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Research Paper

Size and attributes of development of fruit blueberry

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ABSTRACT

The objective of this study is to evaluate the effect of blueberry cultivars, group Rabbiteye, and the fruit size on its development attributes to the growing conditions of Pelotas/RS – Brazil mesoregion. The experiment was conducted in full production plants of the cultivar Climax, Bluegem and Powderblue grown in a commercial grove. A completely randomized design (CRD) conducted in a 3 × 3 factorial (Cultivars × Fruit size) was used in this study. Fruit dry and wet weight (g), number of seeds, fruit diameter and height and fruit dry matter (%) were assessed and this led to the correlation between the fruit diameter and height for the estimation of fruit moisture (%). All data were submitted to analysis of variance and observed to be significantly different when compared using Tukey's HSD test ($p \leq 0.05$). The results show that the variables fruit diameter, fruit height, fruit wet weight, number of seeds and dry weight fruit size influence the results. Among the cultivars, in general, Powderblue presents bigger, more proportionate and heavier fruits, therefore with greater moisture content in relation to the other cultivars.

Keywords: Family farming, climax, small fruits, seeds.

INTRODUCTION

Blueberries (*Vaccinium* spp.) belong to the small-fruit group of plants (Fachinello, 2008) and produce fruits with a high antioxidant potential and nutraceutical properties (Kalt et al., 2007), a fact that has called the attention of consumers, food handlers, marketing agents and farmers (Lima et al., 2010).

In this sense, these plants were considered a great alternative to diversify the productive matrices of family units due to their productive characteristics (Radunz et al., 2014) and the feasibility to process the fruits in small agro-industries (Marangon and Biasi, 2013). The group, Rabbiteye is one of the more commercially cultivated groups of blueberries *(*Vaccinium ashei*)* (Strik, 2007), mainly in southern Brazil for presenting among other characteristics, a low chill requirement (Ehlenfeldt et al., 2007; Avilés et al., 2014).

According to Facchinello et al. (2011), for the production of fruits with high quality, the knowledge of the growing characteristics of the species for the edaphoclimatic conditions of temperate regions of Brazil is of extreme importance. Therefore, considering the influence of the cultivar and the growing environment on the morphological characteristics of the fruit and also the correlation between the number of seeds and the size of the fruits (Vieira and Carvalho, 2009; Silva et al., 2013), the objective of the present study was to evaluate the effect of blueberry cultivars, group Rabbiteye and the fruit size on its development attributes to the growing conditions of Pelotas/RS – Brazil mesoregion.

MATERIALS AND METHODS

The research was carried out on plants of the cultivars Climax, Bluegem and Powderblue (group Rabbiteye) grown in a commercial grove located in Morro Redondo, RS. Brazil (31°32'S 52°34'O, 150 m of altitude).

A completely randomized experimental design for the

selected cultivars was adopted and conducted under a 3 × 3 factorial scheme (Cultivars × fruit size). In factor A, the three cultivars (Clímax, Bluegem and Powderblue) were allocated. For factor B, three fruit sizes (small, medium and large) were used and randomly selected by visual observation based on their predominance in the collected sample. On average, the small-size fruits presented 0.75, 0.76 and 0.78 g for the cultivar Climax, Bluegem and Powderblue, respectively. The medium-size fruits presented 1.30, 1.21 and 1.48 g for the cultivar Climax, Bluegem and Powderblue and the large-size fruits presented 1.92, 1.68 and 1.94 g for the cultivar Climax, Bluegem and Powderblue, respectively.

In the experimental area, for each cultivar, 30 eight-year-old plants in full production were randomly selected and during the harvest performed at the stage of complete maturation had their fruits homogenized to obtain the samples. From the samples, 30 fruits of each size were visually separated and assessments on fruit diameter and height (mm), fruit wet weight (g), number of seeds, fruit dry weight (g), dry matter (%) and moisture (%) conducted. These assessments led to the generation of a correlation between the number of seeds and the dry weight of the fruit between the diameter and height of the fruit.

The fruit weight was measured using an analytical scale; the diameter and height of the fruits were performed with the aid of a digital caliper. To determine the dry matter, the samples were kept in a forced circulation oven at a temperature of 65 ± 5°C, until a constant weight was obtained.

Statistical analysis

All the data collected were submitted to analysis of variance and when compared using Tukey's HSD test ($p \leq 0.05$) was found to be significantly different.

