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Influence of Chilling Hours on Flower Bud Growth and Rooting Ability of Blueberry Budsticks[1]

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Abstract

Budsticks from 3 rabbiteye blueberry cultivars ('Baldwin,' 'Brightwell,' and 'Tifblue') and 2 highbush blueberry cultivars (TH-275 and 'Georgiagem') were subjected to 0 to 650 hrs at 4.4 °C (40 °F) to determine the effects of accumulated chilling on terminal flower bud growth and rooting ability. The cultivar X chilling hours interaction was significant for both flower bud growth and rooting ability. The 2 highbush cultivars had wider flower buds than the 3 rabbiteye cultivars. 'Baldwin' and 'Georgiagem' produced the best overall root systems. Chilling requirements ranged from 350 to 550 hr for the rabbiteye cultivars and 350 to 450 hr for the highbush. Except for rooting score of clone TH-275, the functional relationships between flower bud width or rooting score and chilling hours were non-linear. In general, chilling hours enhanced the growth of terminal flower buds and increased the rooting ability.

Index words: *Vaccinium ashei,* rabbiteye, low-chill, highbush, hardwood cuttings

Introduction

Several chilling studies have been made on rabbiteye blueberry (*Vaccinium ashei* Reade), 'Tifblue,' using various techniques (1, 4, 5, 10, 12, 14, 15). Chilling requirements for 'Tifblue' varied from 400 to 650 hrs below 7.2 °C (45 °F), depending upon the technique used for determination and the range of climatic conditions. Initial tests using terminal flower bud measurements indicated that chilling requirements for 'Brightwell' and 'Baldwin' were 350 to 400 (2) and 450 to 500 hrs (3), resp. In recent studies on rabbiteye blueberries (4), it was concluded that measurements of the terminal flower bud could be used reliably to determine the chilling requirements. Chilling studies have not been reported on highbush clone TH-275 and 'Georgiagem.'

Poor results have been obtained on rooting rabbiteye blueberry from hardwood cuttings. However, Mainland (6) reported good results from hardwood cuttings of 2 rabbiteye cultivars. Hardwood cuttings of 'Tifblue' produced better root growth after the cuttings were chilled 500 hrs than from cuttings chilled only 250 hrs (13).

Highbush blueberry (*V. corymbosum* L.) 'Blueray' and 'Collins' rooted best and had better root systems after 1220 chilling hrs were accumulated, but the roots were still less than average marketable (11). Highbush clone TH-275 had a higher percentage of cuttings rooted, a higher root rating, and a greater percentage of marketable rooted cuttings when compared with cuttings of 'Tifblue,' regardless of the medium in which they were rooted (8).

The purposes of the present experiment were to: (a) determine growth response of flower buds from 3 rabbiteye cultivars and 2 highbush cultivars to various accumulated chilling periods; and, (b) compare rooting responses of these cultivars to the 10 accumulated chilling periods.

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Materials and Methods

One hundred one-year-old budsticks from each of 3 rabbiteye cultivars ('Baldwin,' 'Brightwell,' and 'Tifblue') and 2 highbush (clone TH-275 and 'Georgiagem') were collected before any natural chilling on October 28, 1982. The budsticks, 13 to 15 cm (5 to 6 in) in length with terminal flower buds, were chosen at random from field plants. Leaves that had not already abscised were removed at cutting. Ten budsticks of the 100 taken from each cultivar or clone were placed upright with their basal ends in 4 to 5 cm (1.75-2.0 in) of distilled water in a laboratory maintained at a day/night temperature regime of approximately 22°/18°C (71°/65°F) (0 chilling hr treatment). The remaining 90 budsticks were wrapped with damp sphagnum peat, put in 1.5 mil black polyethylene bags, and placed in a 4.4° ± 1.1°C (40 ± 2°F) constant temperature dark chamber. Ten randomly selected budsticks of each cultivar or clone were removed after 250, 300, 350, 400, 450, 500, 550, 600, and 650 hrs of chilling were accumulated. Budsticks were then immediately placed in forcing conditions identical to those that received 0 chilling hr. The widest diameter of the terminal flower buds were measured with a direct-reading caliper gauge graduated to 0.1 mm, after 2 weeks in forcing conditions.

