RESEARCH REGARDING FRUIT YIELD OF SOME VARIETIES OF HIGHBUSH BLUEBERRY IN THE THIRD HARVESTING YEAR IN THE CONDITIONS OF LOW HILL AREA FROM WESTERN ROMANIA – CASE STUDY

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Abstract. The purpose of this work is to assess the suitability for cultivation of some varieties of Vaccinium corymbosum L. (highbush blueberry) in the low hill area from Western Romania. The importance of this kind of research is given to the increase of the interest for cultivation of this species in our country there being necessary assessments regarding the proper area for cultivation to help the interested farmers and researchers with recommendations in this topic. The work presents response of the highbush blueberry (Vaccinium corymbosum L.) yield in the ecological conditions of low hill area from Western Romania (Caraş-Severin County) in 2020. The researches were developed on a highbush blueberry plantation of 22.07 hectares from the locality Gherteniş on three varieties. The plantation was set in 2015. The varieties analysed from the point of view of the yields were Duke, Hannah's Choice and Elliot. The results were targeted on the analysis of the yield in the third year of harvesting, respectively the fifth year from planting. According with the obtained results the cultivation of highbush blueberry has perspectives in the low hill area from western Romania. The best yield was obtained in the variety Duke, this being the most productive in comparison with the other two analysed varieties from this plantation.

Keywords: Vaccinium corymbosum L., highbush blueberry, blueberry yield.

INTRODUCTION

Highbush blueberry (*Vaccinium corymbosum* L.) is a shrub species highly appreciated for the fruits that are consumed fresh or processed, but also for the therapeutic value of the fruits and leaves because they have a series of medicinal utilisation (PRIOR *et al*., 1998; NOUR *et al*., 2015; COSMULESCU, 2014). Thus, the species is appreciated from economic point of view due to the income that can earned by the farmers, where are provided the proper technological and ecological conditions for the growth demands of this species. The present trend is the expansion of the cultivated surface in Europe and in other continents too. A great importance in the highbush blueberry plantation has the soil reaction that can be a limiting factor the plantation of this species. But a great importance in the success of a highbush blueberry plantation has the cultivation technology and the selection of the varieties used too (HOLZAPFEL *et al*., 2004; WARMAN, 1987; ESAU *et al*., 2019). There were created a series of varieties that are adapted to different cultivation conditions and areas. Thus, the fruits of the cultivated varieties have different features dependent to the tolerance to different soil and climate conditions and to applied cultivation technology (ZENKOVA *et al*., 2019; KOTROTSIOS *et al*., 2017). In the case of cultivation of these species it could be exposed to the attack of some specific pests from the cultivation area (PARASCHIVU M., 2020a), or they can be attacked by diseases that aren't found in the area of origin of this plant (PARASCHIVU M., 2020b). Similar researches regarding the suitability of certain varieties for a certain area were developed in Poland where were assessed five American varieties of highbush blueberry in western part of Poland (MASŁOWSKA *et al*. 2018). The firs plantation of highbush blueberry

from Romania was created in the year 1968. Nowadays, there is an increasing interest for the cultivation of this berry bush species, due to the profitability of this species. Thus, the increase of the demand for highbush blueberry fruit and the income provided by this species is one of the drivers for the increase of the cultivated surfaces in comparison with other fruit species (ASĂNICĂ e*t al.*, 2016). According with ASĂNICĂ (2018) there were assessed by consumers the fruits of 26 varieties of highbush blueberry cultivated in Romania, and from those the best general scores were obtained by the varieties Coville and Handler. According with MOLDOVAN *et al.* (2017) one of the favourable areas for the cultivation of highbush blueberry from Romania is Maramureș (northern Romania). The importance of this research is given by the need of assessments regarding the varieties proper for cultivation in low hill area from western Romania where is interest for the cultivation of highbush blueberry. Thus, the purpose of this work is to evaluate the yield capacity of three highbush blueberry varieties (Duke, Elliot and Hannah's Choice) from a relatively small plantation in the third year of fructification.

