Journal of Applied Sciences Research, 9(2): 1228-1237, 2013
ISSN 1819-544X
This is a refereed journal and all articles are professionally screened and reviewed

ORIGINAL ARTICLES

Effect of Some Antioxidants and Micronutrients on Growth, Leaf Mineral Content, Yield and Fruit Quality of Canino Apricot Trees

El-Badawy, H.E.M.

Hort. Dept. Fac. of Agric. Benha Univ. Egypt.

ABSTRACT

A two year- trial was conducted during 2008 and 2009 seasons in a private orchard at El-Nubaria, Behaira Governorate, Egypt, to study the effect of some antioxidants i.e ascorbic acid and citric acid each at 1000 or 2000ppm and mixture of Fe, Zn and Mn at 100 or 200ppm as well as their combinations three times a year started from the first week of March with two weeks intervals on tree growth, leaf mineral content, fruiting and fruit quality of Canino apricot trees. All tested antioxidant and micronutrient treatments as well as their combinations, improved vegetative growth traits i.e. shoot length, number of leaves/shoot and leaf area (cm^2), especially the high levels in both seasons. The highest leaf N, P and K content was gained by different tested treatments particularly, the combination of ascorbic acid at 2000ppm and micronutrients at 200ppm in both seasons. In addition, fruiting parameters i.e. fruit set and fruit yield (kg/tree) were greatly enhanced by the antioxidants and micronutrients as well as their combinations in both seasons. Moreover, the best results of fruiting parameters were existed with high level of antioxidant and micronutrient combinations in both seasons. Furthermore, the heaviest fruit weight (g) and the highest T.S.S. %, V.C (mg/100 ml juice), total sugars % and fruit firmness ($lb/inch^2$) values as well as the lowest value of total acidity % were scored by the high level of antioxidants and macronutrients as well as their combinations.

Key words: antioxidants, micronutrients, vegetative growth, yield, chemical constituents and apricot.

Introduction

Apricot (*Prunus armeniaca* L.) is the specie of genus *Prunus*, classified with the *Prunoidae* subfamily of *Rosaceae* family. Fruits of apricot are being not only consuming fresh but also produce dried apricot, frozen apricot, jam, jelly, marmalade, pulp, juice nectar dried and extrusion products etc. Also, apricot kernel is used in production of oil, benzaldehyde, cosmetics, active carbon and aroma perfume (Yildiz, 1994).

Several investigators have made trials to enhance production and quality of apricot trees. Recently, antioxidants are suggested for improving yield, integrity and producing organic fruits in various fruit crops. These compounds as non-enzymatic materials have beneficial effects on catching free radicals or the active oxygen species namely, singlet oxygen, superoxide anion, hydrogen peroxide, hydroxyl radicals and ozone that biosynthesized during plant metabolism. Leaving these free radicals without chelating or catching leads to oxidation of lipids, loss of plasma membrane permeability and death of cells with plant tissues. In addition, they also have an auxin action (Prusky, 1988; Elade, 1992 and Raskin, 1992a&b). The positive effects of antioxidants have been reported by several researchers on growth, yield and fruit quality of fruit trees (Bertschinger and Stadler, 1997, Ahmed and Abdelaal, 2007 and Mansour *et al.*, 2011).

On the other hand, the importance of micro elements fertilization was known since 1938, where Fe, Mn, Zn and Cu were applied in most commercial fruit orchards. The application of these elements proved to be successful for correcting some nutrient deficiencies, improve tree condition and increase yield. The insufficient supply of micro elements to fruit trees under different soils and environment conditions is considered to be one of the most important nutritional problems (El-Gazzar *et al.*, 1979).

Iron (Fe) is an essential element for several plant metabolic functions, including chlorophyll synthesis and the electron transport system of respiration (Taiz and Zeiger, 1998a&b). All plants need a continuous supply of iron during growth because it is not translocated from the mature to developing leaves and is classified as an immobile nutrient element (Mengel and Kirkby, 1982).

Zinc (Zn) is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their vigorous growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism (Swietlik, 1999). Zinc availability to plants is reduced in high pH soils (Marschner, 1995).

Corresponding Author: El-Badawy, H.E.M., Hort. Dept. Fac. of Agric. Benha Univ. Egypt.
E-mail: h.elzaabalawy@yahoo.com

Similar to zinc; manganese (Mn) also is a micronutrient, the functions of which are fairly known. It is involved in the oxygen-evolving step of photosynthesis and membrane function, as well as serving as an important activator of numerous enzymes in the cell (Wiedenhoeft, 2006). Soil application of Mn is problematic, since its efficiency depends on many soil factors, including soil pH. A suitable method for the correction and /or prevention of Mn deficiency in plants is the foliar application of ionic or chelated solution forms of this nutrient (Papadakis *et al.,* 2007).

Thereupon, this study aimed to evaluate the effect of some antioxidants (ascorbic acid and citric acid) and micronutrients mixture (Zn, Fe and Mn) on growth, yield and fruit quality of Canino apricot trees.

Material and Methods

This investigation was conducted during 2008 and 2009 seasons in a private orchard at El-Nubaria, Behaira Governorate, Egypt. Ten-year-old 'Canino' apricot trees (planted at 5 x 5m a part and budded on local apricot rootstock), grown in a sandy soil under drip irrigation system and received the common cultural practices. Trees used in the experiment were selected to be healthy and as uniform in growth behavior and yield as possible. The trees were trained and pruned uniformly to an open center shape.

The selected trees were subjected to the following treatments:

A- Trees were foliar sprayed with antioxidants i.e. ascorbic and citric acids at 1000 and 2000ppm for each three times a year started from the first week of March with two weeks intervals.

