FACULTY OF AGRICULTURE

Minia J. of Agric. Res. & Develop.
Vol. (29) No. 2 pp 333-348, 2009

THE PROMOTIVE EFFECT OF SOME ANTIOXIDANTS ON THE PRODUCTIVITY OF TAIMOUR MANGO TREES

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Received 14 May 2009 Accepted 14 June 2009

ABSTRACT

This study focused on identifying the effect of antioxidants on leaf area and the content of N, P, K and Mg , fruit retention, yield / tree, fruit weight and thickness, pulp, edible to non – edible portions, total soluble solids, total and reducing sugars, total acidity and fruit ascorbic acid content of Taimour mango trees. The trees were sprayed three times with three antioxidants namely citric acid, ascorbic acid and B vitamins, (B_1 + B_6 + B_{12}) each at 500, 1000 or 2000 ppm..

Results showed that spraying with antioxidants at 500 to 2000 ppm concentrations improved leaf area and N, P and K content, fruit retention yield/ tree, fruit weight and thickness, edible to non- edible portions, total soluble solids total and reducing sugars and ascorbic acid content and decreased total acidity compared to the control treatment. The treatments had no effect on the leaf content of Mg. Antioxidant concentrations above 500 ppm had no practical promotion on the investigated characters. Thus, from the economical point of view, the recommended concentration of these antioxidants was 500 ppm. Spraying with citric acid, ascorbic acid and B vitamins, in the descending order was favorable in that respect.

The best results with regard to yield and fruit quality of Taimour mango trees grown in sandy soil were obtained when the trees received three sprays of citric acid at 500 ppm.

INTRODUCTION

Mango has great adaptability and thrives in a wide range of climate and soil conditions. It is the most popular fruits in Egypt and is generally called the king of fruits. It has high nutritional values. It is used in making cocoa butter, juice, jams, prickles, chutney, bread and puddings.

Taimour mango cv. is considered a prime and outstanding mango cv grown in Egypt. The fruits have high content of total soluble solids and total sugars and free from fibers, and ripen in the first week of August. It is popular in the domestic market for fresh consumption and have a wide acceptance in the international markets. The trees have regular bearing.

Yield decline is the major problem faces Taimour mango tree growers under middle Egypt conditions. This has been attributed to the great reduction of flowers and fruits that retained on the trees, unbalanced or male- nutrition of the essential mineral and organic foods as well as the unsuitable environmental conditions. Amending the trees with their requirements from organic and inorganic nutrients at balanced rate may be partially very beneficial for overcoming the yield reduction. Also, spraying with 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, building up of organic acids, the biosynthesis of organic foods and controlling the incidence of fungal attack (Prusky, 1988). The positive action of antioxidants in chelating these hazard radicals could result in extending the shelf- life of plant cells and producing vigorous plants (Raskin, 1992, Elade, 1992, and Orth *et al.,* 1993).

Using antioxidants was very favourable for improving growth , nutritional status of the trees, yield and fruit quality in different fruit

crops (Ahmed *et al.*, 1998; Abd El- Wahab, 1999; Hegab, 2000; Ahmed, *et al.*, 2001; Hammam, *et al.*, 2001; Ahmed, 2001; Ragab , 2002; Ahmed and Ragab, 2003; Ahmed *et al.*, 2003 ; Abo- El Komsan *et al.*, 2003; Hamad, 2004; Gobara , 2004 ; Ali, 2004 ; Gamal, 2006; Ahmed, 2007; Ali- Ragaa, 2008 and Zagzog, 2009).

The present study aimed to throw some light on the impact of citric acid, ascorbic acid and B vitamins on growth, nutritional status, yield quantitively and qualititively of Taimour mango trees grown under sandy soil conditions at middle Egypt.

