multiple rows, shading is excessive on the lower cordon. Two wires are placed along posts at heights of 3 and 6 feet. Training is similar to the previous method except that the lateral shoots are encouraged and selected at the 3-foot height in addition to the top wire. This system will provide twice the cordon fruiting area as the bilateral cordon method, but cordon maintenance on the lower cordon is a job that requires hands-and-knees labor.

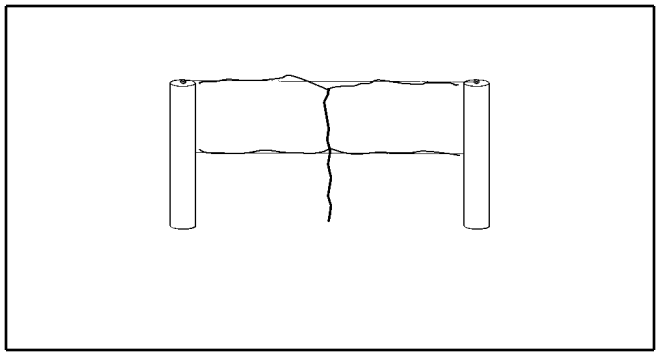

Figure 2. Two wire vertical training system.

The Geneva double curtain system was designed to maximize light interception per acre, particularly in northern grape-growing regions. A V-shaped support system is established about 4 feet above the ground, and a wire traverses the top of each arm of the V at about 5 feet. The top of the V should be about 3 to 3- feet across. The V can be constructed out of metal or a pressure-treated 2 x 4 and fastened to the post with bolts and/or lag screws. Historically, wooden-based structures have only lasted about 5 to 10 years due to wood decay and the strain associated with high crop loads. Metal V frames can be manufactured with a longer life expectancy. The vine is trained to the center wire as indicated for the bilateral cordon training system; however, the vine is encouraged to produce lateral shoots directed toward the top of each V. At that point, the shoot can once again be pinched to encourage lateral branches along the wires located at the top of the V.

The advantages of the Geneva double curtain training system are high per-acre yields and good berry quality, and the avoidance of problems associated with maintaining a lower wire. Disadvantages are higher maintenance costs. Thinning shoots in the head region can be especially troublesome. Long-term yield for 31 cultivars in one study (Andersen et al. 1985) and 23 cultivars in another (Andersen et al. 1992) have produced the following average yields results: Geneva double curtain, 6.4 tons/acre; two-wire vertical, 5.5 tons/acre; and bilateral cordon, 4.5 tons/acre. Regardless of training system, self-fruitful vines tend to out-produce pistillate cultivars by 40 to 50 %. Pruning and harvesting is much easier with the Geneva system. In reality, economic return per dollar invested may be highest for a bilateral cordon training system, especially over the long term. For much of the muscadine growing region, land costs are not particularly high, which is another reason why maximizing yield per acre is not overly critical.

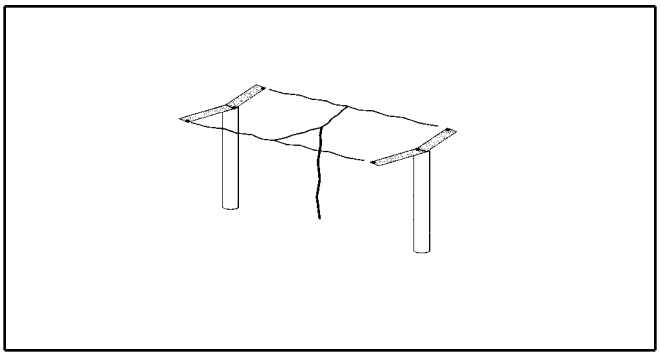

Figure 3. Geneva double curtain training system.

Pruning

The shoots of muscadine grapes arise from buds in the leaf axils of the past seasons growth. The fruit of muscadine grapes is borne in 6- to 12-berry

clusters on the current years growth. Flowers appear after several weeks of shoot growth, usually in late April. Muscadine grapes seldom sustain frost injury in the spring due to the late bloom date. Certain cultivars are susceptible to winter injury, especially if drastic decline in temperature occurs before the vine is acclimated to minimum winter temperatures. Pruning in November or December can exacerbate the degree of winter injury. For this reason, the best time to prune is mid-January to mid-March. When acclimated, most vines can tolerate temperatures down to about 10°F without injury.

