RELATION OF FRUITING IN BALADY MANDARIN TREES WITH SPRAYING THE TWO ANTIOXIDANTS CITRIC AND ASCORBIC ACIDS

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Abstract

During 2006 and 2007 seasons, the two antioxidants namely citric and ascorbic acids were applied four times at 250 to 2000 ppm. The study was focused ob examining their effects on leaf area, leaf content of N, P and K, yield as well as physical and chemical characters of Balady mandarin fruits.

Results revealed that carrying out four sprays of both antioxidants at 250 to 2000 ppm were very effective in improving the leaf area, leaf content of N, P and K, yield and fruit quality compared with non- application. The promotion was associated with increasing concentrations without measurable influence among 1000 and 2000 ppm. Citric acid was superior ascorbic acid in this respect.

Conducting four sprays of 1000 ppm citric acid was suggested to be beneficial for obtaining an economical yield and improving fruit quality of Balady mandarin trees.

INTRODUCTION

Citrus is suggested to be one of the most important cash crop allover the world, especially in U.S.A. and warm temperate regions and grown successfully in Egypt. Citrus occupied the third position between fruit crops in the world after grapes and apples. The total production of citrus in the world reached more than 98 million metric ton fruits (according to F.A.O. 2005 statistics).

Citrus is the backbone of fruit crop cultivation in Egypt. During the last few years, citrus area dramatically increased due to increasing demands of local consumption and exports, which is expected to boom in the future. In Egypt, citrus is considered among the principal and strategic fruit crops and it ranked the first position. The fruiting area reached 332758 feddans produced 3030244 metric ton fruits. Mandarin trees occupied 91243 feddans, representing 27.42% of the fruiting citrus occupied acreage. The yearly production was more than 711464 ton fruits. The major mandarin production in Egypt is confined to the local variety Balady which belongs to common Mediterranean mandarin (*Citrus reticulata* Blanco).

Poor cropping is considered to be a serious and major problem that faces Balady mandarin growers in Middle Egypt. This problem could be attributed mainly to poor setting and / or extensive dropping of flowers and fruits. It has been reported that

many factors are responsible for low yielding such as environmental conditions and malnutrition.

The widespread of free radicals or active oxygen species namely singlet oxygen, superoxide anion, hydrogen peroxide, hydroxyle radicals and ozone produced through photosynthesis, respiration and other metabolism processes are accompanied with destroying plant cells and accerlating most plants to reach senscenses. Antioxidants namely organic acids, amino acids and vitamins may play a definite role in solving the problem of poor yield through stimulating growth and nutritional status of the trees. They have an important role in protecting the plant cells from senescence and death, preventing the free radicals from oxidation of lipids, the components of plasma membrane which is accompanied with the loss of permeability as well as their effects in enhancing cell division and building of organic acids and the biosynthesis of organic foods and controlling the incidence of fungal attack.

The positive action of antioxidants in chelating these hazard radicals could result in extending the shelf- life of plant cells and producing vigorous plants (Sandermann *et al.,* 1998, Klesiig *et al.,* 2000 and Rao *et al.,* 2000).

Vitamins such as citric and ascorbic acids at as co- enzymes in a number of enzyme systems and thus take part in the regulation of metabolism. Recently, it was suggested that vitamins participate in plant growth and development indirectly by enhancing the endogenous levels of various growth factors such as cytokinins and gibberellins. Most vitamins are synthesized in leaves and translocated in the pholem. Vitamins with their antioxidative properties play an important role in plant defense against oxidative stress induced by surfactants and selected pesticides. Application of vitamins is accompanied with enhancing alpha keto glutaric acid biosynthesis which is united with ammonia to form amino acids and proteins (Orth *et al.,* 1993).

Improving growth, nutritional status of the trees, fruit retention, yield and fruit quality of citrus crops can be achieved through better cultural practices. Among the major cultural practices must be applied are the application of antioxidants.

Previous studies showed that application of antioxidants in Citrus was responsible for improving growth characters, yield as well as physical and chemical properties of fruits of Balady mandarin (Hegab, 2000,), Washington Navel orange trees (Abd El- Wahab, 1999, Erner, 1999, Ragab, 2002, Gobara, 2004 and Gamal, 2006), Valencia oranges (Sayed *et al,* 2004) and Balady orange (Abo El- Komsan *et al.*, 1999).

