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Evaluation of the application leaf of CALCIUM and BORON in pre-harvest and post-harvest of BLUEBERRY about parameters NUTRITIONAL and of quality of fruit grow DUKE

INTRODUCTION

The quality and status of the fruit of Blueberry for export is every time more relevant for the industry national e international, given the growing demand in the market of far East whose price is also more attraction as also the more culture of habit food of this species by the population World (Muñoz *et to the*.) 2016).

The growing consumer of the fruit of Blueberry to level world generates expectations of culture and of growth of surface grown not only in Chile, but also in countries competitors of the same hemisphere and continent. Also is essential improve the competitiveness of the field, and one of most important factors is the quality and status of the fruit. Some of the indicator of quality are the content nutritional the gauge and the firm of fruits. In the nutrients Associates to the quality is are the calcium and the boron, both by your functions metabolic as by the features structural inside of the tissue of the fruit mainly on the structure of membranes cell phones and of wall cell, to improve firm and elasticity.

The knowledge World like national connection to these topics is still very scarce, without background that allow discriminate between the various varieties mind on the market. Some efforts have been made by the INIA, indicating differences varietal on the content of nutrients so much in fruit as in leaves, discarding the use of a standard by species, as is coming making to the date (Hirzel, (2014 and 2016).

Of the same mode, not be known with accuracy the effects of improvement in quality and status as result of the applications leaf of the nutrient calcium and boron, in various stages of culture and number of applications. Is unknown also differences on the responses of various varieties or cultivars of Blueberry.

To help to generate knowledge in this respect is raised the this Research whose goal general he evaluate the effect of applications leaf of the products Metalosate Calcium and Metalosate Boron in post-harvest and pre-harvest, on the composition nutritional gauge and firm of fruit of Blueberry cv. Duke.

MATERIALS AND METHODS

Hold the experiment in a property commercial of blueberries, located on the local of Santa Cruz de Cuca, way Chillan to design by the route of the Itata, with a Garden of Blueberry CV. Duke of 8 years of age, planted in a frame of 3 m * 1 m. The ground is of texture sandy, deep, with irrigation by dripping double line, and business performance fluctuating between 9 and 12 Ton / ha.

The treatment evaluated and your number of applications were the following:

1. Control
2. Applications of calcium leaf (4) in post-harvest
3. Applications of calcium leaf (4) in pre-harvest
4. Applications of calcium leaf (4) in post-harvest + pre-harvest
5. Applications of boron leaf (4) in post-harvest
6. Applications of boron leaf (4) in pre-harvest
7. Applications of boron leaf (4) in post-harvest + pre-harvest
8. Applications of calcium + boron leaf (4) in post-harvest
9. Applications of calcium + boron leaf (4) in pre-harvest
10. Applications of calcium + boron leaf (4) in post-harvest + pre-harvest

The products used were Metalosate calcium in dose of 3 Lt / ha in every application, and Metalosate Boron in dose of 1 Lt / ha in every application.

The application of post-harvest (season 2015-16) did the first week after of have ended the harvesting, and with a frequency of 1 application weekly, covering all the month of January of 2016.

Application of pre-harvest began to home of bloom (late of) (September of 2016) with a frequency of 1 applied weekly, covering all the month of October of 2016.

The applications be did with hand sprinkler, whereas a volume of application of 300 Lt of water / ha, and a dose individual of 90 DC of water/plant. These applications be did always in the tomorrow between the 9: 00 and 11:00 hr, forget best efficiency of absorption leaf.

Each treatment had with 4 repetitions, and each replay with 3 plants, leaving a plant between each treatment as effect edge. The assessment be did in the plant central.

The assessment made were the following:

1. Content of nutrients in fruit to the time of home of harvest (21 of November of 2016).
2. Caliber of fruit to the time of harvest (21 of November of 2016).
3. Weight of fruit to the time of harvest (21 of November of 2016).
4. Firmness fruit to the time home of harvest (21 of November of 2016).
5. Content of chlorophyll (Spad) to the time of start the harvest and for the first week of harvest (21 and 28) of November of 2016).

