

Spring Freeze Damage to Rabbiteye Blueberry Buds and Berries

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Abstract

A spring freeze on March 31, 2003 with a low temperature of -1.9°C provided an opportunity to evaluate freeze tolerance of 11 rabbiteye (*Vaccinium ashei*) blueberry cultivars over a range of bloom maturity. On April 4, three flower buds at bloom maturity stages of 4, 5, and 6 along with 3 small fruit (≤ 4 mm) and 3 large fruit (≥ 5 mm – all still green) were tagged and labeled with stage of bloom and number of individual flowers present or number of fruit present. On April 25, flower bud, flowers, and fruit were rated for survival and viable flowers and fruit were counted. Rate of survival was calculated from the number of potential fruit present (flower buds and green fruit) and the number of fruit alive after freeze. Over all cultivars, flower buds, regardless of stage, had a higher survival rate than did fruit. There were differences between cultivars. 'Austin', 'Centurion', and 'Yadkin' sustained more freeze damage to smaller fruit compared to larger fruit. The large fruit of 'Yadkin' and 'Centurion' had equal damage resistance as flower buds. Overall, 'Powderblue', 'Ira', and 'Centurion' had the greatest freeze damage resistance while 'Climax', 'Montgomery', 'Tifblue', and 'Premier' were more susceptible to spring freeze damage.

INTRODUCTION

A problem that faces many commercial blueberry growers in the Southeastern U.S. is the susceptibility of plants with low chilling requirements to early spring freezes. Rabbiteye blueberries are grown in areas where temperatures normally are below 7°C for 400 to 1000 hours annually. The total hours below 7°C varies from year to year and chilling requirements are often satisfied by late December to mid January. Once chilling requirements are met, warming temperatures can cause vegetative and flower buds to break dormancy (begin swelling and visible growth). Only plants with low chilling requirements are adapted to this area, and after their chilling requirements have been met, a spring frost can damage and/or kill early blooms and developing fruit.

A temperature of -28°C before mid-December reportedly damaged 'Tifblue' plants only slightly and did not damage 'Woodard' plants (Kender and Brightwell, 1966). Another report states that a temperature -27°C in January killed *V. ashei* Reade fruit buds and caused some shoot injury in Maryland (Darrow et al., 1944). Spiers (1978) found that under forced conditions and artificial chilling there is a strong inverse relationship between the stage of flower-bud development and the temperature that damages buds and blossoms.

NeSmith (2003) states that during the winter, dormant flower buds of highbush blueberries could survive temperatures as low as -28.9°C while the less hardy rabbiteye (*V. ashei* Reade) have survived -23.3°C but are often damaged below -17.8°C . As flower buds mature, cold tolerance decreases. By the time individual flowers begin to protrude from the bud (stage 3-4), temperatures below -28.9°C could damage the most exposed flowers. When corollas have reached half of their full length (stage 4-5), temperatures below -4.0°C will kill the complete flower. However, at this stage, blossoms on rabbiteye blueberries may receive corolla damage at temperatures as high as -1.1°C .

This study was initiated to evaluate the damage to buds and developing berries incurred under natural spring freeze conditions.

MATERIALS AND METHODS

Mature (5-year-old) rabbiteye blueberry plants of 11 varieties grown on Ruston fine sandy loam soil (fine-loamy, siliceous, thermic Typic Paleudult) at the USDA Small Fruits Research Station site in Stone County, MS were used. By March 18, 2003 the plants had acquired 1076 chilling hours (temp $\leq 7^{\circ}\text{C}$) which would satisfy the chilling requirements for all the rabbiteye cultivars being observed. A spring freeze occurred on March 31, with a low temperature of -1.9°C providing an opportunity to evaluate freeze tolerance of 11 rabbiteye (*Vaccinium ashei*) blueberry cultivars over a range of bloom maturity. A HarvestGuard degree-day and chill-hour recorder (Spectrum Technologies, Inc.) was placed in a white metal multiple-plate Radiation Shield (Spectrum Technologies, Inc.) approximately 1.4 m high to determine low temperature and accumulated chill hours. Due to the cold temperatures over the next 3 days, we postulated that flower buds and green fruit development had not significantly advanced from March 31 to April 4. On April 4, fifteen stems were labeled on each of 6 plants per variety within the same field. It was attempted to tag and label three flower buds at bloom maturity stages of 4, 5, and 6 (Spiers, 1978) along with 3 small fruit (≤ 4 mm – stage 7) and 3 large fruit (≥ 5 mm – all still green – stage 8). For the cultivars that did not have any stage 4 buds remaining, 4 or 5 stems were tagged at the maturity stages present so that 15 stems were tagged. Stems were selected from the entire plant. Stems were tagged and labeled with stage of bloom and number of individual flowers present or number of fruit present. On April 25 viable flowers and fruit were counted. Rate of survival was calculated from the number of flowers and/or fruit present before the freeze and the number of fruit undamaged after freeze.

