

INTRODUCTION

The muscadine grape, *Vitis rotundifolia* Michx. (subgenus *Muscadinia* Planch.), is native to the southern United States and is commonly found growing wild in many areas of Arkansas except the more northern counties. Fruit of muscadines is usually black or deep purple, or bronze. The muscadine grape differs from the familiar bunch grape (example species include *Vitis vinifera* L. and *Vitis labrusca* L., both in the subgenus *Euvitis* Planch.) in several morphological characteristics in that muscadines have smaller clusters, the berries abscise from the cluster at maturity, the tendrils are unbranched, and the stem pith is continuous at the nodes. Another major difference is that muscadines are resistant to many of the more common diseases found on bunch grapes such as black rot [caused by *Guignardia bidwellii* (Ellis) Viala & Ravaz], powdery mildew [caused by *Uncinulata necator* (Schw.) Burr.], anthracnose [caused by *Elsinoë ampelina* (de Bary) Shear], and downy mildew [caused by *Plasmopara viticola* (Berk. & Curt.) Berl. & de Toni], thus making muscadines a desirable fruit crop with low pest control inputs compared to bunch grapes.

Muscadines have been under cultivation since the middle of the 18th century (Olien, 1990). The early cultivars grown were selections made from the wild, and the

most famous is ‘Scuppernong’, which was widely grown but is seldom planted commercially at this time (Olien, 1990). This is a bronze-fruited, pistillate (not self-fruitful) cultivar that was found in eastern North Carolina (Reimer, 1909). Muscadines were not produced commercially in Arkansas as of 1972 (Moore, 1972); however, commercial production began in the middle 1970s and continues today. Production has not been documented in Arkansas as to acreage; muscadine processing takes place in the Arkansas River Valley and several counties are involved in commercial fresh market sales (Keith Striegler, Extension Fruit Specialist, personal communication).

Public muscadine breeding programs were initiated in the early 1900s at the University of Georgia, and cooperatively between North Carolina State University and the U.S. Department of Agriculture (USDA). Additionally, the USDA conducted a cultivar development program at Meridian, Miss., from 1941–1965 (Olien, 1990). The University of Florida also conducted a breeding program for many years until the early 1990s. The North Carolina program was phased out in the late 1980s, but the University of Georgia program continues. Ison’s Nursery of Brooks, Ga., began a private cultivar development program and has released a number of cultivars in the last 25 years. Major advances in muscadine breeding have included development of perfect-flowered (having both male and female flower components on the same flower and thus not needing a pollinator vine for fruit set) and self-fruitful cultivars by the North Carolina program and major advances in berry size, which largely came from the Georgia program (Olien, 1990).

Muscadine cultivars were first tested in Arkansas in 1964 at both the Southwest Branch Station (now known as the Southwest Research and Extension Center), Hope, and the Fruit Substation, Clarksville (Moore, 1972), followed by the establishment of a test planting at the Strawberry Substation (now closed), Bald Knob, in 1967 (Moore and Bowden, 1976). The best performing cultivars in these trials were the black or purple cultivars ‘Hunt’, ‘James’, ‘Duplin’, ‘Creek’, and ‘Albermarle’, and the bronze ‘Higgins’, ‘Roanoke’, ‘Wallace’, and ‘Magnolia’ (Moore, 1972; Moore and Bowden, 1976). Yields averaged across all entries were as high as 50 lb/vine at Hope and 45 lb/vine at Clarksville. Similar yields were seen at Bald Knob. Fruit weight averaged over all years at all locations was largest for ‘Higgins’, with an individual berry weight of between 6 and 7 g.

Numerous new cultivars were released from various breeding programs in the late 1960s into the early 1980s and were incorporated into commercial production. For example, during the late 1970s and 1980s in North Carolina, ‘Carlos’ made up 47% of the production in that state (Poling et al., 1987), and most fruit was used for processing. Production in Georgia shifted largely to the large, bronze-fruited cultivar ‘Fry’ during that time (Phatak et al., 1980), which was grown mainly for fresh fruit sales. Olien (1990) conducted a survey of muscadine cultivar popularity and found that across the

South, 'Carlos' was the single most popular, with 'Magnolia' also commonly grown. However, he also found that 'Magnolia' was declining in acreage. Other important cultivars reported included 'Fry', 'Higgins', 'Summit', and 'Doreen', and the black-fruited 'Sugargate', 'Coward', 'Hunt', 'Jumbo', and 'Noble'. Olien also found that 'Hunt' was decreasing in acreage, while 'Doreen' was gaining in popularity.

With the advent of many new cultivars since the original trials in Arkansas were established in the 1960s (these trials were completed in the early to mid-1970s), a new cultivar trial was needed to test new developments in Arkansas. The objective was to evaluate fruit and vine characteristics of newly developed cultivars, including yield, berry weight, quality, hardiness (resistance to cold damage), and susceptibility to disease.

MATERIALS AND METHODS

This cultivar evaluation planting was first established in 1982 at the Fruit Substation, Clarksville [west-central Arkansas, lat. 35°31'58"N and long. 93°24'12"W; USDA hardiness zone 7a; soil type Linker fine sandy loam (Typic Hapludult)]. The planting initially included 25 entries of both named cultivars and breeding selections (noted by letter and number designations rather than names) (Table 1). Many of the initial vines did not survive, and new vines were planted in 1983 and 1984. Additionally, 16 new cultivars or selections were added to the planting between 1990 and 1994. This planting was maintained through 1998, with unacceptable cultivars being discarded periodically. The planting consisted of three to six replications of each entry, arranged in a randomized block design. Vines were spaced 20 ft apart in rows spaced 12 ft apart. All vines were trained to a single-wire trellis, maintained at a height of 5 ft. The training system used was a bilateral cordon, with each mature vine having two cordons of 10 ft long. Some vines began fruiting prior to completely filling the trellis area, and usually the first fruit was harvested in the third year after planting. The major exception was in the early life of the planting, in which vine establishment was delayed because there was no irrigation. Vines were fertilized annually with either nitrogen only or complete fertilizers (providing potassium and phosphorus in addition to nitrogen) as needed on the basis of soil tests. Total nitrogen applied each year was 50 lb/acre. Weeds were controlled by a combination of pre- and post-emergence herbicides and mechanical weed removal around young (1- to 3-year-old) vines. No fungicides or insecticides were applied to the planting at any time. Vines were spur-pruned in late winter to early spring each year, with previous season's growth pruned to three to five nodes. Occasionally, spurs were thinned on the oldest vines when spur density became too high. The vineyard was trickle- (drip-) irrigated beginning in 1985. The first yield data were collected in 1986, but the most consistent yield and other data were collected during the period 1987 through 1998 and are reported here. Fruit were not harvested in one

year, 1991, because of poor crop and vine health that appeared to result from winter injury that carried over from the severe freeze of 1989.

Data collected included total yield as measured by a once-over harvest at fruit maturity; fruit was harvested by striking the vines, causing the fruit to be caught by a catch frame held under the vine. Some fruit was lost in this process, but was estimated to be less than 5% of the total yield. Determination of harvest date was made by examining the vines for evenness of fruit maturity and observing for any early berry drop from the vines (if the cultivar had very mature fruit and some berry drop, while some berries were not fully ripe, then the cultivar was harvested to prevent yield loss). Total yield per vine was recorded. Because of the uneven age of the vines in the planting and occasional winter injury to the vines, major differences in yields were recorded; thus it is difficult to compare cultivars for yield over the life of the planting.

Berry weight of 25 fully ripe berries was recorded for each vine from the total harvest. Using this sample, juice was extracted from the berries and percent soluble solids (reflecting sugar content) was determined by a handheld refractometer. The total harvest from each replication of each vine was rated for a range of berry characteristics, using a scale of 1 to 10, with 10 being the most desirable rating for the trait, but a rating of 7 or above considered acceptable. Berries were examined for fruit picking or attachment scar (the point of attachment of the berry to the stem) and rated highest if the cultivar had a high percentage of berries with small, dry scars. Evenness of ripening was rated to reflect the ability of the cultivar to ripen its fruit to an even maturity level. Flavor was rated on the basis of a combination of flavor components of sweetness, true muscadine fruitiness, and the absence of undesirable flavors. Berry appearance was rated on the basis of the attractiveness of the berries, with berries evenly colored, free of blemish or other surface deficiency, and free of disease symptoms rated the highest. Overall quality was a rating assigned to the overall harvest of each vine combining the various quality components of the fruit such as scar, evenness of ripening, and appearance, along with the absence of disease and uneven berry size.

Data for yield, berry weight, and soluble solids were analyzed each year by analysis of variance using SAS (SAS, 1989), and means were separated by least significant difference ($P \leq 0.05$). A multi-year analysis of data was not done because the presence of vines of all cultivars was not consistent over the years. Overall means for berry weight and soluble solids were calculated for all years that data were available for a cultivar. Data for harvest date, scar, evenness of ripening, flavor, appearance, and overall quality were averaged for the replications each year, and the replication means were averaged over all the years the cultivar was present. Standard deviations were also calculated for these multi-year means.

