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Muscadine Traits Potentially Useful in Breeding

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Abstract

Twenty-seven muscadine cultivars were evaluated to characterize them for traits that are potentially useful in breeding. Ranges among cultivars were: Yield-31 Kg per vine, percentage of berries with dry scar-41, berry weight-10 g, °Brix-6, number of seeds per berry-1, pH of ripe berries-0.9, and seed weight-8 g, suggesting that gains from breeding is possible for most traits. Fresh fruit cultivars need improvement in one or more of these traits. Pearson correlation coefficients of yield versus berry weight and seed weight were either negative or non-significant. Unlike most small fruits, berry weight was either not correlated or negatively correlated with number of seeds per berry. Variation in seed count among cultivars was small. Most cultivars produced three or four seeds per berry. Only 'Summit' and 'Fry' produced less than three seeds per berry. Except in 1998, the relationship between number of seeds per berry and seed weight was not significant.

Introduction

Muscadines (*Vitis rotundifolia* Michx) have been cultivated in the southeastern United States since the Mid 18th Century (9). The first cultivars were simply selections from the wild. The first and most important of these was 'Scuppernong' identified in the Mid 1700s (5, 9). All early cultivars were pistillate and required pollen from another vine for fruit set (10). The development of perfect-flowered, self-fertile cultivars was a major goal of early breeding programs. The first self-fertile cultivars were released in 1948 (3). Since that time, many hermaphroditic cultivars have been released (2). However, most of the so-called "fresh fruit" cultivars released in the 1970s and 80s are pistillate and have large fruit, eg. 'Black Beauty,' 'Black Fry,' 'Darlene,' 'Fry,' 'Jumbo,' 'Pam,' 'Supreme,' and 'Sweet Jenny.' Several hermaphroditic fresh fruit cultivars, eg. 'Alachua,' 'Ison,' 'Janebell,' 'Janet,' 'Nesbitt,' and 'Tara,' were released between 1985 and 1990 but their berry size is smaller than that of the forenamed cultivars. Improvements are still needed in skin tenderness, pulp texture, and seed size in cultivars developed for the fresh fruit market. 'Alachua,' 'Southern Home,' and 'Tara' have thin skins and crunchy pulps which are desirable for table grapes. Several selections from the Georgia and Florida breeding programs have these desirable traits (unpublished data).

The discovery that resveratrol in *V. vinifera* and *V. labrusca* has cancer chemopreventive activity (6) led to the evaluation of muscadines for resveratrol content. It has been reported that resveratrol is only synthesized in the skin of *V. vinifera* and *V. labrusca*. Ector et al. (4), however, found an average of about 44 µg/g resveratrol in muscadine seed, which is about 44 X that reported in other grape seed. Resveratrol concentrations in wines made from *V. rotundifolia* were higher than those in *V. vinifera* and *V. labrusca* grapes (7). These findings may have implications on skin thickness or seed size when breeding muscadines.

The objectives of the present study were: 1) to collect and preserve muscadine germplasm; 2) to evaluate the germplasm for traits potentially useful in breeding; and 3) to determine correlations among traits that might be useful in breeding.

Materials and Methods

Twenty-two muscadine cultivars (Table 1) were planted at McNeil, Miss. On 8 Mar. 1990 in a randomized complete block design with four replications and two-plant plots. Plants were spaced 20 ft apart in rows spaced 12 ft apart. Data for this study were taken from one plant of

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each plot at random. The vines were trained to a Geneva double curtain system. Overhead irrigation was applied as needed the first year. The plants were watered by drip irrigation thereafter. The vines were fertilized according to soil test recommendations (Mississippi State soil testing lab, Mississippi State, Miss.) except that rates were increased slightly to replace leached fertilizer elements.

Thirty-three additional clones (cultivars and selections) were planted 28 April 1992 in a single plant randomized complete block design with four replications. However, complete data were taken from only five of the newer cultivars (Table 2). The same cultural practices as used in the 1990 planting were employed.

During 1992-94 for the 1990 planting and 1998-99 for the 1992 planting, muscadines were harvested when it was judged that most ripe berries could be recovered. The berries were knocked into a catch frame with padded baseball bats. Berries from each vine were weighed in pounds and converted to kg/vine yield. A 30 berry sample of ripe fruit was collected for further evaluations. Percentage of berries with a dry picking scar was determined from each sample. Average berry weight (g/berry), an estimate of berry size, was also determined from each sample. The seeds from each sample were counted to calculate mean seed number per berry. Then seed size was estimated as weight (g) per 100 seeds. The pH of juice extracted from the pulp with a Waring blender was determined using an Orion SA520 pH meter. °Brix, an estimate of sugar content, was also determined from the juice using a refractometer.

