

# The Productivity of Some Blueberry Cultivars under Estonian Conditions

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## Abstract

Success in the cultivation of half-high and lowbush blueberry has been achieved in Estonia. The objective of the experiment was to evaluate highbush blueberry (*Vaccinium corymbosum* L.) cultivation possibilities in northern conditions. The field trial with 15 highbush blueberry and three half-high blueberry cultivars was established in South Estonia (58°21' N, 26°31' E) in 2003. To select cultivars for experiment we took into consideration the winter hardiness of plants and harvest season of berries. The experimental plantation produced its first yield in 2007 and current data are based on this year. In 2007, 'Blue Rose', 'Bluegold', 'Bruni', 'Caroline Blue', 'Chandler', 'Denise Blue', 'Nui' and 'Reka' had more winter damage. The blueberry plants of all cultivars had winter damage, but none of the plants died for that reason. 'Blue Rose' and 'Nui' had smaller plants. The yields of highbush blueberries 'Bluecrop', 'Denise Blue' and 'Hardyblue' were the highest. The berry weight ranged from 1.1 to 4.2 g. 'Bruni' and 'Nui' had the largest berries. The harvest season of 'Caroline Blue' was very late; therefore, some berries did not ripen. Results showed that highbush blueberry grew satisfactorily in Estonian conditions and we can recommend all of these cultivars for the home garden. 'Bluecrop', 'Denise Blue', 'Hardyblue' (syn. 1613A), 'Olympia' and 'Reka' are more suitable for commercial cultivation.

## INTRODUCTION

About 10% of the world blueberry production area was situated in Europe in 2003. An estimated, 1,100 ha were situated in Poland, 1,350 ha in Germany, 410 ha in France, 300 ha in The Netherlands, 250 ha in Spain and Portugal, 65 ha in Italy and 15 ha in the United Kingdom (Strik, 2005). In northern Europe, several field experiments with blueberries have been carried out (Vestrheim et al., 1997; Heiberg and Stubhaug, 2006), also some greenhouse experiments have been conducted in Norway (Heiberg and Lunde, 2006). Research into possibilities for cultivating highbush blueberries have also been started in Latvia (Abolins and Gurtaja, 2006). In Finland, attention has been mainly paid to cultivation and breeding of half-high blueberries (Lehmushovi and Ylämäki, 1994; Hiirsalmi, 1989). The experimental work with blueberries in the department of Horticulture at the Estonian Agricultural University began in 1997. Experiments have shown that due to good winter resistance, lowbush and half-high blueberries could be prospective berry cultivars in Estonia (Starast et al., 1999; Karp et al., 2000). Highbush blueberries have higher yields than lowbush blueberries; in field conditions lowbush blueberries usually give 1.8 t ha<sup>-1</sup>, while highbush blueberries may yield at least 4.5 to 5.5 tons of berries per hectare. The berry weight of highbush blueberries may reach 3 to 4 g, whereas berry weight of lowbush blueberries is usually less than 1 g (Hancock and Draper, 1989).

Since previous experiments with other blueberry species were successful, we presumed that northern highbush cultivars may possibly grow in Estonia. The objective of the experiment was to evaluate highbush blueberry (*Vaccinium corymbosum* L.)

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cultivation possibilities in northern conditions.

## MATERIALS AND METHODS

The experiment was situated in South Estonia (58°21' N, 26°31' E) at the Research Centre of Estonian University of Life Sciences. Soil in the experimental area was sandy loam. The experimental plantation was established in 2003. Plant to plant spacing was 1.0 m and space between the rows was 2.5 m. Pine bark mulch was used in between the plants and turfgrass in between the rows. For each cultivar, five plants in each of four replications were planted randomly. The following cultivars were used in the experiment: half-high cultivars, 'Northblue' (control), 'Northland'; lowbush cultivar, 'Putte'; and highbush cultivars, 'Ama', 'Blue Rose', 'Bluecrop', 'Bluegold', 'Bluejay', 'Bruni', 'Caroline Blue', 'Chandler', 'Denise Blue', 'Hardyblue' (syn. 1613A), 'Nui', 'Olympia', 'Puru', 'Reka' and 'Toro'. In 2007 plants were fertilized by irrigation using Kemira blueberry fertilizer (7-3-18 + micronutrients), 0.8% solution. Plants were fertilized on 18 May, 29 May and 8 June.

