

THE BEHAVIOR OF SOME Highbush BLUEBERRY CULTIVARS (*VACCINIUM CORYMBOSUM* L.) ON THE SANDY SOILS FROM SOUTH-WEST OF ROMANIA

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Abstract

The highbush blueberry was introduced to Romania by Prof. Nicolae Stefan in 1968. The first plantations were concentrated in the area of the hilly hills, so in the 80s years the cultivated area in Romania amounted to approximately 300 ha, but in the 90s years it decreased to only 60 ha. With the beginning of the new National Rural Development Programme 2014-2020, and allocation of European funds for the fruit growing, the blueberry crop became even better. In the present in Romania are about 1000 ha with blueberry orchard distributed in the mountain and hilly areas. Starting from 2019, at Dăbuleni Research & Development Station for Plant Cultivation on Sandy Soils, on a soil with a pH of 6.36, studies began on the behaviour of high bush blueberry in the plain area. An experimental plot with the Duke, Nelson and Patriot cultivars was established; the plants were planted on raised beds covered with polypropylene mulch fabric (Agrotexile). Drip irrigation was provided under the mulch. Following the studies carried out in the 2020-2022 period, the Patriot cultivar stood out with an average fruit weight of 2.65 g/fruit and a production in the 4th year after planting by the 3.2 t/ha. The Duke variety recorded the highest value of fruit vitamin C content (13.11 mg) versus to the other studied cultivars.

Key words: blueberry, yields, phenological and physicochemical characteristics

INTRODUCTION

Highbush blueberry (*Vaccinium corymbosum* L.) comes from North America where it grows as wild species (Charles M., 2012). At the beginning, only those from the upper social classes enjoyed the taste of the blueberry fruits. Frederick V. Coville, being fascinated by the fruits of this species, in 1906 began to make selections in the spontaneous flora. In 1910 year, Coville determined the blueberry's pH and moisture requirements and began breeding activities. Later he co-opted Elisabeth Waith in his work (Kim J.G., et al. 2013; Charles M., 2012; Ancu I. et al. 2008). The first blueberry commercial plantations were established in 1937, in Michigan. In Europe in 1930 year, the blueberry was cultivated for first in

France, later it was spread throughout the whole continent (Charles M., 2012).

In Romania, the high bush blueberry was introduced in 1968, by Prof. Nicolae Stefan (Ancu I., et al 2019). Considering the requirements of this species for soil pH (4.8-5.5), the researchers considered that the most suitable areas for blueberry culture are natural peatlands, but this have an insular character and are on high mountain-lying areas. Later, in Romania research regarding the maintenance of the soil in optimal parameters for the growth of this blueberry species (*Vaccinium corymbosum*) was also carried out (Sumedrea D., et al. 2016). Thus, until the 1980s, in Romania a blueberry cultivated area of 300 ha had been reached, and it was desired to increase these areas to

over 1000 ha. The socio-economic conditions after the 1990s years made the areas cultivated with highbush blueberries to be greatly reduced and even to disappear from the statistics.

In 2004, Romania had only an area of 24 ha of highbush blueberry orchard, being a profitable crop, aroused the interest of blueberry growers (Asanica A. et al. 2017). Starting from 2014 year, through the Romanian National Development Plan measure 4.1.a for the relaunch of fruit growing financed by the Ministry of Agriculture, the areas cultivated with blueberry began to increase, and today it is estimated that in Romania there are more than 1000 ha highbush blueberry orchards (Asanica A. et al. 2017; Ancu I. et al 2019). The largest highbush blueberry orchards are located in the mountainous and submontane areas, the Braşov county being in first place with an area of 228 ha blueberry orchards, followed by Baia-Mare county. The purpose of the present paper is to evaluate the behavior of some blueberry varieties in the specific conditions of the sands from Romania Southwest plaine areas.

