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Particular Fruiting of the Highbush Blueberries (*Vaccinium corymbosum*) Different Cultivars in the Conditions of Belarus

Mikalai Paulouski*

Central Botanical Garden of National Academy of Sciences of Belarus, Minsk, Belarus

***Corresponding Author:** Mikalai Paulouski, Central Botanical Garden of National Academy of Sciences of Belarus, Surganova St., 2v, Minsk 220012, Belarus, Tel: 375292007558; E-mail: pavlovskiy@tut.by*

ABSTRACT

The peculiarities of the beginning of the stage of reproductive growth, industrial fruiting, the yield of twenty highbush blueberries, and three half-highbush blueberry cultivars introduced in Belarus are shown based on the results of multi-year stationary research. At the age of 4 blueberries enter the reproductive growth stage and at the age of 6 they enter into the stage of industrial fruiting. 'Bluecrop', 'Bluetta', 'Denise Blue', 'Duke', 'Earliblue', 'Elizabeth', 'Jersey', 'Northblue', 'Northcountry', 'Northland', 'Patriot' and 'Weymouth' cultivars have a higher berry yield. The yield of blueberry cultivars varies from year to year of fruiting. 'Blueray', 'Northland', and 'Jersey' have shown regular fruiting. The changes in blueberry fruiting in Belarus were caused by flower bud mortality in winter and/or drought during their fruit set.

Keywords: *Vaccinium corymbosum*, Highbush blueberry, Fruiting, Yield, Variability in fruiting, Belarus.

INTRODUCTION

Recently, Belarus has been steadily increasing the area of blueberry industrial plantations (*Vaccinium corymbosum L.*); from 2014 to 2017, their area doubled and reached 1000 ha. This happens due to favourable environmental conditions of the republic and high cost of blueberries which provides the payoff of their growing. Considering the significant expenses on growing this cropper and its longevity, one of the main components which determine the high blueberry yield and, hence, profitability is the selection of appropriate cultivars. Currently more than 400 blueberry cultivars have been selected in countries with different natural conditions (Australia, Finland, Germany, New Zealand, Poland, Romania, Spain, USA, and Japan) [1]. Very often a cultivar with a high yield in one region shown low productivity in another [2]. It seems that not all blueberry cultivars are equally suitable for growing in Belarussian conditions. For revealing the most prospective and preventing possible errors the maximum quantity of taxons should be used for introductory research.

Fruiting is considered as the main criterion for evaluating the success of introducing berry plants because it shows the result of the whole plant activity. Analysis of literary sources with data on highbush blueberry yield allows classifying these data by two types: 1) information about the yield of blueberry in whole as a cultivar [3-7] 2) data on yield of pomological cultivars [2,8-15].

In the USA, the habitat of blueberry cultivar, the average yield in Oregon State is 4.5 tons per hectare [7]. M. Longstroth [5] gives a similar yield figure for Michigan State. According to J. Frecon [4] this figure ranges between 4.5-6.5 tons per hectare for New Jersey State. According to B. Strik [6], the yield of highbush blueberry in north-east, southern and south-west states of the USA ranges between 7.0-10.0 tons per hectare, 10.0-11.0 tons per hectare in Central-West states and 22.0 tons per hectare in Western states. The same author states that the average yield of highbush blueberry in Canada is 12.0 tons per hectare and higher in Ontario and Quebec and up to 19.0-22.0 tons per hectare in British Columbia.

American researchers J. Hancock and A. Draper [16] mention strong ranging of highbush blueberry yield depending on biotic and abiotic factors. The author state that the average yield of highbush blueberry is (1.5-1.8) kg/plant, but in working crop and in optimal environmental conditions the yield can reach (8.0-9.6) kg/plant, if converted into area units – (4.5-5.5 and 25.0-30.0) tons per hectare correspondingly. According to R. Funt et al. [10], in the conditions of Ohio State the blueberry yield ranged from 0.8

kg/plant ('Patriot') to 4.9 kg/plant ('Blueray') depending on cultivar peculiarities.

In Chile conditions, (10.0-14.0) tons per hectare is considered as the usual yield of blueberry [3].

According to A. Lehmushovi [17], in Finland the yield of highbush blueberry is (1.3-3.2) kg/plant or 5.0-16.0 tons per hectare.

In Norway the yield of highbush blueberry was 0.2 kg/plant and higher ('Bluerose') and up to 2.0 kg/plant ('Reka') depending on cultivar peculiarities [12].

According to A. Ripa et al. [18], in Latvian conditions the average yield of blueberry ranges between 0.2 kg/plant ('Herbert') and 1.6 kg/plant ('Coville'). According to D. Šterne et al. [19], in this republic the berry yield of this cultivar ranged between (0.2-0.8) kg/plant ('Blueray') and (2.6-6.0) kg/plant ('Patriot') depending on the season.

According to E. Stackeviciene [11], in Lithuania the blueberry yield ranged between 1.0 kg/plant ('Northblue') and 2.5 kg/plant ('Patriot') depending on the cultivar. According to Butkus and Butkiene [8] the 'Bluecrop' cultivar had the highest yield (2.9 kg/plant).

According to K. Smolarz et al. [13], the average blueberry yield in central Poland was ranged between 1.8 kg/plant ('Earliblue') and 3.2 kg/plant ('Weymouth') depending on the cultivar. B. Kozinski [2] gives similar figures for the yield of other blueberry cultivars in this region of Poland.

According to I. Danilova [9], in the Main Moscow Botanical Garden, Russia, the blueberry yield varied between 0.6 ('Weymouth') to 4.3 kg/plant ('Herbert') depending on the year of research and cultivar. In the conditions of Mari El Republic the yield was between 0.1 kg/plant ('Bluecrop') and 0.7 kg/plant ('Patriot') depending on cultivar peculiarities [20]. According to Briksin [15], in Central Black Earth Region (Michurinsk) the blueberry yield ranged between 0.2 kg/plant ('Herbert') and 1.2 kg/plant ('Bluecrop'). In researches of Suslin and Pchelintsev (2001) 'Bluecrop' cultivar had the highest yield in Central Black Earth Region-2.1 kg/plant. According to A. Konobeyeva [21] 'Blueray' cultivar of highbush blueberry has the highest yield in this region of Russia (0.5 tons per hectare).

T. Kurlovich and V. Bosak [22] have estimated the yield of seven cultivars of highbush blueberry in Belarusian conditions. According to these authors, 'Coville' has the highest average yield (3.2 kg/plant) and 'Bluecrop' has the lowest yield (0.5 kg/plant). In his more recent T. Kurlovich's [23] researches the 'Bluecrop' cultivar yield ranged between (0.7 and 4.4) kg/plant and between (0.9 and 2.2) kg/plant for 'Coville' cultivar depending on the season. According to her, the 'Northcountry' cultivar has the highest yield with figures (4.8-8.0) kg/plant, and 'Bluerose' has the lowest yield-(0.1-1.1) kg/plant.

So the literary data show that the figures of high bush blueberry vary strongly and increase to the north. It should be mentioned that different cultivars of blueberry had the highest yield in different geographical regions. So for finding blueberry cultivars with high yield for certain environmental conditions a direct experience is required.

