

Effect of Calcium and Boron Foliar Application on Postharvest Quality of Florida Prince Peach Fruit

Hemat M. Kamal, Mohamed A. Eissa and Ahmed A. Albayaty

Department of Pomology, Faculty of Agriculture, Cairo University, Giza, Egypt

Abstract: The current research was carried out during two successive seasons (2012 and 2013) to examine the effect of calcium and boron applications on quality and storability of Florida prince peach fruits. This study conducted on six years old peach trees grown in a sandy soil in a private orchard. The trees treated with, calcium green (34% Ca), micro net.30/1 (30% Ca + 1% B), micro net 18/6 (18% Ca + 6% B) while the control sprayed with water only. At maturity stage fruits were picked and stored under (0°C and 90-95% RH). Results indicated that, spraying calcium green at different concentration reduced fruit decay during storage and increased fruit firmness. In addition, treat the fruit with calcium green during of storage time gave the highest total soluble solid, total sugars contents and the lowest phenol contents. The micro net (30/1) and micro net (18/6) were less efficient in improving fruit quality compared with calcium green. Calcium green improved fruit quality and extend storage period with good quality.

Key words: Peach • Florida prince • Calcium • Boron • Postharvest • Fruit quality

INTRODUCTION

Peach (*Prunus persica* L. Batsch) is a temperate stone fruit originated in china and separated to the different wide world. Today it is one of the major fruit crops in worldwide [1]. It ranks third to the apple and grape among the temperature zone fruit trees from the standpoint of production and value [2]. Peach is one of the most important deciduas fruit trees growing in Egypt. The total harvest area reached 26611 ha producing 285, 194 ton [3]. Peach fruit is very perishable, lend to ripen and sense rapidly at room temperature which results in post harvest decay and wastage during handling [4]. During growth and development of peach fruits, there are many factors which have a direct effect on fruit quality and their postharvest behavior; among these factors is the mineral nutrition. Calcium play a very important role in structure of cell wall, thus contributing to the firmness of fruit tissue [5]. Calcium contributing in prevent physiological disorders, reduce rate of respiration, maintaining firmness and slow down ripening process [6].

Boron found to affect fruit set, fruit retention and quality. Foliar spray of boric acid alone or in combination with calcium companioned improved fruit quality of

navel Orange [7]. Also, Khalif *et al.* [8] reported that foliar application of boric acid improved the physical and chemical characteristics of apple fruits.

The present study was aimed to evaluate the effect of calcium and boron applications on quality and storability of Florida prince peach fruits.

MATERIALS AND METHODS

The current research was carried out during two successive seasons (2012 -2013) to examine the effect of calcium and boron applications on quality and storability of Florida prince peach fruits. This study conducted on six years old peach trees growing in a sandy soil in a private orchard located at Cairo-Alexandria desert road. The trees were planted at 4 x 5 distance under drip irrigation system. All the chosen trees were uniform in size and receive the recommended horticulture practice.

The Used Treatments Were: Control (sprayed with water only), calcium green (34% Ca) at 1500, 2000 and 2500 ppm, micro net (30/1) (30% Ca and 1% B) at,1500, 2000 and 2500 ppm, micro net (18/6) (18% Ca /6%B) at 2000, 2500 and 3000 ppm.

The treatments repeated tow times during each season (15February and 15March in the 1st season) and (20 February and 20 March in the 2^d season).

At the maturity stage, fruits from each treatment were picked in the early morning and immediately transported to the laboratory then packed in carton boxes and stored at cold temperature 0 °C with 90-95% RH.

Three replicates (one box for each replicate contain 30 fruits) from each treatment were used to study the physical and chemical properties of the stored fruits. Fruit sample was taken every week and the following parameters were recorded:

Fruit decay percentage was determined according to McCornack and Brown [9].

Fruit firmness (lb/inch²) was determined by U.S. firmness tester. Firmness of fruits sample was measured and the average was calculated.

Total sugars was determined according to Smith *et al.* [10] and the results were expressed as mg equivalent of glucose per g fresh weight using phenol sulfuric acid method.

Total soluble solid (TSS %) was determined by using a hand refractometer.