To perform the measurements of firmness, caliber and fruit weight, be they collected 30 fruits of every drive experimental. The firm be determined with an equipment Cherry-Tex of the Apartment of electronic of the career of Engineering Civil agricultural of the University of Conception. The determinations of gauge be did with foot of metro digital on the area Equatorial of the fruit in both ways of shaft Equatorial, and the measurement of weight with a balance digital. These measurements be did in the laboratory of analysis of ground of INIA Quilamapu in Chillan. The measurement of Spad be did to level of field with an equipment

SPAD Meter Minolta II, using the leaf of the third Middle of the twigs air of the same season.

The design experimental corresponded to block to the chance whereas analysis of variance and separation of average when be detected differences statistics, whereas a significance of 5%. Also is did analysis of contrasts for separated effects of a same nutrient applied in pre-harvest or post-harvest. For these effects, the software used was SAS version 6.0.

RESULTS AND DISCUSSION

The results of concentration nutritional in fruit to the time of Start the harvest of fruit is have in the box 1. To your time in the box 2 be presents the significance of the contrasts made for the concentration of calcium and Boron in fruit of Blueberry between different treatments.

The results of gauge, weight and firm of fruit to the time of start the harvest is have in the box 3. The content of chlorophyll (units Spad) to the time of start the harvest, and a week after in the box 4.

The analysis of fruit (picture 1) only said differences significant on the concentrations of Potassium, Calcium, Magnesium and Boron, and in general, the concentrations of nutrients in fruit were in of the range said for the cv. Duke (Hirzel, 2014).

The most concentration of potassium in fruit be obtained with the application of the treatment 6 (boron leaf in pre-harvest). Only he outpointed to the values obtained with the treatment 3 (calcium leaf in pre-harvest), 4) (calcium leaf in post-harvest + pre-harvest), 8 (calcium + boron) leaf in post-harvest), 9 (calcium + boron leaf in pre-harvest) and 10 (calcium + boron leaf in post-harvest + pre-harvest) ($p < 0.05$). The difference detected on the concentration of Potassium in the treatment 6 connection of the treatments 3, 4, 8 9 and 10 could reply to the competition of cations Potassium-Calcium generated with the application of calcium leaf, which could reduce the concentration of potassium on the woven.

The most concentration of calcium in fruit be obtained with the treatment 2 (calcium leaf in pre-harvest), that only he outpointed to the treatment 4 (calcium leaf in post-harvest + pre-harvest), 7 (boron leaf in post-harvest + pre-harvest), 8 (calcium + boron leaf in post-harvest) and 9 (calcium + boron leaf in pre-harvest) ($p < 0.05$). To the connection not be should expected differences with the treatments that also received calcium in pre-harvest (9) or even in pre-harvest + post-harvest (4), by it what be notes an effect erratic for the concentration of calcium in fruit.

In the case of the concentration of Magnesium in fruit the highest value found in the treatment 2 (calcium leaf in pre-harvest), and that only he outpointed to the treatment 4 (calcium leaf in post-harvest + pre-harvest), 5 (boron leaf in post-harvest), 6 (boron leaf in pre-harvest) and 7 (boron leaf in post-harvest + pre-harvest) ($p < 0.05$). In this regard be notes other time an effect erratic, since there are differences with treatment that also received calcium in pre-harvest (treatment 4). By other part be should expected a reduction on the concentration of Magnesium like effect of the application of calcium derivative of the competition of cations inside of the woven.

The more concentration of Boron be obtained in the treatment 6 (boron leaf in pre-harvest) and 7 (boron leaf in post-harvest + pre-harvest), that only they overcame the values obtained with the treatment 1 (control without applications), 3 (calcium leaf in pre-harvest), 4 (calcium leaf in post-harvest), 5 (boron leaf in post-harvest) and 8 (calcium + boron leaf in post-harvest) ($p < 0.05$). The effect the application of boron on the concentration of this nutrient on the fruit is long more clear that the obtained with the application of calcium without however also is detected difference with the treatment 5 (boron leaf in post-harvest) and 8 (calcium + boron leaf in post-harvest), the which indicates that is an important effect the application of Boron leaf in pre-harvest on the concentration of boron in the fruit to the time of harvest, This effect expected since it occurs a period of 30 to 40 days between the last application of boron leaf of pre-harvest (was did 4 applications) and the harvest of fruit.

Picture 1. Concentration of nutrients in fruit of Blueberry cv. Duke to the time of home of harvest (2016).