Observations on plant vigor and winter injury were made each year but no data were recorded for these variables. Since this planting was located near the northern

limit of adaptation of muscadines, the opportunity was present to attain hardiness observations on the cultivars. Winter injury was observed in several years of the evaluation period, and was most severe following -7°F in December 1989. Minimum low temperatures occurring at the location of the planting are provided to characterize the exposure to cold in the planting (Table 2).

Disease presence on fruit was observed each year at harvest. The diseases observed in the planting and confirmed by fungal identification included bitter rot [caused by *Greeneria uvicola* (Berk. & Curt) Punithalingam (syn. *Melanconium fuligineum* (Scribner & Viala)) Cav.], macrophoma rot [caused by *Botryosphaeria dothidea* (Moug. ex. Fr.) Ces. & de Not.], ripe rot [caused by *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.], and powdery mildew. Powdery mildew was most commonly seen as mycelia on the fruit surface, but infection did not result in fruit rot. Routine, annual differentiations of fruit rots by fungal culture were not done; thus the fruit rots, caused most commonly by bitter rot and macrophoma rot, were not identified, but overall occurrence of fruit rots was noted. Ripe rot was more easily identified by its salmon-colored sporulation, but it was not commonly seen.

RESULTS AND DISCUSSION

Differences in yield occurred each year among cultivars. The largest yield recorded in the planting at any time was in 1989: 84.5 lb/vine for 'Redgate' (Table 3). Common high-yielding genotypes included 'Carlos', 'Fry', 'Jumbo', NC67AO15-17, NC67AO15-26, 'Redgate', and 'Summit'. Fruit weight among cultivars varied greatly (Table 4). The largest individual-year berry weight recorded was 14.0 g for 'Jumbo' in 1992. The largest multi-year average berry weight was found for 'Darlene', 12.6 g. Other very large-fruited genotypes included 'Black Beauty', GA 29-4-4, GA 33-2-1, and 'Sugargate'.

Soluble solids values were different among cultivars each year, with the highest value recorded in 1997 on GA 33-3-4 of 23.8%. Other cultivars with high soluble solids content included 'Dixie', GA 15-17-2, GA 33-2-1, 'Late Fry', 'Southern Home', 'Sugargate', and 'Summit'.

Date of harvest varied among cultivars. The earliest average harvest dates were recorded for GA 15-17-2, GA 33-2-1, 'Sugargate', and 'Triumph', with these genotypes being harvested between 10 and 13 Sept. on average. The latest harvest date was recorded for 'Doreen', at an average of 4 Oct.

Fruit ratings also varied among the characteristics observed. Several genotypes consistently had high ratings (9.0 or above) for scar, including GA-33-2-1, GA 33-3-4, GA 3-4-1, NC67AO15-17, 'Summit', and 'Tara'. The more evenly ripening genotypes included 'Cowart', NC67AO15-26, 'Southern Home', and 'Sugargate'. Flavor ratings

varied also, with ‘Sugargate’ and ‘Summit’ rating highest for this variable. Appearance and quality were rated highest for NC67AO15-26, NC67AO15-17, ‘Nesbitt’, and ‘Coward’.

A synopsis of performance follows for each named cultivar (non-released entries are not available for purchase, thus are not discussed in detail), including comments on winter injury and disease presence. Data presented in Tables 3, 4, 5, and 6 are included in the discussion.

‘Alachua’ (black, self-fruitful). This Florida-developed, midseason cultivar first fruited in 1996, and by the third year, the vines had fair to good yields. Berry weight averaged 6.8 g and most fruit characteristics were acceptable. Unevenness of ripening was noted as a shortcoming. Slight surface infection by powdery mildew was seen in two of three years, but no other diseases were noted. Vine vigor was observed to be medium to low, with chlorosis (yellowing) of leaves noted most years. Vine hardiness was a major concern in that trunk splitting (a sign of winter injury to the trunk of the vine) was noted in 1996, and poor health was likely related to this injury for the later years also. From the observations in this trial, it was concluded that ‘Alachua’ is not adapted at the location of this trial because of lack of hardiness. This is not surprising, since it had not been subjected to the same level of cold in its development at Leesburg, Fla.

‘Black Beauty’ (black, pistillate). This late midseason ripening, Ison’s Nursery-developed cultivar, exhibited a very noteworthy skin and pulp texture. Its skin was the most edible of any entries tested, and this characteristic would be desirable in the fresh market. Yields of ‘Black Beauty’ were low the first two harvest years, but yield improved in 1998. Berry weight was very large and averaged 11.0 g. Quality of fruit was rated good to very good for all variables, and little to no disease was observed on the berries. Vines had medium to medium-low vigor. Winter injury was a major concern with ‘Black Beauty’, however. Winter injury symptoms on the trunks were first seen in 1996 and were most severe in 1997, likely a result of the 1 °F temperatures that occurred in the winters prior to these two growing seasons. By 1998, one of the three vines had died, likely resulting from the winter injury, as evidenced by trunk splitting. Therefore, even though ‘Black Beauty’ had excellent fruit quality, the lack of hardiness limits the full recommendation of this cultivar based on these results. It may perform better in warmer climates, however.

‘Black Fry’ (black, pistillate). This cultivar produced good yields in the trial (it was quite precocious, yielding well as a rather young vine), and was large-fruited (averaging 9.1-g berries). It ripened on average 27 Sept. Fruit quality was usually rated good, but not exceptional. Berry skin was noted to be quite thick. In several years, berry shrivel was noted. This could indicate that harvest was delayed to allow the overall crop to ripen more evenly or that the fruit did not hold on the vines as well as other cultivars. Uneven berry size was also noted several years on ‘Black Fry’. Vines had medium to medium-high vigor, but leaves were often noted to be pale (slight yellowing

but not a severe chlorosis). Winter injury was not observed in any years on 'Black Fry'. Several diseases were observed on this cultivar, including powdery mildew on berry surfaces and slight fruit rot (likely bitter or macrophoma rot). 'Black Fry' did not exhibit enough attributes in this trial to recommend it for planting.

'Carlos' (bronze, self-fruitful). A proven winner in trials in various states, 'Carlos' performed very well in this planting. Yields were good to very good in most years, and harvest date was midseason. Berry size was medium, averaging 5.5 g. Fruit quality was rated good to very good, with one of the highest ratings of any cultivar for scar and evenness of ripening. Vine vigor was rated high in all years except 1990, and 'Carlos' was the healthiest, or among the healthiest, cultivars in the trial. It experienced some winter injury following the -7°F that occurred in December 1989, which resulted in the reduced vigor in 1990. Only limited winter injury occurred at any other time, and 'Carlos' appeared to be among the hardiest cultivars in the planting. Small amounts of fruit rot were seen in some years, but usually disease was not common enough to be a concern. Although berry size is only medium and is likely not large enough for many fresh market outlets, the self-fruitful 'Carlos' is recommended for planting as a processing cultivar or for limited fresh fruit sales. Its reliability in cropping and health make it one of the most dependable cultivars in existence.

'Coward' (black, self-fruitful). This midseason cultivar produced good yields of medium to medium-small berries. Fruit quality was good; 'Coward' was one of the highest rated cultivars for evenness of ripening, flavor, appearance, and overall quality. Wet scars were commonly noted, and the fruit from the vines were often wet with juice after harvest. This was the major concern with this cultivar. Vine vigor was medium to high, and health was consistently good. No winter injury was noted. Fruit diseases were seldom seen and were never noted to be common enough to be of concern. On the basis of its performance in this trial, 'Coward' should be considered for planting if medium to medium-small berry size is acceptable, but it is likely not a good choice if berries are to be packaged and shipped, because of the wet scar limitation.

'Darlene' (bronze, pistillate). Observed with this cultivar was a non-precocious fruiting tendency in that although it was planted in 1990, it did not produce measurable yields until 1994, and yields that year and in 1995 were low. Good yields were recorded from 1996 through 1998, however. Berry weight was exceptional, and overall it produced the largest fruit in the planting. Vines were harvested in early midseason. Fruit ratings were good for 'Darlene' also, and the skin and pulp texture were noted to be better than most other cultivars. Fruit is considered bronze, but some red pigment on berries was noted some years. Vine vigor was very high on both young and mature vines. After planting, it filled the trellis area quicker than any other cultivar in the trial, although it did not begin fruiting as rapidly as most entries. Various diseases were observed on berries in several years, including powdery mildew and some fruit rots.

However, disease was not severe or limiting in any years. Slight winter injury was noted in 1996 on one vine, but the vine recovered well. Thus winter hardiness appears to be good for 'Darlene', at least to the temperatures it was exposed to in this trial (minimum of 1 °F). Because of its exceptional fruit size and performance in other traits, the female-flowered 'Darlene' is recommended for trial where a large-fruited, bronze cultivar is desired.

'Dixie' (bronze, self-fruitful). This cultivar was tested through 1993. It produced good yields early in the trial, but it appeared to be damaged substantially—resulting in very low yields—after exposure to -7 °F in the winter of 1989-90. Vine death or kill to the ground (the killing of all above-ground portions of the vine) was observed in 1990. Berries averaged 5.1 g. 'Dixie' was one of the sweetest cultivars in the trial, with an average soluble solids value of 19.6%, but over 20.0% in two of six years. Fruit quality was acceptable overall, with flavor rated among the best. It was one of the most susceptible cultivars to powdery mildew, which was seen on berries each year. An unusual occurrence was noted in that powdery mildew caused the skin of the berries to split, which is very uncommon on muscadines. Fruit rots were also observed on fruit of 'Dixie' in each year also, resulting in it being judged one of the most disease-susceptible cultivars in the trial. Vine vigor varied from low to high, with low vigor likely a result of winter injury in some years. These various shortcomings resulted in 'Dixie' being discarded from the trial after the 1993 fruiting season, and it is not recommended for production on the basis of these findings.