MATERIALS AND METHODS

The study was carried out in the period 2020-2022, in an experimental plot, of the Research and Development Station for Plant Culture on the Dăbuleni Sands, located on the North bank of the Danube, in the Southwest of Romania. The experimental plot was established in the spring of 2019, with 3 cultivars: Patriot, Duke and Nelson in a sandy soil poorly supplied with nitrogen (0.02%), medium to well supplied with phosphorus (24 ppm), low supplied in exchangeable potassium (38 ppm) and with a low organic carbon content (0.07%), and the soil pH was moderately acidic to the neutral (6.36). the

planting was carried out at a distance by 3 meters between raised beds and 1 meter between the plants on the rows, it mulched with Agrotexil, with drip irrigation under the mulche. The soil was improved with acid peat 60-70 l/ml and the pH brought to 5.5. In order to evaluate the suitability of these genotypes for the pedoclimatic conditions to the South of Romania, the following determinations were made: the plants phenology, the dynamics shoots growth (cm), average fruits weight (g), the fruits diameter (mm), the fruits height (mm), the yield (kg/bush and t/ha). The phenology of the plants was performed visually by comparing with the BBCH stages, it was monitored, early pink bud (BBCH 57), the beginning of shoots growth (BBCH 67), early bloom (BBCH 61), the early fruits ripening (BBCH 87), the second wave of shoot growth, according to the BBCH (Biologische Bundesanstalt, Bundessortenamt und Chemische Industrie) scale (described by Longstroth, M. et al., 2008) (Fig 1):



Fig. 1. Phenological stages of highbush blueberry

The dynamics of shoot growth was determined by monthly measurement of shoots, and the monthly growth increment was calculated by the difference. Average fruit weight was determined by weighing a sample of 50 fruits at each harvest, and fruit diameter and height were determined by measuring a sample of 30 fruits at each harvest. Determinations were made regarding the biochemical composition of the fruits: total dry matter (%) by the gravimetric method; the soluble solids (%) by the refractometric method; total glucides

(%) by the Fehling Soxhlet method; vitamin C (mg/100 g fresh substance) by the iodometric method; titratable acidity (g malic acid per 100 g fresh substance) by the titrimetric method. The results obtained were statistically analysed using the analysis of variance (ANOVA). Means were compared using Duncan test at 0.05 probability levels. The different letters from figures are significantly different according to Duncan test ($P \leq 0.05$). The bars in the figure represent the standard deviation at 5%.

RESULTS AND DISCUSSIONS

The main phenological stages of highbush blueberry

The analysis of plant development phenophases shows that early pink bud (BBCH 57) occurred in both years of study in the first decade of April month. the late pink bud and the first wave of shoot growth (BBCH 59) was recorded in the first decade of May in the year 2021, for the

variety Patriot (May 5) and Nelson (6 May) in the year 2022, and for the other 2 varieties studied in second decade of May month (Table 1). The second wave of shoot growth in both years of the study was recorded in the second decade of June for the Duke variety, and for the other studied varieties the second wave of growth was recorded in the third decade of the month June. For all studied cultivars, the early bloom (BBCH 61) was recorded in the second and the third decade of April month respectively. The phenophase of the petal fall and early green fruit (BBCH 71) was recorded in the third decade of May, in both years of study for the Duke cultivar but for the Nelson and Patriot varieties the end of flowering was recorded in the June month period (Table 1). In the variety Duke the blue fruit (BBCH 83) in the first decade of June, and the 75% blue (ripe) fruits (BBCH 87) three days after (Table 1).

Table 1. The blueberry plant phenology annually monitored

Year	Cultivars	Early pink bud (BBCH 57)	Late pink bud (BBCH 59)	Early bloom (BBCH 61)	Petal fall early green fruit (BBCH 71)	Fruit colouring (BBCH 81)	10% blue fruit (BBCH 83)	75 % blue fruit (BBCH 87)
2021	Patriot	<i>Month</i>						
		2. IV	26.IV	5. V	29.VI	15. VI	22.VI	25.IV
	Duke	3. IV	15. IV	20. V	15.VI	22.V	5.VI	8.VI
	Nelson	2. IV	16. IV	11. V	30.VI	3. VI	22.VI	25.IV
2022	Patriot	8. IV	27.IV	10.V	26.VI	10.VI	26.VI	27.IV
	Duke	8. IV	14.IV	12.V	19.VI	27. V	9.VI	10.IV
	Nelson	6. IV	12.IV	6. V	28.VI	4.VI	20.VI	24.IV

The dynamics of the shoots growth

On average over the study period, the cultivars recorded values of annual shoots both in the first and in the second wave of growth that had differences assured from statistical point of view in each monitored month (Table 2). Thus, at the end of the first wave of growth, on average over the three years of the study, the Duke cultivar recorded the highest values of the average

length of the shoots (18.14 cm) with differences between 14.1-19.7 % compared to the other studied cultivars, differences statistically insured (Table 2).

