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Northern Highbush and Half-high Blueberries on the Alaskan Kenai Peninsula: Preliminary Observations

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Abstract

Home and commercial cultivation of small fruits is popular in Alaska and blueberries of several species, such as *V. corymbosum* and *V. angustifolium*, have potential as cultivated crops for local production. In June 2009, we established blueberry plantings in two locations on the Kenai Peninsula, approximately 106 kilometers southwest of Anchorage, Alaska. Our objectives were to compare effects of location and cultivar for three northern highbush (*Vaccinium corymbosum* L.) and six half-high (*V. corymbosum* × *V. angustifolium*) blueberry cultivars on plant survival, fall tip dieback, winter injury, yield and fruit weight. Severe winter injury and some mortality were observed by June 2011. At both locations, highbush cultivars 'Duke', 'Earliblue', and 'Patriot', and the half-high cultivars 'Chippewa' and 'Northland' had severe fall tip dieback and winter injury. These five cultivars are not recommended for Southcentral Alaska, although 'Patriot' produced a few large ripe fruit in 2011. The remaining half-high cultivars survived well and produced yields in 2011. 'Northblue' and 'Northsky' ripened first, followed by 'Northcountry' and 'Polaris'. Fruit was harvested three times in September 2011. 'Northblue' yield was 0.25 kg·plant^{-1} (2-years post-establishment) and mean berry size was 1.98 g·berry^{-1}. Yields for 'Northcountry', 'Northsky', 'Polaris', and 'Patriot' were 0.09, 0.18, 0.05, and 0.02 kg·plant^{-1}, respectively. Berry weights were 0.66, 0.88, and 1.50 g·berry^{-1} for 'Northcountry', 'Northsky', and Polaris', respectively. Berry weights were not determined for 'Patriot'. Based on our initial observations, given appropriate cultivar selection and plant management, half-high blueberry production on the Kenai Peninsula appears feasible for home and small-acreages. Snow-catch strategies for winter protection and tunnels for season extension are recommended.

Indigenous fruit crops have been harvested from the wild for food and trade in Alaska, including red raspberry (*Rubus strigosus* L.), salmonberry (*R. spectabilis* Pursh), cloudberry (*R. chamaemorus* L.), and nagoonberry (*Rubus arcticus* L.); crowberry (*Empetrum nigrum* L.); highbush cranberry (*Viburnum edule* (Michx.) Raf.; and assorted blueberries, bilberries, and huckleberries (*Vaccinium* sp.) (2, 7, 8, 9). Domestic berry crops are cultivated (3) and efforts are underway to introduce berry production into rural Native Alaskan communities (5). Fruit crops are produced both in open fields and under various plastic-film-covered low or high tunnel designs.

While cultivation of domestic small fruits and harvesting of wild, indigenous small fruits are established in Alaska, little research has been published on the adaptability of highbush and half-high blueberries in southcentral Alaska. The area is subject to abrupt onset of cold, harsh winters, drying winds, and a short growing season. Summer temperatures tend to be cool, although the day-length is long, ranging from 14 to 19 hours during June-August. Plants produce rapid spring growth. The goal of this project was to evaluate the survival and performance of nine northern-adapted blueberry cultivars on the Kenai Peninsula. Our objectives were to compare location and cultivar effects for plant survival, fall tip dieback, winter injury, yields and berry weight.

Materials and Methods

Locations and soils - The blueberries

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were planted at two sites, the Olson and the O'Brien Farms. These were located approximately 60.5° N latitude, 151.0° W longitude, and elevation 30.5 m. The Olson Farm site was primeval forest first cleared in 2008. The site is level, with a clay loam soil. The O'Brien Farm was on a slope on the northern edge of a small bog and was previously used for agriculture. The O'Brien site is south-facing and terraced. The soils are clay loam. In May 2009, soil testing indicated pH values between 4.6 and 5.0 at the O'Brien Farm and 4.2 and 5.0 at the Olson Farm. Soil phosphorus averaged 3.8 and 3.5 ppm, potassium 120.0 and 36.9 ppm, and magnesium 98.8 and 117.3 ppm, respectively.