'Dixieland' (bronze, self-fruitful). This very large-fruited cultivar (average 10.1 g) produced good yields in some years but poor yields in other years. It was tested only through 1993. Overall quality was good, with flavor (7.8) its highest-rated quality. In 1990, three of four vines present in the planting (one of the five originally planted vines did not become established) showed winter injury, with two of the three being completely killed. Thus winter injury was a major limitation of this cultivar. Another shortcoming of 'Dixieland' was fruit rot susceptibility. In 1992 and 1993, it had severe fruit rots and was the most susceptible cultivar to ripe rot. This disease was very easily identified because of its salmon-colored conidia masses present on the berries and was seldom seen on any other cultivars in any years. On the basis of these shortcomings, 'Dixieland' is not recommended for planting.

'Dixiered' (red-bronze, self-fruitful). This high-yielding cultivar, which produced red berries, was tested through 1993. It was medium in size (6.4 g) but was lacking in fruit quality. It was rated below 7.0 for evenness of ripening, appearance, and overall quality. The red-colored fruit were found to be unattractive because of their unusual color. Vigor was medium to high on average, but in 1990 following -7 °F in December 1989, most vines had very low vigor, appeared to have winter injury, and overall performed poorly. They did recover to a high-yielding status by 1993. Fruit rots

were common on 'Dixiered' in most years also. This poor performance results in this cultivar not being recommended for planting.

'Doreen' (bronze, self-fruitful). The late-ripening 'Doreen' was the final cultivar to be harvested in each year of evaluation, with an average harvest date of 4 Oct. It was not a high yielder early in the planting, but it produced good yields from 1994-98. It also had small berries (average 4.0 g). Doreen was often high in soluble solids, averaging 19.0% with 5 years of soluble solids readings of 20.0% or above. Fruit quality ratings were good overall for 'Doreen', and it had a very good scar rating (8.8). Berries of 'Doreen' are attractive and are elliptic to oval, rather than the more common round shape of most muscadines. Vine vigor was medium to high; some magnesium deficiency-induced leaf chlorosis was seen in some years. Vine damage was observed after the -7 °F temperature occurred in December 1989, but no winter injury was noted from 1993 through 1998. Only limited fruit rots were seen. This cultivar might be considered for the late season, since it is among the latest if not the latest-ripening cultivar available. However, harvest date, plus small berry size, should be examined closely for this cultivar prior to serious consideration for planting.

'Farrer' (black, pistillate). Yields were not impressive for 'Farrer' until 1998, when it averaged 60.3 lb/vine—the highest average yield of all entries that year. Berry weight was large at 9.5 g. This cultivar was rated below 7.0 for most fruit variables, however. Major limitations were uneven ripening, poor scar, along with a very thick skin. Fruit rots were seen to a limited extent but were not severe. Vine vigor was medium, but vine health was usually lacking and chlorosis was commonly noted. Winter injury was not observed. Lack of outstanding fruit quality results in 'Farrer' not being recommended for planting.

'Florida Fry' (bronze, self-fruitful). Added to the planting in 1992, 'Florida Fry' achieved fair to good yields in 1996 through 1998. Berries were medium-large, averaging 7.6 g. This midseason cultivar had a good rating for scar but was not outstanding for other fruit characteristics. Uneven berry size was noted, along with uneven ripening. Vines were usually chlorotic and low to medium in vigor. No winter injury was observed, even though its Florida origin would indicate this as a potential limitation. Powdery mildew was severe on 'Florida Fry' in numerous years, and slight fruit skin splitting was observed one year. Fruit rots were observed to a limited extent also. Overall this cultivar did not perform well enough to be recommended for planting.

'Fry' (bronze, pistillate). Overall, this industry standard for bronze fresh fruit performed well in the trial. Moderate to high yields were recorded for all years except 1990, a year in which the vines showed severe winter injury following -7 °F. Fruit weight was high, averaging 9.1 g. This midseason, female-flowered cultivar had acceptable to high ratings for fruit quality. Flavor was rated among the best. Some fruit rots were observed, and these were a concern in some years. Vine vigor was medium to

medium-high except in the two years following the severe freeze of 1989-90. Even though hardiness and fruit rot concerns were noted in this trial, 'Fry' is still recommended as a proven large-fruited, bronze cultivar for fresh marketing.

'Golden Isles' (bronze, self-fruitful). Tested through 1993, 'Golden Isles' was a poor performer in this trial. Yields were very low, and fruit quality was rated low for most characteristics. Vine vigor was low, and vines were noted to have poor leaf color and poor health. Fruit rots were seen in some years also. Therefore, this cultivar showed no merit for consideration for planting.

'Ison' (black, self-fruitful). Yields for 'Ison' were usually low. Berry weight was medium-large, averaging 8.0 g. Fruit quality was rated highly except for flavor. Fruit rots were observed but were not severe. Vine hardiness was the poorest of all entries tested, and by 1997, all vines had died from winter injury. These vines did not resprout from the ground as is common for muscadine vines that have experienced winter injury. 'Ison' was one of the few cultivars on which crown gall [caused by *Agrobacterium tumefaciens* (E.F. Smith & Townsend) Conn] was observed also. Because of hardiness limitations, 'Ison' is not recommended for planting.

'Jumbo' (black, pistillate). High yields were recorded for 'Jumbo' in most years. This cultivar was among the largest-fruited entries also, averaging 11.4 g. 'Jumbo' often had among the lowest soluble solids contents of all cultivars, averaging 15.8% during the trial. Overall fruit quality was acceptable for several traits, but flavor was rated 6.8, which was one of the poorest ratings for this characteristic. 'Jumbo' also was noted to have an exceptionally thick skin, possibly the thickest of any entries in the trial. Fruit rot was among the worst in some years, resulting in substantial yield loss occasionally. Vine vigor was high in most years, except following the severe freeze of December 1989, in which vines showed considerable winter injury. No winter injury was noted after the vines recovered from that freeze damage. 'Jumbo' could be considered for planting if a large-fruited, high-yielding cultivar is desired. However, because of quality concerns and fruit rot potential, extensive planting is not recommended.

'Late Fry' (bronze, self-fruitful). A 1994 addition to the trial, 'Late Fry' had moderate to low yields in the three years of harvest. Its berries were medium-large, and scar and flavor ratings were good. However, evenness of ripening, appearance, and overall quality were lacking. Date of ripening was similar, rather than later than 'Fry' as its names suggests. 'Late Fry' was also smaller than 'Fry' by 1.9 g. Uneven berry size contributed to the poor appearance and overall quality, and the skin was noted to be quite thick. Vine health was noted to be poor, with vines showing chlorosis and vine vigor being low to medium. Fruit diseases included occasional to severe powdery mildew and some fruit rots. Winter injury was not observed. Because of quality concerns and better cultivar choices for this harvest season, 'Late Fry' is not recommended for planting.

‘Loomis’ (black, pistillate). In only two of five years of testing did ‘Loomis’ produce any significant crop. It was among the poorest performers for yield of all entries. Berry weight was medium to medium-large, and the few berries produced were of very good quality. Berries were noted to have somewhat different in flavor components than most muscadines. They had a distinct appearance of numerous lenticels on the berry skin, which differed from most muscadine cultivars. Fruit diseases were not common. Vigor was medium to high, and the vines had a more upright growth habit than is common for muscadines. Slight winter injury of the trunk was observed in 1998, but no other winter injury was observed. On the basis of poor yield performance, ‘Loomis’ is not recommended for planting.

‘Magnolia’ (bronze, self-fruitful). This cultivar was tested until 1993. Overall it produced very good yields in most years, and like ‘Carlos’, it was able to produce a fairly good crop the season after the -7°F that occurred in December 1989. Berry weight of ‘Magnolia’ was medium and averaged 5.5 g. Soluble solids were rather low, averaging 16.3%, and flavor was not rated highly. Otherwise, fruit was acceptable. Vine vigor was usually moderate, and winter injury was noted to be not as severe for ‘Magnolia’ as for most other cultivars in 1990. Powdery mildew was seen on fruit surfaces in most years of evaluation and ranged from slight to heavy, with skin splitting observed in some years. ‘Magnolia’ did not perform as well as its main cultivar competitor ‘Carlos’; thus ‘Carlos’ is recommended over ‘Magnolia’.

‘Nesbitt’ (black, self-fruitful). Yields for ‘Nesbitt’ ranged from fair to very good. Berries were large, averaging 8.6 g. ‘Nesbitt’ fruit ratings were among the highest of any cultivar, and exceeded 8.0 for all characteristics. Fruit skin was noted to be thick but not unusual for most muscadine cultivars. Very little disease was seen in most years on ‘Nesbitt’ fruit, and it was one of the most disease-resistant cultivars in the trial. Slight fruit rot and powdery mildew were observed in some years but was minimal and not of major concern. Vine vigor was usually medium to occasionally high. Winter injury was observed in 1990, but it was not seen again during the trial. ‘Nesbitt’ is recommended for planting because of its good yield potential, large berries, and good fruit quality.