B- Trees were foliar sprayed with a mixture of iron, zinc and manganese sulphates at 100 and 200ppm three times a year started from the first week of March with two weeks intervals.

C- Trees were foliar sprayed with tap water as a control in the previously mentioned three dates.

Tween twenty at 0.01% was applied as a wetting agent to all sprayed solutions including the control. Trees were sprayed till runoff and received the recommended agricultural practices regularly followed in commercial orchards. Each treatment was replicated three times, with two trees for each replicate.

Experiment layout:

The design of the experiment was a split plot design with 15 treatments (5 antioxidant concentrations x 3 micronutrients concentrations) replicated 3 times (each replicate consisted of two trees). The antioxidants treatments assigned to the main plots, where the micronutrients treatments were employed to the sub plot.

The response of Canino apricot trees to the tested treatments was evaluated through the following data measurements:

Data were recorded on shoot length, number of leaves/ shoot, leaf area during August. Percentage of fruit set was estimated, fruit yield per tree was weighed (Kg) and fruit weight (g). Data of chemical properties were determined for total soluble solids in fruit juice using a hand refractometer. Moreover, fruit titratable acidity (malic acid (g)/ 100ml of juice) and ascorbic acid (V.C) content (ascorbic acid (mg)/ 100ml fruit juice) were estimated according to A.O.A.C. (1985). Fruit total sugars (%) of fresh weight were determined using the Nelson arseno molybdate colorimetric method as described by Malik and Singh (1980). Besides, leaf N, P and K content were determined according to A.O.A.C. (1985).

Statistical analysis:

Data obtained during the both seasons of study were subjected to analysis of variance as a factorial experiment in split plot design. L.S.D. method was used to compare between means according to Snedecor and Cochran (1980).

Results and Discussion

1. Tree growth:

1.1. Shoot length (cm):

Results show that all tested antioxidant sprays significantly increased shoot length with superiority for 2000ppm ascorbic acid-sprayed trees as compared with control in both seasons of this study (Table, 1). As for the effect of micronutrients, data in the same Table reveal that both levels of micronutrients statistically increased shoot length, especially the high level as compared with control (tap water) in both seasons. Regarding the interaction effect between antioxidant and micronutrients, data in Table (1) show that all combinations succeeded in increasing shoot length of Canino apricot trees as compared with control in both seasons. However, the combined treatment between ascorbic acid at 2000ppm and micronutrients at 200ppm is being the most effective one for inducing the highest value in this concern, followed by the combined treatment of 1000ppm ascorbic acid and 200ppm micronutrients as compared with control (an average of both seasons).

1.2. Number of leaves/shoot:

Data in Table (1) reveal that the highest number of leaves/shoot was gained by ascorbic acid at 2000ppm, followed by citric acid at 2000ppm as compared with control in both seasons. Also, both levels of micronutrients exhibited highly significant increments in this concern, particularly the high level when compared with untreated trees (control) in both seasons. As for the interaction effect between antioxidants and micronutrients, results of Table (1) indicate that all tested combinations significantly increased the number of leaves/shoot, especially the combined treatment of citric acid at 2000ppm and micronutrients at 200ppm in the first season, and the combined treatment of ascorbic acid at 2000ppm and micronutrients at 200ppm in the second one as compared with other combinations and control in both seasons.

Table 1: Effect of some antioxidants and micronutrients on shoot length (cm), number of leaves/ shoot and leaf area (cm^2) of Carino apricot trees during 2008 and 2009 seasons.

Parameters	Shoot length (cm)				Number of leaves/ Shoot				Leaf area (cm^2)			
B- (Fe, Zn and Mn) A- Antioixidants	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean
2008 season												
0.0ppm	35.32	42.08	43.83	40.41	34.17	36.21	37.19	35.86	32.60	33.09	33.96	33.22
Ascorbic acid at 1000ppm	36.49	44.30	47.20	42.66	34.48	37.27	39.31	37.02	33.08	33.06	33.10	33.08
Ascorbic acid at 2000ppm	41.47	44.40	47.17	44.35	35.01	37.93	39.17	37.37	32.73	33.12	35.20	33.68
Citric acid at 1000ppm	35.70	42.97	43.56	40.74	34.50	35.92	37.23	35.88	32.66	33.13	35.07	33.62
Citric acid at 2000ppm	40.70	43.73	47.37	43.93	35.27	36.25	39.70	37.07	32.74	33.20	35.17	33.70
Mean	37.94	43.50	45.83		34.69	36.72	38.52		32.76	33.12	34.50	
L.S.D at 5%	A = 1.303 B = 1.009 A*B = 2.25				A = 1.089 B = 0.921 A*B = 2.060				A = 0.680 B = 0.527 A*B = 1.178			
2009 season												
0.0ppm	41.20	43.47	45.62	43.43	36.92	38.13	40.17	38.41	32.67	33.90	34.46	33.68
Ascorbic acid at 1000ppm	47.32	46.32	52.07	48.57	36.72	40.56	42.30	39.86	33.20	33.93	35.33	34.16
Ascorbic acid at 2000ppm	43.51	48.02	54.70	48.74	37.70	41.61	43.30	40.87	33.33	34.33	36.70	34.79
Citric acid at 1000ppm	42.70	47.18	50.20	46.69	36.83	39.74	41.20	39.26	33.32	33.97	35.26	34.18
Citric acid at 2000ppm	42.70	48.20	48.20	46.37	37.20	40.92	42.13	40.08	33.58	34.00	35.36	34.31
Mean	43.49	46.64	50.16		37.07	40.19	41.82		33.22	34.03	35.42	
L.S.D at 5%	A = 0.956 B = 0.740 A*B = 1.657				A = 1.314 B = 1.018 A*B = 2.277				A = 0.330 B = 0.256 A*B = 0.572			

