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Effect of Foliar Fertilization of Boron and Calcium on Physico-Chemical Properties of Peach cv Florida Prince

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ABSTRACT

In this study, the effect of foliar fertilization of boron and calcium, separately and in combination, on physico-chemical aspects of peach cv Florida Prince was studied. The first spraying of boron @ 0.10% in the form of solubor at 10, 20 and 30 days was done after fruit set, while the second spraying of calcium @ 0.5% were performed one week before final harvesting. Results revealed that boron sprays @ of 0.10% thrice (10, 20 and 30 days after fruit set) plus (+) calcium spray @ 0.5% one week before harvesting improves the physico-chemical attributes of peach cv Florida Prince.

Keywords Pre-harvest, Foliar fertilization, Physical, Quality parameters.

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INTRODUCTION

The peach (*Prunus persica* (L.) Batsch) is a member of the Rosaceae family and is one of the most popular temperate fruits in the world due to its high nutritional content and pleasant flavor. It is an important fruit crop of temperate climate and can be grown quite successfully in the sub-tropics due to availability of low-chill varieties. The successful introduction of high-quality low chilling peach cultivars in India have created a tremendous scope for its cultivation in north western plains (Nijjar and Khajuria 1979). The varieties like Florida Prince, Earligrande, Partap, Shan-e-Punjab and Sharbati have become very popular and are grown commercially in plains and valley area of Uttarakhand.

But despite of the good production levels, the subtropical peaches have very low proportion in international and domestic trade due to the high perishability of the fruits after harvest. Plant nutritional status is an important factor of fruit quality and post-harvest life potential. Boron is one of the essential micronutrients and is vital for optimal growth of the plants. It's deficiency in plants may result in reduced growth, yield loss and even death, depending on the severity of deficiency (Jones 1998). Fruit decay caused by *Monilinia laxa* (brown rot) is a serious problem in peaches and can be checked by appropriate nutrition mainly calcium and boron (Kavvadias *et al.* 2012). Boron spray was highly effective in increasing of nutritional status, yield and quality of fruits (Mosa *et al.* 2016).

Calcium is also involved in numerous biochemical and morphological processes in plants and has been implicated in many physiological disorders of considerable economic importance to production and post-harvest quality. It helps to delay the onset of senescence in fruits while having no negative impact on consumer acceptance thus have a significant role in determining fruit quality (Alizade *et al.* 2011, El- Badawy 2012, Barker and Pilbeam 2015). It is considered that fruits with low calcium content are more sensitive to various physiological and pathological disorders and the shelf life will be shorter if it is not available in the fruits in an appropriate proportion.

Various authors have observed that pre-harvest calcium spray increases calcium content of the cell wall which was effective in delaying senescence, resulting in firmer and higher fruit quality (Poovaiah *et al*.1988, Serrano *et al.* 2004, Sarrwy *et al.* 2012). Foliar fertilization has the benefit of low application scale, equal distribution and rapid responses to applied nutrients. Moreover, many researchers have found that soil application of nutrients has less effect on enhancing of fruit yield as compared to foliar spray. Therefore, the current experiment was carried out in light of the favorable responses of foliar application of boron and calcium on fruit quality.

MATERIALS AND METHODS

Experimental site

The field experiment was conducted at Horticultural Research Center, Patharchtta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. It is located at an altitude of 243.94 meetrs above mean sea level in the Tarai areas of the Himalayas, at 29.5º North latitude and 79.3º East longitudes. The experimental location has a humid subtropical environment with a dry and hot summer. Summer temperatures range from 32 ºC to 45 ºC, while winter temperatures range from 5 ºC to 10 ºC. The annual rainfall is 1200 mm. The monsoon season typically begins in the third week of June and lasts until the middle of September.

Experimental material and design

The experiment was carried out on 15-years old peach trees of cv "Florida Prince" during February to May 2021. The 21 uniform vigorous plants, planted at 6 m × 6 m distance were selected for the study. Peach trees were sprayed with boron (0.1%) in the form of solubor at 10, 20, and 30 days singly or repeatedly after fruit set and along with calcium nitrate (0.5%), one week before final harvesting with water as a control. Each tree was sprayed with 10 liters of solution using a foot-operated sprayer equipped with a duronist spray nozzle. The experiment was laid out in Randomized Block Design (RBD) with three replications and seven treatments by taking one tree as a unit of treatment in each replication.

