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Performance of Muscadine Grape Cultivars in Southern Georgia

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Abstract

A trial of 31 muscadine grape cultivars was evaluated in southern Georgia, USA, from 2004 through 2008. The vineyard was planted in 2000 and expanded in 2006. Vines were evaluated for vigor, leaf and fruit disease, harvest period, ripening uniformity, pedicel scar, and visual estimation of crop load. In 2007 and 2008 berry weight, berry diameter, and percent soluble solids was measured on a subset of the cultivars. Based on these data, 'Early Fry', 'Fry', 'Summit' and 'Supreme' are recommended as main cultivars for the commercial fresh fruit market in Georgia. 'Triumph', 'Tara', and 'Granny Val' are recommended as commercial market pollinizers. Additionally 'Nesbitt' and 'Cowart' are recommended as pick-your-own pollinizers. 'Noble' is recommended as a black juice grape, and growers are encouraged to try 'Doreen' and 'Welder' as replacements for 'Carlos' as bronze juice grapes with better fruit rot resistance.

The genus *Vitis* contains two subgenera, Euvitis Planch. (bunch grapes) and Muscadinia Planch. (muscadine grapes). The muscadine grape, *Vitis rotundifolia* Michx., is the only commonly cultivated member of the *Muscadinia* subgenus. Muscadines range naturally from Delaware to central Florida and along the Gulf of Mexico to eastern Texas (6,9), and can commonly be found growing wild within their natural range. Muscadine grapes have been cultivated for over 400 years (9). The muscadine grape differs from the familiar bunch grape (*Vitis labrusca* L., *V. vinifera* L., and their various hybrids) by the presence of smaller clusters, unbranched tendrils, and thick-skinned berries with a unique fruity aroma. The berries also abscise (shatter) at maturity.

Muscadine grapes grow best on fertile sandy loams and alluvial soil and grow poorly on wet and heavy soils (8). Muscadines need a long growing season, requiring approximately 100 days to mature fruit. They are not tolerant of extremely cold winter temperatures and are not widely grown in regions where temperatures go lower than -12 °C to -18 °C (8).

Alternative crops are being explored by many Georgia growers as a means of increasing profits or diversifying farm operations. Muscadine grapes are grown throughout the state of Georgia, except in the cold mountain region. The size of bearing age commercial plantings ranges from less than one hectare to a few hundred hectares. During the 10-year period 1990-1999 there was an average of 600 ha of bearing-age grape vines in Georgia (4), primarily muscadines but also including some bunch grapes grown in the mountain region. Utilized production in Georgia over this 10-year period averaged 2540 MT per year for an average annual farmgate value of U.S. $2.7 million (4). About 1,620 ha were grown throughout the southern U.S.A. during this same time (1). While fresh market muscadines have always been popular in this region, there has been a recent increase in consumption of juice and wine products. Muscadine wines are gaining in regional appeal as consumers begin to appreciate their unique fruity bouquet and the positive health effects derived from moderate consumption (10).

Numerous muscadine cultivars are of commercial importance. Olien (8) listed 25 important cultivars, with various states growing from 1 to 14 of them. Newer cultivars have increased in importance since that report, and there is continuing interest in developing improved cultivars better suited to growers'

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needs. The current muscadine production guide for Georgia (5) lists 34 fresh market cultivars (nine most recommended) and six processing cultivars. Muscadine cultivars have recently been evaluated in other growing regions including Florida (1), Mississippi (12), and Arkansas (2). This report evaluates 31 muscadine cultivars (Table 1) in Tifton, Georgia which is located in the southern coastal plain near the largest muscadine acreage in Georgia.

Materials and Methods

The vineyard was established in 2000 in Tifton, Georgia (31° 30'N, 83° 31'W) which is close to the major muscadine production regions within the state. The soil at the site is a Tifton loamy sand with a pH of 5.7. Winter lows in Tifton are typically -5 to -10 °C and summer highs are 38 to 40 °C. Vines were planted at a spacing of 3 m between vines within the row and 4.5 m between rows. Vines were trained to a single wire trellis 1.5 m above

Table 1. Flower type, berry color, year of introduction, and variety protection status of muscadine grape cultivars studied.

