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Effects of Pre-harvest Foliar Sprays on Fruit Quality and Nutritional status of peach *cv.* shan – i - punjab.

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Abstract: *Peach cultivar Shan-i-Punjab is an important fruit crop of Punjab. Fruit texture and size are important quality factors influencing its market value. Optimizing these characteristics will increase acceptability and decrease losses through transportation. The present experiment was designed to study the effect of preharvest foliar sprays of calcium chloride, boric acid and potassium nitrate with different concentrations on fruit quality attributes and nutritional status of the peach cultivar Shan-i-Punjab for a 2-year period. Peach trees of cv. Shan-i-Punjab were sprayed with calcium chloride, boric acid and potassium nitrate (@1.0, 2.0 and 3.0 per cent) , one and two weeks before harvesting. Fruits after harvesting at hard mature stage were transported to the laboratory for the physical and chemical analysis. Foliar application of all calcium chloride and boric acid treatments did not affect mean fruit weight compared with potassium nitrate treatments. The highest fruit firmness and total phenol content were measured after application of the calcium chloride @ 2.0 per cent. Whereas, maximum total soluble content and pectin methyl esterase activity was recorded after the application of potassium nitrate @ 2.0 percent. The levels of calcium, nitrogen, potassium and boron in leaves were higher in the treatments where the respective chemicals were applied. The efficacy of the foliar sprays on some of the tested parameters varied from year to year indicating the influence of other parameters on peach nutrition.*

Keywords: *Peach, Shan-i-Punjab, quality, pre-harvest sprays, calcium chloride, potassium nitrate, nutrition.*

INTRODUCTION

Peach is an important fruit crop of Punjab state of India. The area under peach cultivation is picking up rapidly due to its higher returns on unit area basis and availability of suitable cultivars and their production technology. Among the various varieties recommended for cultivation under Punjab conditions, Shan-i-Punjab is widely cultivated due to its high yield and superb fruit quality. However, there are heavy post-harvest losses of this cultivar since it has shortest shelf life of 2-3 days. These losses can be measured in terms of shrinkage which leads to softening of fruits. After softening, peach fruit is susceptible to physical injury and pathogen attack and become unfit for storage [1].

Different chemicals with varies concentrations have been reported to extend the storage life and quality of many fruits by minimizing the rate of respiration and retarding senescence [2]. Calcium has a well-established role in strengthening the cell wall. The influence of calcium on diverse physiological and biochemical changes during fruit softening has been reviewed by Poovaiah et al, 1988[3]. They have reported the benefit of direct calcium applications in reducing the incidence of physiological disorders.

The role of Ca on the maintenance of cell membrane integrity and its cooperative role with boron (B) in the building of the plant cell wall is well documented.[4] Although not all impacts of Ca on fruit quality appear to be positive, it is clear that Ca formulations, their rate, and timing of

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Table 1
Effect of foliar sprays on fruit weight, fruit firmness, total soluble solids, total titratable acidity, total phenols and pectin methyl esterase activity (PME) of peach at harvest during the 2 years of experiment.

Treatments	*Fruit wt (g)*	*Fruit firmness (kg cm^{-2})*	*Total soluble solids (%)*	*Total titratable acidity (% mallic acid)*	*Total phenols (mg mallic acid equivalent/g fresh wt)*	*PME Activity (μEq/ml of Enzyme)*
First year						
$CaCl_2$ 1%	54.00	7.74	9.52	0.81	268.33	1.30
$CaCl_2$ 2%	55.50	7.78	9.45	0.83	269.26	1.22
$CaCl_2$ 3%	50.20	7.62	9.55	0.78	263.03	1.39
Boric acid 1%	55.50	7.54	9.55	0.75	254.87	1.33
Boric acid 2%	54.20	7.51	9.67	0.74	256.37	1.36
Boric acid 3%	54.00	7.48	9.75	0.72	260.33	1.38
KNO_3 1%	60.00	7.42	10.77	0.72	254.63	1.54
KNO_3 2%	60.50	7.40	10.82	0.71	255.77	1.56
KNO_3 3%	59.00	7.46	10.71	0.73	256.43	1.47
Control	49.80	7.49	10.00	0.77	258.43	1.49
CD (p = 0.05)	5.8	0.6	NS	NS	0.03	NS
Second year						
$CaCl_2$ 1%	55.50	7.80	9.60	0.82	257.29	1.19
$CaCl_2$ 2%	56.50	7.88	9.49	0.86	258.31	1.17
$CaCl_2$ 3%	49.80	7.70	9.45	0.79	251.33	1.22
Boric acid 1%	54.80	7.74	9.47	0.74	243.61	1.20
Boric acid 2%	54.00	7.76	9.62	0.76	245.59	1.25
Boric acid 3%	53.60	7.64	9.70	0.70	249.62	1.26
KNO_3 1%	64.00	7.50	10.70	0.72	243.33	1.45
KNO_3 2%	68.50	7.46	10.80	0.73	245.53	1.43
KNO_3 3%	60.00	7.56	10.69	0.75	245.41	1.36
Control	49.00	7.60	10.05	0.78	247.59	1.38
CD (p = 0.05)	5.4	0.4	NS	NS	0.04	NS