Measurements and observations

The observations were recorded on fruit weight, diameter, fruit volume and specific gravity. Quality parameters like total soluble solids (°B), titratable acidity (%), total sugars (%), reducing sugars (%), non-reducing sugars (%) and ascorbic acid (mg/100 g) were assessed following standard procedures (AOAC 3).

Statistical analysis

All data were subjected to Analyses of Variance (ANOVA). Significant differences among groups were determined using Duncan's multiple range tests at $p<0.05$ All computation and statistical analyses were done using IBM SPSS Statistics 19 statistical software (IBM, NY, USA).

RESULTS AND DISCUSSION

Effect on physical parameters

The data recorded for different physical parameters of peach fruits are presented in Table 1, which clearly indicates that the foliar application of boron and calcium significantly improved the physical parameters of fruit in comparison to control. The maximum fruit weight (87.28 g) was recorded under T_7 (T_4 + 0.5% calcium nitrate) followed by T_6 (85.56 g), whereas the minimum fruit weight (75.03 g) was found in T_1 i.e., control or unsprayed. The improvement in the fruit weight may be attributed to the vital role of boron in proper growth and increasing of cell size and inter

Table 1. Effect of foliar fertilization of boron and calcium on fruit physical characteristics of peach cv Florida Prince. T_1 (Control), T_2 (Boron spray at 10 days after fruit set @ 0.10%), T_3 (Boron spray at 10 days and 20 days after fruit set @ 0.10%), T_4 (Boron spray at 10 days, 20 days and 30 days after fruit set @ 0.10%), T_5 (T_2 + calcium nitrate @ 0.5% one week before maturity), T_6 (T_3 + calcium nitrate @ 0.5% one week before maturity), T_7 (T_4 + calcium nitrate @ 0.5% one week before maturity). Means within a column having same letters are statistically non- significant as per Duncan's multiple-range test ($p \leq 0.05$.

Treatments	Fruit weight (g)	Fruit diameter (mm)	Fruit volume (ml)	Specific gravity (g/ml)
T_1	75.03e	51.00b	65.23f	1.15a
T_2	78.45d	51.50b	67.47e	1.16a
T_3	79.50d	52.03b	73.77d	1.08b
T_4	82.70c	53.53a	75.93c	1.08b
T_5	83.23c	54.17a	76.93c	1.07b
T_6	85.56b	54.43a	78.51b	1.09b
T_7	87.28a	54.63a	79.77a	1.09b

cellular spaces of fruits and calcium supplementation might have increased the assimilatory ability of leaves to synchronize additional metabolites. The findings of Abd El-Megeed and Medan (2017) in the peach are consistent with the findings of the current investigation.

The diameter of peach fruits was significantly affected by foliar fertilization of boron and calcium. The maximum fruit diameter (54.63 mm) was obtained under T_7 (T_4 + 0.5% calcium nitrate), followed by T_6 (54.43 mm), T_5 (54.17 mm) and T_4 (53.53 mm) while the minimum fruit diameter (51.00 mm) was noted in T_1 (control). The enhancement in the fruit diameter may be on account of role of boron in better supply of water, which could improve the internal physiology of developing fruits. As well as there is an accepted opinion that diameter increase in fruit is because of enlargement of the existing cells and the enlargement of the cell is due to calcium application. The findings are in accordance with the study of Al-hajjaj and Ayed (2018) in date palm.

Similarly, the maximum fruit volume (79.77 ml) was recorded in T_7 (T_4 + 0.5% calcium nitrate) closely followed by T_6 (78.51 ml), whereas the minimum fruit volume (65.23 ml) was noted in T_1 (control). Increase in fruit volume under different treatments may be due to the correlation between increase in cell size and intercellular space. These results are in agreement with the findings of Meena *et al.* (2017) in Nagpur mandarin. The highest specific gravity (1.16 g/ml) was estimated under T_2 (0.1% single spray of boron) followed by T_1 (1.15 g/ml), while the minimum specific gravity (1.07 g/ml) was observed under T_5 (T_2 + 0.5 calcium nitrate). Our results are in line with the findings of Wali and Kumar (2006) in guava.

