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CHILLING REQUIREMENTS OF 3 FLORIDA BLUEBERRY CULTIVARS[1]

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Abstract. **Models were developed for rabbiteye blueberries (**Vaccinium ashei **Reade) for prediction of chilling completion. Plants and budsticks were held at constant temperatures ranging from 25°F to 75°F (—4.0°C to 24.0°C). Plants and budsticks were removed at intervals over the suspected chilling requirement. Days to budbreak were compared to observed chilling completion dates in the field. 'Aliceblue' and 'Woodard' have higher chilling temperature optima, 45°F and 50°F (7.2°C and 11.0°C), respectively. 'Tifblue' has a lower chilling temperature optimum near 40°F (6.7°C). Flowering in 'Aliceblue' and 'Woodard' is normal after exposure to temperatures below their optimum, provided temperatures remain above 25°F (—4.0°C). However, 'Tifblue' budbreak is poor after constant exposure to 32°F (0.0°C) and below.**

Insufficient chilling in perennial fruit crops has been noted as a limiting factor in production in the Southeastern United States and especially Florida (7, 11, 16). Winter temperature fluctuations may often lead to early bloom and frost damage, or prolonged dormancy due to insufficient chilling. Chilling model development has been helpful in investigating the behavior of perennial fruit crops in response to variation in winter temperatures. A plant held for 1 hr at its optimum chilling temperature is said to have

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accumulated one chill unit (8). The number of hours at the optimum temperature required to complete rest is defined as the plant's chilling requirement (2).

This experiment was to determine the chilling requirement and develop models for estimating the date of chilling completion of rabbiteye blueberry (*Vaccinium ashei* Reade) cultivars Aliceblue, Woodard and Tifblue. The chilling requirement of 'Aliceblue' has not been determined, but thought to be short based on bloom date (9). 'Woodard' is thought to have a chilling requirement of 350-450 hr (5), and 'Tifblue' a 650 hr chilling requirement (14).

Materials and Methods

Hourly temperatures were recorded by a multipoint thermograph from November 8 through March 15 in 1980-1981 and 1981-1982 at the Univ. Florida blueberry planting. The date plants entered rest was determined by observing budsticks cut at the planting on 10-day intervals and forced to grow in a greenhouse through November until the budsticks could not be forced to grow. Budsticks were cut on the estimated date of rest initiation in 1980 for chilling treatments. One-yr-old rooted cuttings were used in chilling treatments in 1981-1982. These treatments began on the date of rest initiation of 'Aliceblue', December 12, 1982.

Plants and budsticks were placed in 8-dark, controlled-temperature chambers, as described by Gilreath et al. (6), and held at constant temperature. Budsticks used in 1980-1981 were held at 30, 37, 43, 48, 54, 59, 64, and 70.0 ± 3°F (–1.0, 3.0, 6.0, 9.0, 12.0, 15.0 18.0, and 21.0 ± 1.25°C). The plants used for trials in 1981-82 were held at 24, 32, 39 46, 54, 61, 68 ± 3°F (–4.0, 0.0, 4.0, 8.0, 12.0, 16.0, 20.0, and 24.0 ± 1.25°C).

Budsticks were divided into 5-1000 hr duration treatments with 5 replicates of 6 budsticks. Replicates were laced in moist sphagnum peat and wrapped in a plastic bag. Budsticks of 'Aliceblue' were chilled from 500 to 800 hr; 'Woodard', from 250 to 650 hr; and, 'Tifblue' from 500 to 900 hr. Plants were grouped in 9-one plant replicates for each cultivar in 1981. 'Aliceblue' and 'Woodard' plants were held for 300, 450, and 600 hr; and 'Tifblue' plants were held for 600, 800, and 1000 hr.

Budsticks and plants were placed in a heated greenhouse following chilling treatments. Growth of floral buds was measured using the index in Table 1, where level 2.5 was defined as budbreak. Days to budbreak were calculated from the date of removal from temperature chambers.

Table 1. Rabbiteye blueberry floral budbreak index.

0—No response
1—Budswell
2—Green tip
3—Tight cluster
4—Flower expansion
5—Full bloom

Observations from durations near the chilling requirement were used to make an equation for each cultivar relating chilling temperature to days to budbreak. This equation was fit to a unit scale to calculate chill units over temperature ranges. All observations on 'Aliceblue' were used to derive the chilling model. Observations from the 250, 300, 350-hr durations were excluded from the 'Woodard' model. The 450, 550, and 650-hr duration observations were excluded from the 'Tifblue' model.

Results and Discussion

'Aliceblue' accumulates more chill units at lower temperatures than either 'Woodard' or 'Tifblue', accumulating 0.5 chill units each hour at 25.7°F (–3.5°C). 'Woodard' and 'Tifblue' did not accumulate chill units below 28.4°F (–2.0°C) (Table 2). High temperature interference with chill unit accumulation began to occur near 55.4°F (13.0°C) in 'Tifblue', 59°F (15.0°C) in 'Woodard', and 62.6°F (17.0°C) in 'Aliceblue' (Table 2).

Table 2. Chill unit accumulation by chilling temperature range as predicted by each blueberry model.