application affect the efficacy of Ca on several fruit quality attributes[5]. The $CaCl_2$ sprays delayed fruit ripening processes and maintained fruit quality of "Hayward" kiwifruit. [6]

Potassium ions are believed to play an important role in the interplay of metabolic events involved in fruit ripening and senescence. Potassium is reported to increase peach fruit firmness[7]. Foliar application of potassium sulphate in Royal Glory' peach increases soluble solids content and fruit appearance[8].

Foliar application of boron act as a signal capable of interacting with cellular transcription factors to regulate various physiological processes affected by boron deficiecy[9]. Pre-harvest treatments greatly influence the fruit ripening process and postharvest behaviors of the fruit. Therefore, the correct management of these has a significant effect on the final quality [10].

So, the purpose of this research was to investigate the effect of various commercial products applied as foliar sprays on fruit quality attributes and nutritional status of the peach cv Shan-i-Punjab.

MATERIALS AND METHODS

The research was conducted in a commercial peach fruit [*Prunus persica* L. Batsch] orchard at PAU seed farm orchard, Ladhowal and physical and chemical analysis were performed in the post harvest laboratory of Department of Horticulture, PAU, Ludhiana. Eight years old peach trees of cv. Shan-i-Punjab planted at a distance of 6x6 m were selected for the present studies. The orchard soil was deep, well drained and loamy sand. All the trees received recommended doses of fertilizers and other cultural practices during the course of these investigations. Experimental trees were given two sprays with different concentrations of $CaCl_2$, Boric acid and KNO_3 (all at 1%, 2% and 3%) during the seasons 2010 and 2011.

The first spray was done 2 weeks before harvesting and the second spray was done one week before harvesting on the same tree when the fruits showed appearance of pink color at the blossom end. One tree served as treatment unit and each treatment was replicated three times. A surfactant (tween 20) was also added in all treatments.

Fruit samples were collected on 5th and 10th May during the first year and second year, respectively. (Harvest period; one week after the last spray). Leaf samples were collected at midsummer (16th July and 20th July during the first year and second year, respectively).

The following measurements were taken:

Mean fruit weight, flesh firmness (measured by a penetrometer (Model FT-327, USA) 8-mm tip; total soluble solids (measured with the *Erma* hand refrectometer in terms of degree Brix (%), total titratable acidity [after titration with 0.1 N sodium hydroxide (NaOH)], and Pectin Methyl Esterase (PME) activity (µEq/ml of Enzyme). In addition total phenols by method developed by Swain and Hillis, 1959 [11] were determined.

Oven dried leaves were analyzed for nitrogen, potassium, calcium and boron according to the methods given below.

Nitrogen: Kjeldahl's method [12]

Potassium: Flame photometer [13]

Calcium: Atomic absorption spectrophotometer [14]

Boron: Azomethine–H spectrophotometer method [15]

The experiment was conducted and repeated for 2 years. The data recorded during the course of this study was analyzed statistically as Randomized Block Design in Factorials as per the procedures described by Singh *et al* (1998) [16] and results are summarized in tables with average of three replications.

RESULTS AND DISCUSSION

The data shows that the maximum fruit weight (60.50 g and 68.50 g during the first and second year, respectively) was recorded in 2.0 per cent KNO_3 treatments (Table 1). In general, maximum fruit weight during the present studies were found to be statistically significant in KNO_3 treatments. None of the Ca concentrations and B concentrations affected mean fruit weight compared with KNO_3 for the 2 years (Table 1).

The increase in fruit weight with KNO_3 application might be due to the fact that N is extremely mobile and developing fruit acts as a metabolic sink for the nutrient elements[17]. Further, nitrogen has been reported to prolong the phase of fruit cell division resulting in greater number of cells per fruit.[18]

It is evident from the data that $CaCl_2$ treatments had a significant effect in maintaining the fruit firmness. Higher flesh firmness (7.78 kg/cm^2 and 7.88 kg/cm^2 during first and second year, respectively) was measured after application of $CaCl_2$ 2.0% (Table 1) and the minimum (7.40 kg/cm^2 and 7.46 kg/cm^2 in first and second year, respectively) was observed in 2.0 per cent KNO_3 treated fruits (Table1). Cicco *et al.* (2007) [19] reported that fruit firmness throughout the postharvest period could be related to the Ca content of fruits. Low Ca concentrations in fruits have generally been found to accelerate the ripening process by stimulating the production of ethylene and by increasing the activity of enzymes, which are responsible for softening of the tissues [20].