This research aims to evaluate the yield of highbush blueberry cultivars in Belarusian conditions and to find those with the highest yield.

MATERIALS AND METHODS

The observational material had been collected during 2001-2016 in the collection crop of berry plant introduction and technology laboratory at Central botanic garden of the National Academy of Sciences of Belarus located in Hantsevichy district Brest region (N 52°44', E 26°22'). Twenty cultivars of highbush blueberry ('Bluecrop', 'Blueray', 'Bluerose', 'Bluetta', 'Carolinablue', 'Coville', 'Croatan', 'Darrow', 'Denise Blue', 'Duke', 'Earliblue', 'Elizabeth', 'Hardyblue', 'Herbert', 'Jersey', 'Nelson', 'Patriot', 'Reka', 'Rubel', 'Weymouth') and three half-highbush blueberries ('Northblue', 'Northcountry' и 'Northland') became the target of the research. 'Bluecrop' mid-season cultivar wide-spread and area-specific in Belarus is adopted as the standard cultivar.

The blueberry crop was formed from 2-year own-root nursery plants in 1999. Planting area-2.0 × 1.5 m. The soil at the garden plot is inorganic with 4.5 pH (H_2O) and loose anisometric subjacent sand. The crop line around the tree trunk is mulched with wood shavings 10 cm deep and 1 m wide. The spacing was kept under natural swarding. Sanitation pruning of plants was performed annually during which the dead, damaged or poorly placed stems were removed.

The yield was recorded annually by weighing [24]. Berries were gathered in 2-5 stages according to their ripening separately from each of the 10 accountable plants. The average weight of one berry was determined by weighing 100 berries at each harvest in triplicate. The average multiyear yield of blueberry cultivars and fruiting rate indices were determined to start from the industrial fruiting stage. The fruiting rate coefficient was calculated according to Singh's formula [25]:

$$J = (Y2-Y1)/(Y1+Y2) \times 100,$$

Where J is the rate coefficient and Y1, Y2 - the yield during the approximal years.

Hydrothermal index of Selyaninov shows the level of water availability of the territory, calculated by the formula [26]:

$$K = R \times 10/\Sigma t,$$

Where R is precipitation amount in millimeters for a period when temperatures exceed +10°C, Σt determines accumulated temperatures in degrees (°C) for the same time.

The data were processed statistically at the 95th level of importance using the Microsoft Excel data analysis package.

RESULTS AND DISCUSSION

Entering into the fruiting

Twenty-two among twenty-three blueberry cultivars under research had begun bearing berries on the third year after planting, i.e. at the age of 4. Only 'Herbert' cultivar has entered the reproductive growth stage a year later. On average, during the first year the berry yield was withing (0.1 and 0.3) kg/plant. 'Jersey' and 'Rubel' cultivars had a higher yield-0.4 kg/plant and the yield of 'Patriot' cultivar was 0.6 kg/plant (Table 1). Specifically it should be mentioned that during the next two seasons the yield of 'Patriot' reduced. Besides that, the yield of 5-year 'Bluecrop', 'Bluerose' and 'Carolinablue' cultivars reduced or remained the same. The yield of other blueberry cultivars increased 1.5-10.0 times and was within 0.3 ('Hardyblue') and 2.0 kg/plant ('Earliblue'). At the age of 6 the average yield of 'Bluecrop', 'Denise Blue', 'Earliblue', 'Northland', 'Reka', 'Rubel', 'Weymouth' cultivars was 2.0 kg/plant and higher; other cultivars had a significantly lower yield. The yield of 7-year plants of 40% of blueberry cultivars had slightly reduced if compared with the previous season, 35% of taxons had a higher yield and the yield of 25% had remained the same if compared with the previous year. During the next season (2006) the yield of almost all cultivars (except 'Weymouth' whose yield reduced from 6.1 to 3.3 kg/plant) significantly increased. Notwithstanding, the yield of 8-year 'Weymouth' cultivars was by 52% higher than the average blueberry yield during the season and ranks below only to 5 cultivars: 'Elizabeth', 'Northblue', 'Patriot', 'Reka', 'Rubel'. During the next three seasons the blueberry yield was increasing in general.

Table 1. Dynamics of productivity of highbush blueberry of different cultivars in the conditions of the central agroclimatic region of Belarus (Gantsevichi), kg/plant