After each flower bud was measured, flower buds and about 2 cm (0.75 in) of the basal end were removed. Each moistened cutting was momentarily dipped in Rootone F* (0.067% 1-naphthaleneaceacetamide (NAD), 0.033% 2-methyl-1-naphthaleneacetic acid (NAAm), 0.013% 2-methyl-1-naphthaleneacetamide (NADm), 0.057% indole-3-butyric acid (IBA), 4.0% tetramethylthiuram-disulfide (thiram), and 95.83% inert ingredients), rooting powder, and immediately placed in a propagating bed containing moist milled peat moss 15 cm (6 in) in depth and layered on an open mesh bench in a greenhouse. The medium was kept moist with hand watering when necessary.

Root quality (density and length) was rated June 2, 1983 on a scale of 0 to 5 (5 = excellent, 4 = good, 3 = fair, 2 = poor, 1 = callus, and 0 = dead). Marketable cuttings were those receiving a rooting score of 4 or 5 in rating.

The data were analyzed by the least-squares procedures using General Linear Models (GLM) and by the Chi-square statistic (9). Preliminary analysis of variance was conducted with cultivar (including 2 highbush), chilling hours, and their interaction in the model. A separate analysis was also performed for each cultivar and clone. The model included chilling hours as a source of variation and polynomials of successively higher order were also fitted to determine the best relationship between flower bud width or rooting score and chilling hours. Cultivar means were compared by Duncan's multiple range test and chilling hour means were compared with the 0-hr mean (pair-wise t-test) by the same computer package. The dependence of marketable or non-marketable rooting score on cultivar or chilling hours was tested by Chi-square.

Results and Discussion

Cultivar and chilling hours main effects, as well as their interaction, significantly influenced flower bud width and rooting score. Evidence of a strong cultivar X chilling hours interaction suggested that the relationship between bud width or rooting score and the chilling hours be examined separately for each cultivar or clone. Because chilling hours is a quantitative factor ranging from 0 to 650 hrs, data were examined for a functional relationship between bud width or rooting score and chilling hours. Results of the subsequent analyses indicate that these functional relationships are generally complicated and non-linear (except for rooting score of clone TH-275). Chilling hours significantly influenced flower bud width of all 5 cultivars but the effect was significant on rooting score of 2 out of the 3 rabbiteye cultivars ('Baldwin' and 'Brightwell'), and one highbush clone (TH-275).

Means, standard errors, and mean comparisons are

Table 1. Effect of chilling time on flower bud width of 3 rabbiteye ('Baldwin,' 'Brightwell,' and 'Tifblue') and 2 highbush (TH-275 and 'Georgiagem') cultivars.

Chilling	Rabbiteye cultivars			Highbush cultivars		
hrs	Baldwin	Brightwell	Tifblue	TH-275	Georgiagem	Pooled
	Actual means ± standard errors					
0	2.29 ± .077	2.63 ± .078	2.61 ± .055	2.99 ± .098	3.00 ± .080	2.70 ± .035
250	111[z]	102	104	101	107	105**
300	105	95	102	104	106	103
350	109	110*	103	102	112**	107**
400	100	98	103	110*	95	101
450	98	91*	97	114**	99	100
500	106	102	108**	108	107	106**
550	114**	95	103	93	107	102
600	114**	90*	105	99	92*	100
650	111*	108	105	102	110**	107**
	Actual cultivar means ± standard errors					
pooled	2.45[d][y] ± .025	2.60[c] ± .026	2.69[b] ± .025	3.10[a] ± .025	3.10[a] ± 0.25	

[z]Means within a column bearing * (P < .05) or ** (P < .01) superscripbs differ from the 0-hr mean.