The data on freshly harvested fruits in Table1 revealed that 2.0 per cent KNO_3 treated fruits recorded the highest total soluble solids (10.82 per cent and 10.80 per cent during the first year and second year, respectively) and minimum total soluble solids (9.45%) were noticed in fruits treated with 2.0 per cent $CaCl_2$ and 3.0 percent $CaCl_2$ treatments in the first year and second year respectively. The increase in TSS with KNO_3 treatment could be attributed to the enhanced photosynthetic efficiency of the leaves [21] and a possible increase in translocation of assimilates into the fruits.

Foliar application of potassium nitrate @ 1.0 per cent increased juice content, TSS and total and reducing sugars in Dancy tangerine' mandarin [22] and TSS of mandarin [23].

On the day of harvesting, maximum titratable acidity (0.83 per cent and 0.86 per cent during the first year and second year respectively) was observed in 2.0 percent $CaCl_2$ and minimum (0.71 per cent) titratable acidity was recorded in 2.0 per cent KNO_3 treatment during the first year and 0.73 per cent in the second year was observed (Table 1). The maintenance of higher acidity in $CaCl_2$ treated fruits may be due to the decreased hydrolysis of organic acids and subsequent accumulation of organic acids which were oxidized at a lower rate because of decreased respiration. Dris and Niskanen, 1999 [24] recorded higher titratable acidity in apple fruits with calcium treatments as compared to control.

On the day of harvesting, maximum total phenols (269.26 mg/100g and 258.31 mg/100g during first and second year, respectively) were recorded in 2.0 per cent $CaCl_2$ treatment. The minimum total phenols (255.77 and 245.53 mg/ 100g) were recorded in 2.0 per cent KNO_3, followed by 1.0 per cent KNO_3 treatment and control fruits (Table1). Present findings are in agreement with those of Faust and Shear, 1972 [25]; Leopold and Kriedmann, 1979 [26] who also reported that $CaCl_2$ slowed down cellular disintegration by maintaining protein and nucleic acid synthesis thereby delaying senescence. Akhtar *et al,* 2010 [27] investigated the effect of various calcium concentrations on loquat fruit and recorded that calcium chloride @ 2.0 per cent reduced the flesh browning of loquat fruits. In Jacobo-Velazquez *et al.,* 2011 [28] suggested model, higher phenolics compounds accumulation due to PAL activity under Ca^{2+} participation that lead to higher total antioxidant activity reflected by higher oxygen radical absorbance activity. A higher DPPH scavenging activity supports the hypothesis that $CaCl_2$ treatment can enhance nutritional quality, according with Supapvanich *et al.* 2012 [29].

Table 2
Effect of foliar sprays on nitrogen (N), potassium (K), calcium (Ca), and boron (B) concentration of the Peach fruit leaves during the 2 years of the experiment

Treatments	*Calcium (%)*	*Nitrogen (%)*	*Potassium (%)*	*Boron (ppm)*
First year				
$CaCl_2$ 1%	1.79	2.60	1.24	45
$CaCl_2$ 2%	1.82	2.69	1.25	46
$CaCl_2$ 3%	1.87	2.63	1.20	60
Boric acid 1%	1.57	2.69	1.25	110
Boric acid 2%	1.55	2.63	1.26	125
Boric acid 3%	1.45	3.04	1.30	150
KNO_3 1%	1.24	2.88	1.85	24
KNO_3 2%	1.21	2.95	1.93	14
KNO_3 3%	1.38	3.50	1.55	12
Control	1.21	2.45	1.82	21
CD (p = 0.05)	0.06	0.11	0.18	0.02
Second year				
$CaCl_2$ 1%	1.83	2.52	1.36	42
$CaCl_2$ 2%	1.84	2.54	1.28	42
$CaCl_2$ 3%	1.87	2.62	1.34	58
Boric acid 1%	1.58	2.78	1.28	112
Boric acid 2%	1.59	2.68	1.45	123
Boric acid 3%	1.54	3.15	1.46	158
KNO_3 1%	1.27	3.08	1.80	26
KNO_3 2%	1.24	3.15	2.05	16
KNO_3 3%	1.35	3.74	1.65	14
Control	1.29	2.55	1.84	23
CD (p = 0.05)	0.08	0.12	0.21	0.02