This study was designed to highlight the impact of two antioxidants namely ascorbic and citric acids at various concentrations on growth, nutritional status of the trees, yield and fruit quality of Balady mandarin trees growing under middle Egypt conditions.

MATERIALS AND METHODS

This investigations was conducted during the two consecutive seasons of 2006 and 2007 on thirty 10- years old Balady orange trees onto sour orange rootstock. The trees are grown in a private orchard situated at Bany Suef district, Bany Suef Governorate (about 100 km southern Cairo). The soil of the orchard is well drained clay loam with a water table not less than two meters deep.

Analysis of the tested soil at 0.0 to 90 cm deep was carried out (according to Wilde *et al.,* 1985) and the data are given in Table (1).

The experiment included two factors A and B. The first factor (A) consisted from the two antioxidants namely a_1) Ascorbic acid and a_2) citric acid. While, the second factor (B) contained the five concentrations of each antioxidants namely b_1) 0.0 ppm, b_2) 250 ppm, b_3) 500 ppm, b_4) 1000 ppm and b_5) 2000 ppm.

Therefore, the experiment included ten treatments, each treatment replicated three times, one tree per each. The two antioxidants at the previous concentrations were sprayed four times during each season on the middle of March, May, July and September at the early morning. Triton B as a wetting agent was added to all solutions of antioxidants at 0.05 %. The trees were sprayed till runoff (complete covering) (30 L/ tree).

Table 1. Analysis of the tested soil

Particle size distribution

Clay	55.0 %
Silt	32.00 %
Sand	13 %
Texture	Clay loam
pH (1: 2.5)	8.0
E.C. (1: 2.5)	0.61 mmohos/1/cm25°C
Organic Matter	2.1%
Total $CaCO_3$	3.1 %
Available macronutrients (ppm):-	
N	30.6
P	11.50
K	398.0
Ca	151.0
Mg	22.5
DTPA extractable available micronutrient (ppm):-	
Zn	5.2
Fe	13.0
Mn	6.0
Cu	2.0

The experiment was set up in a complete randomized block design in split- plot arrangement. The two antioxidants and the five concentrations of each occupied the main and the sub- plots, respectively.

Methodology as has been reported in this experiment for different investigated characteristics in response to various antioxidant treatments were carried out as follows:

Sixteen new shoots from Spring growth cycle were chosen on four labelled branched (four shoots for each direction) for measuring number of leaves per shoot. To determine the leaf area in Spring growth cycle according to Ahmed and Morsy (1999).

To determine percentages of N, P and K, fifty mature leaves seven months age from non fruiting shoots in the Spring growth cycle (in the first week of Sept.) according to Summer (1985) were taken and dried at 70°C and digested using H_2SO_4 and H_2O_2. In the digested. Solution percentage of nitrogen was determined by micro-Kjeldahl method (According to Wilde *et al.,* 1985), phosphorus was determined

following Olsen method and potassium was determined using a flame photometer according to Chapman and Pratt, 1961).

Initial fruit setting percentage were estimated by counting the number of flowers on the labeled shoots periodically at five days intervals starting at the second week of March in both seasons till setting completed (1st week of April) then the number of fruitlettes was counted and the percentage of initial fruit setting was calculated by dividing the number of fruitlettes by total number of flowers and multiplying the product x 100. Final fruit setting was calculated by dividing the number of fruits just before harvesting by total number for flowers and multiplying the product x 100.

Harvesting was achieved during the regular commercial harvesting time (mid. of Dec. in both seasons) when T.S.S./ acid reached 8/1. Yield expressed in weight (kg.) and number of fruits / tree was estimated.

To study physical and chemical properties of the fruits, ten fruits per tree at harvesting date were picked at random from constant height and from all directions of each tree. All fruit samples were tested for:

1- Average fruit weight (g.)

2- Fruit dimensions (height and diameter in cm) by using vernier caliper

3- Percentage of total soluble solids by using a handy refractometer.

4- Percentage of total acidity (as g citric acid/ 100 ml juice) by titration against 0.1 N sodium hydroxide using phenolphthalein as an indicator (A.O.A.C., 1985).

5- Percentage of total sugars were determined according to volumetric method of Lane and Eynon (1965).

6- Ascorbic acid content (as mg/ 100 ml juice) was determined by using 2,6 dichlorophenol indophenol dye (A.O.A.C., 1985).