After a grapevine has been trained to a desired configuration, it must be pruned to keep it manageable and to ensure maximum vine performance. As indicated above, major pruning is normally done during the dormant season, although touch-up pruning can be done during the growing season. Earlier pruning can sometimes enhance winter injury. You may notice that pruning cuts bleed when soil temperatures are high, but there is no evidence that this is injurious to the vine. In addition, it is necessary to remove shoots that grow within 2 1/2 feet of the ground prior to herbicide application. The standard rule is to allow 2 to 4 node spurs spaced about every 6 inches of cordon. This will allow approximately 120 nodes per bilateral cordon-pruned vine at a 16-foot spacing. For a heavy yielding vine such as Carlos or Noble, it is not uncommon to achieve an average sustained yield of 8 tons/acre, which translates to about 60 lbs/vine at a 10- by 16-foot spacing within and between rows, respectively. A problem invariably encountered over time is that the new nodes that are selected each successive year are located further and further from the cordon. Nodes that emanate on spur locations that are too far from the cordon eventually lose productivity and also result in a vine that is more difficult to manage. Under these situations, spur renewal is recommended every 3 to 6 years so that new fruiting wood never arises more than a foot from the cordon. Spur thinning can be accomplished by removing entire spurs or part of them. After 5 to 10 years, it is not uncommon for cordons to lose vigor or die from disease or winter injury. Simply select another young shoot to train along the wire. It will become your cordon the following year.

In order for muscadine juice or wine grapes to be profitable, mechanized pruning and harvesting is essential. Mechanized pruning can take place with a gas-powered hedge trimmer or chain saw. On a larger scale, sickle bars can be mounted to a tractor in both horizontal and vertical orientations so that all shoot growth more than 8 to 12 inches from the cordons is removed. Mechanized pruning saves a tremendous amount of pruning labor; however, every second or third year it should be followed by touch-up hand pruning. In a 6-year study, Noble muscadine grapes subjected to mechanized pruning displayed a linear reduction in yield and total soluble solids, indicating that vines needed to be reinvigorated by touch-up hand pruning and spur renewal (Andersen et al. 1996). Rather severe hand pruning in alternate years induced alternate bearing where high and low yields were recorded in successive years.

Irrigation

Irrigation is essential during the entire establishment year for muscadine grapes. Irrigation will also be beneficial for fruiting vines. The most critical period for irrigation is May through June. After this time, the quantity of summer rainfall is usually sufficient to meet the vine needs. Drip irrigation is the most efficient form of irrigation. During the first year, one emitter placed within 1 foot of the vine is sufficient. Two additional emitters can be placed about 3 feet to either side of the vine for subsequent years. This is especially advisable for sandy soils where water-holding capacity and the quantity of soil volume is limited. One- or 2-gallon-per-hour emitters are satisfactory. During dry periods, two gallons per emitter per day (2 gallons per vine) is satisfactory the first year, while 4 gallons per emitter per day (12 gallons per vine) is satisfactory for subsequent years. Irrigation to bearing vines should be limited in August and September to facilitate berry ripening and sugar accumulation.

Fertilization

Prior to planting, determine soil pH and soil nutrient status. Soil pH should be in the range of 5.5 to 6.5. To increase the pH by 1 unit, mix about 5 lbs

lime per 100 square feet of soil. To decrease pH by 1 unit, add 1 lb elemental sulfur per 100 square feet of soil. Fertilize soil with 1/4 lb 8-8-8 or 10-10-10 in April after growth begins. Apply the fertilizer in bands about 1 foot to either side of the vine. It is sometimes beneficial to apply fertilizer that has micronutrients added. Repeat this process in June and in August. During the second year, apply to 1 lb of fertilizer in March and again in June/July. In future years, the fertilization rates can increase by 3 lbs of fertilizer during March and June/July.