RESULTS AND DISCUSSION

The results show a positive two-way interaction between the factors "cultivar" and "fruit size" for the variables fruit diameter (mm), fruit height (mm), fruit wet weight (g), number of seeds, fruit dry weight (g), dry matter (%) and fruit moisture (%). However, for the correlation between fruit diameter and height, no interaction between the factors was observed, only the single effect of the factors cultivar and fruit size.

Analyzing the effect of the interaction between cultivars and fruit size on the diameter of the fruits (Table 2 and 3), it was possible to verify a variation between the cultivars only for the medium- and large-size fruits, as the cultivar Powderblue had a greater diameter in relation to the others, on average, 7.8 and 6.3% for medium- and large-size fruits, respectively. For the diameter of the fruit in relation to the fruit size, a difference in both cultivars was observed as the large-size fruit was superior to the medium-size fruit that in turn was superior to the small-size fruit. A similar behavior was verified for the variables fruit height, fruit wet weight, number of seeds and fruit dry weight (Table 1). It represents an important finding, considering that the size, weight and shape of the fruits are linked to their quality attributes (Medina, 2016). Antunes et al. (2008) evaluating blueberry cultivars belonging to the group Rabbiteye, verified that the means for the longitudinal diameter of the fruits between the cultivars, were statistically similar, a different result than that reported in the present experiment. This fact may be associated with plants age, which in the present experiment were in full production. On the other hand, Pasa et al. (2014) for the cultivar Climax, obtained fruits with a diameter ranging between 14.13 and 16.54 mm, similar to the values reported in the present experiment.

In regard to fruit height and apart from their size, it can be verified that the highest height was found for the cultivar Powderblue, which is higher than the others and on average, 10, 16 and 15%, for small-, medium- and large-size fruits, respectively. Thus, it is possible to observe a similarity between the characteristics for the fruits of the cultivars, Climax and Bluegem as they presented fruits with smaller height and diameter when compared to the cultivar Powderblue.

In relation to the wet weight of the fruits (Table 1), differences between the cultivars were observed only for the medium- and large-size fruits, as the cultivar, Powderblue was 13.7 and 23.1% superior than the cultivars Bluegem and Climax for medium-size fruits, respectively. As for large-size fruits, the cultivars Powderblue and Climax did not differ from each other, however they were 14.9% superior than the cultivar Bluegem (Table 1). A similar behavior was observed by Raseira and Franzon (2012) with the report that the average fruit weight was 1.8 g for the cultivars, Bluegem and Climax and 2.0 g for the cultivar Powderblue and Pasa et al. (2014) who found averages of 0.81 to 1.65 g in the region of Pelotas/RS. Brazil.

When evaluating the effect of the cultivar on the number of seeds, a distinct behavior between them for each fruit size was observed, all of which differed from each other regardless of the size evaluated (Table 1). The greatest number of seeds was verified in the cultivar Climax for small-size and large-size fruits and in the cultivar Bluegem for medium-size fruits. For both sizes, the cultivar Powderblue presented the lowest number of seeds (Table 1). It is possible to verify that there is a correlation between the number of seeds and the fruit size, however, this behavior was not constant when comparing the cultivars since Powderblue cultivar presented the greatest fruit diameter and height and also the lowest number of seeds.

The dry weight of the fruits showed no difference between the cultivars Climax and Bluegem in small-size

Table 1: Characteristics of the interaction between blueberry cultivars (Climax, Bluegem and Powderblue) and fruit size (small, medium and large) for the variables fruit diameter (mm), fruit height (mm), fruit wet weight (%), number of seeds, fruit dry weight (g), dry matter (%). relationship between number of seeds and dry weight of fruit and moisture of fruits (%), Harvest 2012/2013, Morro Redondo, RS. Brazil.