Cultivar	Year														
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bluecrop (st)	0,2 ± 0,1	0,1 ± 0,0	2,3 ± 0,2	1,4 ± 0,3	1,9 ± 0,3	3,5 ± 0,2	1,5 ± 0,2	2,3 ± 0,3	2,4 ± 0,2	0,7 ± 0,1	3,9 ± 0,2	4,3 ± 0,4	1,6 ± 0,5	3,1 ± 0,6	1,4 ± 0,2
Blueray	0,1 ± 0,1	1,0 ± 0,2*	0,7 ± 0,2*	0,8 ± 0,2*	1,6 ± 0,4	2,0 ± 0,2*	1,8 ± 0,3	3,7 ± 0,7*	1,6 ± 0,3*	1,3 ± 0,2*	2,3 ± 0,2*	1,7 ± 0,2*	1,8 ± 0,3	2,2 ± 0,2	1,3 ± 0,1
Bluerose	0,1 ± 0,1	0,1 ± 0,0	0,3 ± 0,1*	0,2 ± 0,1*	0,4 ± 0,2*	0,6 ± 0,1*	0,6 ± 0,1*	0,8 ± 0,1*	0,6 ± 0,1*	0,1 ± 0,1*	1,1 ± 0,2*	0,2 ± 0,1*	0,3 ± 0,1*	0,7 ± 0,2*	0,5 ± 0,1
Bluetta	0,2 ± 0,1	1,0 ± 0,2*	0,6 ± 0,2*	1,5 ± 0,2	1,9 ± 0,6	2,1 ± 0,2*	1,8 ± 0,2	2,8 ± 0,2	2,1 ± 0,2	2,9 ± 0,3*	3,8 ± 0,4	5,6 ± 0,6*	0,7 ± 0,2*	4,3 ± 0,4*	2,1 ± 0,9
Carolinablue	0,2 ± 0,0	0,2 ± 0,1	0,2 ± 0,1*	0,2 ± 0,1*	0,3 ± 0,1*	0,6 ± 0,1*	0,2 ± 0,1*	0,4 ± 0,1*	0,5 ± 0,1*	0,5 ± 0,1	0,3 ± 0,1*	0,2 ± 0,1*	0,6 ± 0,3*	0,7 ± 0,1*	0,9 ± 0,1
Coville	0,2 ± 0,1	0,4 ± 0,1*	1,5 ± 0,4*	0,8 ± 0,2*	2,4 ± 0,2	3,5 ± 0,3	3,1 ± 0,2*	2,5 ± 0,2	2,5 ± 0,2*	0,9 ± 0,1	2,2 ± 0,1*	2,4 ± 0,3*	1,1 ± 0,4	1,7 ± 0,3*	1,4 ± 0,3
Croatan	0,2 ± 0,0	0,6 ± 0,1*	0,4 ± 0,1*	0,1 ± 0,0*	1,1 ± 0,4	1,4 ± 0,3*	2,6 ± 0,1*	1,9 ± 0,1	1,0 ± 0,1*	0,1 ± 0,1*	1,4 ± 0,1*	4,0 ± 0,2	0,4 ± 0,1*	3,5 ± 0,9	3,1 ± 0,2*
Darrow	0,2 ± 0,1	0,4 ± 0,1*	1,0 ± 0,2*	0,5 ± 0,1*	1,0 ± 0,1	1,2 ± 0,1*	2,0 ± 0,6*	2,1 ± 0,2	1,1 ± 0,1*	1,3 ± 0,1*	1,6 ± 0,1*	2,2 ± 0,2*	0,9 ± 0,3*	1,3 ± 0,3*	1,7 ± 0,2
Denise Blue	0,3 ± 0,1	0,8 ± 0,2*	2,0 ± 0,3	1,5 ± 0,2	3,0 ± 0,4*	4,0 ± 0,5*	2,2 ± 0,2*	4,0 ± 0,3*	3,0 ± 0,3*	2,0 ± 0,3*	7,9 ± 0,4*	4,4 ± 0,3	3,1 ± 0,3*	3,9 ± 0,5	2,1 ± 0,1
Duke	0,2 ± 0,0	0,6 ± 0,1*	0,8 ± 0,3*	0,9 ± 0,3*	1,6 ± 0,4	0,9 ± 0,3*	1,3 ± 0,1	2,1 ± 0,1	2,1 ± 0,1	1,1 ± 0,1	5,7 ± 0,2*	6,0 ± 0,5*	2,1 ± 0,6	3,7 ± 0,7	1,7 ± 0,3
Earliblue	0,2 ± 0,1	2,0 ± 0,2*	2,1 ± 0,2	1,3 ± 0,3	1,4 ± 0,2	2,7 ± 0,1*	1,2 ± 0,2	3,6 ± 0,3*	1,5 ± 0,3*	1,1 ± 0,2	2,8 ± 0,2*	2,3 ± 0,2*	1,5 ± 0,2	3,3 ± 0,4	2,0 ± 0,2
Elizabeth	0,2 ± 0,0	1,5 ± 0,2*	1,0 ± 0,2*	0,9 ± 0,3*	3,5 ± 0,2*	5,0 ± 0,5*	3,8 ± 0,4*	3,5 ± 0,2*	2,0 ± 0,4	2,2 ± 0,2*	0,8 ± 0,1*	3,6 ± 0,3	0,7 ± 0,2*	2,9 ± 0,6	1,6 ± 0,2
Hardyblue	0,2 ± 0,0	0,3 ± 0,0	0,6 ± 0,1*	1,0 ± 0,1	1,9 ± 0,4	2,7 ± 0,2*	2,7 ± 0,1*	3,0 ± 0,2*	1,1 ± 0,1*	0,3 ± 0,1	1,9 ± 0,1*	3,1 ± 0,2*	1,6 ± 0,3	2,2 ± 0,4	1,3 ± 0,2
Herbert	-	0,3 ± 0,1	0,4 ± 0,1*	0,5 ± 0,1*	2,3 ± 0,3	1,3 ± 0,1*	3,2 ± 0,1*	3,7 ± 0,1*	0,9 ± 0,1*	0,1 ± 0,0*	2,3 ± 0,2*	2,1 ± 0,1*	1,4 ± 0,2	1,6 ± 0,2*	1,0 ± 0,1
Jersey	0,4 ± 0,1*	0,7 ± 0,1*	1,3 ± 0,3*	1,5 ± 0,4	2,7 ± 0,9	2,8 ± 0,4*	3,8 ± 0,2*	3,6 ± 0,3*	4,9 ± 0,2*	2,4 ± 0,2*	4,4 ± 0,3*	3,9 ± 0,2	1,3 ± 0,1	1,6 ± 0,1*	2,3 ± 0,3

Northblue	0,3 ± 0,2	0,7 ± 0,1*	1,2 ± 0,3*	1,7 ± 0,5	3,6 ± 0,6*	0,5 ± 0,1*	0,8 ± 0,2*	6,9 ± 0,4*	0,6 ± 0,1*	7,8 ± 0,4*	2,6 ± 0,2*	4,5 ± 0,2	0,5 ± 0,2*	7,6 ± 0,8*	4,3 ± 1,3*
Northcountry	0,3 ± 0,1	0,4 ± 0,1*	0,6 ± 0,1*	0,9 ± 0,3*	2,4 ± 0,4	1,7 ± 0,2*	1,1 ± 0,1	5,1 ± 0,4*	1,4 ± 0,2*	7,9 ± 0,4*	4,8 ± 0,3*	7,6 ± 0,3*	0,5 ± 0,2*	5,5 ± 0,6*	3,1 ± 0,6*
Northland	0,3 ± 0,1	1,0 ± 0,2*	3,5 ± 0,6*	2,3 ± 0,3*	2,7 ± 0,9	3,0 ± 0,5	3,0 ± 0,2*	4,5 ± 0,4*	2,5 ± 0,4	2,2 ± 0,5*	1,5 ± 0,2*	2,1 ± 0,9*	1,8 ± 0,1	2,3 ± 0,3	2,5 ± 0,4*
Nelson	0,1 ± 0,0	0,5 ± 0,1*	1,0 ± 0,2*	0,2 ± 0,1*	0,3 ± 0,1*	0,9 ± 0,1*	1,1 ± 0,1	1,2 ± 0,2*	0,9 ± 0,1*	0,5 ± 0,1	0,7 ± 0,1*	2,9 ± 0,9*	0,2 ± 0,0*	3,1 ± 0,4	1,4 ± 0,3
Patriot	0,6 ± 0,1*	0,2 ± 0,0	0,4 ± 0,1*	0,9 ± 0,2*	3,5 ± 0,7*	0,6 ± 0,1*	4,5 ± 0,2*	4,9 ± 0,2*	3,8 ± 0,1*	3,0 ± 0,5*	6,4 ± 0,3*	4,8 ± 0,4	0,7 ± 0,4*	7,0 ± 0,5*	3,3 ± 0,7*
Reka	0,3 ± 0,1	1,3 ± 0,2*	3,7 ± 0,2*	0,9 ± 0,1*	3,5 ± 0,2*	3,8 ± 0,3	2,8 ± 0,3*	6,4 ± 0,4*	2,8 ± 0,3	3,1 ± 0,2*	6,0 ± 0,5*	3,6 ± 0,3	1,7 ± 0,2	0,9 ± 0,1*	3,8 ± 0,3*
Rubel	0,4 ± 0,1*	1,0 ± 0,2*	2,0 ± 0,2	3,4 ± 0,3*	4,7 ± 0,4*	8,0 ± 0,6*	4,3 ± 0,2*	8,1 ± 0,4*	4,3 ± 0,3*	4,4 ± 0,6*	7,8 ± 0,4*	2,3 ± 0,2*	3,0 ± 0,4*	4,3 ± 0,5*	3,0 ± 0,4*
Weymouth	0,3 ± 0,1	1,2 ± 0,2*	3,8 ± 0,3*	6,1 ± 0,4*	3,3 ± 0,2*	2,6 ± 0,2*	8,0 ± 0,5*	6,8 ± 0,4*	4,5 ± 0,3*	3,6 ± 0,2*	5,4 ± 0,2*	3,0 ± 0,5*	2,0 ± 0,2	14,0 ± 1,0*	3,0 ± 0,5*
Average	0,3 ± 0,1	0,7 ± 0,3	1,4 ± 0,7	1,4 ± 0,9	2,2 ± 0,8	2,4 ± 1,2	2,5 ± 1,2	3,6 ± 1,4	2,1 ± 0,9	2,1 ± 1,5	3,4 ± 1,6	3,4 ± 1,2	1,3 ± 0,6	3,5 ± 2,0	2,1 ± 0,7
LSD	0,16	0,23	0,46	0,47	0,85	0,55	0,49	0,56	0,41	0,42	0,41	0,74	0,53	1,00	0,98
Note: *statistically significant differences															

