INFLUENCE OF CHOLINE CHLORIDE ON QUALITY AND STORABILITY OF PEACH FRUITS CV. EARLIGRANDE.

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ABSTRACT: The effects of preharvest foliar application of Choline Chloride (CC) on fruit quality of "EarliGrande" peaches at harvest and during cold storage at 1ºC temperature was investigated. CC was sprayed at concentrations of 0, 500, 1000, 1500 and 2000 mg/L at 30 days preharvest time (DPH). Fruit weight was increased by 500, 1000 and 1500 mg/L CC. At the same concentrations SSC/TA ratio was increased while, fruit acidity was decreased. Sugar, phenol and vitamin C content tended to increase by CC at harvest time. The combination of CC treatments at 1000 and 500 or 1000 mg/L and cold storage at 1ºC resulted in a reduction of weight loss (%) in two seasons, respectively. CC in combination with storage resulted in higher fruit firmness, SSC, SSC/acidity and total sugar and a reduction in fruit acidity in both seasons.
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INTRODUCTION

Peach [*Prunus persica* (L.) Batsch] is one of the most important fruit species, which cultivated widely worldwide. In Egypt, it is considered one of the most important and favorable five fruit crops. The total area of peach grown in Egypt reached (78840 feddan) most of them concentrated in the new lands, **78% of th**is area is in North Sinai (61500 feddan) (Egyptian Ministry of Agriculture 2008). The main cultivar grown in North Sinai is EarliGrande that considered early season cultivar **(Wahdan *et al.*, 2003)**. The total areas of peach produce about 376067 Tons (Egyptian Ministry of Agriculture 2008).

Average for peach growing is increasing in Egypt, but fragile storability due to rapid softening and price fluctuation from short harvest span is a problem. As a result of increasing, the supply of peach fruits some methods need to improved the fruit quality be developed to distribute this production over a long period of time during the season. From these methods using some chemical treatments and cold storage to prolong the shelf life of the fruits.

Choline Chloride (CC) increases fruit growth and coloration in peaches and cherries **(Sato, 1994). Benincore *et al.*, (2000)** reported that, the foliar application of CC with different concentration on apple trees increased fruit weight and SS contents especially at 500 ppm. Moreover, CC produced oblong fruits with low flesh firmness. Rare information is available about the effect of foliar application of CC on "EarliGrande" peach fruits at harvest time and during cold storage. Thereat, this study aim to effect of preharvest CC sprays on peach quality at harvest and after cold storage at 1ºC temperature.

MATERIALS AND METHODS

EarliGrande peach trees 8 years old budded to Meetghamr rootstock grown in a sandy soil at Abou-Sweer, Ismailia Governorate, Egypt. Chosen trees were spraying month preharvest time (first week of April) with 0, 500, 1000, 1500 and 2000 mg/L Choline Chloride (CC) in two successive seasons 2007 and 2008. All treatments were applied with a handgun to the run off. The experimental treatments were arranged in a randomized complete block design, where five treatments were conducted, with three replicates each of one tree.

Commercial ripe fifteen fruits from each treatment were hand harvested in the first week of May for studying both physical and chemical characteristics at harvest date. One hundred maturity fruits as another sample from each treatment were hand harvested in the same time. The fruits were transported the lap within one hour of harvest. Fruits were stored to eliminate defects. Sound fruits were cleaned by using soft brush and packed in foam plates in one layer (every plate contain five fruits) covered with perforated polyethylene sheet (thickness 14 µ). All plates from each treatment

were stored at 1ºC and 85-90% RH: A plate (contain five fruits) was used per replicate. Three replicates were used per treatment.

Fruits were sampled at Zero time and at 7 days intervals for studying both physical and chemical characteristics as follows:-

-Fruit weight and weight loss (g) evaluation: fruits were weighted individually after harvest, labeled and stored. At each sampling time (7days intervals up to 21days) the same fruits were reweigh. Weight loss was expressed as a percentage of the original fresh weight of fruit and calculated as the following equation:

Fresh weight loss % = [(initial weight-sample weight)/initial weight] ×100

-Fruit shape: fruit length, diameter and length/diameter ratio were evaluated. Firmness (N): It was measured on two sides of the fruit using Effegi penetrometer, soluble solids contents (SSC%) by hand refractometer, fruit acidity and vitamin C according to **A. O. A. C. (1985),** total sugars according to **Stewart (1974),** total soluble phenols by Folin and Ciocaltu colorimetric method **(A. O. A. C., 1985).**

The statistical analysis was done between all the effects, CC treatments and storage duration. The experimental design was complete randomized block with a factorial arrangement of CC treatments and storage duration **(Steel and Torrie, 1980)**. Analysis of variances and mean comparison (LSD at 5%) were performed with Co-Stat program version 3.