Treatment	mg / 100 gr of fruit fresh												%
	N	P	K	Ca	Mg	NA	S	CU	Faith	MN	Zn	B	MS
1	119.7	10.7	72.4 AB	12.6 AB	10.7 AB	5.44	7.95	0.05	0.35	0.15	0.10	0. 107 c	13.8
2	117.6	11.2	71.4 AB	13.0 to	11.3 to	5.00	9.14	0.06	0.36	0.16	0.09	0.117 ABC	14.2
3	115.4	11.2	64.9 b	10.8 AB	9.0 ABC	5.05	8.68	0.07	0.32	0.19	0.12	0.108 c	14.1
4	112.7	10.9	67.5 b	9.8 b	7.9 c	5.04	8.46	0.07	0.30	0.16	0.10	0.110 c	14.3
5	114.3	11.4	72.1 AB	11.1 AB	8.3 BC	5.04	8.35	0.07	0.32	0.16	0.10	0.111 BC	14.0
6	113.6	11.0	81.3 to	11.1 AB	8.2 BC	4.60	8.50	0.07	0.30	0.15	0.10	0.134 to	14.0
7	111.1	10.7	74.6 AB	10.1 b	7.9 c	4.53	8.27	0.06	0.27	0.18	0.09	0.127 to	13.9
8	106.8	10.4	69.4 b	9.9 b	9.1 ABC	4.17	8.22	0.06	0.30	0.18	0.09	0.106 c	14.1
9	108.0	10.4	67.4 b	10.0 b	8.8 ABC	4.22	8: 30 am	0.06	0.26	0.17	0.10	0.124 AB	13.5
10	105.6	10.6	66.5 b	11.2 AB	8.7 ABC	3.51	8.35	0.06	0.23	0.16	0.09	0.118 ABC	14.5
Significance	NS	NS	**	**	**	NS	NS	NS	NS	NS	NS	**	NS
CV (%)	7.1	7.9	6.8	10.5	12.3	19.9	7.9	17.1	23.9	17.4	12.6	9.9	4.3

Different letters in a same column show difference significant of agreement to the test Tukey ($p < 0.05$)

1. Control
2. Applications of calcium leaf (4) in post-harvest
3. Applications of calcium leaf (4) in pre-harvest
4. Applications of calcium leaf (4) in post-harvest + pre-harvest
5. Applications of boron leaf (4) in post-harvest
6. Applications of boron leaf (4) in pre-harvest
7. Applications of boron leaf (4) in post-harvest + pre-harvest
8. Applications of calcium + boron leaf (4) in post-harvest
9. Applications of calcium + boron leaf (4) in pre-harvest
10. Applications of calcium + boron leaf (4) in post-harvest + pre-harvest

The analysis of contrasts (picture 2) lets detect with greater grade of detail the effect of treatment contrasting on the concentration of Calcium and Boron in fruit (items assessment of agreement to products applied).

In this regard, only is detected difference in the concentration of calcium when is contrasted the application calcium in post and pre-harvest connection of the control without application, and of calcium + Boron in pre-harvest connection of the control without applications. Without However, in both contrasts the more concentration of Calcium in fruit be did in the treatment control without applications (picture 1); effect that not has explanation of behavior nutritional may have any impact of the concentration of product used or of the number and/or time of applications carried out. However, a great number of experiments are required to control the effects of the growth and of the concentration of product used and of the number and moments of application of the product calcium.

For the case of the Boron (picture 2), be detected difference between the control and the application of Boron in pre-harvest, very favorable the application of this item (picture 1). Not be detected differences between other contrasts associates to various strategies of application of Boron leaf about the concentration of Boron in fruit.

Picture 2. Significance of the contrasts between treatment with or without Calcium and Boron leaf for the concentration of Calcium and Boron in fruit to the time of home of harvest (2016).

Contrast	Calcium	Boron
	Significance	
Control versus calcium pre-harvest	NS	NS
Control versus calcium post-harvest	NS	NS
Control versus calcium in post and pre-harvest	**	NS
Calcium in pre-harvest versus calcium in post-harvest	NS	NS
Control versus Boron pre-harvest	NS	**
Control versus Boron post-harvest	NS	NS
Control versus Boron in post and pre-harvest	NS	NS
Boron in pre-harvest versus Boron in post-harvest	NS	NS
Control versus calcium + Boron in pre-harvest	*	NS
Control versus calcium + Boron in post-harvest	NS	NS
Calcium + Boron in pre-harvest versus calcium + Boron in post-harvest	NS	NS

Picture 3. Gauge, weight and firmness in fruit of Blueberry HP. Duke to the time of home of harvest (2016).