Plant materials – Plants were provided by Fall Creek Nursery, Lowell, Oregon and consisted of northern highbush cultivars 'Duke', 'Earliblue', and 'Patriot' and half-high cultivars 'Chippewa', 'Northblue', 'Northcountry', 'Northland', 'Northsky', and 'Polaris' that had been grown in a soilless medium and shipped in no. 1 nursery pots (ca 3.4 L). The plants were held inside a greenhouse in Alaska for about six weeks and planted on 29-30 June 2009. Flowers were removed prior to planting.

Cultural practices - Planting designs were similar at both locations and consisted of three plants of each cultivar planted in blocks, with three blocks of each cultivar randomly located within three planting rows (nine plants per cultivar at each farm). Plants at the Olson Farm were spaced 1.2 m apart in rows 3 m apart. Those at the O'Brien Farm were spaced 1.2 m apart in rows about 2.4 m apart.

Beds (ca 90 cm wide by 30 cm high) were formed and a trench 30 cm wide and deep was made on the top center of each bed and filled with peat soil harvested from a local bog. The beds and alleyways were then covered with weed barrier fabric. Irrigation water was provided through drip systems. Two drip tapes per row with one drip tape on either side of the plants were used at the O'Brien farm. A single semi-rigid PVC lateral per planting row and a single 3.8 $L \cdot h^{-1}$ emitter per plant was installed at the Olson farm at the time of planting and replaced with two drip tapes per row in 2011. The irrigation systems were turned on and off manually, as needed. The blueberries were planted into 20 cm diameter holes burned into the weed fabric along the centers of each row. In May 2010, the holes in the fabric were enlarged to 40 cm and the soil surface mulched with spruce sawdust and shavings from a local log home builder. Two Hobo temperature data loggers (Onset Computer Corporation, Bourne, MA) were installed at each farm to monitor air temperature ca 1 m above the soil and soil temperatures at the surface, 15 cm, and 30 cm deep.

During winter 2009-2010, no cold or desiccation protection was provided for the plants. In October 2010, steel "T"-shaped fence posts were set at the ends and along the centers of the planting rows to support bird netting for each row individually. The bird netting had a mesh of approximately 1.9 cm and was left in place permanently to help trap snow around the plants.

Plant performance was evaluated in July 2010, October 2010, June 2011, and September 2011. Plant survival (0 = dead and 1 = alive) and vigor (1 = very few new shoots and little elongation, 2 = below average shoot growth, 3 = average shoot growth, 4 = above average shoot growth, 5 = exceptional shoot growth) were rated. Fall tip dieback and winter injury were rated (0 = none, 1 = mild, 2 = moderate, 3 = severe). Injury ratings were based on the relative amounts per plant of stem and bud browning and necrosis, and failure of buds to form new growth in the spring. Stems and buds were not examined under a microscope. Berry weights were determined on 8-9 September 2011 and the berries were harvested on 11, 18, and 30 September 2011 at the Olson farm. Insufficient ripe fruits were available at the O'Brien farm for harvest and fruit weight determinations. Yield ($kg \cdot plant^{-1}$) was calculated and berry weight ($g \cdot berry^{-1}$) was measured. Results were analyzed using analysis of variance (fall tip dieback and winter injury) and general linear model (berry weight).

Results and Discussion

Climate – During the winter of 2009-2010, fall minimum air temperatures of -27 to -29°C were recorded on 17 November 2009 with winter lows of -27 to -32°C occurring on 10 March 2010. On both dates, the O'Brien Farm was the colder of the two locations. During late fall and winter of 2010-2011, minimum air temperatures of -28 to -33°C were recorded (Fig. 1).