Cultivar	Flower type[z]	Berry color	Year introduced	Variety protection[y]
Alachua	SF	Black	1990	U
Carlos	SF	Bronze	1970	U
Cowart	SF	Black	1960	U
Darlene	F	Pink/Bronze	1988	PE
Dixieland	F	Bronze	1976	PE
Doreen	SF	Bronze	1981	U
Early Fry	F	Bronze	1993	P
Fry	F	Bronze	1970	U
Golden Isles	SF	Pink/Bronze	1987	U
Granny Val	SF	Bronze	1983	PE
Higgins	F	Pink/Bronze	1955	U
Jumbo	F	Black	1970	U
Loomis	F	Red	1989	U
Magnolia	SF	Bronze	1954	U
Magoon	SF	Red/Black	1959	U
Nesbitt	SF	Black	1985	U
Noble	SF	Black	1973	U
Pam	F	Bronze	1988	PE
Polyanna	SF	Red/Black	1998	U
Pride	F	Black	1972	U
Regale	SF	Black	1981	U
Scarlett	F	Pink	1997	P
Scuppernong	F	Bronze	Wild Selection	U
Southland	SF	Black	1950	U
Sterling	SF	Bronze	1981	U
Summit	F	Pink/Bronze	1977	U
Supreme	F	Black	1988	PE
Sweet Jenny	F	Bronze	1986	PE
Tara	SF	Bronze	1993	U
Triumph	SF	Pink/Bronze	1971	U
Welder	SF	Bronze	1972	U

[z] (F) female, (SF) self-fertile

[y] (P) patented, (PE) patent expired, (U) unpatented

the ground and were annually spur pruned to two nodes per spur. For most cultivars, two replications were planted for each cultivar with each replication consisting of two vines planted in a 6 m trellis section between the posts. However, for 'Pam', 'Supreme', 'Granny Val', 'Early Fry', 'Darlene', and 'Sweet Jenny', one replication was planted in 2000 and the other in 2006. Vines were watered via a drip tube with two 4 $L \cdot h^{-1}$ emitters per vine distributing 15 L of water per vine per day. Vines were fertilized according to commercial recommendations (5), with mature vines receiving 22 $kg \cdot ha^{-1}$ of 10 N – 10 P – 10 K broadcast in the spring of the year. Diseases and insects were controlled according to commercial guidelines (10), normally resulting in 4-5 fungicide applications and 0-1 insecticide application. Weeds were controlled in a 3 m wide strip under the trellis using labeled post-emergent herbicides.

Because the vines were being actively used in my breeding program, actual yields were not taken due to flowers and fruit being used for crossing. Visual estimations of yield were recorded at the beginning of the harvest season and vines were subjectively rated for percentage of a full crop, to the nearest 10%. The values generally varied from a low of 20% to a high of 120% for those vines that overloaded with fruit. Vines were subjectively rated for vine vigor in 2004, 2005, and 2008 with vigor rated as low, medium, or high based on tendril length and trunk diameter. Leaf disease was rated during the 2004, 2005, and 2008 harvest as none, slight, moderate, or high. Harvest period was rated as very early, early, midseason, late, or very late. Uniformity of ripening of the berries was rated as very even, even, uneven, or very uneven in 2004, 2005, 2007, and 2008. Percentage dry scar was evaluated by picking 10 berries per replication and determining the percentage of berries with no tearing of the epidermis or leaking of juice. Berries were evaluated for dry scar in 2004, 2005, 2006, 2007, and 2008 and the average percentage dry scar for all years and replications is presented. Fruit were observed at time of harvest for berry rot and rot prevalence was rated as none, slight, moderate, or heavy. In 2007 and 2008, 10 berries were collected from each vine and berry weight, berry diameter, and percent soluble solids were measured. Average values across years and least significant differences were reported for percent full crop, percent dry scar, berry weight, berry diameter, and percent soluble solids.