[y]Means within a row bearing different superscripts (a,b,c,d) differ (P < .05).

presented in Table 1 for flower bud width and in Table 2 for rooting score. Cultivar means have been compared in all possible combinations, but means for the chilling hours have been compared with the 0-hr mean. Distribution of marketable and non-marketable rooting scores are presented in Table 3 for each cultivar.

The width of terminal flower buds varied among the blueberry cultivars and clone. When combined over chilling hours, the 2 highbush were similar in bud width and both had wider flower buds than the rabbiteye cultivars (Table 1). 'Baldwin' had the smallest flower bud width. The different widths of various rabbiteye cultivars observed in this study are consistent with an earlier study (4).

These data indicate that using the constant temperature chilling system and forcing detached budsticks may not be as effective in determining chilling requirements of flower buds as natural field chilling. A comparison of these 2 systems had shown that natural field chilling was more effective in calculating a chilling hour model as well as a chill unit model for blueberry leaf buds (7). However, expressing the chilled flower bud width means as percentages of the 0-hour means (Table 1) shows chilling requirements for the rabbiteye cultivars used in this study to be in accordance with previously conducted studies. For instance, the chilling requirements of 550 hrs for 'Baldwin' at the 1% probability level and 350 hrs for 'Brightwell' are similar to 450-500 hrs reported earlier (3) for 'Baldwin' and 350-400 hrs (2) for 'Brightwell.' 'Tifblue' required 500 hrs of chilling which is within the range of 400-650 hrs reported by Austin and Bondari (4). Also, with 1% probability highbush clone TH-275 and 'Georgiagem,' required 450 and 350 hrs of chilling respectively. No previous data are available for comparison with chilling requirements determined for the 2 highbush.

Rabbiteye 'Baldwin' and highbush 'Georgiagem' did not differ in rooting score, and produced the best overall root system (Table 2). TH-275 had a better root system than 'Brightwell' and 'Tifblue' which did not differ. After 'Baldwin' budsticks were chilled, they required 550 chilling hrs or more for satisfactory rooting. 'Brightwell' required some degree of chilling for rooting activity, rooting better after receiving at least 250 chilling hrs with maximum obtained at 500 chilling hrs.

Rooting activity of 'Tifblue' and 'Georgiagem' was not responsive to chilling. 'Tifblue' budsticks rooted poorly [rooting score ranged from 0.4 to 2.2 (Table 2)]. The difficulty of rooting 'Tifblue' in peat moss agrees with a previous study (8). On the other hand, in another previous study (13) hardwood cuttings of 'Tifblue' exposed to 250 hrs of chilling had more root growth but less percentage of roots in propagating beds than IBA, chilling, or IBA + chilling treatments. 'Georgiagem' rooted well without chilling (average score of 4.3) and increased chilling did not improve rooting. Chilling regimes from 0 to 400 hrs did not influence rooting of TH-275 and additional chilling decreased root development (Table 2).

Percentage of marketable cuttings was influenced by cultivar (Table 3). Among rabbiteye cultivars, 'Baldwin' had the highest pooled percentage (59%) of marketable cuttings. After chilling was initiated, 90% of the 'Baldwin' cuttings were marketable at 350 hrs and 80% marketable at 450 and 550 hrs, the latter of which is the lowest chilling hour for maximum bud width. However, with 'Brightwell' the 80% marketability occurred at 500 hrs of chilling which was 150 hrs of chilling more than for maximum bud width. The variation of rooting ability of 'Brightwell' cuttings that occurred with less or more chilling hours than 500 hrs can not be fully explained, but it could be that 500 chilling hrs was needed after some chilling occurred for maximum root development. As indicated by Chi-square, root marketability of 'Baldwin' and 'Brightwell' varied with the degree of accumulated chilling. Percentage of marketable cuttings of 'Tifblue' was little influenced by chilling treatments and ranged from 0 to 30% with varied accumulated chilling hrs. The percentage of marketable cuttings of TH-275 and 'Georgiagem' at 0-hr chilling was 80% and the distribution was dependent on chilling treatment. Overall, 74% of 'Georgiagem' were marketable as compared to 47% for TH-275. Percent marketability reached 100 for the 'Georgiagem' cuttings at the 400 chilling hrs.

