RESEARCH ON GROWING BLUEBERRY (*VACCINIUM CORYMBOSUM L.*) FRUITS IN IRRIGATED CULTURES

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Abstract. Due to the special qualities that blueberry fruits have, both in alimentation and also for their pharmaceutical action, it is intended to expand and develop these cultures on larger areas in Romania. Researches conducted in this paper are designed to track the influence of water on the size and weight of blueberry berries in a field irrigated culture. This experimental field is located at the Tohat-Ulmeni farm, Maramureş County, consisting of 8 blocks randomized in three repetitions, thus comprising 24 plots, each plot having 10 shrubs planted on ridges. Experimental field irrigation is done by dripping in a system sustained by a water source from a well and controlled from a control panel through a pump distributing water from the main pipe through joints to the zonal pipes, from which watering is done by dripping on each ridge through nozzles situated at a 30 cm distance from each other. Weather conditions in the area during research were very hot and excessively hot, and in terms of rainfall weather was dry and excessively dry. From observations, in these heat and excessive drought, abiding by the project’s program and graduations of studied factors, we can observe that the medium diameter of blueberry berries varies between 10.63-20.8 mm for Hannah’s Choice breed and between 10.9-19.5 mm for Elliott breed; average berry width is between 8.5-16.6 for Hannah’s Choice breed and between 8.5-15.6 mm for Elliott breed and average weight of fruits is between 0.685-2.005 g for Hannah’s Choice breed and between 0.756-1.890 g for Elliott breed.

Keywords: *afin*, *Vaccinium corymbosum. L*, irrigation, fertilization, bace.

INTRODUCTION

Highbush blueberry (*Vaccinium corymbosum.L*) is a shrub valued for its fruits; it is consumed in various forms, in natural state or in various preparations, having great nutritive and therapeutic value for human health (Hoza and Velcea, 2004). Blueberry leaf tea is good for diabetes and skin diseases, fruits are astringent, have a high content of bactericides and tannins and thus are recommended in diseases of the digestive tract (Fischer, 2002).

Blueberries are a powerful liver tonic that contributes to liver cell regeneration because it contains vegetal insulin, also called myrtillin, have an anti-putrid effect, lower blood sugar levels, being recommended in the treatment of diabetes. Anthocyanins give blueberries vasoprotective properties, for which blueberries are recommended in atherosclerosis, coronary heart dis ease, heart attack sequelae, arteritis, phlebitis, varicose veins. Blueberries improve eyesight and blueberry leaves have an astringent, antidiarrheal and bactericide effect; they disinfect urinary and biliary tracts (Mihăiescu, 2007).

Worldwide, countries with the highest blueberry production are United States of America, Canada, Germany, then England, Poland, Holland, Switzerland, Italy and France (Mitre, 2001). First blueberry crops in Romania were established in 1967 at the Bilcești Fruit Tree Research Resort, Argeș County. In the following years, plantings were made in Băiculești, Brăilești – Argeș County, Făgăraș – Sibiu County, Fălticeni, Todirești – Suceava County, Caransebeș - Caraș Severin County (Pârvu, 2002). At Bilcești (Romania) were conducted the early research for obtaining high production fruits of as high quality as possible. Following research that has been conducted for 30 years it has been proven that irrigation and fertilization of the crops is of great importance. Research results obtained in 2004 show that the highest production was obtained for dripping irrigation, which is more than 30 t/ha (Bădescu, 2007).

Required blueberry crop rainfall is over 700 mm/year. Blueberry can stagnate or grow slowly, if there is no rainfall for over 8-10 days in the growth or fruit formation period (Pârvu, 2002). Moisture requirements can be estimated by establishing the daily quantity of water the plant needs, based on root volume and water retention capacity of the soil. Under hydric stress, plant growth is seriously affected, leaves turn brown and then red, sprouts become frail and thin, fruit is not fixed; if water ponds, roots rot. Irrigation regime is influenced by natural, technical and agrotechnical factors. Among the natural factors, climate has a decisive influence, by rain quantity and its distribution, by evolution of temperature, air relative humidity, droughts (Nagy and Luca, 1994).