Results and Discussion

Vine growth was generally quite vigorous (Table 2) and no vine death occurred during the study. Yield potential varied dramatically from a low of 20% of a full crop for 'Loomis' to a high of 110% for 'Golden Isles' (Table 2). In general, self-fertile cultivars produced larger, more consistent crops than did female vines (Table 2). This factor is well-known among growers and is the primary reason self-fertile cultivars are preferred to female cultivars. Several cultivars had yields too low or uneven for commercial use including 'Darlene', 'Loomis', 'Pam', 'Scarlett', 'Scuppernong', and 'Sweet Jenny'. All these cultivars are female, suggesting pollination may have been a limiting factor. Lack of pollinators was not likely a problem as this vineyard contained nearly equal numbers of female and self-fertile vines. I commonly observed "cap stick" problems on 'Scarlett' where the petals did not fall off preventing pollination from taking place. Other cultivars such as 'Darlene' simply did not produce enough flower clusters for a full crop in several years. Three cultivars, 'Granny Val', 'Golden Isles', and 'Regale' set a larger crop than optimum. This was a particular problem in 'Golden Isles' because this cultivar also had low vine vigor (Table 2) and there was seldom enough canopy to fully ripen the large crop. These cultivars might benefit from cluster thinning to reduce crop load and increase quality, but this is currently not practiced in commercial muscadine operations.

Leaf disease was primarily composed of black rot (*Guignardia bidwellii* f. *muscadinii* (Ellis) Viala &Rvaz) and angular leaf spot (*Mycosphaerella angulata* Jenkins). Most cultivars had only slight to moderate leaf disease as fungicide sprays were employed to

Table 2. Vine vigor, leaf disease ratings, productivity, harvest period, ripening evenness, percent dry scar, and berry rot ratings of 31 muscadine grape cultivars at Tifton, GA.

Cultivar	Vine vigor	Leaf disease	%Full crop *(cv)*	Harvest period	Ripening	% Dry scar	Berry rot
Years evaluated	2004 2005 2008	2004 2005 2008	2004 2005 2006 2007 2008	2004 2005 2007 2008	2004 2005 2007 2008	2004 2005 2006 2007 2008	2004 2005 2007 2007
Alachua	M/H[z]	S[y]	100 (0)[x]	M[w]	E[v]	50	S[y]
Carlos	H	S	90 (30)	M	E	90	H
Cowart	M	S	90 (10)	M	E	30	S
Darlene	H	S	40 (20)	M	E	20	S
Dixieland	M	S	90 (10)	L	U	10	S
Doreen	H	N	90 (20)	L	E	60	S
Early Fry	M	S	80 (20)	E	E	20	S
Fry	M	S	70 (30)	M	E	30	S
Golden Isles	L	M	110 (10)	L	VU	10	M
Granny Val	M/H	M	110 (10)	VL	U	50	S
Higgins	H	M	70 (20)	L	U	30	M
Jumbo	H	S	80 (30)	M	E	30	S
Loomis	H	N	20 (110)	L	U	30	S
Magnolia	H	N	90 (10)	M	E	90	M
Magoon	M	S	90 (10)	L	E	60	S
Nesbitt	M	M	100 (10)	M/L	VU	40	S
Noble	H	S	100 (10)	M	E	30	S
Pam	M/H	M	60 (60)	L	U	40	M
Polyanna	M/L	M	80 (10)	L	VU	70	N
Pride	H	M	90 (50)	M	E	40	S
Regale	H	S	110 (10)	M	VE	10	S
Scarlett	H	S	30 (40)	M	E	70	S
Scuppernong	H	S	40 (30)	L	U	60	N
Southland	M	N	90 (20)	L	E	100	S
Sterling	M/H	M	100 (0)	L	E	10	H
Summit	H	N	80 (20)	M	E	80	S
Supreme	M	S	90 (30)	M	U	60	N
Sweet Jenny	H	S	50 (50)	M	E	30	S
Tara	M	S	90 (10)	E	E	80	S
Triumph	H	S	100 (0)	E	U	60	S
Welder	H	S	90 (20)	M	E	50	M
LSD 0.05			15.3			22.0	

[z] (H) high, (M) medium, (L) low
[y] (N) none, (S) slight, (M) moderate, (H) heavy
[x] Coefficent of variation (%) of yield estimates
[w] (E) early, (M) midseason, (L) late, (VL) very late
[v] (VE) very even, (E) even, (U) uneven, (VU) very uneven

limit disease. 'Doreen', 'Loomis', 'Magnolia', 'Southland', and 'Summit' had the least leaf disease in this trial (Table 2).