Weed Control

In Florida, weed control is an extremely critical vineyard operation. A 5- to 6-foot-wide, in-row strip should be maintained free of weeds. Check with your county Extension office each year to obtain a list of herbicides labeled for muscadine vineyards. Pesticide recommendations change each year as labels change and pesticides are removed and added to the agricultural marketplace. It is essential to check yearly to make sure your herbicides are the most effective available. Alternatively, in small vineyards weeds can be manually controlled. Remember that the roots of muscadine grapevines are shallow, and deep cultivation can injure root systems. Weed control is not only beneficial to vine growth and vine productivity, but it also facilitates all vineyard operations.

Insect Control

Muscadine grapevines are tolerant of most insect pests, and seldom are insecticides warranted. Periodically, aphid outbreaks may occur on shoot terminals, but they seldom persist more than a few weeks due to the work of natural enemies. The grape root borer (*Vitacea polistiformis*) is thought to be a significant pest of muscadine grapevine, and may contribute to vine mortality, but good data on its economic impact are lacking. The adult is a moth that resembles a wasp and emerges and lays its eggs at a time of the year dependent on latitude. The larvae bore into roots at the base of the trunks and damage vines by consuming root tissue. An in-row strip maintained weed-free by the use of herbicide is thought to minimize the density of grape root borers in the root. Also, a soil insecticide can be used to control this pest. Monitor and watch for the emergence of the adult insects so that you can time the application of insecticide. For more information, the reader is referred to the EDIS publication ENY802, "Insect Management in Grapes."

Other Animal Pests

A multitude of animal pests consume muscadine grapes, including raccoons, squirrels, crows, opossums, coyote and deer. Moderate to large vineyards can outstrip the ability of animal pests to drastically reduce production; however, small vineyards, particularly when adjacent to woodlands or other good wildlife habitat, can be severely impacted. For this reason and the fact that muscadine grapes perform well only in full-sun, vineyard locations should be away from woodlands as much as possible.

Diseases

Muscadine grapes are one of the fruit crops grown in Florida that is considered a sustainable crop, and many cultivars can be grown completely without pesticides. Some of both the established and recent cultivars are not quite as disease-resistant, so if you are establishing a new vineyard with organic growing in mind, be cognizant of the different levels of disease resistance. Also, if blemish-free berries are desired for fresh market sales in grocery stores, then it may be advisable to spray fungicides.

There are many cultural practices that can minimize the incidence of grape diseases. First and foremost, plant disease-resistant cultivars (See Table 4). Second, choose training systems and use maintenance practices that confer good air circulation. Bilateral cordon systems are much better than Geneva double curtain or two-wire vertical training systems at facilitating air movement through a canopy, and maintaining a clean vineyard floor under the vines also promotes beneficial movement of air. Third, avoid irrigation systems that wet the foliage: instead of overhead systems, use drip or microjet irrigation. Fourth, pick the grape berries at harvest time and remove mummified berries, dead wood and pruning wood from the vineyard.

The most common diseases on muscadine grape berries and/or leaves are angular leaf spot, black rot, ripe rot, macrophoma rot and powdery mildew. Bitter rot can infect all above ground tissue. Black rot and powdery mildew are cool-weather diseases and are easy to control. Bitter rot, macrophoma rot and ripe rot are diseases that occur toward berry maturity, and are more problematic. Anthracnose is a common disease of bunch grapes and is a dominant factor precluding the culture of most bunch grape cultivars; however it is not a major problem on muscadine grapes. A brief description of the diseases will follow. Positive diagnosis can be accomplished by any of the statewide University of Florida Plant Diagnostic Laboratories.

Angular Leaf Spot

Angular leaf spot (*Mycosphaerella angulata*) is a disease that only attacks the foliage and may cause premature leaf drop. This disease appears as angular, dark brown spots surrounded by a halo. Premature leaf loss can result in increased levels of vine stress that may reduce fruit quality and vine longevity.

Bitter Rot

Bitter rot is fairly common and is primarily a berry disease. It is caused by the fungus *Melanconium fuligineum*. Mature fruit are most susceptible, and fruit characteristically have a bitter taste. Symptoms are a bleached, water-soaked spot that eventually expands to encompass the entire berry. It typically begins at the pedicel, or the fruit attachment point. The fruit eventually becomes dry, mummified and dark in color. Bitter rot may also infect leaves, tendrils and shoots, where it over-winters as lesions. It is difficult to control.