1.3. Leaf area (cm^2):

Table (1) shows that leaf area of Canino apricot trees was increased in most cases by all tested applications of antioxidants in both seasons. The increase in this parameter was insignificant in the first season and significant in the second one. However, the highest value of leaf area was scored by 1000ppm citric acid-sprayed trees in the first season and 2000ppm ascorbic acid-sprayed trees in the second one. In addition, all micronutrient treatments significantly increased leaf area with superiority was for the higher concentration as compared with control in both seasons. Referring to the interaction effect between antioxidant and micronutrients, data in Table (1) illustrate that leaf area of Canino apricot trees was increased due to all tested combinations as compared by control in both seasons. However, the combined treatment between ascorbic acid at 2000ppm and micronutrients at 200ppm induced the highest value in this concern, followed by the joined treatment between citric acid at 2000ppm and micronutrients at 200ppm in the first and second seasons of this study.

The improving effect of ascorbic and citric acid on growth might be attributed to its auxinic action that was reflected on enhancing cell division as well as its effect on simulating the biosynthesis of carbohydrates. Auxinic action of both ascorbic and citric acid on enhancing cell division and cell enlargement which reflected positively on leaf area was concluded by Ahmed *et al.*, (1998) and Omar (1999). The benefits of ascorbic acid on controlling various disorders give another interpretation (Khiamy, 2003). The obtained results of ascorbic and citric acid on vegetative tree growth of Canino apricot trees are in agreement with those of Fathi *et al.*, (2002) on Desert Red peaches and Hasaballa (2002) on Manfalouty pomegranate trees and Ali (2000), Ahmed *et al.*, (2002), Sayed (2002), Khiamy (2003) and Wassel *et al.*, (2007) on different grapevine cultivars. They pointed out that antioxidants such as ascorbic acid, citric acid, Ascobine or Citrine were very effective in enhancing growth parameters namely shoot length, Number of leaves/shoot and leaf area.

Enhancing growth characters in response to the foliar application of micronutrients may be due to their positive action on increasing cell division in the meristematic tissues and accelerating carbohydrates and proteins formation (Ghanta and Metra, 1993). Also, these elements play an important role in the multi-biological processes such as the role of Zn in the synthesis of IAA (Nijjar, 1985). The obtained results concerning the positive effect of foliar sprays with the mixture of micronutrients (Fe, Zn and Mn) on some vegetative growth parameters of Canino apricot trees go in line with the findings of Gendiah and Hagagy (2000), Kumar and Jayakumar (2001), Wassel *et al.*, (2007), Maklad (2010) and Seyam (2012). They mentioned that spraying the different studied of fruit crop species with Fe, Mn and Zn alone or in combinations enhanced many vegetative growth parameters.

2. Leaf N, P and K content:

Data in Table (2) clear that all antioxidant treatments succeeded in increasing leaf N, P and K content, with superiority for 2000ppm ascorbic acid-treated trees as compared with untreated ones (control) in both seasons with the exception of leaf N content in the second season, hence the increment failed to reach the significant level. The obtained results of ascorbic and citric acid are in harmony with earlier reports of Ali (2000), Ahmed *et al.*, (2002) and Khiamy (2003) on Flame seedless grapevines. They reported that percentages of N, P and K in the leaves were positively response to spraying with citric acid and ascorbic acid as antioxidant. Increasing concentrations of antioxidant was accompanied with a progressive increments in the leaf N, P, and K content.

Table 2: Effect of some antioxidants and micronutrients on leaf N, P and K % of Carino apricot trees during 2008 and 2009 seasons.

Parameters	N %				P %				K %			
B- (Fe, Zn and Mn) / A- Antioixidants	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean
2008 season												
0.0ppm	2.08	2.23	2.42	2.24	0.150	0.156	0.160	0.155	1.29	1.40	1.44	1.38
Ascorbic acid at 1000ppm	2.26	2.40	2.50	2.39	0.150	0.162	0.170	0.161	1.36	1.52	1.56	1.48
Ascorbic acid at 2000ppm	2.30	2.46	2.53	2.43	0.155	0.164	0.176	0.165	1.42	1.56	1.63	1.54
Citric acid at 1000ppm	2.16	2.40	2.48	2.35	0.153	0.162	0.168	0.161	1.29	1.45	1.52	1.42
Citric acid at 2000ppm	2.30	2.42	2.50	2.41	0.155	0.162	0.166	0.161	1.39	1.50	1.56	1.48
Mean	2.22	2.38	2.49		0.153	0.161	0.168		1.35	1.49	1.54	
L.S.D at 5%	A = 0.034 B = 0.033 A*B = 0.075				A = N.S B = N.S A*B = 0.050				A = 0.031 B = 0.024 A*B = 0.053			
2009 season												
0.0ppm	2.32	2.48	2.55	2.45	0.139	0.150	0.155	0.148	1.32	1.40	1.47	1.40
Ascorbic acid at 1000ppm	2.40	2.51	2.55	2.49	0.153	0.157	0.164	0.158	1.40	1.56	1.56	1.51
Ascorbic acid at 2000ppm	2.40	2.53	2.60	2.51	0.162	0.164	0.167	0.164	1.42	1.56	1.60	1.53
Citric acid at 1000ppm	2.35	2.47	2.48	2.43	0.150	0.158	0.162	0.157	1.37	1.54	1.52	1.48
Citric acid at 2000ppm	2.35	2.47	2.52	2.45	0.156	0.160	0.165	0.160	1.40	1.50	1.52	1.47
Mean	2.36	2.49	2.54		0.152	0.158	0.163		1.38	1.51	1.53	
L.S.D at 5%	A = 0.153 B = 0.118 A*B = 0.264				A = N.S B = N.S A*B = 0.047				A= 0.029 B = 0.022 A*B = 0.050			