RESULTS

Fruit quality

Physical properties

Data in **Table (1)** clear that, Choline Chloride (CC) treatments increased the average weight of fruit with all concentrations except highest level (2000 ppm) which gave lowest weight (93.8 and 93.5 g) in both seasons, respectively.

Regarding fruit volume, data tabulated in the same table show that, CC at 500 ppm in both seasons significantly increased fruit volume. On the other hand, CC at 2000 ppm in both seasons also significantly decreased fruit volume. While, the other treatments no significant differences obtained between of them in both seasons.

Concerning, specific gravity of fruits, no significant differences were noticed between treatments of CC in both seasons.

In the first season no significant differences were noticed in fruit length between CC treatments and control, except CC at 2000 ppm which significantly decreased fruit length. While in the second one all treatments significantly decreased fruit length relative to the control. Fruit diameter was increased with treatments of CC, except CC at 2000 ppm in the first season and CC at 1000 and 2000 ppm in the second one decreased fruit diameter relative to the other treatments **(Table 1).**

Fruit length/diameter ratio decreased by CC treatments in comparison with the control in both seasons, except the treatment of CC at 1000 ppm in the first season slightly increased fruit length/diameter ratio relative to control. The highest reduction of ratio was obtained by CC at 500 ppm in the two seasons.

Regarding to fruit firmness, data in **Table (1)** also shows that, the increment in fruit firmness was obtained by CC at 2000 ppm in the first season and by CC at 1000, 1500, 2000 ppm in the second one. The lowest values of fruit firmness (2.15 and 2.76) were obtained by CC at 500 ppm compared to (3.12 and 3.63) by control in both seasons, respectively.

Chemical properties

Data in **Table (2)** showed that, no significant differences were noticed in fruit SSC between the different CC concentrations in the first season, while in the second one the treatment of CC at 2000 ppm only significantly increased fruit SSC relative to other treatments which no significant differences were found among them.

CC treatments resulted in decreasing fruit acidity in comparison with the control in both seasons, except CC at 2000 ppm which increased fruit acidity and gave highest value (0.95 %) relative to other treatments in both seasons. As a result of this trend, all treatments of CC resulted in increasing SSC/acid ratio compared with control, except CC at 2000 ppm which reduced SSC/acid ratio in both seasons.

Data in the same table, showed that, CC at 1000 and 2000 ppm significantly increased fruit content of vitamin C in both seasons while, no significant differences were noticed among other treatments in both seasons. The highest values (22.65 and 23.4 mg/ g) were found with 2000 ppm CC and lowest values (15.85 and 15.15 mg/ 100g) were obtained from 500 and 1500 ppm CC in both seasons, respectively.

Sugar content tended to increase by all CC treatments in the first season and by CC at 1000 ppm only in the second one gave highest value of total sugars in peach fruits (6.5 mg/100g) in comparison with the other treatments.

CC treatments increased peach fruits content of total phenols in both seasons. The highest values of phenols (75.2 and 76.7 mg/ 100g) were obtained with CC at 1000 ppm and 500 or 1000 ppm

in comparison with the lowest values (72.2 and 73.4 mg/ 100g) which obtained with CC at 500 ppm and control in both seasons, respectively.

Weight loss (%)

Data in **Table (3)** revealed that, interactions of Chholine Chloride (CC) × storage periods (SP) were significant in both seasons. In first season, the significant increase in weight loss was obtained from CC at 1500 ppm (3.39 %) relative to the control (2.72 %) and CC at 1000 ppm (2.31 %). No significant differences were noticed between other treatments. In the second one, no significant differences were noticed in weight loss between 0 ppm (2.86 %) and 1000 ppm CC (2.54), but significant differences were noticed between all treatments. The highest value of weight loss % (3.71) was obtained with CC at 2000 ppm while, lowest value (2.12 %) was obtained with CC at 500 ppm compared with control (2.86 %). In general, during storage fruit weight loss increased significantly. The highest losses were obtained at last week in both seasons.