‘Redgate’ (red, self-fruitful). Tested through 1990, ‘Redgate’ was very high-yielding for three of the four years of data collection. Berries were medium (averaging 6.3 g) but were rated below 7.0 for four of five fruit quality characteristics. The most outstanding deficiency was for scar, which was the lowest rating for any entry in the planting. Severe fruit rots were noted, as was the presence of powdery mildew. Winter injury was severe in 1990. Vine vigor was high for all years except 1990. Poor fruit quality and disease concerns prevent ‘Redgate’ from being recommended for planting.

‘Regale’ (black, self-fruitful). Tested through 1989, ‘Regale’ performed poorly in the trial. Yields were low, and berry weight was near the lowest of all entries. Even-

ness of ripening was very good, but other fruit ratings were not impressive. Flavor was noted as poor. Some powdery mildew was observed on fruit, but no other diseases were seen. Vine vigor was low. Winter injury was not seen on 'Regale'. This cultivar is not recommended because of its poor performance in this trial.

'Senioia' (bronze, self-fruitful). Yields were fair to poor for the early-ripening 'Senioia'. Berry weight was medium-large (7.2 g). Fruit quality was marginally acceptable for most characteristics. Many vines died after the December 1989 freeze; thus hardiness was poor for 'Senioia'. Vigor varied from medium-high prior to freeze damage, to low after 1989. Fruit rots were common. This cultivar is not recommended.

'Southern Home' (black, self-fruitful). This is the only bunch grape-muscadine hybrid in the trial planting. It was developed by the University of Florida and has in its background not only *V. rotundifolia*, but also the bunch grape species *V. popenoei* Fennel, *V. munsoniana* Simpson ex Munson, and *V. vinifera* (Mortensen et al., 1994). The fruit of 'Southern Home' is much like a muscadine, but the leaves have a shape common to bunch grapes, with large lobes resulting in very attractive foliage. Yields were poor in the early years of fruiting but were more acceptable in 1997 and 1998. Berry weight was medium at 5.5 g. 'Southern Home' averaged 19.4% soluble solids, and fruit ratings were among the best of all cultivars. Berries are oval and very attractive, with a more crisp texture than most muscadines. Vine vigor was noted to be medium to medium-high. Winter injury was noted in the 1996 growing season following exposure to 1 °F in February of that year. Crown gall and aerial roots (an indication of winter injury) were also seen that year. Vines recovered from this injury and were very productive and medium-high in vigor by 1997 and 1998. The only fruit disease seen was powdery mildew on the berry surfaces in most years. This cultivar is recommended for consideration in the home garden owing to its attractive foliage, and this was the recommended use when it was released (Mortensen et al., 1994). Hardiness, berry weight, and yield concerns diminish its potential as a commercial cultivar.

'Sterling' (bronze, self-fruitful). Productivity of 'Sterling' was fair to very good in this trial. It also had one of the lowest percentage reductions in yield from 1989 to 1990 following -7 °F in December 1989, probably reflecting a higher level of hardiness than most cultivars tested. Berries were medium-large, averaging 6.8 g. Fruit quality was rated good for all characteristics, with its highest rating for evenness of ripening. Thick skin was noted, however. Fruit rots were noted in most years and were occasionally severe. Vine vigor was usually medium. Overall performance of the midseason 'Sterling' was good, but it is not the best midseason cultivar. Therefore, it is only marginally recommended for planting.

'Sugargate' (black, pistillate). Yields of 'Sugargate' varied from low to good but were not consistent in the trial. This cultivar was among the earliest ripening in the planting, with an average harvest date of 11 Sept. Berry weight averaged 10.3, and

‘Sugargate’ was one of the largest-fruited of the named cultivars in the trial. Soluble solids averaged 20.2%, the highest of the named entries. Fruit quality was rated very high for all characteristics except scar. It commonly had wet, torn scars at harvest. It was the top-rated cultivar for flavor, however. Fruit diseases were seldom seen, and this cultivar was among the least disease-susceptible of all cultivars, which may be related to its early harvest date. Vine vigor was medium to high, and hardiness was above average. It did suffer some winter injury in 1989 and again in 1997, but severe vine damage did not occur as it did with some of the other entries. Aerial roots were occasionally seen on cordons. Because of its early harvest date, good fruit quality, and low occurrence of disease, ‘Sugargate’ is recommended for planting for pick-your-own or other local sales outlets. It is a good choice to begin the harvest season. The wet, torn scar characteristic limits this cultivar for the shipping market.

‘Summit’ (bronze, pistillate). Productivity of ‘Summit’ was among the highest in many years of data collection. Fruit weight averaged 8.7 g, near that of ‘Fry’, another bronze-fruited, pistillate cultivar. The average harvest date was 17 Sept., a week earlier than ‘Fry’, and ‘Summit’ is considered an early midseason cultivar. ‘Summit’ was one of the sweetest named cultivars, averaging 19.7% soluble solids. ‘Summit’ was among the highest-rated cultivars for scar and flavor. Appearance was rated 7.6, and was not rated higher because of the commonly seen disease lesions on many fruit surfaces. Fruit rots, most likely either macrophoma or bitter rot, were usually seen on ‘Summit’ and were severe in some years. Vine vigor ranged from medium to high. Winter injury was seen in numerous years, but vines recovered well from this injury. The -7°F freeze in 1989 resulted in significant cordon damage, but no vines were killed to the ground. In several other years, including 1995 through 1998, aerial roots were seen on cordons, likely reflecting some degree of winter injury. Again, vine vigor was usually good, reflecting a tolerance to this injury. ‘Summit’ should be considered for planting for the early midseason, as it offers a good quality, bronze muscadine for this season.

‘Tara’ (bronze, self-fruitful). Added to the planting in 1991, ‘Tara’ yielded moderately in the trial. It ripened early midseason, with an average harvest date of 18 Sept. Berry weight averaged 9.1 g. ‘Tara’ was second only to ‘Dixieland’ among the perfect-flowered, named cultivars in the trial. ‘Tara’ was rated very high for scar and was acceptable for other fruit characteristics. Flavor was noted to be acceptable but not outstanding in all years of evaluation. ‘Tara’ fruit were softer than other entries, unusual for a muscadine cultivar, but were not damaged in handling. Fruit color was lighter than most other bronze entries, with a distinct semi-green fruit. In 1997 and 1998, some berry shrivel was seen at harvest, possibly reflecting a limitation for the fruit holding on the vine or a lack of stress tolerance during this commonly hot, dry period. It is not known whether this shriveling was related to the softer fruit texture.

Fruit rots were not commonly seen, and ‘Tara’ was judged to be one of the most disease-resistant cultivars. No winter injury was seen in any years. Vine vigor was medium to medium-high. ‘Tara’ should be considered for grower trial, since it performed quite well in this trial, and it can serve as a pollinizer cultivar for the numerous female-flowered cultivars with similar ripening dates.

‘Triumph’ (bronze, self-fruitful). Yields for ‘Triumph’ were quite variable and ranged from among the poorest to the best during the trial. The self-fruitful ‘Triumph’ ripened early, averaging 11 Sept. for its harvest date. Berry weight averaged 8.2 g. ‘Triumph’ rated very high for scar and rated good for other fruit characteristics except evenness of ripening, for which it averaged a rating of 6.7. Fruit diseases were not severe. Vine vigor varied from low to medium-high. The major shortcoming of ‘Triumph’ was lack of hardiness. Following the -7°F of December 1989, two vines died, one was killed to the ground, and the remaining two exhibited severe damage on cordons and spurs. Yield was greatly reduced on the surviving vines for several years after the freeze damage. Aerial roots were observed, along with some cordon winter injury, from 1996 through 1998. On the basis of this hardiness concern, ‘Triumph’ is not recommended unless a very early-ripening, bronze cultivar is needed.

‘Watergate’ (bronze, pistillate). This entry had very poor yields in the trial and was removed after fruiting in 1990. Berry weight averaged 7.4 g. Fruit quality ratings were not acceptable for most characteristics. It had severe winter injury in the December 1989 freeze. Therefore, this cultivar is not recommended for planting.

‘Welder’ (bronze, self-fruitful). A processing cultivar developed by the University of Florida, ‘Welder’ had variable yields in its four harvest years. Berry weight was the lowest of any entry, averaging 3.3 g. Evenness of ripening and flavor were judged acceptable, but other fruit characteristics were not rated highly. Powdery mildew was noted to be heavy in all years of fruiting. As might be expected from its area of origin, ‘Welder’ experienced severe winter injury following the -7°F freeze in December 1989, and only two of five vines produced any crop in 1990. On the basis of the hardiness limitations observed, ‘Welder’ was discarded in 1991 and is not recommended for planting.

CONCLUSIONS

Given the findings of this evaluation, the following cultivars are recommended for consideration for planting:

- Black, Pistillate: ‘Sugargate’; for trial (limited planting owing to some observed limitations), ‘Black Beauty’ (hardiness concern), ‘Jumbo’ (fruit quality concern).