RESULTS AND DISCUSSION

Over all cultivars, flower buds and flowers, regardless of stage, had a higher survival rate than did fruit (Table 1). Across all cultivars, stage 6 bloom consistently had an average of 75% freeze survival. The percentage of survival for other bloom stages and berry sizes differed with cultivars. 'Austin' had greater than 90% survival rate for all stages of flower buds, yet the small fruit (stage 7) had only 24% survival and the larger fruit (stage 8) fared better with 62% survival (Table 2). 'Centurion' flower buds and larger berries had a higher survival rate than did the smaller fruit. This pattern was also found in 'Yadkin' and 'Austin'. The large fruit of 'Yadkin' and 'Centurion' had equal damage resistance as flower buds. 'Ira' fruit and buds had no difference in buds and berries with all having a consistently high survival rating of $\geq 67\%$. 'Premier' also had no difference in survival between buds and berries with all having a consistently low survival of $\leq 60\%$. Overall, 'Powderblue', 'Ira', 'Centurion', 'Austin' and 'Yadkin' had the greatest freeze damage resistance while 'Climax', 'Montgomery', 'Beckyblue', 'Tifblue', and 'Premier' are most susceptible to spring freeze damage.

CONCLUSIONS

Resistance and susceptibility to spring freeze damage depends on the stage of development of the bud or berry, but there are also cultivar differences. Flower buds were more resistant to freeze damage than young berries over the 11 cultivars rated and the stage of maturity of the bud or bloom depends on the cultivar bloom time. Yet the amount of resistance is dependent on the cultivar. This study also indicates the need for regional testing, since all of the resistant cultivars except 'Austin' were released from North Carolina, and with the exception of 'Montgomery' the more susceptible cultivars were all released from Georgia.

Literature Cited

Darrow, G.M., Woodard, O. and Morrow, E.G. 1944. Improvement of the rabbiteye blueberry. Proc. Amer. Soc. Hort. Sci. 45:275-279.

Kender, W.J. and Brightwell, W.T. 1966. Environmental relationships. P. 75096. In. P. Eck and N.F. Childers (eds.) Blueberry culture. Rutgers. Univ. Press, New Brunswick N.J.

NeSmith, S. 2003. UGA CAES Garden Packet. Volume XXVIII, Number 1 Page 223.

Spiers, J.M. 1978. Effect of stage of bud development on cold injury in rabbiteye blueberry. J. Amer. Soc. Hort. Sci. 103(4): 452-455.

Tables

Table 1. The survival rate of flower buds, flowers, and berries as affected by sub-freezing temperatures (-1.9° C) over all cultivars.

Stage of development	% Survival
4	78 a
5	86 a
6	77 a
7 (fruit ≤ 4mm)	40 b
8 (fruit ≥ 5mm)	51 b

Means separation within columns by Duncan Multiple Range Test P≤ 0.05 level.

Table 2. Survival ratings of individual cultivars as affected by sub-freezing temperatures (-1.9° C)

	Austin	Beckyblue	Briteblue	Centurion	Climax	Ira	Montgomery	Powderblue	Premier	Tifblue	Yadkin
4	94 a		57 ab	82 a	75a	90 a		96 a	40 a	68 ab	77 a
5	97 a		85 a		25 bc		100 a	94 a		50 bc	
6	94 a	72 a	80 a	94 a	65 ab	72 a	61 b	78 a	60 a	88 a	81 a
Sm	24 c	42 b	27 b	48 b	19 bc	67 a	17 c	70 a	60 a	29 c	35 b
Lg	62 b	41 b		81 a	13 c				49 a		88 a

Means separation within columns by Duncan Multiple Range Test P≤ 0.05 level.