Effect on bio-chemical parameters

The significant differences among all the treatments were observed for different fruit's quality parameters (Table 2). The data clearly reveals that the maximum total soluble solids (12.01 ºB) was recorded under T_7 (T_4 + 0.5% calcium nitrate) followed by T_6 (11.73 ºB), whereas the minimum total soluble solids was estimated under control (10.45 ºB). Higher TSS induced by spray of boron and calcium nitrate might be due to a more rapid translocation of sugars from the leaves to the developing fruits. The results are in harmony with the findings of Abd El-Megeed and Medan (2017) in peach.

The data in Table 2 manifest that minimum titratable acidity (0.75%) was obtained under T_7 (T_4 + 0.5% calcium nitrate) followed by T_6 (0.77%) and T_5 (0.79%), whereas the maximum titratable acidity (0.88%) was recorded in control. All boron and calcium treated fruits have lower acidity than untreated fruits, which may be owing to an increase in total soluble solids at the expense of acid content. The other reason might be because of reduction in the activities of enzyme by calcium sprays. Our results are very similar to those of Mosa *et al.* (2016) in peach fruits cv Florida Prince.

It is clear from Table 2 that ascorbic acid content in peach fruit is significantly affected by foliar application of boron and calcium. The highest ascorbic acid content (6.42 mg/100 g) was recorded under T_7 (T_4 + 0.5% calcium nitrate) and T_6 (6.25 mg/100 g), while the minimum ascorbic acid content (5.48 mg/100 g) was noted in control. Higher level of ascorbic acid with application of boron and calcium may be due to increased growth and availability of more metabolites for ascorbic acid synthesis. The results are also in consonance with the earlier findings of Patel and Singh (2021) in guava.

Table 2. Effect of foliar fertilization of boron and calcium on chemical parameters of Peach Cv. Florida Prince. T_1 (Control), T_2 (Boron spray at 10 days after fruit set @ 0.10%), T_3 (Boron spray at 10 days and 20 days after fruit set @ 0.10%), T_4 (Boron spray at 10 days, 20 days and 30 days after fruit set @ 0.10%), T_5 (T_2 + calcium nitrate @ 0.5% one week before maturity), T_6 (T_3 + Calcium Nitrate @ 0.5% one week before maturity), T_7 (T_4 + calcium nitrate @ 0.5% one week before maturity). Means with in a column having same letters are statistically non- significant as per Duncan's multiple-range test ($p \leq 0.05$).

Treatments	TSS (ºB)	Acidity (%)	Ascorbic acid (mg/100 g)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
T_1	10.45d	0.88a	5.48f	5.70f	4.44f	1.20c
T_2	10.97c	0.86a	5.69e	5.96e	4.68e	1.22c
T_3	11.22bc	0.83ab	5.83de	6.08de	4.78d	1.24bc
T_4	11.35bc	0.80bc	5.94cd	6.15cd	4.83d	1.25abc
T_5	11.52ab	0.79cd	6.07bc	6.24bc	4.91c	1.26abc
T_6	11.73ab	0.77cd	6.25ab	6.35b	4.99b	1.29ab
T_7	12.01a	0.75d	6.42a	6.50a	5.12a	1.31a

With respect to total sugars, reducing sugars and non-reducing sugars, treatments differ significantly from each other. The highest total sugars (6.50%), reducing sugars (5.12%) and non-reducing sugar (1.31%) was reported in T_7 (T_4 + 0.5% calcium nitrate) followed by T_6 i.e., 6.35%, 4.99% and 1.29% respectively. However, the minimum values for them were recorded in control (T_1). Boron facilitates sugar transport within a plant and it is reported that borate reacts with sugars to form a sugar-borate complex that is more easily available to the transverse membrane (Gauch and Duggar 1953). In the present investigation increase in total sugars might be because of calcium involvement in hydrolysis of starch into sugar. Similar results were reported by Mosa *et al.* (2016) in peach, Thirupathaiah (2017) in sapota and Kumar *et al.* (2021) in papaya.

CONCLUSION

The present study demonstrated that sequential pre-harvest foliar application of combination of Ca and B in the 'Florida Prince' peach is fairly beneficial in the production of high marketable fruits with improved physical and quality metrics.

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