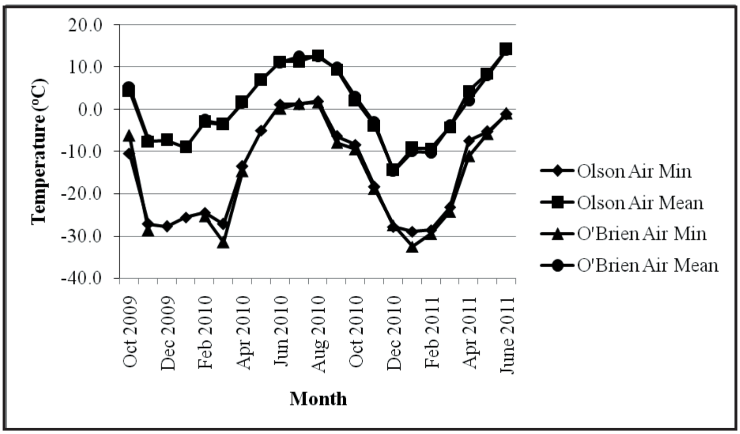

Fig. 1. Minimum and mean air temperatures (°C) at the Olson and O'Brien Farms, Kenai Peninsula, Alaska during October 2009 through June 2011. Data for July-September 11 were not available due to difficulties with the dataloggers.

During the winter of 2009-2010, the lowest soil surface temperatures recorded were -1.3°C and -1.7°C at the Olson and O'Brien Farms, respectively. The lowest soil surface temperature recorded was -6.4°C during January 2011 at the Olson Farm (Fig. 2).

No records of snow depths or wind speeds and duration were maintained at the planting sites. Snow depths measured at the U.S. National Weather Service in Soldotna, 8.4 km from the Olson Farm, are shown in Table 1.

All plants survived through 20 October 2010. Cumulative winter damage was minor to moderate, depending on cultivars. Some fall frost damage was evident on that date, primarily to the tips of current-season canes. Overall plant heath and vigor appeared good; however, damage during the winter of 2010-2011 was severe. Three 'Duke' and two 'Northland' plants died. The remaining plants of those cultivars did not produce fruits.

The reason for the increased stem and bud injury observed in June 2011 is not entirely clear. The recorded data suggests that minimum and mean air temperatures 1 m above the ground during the winters of 2009-2010 and 2010-2011 were similar in magnitude (Fig. 1). The temperature decline in October 2009 was more rapid and reached a lower temperature than the corresponding period in 2010 and there was an approximate 5°C dip in mean air temperatures during December 2010. Air temperatures were also relatively stable during November 2009 through March 2010, in contrast to the smooth curve and single minimum exhibited during November 2010 through March 2011. Given relatively greater regional snowfall (Table 1) during the winter of 2010-2011, one might expect to have seen less injury in the spring of 2011 due to insulation provided by the snow. Perhaps the critical point is that soil surface temperatures were 5.2°C lower in January 2011 than in January 2010, suggesting that the above-ground tissues and soil surface were exposed to colder temperatures during that period than in the year before. Unmeasured factors that might have contributed to these observations include on-site snow depths, snow density and moisture content, and wind

Table 1. Snowfall recorded by the National Weather Service in Soldotna, Alaska 8.4 km from the Olson farm for October 2009 through April 2011. Snowfall data were not reported by NWS for March 2011.

	2009		2010		2011	
Month	Total snowfall (cm)	Snow depth (cm)	Total snowfall (cm)	Snow depth (cm)	Total snowfall (cm)	Snow depth (cm)
Jan	---	---	13.5	20-30	17.0	20-38
Feb	---	---	18.0	13-43	23.4	38-53
Mar	---	---	30.5	15-43	---	---
Apr	---	---	8.4	0-18	2.5	0-20
Oct	0	0	0	0	---	---
Nov	18.0	0-13	50.8	0-38	---	---
Dec	32.5	20-28	27.2	20-43	---	---

speed and duration.

Highbush cultivars were severely affected by fall tip dieback and winter damage. For fall tip dieback (Fig. 3), differences due to location and cultivar were significant, but the interaction between location and cultivar was not significant (Table 2). For winter damage (Fig. 4), location and cultivar effects were significant and the interaction was not (Table 2). 'Northcountry', 'Northsky', 'Northblue', and 'Polaris' suffered significantly less fall tip dieback in 2010 than any of the highbush cultivars or the other half-high cultivars 'Chippewa' and 'Northland' (Fig. 3). 'Northcountry' suffered the least winter injury during the winter of 2010-2011, followed by 'Northsky'. 'Patriot' and 'Northblue' followed next in terms of winter injury, but were not statistically different than 'Chippewa' and 'Polaris'. 'Duke', 'Earliblue', and 'Northland' all suffered severe winter injury (Fig. 4).