Black Rot

Black rot is mainly a disease of immature berries, young canes and leaves. It is caused by the fungus *Guignardia bidwellii*. On fruit, black rot appears as dry, black, scabby spots. It can cause mummification and fruit drop. Leaf infection initially appears as light reddish-brown spots that expand to 1/4 inch and turn light brown. Black rot over-winters on infected canes. It is much more of a problem on bunch grapes than on muscadine grapes.

Macrophoma Rot

Macrophoma rot is caused by *Botryosphaeria dothidea*, which is a fungus with an extremely broad host range. It is difficult to control because of its broad host range. Macrophoma rot over-winters on wood of numerous host plants and on the remains of infected berries. When it occurs, it usually appears close to berry maturity. This disease progresses rapidly and is particularly severe on the Fry cultivar. Macrophoma rot begins as a small, light brown spot which becomes water soaked and consumes the entire berry. On certain cultivars this disease is difficult to control.

Powdery Mildew

Powdery mildew is caused by the fungus *Uncinula necator*. It is a rather unmistakable fungus that is identified by an off-white, powdery growth on the plant surface. It strikes in dry, cool to warm weather. It is not a hot-weather disease. On leaves, a powdery mildew infection is seldom serious. On fruit, it may reduce berry size and induce fruit drop. Infected berries may exhibit brown scarring and may crack. Chemical control is normally not warranted.

Ripe Rot

Ripe rot is induced by the fungus *Glomerella cingulata*. Ripe rot is a disease of mature berries and spreads very quickly. It is particularly severe on Fry. Spore-producing bodies on the berry skin give infected bronze berries a rusty appearance; this disease is more difficult to spot on red- or black-skinned berries. The berries eventually decay and become mummified. The disease over-winters on mummified berries.

Harvesting

Harvesting can be accomplished by selecting individual grapes or bunches of grapes by hand, or by shaking berries loose from a vine into tarps positioned beneath the vine or by using mechanical harvesters that rake and shake the berries lose. Harvest is as early as late July for some cultivars and extends to late September for others. Typically, at least two harvests are required, but cultivars such as Fry may require up to 5 harvests. Harvesting by hand is a

labor-intensive vineyard operation. A disadvantage to the quality and post-harvest shelf life of muscadine grapes is that many tear at the point of pedicel attachment. Those with a dry percentage scar are preferable. Fruit degradation and attack by disease organisms can reduce quality quickly and substantially. Harvesting early or late in the day is a definite advantage in preserving fruit quality. For juice or wine grapes, maintaining fruit integrity is not a major issue if fruit will be crushed in a few hours.

The only feasible method to pick juice or wine grapes on a moderate sale is to shake berries onto tarps. For large scale operations, mechanical harvesting is worthy of investigation. The price of muscadine grapes is too low to justify hand harvesting. Before embarking on a moderate to large-scale muscadine juice or vine venture, it would be prudent to know your market potential and check on contracts with nearby processing plants. On a small scale, homeowners or hobbyists may hand pick if they wish.

Muscadine grapes should be refrigerated after harvest and on the way to the market. Muscadine grapes can be stored with refrigeration for up to three weeks at 33°F if no wet scars are present. However, most fresh market cultivars have a shelf life of about 1 week. Relative humidity should be kept high. Refrigeration can extend the marketing duration of muscadine grapes, although the first large-fruited muscadine grapes bring the highest price.

Many growers allow people to pick their own grapes in the form of U-Pick operations. Berries marketed in this manner normally sell for a lower price than in the supermarket. In addition, the consumer is getting a fresh product. It is advisable to start small and expand in size with demand. Convenience to a highway and proximity to a city or town is a prerequisite. U-Pick operations must be clean, and insurance risks such as snakes and wasps must be minimized. Good weed control and closely cut grass are advisable.

Suggested Further Reading

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Table 1. Yield, berry weight, soluble solid, berry no./cluster for 2 wire vertical (2WV) and Geneva double curtain (GDC) trained muscadine grape vines at the North Florida Research and Education Center in Monticello FL from 1978-1982.