All the obtained data during the course of this study in both seasons were tabulated and statistically analyzed. The differences between treatment means were compared using New L.S.D. test at 5% according to Mead *et al,* (1993).

RESULTS AND DISCUSSION

1- Effect of different concentrations of ascorbic and citric acids on leaf area and number of leaves per shoot

It is clear from the obtained data in Table (2) that the two vegetative growth characters namely the leaf area and number of leaves per shoot were significantly varied among the application of the two antioxidants namely ascorbic and citric acids. Foliar application of citric acid significantly was accompanied with stimulating such two growth characters compared to using ascorbic acid. These results were true for both seasons.

Data also reveal that foliar application of ascorbic and citric acids each at 250 to 2000 ppm significantly stimulated the leaf area and the number of leaves per shoot compared to non- application. The stimulation was associated with increasing concentrations. Significant differences on such two characters were observed among all concentrations of ascorbic and citric acids except between using the two higher concentrations namely 1000 and 2000 ppm. Treating the trees four times with ascorbic or citric acids at 2000 ppm produced the maximum values. The lowest values were recorded on untreated trees. Similar results were obtained in both seasons.

The investigated interaction between the two antioxidants and their concentrations had significant influence on the two growth characters of Balady mandarin trees namely the leaf area and the number of leaves per shoot. Treating the trees four times with citric acid at 2000 ppm gave the maximum values. The minimum values were recorded on the trees did not receive any antioxidant. These results were true for both the two seasons.

The results regarding the stimulating effect of antioxidants on some vegetative growth characters of Balady mandarin trees are in harmony with those obtained by Hegab (2000) on Balady mandarins, Ragab (2002), Gobara (2004) and Gamal (2006) on Washington Navel oranges and Sayed *et al.,* (2004) on Valencia oranges.

2-Effect of different concentrations of ascorbic and citric acids on percentages of N, P and K in the leaf

It is evident from the obtained data in Table (3) that percentages of N, P and K in the leaves were significantly improved in response to foliar application of citric acid compared to using ascorbic acid. These results were true for both seasons.

There was a gradual promotion on such essential nutrients with increasing concentrations of such two antioxidants. Significant differences on these nutrients were observed among all concentrations except among the two higher concentrations namely 1000 and 2000 ppm. Spraying the trees with any antioxidant at 2000 ppm

Table 2. Effect of different concentrations of ascorbic and citric acids on the leaf area (cm^2) and number of leaves per Spring shoot of Balady mandarin trees during 2006 and 2007 seasons.

Concentrations (B) ppm	leaf area (cm^2)					
	2006			2007		
	The two antioxidants (A)					
	a_1 ascorbic	a_2 citric	Mean (B)	a_1 ascorbic	a_2 citric	Mean (B)
b_1 0.0	7.2	7.5	7.4	8.1	8.6	8.3
b_2 250	9.0	10.5	9.8	9.2	10.7	10.0
b_3 500	11.0	12.5	11.8	10.3	12.0	11.2
b_4 1000	12.5	14.0	13.3	11.6	13.3	12.5
b_5 2000	12.6	14.2	13.4	11.9	13.9	12.9
Mean (A)	10.5	11.7		10.2	11.7	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	1.1	1.2	1.7	0.9	1.0	1.4
Number of leaves per Spring shoot						
b_1 0.0	15.0	15.0	15.0	16.0	16.1	16.1
b_2 250	18.0	21.0	19.5	18.0	21.0	19.5
b_3 500	21.0	24.0	22.5	21.0	25.0	23.0
b_4 1000	24.0	27.0	25.5	25.0	29.0	27.0
b_5 2000	25.0	28.0	26.5	26.0	30.0	28.0
Mean (A)	20.6	23.0				
New L.S.D. at 5 %	A	B	AB	A	B	AB
	2.0	2.0	2.8	2.0	1.0	1.4

Table 3. Effect different concentrations of ascorbic and citric acids on the percentages of N, P and K in the leaf of non-fruiting Spring shoots of Balady mandarin trees during 2006 and 2007 seasons.