Cultivar	Fruit size		
	Small	**Medium**	**Large**
Fruit diameter			
Climax	11.49^{aC}	13.73^{bB}	15.26^{bA}
Bluegem	11.34^{aC}	13.28^{cB}	15.16^{bA}
Powderblue	11.57^{aC}	14.56^{aB}	16.17^{aA}
Fruit height			
Climax	8.93^{bC}	10.51^{bB}	11.55^{bA}
Bluegem	8.98^{bC}	10.6^{2bB}	11.83^{bA}
Powderblue	9.90^{aC}	12.58^{aB}	13.83^{aA}
Fruit wet weight			
Climax	0.75^{aC}	1.31^{bB}	1.92^{aA}
Bluegem	0.76^{aC}	1.21^{cB}	1.68^{bA}
Powderblue	0.78^{aC}	1.49^{aB}	1.94^{aA}
Number of seeds			
Climax	63.73^{aC}	75.40^{bB}	104.33^{aA}
Bluegem	35.10^{cC}	81.27^{aB}	90.03^{bA}
Powderblue	45.87^{bC}	67.73^{cB}	81.63^{cA}
Fruit dry weight			
Climax	0.19^{aC}	0.30^{aB}	0.39^{bA}
Bluegem	0.18^{aC}	0.27^{bB}	0.36^{cA}
Powderblue	0.16^{bC}	0.30^{aB}	0.42^{aA}
Dry matter			
Climax	25.33^{aA}	23.07^{aB}	20.53^{bC}
Bluegem	23.76^{bA}	21.93^{bB}	21.52^{abB}
Powderblue	20.16^{cB}	20.18^{cB}	21.71^{aA}
Fruit moisture			
Climax	74.67^{cC}	76.93^{cB}	79.47^{aA}
Bluegem	76.24^{bB}	78.07^{bA}	78.48^{abA}
Powderblue	79.84^{aA}	79.82^{aA}	78.29^{bB}

Means followed by the same letters (lowercase in the column and uppercase in the same line) are not significantly different (Tukey's HSD, p≤0.05).

fruits; Clímax and Powderblue in the medium size was higher (Table 1). For large-size fruits the cultivar Powderblue was 7.7 and 16.7% superior than the cultivars, Climax and Bluegem, respectively (Table 1).

For the fruit dry matter, dry weight and moisture, a distinctive behavior was observed when checking for the behavior between the fruit size for the same cultivar (Table 1). The dry matter, for the cultivars, Climax and Bluegem presented a greater percentage in small-size fruits. This fact can be corroborated when analyzing the fruit moisture percentage, which followed the previously described behavior only presenting the lowest values. For the cultivar, Powderblue, the greatest dry matter percentage was found in the large-size fruits, which presented the lowest fruit

Table 2: Correlation between fruit diameter and height for the blueberry cultivars Climax, Bluegem and Powderblue harvest 2012/2013, Morro Redondo, RS. Brazil.

Cultivar	Correlation between diameter/fruit height
Climax	1.31[a]
Bluegem	1.27[b]
Powderblue	1.17[c]

Means followed by the same letters are not significantly different (Tukey's HSD, p≤0.05).

Table 3: Correlation between fruit diameter and height as a function of fruit size harvest 2012/2013, Morro Redondo, RS. Brazil.

Fruit size	Correlation between diameter/fruit height
Small	1.24[a]
Medium	1.24[a]
Large	1.26[a]

Means followed by the same letters are not significantly different (Tukey's HSD, p≤0.05).

moisture percentage.

Table 1 shows that when analyzing the effect of the cultivar for the same fruit size using variables such as fruit dry matter and fruit moisture, it was observed that for the small- and medium-size fruits the cultivar Climax presented a greater dry mass than the cultivars Bluegem and Powderblue. For the large-size fruit, the cultivar Climax had the lowest percentage value and on average, 5.0% lower than the values found for the cultivars, Bluegem and Powderblue, which did not differ (Table 1). For fruit moisture (%), the behavior was exactly the opposite of that observed for the dry matter, as the cultivar Powderblue was superior in small- and medium-size fruits and lower in the large-size fruit (Table 1). A fact that may help explain why the cultivar Powderblue, despite presenting the largest fruit size did not present the greatest dry mass in small- and medium-size fruits.

The relationship between fruit diameter and fruit height was influenced by the cultivar, as the greatest relationship was verified for the cultivar Climax, followed by Bluegem and Powderblue (Table 2), demonstrating that the cultivar Powderblue presents fruits more proportional in relation to its diameter and height. However, the fruit size was not affected by the interaction between fruit diameter and fruit height (Table 3).

Finally, the research is consolidated indicating that the size of fruits influence the variables fruit diameter, fruit height, fruit wet weight, number of seeds and fruit dry weight. Among the cultivars, in general, Powderblue presents bigger, more proportionate and heavier fruits and greater moisture content in relation to the other cultivars.

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