The most used irrigation methods for blueberry cultures are by dripping, thus by applying the watering norm phenophase function specific fertilizers are also distributed.

Crop watering duration also depends on the distance between dispenser and flow of a dispenser (Luca and Nagy, 1999). Blueberry needs continuous supply of water from the opening of the bud in spring until leaves fall in autumn, especially during fruit fixing period when there are needed 25-40 mm/week. Dripping irrigation, micro irrigation, positions water in the root area, can replace the need of soil for organic matter, less water is lost by evaporation, smaller engines and pumps are used, and pressure is lower, leading to lower operating costs (Korcak, 1992).

Researches conducted in this experiment have the goal of determining the influence of blueberry crop irrigation on berry size and weight, comparative and differentiated for the two varieties.

MATERIALS AND METHODS

The experiment field is located at the Tohat-Ulmeni farm, Maramureş County, and has the geographic coordinates between 47°29’43.51” and 47°29’45.87” north latitude and 23°17’5.19” and 23°18’14” east longitude.

Farm’s surface is 0.837 ha and experiment field’s surface is 864 square meters. The soil has low productivity, a high content of clay and a pH of 5.5. In order to correct soil texture, when establishing the farm an amendment was made with river gravel and to maintain the appropriate pH 5 liters / plant of acidic peat was applied. Structure of the experiment field is comprised of 8 blocks randomized in 3 repetitions with 80 shrubs / repetition, planted on ridges at a distance of 1 meter and at 3 meters between rows. There are 24 plots, 12 plots with shrubs from the Hannah’s Choice variety and 12 plots with shrubs from the Elliott variety, the total number of shrubs in the experiment field being 240. Factors included in the study are: A – water, with two graduations: a_1-basic irrigation,

a_2-basic and supplementary irrigation; B – fertilizer, with two graduations: b_1-basic fertilization, b_2- basic and supplementary fertilization; C – variety: c_1-Elliott and c_2 Hannah's Choice (Fig.1).

R	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8
R_1	$a_1b_1c_1$	$a_1b_1c_2$	$a_1b_2c_1$	$a_1b_2c_2$	$a_2b_1c_1$	$a_2b_1c_2$	$a_2b_2c_1$	$a_2b_2c_2$
R_2	$a_2b_2c_2$	$a_2b_2c_1$	$a_2b_1c_2$	$a_2b_1c_1$	$a_1b_1c_2$	$a_1b_1c_1$	$a_1b_2c_2$	a_1b_2c1
R_3	$a_1b_2c_1$	$a_1b_2c_2$	$a_1b_1c_1$	$a_1b_1c_2$	$a_2b_1c_1$	$a_2b_1c_2$	$a_2b_2c_1$	$a_2b_2c_2$

Fig. 1. The structure of field experiments

The significance of each plot are:

R_1B_1, R_2B_6, R_3B_3	$a_1b_1c_1$	Basic irrigation and fertilization for Elliott
R3B_1, R_1B_3, R_2B_8	$a_1b_2c_1$	Basic irrigation, basic and supplementary fertilization for Elliott
R_1B_5, R_2B4, R_3B_5	$a_2b_1c_1$	Basic and supplementary irrigation, basic fertilization for Elliott
R_2B_2, R_1B_7,R_3B_7	$a_2b_2c_1$	Basic and supplementary irrigation, basic and supplementary fertilization for Elliot
R_1B_2, R_2B_5, R_3B_4	$a_1b_1c_2$	Basic irrigation and fertilization for Hannah's Choice
R_1B_4, R_2B_7, R_3B_2	$a_1b_2c_2$	Basic irrigation, basic and supplementary fertilization for Hannah's Choice
R_1B_6, R_2B_3, R_3B_6	$a_2b_1c_2$	Basic and supplementary irrigation, basic fertilization for Hannah's Choice
R_1B_8, R_2B_1, R_3B_8	$a_2b_2c_2$	Basic and supplementary irrigation, basic and supplementary fertilization for Hannah's Choice

In the Tohat-Ulmeni area, between January and June 2014, the thermal regime was characterized by high temperatures. Comparing normal with average values by decades from 1961-1993, we can observe that weather was hot and excessively hot (Fig. 2).