- Black, Perfect-flowered: ‘Coward’, ‘Nesbitt’; for trial, ‘Southern Home’ (home garden).
- Bronze, Pistillate: ‘Fry’, ‘Summit’; for trial, ‘Darlene’ (lack of precociousness concern).
- Bronze, Perfect-flowered : ‘Carlos’; for trial, ‘Doreen’ (very late harvest), ‘Sterling’ (hardiness above-average), ‘Tara’ (fruit shrivel concern).

Growers should be aware that this trial did not include all cultivars released during this time period. There are several other cultivars released in recent years that have shown promise in other states, including ‘Supreme’, ‘Early Fry’, ‘Granny Val’, and ‘Scarlett’, but these were not tested in this planting. Additionally, a longtime processing industry standard cultivar, ‘Noble’, was not included in this planting, but this cultivar should also be considered for processing cultivar consideration. In addition, the location of the planting is a major consideration, since the trial was located in a northern area of Arkansas, which experiences extreme winter cold. Hardiness will not be as limiting in more southern areas of the state. However, data for fruit weight, quality, relative harvest date and disease susceptibility should be pertinent for other regions of the state.

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Table 1. Muscadine cultivars and selections, fruit color, flower type, origin, primary use, and year planted in the cultivar evaluation trial at the Fruit Substation, Clarksville.

Cultivar/ selection	Fruit color	Flower ^z type	Origin ^y	Primary ^x use	Year ^w planted
Alachua	Black	S	U. of Fla.	F, H	1994
Black Beauty	Black	P	Ison's	F, H	1994
Black Fry	Black	P	Ison's	F, H, P	1990
Carlos	Bronze	S	N.C. State	F, H, P	1982
Cowart	Black	S	U. Ga.	F, H, P	1982
Darlene	Bronze	P	Ison's	F, H	1990
Dixie	Bronze	S	N.C. State	F, H, P	1982
Dixieland	Bronze	S	Ison's	F, H	1982
Dixiered	Red-bronze	S	Ison's	F, H	1982
Doreen	Bronze	S	N.C. State	H, P	1982
Farrer	Black	P	Ison's	F, P	1990
Fla. Fry	Bronze	S	U. of Fla.	F, H	1992
Fry	Bronze	P	U. Ga.	F, H	1982
GA 15-17-2	Bronze	S	U. Ga.	F	1994
GA 15-6-2	Bronze	P	U. Ga.	F	1994
GA 28-11-1	Bronze	S	U. Ga.	F	1982
GA 29-10-2	Bronze	P	U. Ga.	F	1982
GA 29-4-4	Bronze	P	U. Ga.	F	1982
GA 33-2-1	Bronze	S	U. Ga.	F	1994
GA 33-3-4	Bronze	S	U. Ga.	F	1994
GA 3-4-1	Bronze	S	U. Ga.	F	1982
Golden Isles	Bronze	S	U. Ga.	P	1982
Ison	Black	S	Ison's	F, H	1990
Jumbo	Black	P	Ison's	F, P	1982
Late Fry	Bronze	S	Ison's	F	1994
Loomis	Black	P	U. Ga./Miss	F	1990
Magnolia	Bronze	S	N.C. State	H, P	1982
NC67A015-17	Black	S	N.C. State	F, P	1982
NC67A015-26	Black	S	N.C. State	F, P	1982
Nesbitt	Black	S	N.C. State	F, H	1982
Redgate	Red	S	Ison's	F	1982
Regale	Black	S	N.C. State	P	1982
Senoia	Red-bronze	S	U. Ga.	P	1982
Southern Home	Black	S	U. of Fla.	F, H	1992
Sterling	Bronze	S	N.C. State	P	1982
Sugargate	Black	P	Ison's	F, H	1982
Summit	Bronze	P	U. Ga.	F, P	1982
Tara	Bronze	S	U. Ga.	F, H	1991
Triumph	Bronze	S	U. Ga.	F, H	1982
Watergate	Bronze	P	Ison's	F, P	1982
Welder	Bronze	S	U. of Fla.	P	1982

^z S = self-fruitful or perfect-flowered; P = pistillate or female-flowered. If pistillate cultivars are planted, one or more self-fruitful cultivars must also be planted to provide pollen.

^y U. of Fla. = University of Florida (Leesburg, Fla.); Ison's = Ison's Nursery and Vineyard (Brooks, Ga.); N.C. State = North Carolina State University (Raleigh, N.C.); U. Ga. = University of Georgia (Griffin, Ga.); Miss. = USDA station, now closed (Meridian, Miss.).

^x F = fresh; H = home; P = processing.

^w Year planted in the trial.

Table 2. Minimum winter temperatures occurring at the Fruit Substation, Clarksville, 1986 through 1998.

Winter season	Minimum temperature recorded °F (°C)	Date recorded
1986–87	11 (–12)	November 13, 1986
1987–88	–2 (–19)	January 8, 1988
1988–89	8 (–13)	February 4, 1989
1989–90	–7 (–22)	December 22, 1989
1990–91	7 (–14)	December 24, 1990
1991–92	10 (–12)	January 16, 1992
1992–93	9 (–13)	February 18, 1993
1993–94	9 (–13)	January 19, 1994
1994–95	13 (–11)	January 8, 1995
1995–96	1 (–17)	February 4, 1996
1996–97	1 (–17)	January 15, 1997
1997–98	10 (–12)	March 11, 1998

Table 3. Muscadine cultivar yields (lb/vine) at the Fruit Substation, Clarksville.

Cultivar	Year										
	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998
Alachua	-	-	-	-	-	-	-	-	3.5 h ^r	17.0 c-e	32.0 a-f
Black Beauty	-	-	-	-	-	-	-	-	6.7 gh	9.3 fg	23.0 d-f
Black Fry	-	-	-	-	-	11.0 b-d	44.6 a-c	19.6 c-e	35.3 a-h	52.8 ab	44.7 a-e
Carlos	14.6 b-e	30.7 b-i	37.3 b-g	18.6 a	25.3 a-c	32.9 a-d	73.3 a	55.2 a	56.1 a-c	35.3 a-g	38.9 a-f
Cowart	-	-	11.4 fg	6.3 b	^y	^y	8.7 bc	22.5 c-e	41.7 a-g	48.1 a-d	39.1 a-f
Darlene	-	-	-	-	-	-	11.9 bc	14.9 c-e	42.5 a-g	46.5 a-f	32.0 a-f
Dixie	28.0 a-e	25.3 c-i	40.6 b-g	7.8 b	32.1 a-c	48.4 a-d	-	-	-	-	-
Dixieland	14.3 b-e	36.6 a-i	47.4 a-f	13.6 ab	25.1 a-c	4.5 c-d	-	-	-	-	-
Dixiered	52.4 a	49.7 a-c	75.2 ab	11.2 ab	36.2 a-c	64.6 a	-	-	-	-	-
Doreen	12.8 b-e	25.8 b-i	19.6 d-g	0.3 b	11.4 bc	26.8 a-d	42.0 a-c	52.3 ab	46.3 a-f	47.2 a-d	42.3 a-f
Farrar	-	-	-	-	-	-	28.8 ab	14.5 c-e	15.5 c-h	14.8 d-g	60.3 a
Fla. Fry	-	-	-	-	-	-	12.5 bc	17.3 c-e	30.3 a-h	45.7 a-d	29.5 a-f
Fry	25.4 a-e	39.2 a-g	51.8 a-e	0.2 b	^x	^x	32.6 a-c	26.5 c-e	55.9 a-c	60.3 a	44.0 a-e
GA 15-17-2	-	-	-	-	-	-	-	-	6.6 gh	14.7 d-g	14.7 ef
GA 15-6-2	-	-	-	-	-	-	-	-	9.7 fh	16.3 d-g	25.6 c-f
GA 28-11-1	17.0 b-e	28.8 b-i	47.5 a-f	24.4 a	24.2 a-c	39.1 a-d	-	-	-	-	-
GA 29-10-2	13.7 b-e	10.4 i	21.7 c-g	3.8 b	6.8 bc	14.2 a-d	-	-	-	-	-
GA 29-4-4	10.5 de	12.7 fj	21.0 c-g	18.8 a	15.0 bc	41.5 a-d	38.1 a-c	10.5 c-e	19.7 c-h	22.8 b-g	17.8 ef
GA 33-2-1	-	-	-	-	-	-	-	-	-	10.5 e-g	16.4 ef
GA 33-3-4	-	-	-	-	-	-	-	-	-	17.9c-e	17.3ef
GA 3-4-1	16.7 b-e	38.3 a-h	48.4 a-f	17.0 a	27.1 a-c	54.8 a-c	-	-	-	-	-
Golden Isles	15.1 b-e	15.2 e-i	29.3 c-g	6.7 b	2.9 c	3.9 c-d	-	-	-	-	-
Ison	-	-	-	-	-	3.1 d	14.2 bc	33.0 a-d	19.0 c-h	- ^w	-
Jumbo	41.4 a-d	62.1 a	57.4 a-d	2.1 b	7.2 bc	40.0 a-d	73.9 a	53.5 ab	67.0 a	44.7 a-e	54.4 a-c
Late Fry	-	-	-	-	-	-	-	-	10.8 d-h	30.7 a-g	12.8 f
Loomis	-	-	-	-	-	-	1.5 c	2.1 e	30.1 a-h	5.9 g	21.3 df
Magnolia	27.4 a-e	32.4 b-i	48.1 a-f	21.4 a	53.6 a	56.3 ab	-	-	-	-	-

continued

Table 3. Continued.

