Foliar Applications of Boron and Calcium Fertilizers Do Not Improve Fruit Set of Northern Highbush Blueberry

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ABSTRACT

Fruit set in northern highbush blueberry (*Vaccinium corymbosum*) can be low under certain climactic conditions and contributes to reduced yields, particularly in western Washington. The mechanisms influencing fruit set are complex, but poor fruit set can be associated with inadequate nutrient availability during critical stages of flower and fruit development. Boron (B) and calcium (Ca) and may be of specific importance for reproductive developmental processes, but little research has been done to evaluate their influence on improving fruit set and yield in Washington blueberry. The objective of this project was to evaluate if foliar-applied B and Ca increase fruit set and resultant yields of highbush blueberry. Specific sub-objectives were to: 1) evaluate the effects of foliar applied B and Ca, alone or in combination, on fruit set, yield, and fruit quality (berry firmness and weight) of blueberry; and 2) Measure the effects of B and Ca application on blueberry pollen germination, tube growth, and fertilization potential. Commercially available fertilizers containing these nutrients were applied either alone or in combination as foliar sprays during the 2015 and 2016 growing season in western Washington. Nutrient were applied as: calcium chloride, calcium sulfate, and tetra borate foliar sprays, repeated 6 times per year, 7-10 days apart. Applications were timed from pink bud through petal fall in 'Draper' and 'Bluecrop'. No significant increases were observed in fruit set, estimated yield, or fruit quality (berry firmness and weight) across any of the treatments, however year and cultivar effects were observed. Increased B was observed in leaf tissue nutrient analyses in 2015 and 2016, suggesting foliar nutrient applications of B were effectively taken up by the plants. However, elevated levels did not lead to increased fruit set or yield. Results indicate that foliar applications of B and Ca, either alone or in combination under the conditions of the experiment, do not increase fruit nutrient levels, fruit set, yield, and attributes of berry quality in Washington blueberry.

INTRODUCTION

- Highbush blueberry relies on honey bees (*Apis mellifera*) for pollination in western Washington.
- Honey bee activity can be deficient during cool springs (e.g. air temp. below 13°C, wind speed above 20-25 kph, precipitation) (Butler, 1945) this can lead to reduced fruit set and yields.
- Increased B concentrations in pollen and floral tissues may increase pollen viability and subsequent fruit set (Dell and Huang, 1997).
- Ca applied during dynamic stages of floral and fruit development may decrease abscission and increase fruit quality.
- Increased pollen and reproductive viability could lengthen the pollination window and increase fertilization rates, as well as subsequent fruit set and yields.

Figure 1. 'Early pink bud' bloom stage.

Figure 2. Honey bees entering/exiting a hive.

OBJECTIVES

The objective of this project was to evaluate if foliar-applied B and Ca increase fruit set and resultant yields of highbush blueberry. Specific sub-objectives were to:

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2. Measure the effects of B and Ca application on blueberry pollen germination, tube growth, and fertilization potential.

MATERIALS AND METHODS

In 2015 and 2016, 'Draper' and 'Bluecrop' plants were selected across four commercial grower sites in Whatcom and Skagit counties in Washington (two sites per cultivar). Five-plant treatment plots were established at each site. Treatments (Table. 1) were randomized within a row and replicated four times per site.

Table 1. Table lists treatment identification, year applied, product name, chemical formulation and form, rate, and concentration (in ppm).

Treatment identification[z]	Year applied[y]	Product name	Chemical form	Form	Rate (kg·ha)[x]	Concentration (ppm)
Untreated (control)	2015/2016	-	-	-	-	-
Low B	2015	Solubor®[v]	Disodium octaborate tetrahydrate	powder	1.5	125[w]
High B	2015/2016	Solubor®	Disodium octaborate tetrahydrate	powder	3	250
Low Ca	2015	Phyta-Cal QC™	Calcium chloride	liquid	37	750
High Ca	2015/2016	Phyta-Cal QC™	Calcium chloride	liquid	74	1500
Alt Ca	2016	LiberateCa™	Calcium sulfate	liquid	20	150
Low Combo	2015/2016	Phyta-Set QC™	Calcium chloride and sodium tetraborate	liquid	50	125/750
High Combo	2015/2016	Phyta-Set QC™	Calcium chloride and sodium tetraborate	liquid	100	250/1500
Alt B	2016	microLink™ B+Mn	Sodium borate and manganese sulfate	liquid	13	165/130