Moreover, both levels of micronutrients increased leaf N, P and K content as compared with untreated trees in both seasons. The increment was insignificant in case of leaf P content and significant in case of leaf N and K content in both seasons. The obtained results of foliar sprays with micronutrients mixture (Fe, Mn and Zn) on leaf mineral content of Canino apricot trees are in harmony with the findings of Gendiah and Hagagy (2000), Rathore and Atul-Chandra (2001), Tariq *et al.*, (2007) and Seyam (2012). They mentioned that foliar sprays with Fe, Mn and Zn alone or in combinations enhanced leaf mineral content.

In general, different applied combinations between antioxidants and micronutrients increased leaf N, P and K content as compared with control in both seasons. However, the richest leaf N, P and K contents were obtained by the combined treatment of ascorbic acid at 2000ppm and the micronutrients at 200ppm in both seasons.

3. Fruiting:

3.1. Fruit set (%):

Table (3) indicates that all studied antioxidant treatments succeeded in increasing fruit set % of Canino apricot trees, particularly 2000ppm ascorbic acid treatment in both seasons. Additionally, both levels of micronutrients exhibited highly significant increments in this parameter, especially the high level when compared with untreated trees (control) in both seasons. Regarding the interaction effect between antioxidant and micronutrient treatments, data in Table (3) reveal that fruit set percentages was greatly increased by different combinations, especially the combined treatment between ascorbic acid at 2000ppm and micronutrients at 200ppm as an average of both seasons as compared with untreated trees (control) in both seasons.

Table 3: Effect of some antioxidants and micronutrients on fruit set % and fruit yield (kg/tree) of Carino apricot trees during 2008 and 2009 seasons.

Parameters	Fruit set %				Fruit yield (kg/tree)			
B- (Fe, Zn and Mn) / A- Antioixidants	0.0ppm	100ppm	200ppm	mean	0.0ppm	100ppm	200ppm	mean
2008 season								
0.0ppm	19.70	22.13	24.03	21.95	35.43	38.17	40.74	38.11
Ascorbic acid at 1000ppm	20.20	24.70	24.67	23.19	37.52	41.36	42.94	40.61
Ascorbic acid at 2000ppm	21.70	26.23	26.17	24.70	40.31	43.58	45.73	43.21
Citric acid at 1000ppm	19.90	24.27	24.33	22.83	37.25	40.55	41.41	39.74
Citric acid at 2000ppm	20.60	25.17	24.90	23.56	39.76	40.43	43.17	41.12
Mean	20.42	24.50	24.82		38.05	40.82	42.80	
L.S.D at 5%	A = 0.465 B= 0.360 A*B = 0.806				A = 0.891 B = 0.861 A*B = 1.544			
2009 season								
0.0ppm	21.30	20.33	23.97	21.87	37.35	41.30	42.10	40.25
Ascorbic acid at 1000ppm	24.70	23.70	25.20	24.53	40.57	44.73	45.33	43.54
Ascorbic acid at 2000ppm	24.90	24.87	26.10	25.29	40.95	45.73	46.50	44.39
Citric acid at 1000ppm	23.43	23.88	24.30	23.87	39.90	43.10	43.15	42.05
Citric acid at 2000ppm	23.60	24.33	24.70	24.21	40.70	43.10	45.10	42.97
Mean	23.59	23.42	24.85		39.89	43.59	44.44	
L.S.D at 5%	A = 0.545 B = 0.423 A*B = 0.945				A= 0.668 B = 0.517 A*B = 1.156			

3.2. Fruit yield (kg/tree):

Table (3) demonstrates that the highest fruit yield/tree was recorded by 2000ppm ascorbic acid-treated trees, followed by 1000ppm ascorbic acid-treated trees as compared with control in both seasons. Besides, micronutrients at 200ppm induced highly significant increments in this parameter as compared with control in both seasons. Generally, the highest fruit yield (kg/tree) was gained by the interaction between 2000ppm ascorbic acid and 200ppm micronutrients as compared with control in both seasons.

The enhancing effect of ascorbic and citric acids on growth parameters and nutritional status of Canino apricot trees was surely reflected on improving fruit set and yield. These results are in harmony with those of Mansour *et al.*, (2006) and Ahmed and Abdelaal (2007) on Anna apple trees, Khiamy (2003), Wassel *et al.*, (2007) and Fayed (2010) on grapevines and Mansour *et al.*, (2010) on four mango cultivars.

Foliar sprays of micronutrients mixture (Fe, Zn and Mn) that gave positive effects on tree fruiting parameters of Canino apricot trees go in line with the findings of Hammam *et al.*, (2001), Saleh and El-Monem (2003), Dutta (2004), Tariq *et al.*, (2007), Ranjit *et al.*, (2008), El-Kosary *et al.*, (2011) and Seyam (2012). They mentioned that the application of micronutrient treatments (Fe, Zn and Mn) lonely or in combination enhanced fruiting parameters of the different fruit crop species. In this concern, Akl *et al.*, (1996), Youssef (1997) and Abd El-Aziz (2001) supported the beneficial effect of applying micronutrients on trees yield.