Cultivar	Year											
	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998	
NC67A015-17	4.0 e	16.8 e-i	31.9 c-g	18.2 a	18.8 a-c	22.6 a-d	58.8 ab	54.1 ab	63.2 ab	56.7 ab	57.0 ab	
NC67A015-26	21.5 a-e	28.8 b-i	57.3 a-d	13.6 ab	14.3 bc	38.8 a-d	41.9 a-c	33.2 a-c	37.0 a-h	50.8 a-c	51.4 a-d	
Nesbitt	13.9 b-e	26.7 b-i	28.7 c-g	4.5 b	15.9 a-c	24.8 a-d	35.8 a-c	31.7 a-d	50.1 a-c	41.2 a-f	53.9 a-c	
Redgate	41.4 a-d	45.9 a-d	84.5 a	3.8 b	-	-	-	-	-	-	-	
Regale	13.7 b-e	17.7 e-i	23.3 c-g	-	-	-	-	-	-	-	-	
Senoia	34.0 a-e	11.8 g-i	29.3 c-g	6.2 b	-	-	-	-	-	-	-	
So. Home	-	-	-	-	-	-	3.0 bc	7.0 de	8.8 f-h	36.1 a-g	35.4 a-f	
Sterling	11.4 c-e	21.0 d-i	32.8 c-g	16.3 a	37.9 a-c	61.6 ab	49.2 ac	34.2 a-c	47.6 a-e	40.0 a-g	37.8 a-f	
Sugargate	11.0 de	14.7 e-i	33.1 c-g	11.7 ab	17.6 a-c	46.4 a-d	74.2 a	29.0 b-d	48.0 a-d	37.1 a-g	18.6 ef	
Summit	45.8 a-c	40.0 a-f	76.3 ab	10.3 ab	44.8 ab	51.6 a-d	71.1 a	24.5 c-e	36.2 a-h	34.4 a-g	38.7 a-f	
Tara	-	-	-	-	-	2.7 d	20.7 a-c	23.4 c-e	20.4 c-h	46.2 a-d	27.3 b-f	
Triumph	20.7 a-e	28.6 b-i	57.4 a-d	3.2 b	5.4 c	17.6 a-d	24.0 a-c	30.5 a-d	29.2 a-h	54.3 ab	54.5 a-c	
Watergate	4.0 e	11.2 hi	15.4 e-g	2.9 b	-	-	-	-	-	-	-	
Weider	16.4 b-e	23.9 c-i	40.4 b-g	2.0 b	-	-	-	-	-	-	-	

Missing values in the table without superscripts indicate the cultivar was not present or fruiting in the planting that year.

z Values not followed by the same letter within columns are significantly different ($P \leq 0.05$ level) as determined by LSD.

y Cowart had four replications removed in 1991; fruit harvest data were not collected in 1992 or 1993.

x Fry had four replications removed in 1991; fruit harvest data were not collected in 1992 or 1993.

w Ison vines all died in the winter of 1996-97 or during the 1997 growing season due to winter injury.

Table 4. Muscadine cultivar berry weights (g) at the Fruit Substation, Clarksville.

Cultivar	Year												Average
	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998	1998	
Alachua	-	-	-	-	-	-	-	-	8.7 e- ^z	6.7 fj	5.0 h-j	6.8	
Black Beauty	-	-	-	-	-	-	-	-	14.2 a	8.9 c-f	10.0 a-d	11.0	
Black Fry	-	-	-	-	-	8.2 cd	11.2 a-c	9.6 cd	9.5 d-g	8.7 c-g	7.6 d-h	9.1	
Carlos	4.9 d-h	5.0 j-m	5.2 mn	5.0 f-h	6.2 gh	4.9 e-g	5.2 hi	5.5 g	8.5 l-n	5.1 j-l	5.0 h-j	5.5	
Cowart	-	-	5.4 l-n	4.4 gh	- ^y	- ^y	5.5 hi	5.5 g	4.6 mn	4.7 kl	4.4 j	4.9	
Darlene	-	-	-	-	-	-	12.4 a	12.9 a	12.6 ab	12.8 a	12.3 a	12.6	
Dixie	5.3 c-h	4.9 j-m	5.3 mn	5.2 f-h	5.4 hi	4.6 fg	-	-	-	-	-	5.1	
Dixieland	6.9 a-f	9.8 ab	10.7 b-d	9.2 a-d	12.5 a	11.9 ab	-	-	-	-	-	10.2	
Dixiered	5.0 d-h	5.9 f-k	7.3 h-j	6.1 c-h	6.9 e-h	7.0 df	-	-	-	-	-	6.4	
Doreen	4.3 f-h	4.3 k-m	4.2 no	3.1 h	3.8 i	3.6 g	4.2 i	3.6 h	4.5 n	4.0 l	4.8 ij	4.0	
Farrar	-	-	-	-	-	-	11.8 ab	11.0 bc	9.0 e-h	7.6 d-i	8.2 d-g	9.5	
Fla. Fry	-	-	-	-	-	-	9.9 c-e	8.7 de	7.7 g-k	5.6 i-l	5.9 g-j	7.6	
Fry	8.4 ab	8.7 a-c	10.4 b-d	- ^x	- ^x	-	9.8 c-e	11.8 ab	8.0 h-m	7.4 e-j	8.1 d-g	9.1	
GA15-17-2	-	-	-	-	-	-	-	-	7.4 h-k	5.1 j-l	4.9 ij	5.8	
GA15-6-2	-	-	-	-	-	-	-	-	11.3 b-d	8.4 c-g	8.8 c-f	9.5	
GA28-11-1	3.5 gh	5.0 j-m	5.4 l-n	5.7 e-h	4.1 i	3.6 g	-	-	-	-	-	4.6	
GA29-10-2	4.8 d-h	5.8 g-k	6.8 i-l	5.8 d-h	6.2 gh	6.4 d-g	-	-	-	-	-	6.0	
GA29-4-4	8.8 a	9.5 ab	12.7 a	8.9 a-e	9.5 b-d	11.0 bc	12.8 a	11.0 bc	11.7 bc	9.3 b-e	9.7 b-e	10.4	
GA33-2-1	-	-	-	-	-	-	-	-	-	9.8 b-d	11.8 ab	10.8	
GA33-3-4	-	-	-	-	-	-	-	-	-	6.5 g-j	6.3 fj	6.4	
GA34-1	7.6 a-d	7.5 d-g	9.1 e-g	7.9 a-f	10.3 bc	7.6 d-e	-	-	-	-	-	8.3	
Golden Isles	4.2 e-h	5.2 i-l	5.5 k-n	4.3 gh	6.7 f-h	6.0 e-h	-	-	-	-	-	5.4	
Ison	-	-	-	-	-	6.8 d-f	9.8 c-e	8.6 de	6.7 j-l	- ^w	-	8.0	
Jumbo	8.9 a	8.8 a-c	13.4 a	7.7 a-g	14.0 a	13.7 a	12.6 a	13.1 a	11.1 b-d	11.3 ab	10.9 a-c	11.4	
Late Fry	-	-	-	-	-	-	-	-	8.7 e-i	5.6 h-l	7.2 e-i	7.2	
Loomis	-	-	-	-	-	-	8.2 ef	6.9 fg	7.1 i-k	7.3 e-j	5.9 g-j	7.1	
Magnolia	5.0 d-h	5.5 h-l	5.4 l-n	5.7 e-h	6.4 f-h	5.0 e-g	-	-	-	-	-	5.5	

continued

Evaluation of Muscadine Grape Cultivars

Table 4. Continued.