Winter damage was estimated at the beginning of the vegetative growth period on 15 May, 2007. A 9-point scale was used, where 1 = no damage; 9 = whole plant damaged (plant dieback to the soil level). The height of the bush (cm) was measured from the highest point of the plant. The width of the bush was measured along and across the row, and the average width of the plant was calculated. Plant height:width ratio was calculated in order to compare growth habit differences. The number of long shoots (more than 15 cm) was counted per each bush. Plants were measured at the end of the vegetation period on 13 September. At this time it was also estimated to what extent plants had finished their growth. This was done using a 9-point scale, where 1 = plant completely green and continuing to grow; 9 = growth completely finished, leaves yellow and dropped.

Plants were harvested on 16 and 24 July, 1, 9, 16, 23 and 29 August, and 6 and 12 September. Yield from each plant was harvested separately. To find the berry weight (g), 10 fruits from each of four replications were picked, weighed, and the average calculated. Berry length (mm) (from stem to calyx end) and berry diameter (mm) (from side to side) of 10 fruits in four replications was measured with digital caliper. To detect differences in fruit shape berry, length:diameter ratio was calculated.

Data were analyzed by one-way ANOVA table. The least significant difference (LSD) at the 95% confidence level was calculated. Significantly different values from control ('Northblue') are typed in bold letters in tables. In order to find correlations between different parameters, correlation coefficient (r) was calculated.

## RESULTS

Winter damage was detected in all cultivars (Table 1). Winter damage ratings in 'Northblue' averaged 2.3 points. Compared to the control, 'Blue Rose', 'Bluecrop', 'Bluegold', 'Bruni', 'Caroline Blue', 'Chandler', 'Denise Blue', 'Northland', 'Nui', 'Olympia', 'Reka' and 'Toro' showed significantly more winter injury. Conversely, 'Ama', 'Bluejay', 'Hardyblue', 'Puru' and 'Putte' were as hardy the half-high 'Northblue'.

The height of the plants ranged from 42 to 80 cm and the width of the plants from 51 to 71 cm (Table 1). Heights of 'Putte', 'Nui' and 'Blue Rose' plants were similar to the height of 'Northblue' plants. Plants from other cultivars were significantly taller. 'Ama', 'Bluecrop', 'Bluejay', 'Denise Blue', 'Northland' and 'Olympia' had wider plants than others. The plant height:width ratio showed that growth habit of 'Ama', 'Bluecrop', 'Bluegold', 'Bluejay', 'Bruni', 'Caroline Blue', 'Chandler', 'Hardyblue', 'Olympia', 'Puru', 'Putte' and 'Reka' differed significantly from the control. The vertical growth of shoots was modest, since most of the plants had shoot damage by spring frost and had to be pruned back. The number of shoots per plant ranged from 0.9 to 8.8 per plant by autumn (Table 1). 'Putte' had the highest number of shoots, 'Ama' had a similar number and other cultivars had fewer shoots compared to the control

cultivar. On average there were three long shoots per plant at the end of the experiment.

Finishing growth and beginning lignification of shoots before first autumn frosts ensures better overwintering of blueberry plants. Plants that have finished growing have formed a terminal bud at the top of the shoot, the whole shoot is lignified, and the foliage has turned reddish-yellow. The growth completion scores ranged from 4.0 to 7.3 points (Table 1). Compared to the control, 'Northland' plants had significantly lower growth completion scores; all other cultivars were similar to the control. Secondary growth was not noticed in blueberries, but flowering was detected in 'Ama'.

The yield per plant ranged from 6 to 924 g (Table 2). The control cultivar, 'Northblue', had the lowest yield compared to all other cultivars. The highest yield was harvested from 'Denise Blue', which yielded 924 g per plant. The harvest period of 'Denise Blue' was also the longest, lasting for 7 weeks. The yield of 'Denise Blue' was high despite showing significant winter damage. Correlation analysis showed that the yield of the plants had no correlation with winter damage ( $r = -0.03$ ). High yield was also obtained from 'Bluecrop' and 'Northland'. The average yield on the experimental plantation was 354 g/plant.

