

2024 Progress Report R-25

Title:

Evaluating Cold Hardiness of Muscadine Cultivars

Name, Mailing and Email Address of Principal Investigator(s):

Principal Investigator:

Dr. Christine E. H. Coker

1815 Popp's Ferry Rd

Biloxi, MS 39532

cec117@msstate.edu

Co-Principal Investigators:

Dr. Eric T. Stafne, 711 W. North St, Poplarville, MS 39470; eric.stafne@msstate.edu

Dr. Patricia R. Knight, 711 W. North St, Poplarville, MS 39470; prk3@msstate.edu

Ms. Jenny B. Ryals, 711 W. North St, Poplarville, MS 39470; j.ryals@msstate.edu

Ms. Haley N. Williams, 711 W. North St, Poplarville, MS 39470; hnw111@msstate.edu

Objective:

The objective of this study is to evaluate cold hardiness of various Muscadine cultivars (*Vitis rotundifolia* Michx.). Determining the cold tolerance for each cultivar will provide growers and breeders the ability to expand the geographical range where muscadine grapes can be cultivated, increasing the potential for market expansion. This knowledge also helps reduce the risk of crop loss due to winter damage, ensuring a more reliable and sustainable muscadine production industry.

Introduction:

In the face of ongoing climate change, understanding the effect of cold hardiness in muscadine vines is important when selecting cultivars. Muscadines, *Vitis rotundifolia* Michx., are native to the southeastern United States. They thrive in regions characterized by high temps and high humidity and have demonstrated resilience against pests and

diseases that can harm other *Vitis* species. Muscadine vines are deciduous and bear their fruit in small, round, loosely arranged clusters. These round fruits boast thick skins, can contain up to five seeds and have fruit color that can range from bronze to deep purple. Through breeding programs, cultivars have been developed to now be produced on a commercial scale. Muscadine fruit can be purchased and/or sold as fresh fruit, or in products, such as wine, juice, jam, jelly, and similar items.

While they thrive in hot, humid regions, they are particularly sensitive to frost and cold temperatures falling below 10°F. They can suffer damage when exposed to minimum winter temperatures as low as 0°F. As global temperatures continue to fluctuate, extreme weather events, including sudden cold snaps, become more frequent and unpredictable. This poses a significant risk to the cultivation of muscadine grapes. Research into the cold hardiness of these vines is essential for vineyard managers and growers, as it enables them to adapt and implement cultivars that stand up better in the cold weather.

Materials and Methods:

The study took place at the Mississippi State University, MAFES South Branch Experiment Station in Poplarville, MS. We used buds from eight varieties of muscadine grown at the Mississippi State University, McNeill Research Unit in Carriere, MS: ‘Carlos’, ‘Lane’, ‘Noble’, ‘Darlene’, ‘Fry’, ‘Summit’, ‘Black Beauty’, and selection H17-66.

Buds were collected from healthy, vigorous canes. The bud was shaved off the canes with the use of a single edge razor blade. Buds were cut by beginning

approximately 1/2 to 3/4 inch below the bud's base and making a clean, upward cut that reaches 1/2 to 3/4 inch beyond the bud. Buds were collected once a month beginning at the start of dormancy and ending at bud swell (3 collection times: December-February).

Bud low-temperature exotherms (LTEs) were identified by means of differential thermal analysis with a Keithley Multimeter Data Acquisition System (model 2700-DAQ-40; Keithley Instruments, Cleveland, OH, USA) involving a programmable freezer (Tenney Environmental Test Chamber, model T2C, Thermal Product Solutions, Williamsport, PA, USA) and thermoelectric modules (TEM). The temperature protocol involved a one-hour period at 4°C, followed by a gradual decline of 4°C per hour until reaching -40°C. The LTEs that signify the temperature at which buds are fatally affected were determined for each individual cultivar.

Each TEM consisted of ten buds from each cultivar, with six replicates per cultivar per collection date (60 buds per cultivar per collection; 180 buds per cultivar in total for study; 1,440 buds in total).

Results and Discussion:

For 10% bud mortality in December, 'Summit' was significantly more cold-hardy than 'Fry Seedless', H17-66, and 'Lane' (Table 1). At the 50% mortality threshold, both 'Summit' and 'Carlos' were more cold-hardy than 'Lane' and 'H17-66', and this pattern continued in the 90% mortality, where we observed 'Summit' and 'Carlos' again showing significantly greater cold hardiness than 'Lane' and H17-66 (Table 1). As dormancy progressed into January, when vines would be expected to be acclimated to winter/cold conditions, we observed that the cultivar differences shifted. For 10% bud

mortality, 'Lane' became significantly more cold-hardy than 'Black Beauty' and H17-66 (Table 2). At 50% mortality, both 'Lane' and 'Darlene' were more cold-hardy than H17-66 and 'Black Beauty', and at 90% mortality, 'Lane', 'Darlene', and 'Summit' were significantly more cold-hardy than H17-66 and 'Black Beauty' (Table 2). By February, however, there were no significant differences among cultivars at the 10%, 50%, or 90% bud mortality thresholds (Table 3).