[z]Treatments were applied according to manufacturer's recommendations from early pink bud to petal fall every 7 to 10 days for a total of six applications per year.
[y]Low Ca and Low B treatments were removed in 2016 and replaced with alternative (Alt) products, Alt Ca and Alt B; High Ca, High B, High. Combo (Ca + B) applied in both 2015 and 2016.
[x]Application amount given as L·ha except for Low and High B which are kg·ha.
[w]Concentration corresponds to the treatment, except for the combination treatment where B is listed before Ca and for the Alt B treatment, where B is listed first followed by Mn.
[v]Solubor® is manufactured by Rio Tinto, Greenwood Village, CO. Phyta-Cal QC™ and Phyta-Set QC™ are manufactured by California Organic Fertilizers Inc., Fresno, CA. MicroLink™+B18+B6:H19+B5:H19+B4:H19+B18+B6:H19+B3:H19+B5:H19+B4:H19+B3:H19+B4:H19+B3:H19+B4:B4:H19

Metrics Included:

- Initial bloom count (no.) and percent fruit set
- Estimated yield per bush
- Leaf tissue nutrient analyses (28 July 2015 and 2 Aug. 2016)
- Average berry weight (g) and firmness (n=25) using a FirmTech (Bio-Work Inc., Kansas, USA).

Data were subjected to analysis of variance and fisher's LSD using r-studio 'agricolae' package (R Core Team, 2013).

RESULTS

- Year and cultivar effects were observed.
- Pollen from treated flowers germinated at the same rate as the control with no significant difference (data not presented).
- Leaf B concentrations were increased significantly compared to the control. Calcium applications did not lead to significant differences in Ca concentrations in leaf tissue (Table 2). Tissue nutrient concentrations met or exceeded sufficiency standards.
- There were no significant differences in fruit set and estimated yield of treated plots compared to the untreated control (data not presented).
- Berry weight and fruit firmness was the same across treatments (data not presented).

Table. 2- Results show analyses based on dry weights for leaf samples collected in July and Aug. and whole harvested fruit in 2015 and 2016 (n=20 per site with two sites per cultivar).

	'Bluecrop'				'Draper'			
	Leaf		Fruit		Leaf		Fruit	
	Ca (%)	B (ppm)	Ca (%)	B (ppm)	Ca (%)	B (ppm)	Ca (%)	B (ppm)
2015								
Untreated (control)	0.57	47.6 a[z]	0.05	7.5	0.76	38.9 a	0.05	8.0
Low B[y]	0.61	59.6 ab	0.05	9.3	0.81	55.5 ab	0.05	12.6
High B	0.63	75.7 b	0.04	13.7	0.85	84.2 b	0.06	15.7
Low Ca	0.60	48.6 a	0.06	11.3	0.82	38.5 a	0.05	8.9
High Ca	0.62	60.8 ab	0.04	9.5	0.80	39.8 a	0.05	12.3
Low Combo	0.57	62.8 a	0.04	6.9	0.81	38.6 a	0.04	8.1
High Combo	0.62	69.5 ab	0.05	8.2	0.78	36.6 a	0.05	10.4
P-value	NS[x]	0.0175	NS	NS	NS	0.0306	NS	NS
2016[w]								
Untreated (control)	0.64	55.1 a	0.05	10.2	0.75	43.7 a	0.04	10.0
High B	0.69	63.5 ab	0.04	14.3	0.84	85.7 b	0.04	11.5
Alt B	0.64	93.1 b	0.05	16.7	0.75	87.3 b	0.05	11.7
High Ca	0.72	46.1 a	0.05	9.8	0.77	44.6 a	0.05	8.3
Alt Ca	0.80	52.7 a	0.05	13.5	0.86	43.8 a	0.05	10.2
High Combo	0.67	63.1 ab	0.04	14.8	0.74	47.2 a	0.04	12.3
P-value	NS	0.0272	NS	NS	NS	0.0372	NS	NS

[z]Letters of difference, with the same letters within a column denoting not significant at α=0.05.
[y]Indicates Low and High concentration of treatments.
[x]Indicates no significant difference (ND) at α=0.05.
[w]Treatment changes in 2016 included removal of Low Ca and Low B treatments and the addition of Alt B and Alt Ca.

CONCLUSIONS AND OUTLOOK

Boron and Ca applications did not improve fruit set, estimated yield, berry weight, or fruit firmness in 'Bluecrop' or 'Draper' plants under the conditions of this study. Pollen health and viability was also unchanged.

Increased product rates, alternative B and Ca forms and formulations with other nutrients, use of surfactants, and modified timings may increase B and Ca concentrations in blueberry and *possibly* lead to improved fruit set and yield for a region that chronically experiences low fruit set.

REFERENCES & ACKNOWLEDGMENTS

-Butler, C. G. 1945. The influence of various physical and biological factors of the environment on honeybee activity. An examination of the relationship between activity and nectar concentration and abundance. *J. of Exp. Bio. 21*(1-2): 5-12.
-Dell, B., & Huang, L. 1997. Physiological response of plants to low boron. Plant and soil, 193(1-2): 103-120.

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