	Yield (ton/acre)		Berry Weight (g)		Soluble solid (^{0}Brix)		Berry No./ Cluster	
Muscadine Cultivar	**GDC**	**2WV**	**GDC**	**2WV**	**GDC**	**2WV**	**GDC**	**2WV**
BRONZE								
Carlos	6.5	8.3	5.0	5.5	14.3	15.3	9	8
Chowan	1.8	2.2	5.9	5.6	16.7	15.8	8	10
Dearing	3.6	3.9	3.2	3.0	18.1	14.5	9	10
Dixie	7.4	7.3	4.0	5.1	17.7	15.4	11	10
Dixieland	1.6	1.2	9.2	10.2	16.7	15.4	10	11
Dixiered	4.3	4.1	7.4	6.2	16.3	12.8	11	13
Fry	5.5	4.4	13.9	12.4	16.2	15.9	10	9
Higgins	10.2	6.7	8.5	7.6	15.6	14.1	10	8
Magnolia	3.8	5.2	4.6	5.2	13.7	14.1	10	10
Pink Hunt	2.3	2.0	5.3	5.4	15.9	14.2	7	8
Redgate	6.0	6.1	3.5	3.5	15.8	15.6	15	13
Rich	5.2	3.9	6.4	5.8	14.1	15.3	11	9
Roanoke	2.7	5.6	5.7	4.9	12.4	11.9	9	11
Scuppernong	3.5	3.5	5.2	4.9	13.9	13.9	12	10
Summit	5.2	6.8	11	10.6	18.8	15.7	11	7
Topsail	1.7	1.6	5.9	3.8	19.8	19.7	7	8
Watergate	6.9	4.9	9.8	6.9	15.5	14.5	8	8
Welder	7.2	5.7	3.7	3.2	17.1	17.3	9	10
Yuga	7.0	4.1	3.8	3.0	16.6	15.3	13	12
BLACK								
Albemarle	6.0	5.1	5.5	5.8	17.5	16.0	6	7
Bountiful	4.2	3.1	3.3	3.5	14.4	15.1	12	7
Chief	6.8	5.4	3.6	3.3	15.4	15.7	9	8
Cowart	7.2	7.2	6.8	7.5	14.3	14.3	8	8
Creek	8.8	6.4	2.9	3.9	15.7	14.5	11	7
Hunt	5.2	4.0	6.1	4.5	15.3	14.6	10	6
Jumbo	7.4	7.4	15.3	13	13.5	14.3	8	7
Magoon	4.0	6.1	3.4	3.4	15.6	17.9	10	10
Noble	10.7	9.6	2.8	3.3	13.8	14.3	12	15
Pride	6.7	3.4	9.1	9.2	14.6	15.0	7	9
Southland	6.9	7.7	4.8	5.0	15.4	15.4	9	8
Sugargate	1.6	2.1	10.1	12.0	19	16.5	7	8

Table 2. Length, width, seed #, flavor, scar, pH for 2 wire vertical and Geneva double curtain (GDC) and two wire vertical (2WV) trained muscadine grape vines at the NFREC-Monticello during 1980.