Total soluble phenols (mg / 100 gm F. W.) was estimated according to Swain and Hillis [11].

Experimental Design and Statistical Analysis:

The experimental design was the randomized complete blocks design, data were subject to analysis of variance (ANOVA) according to Sendecor and Cochran [12] using MSTAT-C statistical package software [13]. Means of treatment were compared by (LSD) according to Duncan [14] at significant level of 0.05.

RESULTS AND DISCUSSION

Fruit Decay: As shown in tables (1,2), fruit decay percentage was significantly affected by the conducted treatment and storage period. Control treatment recorded the highest fruit decay at the end of storage period (6.63 and 6.30) in the 1st and 2nd season respectively. While, calcium green treatment at all concentrations recorded the lowest fruit decay percentage (0 in both seasons) compared with the other treatments. Calcium green (high calcium content) was superior to the treatment with both calcium and boron (micro net). Also, increasing the concentration of micro net resulted in decreasing the decay percentage. Concerning the effect of storage period, the decay percentage start to increase in the 3rd week in control treatment and 4th week in the micro net (18/6) and the highest decay percentage recorded in the 5th week for the control treatment, while the lowest was recorded for the calcium green treatment.

According to Gautam [15] pre-harvest calcium treatment at pit hardening and 2 weeks later reduced storage losses in the treated fruits compared with the control treatment. Also, the effect of calcium component on reduce fruit decay may be attributed to the role of calcium in cell wall structure [16].

Fruit Firmness: Data presented in Tables (3,4) showed that fruit firmness were significantly affected by storage period and the experimental treatment. Fruit firmness were gradually decreased during storage period from 16.68 (as an average) in the 1st week to 6.19 in the 5th week. Regarding the effect of calcium and boron treatment,

Table 1: Effect of sprayed treatments on decay percentage of Florida prince fruits during storage at 0°C in 2012 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2000	0.00	0.00	0.00	0.00	0.00	0.00	
	2500	0.00	0.00	0.00	0.00	0.00	0.00	
Micro net 30/1	1500	0.00	0.00	0.00	0.00	0.00	5.62	1.15
	2000	0.00	0.00	0.00	0.00	0.00	7.58	
	2500	0.00	0.00	0.00	0.00	0.00	7.58	
Micro net 18/6	2000	0.00	0.00	0.00	0.00	6.62	7.16	1.98
	2500	0.00	0.00	0.00	0.00	0.00	9.85	
	3000	0.00	0.00	0.00	0.00	0.00	12.05	
Control		0.00	0.00	0.00	7.06	15.82	16.88	6.63
Mean		0.00	0.00	0.00	0.71	2.40	6.67	

LSD value at 0.05: Treatments = 0.2744 Storage period = 0.3360 Interactions: 1.1641

Table 2: Effect of sprayed treatments on decay percentage of Florida prince fruits during storage at 0°C in 2013 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2000	0.00	0.00	0.00	0.00	0.00	0.00	
	2500	0.00	0.00	0.00	0.00	0.00	0.00	
Micro net 30/1	1500	0.00	0.00	0.00	0.00	0.00	4.47	0.96
	2000	0.00	0.00	0.00	0.00	0.00	6.43	
	2500	0.00	0.00	0.00	0.00	0.00	6.43	
Micro net 18/6	2000	0.00	0.00	0.00	0.00	5.47	6.80	1.77
	2500	0.00	0.00	0.00	0.00	0.00	8.70	
	3000	0.00	0.00	0.00	0.00	0.00	10.90	
Control		0.00	0.00	0.00	6.80	14.67	16.30	6.30
Mean		0.00	0.00	0.00	0.68	2.01	6.00	

LSD value at 0.05: Treatments = 0.2744 Storage period = 0.3360 Interactions = 1.1641