MATERIAL AND METHODS

The researches were analysed the yield capacity of three highbush blueberry varieties from a plantation from low hill area of western Romania. The plantation was started in the year 2015. The location of the plantation is in the locality Gherteniş (Caraș-Severin County) at the following geographical coordinates: 45°25′48″ N and 21°34′55″ E, the average altitude being 137 m a.s.l. The climate is temperate continental with the annual medium temperature 11.27°C and the medium rainfall amount 890.5 mm (source: Meteorological Station Oravița). The soil in the highbush blueberry plantation is brown forest type. At the setting of the plantation were incorporated 21 tons per hectare acid peat, and manure and sulphur as powder with the purpose of creating optimum soil conditions in accordance with the demands of the plants. Thus, there was added ammonium sulphate with the irrigation water for keeping the pH in the optimum value limit. The surface of the plantation is 22.07 ha there being planted four varieties of highbush blueberry, but here were characterised only three of them, respectively the early varieties Hanna's Choice, Legacy and Duke. The plantation method used is in raised beds with a distance of 0.7 m between plants on row and 3 m between the rows. The water supply is provided with two dripping lines that are placed under an agrotextile ground cover. The yield data were collected in the year 2020. The samples consisted in 10 shrubs that were marked in the field with three replicates for every variety. The harvesting was performed in different stages depending by the maturation rhythm of every variety. There were considered the yield loses too, having in view that harvesting is realised manually. The applied technology for the plantation was in conformity with the recommendations from the literature.

The yield data processed were distributed on four harvests and also was considered the total yield per harvesting season. Thus, there was considered the total number of berries per plant and the fruit loses per plant too. The statistical analysis used was descriptive analysis and comparison among varieties and harvests, modelling and Pearson's correlation coefficient. The software used for this purpose was Excel (2019) and JASP (Version 0.14) (2020).

RESULTS AND DISCUSSIONS

The harvesting of the highbush blueberry varieties was performed differentiated due to the variable maturation stage of the fruit that differs from a variety to other. In the climate conditions of the cultivation area, the climate in was characterized by a dry spring (April – May 110 mm rainfall amount) and a very rainy summer (June – August 491 mm rainfall amount). In these conditions the firs harvested variety was Duke starting from 16 June, this variety being the earliest from the plantation. The last harvest was collected in 17 July, there

being four harvests in total. The total average number of fruits per plant in the variety Duke (Table 1) was 2568.7, the registered values ranging between 2013 and 3941. The very high variation of the berries number per plant is given by the different vigour of the analysed plant, respectively by the number of inflorescences and the number of berries per inflorescence. Starting from these observations there was considered the differentiated pruning depending by the way of development of the shrub. The fruit loses per plant were in average 68.1 berries per shrub. The average weight of every fruit was 1.2 g, this value decreasing from a harvest to other, the biggest fruits being obtained at the first harvest (1.5 g). The decrease of the fruit weight from a harvest to other was noticed by other researchers too (EHLENFELDT *et al.*, 2008).

Table 1

Descriptive analysis of the fruit number per shrub, fruit loses per shrub and yield per shrub (kg) at the highbush blueberry variety Duke in the third year of harvesting in low hill area from Western Romania (2020)

Specification	fruit number / shrub	fruit loses / shrub (no)	yield / shrub (kg)
Mean	2568.7	68.1	3.239
Standard Error	182.739	4.504	0.117
Median	2400	68.5	3.21
Standard Deviation	577.870	14.244	0.370
Sample Variance	333934.210	202.89	0.137
Range	1928	43	1.56
Minimum	2013	46	2.52
Maximum	3941	89	4.08

The berries yield per plant was 3.239 kg with variation limits comprised between 2.52 kg and 4.08 kg, the results indicating an irregularity in the development of the plants. An average fruit weight of 0.8 kg/shrub in the variety Duke was determined in the western side of Poland as average among the years 3 – 5 from planting (MASŁOWSKA *et* LIBERACKI, 2018).