4. Fruit quality:

4.1. Fruit weight (g):

Table (4) demonstrates that the different tested antioxidant treatments statistically increased fruit weight (g) of Canino apricot with superiority for 2000ppm ascorbic acid-sprayed trees as compared with control in both seasons. Also, both levels of micronutrients resulted highly increments in this parameter, especially the high level in both seasons. In general, ascorbic acid at 2000ppm and micronutrients at 200ppm combination showed to be the most promising one in producing the heaviest fruits as compared with the other tested combinations and control in both seasons.

4.2. Fruit firmness (lb/inch^2):

Table (4) shows that fruit firmness of Canino apricot trees was increased due to all tested antioxidant treatments as compared with control with the superiority for 2000ppm ascorbic acid-sprayed trees in both seasons of this study. On contrary, both levels of micronutrients decreased fruit firmness as compared with untreated trees (control) in both seasons. In general, the highest value was scored by the combination of 2000ppm ascorbic acid and 0.0ppm micronutrients as compared with control and other treatments in both seasons.

4.3. Total soluble solid (T.S.S %):

Table (4) illustrates that T.S.S. % of Canino apricot fruit was slightly increased by using all tested applications of antioxidants, particularly 2000ppm ascorbic acid-sprayed trees as compared with control in both seasons of this study. Moreover, both levels of micronutrients succeeded in increasing T.S.S. %, with superiority for 200ppm micronutrient-sprayed trees when compared with control in both seasons. Generally, all combinations between antioxidants and micronutrients treatments increased T.S.S. % of Canino apricot fruits as compared with control in both seasons. However, the highest value of this parameter was registered by the combined treatment of ascorbic acid at 2000ppm and micronutrients at 200ppm in both seasons.

Table 4: Effect of some antioxidants and micronutrients on fruit weight (g), Firmness (lb/inch^2) and T.S.S % of Carino apricot trees during 2008 and 2009 seasons.

Parameters	Fruit weight (g)				Firmness (lb/inch^2)				T.S.S %			
B- (Fe, Zn and Mn) / A- Antioixidants	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean
2008 season												
0.0ppm	28.50	29.60	30.03	29.38	7.80	7.67	7.70	7.72	11.20	11.40	11.86	11.49
Ascorbic acid at 1000ppm	28.70	29.63	31.00	29.78	8.03	7.70	7.70	7.81	11.33	11.50	11.90	11.58
Ascorbic acid at 2000ppm	29.13	29.97	31.00	30.03	8.10	7.87	7.80	7.92	11.47	11.56	12.10	11.71
Citric acid at 1000ppm	28.57	29.77	30.50	29.61	8.00	7.80	7.80	7.87	11.23	11.60	12.00	11.61
Citric acid at 2000ppm	29.00	29.70	30.87	29.86	8.10	7.87	7.80	7.92	11.30	11.50	12.00	11.60
Mean	28.78	29.73	30.68		8.01	7.78	7.76		11.31	11.51	11.97	
L.S.D at 5%	A = 0.130 B = 0.100 A*B = 0.224				A = 0.114 B = 0.089 A*B = 0.198				A= 0.097 B = 0.075 A*B = 0.167			
2009 season												
0.0ppm	26.80	27.70	28.50	27.67	7.93	7.90	7.77	7.87	10.80	11.30	11.50	11.20
Ascorbic acid at 1000ppm	27.24	28.53	29.77	28.51	8.05	7.90	7.90	7.95	10.80	11.43	11.50	11.24
Ascorbic acid at 2000ppm	27.47	29.40	30.67	29.18	8.13	8.10	7.97	8.07	11.03	11.40	11.57	11.33
Citric acid at 1000ppm	26.74	28.87	29.83	28.48	8.10	8.03	7.90	8.01	10.93	11.25	11.27	11.15
Citric acid at 2000ppm	27.10	28.33	30.20	28.54	8.10	8.07	8.00	8.06	11.00	11.36	11.50	11.29
Mean	27.07	28.57	29.79		8.06	8.00	7.91		10.91	11.35	11.47	
L.S.D at 5%	A = 0.110 B = 0.085 A*B = 0.191				A = 0.101 B = 0.078 A*B = 0.175				A = 0.235 B = 0.182 A*B = 0.406			

4.4. Total sugars (%):

Table (5) indicates that antioxidant treatments statistically increased total sugars percentage of Canino apricot fruits, especially 2000ppm ascorbic acid treatment as compared with control in both seasons. Furthermore, both levels of micronutrients succeeded in increasing this parameter, particularly the high level in both seasons. Generally, all tested combinations of antioxidants and micronutrients statistically increased total sugars percentage as compared with control in both seasons. However, the highest value in this respect was recorded by combination of ascorbic acid at 2000ppm and micronutrients at 200ppm as compared with control in both seasons.

4.5. Total acidity (%):

It was noticed from Table (5) that total acidity (%) of Canino apricot fruits was decreased due to all tested antioxidant treatments as compared with control in the two seasons. However, the lowest value in this respect was gained by using 2000ppm ascorbic acid-sprayed trees in both seasons. In addition, all tested micronutrient treatments decreased fruit total acidity (%) especially, the high level as compared with control in both seasons. Generally, the lowest total acidity percentage of Canino apricot fruits was scored by combination of ascorbic acid at 2000ppm and micronutrients at 200ppm as compared with untreated trees (control) in both seasons.