Harvest period ranged from the first week of August through early September. Harvest generally began with the cultivars 'Triumph', 'Tara', and 'Early Fry', and concluded with 'Granny Val'. There is a market for muscadines throughout the harvest period in the southern U.S., and there is interest in new late-maturing cultivars for harvest after 'Granny Val'. Because it is difficult to store muscadines for long periods, one grower has reportedly developed methods of double cropping cultivars in order to provide fresh fruit from the end of September through early October. This is apparently accomplished by early summer pruning which results in the production of new shoots and flowers. The exact procedures used are closely guarded and not widely known.

Evenness of berry ripening is an important trait in assessing the usefulness of a cultivar for a particular market. Some cultivars tend to ripen berries in an uneven fashion with berries at several maturity states within the same cluster. Other cultivars ripen all berries at the same time. Even ripening is desirable for once or twice over harvesting for commercial fresh fruit markets and essential for mechanical harvest for processing. Uneven ripening is more suitable for home use or pick-your-own operations where a longer harvest period will ensure fruit is available for a long period. 'Nesbitt' and 'Polyanna' had very uneven ripening, limiting their usefulness as commercial fresh-fruit cultivars.

Wild muscadine vines normally have berries that shatter from the vine at maturity. Early selection was practiced for non-shattering berries so that the fruit could be more easily collected (3, 11). Current preference is for fruit with a dry, non-tearing pedicel scar to avoid leaking of juice resulting in mold growth and fermentation. There was a very large variation in the percentage of berries with a dry scar, ranging from a low of 5% for 'Regale' to a high of 96% for 'Southland' (Table 2). The newer University of Georgia releases such as 'Summit' (78%), 'Triumph' (60%), and 'Tara' (78%) had a greater percentage of dry scars than older releases such as 'Fry' (34%) and 'Cowart' (31%), reflecting the emphasis in selection placed on this trait.

Despite the application of preventative fungicide sprays, berry rot was significant in many years. Fruit rot-inducing diseases observed in the vineyard included bitter rot (*Greeneria uvicola* (Berk. & Curt.) Punithalingam, syn. *Melanconium fuligineum* (Scribner &Viala) Cav.), ripe rot (*Glomerella cingulata* (Stonem.) Spauld. & Schrenk), and macrophoma rot (*Botryosphaeria dothidea* (Moug. Ex Fr.) Ces. & de Not). Fruit rots varied in prevalence across cultivars and years, and often more than one disease occurred on a single berry making the identification of specific disease-causing organisms difficult. Instead, cultivars were evaluated on the prevalence of any fruit rot at harvest time. Fruit rot was particularly heavy for 'Carlos' and 'Sterling' (Table 2), both bronze juice cultivars. 'Carlos' is the most popular bronze cultivar for juice, but in many years fruit rot resulted in poor quality berries. Growers in this region should consider 'Doreen', which has similar productivity (Table 2), and higher SSC (Table 3), but was selected for high levels of disease resistance and mechanical harvest ability (7).

Berry size is an important aspect for fresh market cultivars. Generally, growers prefer a berry diameter of at least 2.5 cm for fresh market use. Unfortunately, very large berry size is often associated with pistillate flowers either due to metaxenia or gene linkage (13). No self-fertile cultivars were as large as the largest female cultivars 'Pam', 'Supreme', 'Darlene', 'Sweet Jenny', and 'Early Fry' (Table 3). However, the self-fertile cultivars 'Tara', 'Polyanna', and 'Nesbitt' were similar in size to 'Fry', the standard fresh-market cultivar (Table 3). Percent soluble solids averaged about 16% in 2007 and 14% in 2008 (individual data not shown, means shown in Table 3). Cultivars averaging around 16% soluble solids include 'Alachua', 'Early Fry', 'Scarlett', 'Summit', 'Triumph', and 'Welder'. Cultivars averaging 13% or less include 'Nesbitt', 'Pam', 'Scuppernong', and 'Sterling'.