Table 3: Effect of sprayed treatments on firmness (lb/inch²) of Florida prince fruits during storage at 0°C in 2012 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	17.00	15.40	10.20	7.67	7.33	7.30	11.35
	2000	17.10	13.33	11.73	8.13	7.53	7.37	
	2500	18.20	16.93	12.10	9.17	9.17	8.63	
Micro Net 30/1	1500	16.93	11.73	9.97	7.77	7.10	6.00	9.95
	2000	17.03	13.13	8.47	7.47	7.07	6.33	
	2500	16.40	15.10	8.27	7.27	6.73	6.33	
Micro Net 18/6	2000	15.47	10.07	8.13	7.57	6.73	5.90	8.95
	2500	16.83	8.50	7.90	6.47	5.87	5.03	
	3000	16.07	14.13	8.27	6.93	6.50	4.80	
Control		15.80	9.40	8.27	6.23	5.83	4.20	8.29
Mean		16.68	12.77	9.33	7.47	6.99	6.19	

LSD value at 0.05: Treatments = 0.5083 Storage period = 0.6225 Interactions = 2.1564

Table 4: Effect of sprayed treatments on firmness (lb/inch²) of Florida prince fruits during storage at 0°C in 2013 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	18.23	16.74	11.54	9.01	8.64	8.67	12.69
	2000	18.59	14.67	13.07	9.47	8.87	8.71	
	2500	19.59	18.27	13.44	10.51	10.51	9.97	
Micro Net 30/1	1500	18.23	13.07	11.31	9.11	8.44	7.34	11.30
	2000	18.56	14.47	9.81	8.81	8.41	7.67	
	2500	17.79	16.44	9.61	8.61	8.07	7.67	
Micro Net 18/6	2000	17.03	11.41	9.47	8.91	8.07	7.24	10.31
	2500	18.17	9.84	9.24	7.81	7.21	6.37	
	3000	17.41	15.47	9.61	8.27	7.84	6.14	
Control		17.23	10.74	9.61	7.57	7.17	5.54	9.64
Mean		18.08	14.11	10.67	8.81	8.32	7.53	

LSD value at 0.05: Treatments = 0.5081 Storage period = 0.6223 Interactions = 2.1558

all the studied treatment increased fruit firmness compared to the control, the effect of the used formula on fruit firmness increased with increasing the concentration. The highest fruit firmness resulted from calcium green at 2500 ppm followed by micro net (30/1) while the control recorded the lowest value. It is obvious that the effect of the used formula related to its content of a calcium.

These results go in parallel with those previously mentioned by Ochei *et al.* [17] who cleared that, pre and postharvest applications of peach with 2000 ppm CaCl_2 and nutrical (8 %, soluble Ca) increased fruit firmness compared with control during storage. Also, Plich and Wojcik [18] observed that, calcium sprays caused a marked increase of “Stanely” plum fruit firmness at harvest and consequently a slower softening during long-term storage at low temperature. The effect of calcium on fruit firmness could be attributed to its role in stabilization of cell membrane and decrease fruit sorting [19]. Preharvest calcium spray are one of the important practices of new strategies applied to fruit

production which improve fruit quality and minimizing fungicide sprays, since they improve fruit resistance to pathogen [20].

Total Soluble Solids: As shown in tables (5, 6), total soluble solids was significantly affected by the conducted treatment and storage period. The lowest total soluble solids were recorded at the beginning of storage period (11.56 and 12.27) and increased gradually during storage period until the 5th week (14.52 and 15.45). In the 1st season calcium green treatments at all concentrations recorded the highest total soluble solids (13.74) compared with the other treatment, also in the 2nd season calcium green treatments at all concentrations recorded the highest value (14.57). The control recorded the lowest value in both seasons (12.42 and 13.33).

These results are in agreement with those reported by Robson *et al* [21] on peach and Plich and Wojcik [18] on plum who mentioned that, calcium treatments were more beneficial for fruit soluble solids than control.