Firmness

In both seasons, the interaction effects of CC × SP were significant for fruit firmness **(Table, 3).** In both seasons, also fruit firmness increased with all concentrations of CC relative to the control, which record lowest values (4.51 and 4.86 kg/cm^2) in both seasons, respectively. Fruit firmness significantly decreased during storage for three weeks and the lowest value was obtained after three weeks of storage in both seasons. The combination of CC treatments and 1ºC storage temperature resulted in higher fruit firmness than using the same temperature with Zero concentration of CC in both seasons.

Soluble solids contents (SSC)

The interaction effects of CC × SP were significant in both seasons. **(Table, 4)** CC treatments resulted in significantly increasing fruit SSC over control in both seasons. Highest values (10.62 and 10.53 %) were noticed with treatment of CC at 1000 ppm compared with lowest values (8.80 and 8.48 %) which noticed with control in two seasons, respectively. Concerning of storage periods, data tabulated in the same table revealed that, fruit SSC increased significantly during storage periods. The highest values were obtained at the end of storage period in both seasons.

The combination of CC treatments and 1ºC storage temperature gave higher fruit SSC than using the same temperature with Zero concentration of CC in both seasons.

Acidity

In first seasons, the interaction of CC × SP was not significant for fruit acidity (Table, 4), while it was significant in the second one.

CC at all concentration decreased fruit acidity in both seasons, except treatment of CC at 2000 ppm in second season only which gave value of acidity equal to control. However, fruit acidity significantly decreased during storage period in both seasons.

CC treatments in combination with SP resulted in lower fruit acidity during third and fourth week of storage at all concentrations in comparison with the control.

SSC/Acid ratio

From **Table (5)** it clear that, the interaction effect of CC × SP was significant for fruit SSC/acid ratio in both seasons. Fruit SSC/acid ratio was increased significantly by CC treatments and during storage from Zero time up to the end of storage in both seasons. The highest increments in the ratio (17.7 and 18.94) were obtained by CC at 1000 ppm in the first and second seasons, respectively relative to control which gave the lowest ratios (10.51 and 11.08) in both seasons. The increments in ratio during storage can be explained by the increases in SSC and decreases in acidity, in addition to increases of fruit weight loss as result of cold storage and CC treatments.

The combination of 1000 mg/L CC and SP resulted in an increase of SSC/TA ratio during all weeks of storage relative to other concentrations.

Vitamin C

Data tabulated in **Table (5)** revealed that, the interaction of CC × SP was significant for fruit content of vitamin C. CC treatments at all concentrations increased vitamin C in peach fruits in both seasons, except the treatment of CC at 1500 ppm in the second season only. The highest significant increases in fruit content of vitamin C (19.5 and 19.5 mg/100g) from CC at 1000 ppm in the two seasons compared with control (14.75 and 15.5 mg/100g) in both seasons, respectively.

Concerning storage period, slightly decreased of fruit content of vitamin C from Zero time till third week then, significantly decreased in the fourth week was obtained in the first season, while in the second one the decrease was slightly from Zero time up to the end of storage period. CC at 1000 mg/L in combination with SP resulted in higher fruit content of vitamin C than other treatments.

Total sugar

The interaction effect of CC × SP was significant for fruit content of total sugar in both seasons. All treatments of CC in both seasons significantly increased sugar, except the treatment of CC at 500 ppm in second season which no different from control. The highest values of total sugar (5.25 and 5.30 mg/100g) were obtained with CC at 1000 ppm in both seasons in comparison with the control which gave (4.56 and 4.79 mg/100g) total sugar in both seasons.

Concerning the effect of storage period it could be seen that, total sugar significantly increased as the time of storage was increased which reached a maximum values at values at the end of storage period in both seasons. The increase in sugar contents may be due to the higher weight loss of these fruits, as a result of which there might have been an increase in the concentration of sugar. The combination of CC treatments and storage period increased fruit content of total sugar in both seasons specially the treatment of CC at 1000 mg/L during all weeks of storage.

Total phenol contents

From **Table (6)** also, it is clear that the interaction effect of CC × SP was significant for total phenol content in both seasons. CC treatments at all concentrations and in both seasons slightly decreased total phenol content of peach fruits, except the treatment of CC at 500 ppm in the first season only which gave the highest value (77.0 mg/100g) compared with all treatments. During storage, fruit phenol content significantly decreased from Zero time up to the end of storage in both seasons.

Discussion

Concerning physical properties, similar results were obtained by **Benincore *et al*., (2000)** on apple, they found that, spraying of CC at 500, 1000 and 1500 mg/L at 18 days preharvest time (DBH) increased mean fruit weight in apple. In addition, **(Akihinco, 2000)** reported that CC increased fruit weight and produced oblong fruits with low flesh firmness in Masui Dauphino fig cultivar.