Concentrations (B) ppm	N %					
	2006			2007		
	The two antioxidants (A)					
	a_1 ascorbic	a_2 citric	Mean (B)	a_1 ascorbic	a_2 citric	Mean B)
b_1 0.0	1.31	1.31	1.31	1.32	1.33	1.33
b_2 250	1.42	1.62	1.52	1.44	1.55	1.50
b_3 500	1.55	1.76	1.66	1.56	1.70	1.63
b_4 1000	1.71	1.92	1.82	1.69	1.79	1.74
b_5 2000	1.73	1.93	1.83	1.71	1.82	1.77
Mean (A)	1.54	1.71		1.54	1.64	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.09	0.07	0.10	0.09	0.08	0.11
	P %					
b_1 0.0	0.11	0.12	0.12	0.09	0.09	0.09
b_2 250	0.16	0.22	0.19	0.12	0.16	0.14
b_3 500	0.22	0.30	0.26	0.16	0.20	0.18
b_4 1000	0.29	0.40	0.35	0.22	0.24	0.23
b_5 2000	0.30	0.41	0.36	0.23	0.25	0.24
Mean (A)	0.22	0.29		0.16	0.19	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.04	0.03	0.04	0.02	0.03	0.04
	K %					
b_1 0.0	1.01	1.02	1.02	1.05	1.05	1.05
b_2 250	1.12	1.21	1.17	1.12	1.19	1.16
b_3 500	1.29	1.37	1.33	1.20	1.27	1.24
b_4 1000	1.42	1.51	1.47	1.27	1.36	1.32
b_5 2000	1.44	1.53	1.49	1.28	1.39	1.34
Mean (A)	1.26	1.33		0.94	1.25	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.05	0.06	0.08	0.04	0.05	0.07

resulted in the maximum values. The lowest values were recorded on untreated trees. The same trend was detected in both the two seasons.

Percentages of N, P and K in the leaf were significantly affected by the interaction between the two antioxidants and their concentrations. They were recorded the highest values on the trees received four sprays of citric acid at 2000 ppm. Untreating the trees with the two antioxidants resulted in the lowest values. These resulted were true for both seasons.

These results are in agreement with those obtained by Hegab (2000) on Balady mandarins and Abo El- Komsan *et al.,* (2003) on Balady oranges.

3- Effect of different concentrations of ascorbic and citric acids on percentages of initial fruit setting and fruit retention

It is obvious from the obtained data that application of citric acid had significant promotion on percentages of initial fruit setting and fruit retention compared to using the other antioxidant namely ascorbic acid during 2006 and 2007 seasons (Table 4).

Varying concentrations of both antioxidants was followed by great variation on such two percentages. Spraying the two antioxidants at 250 to 2000 ppm significantly improved percentages of initial fruit setting and fruit retention compared to the check treatment. The promotion was associated with increasing concentrations. Negligible increase on such two percentages was observed among the two higher concentrations (1000 and 2000 ppm). Treating the trees four times with antioxidants at 2000 and 0.0 ppm gave the highest and lowest values, respectively. These results were true for both seasons.

The studied interaction had significant influence on percentage of initial fruit setting and fruit retention. The maximum values were recorded on the trees received four sprays of citric acid at 2000 ppm. The untreated trees produced the minimum values. Similar trend was observed in both seasons.

The results regarding the beneficial effect of antioxidants on the fruit retention are in coincidence with those obtained by Erner *et al.,* (1999) on Washington navel orange trees and Hegab (2000) on Balady mandarins.

4- Effect of different concentrations of ascorbic and citric acids on yield

One can state that yield of Balady mandarin trees expressed in weight (kg) and number of fruits per tree, was significantly varied according to the source of antioxidants. It was significantly improved by using citric acid compared to using ascorbic acid. In another words, the highest yield was presented in response to treating the trees four times with citric acid. These results were true during the two experimental seasons.

Table 4. Effect of different concentrations of ascorbic and citric acids on percentage of initial fruit setting, fruit retention, yield (kg) and number of fruits per tree of Balady mandarin trees during 2006 and 2007 seasons.