Table 5: Effect of sprayed treatments on TSS % of Florida prince fruits during storage at O°C in 2012 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	11.57	11.67	13.13	13.23	13.50	14.97	13.74
	2000	11.83	12.30	13.93	13.63	13.63	15.13	
	2500	12.80	13.40	14.53	15.60	15.83	16.57	
Micro Net 30/1	1500	11.90	13.53	13.80	13.80	14.00	14.33	13.16
	2000	11.83	11.90	12.03	13.77	13.83	14.10	
	2500	11.70	12.57	12.57	13.03	13.77	14.43	
Micro Net 18/6	2000	11.80	12.17	12.97	13.27	13.97	14.07	12.87
	2500	11.50	12.37	13.20	13.67	13.90	13.93	
	3000	9.33	12.17	12.17	12.97	13.87	14.30	
Control		11.30	11.40	12.53	12.97	12.97	13.37	12.42
Mean		11.56	12.35	13.09	13.59	13.93	14.52	

LSD value at 0.05: Treatments = 0.3516 Storage period = 0.4306 Interactions = 1.4917

Table 6: Effect of sprayed treatments on TSS % of Florida prince fruits during storage at O°C in 2013 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	12.05	12.35	14.06	14.16	14.43	15.90	14.57
	2000	12.72	12.78	14.56	14.56	14.86	16.06	
	2500	13.12	14.33	15.46	16.53	16.76	17.50	
Micro Net 30/1	1500	12.72	14.46	14.63	14.73	14.82	15.26	14.02
	2000	12.25	12.76	13.12	14.70	14.76	15.03	
	2500	12.22	13.29	13.50	13.96	14.70	15.36	
Micro Net 18/6	2000	12.59	13.10	13.90	14.19	14.90	15.00	13.72
	2500	12.39	13.00	13.30	14.60	14.83	14.86	
	3000	10.39	12.89	13.10	13.90	14.80	15.23	
Control		12.22	12.22	13.46	13.90	13.90	14.30	13.33
Mean		12.27	13.12	13.91	14.52	14.88	15.45	

LSD value at 0.05: Treatments = 2.5601 Storage period = 3.1355 Interactions = 10.862

Table 7: Effect of sprayed treatments on total sugars (mg/g F.W) of Florida prince fruits during storage at 0°C in 2012 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	53.13	53.30	57.57	63.33	68.97	71.77	62.73
	2000	52.70	54.60	57.77	64.73	70.83	72.80	
	2500	54.40	55.73	59.73	67.40	74.27	76.07	
Micro Net 30/1	1500	52.03	51.37	53.73	62.27	66.87	69.50	59.91
	2000	52.97	52.67	54.43	62.73	66.63	70.70	
	2500	52.13	53.10	55.50	63.73	67.23	70.70	
Micro Net 18/6	2000	51.97	50.77	51.57	60.60	64.90	67.80	58.57
	2500	51.67	51.33	52.37	60.83	65.57	69.63	
	3000	51.37	52.13	53.07	62.07	66.20	70.40	
Control		51.30	48.90	49.30	56.40	63.60	64.30	55.63
Mean		52.37	52.39	54.50	62.41	67.51	70.37	

LSD value at 0.05: Treatments = 0.6251 Storage period = 0.7656 Interactions = 2.6521

Table 8: Effect of sprayed treatments on total sugars (mg/g F.W) of Florida prince fruits during storage at 0°C in 2013 season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	54.88	56.35	60.54	66.30	71.94	74.74	65.57
	2000	54.45	57.57	60.74	67.70	73.80	75.77	
	2500	57.05	59.01	62.70	70.37	77.24	79.04	
Micro Net 30/1	1500	54.81	54.34	56.70	65.24	69.84	72.47	62.83
	2000	56.05	55.64	57.40	65.70	69.60	73.67	
	2500	54.38	56.07	58.47	66.70	70.20	73.67	
Micro Net 18/6	2000	55.28	53.74	54.54	63.57	67.87	70.77	61.55
	2500	54.08	54.30	55.34	63.80	68.54	72.60	
	3000	54.81	55.10	56.04	65.04	69.17	73.37	
Control		54.76	51.87	52.27	59.37	66.57	67.27	58.69
Mean		55.06	55.40	57.47	65.38	70.48	73.34	

LSD value at 0.05: Treatments = 0.5877 Storage period = 0.7198 Interactions = 2.4933

Total Sugars: Results presented in Tables (5 and 6) showing the effect of conducted treatments and number of storage weeks on total sugars contents of Florida prince peach fruit in the two seasons. The results indicated that fruit content of total sugars were significantly affected by the experimental treatment and storage period. Total sugars had increased gradually during storage period, the highest sugars content recorded in the 5th week in all the treatments. In respect to the effect of conducted treatments on total sugars contents, results revealed that, calcium green treatment gave the highest total sugars content (62.73 and 65.57). Meanwhile, control treatment gave the lowest total sugars contents (55.63 and 58.68) in both seasons, respectively.