So a great number of blueberry cultivars entered the fruiting stage at the age of 4. The 6-year age of the plants can be considered as the beginning of the industrial fruiting stage because at this period they began producing about 2 kg of berries. To our opinion, it's a satisfactory yield for this cultivar.

Yield

The data provided in Table 2 show that blueberry cultivars greatly vary in yield. North-American 'Weymouth' cultivar has the highest average yield-5.1 kg/plant. 'Rubel' cultivar has a slightly lower (by 10%) yield-4.6 kg/plant. It was extracted in the USA from natural populations of highbush blueberry. It seems that it is used in selection as a donor for this important commercial-biological trait due to the high berry yield peculiar to this cultivar. 'Denise Blue', 'Northblue', 'Northcountry', 'Patriot', and 'Reka' cultivars have shown high yield figures ranging between 3.3 and 3.4 kg/plant. Besides the above-listed cultivars, 'Bluecrop', 'Bluetta', 'Duke', 'Earliblue', 'Elizabeth', 'Jersey', and 'Northland' also shown an average yield exceeding 2 kg/plant. The average yield figure of other cultivars under research was up to 2.0 kg/plant. It should be mentioned that Australian 'Bluerose' and 'Carolinablue' selection cultivars that low yield figures (0.5 and 0.4) kg/plant correspondingly.

In Norwegian conditions 'Bluerose' cultivar also shown the lowest yield-0.2 kg/plant which is 2.5 times lower than in Belarusian conditions. The yield of the most common 'Bluecrop' blueberry (0.8 kg/plant) was 2.9 times lower. 'Reka' is the cultivar with the highest yield in the region (2.0 kg/plant).

In Latvia the average 'Bluecrop' yield was 1.8 kg/plant. which is much lower than the data received by us [19]. 'Patriot' (4.2 kg/plant) and 'Northland' (3.5 kg/plant) cultivars show a slightly higher berry yield than those in Belarusian conditions. At the same time 'Jersey' (0.9 kg/plant), 'Blueray' (1.2 kg/plant) and 'Northblue' (1.6 kg/plant) cultivars show a much lower yield.

In the conditions of the central part of Poland 'Weymouth' shown the highest yield-3.2 kg/plant-as in our research when 21 cultivars of blueberry were evaluated [13]. Specifically it should be mentioned that the yield of this crop is by 1.9 kg lower than in Belarus. In this neighbouring country 'Earliblue' (1.8 kg/plant) and 'Jersey' (1.9 kg/plant) cultivars shown a lower yield. But at the same time 'Bluecrop' (2.7 kg/plant), 'Coville' (2.4 kg/plant), 'Darrow' (2.0 kg/plant), and 'Herbert' (2.2 kg/plant) shown the highest yield.

Evaluation of the yield of twenty-eight highbush blueberry cultivars in Czech conditions F. Paprstein and J. Ludvikova [27] have found that 'Bluecrop' cultivar has the highest yield (6.9 kg/plant) which is 3 times higher than the data of our research. The yield of the 'Earliblue' cultivar which is the lowest in the Czech Republic is 1.7 kg/plant which is 3 times lower than in Belarusian conditions.

The comparison of the yield figures for North-American blueberry cultivars in Belarusian and US conditions shows that the berry yield of 'Bluecrop', 'Blueray', 'Bluetta', 'Coville', 'Darrow' and 'Herbert' cultivars in Ohio State is much higher than in the introduction location. 'Jersey' and 'Northland' yield is similar and 'Patriot' cultivar appeared to show a higher yield than in Ohio State [10].

It is known that the yield of tillable plants is determined by the genotypic peculiarities of the tax on itself and the conditions of its culture. In this research against the background of the generality of agri-environmental conditions for all cultivars the main factor which determines the yield of each cultivar was its capacity of using the natural potential of its habitat for producing the yield. This allowed dividing the cultivars into the following categories [25]:

1. High-yielding (with yield higher than that of the standard cultivar ('Bluecrop') by 35%)-'Denise Blue', 'Northblue', 'Northcountry', 'Patriot', 'Reka', 'Rubel', 'Weymouth' cultivars

2. Yielding (with yield higher than that of the standard cultivar by 15%-34%)-'Jersey'

3. Middleyielding (with yield equal or higher than that of the standard cultivar not more than by 15 %)-'Bluetta', 'Duke', 'Elizabeth', 'Northland'

4. Poor-quality (with yield lower than that of the standard cultivar by 5%-25%)-'Coville', 'Earliblue', 'Hardyblue'

5. Low-yield (with yield lower than that of the standard cultivar by 25% and more)-'Blueray', 'Bluerose', 'Carolinablue', 'Croatan', 'Darrow', 'Herbert', 'Nelson'

Table 2. Indicators of long-term yield and weight of one fruits of highbush blueberries of cultivars in the conditions of the central agroclimatic region of Belarus (Gantsevichi)