MATERIALS AND METHODS

This study was carried out during the three consecutive seasons of 2006, 2007 and 2008 on thirty 20 years old Taimour mango trees onto Balady mango seedling rootstock in a private orchard located at West Samalout, Minia Governorate. The soil of the orchard is sandy, well drained and with water table depth not less than two meters. The chosen trees were planted at 5 X 5 meters apart (square arrangement method), and drip irrigation system was followed. The trees were subjected to normal horticultural practices that are usually followed in the orchard except those concerning the application of antioxidants. The experiment included the following treatments:

1- Control (trees sprayed with water)
2- Spraying with citric acid at 500 ppm.
3- Spraying with citric acid at 1000 ppm
4- Spraying with citric acid at 2000 ppm.
5- Spraying with ascorbic acid at 500 ppm.
6- Spraying with ascorbic acid at 1000 ppm.
7- Spraying with ascorbic acid at 2000 ppm.
8- Spraying with B vitamins ($B_1 + B_6 + B_{12}$) at 500 ppm.
9- Spraying with B vitamins ($B_1 + B_6 + B_{12}$) at 1000 ppm.
10- Spraying with B vitamins ($B_1 + B_6 + B_{12}$) at 2000 ppm.

It is well known that B vitamins are easily soluble in water. Each antioxidant was sprayed three times during each season at the start of Spring growth cycle (1st week of Feb.) , just after fruit setting (1st

week of April) and at one month later (1st week of May). Tritran B as a wetting agent at 0.05 % was added to all antioxidant solutions before spray. The trees were covered completely with antioxidants at different concentrations till runoff (50 L / tree). The control treatment was sprayed with water containing Triton B.

The experiment was set up in a completely randomized block design. Each treatment was replicated three times, one tree per each.

Sixteen new shoots from Spring growth cycle were chosen on four labeled branches (four shoots for each direction) for measuring the leaf area according to the equation given by Ahmed and Morsy (1999).

$$\text{Leaf area } (cm^2) = 0.70 \text{ (leaf length x leaf width) - } 1.06$$

Fifty mature leaves from non- fruiting shoots in the Spring growth cycle were taken for the determination of N, P, K, and Mg using the method described by Summer (1985). Leaves were dried at 70 °C and digested using H_2SO_4 and H_2O_2. (Wilde *et al.*, 1985). In the digestion, percentages of N , P, K and Mg were determined according to the procedures that outlined by Peach and Tracey (1968).

Percentage of fruit retention was estimated by dividing the number of fruits retained on each tree just before harvesting by total number of flowers and multiplying the product by 100.

Harvesting was made at the second week of July in the three seasons. Yield expressed in weight (kg) per tree was recorded. Ten fruits from each tree were taken for determination of the following physical and chemical characters: These include, fruit weight (g) and thickness (cm.); percentage of pulp; edible (pulp weight, g) to non edible portions (peel and seed weights, g); percentage of total soluble solids; percentage of total acidity (as g citric acid/ 100 ml juice) (according to A.O.A. C., 1985); percentages of total and reducing sugars were determined by Lane and Eynon volumetric method outlined in A.O.A.C. (1985) and ascorbic acid content in the juice (as mg/ 100 ml juice) by titration against 2-6 dichloro phenol endophenol (A.O.A.C. 1985).

All obtained data were tabulated and statistically analyzed using New L.S.D. parameters for comparisons among different treatment means according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of some antioxidants on leaf area and N, P , K and Mg content .

It is clear from the obtained data in Table 1 that foliar application of the three antioxidants (citric acid, ascorbic acid and B vitamins each at 500 to 2000 ppm) significantly improved leaf area and N, P and K content compared with the control treatment, but had no significant effect on the leaf content of Mg. Concentrations higher than 500 ppm from each compound had slight and unsignificant promotion on the leaf area and of N, P and K content. Using citric acid, ascorbic acid and B vitamins, in the descending order was significantly preferable in improving leaf area and N, P and K content. The maximum values were recorded on Taimour mango trees sprayed with citric acid at 2000 ppm without significant increase among this concentration from one side and the lower two concentrations namely 500 and 1000 ppm from the other side. Untreated trees produced the minimum values (Table 1).

The promoting effect of antioxidants on the leaf area could be attributed to their positive action on stimulating cell division, root development and the formation of organic nutrients (Raskin , 1992).