Considering the effect of storage period the highest total sugars contents (69.36 and 72.33) was found in the 5th week. Meanwhile, 1th week of storage gave the lowest total sugars contents (51.81 and 54.81) in both seasons, respectively.

These results are in harmony with those obtained by Ashour [22] who found that, foliar application of calcium, gave higher average of total sugars in fruits than control, also Ramdane [23] mentioned that, spraying four apple cultivars with calcium chloride increased sugars in fruit during storage.

Total Phenols: Results presented in Tables (7 and 8) show the effect of conducted treatments and number of storage weeks on phenol contents of Florida prince peach fruits in the two studied seasons. Concerning the effect of conducted treatments on phenol contents results revealed that, calcium green treatment gave the lowest phenol content (84.28 and 80.68). Meanwhile, control treatment gave the highest phenol contents (100.83 and 97.46) in both seasons, respectively. Corresponding to the effect of number of storage weeks, total phenols decreased continuously during the storage. At 5th weeks of storage the fruits had the lowest phenol contents (77.97 and 74.63) compared with the fruits at

Table 9: Effect of sprayed treatments on total phenol (mg/100g F.W) of Florida prince fruits during storage at O°C in 2012season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	102.00	94.33	88.33	82.67	78.00	75.00	84.28
	2000	97.67	92.33	86.00	80.33	75.67	73.33	
	2500	96.00	89.33	84.33	79.33	74.33	68.00	
Micro Net 30/1	1500	105.67	98.33	87.00	84.33	79.33	75.67	86.63
	2000	103.33	101.33	84.33	83.00	77.67	74.33	
	2500	105.67	98.67	83.00	81.67	76.33	74.33	
Micro Net 18/6	2000	109.33	104.00	91.00	86.00	82.00	78.33	90.70
	2500	103.33	101.33	91.33	86.67	83.33	73.33	
	3000	97.67	106.00	94.00	87.33	81.33	76.33	
Control		115.00	109.00	103.00	96.00	93.00	89.00	100.83
Mean		103.57	99.26	89.23	84.73	80.10	75.77	

LSD value at 0.05: Treatments = 1.1497 Storage period = 1.4081 Interactions = 4.8777

Table 10: Effect of sprayed treatments on total Phenol (mg/100g F.W) of Florida prince fruits during storage at O°C in 2013season.

Treatments	conc.	Storage period (weeks)						Mean
		0	1	2	3	4	5	
Calcium green	1500	98.66	90.99	84.77	79.33	74.66	71.66	80.68
	2000	94.33	88.99	82.11	76.99	72.33	69.99	
	2500	92.66	85.99	77.11	75.99	70.99	64.66	
Micro Net 30/1	1500	102.33	94.99	82.44	80.99	75.99	72.33	84.04
	2000	99.99	97.99	80.99	79.66	74.33	70.99	
	2500	102.33	95.33	79.66	78.33	72.99	70.99	
Micro Net 18/6	2000	105.99	100.66	87.11	82.66	78.66	74.99	87.34
	2500	99.99	97.99	88.11	83.33	79.99	69.99	
	3000	94.33	102.66	90.66	83.99	77.99	72.99	
Control		111.66	105.66	99.44	92.66	89.66	85.66	97.46
Mean		100.23	96.13	85.24	81.39	76.76	72.43	

LSD value at 0.05: Treatments = 1.1388 Storage period = 1.3947 Interactions = 4.8315

the beginning of storage which had a higher phenol contents (105.47 and 102.23) in both seasons, respectively.

These results go in parallel with those previously mentioned by Mohsen [24] who studied the effect of pre and post-harvest treatments with calcium chloride and calcium nitrate on Anna apple fruits. She found that, all calcium treatments gave significantly lower total phenols than control at harvest or during storage. Ashour [22] reported that, CaCl₂ treatments on Anna apple trees gave lower total phenol content in the fruits compared with control at harvest or during storage.

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