Cultivar	Total yield, kg/plant	Average yield, kg/plant			Average weight of one fruit, g	
		X ± mx	V, %	deviation, %	X ± mx	V, %
Bluecrop (st)	30,7	2,3 ± 0,7	46	–	2,1 ± 0,2	17
Blueray	23,8	1,7 ± 0,5	42	–26	2,0 ± 0,3	23
Bluerose	6,6	0,5 ± 0,2*	58	–78	1,8 ± 0,2*	13
Bluetta	33,3	2,5 ± 1,0	57	9	1,5 ± 0,2*	16
Carolinablue	6,0	0,4 ± 0,2*	52	–83	1,7 ± 0,2*	15
Coville	26,5	2,0 ± 0,6	42	–13	2,0 ± 0,1	9
Croatan	21,8	1,6 ± 0,9	81	–30	1,3 ± 0,2*	20
Darrow	18,5	1,4 ± 0,4	37	–39	2,0 ± 0,2	11
Denise Blue	44,2	3,3 ± 1,1	50	43	2,1 ± 0,3	22
Duke	30,9	2,3 ± 1,2	75	0	1,9 ± 0,2	16
Earliblue	29,0	2,1 ± 0,6	40	–9	1,7 ± 0,2*	15
Elizabeth	33,3	2,4 ± 0,9	57	4	1,9 ± 0,2	13
Hardyblue	23,9	1,8 ± 0,6	51	–22	1,3 ± 0,1*	15
Herbert	21,2	1,6 ± 0,7	67	–30	2,0 ± 0,3	20
Jersey	37,6	2,8 ± 0,8	43	22	1,3 ± 0,2*	21
Northblue	43,5	3,3 ± 1,9	84	43	2,0 ± 0,2	14
Northcountry	43,4	3,3 ± 1,8	80	43	0,8 ± 0,1*	17
Northland	35,2	2,6 ± 0,5	29	13	1,3 ± 0,2*	18
Nelson	15,0	1,1 ± 0,6*	83	–52	1,9 ± 0,2*	17
Patriot	44,6	3,4 ± 1,5	65	48	2,3 ± 0,2*	13
Reka	44,6	3,3 ± 1,1	49	43	1,8 ± 0,1*	16
Rubel	60,9	4,6 ± 1,4*	45	100	0,9 ± 0,1*	15
Weymouth	67,5	5,1 ± 2,2*	63	122	1,5 ± 0,3*	29
LSD		1,21			0,20	

Note: *statistically significant differences

Fruiting variability

Analysis of the yield dynamics shows that all blueberry cultivars have variable fruiting (refer to Table 1). But the taxons under research have different peculiarities of fruiting variability. 'Northblue' has the highest fruiting variability: its average yield ranged from 0.5 kg/plant (2007 and 2011) to 7.8 kg (2013). The highest variability figures (84 %) (refer to Table 2) and the average multiyear fruiting variability index prove this (Table 3). 'Croatan' (0.1 kg/plant-4.0 kg/plant), 'Northcountry' (0.5 kg/plant-7.9 kg/plant) and 'Nelson' (0.2 kg/plant-3.1 kg/plant) show a strong fruiting variability. Middleyielding 'Northland' cultivar shown the most regular fruiting. Its yield ranged from 1.5 kg/plant (2012) to 4.5 kg/plant (2009). This is shown by the lowest average multiyear fruiting variability index (12.4 %). Also 'Blueray', 'Carolinablue', 'Coville', 'Darrow', 'Jersey', and 'Rubel' had relatively stable fruiting.

Table 3. Indices of the periodicity of fruiting of highbush blueberry cultivars, %

Cultivar	Years												Long-term index
	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	

Bluecrop (st)	-24,3	15,2	30,0	-40,0	21,0	2,1	-54,8	69,6	4,9	-45,8	31,9	-37,8	31,4
Blueray	6,7	33,3	11,1	-5,3	34,5	-39,6	-10,3	-27,8	-15,0	2,9	10,0	-26,0	18,5
Bluerose	-20,0	33,3	20,0	0,0	14,3	-14,3	-71,0	83,3	-69,2	20,0	40,0	-16,6	33,5
Bluetta	42,9	11,8	5,0	-7,7	21,7	-14,3	16,0	13,4	19,1	-77,8	72,0	-34,4	28,0
Carolinablue	0,0	20,0	33,3	-50,0	33,3	11,1	0,0	-25,0	-20,0	50,0	7,7	-12,5	21,9
Coville	-30,4	50,0	18,6	-6,1	-10,7	0,0	-47,1	42,9	4,3	-37,1	21,4	-9,7	23,2
Croatan	-60,0	83,3	12,0	30,0	-15,6	-31,0	-81,8	86,7	48,1	-81,8	79,5	-6,1	51,3
Darrow	-33,3	33,3	9,1	25,0	2,4	-31,2	8,3	10,3	15,8	-41,9	18,2	13,3	20,2
Denise Blue	-14,3	33,3	14,3	-29,0	29,0	-14,3	-20,0	59,6	-28,4	-17,3	11,4	-30,0	25,1
Duke	5,9	28,0	-28,0	18,2	23,5	0,0	-31,2	67,6	2,6	-48,1	27,6	-37,0	26,5
Earliblue	-23,5	3,7	31,7	-38,5	50,0	-41,2	-15,4	43,6	-9,8	-21,0	37,5	-24,5	28,4
Elizabeth	-5,3	59,1	17,6	-13,6	-4,1	-27,3	4,8	-46,7	63,6	-65,9	61,1	-28,9	33,2
Hardyblue	25,0	31,0	17,4	0,0	8,3	-46,8	-57,1	72,7	-24,0	-31,9	15,8	-25,7	29,6
Herbert	11,1	64,3	-27,8	42,2	7,2	-60,9	-80,0	91,7	-4,5	-20,0	6,7	-23,0	36,6
Jersey	7,1	28,6	1,8	15,1	-2,7	15,3	-34,2	29,4	-6,0	-50,0	10,3	17,9	18,2
Northblue	17,2	35,8	-75,6	23,1	79,2	-84,0	85,7	-50,0	26,8	-80,0	86,4	-27,7	55,9
Northcountry	20,0	45,4	-17,0	-21,4	64,5	-56,9	69,9	-24,4	22,6	-87,7	83,3	-27,9	45,1
Northland	-21,1	8,0	5,3	0,0	20,0	-28,6	-6,4	-18,9	-16,7	-7,7	12,1	4,2	12,4
Nelson	-66,7	20,0	50,0	10,0	4,3	-14,3	-28,6	16,7	61,1	-87,1	87,9	-37,8	40,4
Patriot	38,5	59,1	-70,7	76,5	4,2	-12,6	-11,8	36,2	-14,3	-74,5	81,8	-35,9	43,0
Reka	-60,9	59,1	4,1	-15,2	39,1	-39,1	6,0	31,9	-25,0	-35,8	-30,8	61,7	34,0
Rubel	25,9	16,0	25,9	-30,1	30,6	-30,6	1,1	27,9	-54,5	13,2	17,8	-17,8	24,3
Weymouth	23,2	-29,8	-11,8	50,1	-8,1	-20,4	-11,1	20,0	-28,6	-20,0	75,0	-64,7	30,2

The blueberry cultivars were divided into the following groups depending on the frequency index [25]:

1. With regular fruiting (up to 20%)-'Blueray', 'Northland', 'Jersey'

2. With relatively regular fruiting (21-40%)-'Bluecrop', 'Bluerose', 'Bluetta', 'Coville', 'Carolinablue', 'Darrow', 'Denise Blue', 'Duke', 'Earliblue', 'Elizabeth', 'Hardyblue', 'Herbert', 'Reka', 'Rubel', 'Weymouth'

3. With average fruiting regularity (41%-60%)-'Croatan', 'Northblue', 'Northcountry', 'Nelson', 'Patriot'

Field observations and comparative analysis of blueberry yield and meteorological conditions during the research shown that the weather pre-determined the yield reduction and, correspondingly, irregular fruiting, which is returning frost and drought. From the data in Table 4 one can see that winters that froze the blueberry at their reproductive stage and/or droughts in the second half of summer proceeded the seasons with a lower yield.