Small quantities of berries were harvested during September 2010, although yield was not recorded. Due to late ripening, yield data for 2011 was collected only at the Olson Farm. Prior to September, fruits were green.

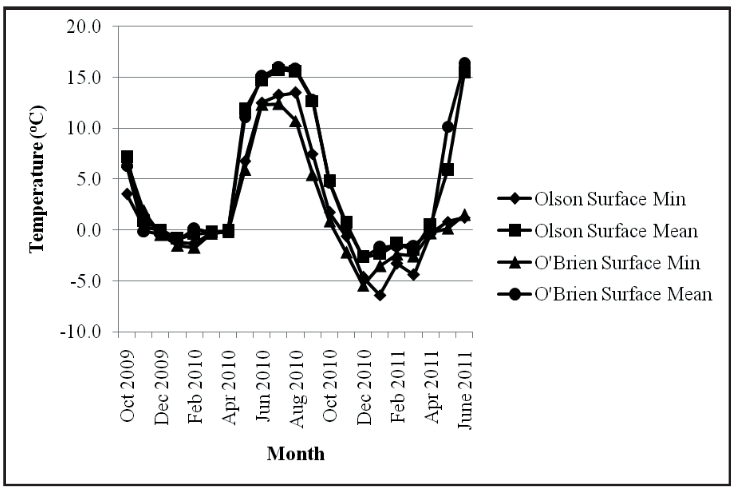

Fig. 2. Minimum and mean soil temperatures (°C) at the soil surface for the O'Brien and Olson Farms, Kenai Peninsula, Alaska, October 2009 through June 2011. Difficulties with the data loggers resulted in lost data during December 2009, May 2010, and July through September 2011.

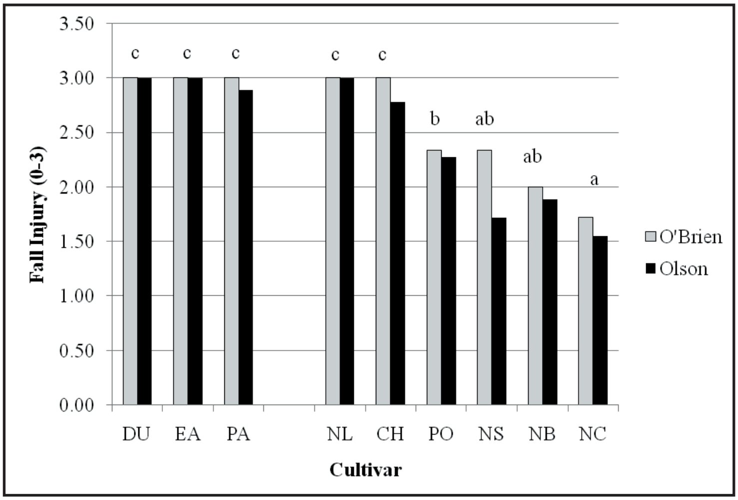

Fig 3. Fall tip dieback on northern highbush blueberry cultivars 'Duke (DU),' 'Earliblue' (EA), and 'Patriot' (PA), and half-high cultivars 'Chippewa' (CH), 'Northblue' (NB), 'Northcountry' (NC), 'Northland' (NL), 'Northsky' (NS), and 'Polaris' (PO) grown at the Olson and O'Brien Farms, Kenai Peninsula, Alaska, as measured June 2011. Fall tip dieback: 0 = none, 1 = slight, 2 = moderate, 3 = severe. Different letters above the bars indicate that the respective means of combined O'Brien and Olson farm data are significantly different ($P \leq 0.05$).