Regarding chemical properties the obtained results in harmony with those of **Kim *et al*., (2004)** who reported that, foliar application of CC on "Mibaek" peach increased SSC, Acidity and sugar content. The results concerning physical characteristics and chemical properties may be attributed to the effect of CC on improving photosynthetic rate **(Akihiko *et al*., 2000).** Loss of moisture from the fruits during storage period might explain the increases in fruit weight loss **(El-Shiekh and Wahdan, 2002 and Abd-El-Salam, 2010).** The foliar application of CC decreased fruit weight loss percentage. **Akihiko *et al*., (2000) and Kim *et al.*, (2004)** found that fruit SSC was reduced by CC on Fig and Peach. In addition, **Abd-El-Salam (2010)** reported that, peach fruit SSC percentage during cold storage at 1ºC was significant increased tell the end of storage period. **Akbudak and Eris (2003)** stated that, the increase in total sugar contents observed in peach fruits having minute quantities of starch mainly, resulted from the conversion of polysaccharides in the cell walls to sugar. An increase in total sugar content during cold storage of peach has been reported by **Soukar and Ladaniya (1999).**

Concerning fruit firmness, the obtained results in this concern are in agreement with those found by **Abd-Al-Salam, (2010)** who reported that peach fruit firmness significantly decreased as storage time was increased. A gradual decline in total phenols may be due to polyphenoloxidase oxidize total phenols in peach fruit during cold storage **(Cheng and Crisosto, 1995).**

Table (1): Effect of foliar application of Choline Chloride (CC) on physical characteristics of Peach fruits cv. EarlyGrande during 2007 and 2008 seasons.

Treatments	Fruit weight (g)	Fruit volume (cm)	Fruit specific gravity	Fruit Length (cm)	Fruit Width (cm)	Fruit Shape index	Fruit Firmness
	2007 Season						
Control	113.65 b	126.1 ab	0.90 a	6.10 a	6.05 ab	1.01 ab	3.12 a
CC at 500 ppm	126.6 a	144.5 a	0.88 a	6.15 a	6.40 a	0.96 c	2.15 b
CC at 1000 ppm	117.65 ab	128.5 ab	0.92 a	6.35 a	6.20 a	1.03 a	3.10 a
CC at 1500 ppm	114.95 b	124.5 b	0.92 a	6.10 a	6.25 a	0.98 bc	3.04 ab
CC at 2000 ppm	93.80 c	102.3 c	0.92 a	5.65 b	5.70 b	0.99 abc	3.85 a
	2008 Season						
Control	111.55 b	129.8 b	0.86 a	6.50 a	6.10 b	1.07 a	3.63 ab
CC at 500 ppm	134.80 a	151.0 a	0.90 a	5.95 c	6.50 a	0.92 c	2.76 b
CC at 1000 ppm	112.55 b	120.0 b	0.94 a	6.20 b	5.90 bc	1.06 ab	4.75 a
CC at 1500 ppm	113.40 b	116.0 bc	0.98 a	6.10 bc	6.10 b	1.00 b	4.11 ab
CC at 2000 ppm	93.50 c	101.1 c	0.93 a	5.70 d	5.75 c	0.99 b	4.09 ab

Table (2): Effect of foliar application of Choline Chloride (CC) on chemical properties of Peach fruits cv. EarlyGrande during 2007 and 2008 seasons.

Treatments	SSC	TA	SSC/TA	V.C.	Total Sugars	Total Phenols
	2007 Season					
Control	8.50 a	0.70 b	12.14 b	16.70 c	5.35 c	73.2 ab
CC at 500 ppm	8.45 a	0.65 b	13.10 b	15.85 c	5.55 b	72.2 b
CC at 1000 ppm	8.40 a	0.50 c	16.80 a	18.65 b	5.80 a	75.2 a
CC at 1500 ppm	8.40 a	0.60 bc	14.00 b	16.70 c	5.65 ab	74.0 ab
CC at 2000 ppm	8.30 a	0.95 a	8.76 c	22.65 a	5.80 a	74.2 ab
	2008 Season					
Control	7.70 b	0.70 b	11.00 c	15.85 cd	5.70 b	73.4 c
CC at 500 ppm	8.15 b	0.70 b	11.65 bc	16.00 c	5.70 b	76.7 a
CC at 1000 ppm	8.20 b	0.55 c	15.07 ab	17.30 b	6.5 a	76.7 a
CC at 1500 ppm	7.90 b	0.50 c	15.80 a	15.15 d	5.65 b	76.5 a
CC at 2000 ppm	9.15 a	0.95 a	9.66 c	23.40 a	5.75 b	75.4 b

Table (3): Effect of foliar application of Choline Chloride (CC) and storage periods (SP) on Fruit weight loss % and Firmness of Peach fruits cv. EarlyGrande during 2007 and 2008 seasons.