Due to the mortality of 58% of buds from returning frosts during winter in 2004-2005 the average yield of blueberry remained the same as in the previous season instead of increasing significantly because by that time blueberry plants had produced a highly-developed crown and had been entering the stage of industrial fruiting. Specifically in 2005 the yield of high-yielding cultivars such as 'Bluecrop', 'Denise Blue', 'Earliblue', 'Northland', and 'Reka' reduced 1.3-4.1 times if compared with the previous year. Analysis of the correlation relationship between blueberry yield and the number of dead buds revealed a rather strong negative dependency (r=-0.52). This means that the freezing of blueberry at its reproductive stage was inversely proportional to its yield. This is determined by the fact that highbush blueberry buds have a relatively short period of biological rest (1.5 months) which ceases by the end of December. Due to annual thaws in Belarus (especially in the second part of winter) the frost tolerance of blueberry on its reproductive stage was reduced and the sudden returning frost damaged the waking buds. This reduced blueberry yield and lead to the absence of fruiting of some cultivars as the mortality of reproductive buds reached 100% [28]. During such low-yield years blueberry plants showed a strong vegetative growth, forming a great number of leafy stems and further reproductive bud set on them. During the next seasons the plants bore a high load of crop and, besides berry growth and fructification, have to provide vegetative organs with nutrients, bud set for the yield for the next year and store nutrients for winter. So during the high-yielding years the ripening berries drained the plant and retarded the process of bud-forming or even prevented it. The inhibiting effect of berries is evidenced in changes in morphogenesis of stem shoot apex affected by growth regulators synthesized in seeds and possessing gibberellic activity [29]. Lack of nutrients during this period lead to a weak vegetative growth, i.e. forming a small number

of weakly-foliated short stems. In turn, a weak assimilatory apparatus lead to the weak supply of growing berries and root system with plastic substances and therefore their weak development. Bud set occurs only after roots and other plant organs accumulate the necessary amount of assimilates [30]. So low yield occurs in the following season and, therefore, intensive vegetative growth. So periodic fruiting with the interchange of high-yielding and low-yield years takes place.

The second prerequisite of blueberry yield reduction and therefore its periodic fruiting is droughts which often happen in Belarus in the second part of summer or at the rise of autumn. Evaluation of correlation dependency between the yield and precipitation in July-August of the year before fruiting revealed a positive relation (r=-0.36) which means that the precipitation during the reproductive bud set is directly proportional to blueberry yield in the future season. The negative impact of the drought on the future yield is especially evident during the years when buds have not been damaged by a return frost (2014, 2016). Lack of soil moisture reduces the intensity of photosynthesis and all plant metabolic processes (including those in buds) [29]. The drought in the second part of summer leads to weak bud set and correspondingly to low yield in the next season. Such a critical situation during some vegetative periods (2002/03, 2005/06, 2009/10) was worsened by a combination of drought and an excessive number of growing berries.

Table 4. Dependence of the average yield of highbush blueberries from the number of dead buds and the amount of precipitation in July and August

Index	Year															Correlation coefficient
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Average yield, kg/plant	0,3	0,7	1,4	1,4	2,2	2,4	2,5	3,6	2,1	2,1	3,4	3,4	1,3	3,5	2,1	
The average number of dead buds, %	0	36	0	58	19	14	0	0	12	20	7	0	0	0	0	-0,52
Amount of precipitation in July and August, mm	133	258	156	136	269	285	193	137	168	198	216	84	118	67	171	0,36
% of precipitation from the climatic norm	87	191	102	89	176	186	126	90	110	129	141	55	77	44	112	0,36

Berry mass

Berry mass is an important criterion of the estimation of the quality of berry products. A comparison of the long-term averages of this parameter indicates that 'Patriot' cultivar produces the biggest berries (2.3 g) (Table 5). Rather big berries are characteristic of 'Bluecrop', 'Denise Blue' (2.1 g) and 'Blueray', 'Coville', 'Darrow', 'Herbert', 'Northblue' (2.0 g) cultivars. 'Northcountry' (0.8 g) and Rubel (0.9 g) cultivars form small berries. The average mass of one berry of the others taxons under research is 1.3-1.9.

Analysis of the dynamics of berry mass by years of research shows that its values vary greatly. However, the berry mass of high-yielding cultivar 'Weymouth' varied significantly (from 0.9 g in 2014 to 2.1 g in 2007, i.e., 2.3 times), which was also indicated by the highest variation coefficient (29%) for this cultivar. During the research cultivar 'Coville' produced the most univariate berries: the limits of variation-1.6 g (2003)-2.5 g (2005), the coefficient of variation- 9%.

During the research period the weather conditions and blueberry yield also varied significantly (Table 6), which influenced the size of the developing berries. To determine the key factor that has the greatest impact on the blueberry mass, we calculated pair correlation coefficients (Table 7). As a result, a close positive dependence of berry mass on the average daily temperature (r=0.83-0.97) and the accumulated temperatures during their growth and ripening (June) for 21 cultivars (r=0.86-0.99) was established, weak positive dependence was established for two blueberry cultivars (r=0.31-0.32). A close positive correlation dependence of the berry size on precipitation amount (r=0.97-0.99) for seven cultivars of blueberries ('Blueray', 'Denise Blue', 'Earliblue', 'Elizabeth', 'Herbert', 'Reka', 'Rubel') was established. It should be noted that the dependence of the berry mass on the Hydrothermal index of Selyaninov, presenting the season's water availability about its temperature, was not established, as well as for the seven above-mentioned blueberry cultivars.

However, the adjoint correlation between yield and berry size was not established. It is because the yield itself, as well the size of the berry, is determined by the same factors, among which is the sufficiency of heat, nutrients, water, etc.

A comparative analysis of the berry mass of blueberry cultivars introduced in Belarus with that under the conditions of their habitat and countries neighbouring Belarus did not reveal significant deviations [31]. However, the dependence of the berry mass decrease with advancing across regions from south to north was observed, which confirmed the dependence of the blueberry mass on the thermal sufficiency of its growth period established by us.

The growth and development of different blueberry cultivars were carried out in identical environmental conditions; the individual characteristic of a cultivar was the key factor determining the formation of berries. This allowed us to arrange blueberries cultivars in accordance with reducing berry mass as follows: 'Patriot'>'Bluecrop'='Denise Blue'>'Blueray'='Coville'='Darrow'='Herbert'='Northblue'>'Duke'='Elizabeth'='Nelson'>'Bluerose'='Reka'>'Carolinablue'='Earliblue'>'Bluetta'='Weymouth'>'Croatan'='Ha

rdyblue'='Jersey'='Northland'>'Rubel'>'Northcountry'.