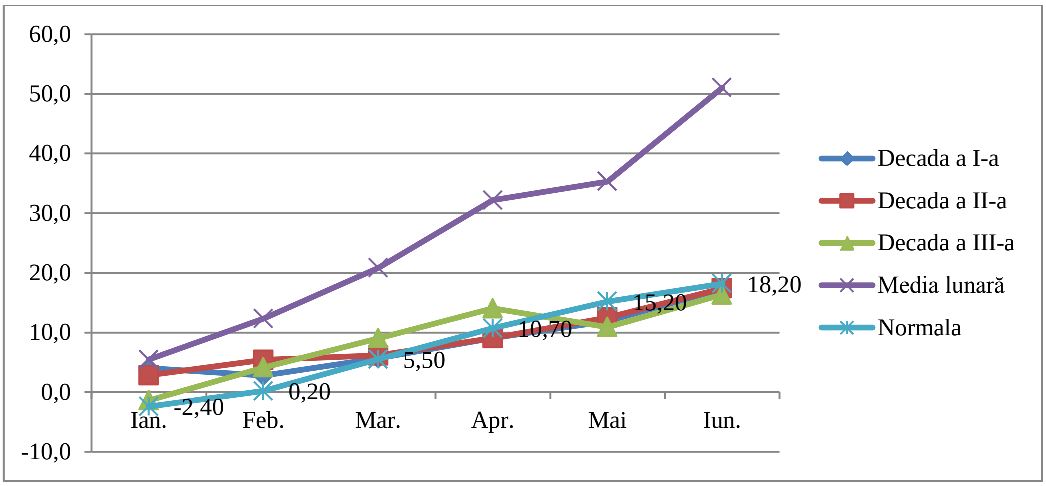

Fig. 2. Thermal regime for the field of experiments

From measurements made at the Ocna Şugatag Weather Station, station code 747356, we can observe that in the Tohat-Ulmeni area, between January and June 2014, weather was very dry and excessively dry (Fig. 3).

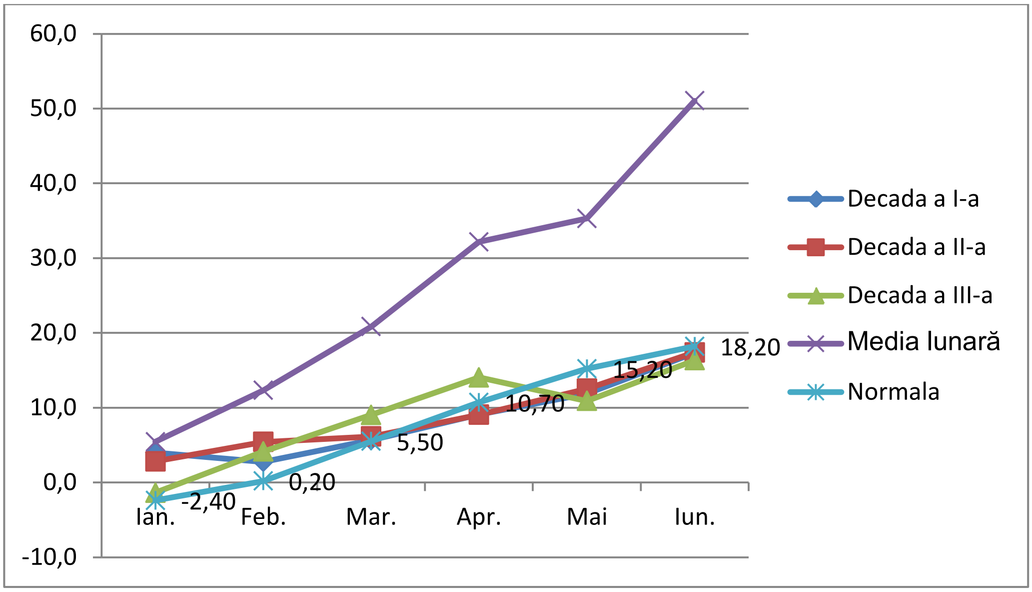

Fig. 3. Pluviometrical regim for the field of experiments

Highbush blueberry (*Vaccinium corymbosum)* is included in the *Ericacee* family, the *Vaccinium* genus and is native from North America. Worldwide there are more than 100 varieties of blueberries for culture.