Table 1 : Effect of some antioxidants on leaf area and N, P and K content (as percentages) of Taimour mango trees during 2006, 2007 and 2008 seasons.

Treatment	Leaf area (cm^2)			Leaf N %		
	2006	2007	2008	2006	2007	2008
Control	59.2	61.3	62.2	1.69	1.74	1.68
Citric acid at 500 ppm	67.5	69.5	69.7	1.95	1.97	1.90
Citric acid at 1000 ppm	67.9	68.6	69.9	1.96	1.98	1.91
Citric acid at 2000 ppm	68.0	68.7	70.0	1.97	1.99	1.92
Ascorbic acid at 500 ppm	64.9	65.9	66.7	1.89	1.91	1.82
Ascorbic acid at 1000 ppm	65.0	66.0	66.9	1.90	1.91	1.83
Ascorbic acid at 2000 ppm	65.3	66.1	67.0	1.91	1.92	1.83
B Vitamin at 500 ppm	62.3	63.3	64.3	1.75	1.80	1.74
B Vitamin at 1000 ppm	62.5	63.5	64.4	1.76	1.82	1.75
B Vitamin at 2000 ppm	62.7	63.7	64.5	1.77	1.83	1.76
New L.S.D. at 5 %	1.8	1.5	1.6	0.04	0.05	0.05
	Leaf P %			Leaf K %		
Control	0.20	0.22	0.19	1.25	1.30	1.27
Citric acid at 500 ppm	0.28	0.33	0.26	1.38	1.46	1.45
Citric acid at 1000 ppm	0.29	0.33	0.29	1.40	1.47	1.45
Citric acid at 2000 ppm	0.29	0.34	0.29	1.40	1.48	1.46
Ascorbic acid at 500 ppm	0.25	0.28	0.25	1.34	1.42	1.39
Ascorbic acid at 1000 ppm	0.26	0.30	0.25	1.35	1.42	1.41
Ascorbic acid at 2000 ppm	0.26	0.30	0.26	1.35	1.43	1.41
B Vitamin at 500 ppm	0.22	0.25	0.21	1.29	1.36	1.32
B Vitamin at 1000 ppm	0.23	0.26	0.21	1.29	1.36	1.33
B Vitamin at 2000 ppm	0.24	0.26	0.22	1.30	1.37	1.34
New L.S.D. at 5 %	0.02	0.02	0.02	0.03	0.04	0.04

The controlling effect of antioxidants on different disorders may be another reason (Prusky, 1988, Elade , 1992 and Orth *et al.*, 1993).

The present results regarding growth traits are in agreement with those obtained by Ahmed *et al.*, (2001) on Taimour mango trees, Hamad (2004) on some mango cvs and Zagzog (2009) on Hendy Meloky mango trees., The same results were also obtained in Washington Navel orange trees (Abd El- Wahab, 1999; Gobara; 2004 and Gamal 2006).

The promotive effect of these antioxidants on nutritional status of the trees was supported by the results of Ahmed *et al.*, (2001) on Taimour mango trees; Abo El- Komsan *et al.*, (2003) on Balady orange trees; Hamad (2004) on some mango cvs, Gamal (2006) on Washington Navel orange trees and Ali – Ragaa (2008) on Balady mandarin trees.

Effect of antioxidants on the percentage of fruit retention and yield per tree.

As shown in Table 2, the percentage of fruit retention and yield per tree of Taimour mango trees were positively affected by the application of the three investigated antioxidants. Spraying the trees with citric acid, ascorbic acid and B vitamins at 500 to 2000 ppm was accompanied with improving fruit retention percentage and the yield per tree compared with the control treatment. A slight promotion on such parameters was observed with using concentration above 500 ppm from these compounds. Spraying with B vitamins, ascorbic acid and citric acid in the ascending order was essential for producing higher fruit retention and yield per tree.