Table 5. Dynamics of the weight of the highbush blueberry fruit of different of cultivars under the - conditions of the central agro climatic region of Belarus (Gantsevichi), g

Cultivar	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Bluecrop (st)	2,5 ± 0,1	2,3 ± 0,1	2,0 ± 0,1	2,1 ± 0,1	1,8 ± 0,1	1,8 ± 0,0	2,2 ± 0,0	1,9 ± 0,0	2,0 ± 0,1	2,5 ± 0,1	1,9 ± 0,1	2,6 ± 0,0	1,8 ± 0,1	1,5 ± 0,1	2,4 ± 0,1
Blueray	2,4 ± 0,1	2,0 ± 0,2*	1,6 ± 0,1*	2,2 ± 0,5	2,1 ± 0,2*	2,3 ± 0,3*	2,4 ± 0,3*	2,6 ± 0,3*	1,7 ± 0,2*	2,4 ± 0,2	1,7 ± 0,1*	2,0 ± 0,1*	1,3 ± 0,0*	1,7 ± 0,1	1,4 ± 0,0*
Bluerose	2,1 ± 0,1*	2,0 ± 0,1*	1,9 ± 0,1	1,7 ± 0,0*	1,8 ± 0,1	1,9 ± 0,1	2,0 ± 0,0	1,8 ± 0,0	1,8 ± 0,0*	1,7 ± 0,1*	1,7 ± 0,0*	1,5 ± 0,1*	1,2 ± 0,3*	1,9 ± 0,1*	1,9 ± 0,2*
Bluetta	1,6 ± 0,2*	1,3 ± 0,1	1,2 ± 0,1*	1,2 ± 0,1*	1,3 ± 0,1*	1,6 ± 0,1	1,8 ± 0,1*	1,3 ± 0,2*	1,4 ± 0,1*	1,5 ± 0,2*	1,7 ± 0,0*	1,8 ± 0,2*	1,5 ± 0,2*	1,1 ± 0,1*	1,7 ± 0,0*
Carolin-ablue	2,0 ± 0,1*	1,7 ± 0,1*	1,7 ± 0,1*	1,6 ± 0,0*	1,6 ± 0,1*	2,1 ± 0,0*	1,7 ± 0,0*	2,0 ± 0,0	1,7 ± 0,0*	1,7 ± 0,0*	1,2 ± 0,1*	1,4 ± 0,0*	1,8 ± 0,2	1,7 ± 0,0	1,6 ± 0,1*
Coville	1,8 ± 0,1*	1,6 ± 0,1*	1,9 ± 0,1	2,5 ± 0,1*	2,2 ± 0,1*	2,3 ± 0,0*	1,9 ± 0,1*	2,3 ± 0,1*	2,0 ± 0,0	2,1 ± 0,1*	1,9 ± 0,0	2,1 ± 0,1*	1,8 ± 0,2	1,8 ± 0,1*	2,0 ± 0,1*
Croatan	1,5 ± 0,2*	1,3 ± 0,1*	1,4 ± 0,0*	1,3 ± 0,0*	1,6 ± 0,0	1,1 ± 0,1*	1,3 ± 0,1*	1,7 ± 0,1	1,5 ± 0,0*	1,0 ± 0,0*	0,9 ± 0,0*	1,2 ± 0,0*	1,6 ± 0,1	1,1 ± 0,1*	1,2 ± 0,1*
Darrow	2,4 ± 0,1	2,1 ± 0,1*	1,8 ± 0,1	1,6 ± 0,0*	2,2 ± 0,0*	1,8 ± 0,1	2,1 ± 0,0	2,3 ± 0,0*	2,0 ± 1,0	2,2 ± 0,0*	1,8 ± 0,1	1,9 ± 0,1*	1,6 ± 0,1	2,2 ± 0,2*	2,0 ± 0,1*
Denise Blue	2,5 ± 0,2	2,0 ± 0,1*	1,9 ± 0,1	2,3 ± 0,1	1,9 ± 0,1*	2,1 ± 0,1*	2,0 ± 0,0	1,9 ± 0,1	2,1 ± 0,1	1,2 ± 0,1*	1,8 ± 0,1	3,0 ± 0,1*	1,8 ± 0,1	2,2 ± 0,3*	2,3 ± 0,3
Duke	1,7 ± 0,2*	1,6 ± 0,2*	1,7 ± 0,1*	2,1 ± 0,2	1,9 ± 0,1*	2,1 ± 0,1*	2,2 ± 0,1	2,2 ± 0,1*	2,1 ± 0,1	2,0 ± 0,0*	1,4 ± 0,1*	1,9 ± 0,0*	1,7 ± 0,1	1,5 ± 0,1	2,2 ± 0,1
Earliblue	2,1 ± 0,1*	1,8 ± 0,1*	1,5 ± 0,1*	1,5 ± 0,1*	1,6 ± 0,1	2,0 ± 0,1*	1,8 ± 0,1*	1,9 ± 0,1	1,4 ± 0,1*	1,5 ± 0,0*	1,5 ± 0,0*	2,2 ± 0,0*	1,8 ± 0,1	1,6 ± 0,1	1,5 ± 0,2*
Eliza-beth	1,8 ± 0,0*	2,0 ± 0,1*	2,1 ± 0,2	2,5 ± 0,0*	2,2 ± 0,0*	1,7 ± 0,0	2,0 ± 0,1	2,1 ± 0,1	2,0 ± 0,1	1,4 ± 0,1*	1,9 ± 0,1	1,8 ± 0,0*	1,9 ± 0,1	1,9 ± 0,1*	1,4 ± 0,1*
Hardy-blue	1,4 ± 0,1*	1,4 ± 0,1*	1,1 ± 0,0*	1,5 ± 0,0*	1,3 ± 0,0*	1,3 ± 0,1*	1,4 ± 0,1*	1,5 ± 0,1*	1,3 ± 0,0*	1,2 ± 0,0*	0,9 ± 0,1*	1,4 ± 0,0*	1,3 ± 0,0*	1,0 ± 0,1*	1,1 ± 0,0*
Herbert	–	2,2 ± 0,2	1,4 ± 0,1*	1,9 ± 0,1	2,2 ± 0,0*	2,4 ± 0,1*	2,3 ± 0,1	2,1 ± 0,3	1,8 ± 0,1*	2,7 ± 0,1*	1,7 ± 0,2	2,5 ± 0,1	1,7 ± 0,1	1,4 ± 0,1	2,2 ± 0,0
Jersey	1,5 ± 0,0*	1,4 ± 0,2*	1,2 ± 0,1*	1,6 ± 0,0*	1,5 ± 0,0*	1,5 ± 0,0*	1,2 ± 0,6*	1,4 ± 0,0*	1,4 ± 0,1*	1,3 ± 0,0*	1,0 ± 0,1	1,2 ± 0,0*	1,0 ± 0,1*	0,6 ± 0,0*	1,0 ± 0,1*
North-blue	2,3 ± 0,3	2,0 ± 0,1*	2,0 ± 0,1	1,9 ± 0,2	1,7 ± 0,1	1,9 ± 0,1	1,7 ± 0,1*	2,2 ± 0,0*	2,0 ± 0,0	1,8 ± 0,0*	2,0 ± 0,0	2,5 ± 0,1	2,0 ± 0,1	1,6 ± 0,1	1,7 ± 0,1*
North-country	0,8 ± 0,0*	0,8 ± 0,1*	0,7 ± 0,1*	0,6 ± 0,0*	0,8 ± 0,0*	0,7 ± 0,0*	0,8 ± 0,1*	0,5 ± 0,0*	0,9 ± 0,0*	0,8 ± 0,0	0,8 ± 0,0	1,0 ± 0,0*	0,8 ± 0,1*	0,7 ± 0,0*	0,8 ± 0,0*
North-land	1,5 ± 0,2*	1,2 ± 0,1*	1,0 ± 0,1*	0,9 ± 0,1*	1,4 ± 0,1*	1,2 ± 0,1*	1,5 ± 0,1*	1,4 ± 0,1*	1,7 ± 0,1*	1,3 ± 0,1*	1,3 ± 0,0	1,6 ± 0,2*	0,9 ± 0,1*	1,1 ± 0,1*	1,3 ± 0,1*
Nelson	2,0 ± 0,1*	1,9 ± 0,1*	1,7 ± 0,1*	1,6 ± 0,1*	2,1 ± 0,1*	2,0 ± 0,1*	1,7 ± 0,0*	2,2 ± 0,1	1,8 ± 0,0*	2,4 ± 0,0	1,5 ± 0,1	2,2 ± 0,1*	1,5 ± 0,1*	1,7 ± 0,1	1,6 ± 0,1*
Patriot	2,2 ± 0,2	2,0 ± 0,3*	2,1 ± 0,1	1,8 ± 0,1*	2,1 ± 0,1*	2,5 ± 0,1*	2,2 ± 0,1	2,5 ± 0,1*	2,1 ± 0,0	3,0 ± 0,1*	2,1 ± 0,1	2,8 ± 0,0*	2,4 ± 0,1*	2,2 ± 0,1*	2,7 ± 0,1*
Reka	2,1 ± 0,1*	1,8 ± 0,1*	1,7 ± 0,1*	1,9 ± 0,1	1,8 ± 0,1	1,8 ± 0,1	1,7 ± 0,1*	1,9 ± 0,1	1,7 ± 0,1*	1,8 ± 0,1*	1,7 ± 0,1	1,6 ± 0,1*	1,8 ± 0,0	1,6 ± 0,1	2,1 ± 0,2*
Rubel	1,0 ± 0,1*	0,9 ± 0,1*	0,7 ± 0,0*	0,8 ± 0,1*	1,1 ± 0,0*	0,9 ± 0,1*	1,0 ± 0,0*	0,6 ± 0,1*	0,8 ± 0,0*	0,9 ± 0,0*	0,9 ± 0,0	0,9 ± 0,0*	0,8 ± 0,0*	0,7 ± 0,0*	1,0 ± 0,0*
Wey-mouth	1,6 ± 0,2*	1,2 ± 0,0*	1,1 ± 0,1*	1,2 ± 0,1*	1,1 ± 0,1*	2,1 ± 0,1*	1,8 ± 0,1*	1,8 ± 0,2	1,2 ± 0,1*	1,7 ± 0,2*	1,1 ± 0,2	1,9 ± 0,1*	0,9 ± 0,0*	1,3 ± 0,2	2,0 ± 0,1*
LSD	0,26	0,22	0,17	0,26	0,17	0,21	0,17	0,22	0,15	0,17	0,14	0,14	0,29	0,23	0,23