4.6. Ascorbic acid content (V.C) (mg/100 ml juice):

Data in Table (5) reveal that 2000ppm ascorbic acid-sprayed trees significantly produced the highest ascorbic acid content (mg/100 ml juice) of Canino apricot fruits as compared with control in both seasons. Also, both levels of micronutrients produced high increments in this parameter, especially the high level as compared with untreated trees in both seasons. In general, the highest values of this parameter were scored by the combination of ascorbic acid at 2000ppm and micronutrients at 200ppm in the first season, while in the second one the interaction between citric acid at 2000ppm and micronutrients at 200ppm showed its superiority in this concern.

Table 5: Effect of some antioxidants and micronutrients on total sugars %, total acidity % and V.C (mg/100 ml juice) and T.S.S % of Carino apricot trees during 2008 and 2009 seasons.

Parameters	Total sugars %				Total acidity %				V.C (mg/100 ml juice)			
B- (Fe, Zn and Mn) / A- Antioixidants	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean	0.0 ppm	100 ppm	200 ppm	mean
2008 season												
0.0ppm	7.22	7.43	7.86	7.50	1.40	1.30	1.30	1.33	14.20	14.73	15.57	14.83
Ascorbic acid at 1000ppm	7.30	7.50	7.90	7.57	1.40	1.28	1.20	1.29	14.53	14.83	15.60	14.99
Ascorbic acid at 2000ppm	7.37	7.54	8.12	7.68	1.36	1.26	1.23	1.28	14.60	15.02	16.40	15.34
Citric acid at 1000ppm	7.30	7.60	8.10	7.67	1.40	1.30	1.25	1.31	14.50	14.93	16.00	15.14
Citric acid at 2000ppm	7.35	7.48	8.12	7.65	1.40	1.28	1.28	1.32	14.60	14.93	16.40	15.31
Mean	7.31	7.51	8.02		1.39	1.28	1.25		14.49	14.89	15.99	
L.S.D at 5%	A= 0.086 B = 0.067 A*B = 0.150				A = 0.043 B = 0.034 A*B = 0.075				A= 0.178 B = 0.138 A*B = 0.308			
2009 season												
0.0ppm	7.06	7.31	7.52	7.30	1.45	1.37	1.37	1.40	13.87	14.50	15.21	14.53
Ascorbic acid at 1000ppm	7.10	7.40	7.67	7.39	1.40	1.37	1.30	1.36	14.20	14.75	16.10	15.02
Ascorbic acid at 2000ppm	7.23	7.40	7.67	7.43	1.40	1.30	1.25	1.32	14.40	14.95	16.10	15.15
Citric acid at 1000ppm	7.15	7.35	7.60	7.37	1.46	1.35	1.35	1.39	14.30	14.65	16.13	15.03
Citric acid at 2000ppm	7.20	7.40	7.60	7.40	1.45	1.30	1.30	1.35	14.33	14.87	15.97	15.06
Mean	7.15	7.37	7.61		1.43	1.34	1.31		14.22	14.74	15.90	
L.S.D at 5%	A = 0.101 B = 0.078 A*B = 0.175				A= 0.043 B = 0.034 A*B = 0.075				A = 0.224 B = 0.174 A*B = 0.389			

The recorded results of ascorbic and citric acids on enhancing fruit quality are in harmony with earlier studies of Ali (2000), Ahmed *et al.*, (2002) and Sayed (2002) on grapevines, Abd El-Aziz (2001) on Anna apples, Hasaballa (2002) and Fayed (2010) on Manfalouty pomegranates and Mansour *et al.*, (2010) on four mango cultivars. They reported that spraying different fruit trees with antioxidants such as ascorbic acid, citric acid, Ascobine and Citrine was very effective in improving fruit quality in terms of raising T.S.S, total sugars and V.C and reducing total acidity.

The obtained results concerning the effects of foliar sprays with micronutrients mixture (Fe, Mn and Zn) on fruit quality traits of Canino apricot trees go in line with the findings of Gendiah and Hagagy (2000), Tariq et al (2007) on orange trees, Wassel *et al.*, (2007) on grapevines, Dutta and Dhua (2002) and El-Kosary *et al.*, (2011) on mango trees. They reported that foliar sprays with micronutrients (Fe, Mn and Zn) induced higher positive effect on chemical fruit quality parameters of the previously mentioned fruit crop species. In addition, Hammam *et al.,* (2001), Dutta (2004) and Vejendla *et al.,* (2008) found that fruit weight increased with increasing the concentration of trace element foliar application of Fe, Zn and Mn.

On the other hand, Elade (1992) stated that, using citric acid as antioxidant is suggested mainly for improving yield and fruit quality instead of using synthetic auxins which greatly damaged and polluted out environment. It has many functions in plant metabolism. It catches all free radical produced during plant metabolism, since leaving these free radicals leads to oxidation of lipids, loss of plasma membrane permeability and later the death of the cells and also it has an auxinic action. In this respect Maksoud *et al.,* (2009) indicated that sole application of either ascorbic acid or citric acid 2000 ppm improved yield and fruit quality of olive trees. Also, Mansour *et al.,* (2008) reported that, a promising influence was detected on yield and fruit quality when all nutrients (Fe, Zn and Mn) and citric acid were applied together.

The present study is strongly admit the use of antioxidants such as ascorbic and citric acids at 1000 and 2000ppm for each as well as micronutrients mixture (Fe, Zn and Mn) at 100 and 200ppm as foliar sprays during the time of early yearly growth of Canino apricot trees. That could be stimulate not only the vigorous tree growth but also reaching to significant increase in fruit yield as well as getting good and high quality of yielded fruits.

References

A.O.A.C., 1985. Association of Official Agricultural Chemists. Official Methods of Analysis. 5th ed. pp. 495-510. Benjamin Franklin Station, Washington. D.C., U.S.A.