The length of the berries ranged from 8 to 14 mm and berry diameter from 13 to 20 mm (Table 2). Berries had oblate-round shape: fruit length was larger than diameter for all cultivars. Berries of 'Putte' and 'Hardyblue' had both diameters similar to the control cultivar's berries. Other cultivars had larger berries compared to the control, and 'Denise Blue' had also one of the largest fruits. Berry length: diameter ratio showed that the berry shape of 'Blue Rose', 'Putte' and 'Toro' was more elongated.

The average fruit weight ranged from 1.1 to 4.2 g (Table 2). Fruits of the 'Putte' were similar to the control cultivar's fruits; all other cultivars had heavier berries compared to 'Northblue'. 'Bruni' had the heaviest fruits. A positive correlation was found between across diameter and berry weight ( $r = 0.927$ ). Berry weight and total yield had no significant correlation ( $r = 0.296$ ).

## DISCUSSION AND CONCLUSIONS

The results of the cultivar comparison experiments with highbush blueberries in 2007 showed that 'Blue Rose', 'Bluecrop', 'Bluegold', 'Bruni', 'Caroline Blue', 'Chandler', 'Denise Blue', 'Northland', 'Nui', 'Olympia', 'Reka' and 'Toro' had the most winter damage. Despite the high incidence of winter damage for these cultivars they had higher yields than the winter hardy 'Northblue'. The experimental year's weather conditions were favourable for blueberries, and therefore, 'Ama', 'Bluecrop', 'Bluejay', 'Denise Blue', 'Northland' and 'Olympia' grew vigorously, forming substantial yield potential for following year. 'Bluecrop' has also grown well in Norway (Heiberg and Stubhaug, 2006). Observations in autumn showed that 'Northland' plants were poorly prepared for winter, since their vegetative growth had not finished yet. 'Ama' plants were flowering, which probably means decreased yield in following year. 'Putte' had the highest number of shoots.

The experimental plantation produced its first yield in 2007. The first harvest was done in the middle of July, which is the same time when first highbush blueberry fruits ripen in Poland (Smolarz, 2006). The yield was harvested nine times; the last harvest was carried out on 12 September. Fruits from each cultivar were harvested 4 to 7 times. The latest ripening cultivar was 'Caroline Blue', for which fruits were first harvested on 9 August and last harvested on 12 September. The total yield of 'Northblue' was extremely low. In Estonian conditions, yield of 'Northblue' have been as high as 400 g per plant (Karp et al., 2006). In this experiment, 'Bluecrop', 'Denise Blue', 'Hardyblue', 'Northland', 'Puru' and 'Toro' had higher yield than 'Northblue's maximum. Plants of 'Denise Blue' had double of the highest yield that 'Northblue' has given in good years. The yield of 'Denise Blue' plants was 3.7 t/ha. In Germany, the yield of 6 t per hectare is considered very good, and the average highbush blueberry yield ranges from 2.5 to 4 tons per ha (Pliszka, 1997). The average yield in our experimental plantation was also 2.5 tons per hectare. Scientists in Norway have found that 'Reka' has high yield, and 'Blue Rose'

has modest yield and poor winter hardiness (Heiberg and Stubhaug, 2006). Similar conclusions can also be made based on our results.

Fruits of 'Caroline Blue' ripened so late that some berries remained unripe. Therefore, this cultivar is more suitable for home gardens than for commercial cultivation, since it can provide fresh berries until the end of the vegetation period.

From the commercial production point of view, cultivars with high yield and large berries are more suitable, since these plantings can return establishment costs more quickly, which in Estonian conditions has estimated to be a minimum of six years (Värnik et al., 2004). In the Netherlands, fruit weight of 'Chandler' has been 2.5 g and fruit diameter 2 cm (Balkhoven and Peppelman, 2002). In our experiment, 'Chandler' had a similar diameter and fruit weight was 3.1 g. 'Nui' had the largest berries (2.9 g) in Norway (Heiberg and Stubhaug, 2006). In our experiment, berries of 'Nui' were on average 1 g heavier, being 3.8 g. Berry weight of more than 3 g was also found in 'Bluegold' (3.1 g), 'Denise Blue' (3.4 g), 'Puru' (3.3 g) and 'Toro' (3.0 g). 'Bruni' had the largest berries in our experiment; the average fruit weight was 4.2 g.