A combined analysis (SAS Institute, Cary, NC) over years was performed on each trait in each planting. $LSD_{.05}$ was calculated to compare cultivars for each trait. Pearson correlation coefficients were determined among yield, berry weight, seed weight, and number of seeds per berry in each year.

Table 1. Performance of muscadine cultivars planted in 1990 and harvest in 1992-94.

Cultivar	Yield (kg/vine)	Dry scar (% of berries)	Berry wt. (g/berry)	°Brix	Seeds (no./berry)	pH	Seed wt. (g/100 seeds)
Black Beauty	27	56	13.4	16.2	3.5	3.5	9.4
Carlos	45	85	8.7	14.5	3.9	3.1	8.3
Cowart	29	68	6.5	14.8	3.7	3.3	8.2
Dixieland	23	66	8.7	15.3	3.6	3.4	8.1
Doreen	36	77	4.2	18.1	3.0	3.2	6.8
Fry	25	63	10.8	15.2	3.0	3.4	9.5
Fry Seedless	13	94	2.2	15.6	0.0	3.0	0.0
Higgins	36	63	7.5	13.6	3.3	3.1	10.1
Hunt	29	59	4.5	13.4	3.4	3.1	6.1
Janebell	37	65	8.1	14.5	3.5	3.2	10.0
Jumbo	23	60	10.6	13.6	3.7	3.5	11.0
Magnolia	43	67	5.4	11.9	3.3	3.1	7.5
Nesbitt	35	77	7.4	14.0	3.4	3.1	7.9
Noble	43	62	3.3	13.2	3.8	3.1	5.5
Southland	30	89	5.0	16.6	3.5	3.0	7.3
Sterling	34	64	5.0	18.1	3.5	3.4	6.5
Sugargate	21	63	11.9	17.5	3.3	3.4	8.8
Summit	37	81	9.1	16.2	2.7	3.3	8.5
Supreme	33	63	12.8	14.1	3.1	3.5	10.4
Sweet Jenny	26	66	12.6	16.6	3.3	3.5	11.3
Watergate	35	68	8.9	15.3	3.8	3.2	9.7
Welder	44	73	4.0	15.7	3.5	3.1	6.8
$LSD_{.05}$	7	12	0.8	1.1	0.3	0.1	0.7

Table 2. Performance of muscadine cultivars planted in 1992 and harvested in 1998-99.

Cultivar	Yield (kg/vine)	Dry scar (% of berries)	Berry wt. (g/berry)	°Brix	Seeds (no./berry)	pH	Seed wt. (g/100 seeds)
Alachua	35	83	6.7	14.6	3.1	3.8	12.4
Fry	26	72	10.7	15.0	2.5	3.8	13.6
Pollyanna	48	97	9.3	16.1	3.3	3.7	8.6
Southern Home	52	78	5.7	16.5	3.6	3.9	5.8
Tara	28	91	10.3	17.0	3.5	3.9	11.1
$LSD_{.05}$	20	11	0.8	0.9	0.2	0.1	1.5

Results and Discussion

Much variability among 27 cultivars was found for most of seven traits evaluated (Table 1, 2). Ranges among cultivars for the traits were: Yield-31 kg per vine, percentage of berries with dry scar-41, berry weight-10 g, °Brix-6, number of seeds per berry-1, pH of ripe berries-0.9, and seed weight-8 g. Cultivar X year interactions were significant for each trait, therefore, means in Tables 1 and 2 are not the exact expectations of each cultivar in a given year. However, cultivars tended to occur in the same group each year. For example, 'Carlos,' 'Doreen,' 'Higgins,' 'Magnolia,' 'Noble,' and 'Welder,' all juice type grapes, were always among the highest yielding cultivars. Current fresh fruit cultivars, eg. 'Fry,' 'Jumbo,' 'Black Beauty,' 'Sugargate,' 'Supreme,' and 'Sweet Jenny' were always among the lowest yielding group (Table 1, 2). Fresh fruit cultivars also produced the largest berries and seeds, and the smallest percentage of berries with a dry picking scar. These data suggest that muscadines should be evaluated for more than one or two years to obtain the best estimates.