Concentrations (B) ppm	Initial fruit setting %					
	2006			2007		
	The two antioxidants (A)					
	a_1 ascorbic	a_2 citric	Mean (B)	a_1 ascorbic	a_2 citric	Mean (B)
b_1 0.0	16.5	16.0	16.3	17.3	17.3	17.3
b_2 250	19.0	21.3	20.2	19.5	22.4	21.0
b_3 500	21.0	24.0	22.5	21.9	26.0	24.0
b_4 1000	23.3	25.9	24.6	24.9	28.0	26.5
b_5 2000	23.6	26.0	24.8	25.0	28.5	26.8
Mean (A)	20.7	22.6		21.7	24.4	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	1.3	1.5	2.1	1.5	1.5	2.1
	Fruit retention %					
b_1 0.0	0.73	0.74	0.74	0.71	0.71	0.77
b_2 250	0.80	0.98	0.85	0.82	0.93	0.88
b_3 500	0.88	0.99	0.94	0.92	1.05	0.99
b_4 1000	0.95	1.06	1.01	0.99	1.10	1.05
b_5 2000	0.96	1.08	1.02	1.02	1.11	1.07
Mean (A)	0.86	0.95		0.89	0.98	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.04	0.05	0.07	0.04	0.05	0.07
	Yield per tree (kg.)					
b_1 0.0	36.1	36.5	36.3	27.7	28.0	27.9
b_2 250	42.4	51.5	47.0	35.5	44.0	39.8
b_3 500	51.5	62.8	57.2	43.2	53.6	48.4
b_4 1000	63.2	74.2	68.7	51.2	61.8	56.5
b_5 2000	64.2	75.5	69.7	52.0	62.7	57.4
Mean (A)	51.5	60.1		41.9	50.0	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	5.2	6.1	8.6	6.1	6.3	8.9
	Number of fruits per tree					
b_1 0.0	420.0	418.0	419.0	330.0	330.0	330.0
b_2 250	451.0	490.0	470.5	370.0	415.0	392.5
b_3 500	490.0	541.0	515.5	400.0	450.0	425.0
b_4 1000	540.0	580.0	560.0	430.0	479.0	454.5
b_5 2000	544.0	585.0	564.5	433.0	482.0	457.5
Mean (A)	489.0	522.8		392.6	439.2	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	21.0	22.0	31.0	22.0	23.0	32.4

Significant differences on yield were observed between all concentrations of the two antioxidants except among the two higher concentrations namely 1000 and 2000 ppm. Therefore, it is suggested to use 1000 ppm concentrations instead of 2000 ppm, from economically point of view The untreated trees produced the minimum values. These results were true in 2006 and 2007 seasons.

The interaction between the two antioxidants and their concentrations had significant effect on yield. Economically point of view, carrying out four sprays of citric acid at 1000 ppm on March, May, July and September is proved to be very beneficial for obtaining an economical yield. Such promised treatment gave 74.2 and 61.8 kg per tree compared to 36.1 and 27.7 kg produced by the check treatment in both seasons, respectively. The increase on the yield over the check treatment reached 105.5 % and 123.1 % on both seasons, respectively.

The results concerning the effect of antioxidants on improving the yield are confirmed by the results of Hegab (2000) on Balady mandarins and Gobara (2004) and Gamal (2006) on Washington Navel oranges.

5- Effect of different concentrations of ascorbic and citric acids on physical characters of fruits

It is evident from the obtained data in Table (5) that application of citric acid was preferable than using ascorbic acid in improving physical characters of the fruits in terms of increasing weight, height and diameter of fruit. Significant differences on such physical characters were observed among the two antioxidants.

Increasing the concentrations of the two antioxidants from 0.0 to 2000 ppm caused a gradual promotion on physical characters of the fruits. Increasing concentrations from 1000 to 2000 ppm failed to show significant effect on such physical characters. Therefore, the recommended concentration was 1000 ppm from each antioxidant. Fruits harvested from trees received 1000 to 2000 ppm tended to be roundish. The untreated trees produced unfavourable effects on physical characters of the fruits.

The investigated combination had significant effect on the physical quality of the fruits. Treating Balady mandarin trees four times with citric acid at 1000 ppm effectively improved physical quality of the fruits from economical point of view.

Similar results were announced by Hegab (2000) on Balady mandarin fruits, Ragab (2002) on Washington navel orange fruits and Sayed *et al.,* (2004) on Valencia orange fruits.