Table 6. June climatic indicators in 2002-2016 in Gantsevichi (Belarus)

Index	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Average daily temperature of air, °C	17,1	15,8	15,1	15,8	16,6	18,7	16,6	16,5	18,4	18,8	16,2	18,5	16,7	17,0	18,4
Sum of sediments, mm	91	527	106	31	59	56	39	154	63	118	117	121	86	47	27

Sum of temperatures,°C	512	475	454	474	497	552	498	494	588	564	482	557	489	510	552
Hydro thermal coefficient of Selyaninov	1,8	1,1	2,3	0,7	1,2	1,0	0,8	3,1	1,1	2,1	2,4	2,2	1,8	0,9	0,5

Table 7. Correlation dependence of the size of highbush blueberry berries from yield and weather factors during the period of fruit growth

Cultivar	Yield	Average daily temperature of air	Sum of temperatures	Sum of sediments	Hydrothermal coefficient of Selyaninov
Bluecrop (st)	–0,39	0,31	0,31	0,15	0,08
Blueray	0,17	0,96	0,99	0,99	–0,16
Bluerose	–0,02	0,97	0,99	–0,01	–0,16
Bluetta	0,40	0,97	0,99	–0,01	–0,16
Carolinablue	0,50	0,97	0,99	0,00	–0,15
Coville	0,31	0,97	0,99	–0,01	–0,16
Croatan	0,33	0,97	0,99	0,00	–0,16
Darrow	0,31	0,97	0,99	–0,01	–0,16
Denise Blue	0,28	0,83	0,86	0,99	–0,17
Duke	0,18	0,97	0,99	–0,01	–0,16
Earliblue	–0,06	0,97	0,99	0,99	–0,16
Elizabeth	0,37	0,97	0,99	0,97	–0,16
Hardyblue	–0,09	0,84	0,87	0,08	–0,07
Herbert	–0,11	0,97	0,99	0,99	–0,16
Jersey	0,46	0,97	0,99	0,00	–0,16
Northblue	0,24	0,97	0,99	–0,01	–0,16
Northcountry	0,47	0,97	0,99	0,01	–0,15
Northland	0,01	0,96	0,99	–0,02	–0,17
Nelson	0,31	0,97	0,99	0,02	–0,14
Patriot	0,49	0,97	0,99	0,00	–0,15
Reka	0,09	0,97	0,99	0,99	–0,16
Rubel	0,45	0,31	0,32	0,98	–0,14
Weymouth	–0,16	0,97	0,99	0,01	–0,14

CONCLUSION

All investigated blueberry cultivars under research in Belarusian conditions perform their objectives, i.e. grow berries. This means that their adaptive potential at the introduction has been implemented successfully. At the age of 4 blueberries enter in the reproductive growth stage and at the age of 6 they enter into the stage of industrial fruiting. Specifically, the cultivars vary significantly in their yield: 'Bluecrop', 'Bluetta', 'Denise Blue', 'Duke', 'Earliblue', 'Elizabeth', 'Jersey', 'Northblue', 'Northcountry', 'Northland', 'Patriot' and 'Weymouth' cultivars have a higher berry yield. No significant deviations in the blueberry yield introduced in Belarus if compared with their native conditions or those in neighbouring countries were found.

The yield of blueberry cultivars varies from year to year of fruiting. 'Blueray', 'Northland', and 'Jersey' have shown more regular fruiting. The changes in blueberry fruiting were mostly caused by flower bud mortality in winter and/or draught during their set. For providing regular blueberry fruiting the agronomic measures (irrigation, fertilization, and cutting) shall be aimed at supporting the annual growth activity of plants, especially during seasons with a high berry load.

The mass of a highbush blueberry varies significantly according to cultivar specification and year. A close correlation was established between the size of the berries and the water availability during the period of their growth and the dependence on the temperature.

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