Pearson Correlation Coefficients of yield versus berry weight and seed weight were either negative or non-significant (Table 3). The correlation between berry weight and seed weight was high each year except 1998 and 99 which probably resulted from the different cultivars evaluated in these two years. The negative correlation between yield and seed weight suggested that it would be difficult to increase seed size, eg. to increase resveratrol content, without decreasing yield. Muscadine seeds are available on the market as a health food. Unlike most small fruits, berry weight is either not correlated or negatively correlated with number of seeds per berry (Table 3). Variation in seed numbers is small in muscadines. Most cultivars produce three or four seeds per berry. Only 'Summit' and 'Fry' produced less than three seeds per berry. Except in 1998, the relationships between number of seeds per berry and seed weight were not significant.

The performance of 'Carlos,' 'Cowart,' 'Fry,' 'Jumbo,' 'Magnolia,' 'Noble,' 'Tara,' 'Welder,' and 'Alachua' (all publicly developed cultivars) were evaluated by Mortensen and Harris (8) and Andersen (1) in Florida. With a few exceptions the performance of these cultivars in Mississippi was similar to that in Florida for yield, berry weight, dry scar, and °Brix. 'Carlos' berries were larger in Mississippi than in Florida and yield of 'Alachua' was higher in Florida than in Mississippi. 'Higgins' was the most

Table 3. Correlations[z] among four selected muscadine traits for five years.

Year	Yield vs berry wt.	Yield vs seed wt.	Berry wt. vs seed wt.	Berry wt. vs seeds/berry	Seeds/berry vs seed wt.
1992	–0.36**	–0.31**	0.74**	–0.09NS	0.04NS
1993	–0.36**	–0.26**	0.74**	–0.16NS	–0.13NS
1994	–0.29**	–0.21NS	0.69**	0.03NS	–0.10NS
1998	–0.61**	–0.85**	0.40*	–0.65**	–0.58**
1999	–0.15NS	0.36NS	0.14NS	–0.03NS	–0.29NS

[z]NS, *, ** Correlation nonsignificant or significant at $P \leq 0.05$ or 0.01, respectively.

susceptible cultivar to berry rots and 'Magnolia' was defoliated by angular leaf spot (*Cercospora brachypus*) in Mississippi.

'Fry' became the industry standard for fresh fruit because of its size. Several cultivars developed by Ison (Ison's Nursery & Vineyard, Brooks, Georgia 30205) produced larger fruit than 'Fry' but are still deficient in yield and percentage dry picking scar. 'Pollyanna' performed well for each trait except that its berry weight is marginal for fresh market fruit. Hybrids between 'Pollyanna' and 'Black Beauty,' 'Supreme,' 'Sweet Jenny.' 'Sugargate,' or 'Carlos' may produce superior fresh fruit cultivars needed to supply the current trend in production. Other Ison developed cultivars such as 'Pam' need to be evaluated. Also, all cultivars need to be screened for resveratrol content.

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Flavonoid and Chlorogenic Acid in Apples

The sun exposed skin of apples had much higher cyanidin 3-glactoside and quercetin 3-glycocide levels than the shaded skin, while phloridzin, catechine and chlorogenic acid were similar in the skin on both sides. Quercetin 3-glycosides and anthocyanjn were almost exclusively found in the skin. Phloridzin was most abundant in the seeds with intermediate levels in the core areas and skin with the lowest level in the flesh. Chlorogenic acid was mainly in the core areas and seeds. Anthocyanins and total flavonoids were highest in the fruit from the top of the tree followed by fruit from the outer canopy. Terminal fruit contained the highest levels of these compounds compared to lateral and spur fruit. Phloridzin and chlorogenic acid were not affected by position in the tree or wood type. There were large differences in flavonoid and chlorogenic acid levels in 'Elstar' between 2 orchards differing in vigor. 'Jonagold' and its mutants had considerably higher levels of flavonoid and chlorogenic acid than 'Elstar' and its mutants. The most blushed mutants of both cvs had higher levels of anthocyanin but not of flavonoids or chlorogenic acid compared to the standard strains or less blush mutants. High color strains had a higher number or red cells per cell layer and more cell layers containing red cells than the standard cultivar. From Awad et al. 2000. Scientia Hort. 83:249-263.