Treatments	Fruit weight loss %					Firmness				
	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean
	2007 Season					2007 Season				
Control	0.00	1.73	3.29	5.83	2.72 BC	5.30	5.20	4.25	3.30	4.51 D
CC at 500 ppm	0.00	2.12	4.31	7.02	3.36 AB	6.40	6.10	5.55	5.30	5.84 AB
CC at 1000 ppm	0.00	1.51	3.10	4.64	2.31 C	6.10	5.45	5.10	4.70	5.34 C
CC at 1500 ppm	0.00	2.57	4.46	6.51	3.39 A	6.55	6.30	5.85	5.10	5.95 A
CC at 2000 ppm	0.00	2.15	4.16	5.58	2.97 ABC	6.45	5.90	5.55	4.90	5.70 B
Mean	0.00 D	2.02 C	3.86 B	5.92 A		6.16 A	5.79 B	5.26 C	4.66 D	
L.S.D. of interaction 5%	1.331					0.354				
	2008 Season					2008 Season				
Control	0.00	1.93	3.70	5.81	2.86 C	6.35	5.45	4.10	3.55	4.86 D
CC at 500 ppm	0.00	1.49	2.79	4.19	2.12 D	6.90	6.55	5.90	5.50	6.21 A
CC at 1000 ppm	0.00	1.76	3.45	4.97	2.54 C	5.65	5.30	5.10	4.70	5.19 C
CC at 1500 ppm	0.00	2.49	4.41	6.24	3.28 D	6.90	6.10	5.55	5.45	6.00 B
CC at 2000 ppm	0.00	2.54	5.03	7.29	3.71 A	7.25	6.45	5.65	5.00	6.09 AB
Mean	0.00 D	2.04 C	3.87 B	5.70 A		6.61 A	5.97 B	5.26 C	4.84 D	
L.S.D. of interaction 5%	0.811					0.358				

Table (4): Effect of foliar application of Choline Chloride (CC) and storage periods (SP) on TSS and TA of Peach fruits cv. Early Grande During 2007 and 2008 seasons.

Treatments	TSS					TA				
	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean
	2007 Season					2007 Season				
Control	8.3	8.1	9.1	9.7	8.80 D	1.05	0.85	0.8	0.75	0.86 A
CC at 500 ppm	8.4	9.5	10.1	10.3	9.58 B	0.85	0.7	0.6	0.575	0.68 BC
CC at 1000 ppm	9.5	10.5	10.7	11.7	10.60 A	0.75	0.63	0.60	0.50	0.62 C
CC at 1500 ppm	7.7	9.3	10.1	10.5	9.40 C	0.95	0.85	0.65	0.58	0.76 B
CC at 2000 ppm	8.2	9.7	9.7	10.4	9.50 BC	0.85	0.80	0.65	0.60	0.73 B
Mean	8.42 D	9.42 C	9.94 B	10.52 A		0.89 A	0.77 B	0.66 C	0.60 C	
L.S.D. of interaction 5%	0.86					0.57				
	2008 Season					2008 Season				
Control	7.5	8.2	8.7	9.5	8.48 E	0.975	0.9	0.75	0.6	0.81 A
CC at 500 ppm	8.0	8.9	9.7	10.3	9.23 D	0.85	0.85	0.75	0.625	0.77 A
CC at 1000 ppm	10.0	10.3	10.7	11.1	10.53 A	0.75	0.63	0.55	0.43	0.59 B
CC at 1500 ppm	8.9	9.7	10.1	10.8	9.88 B	0.95	0.85	0.75	0.55	0.78 A
CC at 2000 ppm	8.9	9.5	9.5	10.2	9.51 C	1.05	0.85	0.75	0.60	0.81 A
Mean	8.66 A	9.32 C	9.73 B	10.38 A		0.92 A	0.82 B	0.71 C	0.56 D	
L.S.D. of interaction 5%	1.00					0.51				

Table (5): Effect of foliar application of Choline Chloride (CC) and storage periods (SP) on TSS/TA and V.C. of Peach fruits cv. EarlyGrande During 2007 and 2008 seasons.