Hourly chill unit accumulation	Chill unit model			
	'Aliceblue'	'Woodard'	'Tifblue'	Norvell[z]
0.0[y]	—	<–2.5°C	<–1.25°C	—
0.5	<2.5°C	–2.5- 0.9	–1.25- 1.9	<1.4- 2.4°C
1.0	–2.5- 9.9	1.0- 9.75	2.0 - 9.9	2.5- 9.1
0.5	10.0-15.9	9.8-13.75	10.0 -12.9	9.2-12.4
0.0	16.0-20.4	13.8-16.4	13.0 -15.4	12.5-15.4
–0.5	20.5-24.0	16.5-20.0	15.5 -18.5	16.0-18.0
–1.0	>24.0	>20.0	>18.5	>19.5

[z]Results from Norvell and Moore (13).
[y]Chill units accumulated for each hour exposure in temperature range. (e.g. 'Woodard' accumulates 0.0 chill units for each hour of exposure to temperatures below –2.5°C).

Chilling completion was predicted closely for 'Aliceblue' in 1981 by counting hours between 32°F and 45°F (0.0°C and 4.4°C). This was within 3 days of the actual chilling completion date. Counting hours between 32°F and 50°F (0.0°C and 10.0°C) predicted chilling completion within 7 days of the actual date. The 'Aliceblue' model predicted the date of chilling completion 8 days early in 1981. The model predicted chilling completion within 3 days in 1982. The date predicted counting hours between 32°F and 45°F, and 32°F and 50°F, were 36 and 10 days, respectively, after the actual date of chilling completion in 1982 (Table 3).

The 'Woodard' model predicted the date of chilling completion closely each year (Table 3). The date predicted was 9 days early in 1981 and 4 days late in 1982. Counting hours by the standard method, hours between 32°F and 45°F, the predicted date was 4 days early in 1981 and 12 days late in 1982. Using the 50°F method, the predicted chilling completion date was 14 days early in 1982 and the actual date in 1982.

The 'Tifblue' model predicted chilling completion 6 days earlier in 1981 than the actual date observed in the field. Measuring temperature between 32°F and 45°F, and 50°F resulted in inaccurate predictions of chilling completion dates each year (Table 3).

Temperature data indicate both years were cooler than normal for Gainesville, Florida. The 1980-81 winter was warmer in the fall and gradually cooled through mid-January, the coldest period of this winter. Temperatures during the 1981-82 winter began cool, plants of all cultivars entered rest early. Later in the winter, when the plants should have been accumulating the largest numbers of chill units, the temperature warmed. The chilling models indicated large negative, daily chill unit accumulation, or loss of chilling hours. The total chilling accumulation by the 'Tifblue' model from November 14, 1981, through March 11, 1982, was 125 chill units. This suggests that the plant could not have completed its chilling requirement. Observations show these plants did not bloom and set normal fruit loads (Davies, personal communication); however, foliation appeared normal.

Predicted chilling completion dates for all cultivars were early in 1980-81. Data from 1982 generally yielded predicted dates later than the actual chilling completion dates ob-

Table 3. Predicted chilling completion date comparisons between models based on counting chill units from the date of rest initiation as determined by forcing budsticks taken from the field in the fall.

Year	Rest initiation date	Chilling completion date	Chill unit counting method[z]		
			Model	45.0°F	50.0°F
		'Aliceblue'—300 hr chililng requirement			
1980-1981	Dec. 21	Jan. 13	Jan. 5 -8 days	Jan. 10 -3 days	Jan. 6 -7 days
1981-1982	Dec. 12	Jan. 7	Jan. 10 +3	Feb. 12 +36	Jan. 17 +10
		'Woodard'—400 hr chilling requirement			
1980-1981	Dec. 12	Jan. 19	Jan. 10 -9	Jan. 15 -4	Jan. 4 -14
1981-1982	Dec. 1	Jan. 13	Jan. 9 -4	Jan. 25 +12	Jan. 13 +0
		'Tifblue'—650 hr chilling requirement			
1980-1981	Nov. 30	Feb. 18	Feb. 12 -6	Jan. 29 -20	Jan. 14 -35
1981-1982	Nov. 15	Feb. 3	No Result	Mar. 7 +32	Jan. 24 -10

[z]Chilling completion date predicted by the methods described and days difference from the actual date of chilling completion observed in the field. Minus (–) values indicate days before the actual date. Plus (+) values indicate days after the actual date.

served in the field. Several researchers (1, 5, 12, 14) have indicated that the effect of warm temperatures on inhibition of chilling may be most important early in the winter dormancy period. Models recently developed (5, 10, 13) calculate chill unit values across a wide range of temperatures. Negative values for chill units are calculated at temperatures significantly higher than effective chilling temperature range, independent of the time during the rest period. The prediction date trends observed in this experiment indicate that warm temperatures are not as effective in inhibiting chill unit accumulation late in the rest period as earlier, in agreement with others (3, 4, 15). This conclusion suggests that a modification of the chill unit model, after completion of a portion of the chilling requirement may be needed to discount negative chill unit accumulation due to high temperatures later in the rest period.

Cultivars with short chilling requirements, adapted to Florida, accumulate more chill units at higher and lower temperatures than longer chilling cultivars. The chilling requirement of 'Aliceblue' is 300 hr. The chilling requirement of 'Woodard' is 400 hr; and, the chilling requirement of 'Tifblue' is 650 hr. Chilling models can be used to accurately predict the date of chilling completion for 'Aliceblue' and 'Woodard'. High temperature interference with chilling completion may not be as important later in the dormant period as earlier. Modification of chill unit models may be needed to account for the effects of high temperature at different times during the chilling period.

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