Given the climatic conditions in our country, specialized nurseries choose some special varieties: early varieties such as Hannah's Choice, Earlierblue, Duke, Spartan which ripen in June and July; season varieties such as Patriot, Bluecrop and Chandler and late varieties such as Legacy and Elliott which ripen from mid-August to early September.

Two varieties of highbush blueberry are studied, arranged on 12 plots of 10 shrubs each.

The Elliott variety is part of the late varieties, is one of the most productive varieties reaching yields between 12-50 tons/ha, the bush grows tall, up to 2-2.5 meters and 2-2.5 meters width, it is vigorous, vertical and robust, likes the sun, tolerates little shade, must be well watered 2-2.5 especially during summer/drought, resist at low temperature down to -30°C, is adapted to mechanical harvesting, 70-80% of fruits are picked at first harvest, has very high productivity until late September, reaching yields of up to 12-50 t/ha. Elliott requires careful and proper trimming. The fruit is medium sized, light blue, of good quality, a bit sour, with very little scar and is arranged in compact bouquets.

The Hannah's Choice variety is part of the early varieties, it ripens early even in colder areas, 50% of fruits are ripe around 25th of June, is very resistant to drought, grows tall up to 1.60 – 1.80 m, fruits are medium to large sized, light blue, they taste sweet with a peach flavor, fruit weight varies between 1.9 g at first harvest to 1.6 g at third harvest. Studies in New Jersey have shown that Hannah's Choice variety is relatively sensible to the *Monilinia vaccinii-corymbosi (Reade)* mushroom; recent studies have also shown that their resistance to anthracnose which is rotting the fruit is better than for the Duke variety (Polashock, et al., 2005).

Natural soil for the blueberry plant is good to be sandy or sandy clay, with a low fertility, a pH of approximately 5.5 and a content of organic matter above 4% (Korcak, 1989).

The Tohat far is establish on a land with a little slope, uniform, with mechanization possibilities, without sliding phenomena, with a soil of acidic reaction corresponding to blueberry cultures of pH 5.5; with little organic matter, having a hummus content of over 4%, with mobile P and K. From the soil analysis report we can observe that soil is little clayey, physical properties, size structure have led to the need to improve its texture with river gravel.

The irrigation system is fed with water from a well; water entrainment is done with a 1.1 W pump, a 4.5 m^3/h flow at a pressure of 3 bars. Water reaches the buffer tanks through polyethylene pipes, and from the tanks it is distributed towards the main line by an input pump, through a command panel. Water passes through a disc filter which provides a mechanical filtering of up to 150 μm, and then it passes to the Dozatron fertilizer dispenser, after which it is distributed, through joints, to the area pipes provided with drip nozzles. Watering is done on each area sequentially. In the existing climate conditions, irrigation started in April until mid-September, five times a week and 1 hour a day, depending on phenophase, with 2 l/nozzle and 4 l/nozzle, at a pressure of 3 bars, and at temperatures higher than 38°C with 2 l/day

Basic fertilization was done at crop establishment with 5 l/plant garden mould and with 5 l/plant acidic peat. In the first two years fertilization by irrigation was done with NPK 20-5-10, at a rate of 2 g/plant. In the third year macro elements were applied, such as: Mg, Cu, Bo and Ca, necessary for developing fruits. Ammonium sulfate was used for supplementary fertilization of the experiment field in a quantity of 4.6 g/plant and it was applied through the irrigation system, once a month. Irrigation was done in rainless periods when soil moisture decreased reaching critic level. The research aimed to determine the influence of water on the development in size and weight of blueberry berries from the same harvest, for all variants of both varieties, for year 2014.