Table 5. Effect of different concentrations of ascorbic and citric acids on fruit weight (g.) and dimensions (diameter and height) (cm.) of Balady mandarin trees during 2006 and 2007 seasons

Concentrations (B) ppm	Average fruit weight (g.)					
	2006			2007		
	The two antioxidants (A)					
	a_1 ascorbic	a_2 citric	Mean (B)	a_1 ascorbic	a_2 citric	Mean (B)
b_1 0.0	86.0	87.3	86.7	84.0	84.8	84.4
b_2 250	94.0	105.0	99.5	96.0	106.0	101.0
b_3 500	105.0	116.0	110.5	108.0	119.0	113.5
b_4 1000	117.0	128.0	122.5	119.0	129.0	124.0
b_5 2000	118.0	129.0	123.5	120.0	130.0	125.0
Mean (A)	104.0	113.1		105.4	113.8	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	7.0	7.1	10.0	8.0	9.5	13.4
	Average fruit diameter (cm.)					
b_1 0.0	5.62	5.63	5.63	5.68	5.70	5.69
b_2 250	5.92	6.11	6.02	6.00	6.21	6.11
b_3 500	6.41	6.62	6.52	6.49	6.72	6.61
b_4 1000	6.82	7.01	6.92	6.86	7.11	6.99
b_5 2000	6.86	7.06	6.96	6.88	7.13	7.01
Mean (A)	6.33	6.49		6.38	6.57	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.10	0.15	0.21	0.14	0.18	0.25
	Average fruit height (cm.)					
b_1 0.0	4.80	4.82	4.81	4.88	4.90	4.89
b_2 250	5.00	5.15	5.08	5.19	5.39	5.29
b_3 500	5.39	5.50	5.45	5.41	5.55	5.48
b_4 1000	6.00	6.20	6.10	6.11	6.25	6.18
b_5 2000	6.03	6.24	6.14	6.13	6.29	6.21
Mean (A)	5.44	5.58		5.54	5.68	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.06	0.07	0.10	0.05	0.06	0.08

6- Effect of different concentrations of ascorbic and citric acids on chemical characters of the fruits

It is clear from the obtained data in Table (6) that application of the antioxidant citric acid was significantly very effective in improving chemical fruit quality of the fruits in terms of increasing total soluble solids %, total sugars and vitamin C content and in reducing the total acidity % compared to using ascorbic acid. Such trend was similar in both seasons.

Varying concentrations of the two antioxidants significantly caused an obvious differences in chemical quality parameters of the fruits. Spraying the trees with the two antioxidants at 250 to 2000 ppm significantly was followed by great promotion on chemical characters of the fruits rather than non- application. There was a gradual and remarkable promotion on such characters with increasing concentrations. No significant promotion on such characters was detected among the two higher concentrations. Therefore, it is enough to use such antioxidants at 1000 ppm for improving chemical quality characters of Balady mandarin fruits. Untreating the trees with such two antioxidants gave unsatisfactory promotion on chemical characters of the fruits. These results were true in both seasons.

The combination between the two antioxidants and their concentrations had an obvious effect on chemical quality parameters of the fruits. The best results with regard to chemical quality parameters were obtained when the trees were sprayed four times with citric acid at 1000 ppm. Unfavourable effects on chemical fruit quality of the fruits were obtained on untreated trees.

These results regarding the enhancing effect of antioxidants on chemical fruit quality of Balady mandarin trees are in conformity with those obtained by Abo- El- Komsan *et al.,* (2003) on Balady orange fruits, Gobara (2004) on Washington Navel orange fruits and Sayed *et al.,* (2004) on Valencia orange fruits.

The aforementioned positive effects of the two antioxidants namely ascorbic and citric acids on growth, yield and fruit quality might be attributed to the following benefits (according to Klesiig *et al.,* 2000 and Rao, *et al.,* 2000).

1- Antioxidants are responsible for protecting plant cells from senescence and death .

2- They play a definite role in preventing the free radicals from oxidation of lipids and the loss of permeability.

3- They enhance cell division and the biosynthesis of organic foods.

4- They play an important role in controlling the incidence of fungal attack.

5- They improve nutritional status of the trees as well as produce healthy plants.

Table 6. Effect of different concentrations of ascorbic and citric acids on some chemical characters of Balady mandarin trees during 2006 and 2007 seasons.