The next variety of highbush blueberry harvested was Hanna's Choice (Table 2), the first harvest starting from 24 June and the last harvest being in 10 June, this variety was harvested in three stages. The average fruit number per plant was 1211.8 with variations between 309 and 1857 fruits/plant. The average fruit loses number at harvesting in the variety Hanna's Choice was 37.1, representing 2.93% from the total yield. The average weight of a fruit was 1.4 g. In the researches performed by VARGA *et al*. (2014) the average weight per fruit in the variety Hanna's Choice was comprised between 0.685 g and 2.005 g. The average berries yield per plant was 1.782 kg with values comprised between 0.44 kg and 2.44 depending by the vigour of every analysed shrub.

Table 2

Descriptive analysis of the fruit number per shrub, fruit loses per shrub and yield per shrub (kg) at the highbush blueberry variety Hanna's Choice in the third year of harvesting in low hill area from Western Romania (2020)

Specification	fruit number / shrub	fruit loses / shrub (no.)	yield / shrub (kg)
Mean	1211.8	37.1	1.782
Standard Error	135.877	5.560	0.198
Median	1298	43	1.945
Standard Deviation	429.682	17.581	0.626
Sample Variance	184626.76	309.09	0.392
Range	1548	50	2
Minimum	309	8	0.44
Maximum	1857	58	2.44

For the variety Elliot the first harvest started on 15 June and the harvest ended in 28 August, this variety being harvested only three times in this year. The average number of berries per plant in this variety was 1055.1, the minimum number of fruits being 621 and the maximum number being 1928 (Table 3).

Table 3

Descriptive analysis of the fruit number per shrub, fruit loses per shrub and yield per shrub (kg) at the highbush blueberry variety Elliot in the third year of harvesting in low hill area from Western Romania (2020)

Specification	fruit number / shrub	fruit loses / shrub (no.)	yield / shrub (kg)
Mean	1055.1	33.5	0.864
Standard Error	121.573	5.350	0.110
Median	912.5	29.5	0.71
Standard Deviation	384.448	16.918	0.348
Sample Variance	147800.69	286.25	0.121
Range	1307	57	1.04
Minimum	621	17	0.55
Maximum	1928	74	1.59

The harvest losses in the variety Elliot were in average 33.5 fruits per plant, the minimum registered being 17 and the maximum 75. The average weight of a fruit was 0.81 g. The yield of the variety Elliot was 0.86 kg/shrub, the lowest yield being 0.55 kg / plant and the highest being 1.59 kg/ shrub. The potential of this variety is good for the research area, but is expressed better in the conditions of the application of a proper technology. In other researches the average weight per fruit in the variety Elliot was comprised between 0.756-1.890 kg / shrub (VARGA *et al*., 2014).

In the conditions of the sandy soil from the area of south-central Chile the average weight of the fruits in the first harvesting season ranged between 1.56-2.63 g (MUÑOZ-VEGA *et al*., 2016).

Other analysed aspect is regarding the comparison among the varieties considering the yield of berries per yield and the total yield being represented as descriptive statistics (Table 4).

Table 4

Descriptive statistics regarding the yield on harvests ant total yield comparative in the 3 analysed varieties of highbush blueberries in low hill area from Western Romania in the year 2020

Specification	Harvest I (kg/shrub)			Harvest II (kg/shrub)			Harvest III (kg/shrub)			Harvest IV (kg/shrub)			Total yield kg/shrub		
	Duke	Elliot	Hanna's Choice	Duke	Elliot	Hanna's Choice	Duke	Elliot	Hanna's Choice	Duke	Elliot	Hanna's Choice	Duke	Elliot	Hanna's Choice
Valid	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean	1.263	0.060	1.291	1.047	0.462	0.334	0.508	0.297	0.107	0.222	0.146	0.000	4.929	0.965	1.733
Std. Deviation	0.415	0.044	0.608	0.218	0.219	0.136	0.262	0.104	0.044	0.226	0.045	0.000	2.972	0.322	0.688
Shapiro-Wilk	0.929	0.884	0.964	0.977	0.913	0.991	0.966	0.971	0.978	0.773	0.959	NaN[a]	0.779	0.935	0.966
P-value of Shapiro-Wilk	0.047	0.004	0.388	0.732	0.018	0.996	0.439	0.570	0.773	<0.001	0.288	NaN[a]	<0.001	0.067	0.431
Minimum	0.330	0.000	0.100	0.580	0.150	0.050	0.040	0.130	0.030	0.000	0.070	0.000	1.640	0.550	0.180
Maximum	1.820	0.220	2.450	1.490	0.940	0.660	0.990	0.540	0.200	0.900	0.230	0.000	10.890	1.650	2.910
[a]All values are identical															