RESULTS AND DISCUSSIONS

To determine the average values, the sizes of 10 berries were measured from each shrub of the 10 shrubs on each plot. Average values, standard deviation and standard deviation of the most probable value are considered the values of the entire population of Tohat farm. Given the drought conditions of 2014, following the procedure provided in the research project and graduations of studied factors, we can observe that for Hannah's Choice variety the average probable minimum value of berry diameter is 10.63 mm, for the basic fertilization and irrigation conditions, for blueberries on plot R_2B_5 , and for the Elliott variety, in the same conditions, it is 10.9 mm for plot R_2B_6.

The average probable maximum value of berry diameter for Hannah's Choice variety is 20.98 mm, for basic and supplementary fertilization and irrigation, for plot R_1B_8, and for Elliott variety, in the same conditions, it is 19.5 mm for plot R_1B_7. Average value for the standard deviation of measured size is 1.2 mm for Hannah's Choice variety and 1.7 mm for Elliott variety, and average value for the standard deviation of the most probable value is 0.4 for Hannah's Choice variety and 0.6 for Elliott variety (Tab. 1 and Tab. 2).

Table 1
Average value of berry diameter for Hannah's Choice variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Hahhah's Plot	Mean value of bacca width [mm]	s_0	s
Basic fertilization	Basic irrigation	R1B2	1.31	0.382	0.127
		R2B5	10.63	1.087	0.362
		R3B4	11.11	1.111	0.37
	Basic irrigation and supplement	R1B6	15.73	1.322	0.441
		R2B3	12.76	1.191	0.397
		R3B6	13.33	1.217	0.406
Basic fertilization and supplement	Basic irrigation	R1B4	18.35	1.428	0.476
		R2B7	14.88	1.286	0.429
		R3B2	15.55	1.315	0.438
	Basic irrigation and supplement	R1B8	20.98	1.527	0.509
		R2B1	17.01	1.375	0.458
		R3B8	17.78	1.405	0.468

Table 2
Average value of berry diameter for Elliott variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Elliott Plot	Mean value of bacca width [mm]	s_0	s
Basic fertilization	Basic irrigation	R1B1	12.2	1.042	0.347
		R2B6	10.9	1.162	0.387
		R3B3	11.1	1.619	0.540
	Basic irrigation and supplement	R1B5	13.4	1.943	0.648
		R2B4	13.0	1.394	0.465
		R3B5	14.6	1.251	0.417
Basic fertilization and supplement	Basic irrigation	R3B1	17.0	1.459	0.486
		R1B3	15.6	2.266	0.755
		R2B8	15.2	1.626	0.542
	Basic irrigation and supplement	R2B2	17.4	1.859	0.620
		R1B7	19.5	1.668	0.556
		R3B7	17.8	2.590	0.863

Average probable value of berry width is 8.5 mm for blueberries on plot R_1B_2, for basic fertilization and irrigation, both for Hannah's Choice variety and also for Elliott variety on plot R_2B_6 and the average probable maximum value of berry width is 16.6 mm for Hannah's Choice variety, for basic and supplementary fertilization and irrigation, for plot R_2B_1 and of 15.6 mm for Elliott variety, in the same conditions, on plot R_3B_7. Standard empirical deviation of berry widths for Hannah's Choice variety is 1.2 mm and for Elliott variety is 1.7 mm, and standard deviation of the most probable value is 0.4 mm for Hannah's Choice variety and 0.6 mm for Elliott variety, identical to the standard deviations of diameter (Tab. 3 and Tab. 4).

Table 3

Average value of berry width for Hannah's Choice variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Plot	Mean value of bacca width [mm]	s_0	s
Basic fertilization	Basic irrigation	R1B2	8.5	0.971	0.324
		R2B5	10.4	1.074	0.358
		R3B4	9.9	0.927	0.309
	Basic irrigation and supplement	R1B6	10.2	1.016	0.339
		R2B3	12.5	1.144	0.381
		R3B6	11.9	1.112	0.371
Basic fertilization and supplement	Basic irrigation	R1B4	11.9	1.185	0.395
		R2B7	14.5	1.334	0.445
		R3B2	13.9	1.297	0.432
	Basic irrigation and supplement	R1B8	13.6	1.354	0.451
		R2B1	16.6	1.525	0.508
		R3B8	15.9	1.483	0.494