	Length (cm)		Width (cm)		Seeds (no.)		Flavor		Scar (% torn)		pH	
Muscadine Cultivar	GDC	2WV	GDC	2WV	GDC	2WV	GDC	2WV	GDC	2WV	GDC	2WV
Bronze												
Carlos	1.9	2.0	1.9	1.9	4.0	4.0	3.0	3.0	20.0	0.0	3.5	3.4
Chowan	2.1	2.1	2.0	2.0	3.0	4.0	2.0	2.0	10.0	60.0	3.4	3.2
Dearing	1.9	1.8	1.7	1.6	4.0	3.0	3.0		40.0	0.0	3.6	3.2
Dixie	1.8	2.0	1.9	1.9	4.0	4.0		3.0	0.0	50.0	3.6	3.5
Dixieland	2.5	2.6	2.5	2.6	4.0	4.0	3.0		40.0	40.0	3.9	
Dixiered	2.5	2.4	2.3	2.2	3.0	3.0			10.0	0.0	3.7	3.7
Fry	2.9	2.7	2.7	2.7	4.0	2.0	3.0	3.0	100.0	80.0	4.0	3.6
Higgins	2.6	2.6	2.4	2.4	3.0	3.0			60.0	60.0	3.6	3.3
Magnolia	2.1	2.0	1.9	1.9	3.0	3.0	4.0	4.0	60.0	80.0	3.4	3.6
Pink Hunt	2.4	2.2	2.3	2.0	3.0	4.0	3.0	3.0	80.0	100.0	3.2	3.5
Redgate	1.8	1.9	1.7	1.8	4.0	4.0	3.0		20.0	0.0		3.2
Rich	2.2	2.1	2.1	2.0	4.0	4.0	2.0	2.0	40.0	20.0	3.3	3.3
Roanoke	2.1	2.2	2.0	1.9	4.0	4.0	2.0	3.0	80.0	70.0	3.3	3.3
Scuppernong	2.0	2.1	2.0	2.0	4.0	3.0	3.0	3.0	15.0	70.0	3.0	3.7
Summit	2.6	2.7	2.5	2.5	3.0	3.0	3.0	4.0	40.0	40.0	4.1	3.8
Topsail	2.1	1.9	2.0	1.8	2.0	3.0	3.0		40.0	10.0	3.5	3.3
Watergate	2.5	2.2	2.5	2.2	4.0	4.0	3.0	2.0	70.0	40.0	3.6	3.3
Welder	1.9	1.8	1.7	1.7	4.0	4.0	3.0		20.0	40.0	3.8	4.2
Yuga	2.0	1.9	1.8	1.6	3.0	3.0			40.0	100.0	3.0	3.0
Black												
Albemarle	2.3	2.2	2.1	2.0	4.0	4.0	4.0	4.0	70.0	70.0	3.3	3.4
Bountiful	1.8	1.7	1.6	1.7	3.0	3.0	3.0	3.0	80.0	40.0	3.2	3.2
Chief	1.7	1.8	1.7	1.6	3.0	4.0	2.0	2.0	30.0	0.0	2.2	3.0
Cowart	2.3	2.3	2.2	2.2	3.0	4.0	3.0	3.0	60.0	50.0	3.0	3.0
Creek	1.7	1.9	1.6	2.0	4.0	3.0		3.0	70.0	50.0	3.0	3.3
Hunt	2.1	2.1	2.1	1.8	4.0	3.0	3.0	4.0	100.0	80.0	3.2	3.3
Jumbo	2.9	3.0	2.8	2.7	4.0	3.0	3.0	3.0	80.0	80.0	3.4	3.8
Magoon	1.7	1.7	1.6	1.6	4.0	3.0	3.0	3.0	60.0	65.0	3.0	2.7
Noble	1.7	1.8	1.7	1.7	4.0	4.0	3.0		80.0	50.0	3.2	3.6
Pride	2.7	2.5	2.4	2.5	3.0	3.0	3.0	3.0	100.0	80.0	3.2	3.5
Southland	2.0	2.0	1.9	1.9	4.0	4.0	3.0	3.0	0.0	40.0	3.1	3.2
Sugargate	2.7	2.9	2.5	2.6	4.0	4.0		3.0	40.0	60.0	3.6	3.5

[z] Flavor rated 1-4 with 4 being the best flavor.

Table 3. Yield, berry weight, soluble solids and % dry scar of muscadine grape trained to a bilateral cordon system at the NFREC-Monticello from 1987-1991.

Cultivar	Yield (tons/acre)	Berry Wt. (g)	Soluble solids (°Brix)	Dry scar (%)
BRONZE				
Carlos	8.2	6.6	14.2	96
Dixie	5.0	6.1	17.2	78
Excel [P]	5.5	10.0	14.4	84
Fry	3.5	12.7	16.3	5
Golden Isles	4.8		14.7	91
Granny Val [P]	6.1	12.8	14.9	79
Magnolia	6.3	6.4	13.9	73
Senoria [P]	5.7	8.5	14.3	87
Summit	3.8	10.0	16.2	90
Tara	2.5	11.0	16.2	95
Welder	6.1	4.2	13.6	88
Black				
Alachua [Z]	2.8	8.0	17.7	98
Albemarle	2.8	6.5	16.9	88
Cowart	4.1	8.3	14.0	79
Farrer [P]	4.8	13.4	15.2	0
Jumbo	3.2	13.4	14.1	74
Loomis [Z]	0.2	9.8	15.1	70
Noble	7.5	4.1	14.7	56
Polyanna [Z]	3.3	10.8	18.8	92
Southern Home	3.3	6.8	19.1	98

[Z] Yield determined during the third year only for these cultuvars

[P] Patented

Missing data indicates that it is not available.