Results showed that northern highbush blueberry grew satisfactorily in Estonian conditions and we can recommend all experimental cultivars for the home garden. 'Bluecrop', 'Denise Blue', 'Hardyblue', 'Olympia' and 'Reka' are more suitable for commercial cultivation due to higher yields and larger fruit size.

## ACKNOWLEDGMENTS

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## Literature Cited

- Abolins, M. and Gurtaja, L. 2006. *Vaccinium* spp. Production Techniques in Latvia. Acta Hort. 715:185–190.
- Balkhoven, J. and Peppelman, G. 2002. Chandler obtains the largest fruits, Brigitta Blue the largest production/ Chandler geeft grootste vruchten, Brigitta Blue grootste productie. Fruitteelt (Den Haag) 92(48):12–13.
- Hancock, J.F. and Draper, A.D. 1989. Blueberry culture in North America. HortScience 24:551–556.
- Heiberg, N. and Lunde, R. 2006. Effect of growth media on highbush blueberries grown in pots. Acta Hort. 715:219–224.
- Heiberg, N. and Stubhaug, E., 2006. First results from cultivar trials with highbush blueberry in Norway. Acta Hort. 715:307–312.
- Hiirsalmi, H.M. 1989. Research into *Vaccinium* cultivation in Finland. Acta Hort. 241:175–184.
- Karp, K., Noormets, M., Starast, M. and Paal, T. 2006. The influence of mulching on nutrition and yield of 'Northblue' blueberry. Acta Hort. 715:301–306.
- Karp, K., Starast, M. and Tiido, T. 2000. Frost damages of arctic bramble (*Rubus arcticus*) and half highbush blueberry (*Vaccinium corymbosum* × *Vaccinium angustifolium*) depend on cultivation methods. Proceedings of the International Conference: Fruit Production and Fruit Breeding. Tartu p.244–247.
- Lehmushovi, A. and Ylämäki, A. 1994. Pensasmustikoiden kasvattamisen ohjet. Puutarha 5:270–273. (in Finnish)
- Pliszka, K. 1997. Overview on *Vaccinium* Production in Europe. Acta Hort. 446:49–52.
- Smolarz, K. 2006. Evaluation of four blueberry cultivar growing in central Poland. Acta Hort. 715:81–84.
- Starast, M., Karp, K. and Tasa, T. 1999. Poolkorge mustika sortide 'Northblue' ja 'Northcountry' talvekindlus. Eesti Pollumajanduslikool. Teadustoode kogumik 203:162–163. (in Estonian)
- Strik B. 2005. Blueberry: an expanding world berry crop. Chronica Hort. 45(1):7–12.
- Varnik, R., Ohvril, T. and Starast, M. Blueberry growing efficiency and marketing in Estonia. Report on 8<sup>th</sup> International Symposium on *Vaccinium* Culture. 3<sup>rd</sup>-8<sup>th</sup> May,

2004, Oeiras/Portugal; Seville/Spain.  
 Vestrheim, S., Haffner, K. and Grønnerød. 1997. Highbush blueberry production and research in Norway. Acta Hort. 446:177–180.

## **Tables**

Table 1. Winter damage and vegetative growth of 18 blueberry cultivars in 2007 grown at Estonian University of Life Sciences.