The obtained results are showing that a great part of the data used in the statistical analysis have a normal distribution, this fact being highlighted by the *P-value* (Shapiro-Wilk test) that are greater than 0.05, but we have also some exceptions respectively the first harvest of the varieties Duke and Elliot, the second harvest in the variety Elliot and the fourth harvest

of the variety Duke. In the case of the variety Hanna's Choice the values were identical, because in fact this variety didn't had yield at this harvest in the year 2020.

The models of the distribution and interrelation between the yield features analysed in 2020 and comparing all the three analysed varieties of highbush blueberry are presented in Figure 1.
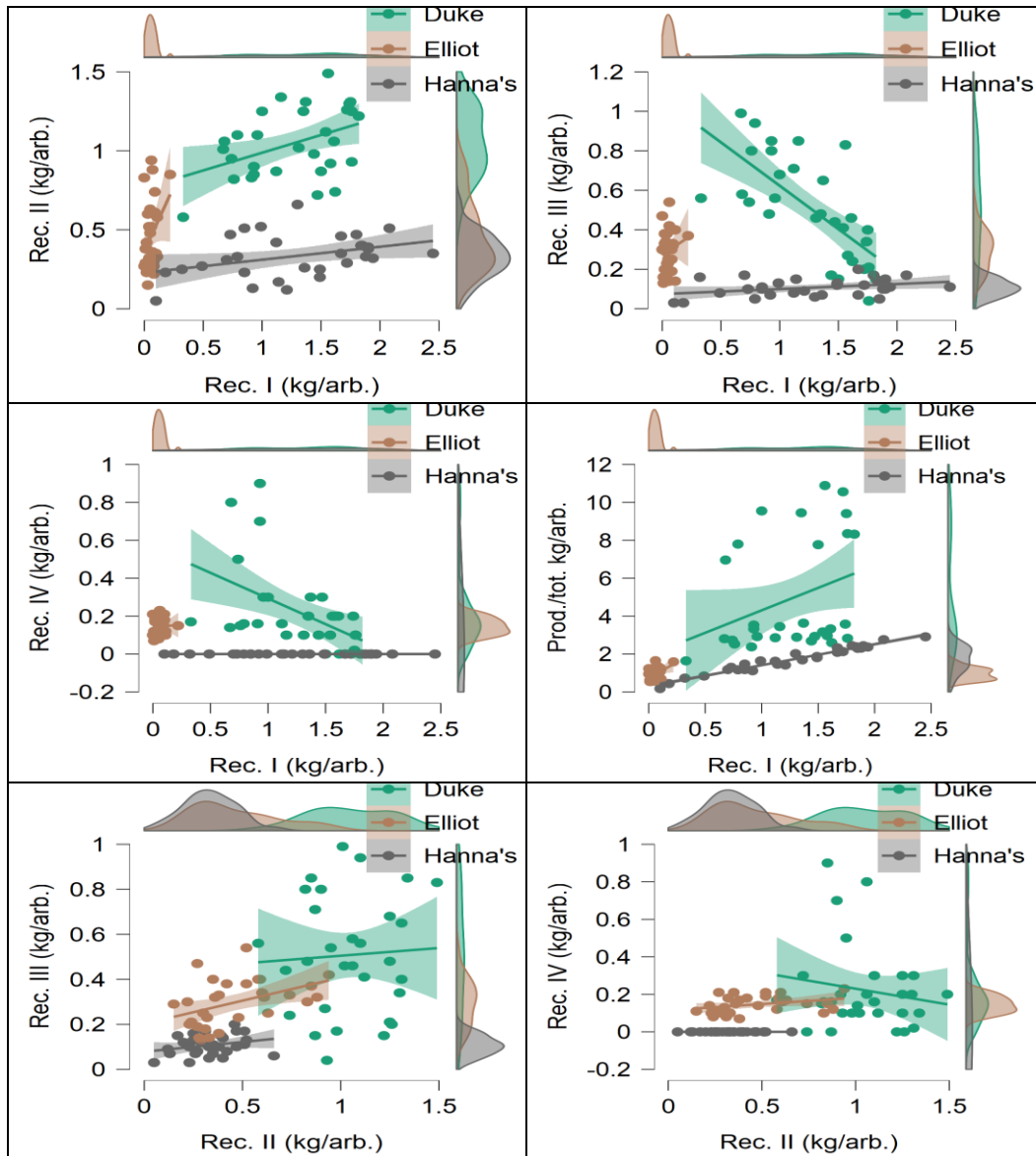