Abd El-Aziz, Y.Z., 2001. Effect of some micro and macro nutrients as well as vitamin C on productivity of Anna apple trees *(Malus domestica,* L.). M. Sc. Thesis. Fac. of Agric. Minia Univ., Egypt.

Ahmed, F.F. and A.M.K. Abdelaal, 2007. Influence of spraying seaweed extract and citric acid on yield and fruit quality of Anna apple trees. The 1st Inter. Conf. on Desert cultivation 27-29 Mar. El-Minia Univ., El-Minia, Egypt.

Ahmed, F.F., A.M. Akl, A.A. Gobara and A.E.M. Mansour, 1998. Yield and quality of Anna apple trees (*Malus domestica,* L.) in response to foliar application of Ascorbine and Citrine fertilizers. Egypt. J. Hort., 25(2): 203-208.

Ahmed, F.F., O.H. Darwish, A.A. Gobara and A.H. Ali, 2002. Physiological studies on the effect of ascorbic and citric acid in combined with some micronutrients on Flame seedless grapevines. Minia J. of Agric. Res. & Develop, 22(1): 105-114.

Akl, A.M., F.F. Ahmed and W.S. Youssef, 1996. Behaviour of Red Roomy grapevines to cycocel and some micronutrients. II-The effect on nutritional status of the vines, berry set and yield. Hort. Sci. Publications of the Amer. Soc. for Hort. Sci., 31(4): 628.

Ali, A.H., 2000. Response of Flame seedless grapevines to spraying with ascorbic acid and boron. Minia J. of Agric. Res. & Develop, 20(1): 159-174.

Bertschinger, L. and W. Stadler, 1997. Vitamin E first results from field trials in Switzerland. Obstund Weinbau, 133(6): 150-152.

Dutta, P., 2004. Effect of foliar boron application on panicle growth, fruit retention and physico-chemical characters of mango cv. Himsagar. Indian J. Hort., 61: 265-266.

Dutta, P. and R.S. Dhua, 2002. Improvement on fruit quality of Himsagar mango through application of zinc, iron and manganese. Hortic. J., 15: 1-9.

Elade, V., 1992. The use of antioxidants to control gray mould (Botrytic cinera) and white mould (Sclerotinia sclerotiorom) in various crops. Plant Pathol., 141: 417-426.

El-Gazzar, A.M., S.M. Elazab and A. Elsafty, 1979. Response of Washington navel orange to foliar application of chelated iron, zinc and manganese. Alex. J. Agric. Res., 27(1): 19-26.

El-Kosary, S., I.E. El-Shenawy and S.I. Radwan, 2011. Effect of microelements, amino and humic acid on growth, flowering and fruiting of some mango cultivars. Journal of Horticultural Sciences &Ornamental Plants, 3(2): 152-161.

Fathi, M.A., M. Eissa-Fawzia and M.M. Yehia, 2002. Improving growth, yield and fruit quality of Desert Red and Anna apple by using some biostimulants. Minia J. of Agric. Res. & Develop, 22(4): 610-628.

Fayed, T.A., 2010. Effect Of Some Antioxidants On Growth, Yield and Bunch Characteristics of Thompson Seedless Grapevines. Amer. Eurasian J. Agric & Environ. Sci., 8(3): 322-328.

Gendiah, H.M. and N.A.A. Hagagy, 2000. Physiological studies on the effect of some micronutrients foliar fertilization treatments on nutritional status, growth and fruiting of Washington navel orange trees. Annals of Agric. Sc., Moshtohor, 38(2): 1811-1194.

Ghanta, P.K. and S.K. Mitra, 1993. Effect of micronutrients on growth, flowering, leaf nutrient content and yield of banana cv., Giant cavandishii. Crop Research, 2: 284-287.

Hammam, M.S., A.M.T. Sabour and E. Sanaa, 2001. Trials for alleviating inflorescence malformation in Taimour and Mabrouka mango trees. Annals of Agri. Sci., Cairo, 46: 753-766.

Hasaballa, M.A., 2002. Effect of spraying some nutrients and Vitamin C on fruit splitting, yield and quality of Manfalouty pomegranate trees. M. Sc. Thesis Fac. of Agric., El-Minia Univ., Egypt.

Khiamy, A.O., 2003. Response of Flame seedless grapevine growing in sandy soil to different pruning dates and application of urea and ascorbic acid. Ph.D. Thesis Fac. of Agric., El-Minia Univ., Egypt.

Kumar, N. and P. Jayakumar, 2001. Influence of micro nutrients on growth and yield of banana *(Musa sp.)* cv. Robusta (AAA). Plant-Nutrition-Food Security and substainabilit of Agro-ecosystems-through-basic and Applied Research. Fourteenth International Plant Nutrition Colloquium. Itannover, Germany, 354-355. (CAB. Abst. 2001).

Maklad, T.N.A., 2010. A comparative study on effect of source, rate and application method of some fertilizers on growth and yield of banana plant. Ph. D. Dissertation. Fac. Agric. Benha University. Egypt.

Maksoud, M.A., M.A. Salah, M.S. El-Shamma and A.A. Fauad, 2009. The beneficial effect of biofertilizers and antioxidants on olive trees under calcareous soil conditions. World. J. Agric. Sci., 5: 350-352.

Malik, C.P. and M.B. Singh, 1980. Plant Enzymology and Histo-Enzymology. A Text Manual, pp: 276-277. Kalyani Publishers, New Delhi, India.