Based on the data collected in this study, 'Summit' and 'Carlos' appears to be the most cold-hardy options for regions that commonly experience early winter freeze events. During the mid-winter period, when vines should be acclimated, 'Lane' and 'Darlene' show the greatest cold hardiness. All cultivars evaluated in this study responded similarly to late-season freeze events, indicating that any of the tested muscadines would tolerate a late freeze to the same degree. Other studies have suggested that vascular tissues are a better indicator of cold-hardiness when compared to vegetative buds. Because of that, future work looking at vascular hardiness of these cultivars should be done to get a clearer picture of overall cold tolerance.

Table 1. Average December temperature associated with 10%, 50%, and 90% bud mortality of eight muscadine cultivars.

Cultivar^z	Month	LTE^y10^x	LTE50^w	LTE90^v
Black Beauty	December	-13.2abc	-14.8ab	-16.7ab
Carlos	December	-14.6ab	-15.8a	-17.2a
Darlene	December	-12.5abc	-13.8ab	-15.2ab
Fry Seedless	December	-12.0bc	-13.8ab	-15.2ab
H17-66	December	-11.2c	-12.1b	-13.0b
Lane	December	-10.5c	-12.1b	-13.5b
Noble	December	-13.7abc	-14.7ab	-15.7ab
Summitt	December	-15.7a	-16.6a	-17.8a
	<i>P-value^u</i>	<i>0.0004</i>	<i>0.0012</i>	<i>0.0003</i>

^zAnalysis of variance was performed using PROC GLIMMIX (SAS 9.4). Means followed by the same letter within a column are similar and not significantly different ($\alpha = 0.05$).

^yLTE - low-temperature exotherm

^xLTE10 - low-temperature associated with 10% bud mortality

^wLTE50 - low-temperature associated with 50% bud mortality

^vLTE90 - low-temperature associated with 90% bud mortality

^u*P values* for differences between means were obtained using Tukey's honest significant difference (HSD) at $P \leq 0.05$.

Table 2. Average January temperature associated with 10%, 50%, and 90% bud mortality of eight muscadine cultivars.

Cultivar^z	Month	LTE^y10^x	LTE50^w	LTE90^v
Black Beauty	January	-20.7b	-21.8c	-22.6b
Carlos	January	-22.5ab	-24.0abc	-24.8ab
Darlene	January	-23.9ab	-25.3a	-26.1a
Fry Seedless	January	-21.9ab	-23.0abc	-24.3ab
H17-66	January	-20.5b	-22.0bc	-23.1b
Lane	January	-24.2a	-25.3a	-26.6a
Noble	January	-21.2ab	-22.5abc	-23.9ab
Summitt	January	-24.1ab	-25.3ab	-26.1a
	<i>P-value^u</i>	<i>0.003</i>	<i>0.0008</i>	<i>0.0003</i>

^zAnalysis of variance was performed using PROC GLIMMIX (SAS 9.4). Means followed by the same letter within a column are similar and not significantly different ($\alpha = 0.05$).

^yLTE - low-temperature exotherm

^xLTE10 - low-temperature associated with 10% bud mortality

^wLTE50 - low-temperature associated with 50% bud mortality

^vLTE90 - low-temperature associated with 90% bud mortality

^u*P values* for differences between means were obtained using Tukey's honest significant difference (HSD) at $P \leq 0.05$.

Table 3. Average February temperature associated with 10%, 50%, and 90% bud mortality of eight muscadine cultivars.

Cultivar^z	Month	LTE^y10^x	LTE50^w	LTE90^v
Black Beauty	February	-19.8a	-20.7a	-21.7a
Carlos	February	-18.6a	-20.0a	-21.1a
Darlene	February	-19.2a	-20.6a	-21.8a
Fry Seedless	February	-18.5a	-19.8a	-21.1a
H17-66	February	-19.4a	-20.3a	-21.1a
Lane	February	-20.3a	-21.2a	-22.3a
Noble	February	-21.5a	-22.5a	-23.6a
Summitt	February	-20.1a	-21.2a	-22.5a
	<i>P-value^u</i>	<i>0.3394</i>	<i>0.2803</i>	<i>0.2104</i>

^zAnalysis of variance was performed using PROC GLIMMIX (SAS 9.4). Means followed by the same letter within a column are similar and not significantly different ($\alpha = 0.05$).

^yLTE - low-temperature exotherm

^xLTE10 - low-temperature associated with 10% bud mortality

^wLTE50 - low-temperature associated with 50% bud mortality

^vLTE90 - low-temperature associated with 90% bud mortality

^u*P values* for differences between means were obtained using Tukey's honest significant difference (HSD) at $P \leq 0.05$.

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