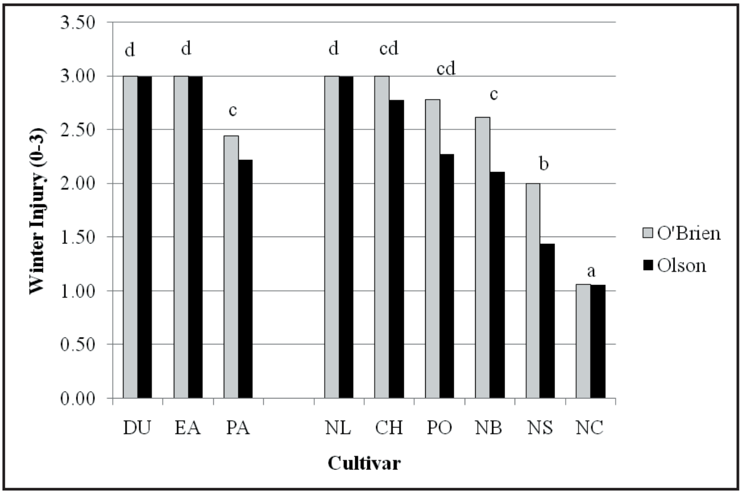

Fig 4. Winter injury on northern highbush blueberry cultivars 'Duke (DU),' 'Earliblue' (EA), and 'Patriot' (PA), and half-high cultivars 'Chippewa' (CH), 'Northblue' (NB), 'Northcountry' (NC), 'Northland' (NL), 'Northsky' (NS), and 'Polaris' (PO) grown at the Olson and O'Brien Farms, Kenai Peninsula, Alaska, as measured June 2011. Winter injury: 0 = none, 1 = slight, 2 = moderate, 3 = severe. Different letters above the bars indicate that the respective means of combined O'Brien and Olson farm data are significantly different ($P \leq 0.05$).

Table 2. ANOVA tables for fall tip dieback, winter injury, and berry weight for northern highbush blueberry cultivars 'Duke', 'Earliblue', and 'Patriot' and half-high blueberry cultivars 'Chippewa', 'Northblue', 'Northcountry', 'Northland', 'Northsky', and 'Polaris' from the Olson and O'Brien Farms, Kenai Peninsula, Alaska. Berry size values refer only to 'Northblue', 'Northsky', 'Northcountry', and 'Polaris'.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Fall tip dieback					
Location	0.816358	1	0.816358	4.955504	0.027561
Cultivar	43.25	8	5.40625	32.81733	0.000
Interaction	1.33642	8	0.167052	1.014052	0.428128
Error	23.72222	144	0.164738		
Total	69.125	161			
Winter injury					
Location	2	1	2	6.48811	0.01191
Cultivar	64.78086	8	8.097608	26.26909	0.000
Interaction	2.083333	8	0.260417	0.844806	0.564825
Error	44.38889	144	0.308256		
Total	113.2531	161			
Berry size					
Cultivar	79.492	3	26.497	201.900	0.000
Error			35.960	274	0.131
Total			115.452	277	

Freezing temperatures after 30 September destroyed the remaining crop. 'Northblue' ripened first and produced the greatest yields (Table 3), followed by 'Northsky', 'Northcountry', 'Polaris', and 'Patriot'. A few berries developed on 'Chippewa' and 'Patriot', but none developed on 'Duke', 'Earliblue', or 'Northland'. The yield for the 2-year plants of 'Northblue' was 0.25 kg·plant^{-1} and that for 'Northsky' was 0.18 kg·plant^{-1}. In Minnesota trials, yields for 4-year plants were 0.2 to 0.3 kg·plant^{-1} for 'Northblue', 'Northsky' and 'Northcountry' (1, 6).

Berry size was analyzed statistically only for the Olson farm as there were insufficient ripe berries available at the O'Brien farm at the time of data collection. Berry size differences due to cultivars were significant (Table 3). 'Northblue' at the Olson farm had the largest fruit with a mean weight of 1.98 g·berry^{-1}. This is similar to fruit produced in Minnesota at 1.6 to 2.3 g·berry^{-1} (1, 4). The largest 'Northblue' berry was 4.48 g. 'Patriot' produced too few ripe fruits at that time to analyze statistically, but the largest fruit was 3.18 g at the Olson farm. 'Northcountry' mean berry weight was 0.66 g, which is larger than Harrison et al. (4) reported in Minnesota trials, with means of 0.55 to 0.64 g·berry^{-1}, depending on pollen source. 'Northsky' berries averaged 0.88 g·berry^{-1} in the Kenai trials, as compared with 0.49 to 0.80 g·berry^{-1} in Minnesota trials (4). In the Minnesota trials (4), increasing percentages of outcross pollen increased berry weights, reportedly due to increased seed numbers, compared with self- or largely self-pollinated plants. In the Kenai trials, pollen from five other cultivars was available for each cultivar reported on here. Some degree of cross-

Table 3. Mean yields and berry weights for half-high and northern highbush blueberry cultivars grown at the Olson Farm, Kenai Peninsula, Alaska in September 2011.