The average sooth lenght values in the second wave of growth, sow that at the end of the end of vegetatite period, the highest value of the average length of the shoots was recorded to the Patriot cultivar (16.43 cm) (Table 2).

Tabel 2. Monthly growth of the shoots length

Cultivars	Mounth						
	The average length of the shoots in the first wave of growth (cm)			The average length of the shoots in the second wave of growth (cm)			
	April 20	May 20	June 20	July 20	August 20	September 20	October 5
Patriot	9.59 a	7.20 b	12.81 c	5.74 a	7.75 ab	11.42 a	16.43 a
Duke	8.84 b	12.32 a	18.14 a	2.63 b	7,25 b	11.16 a	13.99 b
Nelson	5.71 c	11.84 a	16.99 b	5.91 a	8.22 a	9.33 b	10.72 c
Year 2020	7.58 b	10.52 b	14.68 b	7.23 a	10.39 a	10.90 a	11.27 a
Year 2021	10.18 a	12.99 a	18.29 a	7.70 a	10.59 a	10.98 a	11.78 a
Year 2022	6.38 c	7.85 c	14.97 b	5.9 b	7.48 b	9.80 ab	11.40 a

The analise of the the length of the shoots showed that in 2021, at the end of the first wave of growth, the recorded values (18.29 cm) are 18.1% and 19.7% respectively lower than the values recorded in the 2020 and 2022 years.

Table 3. Average shoot length (cumulative I and II growth wave)

Cultivars	Mounth	Year		
		2020	2021	2022
Patriot	April 20	8.41 a	6.44b	2.,30 c
	May 20	9.22 b	10.7 a	4.70 c
	June 20	12.55 b	14.95 a	10.92 c
	July 20	20.44 b	22.08 a	13.12 c
	August 20	22.8 b	25.16 a	16.18 c
	September 20	32.11 a	33.86 a	23.95 b
	October 5	34.0 a	34.02 a	24.92 b
Duke	April 20	7.00 b	12.63 a	6.88 b
	May 20	10.33b	16.36 a	10.26 b
	June 20	14.66 c	22.,62 a	17.15 b
	July 20	20.44 b	23.42 a	18.46 b
	August 20	30.66 a	32.64 a	20.77 b
	September 20	31.33 a	32.97 a	31.50 a
	October 5	32.66 a	35.11 a	33.11 a
Nelson	April 20	9.36 a	9.52 a	9.96 a
	May 20	12.03 a	11.92 a	11.58 a
	June 20	16.66 c	21.62 a	16.15 b
	July 20	22.64 ab	24.08 a	21.97 b
	August 20	32.19 a	30.75 a	30.41 a
	September 20	32.64 a	31.31 a	32.75 a
	October 5	30.76 a	34.32 a	35.21 a

Regarding the second wave of shoots growth, the average values recorded by the studied cultivars in each year of the study, show that in 2021 year the highest value (11.78 cm) was recorded, but the

differences between the three years of study are not statistically assured (Table 2).

The length of the shoots analyzed as the average of the 2 waves of annual growth, in the study period, shows that all the studied cultivars recorded the higher values in the 2021 year, with differences statistically insured, compared to the other study years. The exception is the Patriot cultivar, which in April 20 of the 2020 year recorded the highest value (8.41 cm) with differences between 27.3% compared to the average shoot length on the same date in 2022, and in 2021 the value recorded it was with 1.97 cm smaller, a difference insured from a statistical point of view (Table 3).

The fruits biometrics characteristics to the studied highbush blueberry cultivars, yield.