Treatments	TSS/TA					V.C.				
	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean
	2007 Season					2007 Season				
Control	7.92	9.56	11.57	13.00	10.51 C	18.0	13.0	15.0	13.0	14.75C
CC at 500 ppm	9.93	13.57	16.83	18.25	14.65 B	22.0	18.0	18.0	16.0	18.50 A
CC at 1000 ppm	12.73	16.83	17.83	23.40	17.70 A	20.0	20.0	19.0	19.0	19.50 A
CC at 1500 ppm	8.13	10.97	15.64	18.29	13.26 B	15.0	18.0	15.0	15.0	15.75 BC
CC at 2000 ppm	9.67	12.33	15.02	17.33	13.59 B	20.0	16.0	19.0	18.0	18.25 AB
Mean	9.68 D	12.65 C	15.38 B	18.05 A		19.0 A	17.0 AB	17.2 AB	16.2 B	
L.S.D. of interaction 5%	2.92					5.11				
	2008 Season					2008 Season				
Control	7.69	9.11	11.66	15.83	11.08 C	17.0	15.0	15.0	15.0	15.50 B
CC at 500 ppm	9.43	10.51	13.00	16.74	12.42 BC	18.0	15.0	16.0	15.0	16.00 B
CC at 1000 ppm	13.38	16.51	19.63	26.22	18.94 A	21.0	19.0	20.0	18.0	19.50 A
CC at 1500 ppm	9.40	11.44	13.54	19.80	13.55 B	17.5	14.0	15.0	13.0	14.88 B
CC at 2000 ppm	8.48	11.21	12.69	17.00	12.35 BC	18.0	16.0	17.0	19.0	17.50 AB
Mean	9.68 D	11.76 C	14.10 B	19.12 A		18.3 A	15.8 A	16.6 A	16.0 A	
L.S.D. of interaction 5%	2.97					6.91				

Table (6): Effect of foliar application of Choline Chloride (CC) and storage periods (SP) on Total Sugars and Total Phenols of Peach fruits cv. Early Grande during 2007 and 2008 seasons.

Treatments	Total Sugars					Total Phenols				
	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean	1 Week	2 Weeks	3 Weeks	4 Weeks	Mean
	2007 Season					2007 Season				
Control	4.15	4.20	4.65	5.25	4.56 C	76.0	77.5	72.5	72.0	74.50 AB
CC at 500 ppm	4.10	4.65	5.10	5.70	4.89 B	78.5	77.0	77.5	75.0	77.00 A
CC at 1000 ppm	4.80	5.15	5.45	5.60	5.25 A	76.0	74.0	73.0	72.5	73.88 B
CC at 1500 ppm	4.45	4.80	4.80	5.30	4.84 B	75.5	74.5	74.0	72.5	74.13 B
CC at 2000 ppm	4.45	5.25	5.05	5.70	5.11 A	73.5	74.0	74.5	73.5	73.88 B
Mean	4.39 D	4.81 C	5.01 B	5.51 A		75.9 A	75.4 AB	74.3 AB	73.1 B	
L.S.D. of interaction 5%	0.38					5.23				
	2008 Season					2008 Season				
Control	4.25	4.55	4.90	5.45	4.79 C	77.5	76.5	74.5	72.5	75.25 A
CC at 500 ppm	4.45	4.50	4.90	5.05	4.73 C	76.0	74.0	74.0	72.5	74.13 A
CC at 1000 ppm	4.85	5.05	5.30	6.00	5.30 A	76.5	76.0	73.0	70.0	73.88 A
CC at 1500 ppm	4.50	4.90	5.40	5.75	5.14 AB	77.5	73.5	73.0	71.0	73.75 A
CC at 2000 ppm	4.15	4.70	5.25	5.85	4.99 B	75.5	76.0	74.5	73.5	74.38 A
Mean	4.44 D	4.74 C	5.15 B	5.62 A		76.6 A	75.2 AB	73.8 B	71.5 C	
L.S.D. of interaction 5%	0.33					4.53				

CONCLUSION

Fruit weight and SSC/TA ratio were increased by 500, 1000 and 1500 mg/L CC while, fruit acidity was decreased. Sugar, phenol and vitamin C content tended to increase by CC at harvest time. The combination of CC treatments at 1000 and 500 or 1000 mg/L and cold storage at 1ºC resulted in a reduction of weight loss (%). CC in combination with storage resulted in higher fruit firmness, SSC, SSC/acidity and total sugar and a reduction in fruit acidity.

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