Cultivar	Mean yield·plant^{-1} [z] (kg·plant^{-1} $\pm$ SD)	Mean berry weight (g·berry^{-1} $\pm$ SD)
	Half-high cultivars	
Northblue	0.25 $\pm$ 0.09	1.98 $\pm$ 0.60
Northcountry	0.09 $\pm$ 0.07	0.66 $\pm$ 0.21
Northsky	0.18 $\pm$ 0.08	0.88 $\pm$ 0.21
Polaris	0.05 $\pm$ 0.03	1.50 $\pm$ 0.29
	Highbush cultivar	
Patriot [y]	0.02 $\pm$ 0.02	---

[z] Fall freezing temperatures destroyed much of the crop before it could be harvested.

[y] Insufficient ripe 'Patriot' berries to analyze at that date.

pollination appears to have been possible. Due to the young plant age and limited fruit available for measurement, firm conclusions regarding berry weight and yield potentials in Alaska cannot yet be drawn.

Conclusions

This study provides initial results on cultivated blueberry production in Kenai, Alaska. The authors recognize that the results are preliminary but budget cuts forced the termination of this project in November 2011. We hope to continue research on these plots if possible. Location had a significant effect on winter injury as measured during June 2011. Half-high blueberries grew better, fruited, and are recommended over the tested highbush cultivars for west-central Kenai Peninsula conditions. None of the highbush cultivars tested were suitable. Of the half-high cultivars, 'Northland' is not suitable and 'Chippewa' appears poorly suited to the area.

'Northblue', 'Northsky', 'Northcountry', and 'Polaris' had less fall tip dieback than the other tested cultivars and 'Northcountry' and 'Northsky' suffered only slight to moderate winter injury. 'Northblue' produced the greatest yields and its berry size was similar in Alaska to that reported in Minnesota. 'Northblue' is the most promising half-high cultivar tested. 'Northcountry', 'Northsky', and, to a lesser degree, 'Polaris' may also be successful.

In open field plots, fruit did not begin ripening until September and crop losses due to fall freezing temperatures were substantial. Temporary low or high tunnels installed over blueberries during fruit set through ripening could increase heat units to speed fruit ripening and delay fall freezing temperature damage, thereby increasing fruit yields. Based on initial observations in the west-central Kenai Peninsula, cultivation of domestic blueberries for personal and small-scale commercial uses appears feasible, despite significant challenges.

Acknowledgements

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Comparison of the sub-cellular compartmentation of sugars in mature apples of two cultivars susceptible to different types of watercore and grown in different climates

The cellular compartmentation of sugars was compared between mature 'Orin' and 'Fuji' apple fruit (*Malus* × *domestica* Borkh.) which are susceptible to early and late watercore, respectively. Fruit were grown in a warmer climate (Ehime) and in a cooler climate (Aomori). Slight watercore, with a score of 1.4 (i.e., a remaining trace of early watercore), was detected in 'Orin' at Ehime, whereas severe late watercore, with a score of 3.0, was observed in 'Fuji' at Aomori. Sorbitol contents were significantly higher in watercored fruit than in non-watercored apples, not only in the intercellular spaces, but also in the cytoplasm and vacuoles, irrespective of the type of watercore. The permeability of the tonoplast to sorbitol was higher in watercored fruit than in non-watercored fruit in both cultivars, while a lower permeability of the plasma membrane to sorbitol was observed in watercored apples. Late watercore, which affected 'Fuji' at Aomori, showed similar levels of sorbitol to early watercore in 'Orin' at Ehime, despite the significantly higher watercore score in 'Fuji', suggesting that sorbitol may play only a minor role as a causative agent in the development of late (or low temperature-promoted) watercore compared with early (or high temperature-induced) watercore. Abstract from: H. Yamada, T. Mukai and T. Fukasawa-Akada, 2012. The Journal of Horticultural Science & Biotechnology 87(1): 17-22.