Table 4. Average vine vigor, yield, berry wt. and soluble solids at the NFREC-Quincy from 2002-2005.

Cultivar	Vigor	Yield	Berry wt (g)	Soluble Solids (°Brix)
Alachua	7.6	7.3	6.5	17.5
Black Beauty	7.0	6.9	11.9	17.3
Black Fry	5.8	5.7	10.6	17.7
Carlos	8.8	8.7	5.4	17.4
Creek	7.6	7.9	3.0	15.1
Early Fry	4.4	4.2	10.2	17.4

Table 4. Average vine vigor, yield, berry wt. and soluble solids at the NFREC-Quincy from 2002-2005.

Fry	5.1	6.3	10.4	18.8
Granny Val	6.9	7.4	11.0	17.0
Jumbo	6.7	6.7	9.8	15.1
Noble	8.9	9.4	3.2	16.8
Pam	7.9	6.3	12.7	16.1
Pineapple	6.0	6.8	8.7	15.7
Polyanna	7.4	7.1	9.3	18.2
Regale	7.5	8.2	5.3	14.7
Scarlett	8.0	5.6	10.6	18.9
Summitt	8.5	7.4	8.1	18.7
Supreme	4.8	6.3	11.9	15.2
Sweet Jenny	7.2	6.4	12.6	16.7
Tara	7.3	5.9	9.3	15.6
Triumph	7.0	5.8	8.2	17.4
Lsd 0.05	1.5	1.6	0.8	1.6

[z] Vine vigor and yield estimated from 1 (lowest) to 10 (highest) yield estimates of 10 is roughly equivalent to 45.5 kg/vine.

[Y] All variables were significant at P<0.05.

Table 5. Summary of Vegetable and reproductive characteristcs of muscadine grape cultivars.

Muscadine Cultivar	Yield	Flower Type	Size (in)	Size (g)	Soluble Solids (°Brix)	Disease Resistance	Vigor	Harvest Season	Dry Scar (%)	Recommendation Status
Bronze										
Carlos	VH	SF	0.5	5.0	15	F-G	H	Early-Mid	82	R
Chowan	L	SF	0.5	5.0	16				50	NR
Darlene [p]	M	F	1.5	15.0	22	G	H	Early-Mid	90	T
Dearing	M	SF	0.67	4.0	15					NR
Delight [f]	MH	SF	1	10.0	14		L	Mid-Late	84	NR
Dixie	H	SF	0.5	5.0	15				20	NR
Dixieland	L	SF	1.25	12.5	15	F	VL	Early-Mid	21	NR
Dixiered	M	SF	1	10.0	13	F-G	MH	Mid	76	NR
Doreen	H	SF	0.5	5.0	18	G	L	Late	66	T
Early Fry [f]	VH	F	1.25	12.5	18	E	H	Very Early	79	T
Florida Fry [p]	MH	SF	1.13	11.5	18	E	M	Mid-Late	52	T
Fry	M	F	1.25	12.5	16	F	L	Early-Mid	20	R
Fry Seedless [p]	L	F	0.5	5.0	18	E	H	Early-Mid	91	NR
Golden Isles	M	SF	0.67	6.5	15	G	H	Late	94	T
Granny Val [f]	VH	SF	1.25	12.5	16	G	L	Late	20	R
Higgins	VH	F	1.13	11.5	14	F-G	M	Mid-Late	44	NR
Janebell [fp]	H	SF	1	10.0	16	F-G	H	Early-Mid	35	NR
Janet [fp]	MH	F	1.13	11.5	21	G	H	Mid	95	NR
Late Fry [fp]	H	SF	1.5	15.0	20	E	H	Very Late	15	T
Magnolia	M	SF	0.5	5.0	14		MH	Mid		NR
Pam [fp]	VH	F	1.5	15.0	21	E	H	Early-Mid	47	R
Pineapple [p]	VH	SF	1	10.0	16	E	H	Mid-Late		R
Pink Hunt		SF			14					NR
Redgate [f]		SF	0.75	7.5	16		H	Mid-Late		NR
Rich			0.79	8.0	15					NR

Table 5. Summary of Vegetable and reproductive characteristcs of muscadine grape cultivars.