Table 4

Average value of berry width for Elliott variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Plot	Mean value of bacca width [mm]	s_0	s
Basic fertilization	Basic irrigation	R1B1	9.8	1.264	0.421
		R2B6	8.5	1.421	0.474
		R3B3	8.7	1.169	0.390
	Basic irrigation and supplement	R1B5	10.2	1.705	0.568
		R2B4	11.7	1.517	0.506
		R3B5	10.4	1.403	0.468
Basic fertilization and supplement	Basic irrigation	R3B1	12.1	1.637	0.546
		R1B3	13.7	1.770	0.590
		R2B8	11.9	1.989	0.663
	Basic irrigation and supplement	R2B2	13.8	1.871	0.624
		R1B7	13.6	2.273	0.758
		R3B7	15.6	2.023	0.674

Average probable minimum value of berry weights is 0.685 g for Hannah's Choice variety on plot R_2B_5, for basic fertilization and irrigation, and it is 0.756 g for Elliott variety, in the same conditions, on plot R_2B_6. Average probable maximum value of berry weights is 2.005 g, for basic and supplementary fertilization and irrigation, on plot R_1B_8 for Hannah's Choice variety; in the same conditions it is 1.890 g for Elliott variety on plot R_3B_7. Standard deviation of empirical value is 0.2 for Hannah's Choice variety and 0.3 for Elliott variety, and standard deviation of the most probable value is 0.1 for both varieties (Tab. 5 and Tab. 6).

Table 5

Average value of berry weight for Hannah's Choice variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Plot	Average value of berry weight [g]	s_0	s
Basic fertilization	Basic irrigation	R1B2	1.185	0.164	0.055
		R2B5	0.685	0.186	0.062
		R3B4	0.785	0.099	0.033
	Basic irrigation and supplement	R1B6	1.438	0.161	0.054
		R2B3	1.364	0.250	0.083
		R3B6	1.440	0.168	0.056
Basic fertilization and supplement	Basic irrigation	R1B4	1.592	0.159	0.053
		R2B7	1.664	0.131	0.044
		R3B2	1.786	0.230	0.077
	Basic irrigation and supplement	R1B8	2.005	0.122	0.041
		R2B1	1.965	0.219	0.073
		R3B8	1.894	0.171	0.057

Table 6

Average value of berry weight for Elliott variety, standard deviation of a value and standard deviation of the most probable value

Fertilization regime	Irrigation regime	Plot	Average value of berry weight [mm]	s_0	s
Basic fertilization	Basic irrigation	R1B1	0.945	0.118	0.039
		R2B6	0.756	0.246	0.082
		R3B3	0.892	0.241	0.080
	Basic irrigation and supplement	R1B5	1.428	0.385	0.128
		R2B4	1.512	0.188	0.063
		R3B5	1.210	0.393	0.131
Basic fertilization and supplement	Basic irrigation	R3B1	1.795	0.224	0.075
		R1B3	1.696	0.458	0.153
		R2B8	1.437	0.467	0.156
	Basic irrigation and supplement	R2B2	1.785	0.482	0.161
		R1B7	1.513	0.548	0.183
		R3B7	1.890	0.213	0.071

Comparing size and weight of blueberry berries of the two varieties, on plots with the same graduations of the studied factors, we can observe that Hannah's Choice variety berries are bigger than Elliott variety berries (Fig. 4 and Fig. 5).