Cultivar	Winter damage (point)*	Plant height (cm)	Plant width (cm)	Plant height: width ratio	Number of long shoots per plant	Ending vegetative growth (point)**
Northblue	2.3	42	53	0.8	5.4	6
Ama	2.8	<b>69</b>	<b>67</b>	<b>1.0</b>	5.7	5
Blue Rose	<b>6.7</b>	52	56	0.9	<b>2.8</b>	7
Bluecrop	<b>3.7</b>	<b>80</b>	<b>69</b>	<b>1.2</b>	<b>1.7</b>	5
Bluegold	<b>7.2</b>	<b>63</b>	62	<b>1.0</b>	<b>2.1</b>	6
Bluejay	1.7	<b>69</b>	<b>71</b>	<b>1.0</b>	<b>2.6</b>	6
Bruni	<b>6.8</b>	<b>60</b>	58	<b>1.0</b>	<b>2.3</b>	6
Caroline Blue	<b>6.5</b>	<b>62</b>	54	<b>1.2</b>	<b>2.7</b>	6
Chandler	<b>5.5</b>	<b>59</b>	60	<b>1.0</b>	<b>0.9</b>	6
Denise Blue	<b>7.0</b>	<b>62</b>	<b>66</b>	0.9	<b>3.4</b>	6
Hardyblue (1613A)	1.7	<b>67</b>	61	<b>1.1</b>	<b>4.0</b>	7
Northland	<b>3.3</b>	<b>62</b>	<b>65</b>	0.9	<b>4.3</b>	<b>4</b>
Nui	<b>5.7</b>	48	57	0.8	<b>1.6</b>	7
Olympia	<b>3.3</b>	<b>68</b>	<b>69</b>	<b>1.0</b>	<b>2.4</b>	6
Puru	2.8	<b>61</b>	57	<b>1.1</b>	<b>1.0</b>	6
Putte	2.2	50	51	<b>1.0</b>	<b>8.8</b>	5
Reka	<b>5.7</b>	<b>75</b>	63	<b>1.2</b>	<b>2.5</b>	5
Toro	<b>4.2</b>	<b>56</b>	60	0.9	<b>2.4</b>	6
<i>LSD 95%</i>	<i>0.8</i>	<i>10</i>	<i>11</i>	<i>0.1</i>	<i>0.6</i>	<i>2</i>

\*1 = no damage; 9 = whole plant damaged.

\*\*1 = plant completely green and continuing growth; 9 = growth completely finished, leaves yellow and dropped.

Table 2. Yield and berry parameters of 18 blueberry cultivars in 2007 grown at Estonian University of Life Sciences.

Cultivar	Yield (g/plant)	Berry weight (g)	Berry length (mm)	Berry diameter (mm)	Berry length:diameter ratio
Northblue	6	1.1	8	13	0.6
Ama	<b>81</b>	<b>1.7</b>	<b>11</b>	15	0.7
Blue Rose	<b>92</b>	<b>1.5</b>	<b>11</b>	15	<b>0.8</b>
Bluecrop	<b>591</b>	<b>2.7</b>	<b>11</b>	<b>18</b>	0.6
Bluegold	<b>191</b>	<b>3.1</b>	<b>12</b>	<b>18</b>	0.6
Bluejay	<b>305</b>	<b>2.4</b>	<b>12</b>	<b>16</b>	0.7
Bruni	<b>268</b>	<b>4.2</b>	<b>12</b>	<b>20</b>	0.6
Caroline Blue	<b>163</b>	<b>2.4</b>	<b>13</b>	<b>18</b>	0.7
Chandler	<b>89</b>	<b>3.1</b>	<b>13</b>	<b>20</b>	0.7
Denise Blue	<b>924</b>	<b>3.4</b>	<b>14</b>	<b>19</b>	0.7
Hardyblue (1613A)	<b>518</b>	<b>1.7</b>	10	15	0.7
Northland	<b>598</b>	<b>1.9</b>	<b>11</b>	15	0.7
Nui	<b>322</b>	<b>3.8</b>	<b>13</b>	<b>20</b>	0.6
Olympia	<b>261</b>	<b>2.0</b>	<b>11</b>	15	0.7
Puru	<b>466</b>	<b>3.3</b>	<b>12</b>	<b>18</b>	0.6
Putte	<b>357</b>	1.3	10	13	<b>0.8</b>
Reka	<b>326</b>	<b>2.4</b>	<b>11</b>	<b>17</b>	0.7
Toro	<b>459</b>	<b>3.0</b>	<b>13</b>	<b>16</b>	<b>0.9</b>
<i>LSD 95%</i>	<i>44</i>	<i>0.3</i>	<i>2</i>	<i>2</i>	<i>0.1</i>