The data on Pectin methyl esterase activity in Table 1 showed that on the day of harvesting, minimum PME activity (1.22 and 1.17 μ eq/ml of enzyme during first and second year, respectively) was estimated in 2.0 per cent $CaCl_2$ treatment and maximum PME activity (1.56 and 1.43 μ eq/ml of enzyme during first and second year, respectively) was found in 2.0 per cent KNO_3 treatment followed by 1.0 per cent KNO_3 treatment and control. Our results revealed that $CaCl_2$ spray significantly reduced PG activity of the fruits. This might be due to the reason that calcium is known to strengthen the structure of cells by maintaining the fibrilar packaging in the cell walls thus reinforcing the cell to cell contact which is related to the formation of calcium pectate and counteracts the pectin methyl esterase activity[30]. Pre-harvest application of calcium to guava fruits minimized the activity of PME during storage [31].

On the other hand, KNO_3 sprays increases the PME activity of the fruits. Softening of dragon fruit is paralleled with a gradual increase in activities of the major cell wall degrading enzymes such as PG, pectin methyl esterase (PME), â-galactosidase and cellulose and modification of the various pectic and hemicellulosic components of the cell wall [32]. It is therefore evident that Ca possesses a distinguishable role in reducing the PG and PME activities. PME removes the methyl groups of the galacturonic acid polymers and polygalacturonase preferentially degrades de-esterified pectic substances, thereby producing water soluble pectin [33].

The data in Table 2 showed that maximum leaf calcium content (1.87 per cent during both years) was recorded in 3.0 per cent $CaCl_2$ and minimum leaf calcium content (1.21 per cent and 1.24 per cent during first and second year, respectively) was observed in 2.0 per cent KNO_3. The present findings are in agreement of those of (Crisosto *et al,* 2000 [34] who reported that leaf calcium concentration was significantly increased by foliar sprays of calcium on cultivars 'Cal Red' peach and 'Flaming Red' nectarine. Maximum leaf nitrogen (3.50 per cent and 3.15 per cent during first and second year, respectively) was recorded in 3.0 per cent KNO_3 treatment where highest dose of KNO_3 was applied and it was statistically at par with KNO_3 (1.0 and 2.0 per cent) and were significantly higher than all other treatments (Table 2). An increase in foliar N with increasing dose of nitrogen was also reported by several workers in peach[35]. Maximum foliar potassium content (1.93 per cent and 2.05 per cent during first and second year, respectively) was recorded in 2.0 per cent KNO_3. The minimum leaf potassium (1.27 per cent) was recorded in 3.0 percent $CaCl_2$ and it was significantly lower than all other treatments (Table 2). The data shows that higher doses of potassium resulted in significantly greater leaf K values than the lower doses.

In citrus, higher potassium application resulted in higher leaf K but reduced the Mg and Ca content. [36] [37] [38] Maximum leaf boron (150 ppm and 158 ppm) was recorded in 3.0 per cent boric acid treatments where highest dose of Boric acid was applied and it was statistically at par with Boric acid (1.0 and 2.0 per cent) and was significantly higher than all other treatments. The leaf boron content was found to be minimum (12 ppm and 14 ppm during first and second year, respectively) in 3.0 per cent KNO_3 treated fruits. (Table 2) These results are in agreement of Hafez and Haggy, 2007 [39] who reported that the foliar spray of boric acid at 0.1% significantly increased the concentrations of boron in apple leaves. Khalifa *et al,* 2009 [40] also reported that foliar spraying of boric acid at all concentrations @ 0.025, 0.5 and 0.1% significantly increased the boron concentrations of apple leaves as compared to control.

CONCLUSION

The objectives of the investigation were to study the effect of preharvest chemical treatment *viz.* $CaCl_2$, boric acid and KNO_3 on quality attributes and nutritional status of peach. The results obtained during the course of investigation showed that fruit quality in terms of fruit weight and TSS were found to be better in 2.0 per cent KNO_3 at the time of harvest. But on the other hand, $CaCl_2$ treatments recorded higher fruit firmness and slowed down the respiration rate of fruits. Our results suggest that among the sprays, $CaCl_2$ @ 2.0 per cent was found the most effective treatment in enhancing and maintaining nutritional quality attributes of treated "Shan-i-Punjab" peach fruit under simulated marketing conditions. With a few exceptions, only this treatment had a positive effect and greatly influenced the fruit quality at the harvest time, and maintained the initial quality in terms of fruit phenolic compounds and PME activity.

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