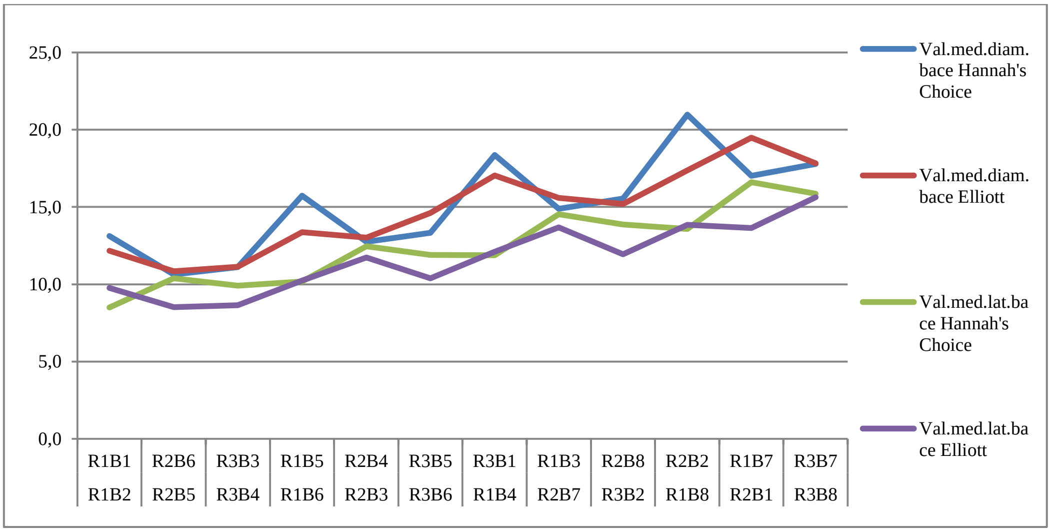

Figure 4. Probable average values of berry sizes of the two varieties

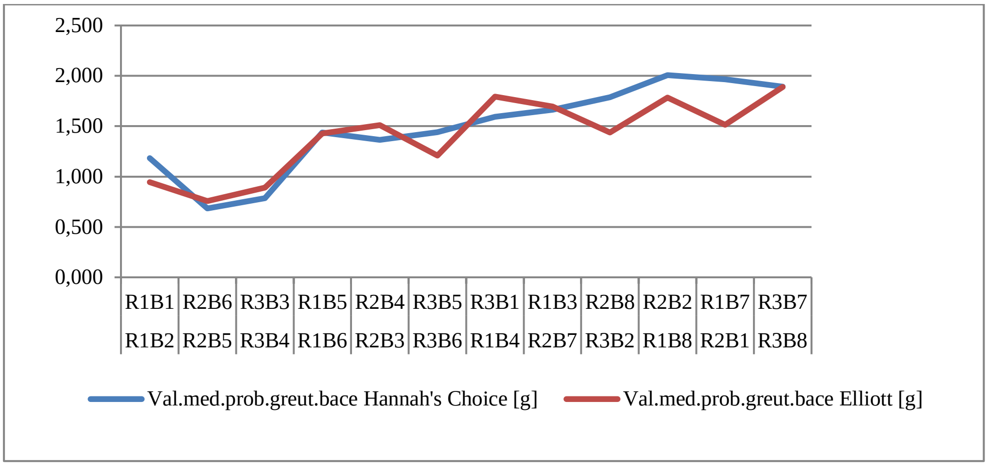

Figure 5. Probable average values of berry weights of the two varieties

CONCLUSIONS

The following were ascertained based on research conducted in the experiment field:

– average probable values of berry diameters are between 10.63-20.98 mm for Hannah’s Choice variety and between 10.9-19.5 mm for Elliott variety, and are minimum on plots with basic fertilization and irrigation and maximum of plots with basic and supplementary fertilization and irrigation;

– average probable values of berry widths are between 8.5-16.6 mm for Hannah’s Choice variety and between 8.5-15.6 mm for Elliott variety, with minimum values on plots with basic fertilization and irrigation and maximum values on plots with basic and supplementary fertilization and irrigation;

– average values of berry weights are between 0.685-2.005 g for Hannah's Choice variety and between 0.756-1.890 g for Elliott variety with minimum values on plots with basic fertilization and irrigation and maximum values on plots with basic and supplementary fertilization and irrigation;

– there are significant differences between sizes and weights of berries from plots with basic fertilization and irrigation compared to those from plots with basic and supplementary fertilization and irrigation;

– there are insignificant differences between sizes and weights of berries from the two varieties, corresponding to plots with same graduations of factors;

– standard deviations of the most probable values of sizes and weights of berries are the same for both varieties.

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