Figure 1. Models of distribution and interrelation among the analysed features of the three analysed varieties of highbush blueberry from low hill area from Western Romania (2020)

From the graphs can be noticed that the model of the interrelations among the pair of variables referring to the yield of berries per shrub is very different from a variety to other in the analysed area in the climatic conditions of the year 2020.

In the following it was analysed the existence of the correlations among the yield features at the level of the highbush blueberry crop for the year 2020 (Table 5). There were considered for this statistic analysis only the harvests I, II and III and the total harvest per harvesting season because the variety Hanna's Choice didn't have the fourth yield in this experimental year. The obtained Bravais – Pearson (r_{value}) correlation coefficients highlight the existence of some highly significant correlations among some of the variables referring to the yield of berries per plant from the year 2020, respectively the third year of harvesting and the fifth year from planting, in the conditions of the plantation from low hill area from Western Romania.

Table 5

Bravais – Pearson correlation coefficients between the yield features of the three analysed varieties of highbush blueberry from low hill area from Western Romania (2020)

Specification	Harvest I (kg/shrub)	Harvest II (kg/shrub)	Harvest III (kg/shrub)	Total yield kg/shrub
Harvest I (kg/shrub)	1	0.315**	-0.123	0.513***
Harvest II (kg/shrub)		1	0.630***	0.755***
Harvest III (kg/shrub)			1	0.371***
Total yield kg/shrub				1
Bravais-Pearson r_{calc} value; α = 0.05; n = 90; df = n – 2 two-tailed; p 0.05 ≥ 0.217*; p 0.01 ≥ 0.283**; p 0.001 ≥ 0.356***				

Thus, there were identified highly significant correlations between the first harvest and the total yield per shrub (r_{value} = 0.513***), between the second and third harvest (r_{value} = 0.630***), between the second harvest and the total harvest per shrub (r_{value} = 0.755***) and between the third harvest and the total harvest per shrub (r_{value} = 0.371***). The existence of a positive significant correlation was determined between the first and the second harvest (r_{value} = 0.315**) too.

CONCLUSIONS

The yield results obtained in the third year of harvesting from the plantation from Ghertenis (western Romania) shows that this species can be cultivated in the area of research. There were found correlations between the harvests yields and total yield obtained. The best yield results were obtained in the case of variety Duke that can be successfully cultivated in the analysed area in the case of correctly applied technology.

The cultivation of the highbush blueberry has good perspective for development in the low hill area from Banat, respectively western Romania. The researches are necessary to continue to analyse the adaptation capacity of the used varieties to the climatic conditions specific from the research area. It is important to asses the suitability of this plant for the target area because the technology of cultivation is already known and shall be applied for the obtaining of high qualitative and quantitative yield of blueberries.

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