Mansour, A.E.M., F.F. Ahmed, A.M.K. Abdelaal, G.P. Cimpoies and E.A. Shaaban, 2011. The benefits of certain Vitamens on Anna Apple orchards. Agrarian Science (Stiinta Agricola), 2: 25-28.

Mansour, A.E.M., F.F. Ahmed, E.A. Shaaban and A. Fouad-Amera, 2008. The Beneficial of Using Citric Acid with Some Nutrients for Improving Productivity of Le- Conte Pear Trees. Research Journal of Agriculture and Biological Sciences, 4(3): 245-250.

Mansour, A.E.M., G.P. Cimpoies and F.F. Ahmed, 2006. The use of some antioxidants to improve yield and fruit quality of Anna apple trees. Agrarian Sci. J. of the Agrarian State Univ. of Moldova, Moldova, 2: 21-35.

Mansour, A.E.M., M.S. El-Shammaa, E.A. Shaaban and M.A. Maksoud, 2010. Influence of some antioxidants on yield and fruit quality of four mango cultivars. Research Journal of Agriculture and Biological Sciences, 6(6): 962-965.

Marschner, H., 1995. Mineral nutrition of higher plants. 2nd ed. London, UK: Academic Press.

Mengel, K. and E.A. Kirkby, 1982. Iron. In: Principles of Plant Nutrition. International Potash Institute, Worblaufen-Bern, Switzerland, pp: 293-512.

Nijjar, G.S., 1985. Nutrition of fruit trees. Kalyani Publishers New Delhi, pp: 50-100, India.

Omar, A. Kh., 1999. Response of Red Roomy (*Vitis vinifera,* L.) to some antioxidants and biofertilizer treatments. M. Sc. Thesis. Fac. Agric. Minia Univ. Egypt.

Papadakis, I.E., T.E. Sotiropoulos and I.N. Therios, 2007. Mobility of iron and manganese within two citrus genotypes after foliar application of iron sulfate and manganese sulfate. J. Plant Nutr., 30: 1385-1396.

Prusky, D., 1988. The use of antioxidants to delay the onset of anthracnose and stem end decay in avocado fruits after harvest. Plant Diseases, 72: 381-384.

Ranjit, K., K. Pawan, S. Kumar and U.P. Singh, 2008. Effect of foliar application of nitrogen, zinc and boron on flowering and fruiting of mango (*Mangifera indica,* L.) cv Amrapali. Environment and Ecol., 26: 1965-1967.

Raskin, L., 1992a. Role of Salicylic acid in plants. Ann. Rev. Plant physiol. Plant Mol. Biol., 43: 439-463.

Raskin, L., 1992b. Salicylata, a new plant hormone . Plant Physiol., 99: 799-803.

Rathore, R.S. and Atul-Chandra, 2001. Effect of application of nitrogen combination with zinc sulfate on nutrients content, quality and yield of acid lime Kagzi lime Current. Agric., 25(112): 107-110. (CAB. Abst. 2001-2002).

Saleh, M.M.S. and E. Abd El-Monem, 2003. Improving the productivity of "Fagri Kelan" mango trees grown under sandy soil conditions using potassium, boron and sucrose as foliar spray. Annals of Agri. Sci., Cairo, 48: 747-756.

Sayed, M.F., 2002. Effect of some horticultural practices on yield and fruit quality of White Banaty grapevines. Ph.D. Tesis Fac. of Agric., El-Minia Univ., Egypt.

Seyam, G.A.A., 2012. Respones of Balady mandarin trees to some horticultural treatments. Ph.D. Thesis Fac. of Agric., Benha Univ., Egypt.

Snedecor, W. and W.G. Cochran, 1989. Statistical Methods, 8th ed. Iowa State Univ. Press Ames. Iowa. U.S.A.

Swietlik, D., 1999. Zinc nutrition in horticultural crops. Horticultural Reviews. John Wiley & Sons, Inc. New York, 23: 109-180.

Taiz, L. and E. Zeiger, 1998a. Assimilation of mineral nutrients. In: Plant Physiology (2nd Edition). Sinauer Assoc., Inc., Publishers, Sunderland, MA., pp: 323-345.

Taiz, L. and E. Zeiger, 1998b. Mineral nutrition. In: Plant Physiology (2nd Edition). Sinauer Assoc., Inc., Publishers, Sunderland, MA., pp: 103-124.

Tariq, M., M. Sharif, Z. Shah and R. Khan, 2007. Effect of foliar application of micronutrients on the yield and quality of sweet orange *(Citrus sinensis,* L.). Pakistan Journal of Biological Sci., 10(1): 1823-1828.

Vejendla, V., P.K. Maity and B.C. Banik, 2008. Effect of chemicals and growth regulators on fruit retention, yield and quality of mango cv. Amrapali. J. Crop and Weed, 4: 45-46.

Wassel, A.H., M. Abd El-Hameed, A. Gobara and M. Attia, 2007. Effect of some micronutrients, gibberllic acid and ascorbic acid on growth, yield and quality of White Banaty seedless grapevines. African Crop Science Conference Proceedings, 8: 547-553.

Wiedenhoeft, A.C., 2006. Micronutrients. In: W.G. Hapkins (ed), Plant Nutrition. Chelsea House Publications, pp: 14-36.

Yildiz, F., 1994. New Technology in Apricot Processing. J. Standard Apricot Special Issue Ankara, pp: 67-69.

Youssef, W.S., 1997. Effect of Spraying mepiquate chloride and some macro and micro nutrients on growth, yield and quality of Red Roomy grapevines (*Vitis vinifera*, L.) Ph.D Thesis Fac. of Agric., El-Minia Univ., Egypt.