Muscadine Cultivar	Yield	Flower Type	Size (in)	Size (g)	Soluble Solids (°Brix)	Disease Resistance	Vigor	Harvest Season	Dry Scar (%)	Recommendation Status
Roanoke	M	SF	0.79	8.0	12				25	NR
Rosa [fp]	MH	F	1.13	11.5	18	G	H	Mid	70	NR
Scuppernong	LM	F	0.5	5.0	14	F-G	M	Mid	38	NR
Sterling [p]	H	SF	0.67	6.5			M	Mid		NR
Sugar Pop [f]		F	1.25	12.5			H	Mid-Late		NR
Summit	MH	F	1	10.0	16	G	F	Mid	82	R
Sweet Jenny [fp]	MH	F	1.5	15.0	23	F	H	Early-Mid	80	R
Tara	LM	SF	1	10.0	17	G	MH	Mid	91	R
Topsail	L	SF	0.73	7.5	20					NR
Triumph	M	SF	1	10.0	18	F-G	M	Early-Mid	90	NR
Watergate	MH	F	0.87	8.5	15		M	Mid		NR
Welder	H	SF	0.67	6.5	17		M	Mid		R
Yuga	MH	SF	0.67	6.5	15					NR
Black										
African Queen [fp]		F	1.13	11.5			H	Mid	Dry	T
Alachua	M	SF	0.67	6.5	18	G	M	Early-Mid		NR
Albemarle	M	SF	0.67	6.5	16					NR
Big Red [fp]		F	1.25	12.5			VL	Mid-Late		T
Black Beauty [fp]	M	F	1.25	12.5	23	E	M	Early-Mid		R
Black Fry [f]	M	F	1.25	12.5	19	E	M	Early-Mid		R
Bountiful	M	SF	0.67	6.5	15					NR
Chief	H	SF	0.67	6.5	16					NR
Cowart	M	SF	0.75	7.5	14	G	M	Mid		NR
Creek	VH	SF	0.79	8.0	15					NR
Farrer [f]	M	F	1.25	12.5	18	G	H	Mid-Late		R
Georgia Red [f]		F					H	Mid		NR
Hunt	M	F	1	10.0	15	F-G	MH	Early-Mid		NR
Ison [fp]	VH	SF	1.13	11.5	19	E	VH	Early-Mid		T
Jumbo	M	F	1.5	15.0	14	G	H	Mid		NR

Table 5. Summary of Vegetable and reproductive characteristcs of muscadine grape cultivars.

Muscadine Cultivar	Yield	Flower Type	Size (in)	Size (g)	Soluble Solids (°Brix)	Disease Resistance	Vigor	Harvest Season	Dry Scar (%)	Recommendation Status
Loomis [f]	L	F	1.13	11.5			H	Mid-Late		NR
Magoon	M	SF			18					NR
Nesbitt	H	SF	1.13	11.5	18	G	H	Mid-Late		T
Noble	H	SF	0.25-0.5	4.0	14	G	MH	Early-Mid		R
Polyanna	H	SF	1	10.0		E	H	Late		R
Pride	M		0.98	9.0	15					NR
Redgate [f]		SF	0.71	7.0			H	Mid-Late		NR
Scarlet [p]	M	F	1.13	11.5	17	G	M	Mid		NR
Southern Home [f]	M	SF	0.67	6.5	19	G	MH	Mid		R
Southland	MH	SF	0.5	5.0	17	G	MH	Mid-LAte		NR
Sugargate [f]	L	F	1.25	12.5	17	E	M	Early-Mid		NR
Supreme [fp]	H	F	1.5	15.0	22	E	VL	Mid-Late		R

Cultivars: f =Female, p=Patented.
Disease resistance: F=Fair, G=Good, E=Excellent.
Vigor: VL=Very Low, L=Low, M=Medium, H=High.
Recommendation status: NR=Not Recommended, T=Recommended for Trail, R=Recommended.