Table 3. Berry weight, diameter, and percent soluble solids of 23 muscadine cultivars during 2007 and 2008 at Tifton, GA.

Cultivar	Berry weight (g)	Berry diameter (mm)	Soluble solids (%)
Alachua	7.4	22	15.5
Carlos	5.3	20	13.8
Cowart	8.7	24	14.7
Darlene	16.3	29	15.1
Doreen	4.4	19	14.4
Early Fry	15.2	29	16.0
Fry	12.7	27	15.3
Golden Isles	6.4	21	13.7
Magnolia	5.5	20	13.5
Nesbitt	10.1	25	13.4
Noble	3.7	18	14.3
Pam	18.7	31	12.4
Polyanna	10.7	26	14.8
Scarlett	12.4	27	16.8
Scuppernong	5.1	20	12.8
Sterling	8.4	24	13.3
Summit	10.4	25	16.1
Supreme	17.7	31	13.9
Sweet Jenny	16.2	29	15.2
Tara	12.7	27	14.1
Triumph	9.4	24	15.8
Welder	4.0	18	15.8
LSD (0.05)	1.4	1.3	1.4

Conclusions. The most recent Georgia Muscadine Production Guide (5) recommends 'Granny Val', 'Tara', and 'Triumph' as commercial pollinizers, and 'Nesbitt' and 'Cowart' as additional potential pick-your-own pollinizors for the fresh-fruit market. The results of this test support those recommendations. 'Polyanna' is a newer self-fertile cultivar that was recommended for trial in that guide. However, very uneven ripening and late harvest date limit its usefulness for commercial production. There is currently a strong need for new self-fertile cultivars with very large berry size and dry pedicel scars.

Female cultivars recommended for fresh fruit production in Georgia included 'Fry', 'Summit', and 'Supreme', with 'Darlene', 'Early Fry', 'Pam', 'Scarlett', and 'Sweet Jenny' listed for trial use (5). 'Fry' is still the leading bronze commercial cultivar in this region and is well known by growers. However, 'Summit' had similar production, drier pedicel scars, and less berry rot than 'Fry' (Table 2) with only a slightly smaller berry size (Table 3) and may be a better choice for commercial production. 'Supreme' is very popular in this region because of its very large berry size. Unfortunately vine vigor is only medium and the skin has a tendency to tear next to the pedicel scar during picking. 'Darlene', 'Pam', 'Scarlett', and 'Sweet Jenny' all had low or uneven yields in this test and are not recommended. 'Early Fry' had good yields, early harvest, large size, and high soluble solids and is recommended for this region. Cultivars not listed in the Georgia guide but which are not recommended based on this trial include 'Dixieland', which had too low a percentage of dry scars, 'Magoon', which had a small berry size (data not shown), and 'Pride' which had very poor flavor in this test (data not shown).

A relatively small market for juice grapes

exists within this region, and 'Carlos' is most often grown for bronze juice and 'Noble' for black juice. 'Noble' was very vigorous, productive, and without significant cultural issues and remains the best choice for a black juice grape. As noted earlier, significant losses can occur on 'Carlos' due to berry rot. Growers should try 'Doreen' and perhaps 'Welder' as a replacement bronze juice cultivar. 'Golden Isles' is not recommended as it has lower vine vigor and tends to overcrop leading to poor fruit quality.

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Water Consumption In Avocado Rootstocks

Sap flow rate and xylem vessel features were studied in non-grafted and grafted avocado trees, namely clonal Duke 7 (D7) and Toro Canyon (TC) trees and 'Hass' clonal scions grafted onto clonal D7 (H/D7) and TC (HITC) rootstocks. Sap flow rate was 29% higher in D7 than TC (grafted and non-grafted trees). Xylem vessel features in the stems did not differ among varieties; in the roots, D7 had wider and fewer vessels than TC, and D7 had 19% more vessel area than TC. They suggest that the differences in water consumption of 'Hass' on different rootstocks may relate to the area of xylem vessels in the root. For details, see Fassio et al. Scientia Hort. 120(1):8-13.