Cultivar	Year													Average
	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998			
NC67A015-17	5.8 b-h	6.3 e-j	6.8 ij	6.2 c-h	7.5 e-g	5.6 f-h	7.3 fg	6.5 fg	6.3 j-m	5.8 h-l	4.9 ij	6.3		
NC67A015-26	5.0 d-h	4.8 j-m	5.8 k-m	5.4 f-h	5.9 gh	4.8 gh	5.4 hi	5.6 g	5.0 l-n	4.6 kl	4.2 j	5.1		
Nesblitt	7.4 a-e	7.6 c-g	9.8 c-f	8.0 a-f	10.6 b	8.7 cd	10.6 b-d	8.7 de	9.7 d-f	6.8 f-k	6.8 f-j	8.6		
Redgate	5.3 c-h	6.4 e-j	6.0 j-m	7.4 a-g	-	-	-	-	-	-	-	6.3		
Regale	4.3 f-h	3.8 lm	3.9 o	-	-	-	-	-	-	-	-	4.0		
Senoia	5.0 d-h	7.1 d-i	8.9 fg	7.6 a-g	-	-	-	-	-	-	-	7.2		
So. Home	-	-	-	-	-	-	6.3 gh	6.2 fg	6.0 k-n	4.0 l	5.0 h-j	5.5		
Sterling	5.6 b-h	6.2 e-j	6.5 j-m	5.7 e-h	8.2 d-f	7.2 d-f	7.6 fg	7.2 e-g	7.0 ij	6.7 l-k	6.7 f-j	6.8		
Sugargate	8.2 a-c	10.5 a	11.1 b	9.9 ab	10.6 b	9.3 b-d	11.4 a-c	12.0 ab	11.0 b-d	10.6 bc	8.9 c-f	10.3		
Summit	7.7 a-d	7.9 c-e	8.5 f-h	10.4 a	8.6 c-e	8.4 cd	8.9 d-f	9.7 cd	9.1 e-h	8.7 c-g	7.8 d-g	8.7		
Tara	-	-	-	-	-	8.7 cd	10.2 b-d	9.8 cd	10.5 c-e	8.1 c-h	7.2 e-i	9.1		
Triumph	6.8 a-f	8.1 c-e	8.1 g-i	8.9 a-e	9.3 bd	8.9 cd	9.0 d-f	7.9 ef	9.0 e-h	7.4 e-j	6.6 f-j	8.2		
Watergate	6.4 a-g	7.2 d-h	9.7 d-f	6.4 c-h	-	-	-	-	-	-	-	7.4		
Weider	3.1 h	3.3 m	3.4 o	3.2 h	-	-	-	-	-	-	-	3.3		

Missing value in the table without superscripts indicate the cultivar was not present or fruiting in the planting that year.

z Values not followed by the same letter within columns are significantly different ($P \leq 0.05$ level) as determined by LSD.

y Cowart had four replications removed in 1991; Fruit harvest data were not collected in 1992 or 1993.

x Fry had four replications removed in 1991; Fruit harvest data were not collected in 1992 or 1993.

w Ison vines all died in the winter of 1996-97 or during the 1997 growing season due to winter injury.

Table 5. Muscadine cultivar soluble solids (%) at the Fruit Substation, Clarksville.

Cultivar	Year											Average
	87	88	89	90	92	93	94	95	96	97	98	
Alachua	-	-	-	-	-	-	-	-	16.5 d-f ^z	19.3 c-g	16.7 e-g	17.5
Black Beauty	-	-	-	-	-	-	-	-	19.1 b-d	19.5 c-g	16.9 d-g	18.5
Black Fry	-	-	-	-	-	19.3 a-c	17.6 b-e	17.9 b-f	17.0 c-f	19.2 c-g	16.1 fg	17.9
Carlos	16.9 a-e	15.1 e-k	18.5 a-f	17.3 a-h	15.6 fg	17.1 cd	16.3 c-f	16.8 ef	16.3 ef	19.0 d-g	17.5 c-g	16.9
Cowart	-	-	20.4 a	19.5 a-d	^y	^y	17.6 b-e	17.3 c-f	17.4 b-e	20.6 b-e	19.1 a-f	18.8
Darlene	-	-	-	-	-	-	16.7 b-f	19.3 a-f	18.6 b-e	19.1 d-g	20.3 a-d	18.8
Dixie	17.7 a-e	17.3 b-h	19.7 a-c	21.5 a	19.1 a-c	22.1 a	-	-	-	-	-	19.6
Dixieland	17.7 a-c	17.8 b-f	19.5 a-d	17.5 a-h	18.6 a-d	19.0 a-d	-	-	-	-	-	18.4
Dixiered	16.4 a-e	16.4 h-k	16.6 c-h	19.1 a-f	16.6 d-g	17.4 c-d	-	-	-	-	-	17.1
Doreen	16.2 a-e	16.5 b-i	20.5 a	15.5 c-i	20.0 a	20.8 ab	22.0 a	16.8 ef	19.1 b-d	22.3 a-c	19.3 a-f	19.0
Farrar	-	-	-	-	-	-	15.2 f	19.8 a-e	17.2 c-f	19.7 c-g	17.2 d-g	17.8
Fla. Fry	-	-	-	-	-	-	16.9 b-f	18.7 a-f	17.5 b-e	19.6 c-g	17.7 b-g	18.1
Fry	17.8 a-e	16.5 b-i	18.0 a-e	19.5 a-d	^x	^x	18.2 bc	19.5 a-e	17-1 c-f	18.9 d-g	17.3 d-g	18.1
GA15-17-2	-	-	-	-	-	-	-	18.6 b-e	18.6 b-e	19.3 c-g	20.7 a-c	19.5
GA15-6-2	-	-	-	-	-	-	-	17.0 c-f	17.0 c-f	21.2 a-e	17.3 d-g	18.5
GA28-11-1	11.4 f	17.0 b-h	18.4 a-f	18.5 a-g	19.6 ab	14.2 e	-	-	-	-	-	16.5
GA29-10-2	16.4 a-e	15.4 d-j	19.0 a-e	15.9 c-i	16.8 c-g	20.6 ab	-	-	-	-	-	17.4
GA29-4-4	17.0 a-e	18.8 a-c	13.5 i	17.5 a-h	18.4 a-e	19.2 a-c	17.2 b-f	20.7 a-c	17.7 b-e	20.7 b-e	19.0 a-f	18.2
GA33-2-1	-	-	-	-	-	-	-	-	-	23.3 ab	21.5 a	22.4
GA33-3-4	-	-	-	-	-	-	-	-	-	23.8 a	19.7 a-e	21.8
GA3-4-1	18.2 a-d	15.7 c-j	18.1 a-f	16.8 c-h	16.5 d-g	18.8 b-d	-	-	-	-	-	17.4
Golden Isles	15.8 a-e	13.4 h-k	17.8 a-g	14.8 f-l	16.5 d-g	20.0 a-d	-	-	-	-	-	16.4
Ison	-	-	-	-	-	21.1 ab	16.7 b-f	17.6 b-f	18.5 b-e	^w	-	18.5
Jumbo	15.8 a-e	14.5 h-k	15.9 e-i	15.7 c-i	16.0 e-g	17.2 cd	16.5 c-f	15.9 f	14.9 f	17.2 fg	15.2 g	15.9
Late Fry	-	-	-	-	-	-	-	-	21.7 a	19.9 c-f	16.6 e-g	19.4
Loomis	-	-	-	-	-	-	18.6 b	18.1 b-f	18.0 b-e	19.7 c-g	17.1 d-g	18.3
Magnolia	16.0 a-e	14.6 g-k	17.6 a-g	16.9 b-h	14.4 g	18.4 b-d	-	-	-	-	-	16.3

continued

Evaluation of Muscadine Grape Cultivars

Table 5. Continued.

Cultivar	Year											Average
	87	88	89	90	92	93	94	95	96	97	98	
NC67A015-17	17.3 a-e	15.2 e-k	16.4 d-i	16.5 c-h	16.0 e-g	17.9 c-e	15.2 f	16.6 ef	17.1 c-f	19.2 c-g	17.1 a-g	16.8
NC67A015-26	18.8 a-c	17.1 b-h	19.1 a-d	19.0 a-f	17.3 b-f	19.5 a-d	16.1 d-f	18.3 b-f	19.2 bc	20.4 b-e	19.8 a-e	18.6
Nesblitt	17.6 a-e	14.7 f-k	18.2 a-f	14.5 f-i	15.2 fg	18.4 b-d	17.7 b-e	18.3 b-f	18.0 b-e	19.4 c-g	16.7 e-g	17.2
Redgate	17.5 a-e	17.8 b-g	18.4 a-f	19.0 a-f	-	-	-	-	-	-	-	18.2
Regale	13.5 ef	12.1 k	15.6 f-i	-	-	-	-	-	-	-	-	13.7
Senolia	14.5 c-f	18.0 b-e	16.6 c-i	16.8 c-h	-	-	-	-	-	-	-	16.5
So. Home	-	-	-	-	-	-	18.3 bc	20.4 a-d	19.9 ab	20.5 b-e	17.7 b-g	19.4
Sterling	17.5 a-e	18.5 a-d	19.5 a-d	16.7 c-h	18.2 a-e	17.2 cd	17.1 b-f	17.1 d-f	18.2 b-e	20.8 b-e	18.0 b-g	18.1
Sugargate	19.4 ab	21.1 a	18.5 a-f	20.0 a-c	20.4 a	21.9 a	18.0 b-d	21.0 ab	18.3 b-e	21.3 a-e	22.0 a	20.2
Summit	18.0 a-e	19.6 ab	16.8 c-h	21.4 ab	18.0 a-e	20.2 a-c	18.2 bc	21.9 a	19.3 bc	22.0 a-d	20.9 ab	19.7
Tara	-	-	-	-	-	19.4 a-c	15.8 ef	18.3 b-f	17.7 b-e	16.7 g	19.3 a-f	17.9
Triumph	18.0 a-e	18.5 a-d	18.1 a-f	19.3 a-e	18.1 a-e	19.8 a-c	16.6 b-f	17.1 d-f	18.3 b-e	18.3 e-g	19.4 a-f	18.3
Watergate	17.6 a-e	15.6 c-j	15.9 e-i	17.0 a-h	-	-	-	-	-	-	-	16.5
Weider	19.5 a	18.5 a-d	20.0 ab	19.0 a-f	-	-	-	-	-	-	-	19.3

Missing values in the table without superscripts indicate the cultivar was not present or fruiting in the planting that year.