Concentrations (B) ppm	Total soluble solids %					
	2006			2007		
	The two antioxidants (A)					
	a_1 ascorbic	a_2 citric	Mean (B)	a_1 ascorbic	a_2 citric	Mean (B)
b_1 0.0	11.0	11.2	11.1	11.2	11.5	11.4
b_2 250	11.4	11.7	11.6	11.6	11.9	11.8
b_3 500	12.0	12.5	12.3	12.0	12.5	12.3
b_4 1000	12.9	13.0	13.0	12.9	13.3	13.1
b_5 2000	13.0	13.1	13.1	13.0	13.4	13.2
Mean (A)	12.1	12.3		12.1	12.5	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.2	0.3	0.4	0.2	0.3	0.4
	Total acidity %					
b_1 0.0	1.372	1.371	1.372	1.391	1.390	1.391
b_2 250	1.336	1.300	1.318	1.341	1.314	1.328
b_3 500	1.300	1.260	1.280	1.300	1.270	1.285
b_4 1000	1.260	1.222	1.241	1.260	1.240	1.250
b_5 2000	1.255	1.220	1.238	1.255	1.238	1.247
Mean (A)	1.305	1.274		1.309	1.290	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.028	0.033	0.047	0.029	0.030	0.042
	Total sugars %					
b_1 0.0	7.52	7.52	7.52	7.41	7.41	7.41
b_2 250	7.80	8.52	8.16	7.70	8.41	8.06
b_3 500	9.33	8.84	8.59	8.21	8.70	8.46
b_4 1000	8.56	9.20	8.88	8.46	9.09	8.78
b_5 2000	8.60	9.22	8.91	8.49	9.11	8.80
Mean (A)	8.16	8.66		8.05	8.54	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	0.25	0.26	0.36	0.22	0.24	0.34
	Vitamin C content (mg/ 100 ml juice)					
b_1 0.0	33.1	33.0	33.1	37.2	37.2	37.2
b_2 250	35.0	38.0	36.2	39.0	41.5	40.3
b_3 500	39.5	41.0	40.3	41.5	44.0	42.8
b_4 1000	44.1	46.0	45.1	44.0	47.0	45.5
b_5 2000	44.5	46.6	45.6	44.4	47.3	45.9
Mean (A)	39.2	40.9		41.2	43.4	
New L.S.D. at 5 %	A	B	AB	A	B	AB
	1.0	1.0	1.4	1.0	1.1	1.5

6-They extend the shelf life of plant cells.

7-They have beneficial effect in delaying the loss of membrane integrity and ethylene production.

8-They are responsible for enhancing of peroxidase and catalase and the oxidation of H_2O_2 which is toxic to cells.

9-They are responsible in regulating of plant metabolism.

10-They enhancing the synthesis of natural hormones, proteins and photosynthesis.

11-They enhance nutrients uptake by plants.

12- They play a definite role in plant defense against oxidative stress induced by chemicals.

CONCLUSION

According to the obtained results, it is suggested to spray Balady mandarin trees four times in March, May, July and September with citric acid at 1000 ppm. Such promised treatment was responsible for obtaining an economical yield and improving fruit quality. This recommendation was true under middle Egypt conditions and the resembling conditions.

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علاقة الإثمار فى أشجار اليوسفي البلدي بالرش بمضادى الأكسدة الستريك والاسكوربيك

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خلال موسمى ٢٠٠٦ و ٢٠٠٧ تم استخدام مضادى الأكسدة الستريك والاسكوربيك بتركيز ٢٥٠ الى ٢٠٠٠ جزء فى المليون أربعة مرات وقد تم دراسة تأثيرهما على مساحة الورقة ومحتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم وكمية المحصول والخصائص الطبيعية والكيمائية لثمار اليوسفي البلدي.

ولقد اشارت نتائج التجربة ان رش مضادى الأكسدة بتركيز ٢٥٠ الى ٢٠٠٠ جزء فى المليون أربعة مرات كان فعالا جدا فى تحسين مساحة الورقة ومحتواها من النيتروجين والفوسفور والبوتاسيوم وكمية المحصول وخصائص الجودة وذلك بالمقارنة بعدم الرش. وكان التحسن مرتبطا بزيادة التركيز المستخدم منهما بدون تأثير واضح بين التركيزين ١٠٠٠ و ٢٠٠٠ جزء فى المليون. وقد تفوق استخدام حامض الستريك عن استخدام حامض الأسكوربيك فى هذا الصدد.

يقترح رش حامض الستريك أربعة مرات بتركيز ١٠٠٠ جزء فى المليون للحصول على محصول اقتصادي وتحسين جودة الثمار فى أشجار اليوسفي البلدي.