On average over the three years of study, the Patriot cultivar recorded the highest values both in the case of the fruit biometric characteristics and yield compared to the other cultivars studied (Table 4). The average weight of the fruits of the 3 analyzed varieties recorded the highest values in 2020, values that differ from a statistical point of view compared to the other years. Also in 2020, the highest values were recorded in the case of fruit diameter and height, but there are no

statistically insured differences between the years of study. The yield in 2022 year was higher by 38.3% compared to the yield in 2020 year and by 31.64% compared to the yield of 2021 year, the differences was statistically insured (Table 4).

Table 4. The blueberry fruits biometrics characteristics and the yield

Cultivar	The fruit weight (g)	Fruit diameter (mm)	Fruit height (mm)	Yield (g/bush)
Patriot	2.651 _a	18.63 a	12.71 a	973.9 a
Duke	2.126 _b	17.54 b	12.71 a	541.5 b
Nelson	2.11 b	17.21 b	12.19 b	544.5 b
Year 2020	2.43 a	17.92 a	12.66 a	422.6 c
Year 2021	2.30ab	17.79 a	12.53 a	753.24 _b
Year 2022	2.16 b	17.68 a	12.43 a	1101.9 _a

From figure 2, it can be seen that the average fruit weight decreased annually to all three studied cultivars, so that in the Patriot cultivar the average fruit weight is maintained annually at values above 2.50g/fruit. In the case of the other 2 studied cultivar , the average fruit weight

dropped below 2g/fruit. The decrease in average annual values was recorded in all varieties both in height and fruit diameter.

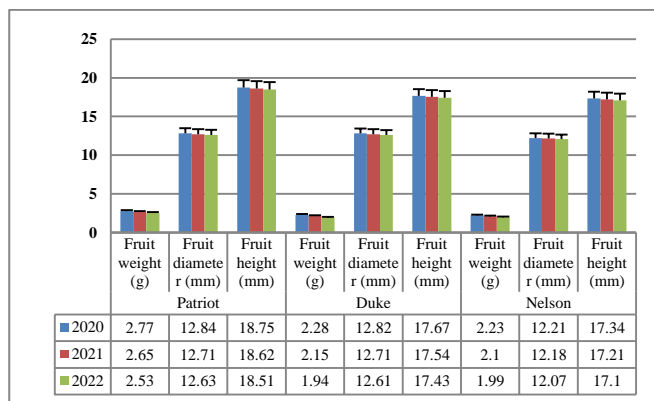


Fig. 2. The blueberry fruits biometrics characteristics, annually analyzed

The biochemical fruits characteristics

Following the study, it was found that the Duke variety, compared to the other varieties, recorded the highest values for 3 (vitamin C, carbohydrates and titratable acidity) of the 5 biochemical characteristics analyzed during the study period (table 5). The average values of the studied cultivars annually, for none of the analyzed chemical properties, did not register differences insured from a statistical point of view (Table 5).

Table 5. The biochemical characteristics analyzed during the study period

Soiul	Dry matter (%)	Vitamin C (mg)	Glucides (%)	Titrable acidity malic acid (%)	Soluble solids (%)
Patriot	12.13a	5.62 c	10.45 a	2.21 a	14.49 b
Duke	11.70 a	13.11 a	10.81 a	2.17 a	16.19 a
Nelson	10.21 b	6.55 b	8.80 b	1.91 b	11.87 c
Year 2020	11.12 a	8.26 a	9.82 a	2.05 a	13.90 a
Year 2021	11.27 a	8.36 a	9.95 a	2.08 a	14.85 a
Year 2022	11.66 a	8.65 a	10.29 a	2.15 a	14.57 a

CONCLUSIONS

Over the three years of study, at the end of the first wave of vegetative growth, the Duke cultivar recorded the highest value of the average length of the shoots with

differences between 14.1-6.76% compared to the other studied cultivars. On average over the 2 growth waves, in 2021 year the Duke and Patriot cultivars recorded the highest length shoots, and in 2022 year the highest value of the average shoot length was recorded by the Nelson cultivar.

During the study period, the Patriot cultivar was highlight with the highest average fruit weight and the highest yield compared to the other studied cultivars.

The evaluation of the biochemical quality of the fruits, in the study period, highlighted the Duke cultivar which recorded the highest vitamin C (13.11mg), glucides (10.81%) and total dry matter (16.19%) berries content.

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