Treatment	Caliber (cm)	Weight (gr)	Firmness (gr/mm²)
1	1,347	1.27	59.2
2	1,291	1.12	59.9
3	1,319	1.23	56.8
4	1.335	1.26	58.2
5	1,310	1.20	59.0
6	1,289	1.16	61.0
7	1,289	1.18	59.9
8	1,298	1.20	55.9
9	1,309	1.20	57.8
10	1,334	1.19	57.2
Significance	NS	NS	NS
CV (%)	4.49	9.95	6.43

Absence of different letters in a same column show absence of difference significant of agreement to the test Tukey ($p < 0.05$)

1. Control
2. Applications of calcium leaf (4) in post-harvest
3. Applications of calcium leaf (4) in pre-harvest
4. Applications of calcium leaf (4) in post-harvest + pre-harvest
5. Applications of boron leaf (4) in post-harvest
6. Applications of boron leaf (4) in pre-harvest
7. Applications of boron leaf (4) in post-harvest + pre-harvest
8. Applications of calcium + boron leaf (4) in post-harvest
9. Applications of calcium + boron leaf (4) in pre-harvest
10. Applications of calcium + boron leaf (4) in post-harvest + pre-harvest

The analysis of caliber, weight and firmness of fruit not indicated differences significant between treatments (picture 3). In general, find in the values of gauge of fruit of the range normal for this cv. Of blueberries, but the values of weight (in relationship to the caliber) and of firm were bottom to the registered for seasons earlier. This effect was observed throughout Chilean industry for the season and was explained by the changes weather of the season, with nights of high temperature for the period of growth of fruits (greater breath of sugar of reserve and stimulus of more development vegetative).

Finally, the content of chlorophyll (units Spad) not submitted differences significant between treatments to the 2 times of evaluation. The values of Spad in general be found inside of the range normal for grow of , Blueberry, whereas that from ago already 3 to 4 seasons is work with under dose of nitrogen that the used on the decade , as a tool for reduce or avoid the appearance of fruit soft and of defects of post-harvest.

Picture 4. Content of chlorophyll (units Spad) in leaf of Blueberry cv. Duke to the time of home of harvest and a week after (2016).

Treatment	Date of measurement	
	21-nov-2016	28-nov-2016
1	47.3	42.0
2	45.0	41.0
3	39.7	39.1
4	44.6	44.8
5	48.1	44.4
6	45.7	43.2
7	46.9	42.3
8	45.0	43.4
9	45.8	42.6
10	44.1	45.3
Significance	NS	NS
CV (%)	8.16	7.06

Absence of different letters in a same column show absence of difference significant of agreement to the test Tukey ($p < 0.05$)

1. Control
2. Applications of calcium leaf (4) in post-harvest
3. Applications of calcium leaf (4) in pre-harvest
4. Applications of calcium leaf (4) in post-harvest + pre-harvest
5. Applications of boron leaf (4) in post-harvest
6. Applications of boron leaf (4) in pre-harvest
7. Applications of boron leaf (4) in post-harvest + pre-harvest
8. Applications of calcium + boron leaf (4) in post-harvest
9. Applications of calcium + boron leaf (4) in pre-harvest
10. Applications of calcium + boron leaf (4) in post-harvest + pre-harvest

CONCLUSIONS

The results obtained indicate that the application leaf of Metalosate calcium and Metalosate Boron in various stages and combinations on the culture of Blueberry CV. Duke not affected the caliber, weight and firmness of fruits. Content of chlorophyll not be affected by the application of these products.

The application leaf of Metalosate Calcium and Metalosate Boron in different stages and combinations on the culture of Blueberry HP. Duke generated some differences of concentration of nutrients in the fruit to the time of start the harvesting, with results erratic for the application of Metalosate Calcium and an effect very marking and positive of the application of Metalosate Boron leaf in pre-harvest as product single (without be mixed with Metalosate Calcium), increasing the concentration of Boron in fruit of Blueberry.

For solve the effects erratic obtained in this experiment with the use of the product Metalosate Calcium, be suggests make new Research that control the effects grow of Blueberry concentration of product to use moments of application and number of applications.

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