^z Values not followed by the same letter within columns are significantly different ($P \leq 0.05$ level) is determined by LSD.

^y Cowart had four replications removed in 1991; Fruit harvest data were not collected in 1992 or 1993.

^x Fry had four replications removed in 1991; Fruit harvest data were not collected in 1992 or 1993.

^w Ison vines all died in the winter of 1996-97 or during the 1997 growing season due to winter injury.

Table 6. Harvest date and ratings for berry attachment scar, evenness of ripening, flavor, appearance, and overall quality for muscadine cultivars and selections, Fruit Substation, Clarksville.

Cultivar	Harvest date		Scar ^z		Evenness of ripening ^y		Flavor ^x		Appearance ^w		Overall quality ^v	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Alachua ^t	21 Sep	12	8.9	0.7	6.6	2.1	7.5	0.7	7.6	1.0	7.3	1.4
Black Beauty ^t	25 Sep	4	7.2	0.8	8.1	1.0	8.0	0.0	8.4	0.5	8.6	0.3
Black Fry ^u	27 Sep	7	7.0	0.5	7.7	0.9	7.6	0.7	7.5	0.8	7.5	0.8
Carlos ⁿ	20 Sep	7	9.3	0.4	8.5	0.6	7.6	0.4	7.7	0.5	7.9	0.6
Cowart ^p	23 Sep	5	6.2	1.1	9.6	0.4	8.1	0.7	9.2	0.5	8.5	0.6
Darlene ^r	16 Sep	6	7.2	0.7	7.8	0.8	7.8	0.3	7.8	1.1	7.5	0.8
Dixie ^r	24 Sep	7	6.9	0.6	7.5	0.9	8.5	0.8	7.1	0.9	7.0	0.9
Dixieland ^q	26 Sep	6	7.0	0.7	7.3	0.6	7.8	0.8	7.2	1.0	7.0	0.8
Dixiered ^q	21 Sep	7	7.1	0.8	6.7	0.5	7.1	0.6	6.7	0.6	6.8	0.3
Doreen ⁿ	04 Oct	6	8.8	1.0	7.3	0.5	7.7	0.7	7.8	0.5	7.8	0.7
Farrel ^s	22 Sep	7	6.5	0.6	6.3	1.0	7.3	0.5	6.8	0.5	6.8	0.5
Fla. Fry	22 Sep	4	8.5	0.5	6.5	0.6	7.3	0.5	7.0	0.6	7.1	0.6
Fry ^o	24 Sep	6	7.2	0.8	7.3	0.4	8.6	0.5	7.8	0.5	7.7	0.5
GA15-17-2 ⁱ	10 Sep	1	7.2	0.2	7.3	1.2	7.1	0.2	6.0	1.0	6.3	0.6
GA15-6-2 ⁱ	25 Sep	5	7.9	0.9	6.4	0.4	7.2	0.4	6.4	0.4	7.1	0.2
GA28-11-1 ^q	26 Sep	6	7.1	1.1	6.5	1.4	6.7	0.8	6.7	0.5	6.5	0.5
GA29-10-2 ^h	30 Sep	10	7.1	0.7	6.3	1.3	7.6	0.7	6.8	0.7	6.8	0.8
GA29-4-4 ⁿ	26 Sep	5	8.1	0.6	6.6	0.8	8.3	0.6	7.3	0.9	7.4	0.8
GA33-2-1 ^u	13 Sep	7	9.0	0.0	6.8	0.2	8.3	0.5	6.5	0.3	7.8	1.2
GA33-3-4 ^u	20 Sep	2	9.0	0.0	7.2	0.2	7.3	0.5	6.7	0.0	6.8	0.2
GA3-4-1 ^q	24 Sep	9	9.4	0.7	6.9	0.6	7.9	0.7	7.8	0.9	8.0	0.7
Golden Isles ^q	24 Sep	9	7.7	0.5	6.4	1.5	5.8	0.8	5.7	1.5	5.6	1.5
Ison ^s	22 Sep	11	8.3	1.0	8.5	0.6	6.8	1.0	8.0	1.4	7.1	1.5
Jumbo ⁿ	26 Sep	5	7.1	0.7	7.2	0.9	6.8	0.4	7.5	0.4	6.9	0.5
Late Fry ^t	25 Sep	5	8.7	0.6	5.9	1.2	7.7	1.3	6.3	1.2	6.3	1.2
Loomis ^r	27 Sep	4	7.8	0.7	8.1	1.3	8.2	0.7	8.2	0.6	8.1	1.2
Magnolia ^q	24 Sep	6	7.5	0.6	7.7	0.7	6.5	0.7	7.3	0.6	7.0	1.0

continued

Table 6. Continued.

Cultivar	Harvest date		Scar ^z		Evenness of ripening ^y		Flavor ^x		Appearance ^w		Overall quality ^v	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NC67A015-1 ⁿ	19 Sep	9	9.1	0.8	8.6	0.7	8.0	0.8	8.9	0.6	8.6	0.7
NC67A015-26 ⁿ	20 Sep	8	8.7	0.6	9.1	0.7	8.5	0.9	9.2	0.8	8.8	0.8
Nesblitt ⁿ	24 Sep	7	8.3	0.8	8.4	0.7	8.4	0.5	8.9	0.8	8.8	0.5
Redgate ^s	23 Sep	8	5.5	1.1	6.8	1.0	7.5	1.0	6.3	1.0	6.3	1.0
Regale ^t	19 Sep	10	6.5	0.9	8.2	0.8	6.0	1.0	7.2	1.4	6.7	1.5
Senoia ^s	15 Sep	3	7.1	0.8	7.1	0.6	7.3	0.5	6.9	0.8	6.9	1.0
So. Home ^r	21 Sep	7	8.5	1.6	9.0	0.7	8.3	0.5	8.9	0.3	8.9	0.1
Sterling ⁿ	23 Sep	6	7.8	0.6	8.4	0.9	7.4	0.6	7.6	1.0	7.5	1.7
Sugargate ⁿ	11 Sep	4	6.2	1.1	8.8	0.7	8.9	0.6	8.6	0.7	8.3	0.6
Summit ⁿ	17 Sep	5	9.0	0.5	7.5	0.9	8.9	0.5	7.6	0.6	8.2	0.7
Tara ^q	18 Sep	9	9.3	0.4	7.5	1.0	7.1	0.7	8.0	0.6	7.8	1.0
Triumph ⁿ	10 Sep	6	8.9	0.5	6.7	0.9	7.8	0.9	7.1	0.5	7.5	0.7
Watergate ^s	18 Sep	2	6.2	0.4	5.3	1.7	7.1	0.5	6.2	0.9	6.3	0.5
Weider ^s	25 Sep	10	6.8	0.5	7.8	0.6	7.2	0.2	6.3	1.0	6.5	1.0

Total harvest from each replication of each vine was rated using a scale of 1 to 10 with 10 = the most desirable rating for the trait, but a rating of 7 or above was considered acceptable.

SD = standard deviation.

^z Scar rated highest if the cultivar had berries with small, dry scars.

^y Evenness of ripening was rated highest if fruit were evenly ripened at harvest.

^x Flavor rating was highest based on a combination of flavor components of sweetness, true muscadine fruitiness, and the undesirable flavor components.

^w Berry appearance was rated highest for attractive berries, including even color, freedom from blemish or other surface deficiency, and free of disease symptoms.

^v Overall quality was rated based on a combination of various quality components of the fruit such as scar, evenness of ripening, and appearance, along with the absence of disease and uneven berry size.

^u Mean of 2 years.

^t Mean of 3 years.

^s Mean of 4 years.

^r Mean of 5 years.

^q Mean of 6 years.

^p Mean of 7 years.

^o Mean of 9 years.

ⁿ Mean of 11 years.

Conversion Table

		U.S. to Metric		Metric to U.S.	
to convert from	to	multiply U.S. unit by	to convert from	to	multiply metric unit by
length			length		
miles	kilometers	1.61	kilometers	miles	.62
yards	meters	.91	meters	yards	1.09
feet	meters	.31	meters	feet	3.28
inches	centimeters	2.54	centimeters	inches	.39
area and volume			area and volume		
sq yards	sq meters	.84	sq meters	sq yards	1.20
sq feet	sq meters	.09	sq meters	sq feet	10.76
sq inches	sq centimeters	6.45	sq centimeters	sq inches	.16
cu inches	cu centimeters	16.39	cu centimeters	cu inches	.06
acres	hectares	.41	hectares	acres	2.47
liquid measure			liquid measure		
cu inches	liters	.02	liters	cu inches	61.02
cu feet	liters	28.34	liters	cu feet	.04
gallons	liters	3.79	liters	gallons	.26
quarts	liters	.95	liters	quarts	1.06
fluid ounces	milliliters	29.57	milliliters	fluid ounces	.03
weight and mass			weight and mass		
pounds	kilograms	.45	kilograms	pounds	2.21
ounces	grams	28.35	grams	ounces	.04
temperature			temperature		
F	C	$5/9(F - 32)$	C	F	$9/5(C + 32)$