Table 2. Means of rooting score[z] of 3 rabbiteye ('Baldwin,' 'Brightwell,' and 'Tifblue' and 2 highbush (TH-275 and 'Georgiagem') cultivars at various chilling times.

Chilling	Rabbiteye cultivars			Highbush cultivars		
hrs	Baldwin	Brightwell	Tifblue	TH-275	Georgiagem	Pooled
0	4.7[y]	0.0	1.5	3.9	4.3	2.9
250	3.3*	1.3*	1.8	3.2	4.6	2.8
300	2.9**	1.5*	1.3	3.4	3.1	2.4
350	4.0	1.9**	1.7	3.8	3.5	3.0
400	2.9**	1.9**	1.5	2.3	4.2	2.6
450	3.7	0.8	0.4	1.3**	3.9	2.0**
500	1.0**	4.1**	2.2	2.0*	4.3	2.7
550	4.1	1.5*	0.9	2.6	3.4	2.5
600	3.7	0.0	1.7	1.3**	4.2	2.2*
650	4.2	1.2	0.7	2.1*	3.6	2.4
pooled	3.5[a x]	1.4[c]	1.4[c]	2.6[b]	3.9[a]	

[y]Means within a column bearing * ($P < .05$) or ** ($P < .01$) superscripts differ from the 0-hr mean.

[x]Pooled means within a row bearing different superscripts (a,b,c) differ ($P < .05$).

[z]Rooting scores: 0 = no rooting; 5 = excellent.

Table 3. Distribution of percent rooting score (0-5 range) for marketable (4-5) and non-marketable (0-3) cuttings of 3 rabbiteye (Baldwin,' Brightwell' and 'Tifblue') and 2 highbush (TH-275 and 'Georgiagem') cultivars.

	Rabbiteye cultivars						Highbush cultivars			
Chill	Baldwin		Brightwell		Tifblue		TH-275		Georgiagem	
hrs	0-3	4-5	0-3	4-5	0-3	4-5	0-3	4-5	0-3	4-5
0	10	90	100	0	70	30	20	80	20	80
250	50	50	90	10	70	30	50	50	10	90
300	70	30	100	0	90	10	50	50	40	60
350	10	90	60	40	70	30	20	80	30	70
400	70	30	70	30	80	20	60	40	0	100
450	20	80	100	0	90	10	70	30	30	70
500	90	10	20	80	80	20	60	40	10	90
550	20	80	80	20	100	0	60	40	50	50
600	40	60	100	0	70	30	80	20	30	70
650	30	70	80	20	90	10	60	40	40	60
Pooled	41	59	80	20	81	19	53	47	26	74
X^2	29.3**[z]		36.3**		7.1		13.7		11.6	

[z]Chi-square with 9 degrees of freedom significant at the .05 (*) or .01 (**) probability level.

Significance to the Nursery Industry

In general, among the cultivars and clone used in this study, most of those chilling hours that affected the growth of terminal flower buds also influenced the rooting ability. It appears that: (a) hardwood cuttings of 'Brightwell' will require some degree of chilling for acceptable rooting, (b) 'Tifblue' cuttings do not root well with or without chilling, (c) cuttings of 'Baldwin,' TH-275 and 'Georgiagem' produce 80% or more marketable roots without chilling. The results also demonstrate that an opportunity may exist to exploit genetic variation among rabbiteye and low-chill highbush cultivars for flower bud growth and rooting ability. Data indicate that once hardwood blueberry cuttings have been chilled up to 250 hrs, further chilling may be necessary to enhance rooting.

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