However, from the economical point of view, spraying citric acid at 500 ppm resulted in the highest yield; the yield per tree reached 72.0 , 74.0 and 72.5 kg compared to 60.3, 62.0 and 61.0 kg in the control treatment in 2006, 2007 and 2008 seasons, respectively. Percentage of increase on yield due to using the striked treatment (500 ppm citric acid) in relation to the control treatment reached 19.4, 16.2, and 15.9 in 2006, 2007 and 2008 seasons, respectively. The control treatment produced minimum values. These results were true in the

three seasons. The great decline in dropping of flowers and fruits as well as the essential role of these antioxidants on activating growth and nutritional status of the trees could result in enhancing fruit retention and yield per tree.

The promoting effect of these antioxidant compounds on yield was confirmed by the results of Ahmed (2001) and Hammam *et al.,* (2001) on Hindy Bissinara mango trees, Ahmed *et al.,* (2001) on Taimour mango trees and Gamal (2006) on Washington Navel orange trees.

Effect of some antioxidants on physical and chemical characters of the fruits.

It is evident from the data in Tables 2 , 3 , 4 and 5 that a remarkable and significant promotion on physical and chemical quality of the fruits in terms of increasing fruit weight and thickness, pulp %, edible to non- edible portions , total soluble solids %, total and reducing sugars %, and ascorbic acid and in decreasing total acidity % were attained with using the three antioxidants compared with the control treatment. The promotion on fruit quality was associated with using citric acid, ascorbic acid and B vitamins, in the descending order. Using concentrations above 500 ppm had no significant promotion on fruit quality of Taimour mango trees. The best results with regard to fruit quality from the economical point of view were obtained when the trees received citric acid via leaves at 500 ppm. Undesirable effects on fruit quality were recorded on trees did not receive these antioxidants. The same trend was observed during the three seasons.

The beneficial effect of these antioxidants on activating cell division and the biosynthesis of sugars could explain the present results.

The results of Ahmed *et al.,* (2001) on Taimour mango fruits as well as Ahmed (2001) and Hammam *et al.,* (2001) on Hindy Bissinara mango fruits support the present findings.

Table 2 : Effect of some antioxidants on leaf content of magnesium, (as percentage), fruit retention %, yield / tree (kg.) and fruit weight (g.) of Taimour mango trees during 2006, 2007 and 2008 seasons.

Treatment	Leaf Mg %			Fruit retention %		
	2006	2007	2008	2006	2007	2008
Control	0.52	0.47	0.55	0.66	0.69	0.72
Citric acid at 500 ppm	0.54	0.48	0.56	0.89	1.02	1.02
Citric acid at 1000 ppm	0.54	0.48	0.55	0.90	1.02	1.06
Citric acid at 2000 ppm	0.54	0.49	0.55	0.90	1.03	1.07
Ascorbic acid at 500 ppm	0.54	0.47	0.55	0.80	0.91	0.92
Ascorbic acid at 1000 ppm	0.54	0.47	0.56	0.81	0.92	0.93
Ascorbic acid at 2000 ppm	0.54	0.49	0.55	0.81	0.93	0.94
B Vitamin at 500 ppm	0.53	0.49	0.55	0.72	0.80	0.82
B Vitamin at 1000 ppm	053	0.48	0.56	0.72	0.81	0.83
B Vitamin at 2000 ppm	0.53	0.48	0.56	0.73	0.81	0.83
New L.S.D. at 5 %	NS	NS	NS	0.05	0.07	0.07
	Yield / tree (kg)			Fruit weight (g)		
Control	60.5	62.0	61.0	205.2	206.0	207.0
Citric acid at 500 ppm	72.0	74.0	72.5	228.0	232.0	233.0
Citric acid at 1000 ppm	72.0	74.5	73.0	229.0	233.0	234.0
Citric acid at 2000 ppm	72.5	75.0	73.0	229.9	234.0	235.0
Ascorbic acid at 500 ppm	68.0	69.0	68.0	220.0	223.0	224.0
Ascorbic acid at 1000 ppm	68.5	69.5	69.0	221.0	223.0	225.0
Ascorbic acid at 2000 ppm	69.0	70.0	69.0	221.5	224.0	226.0
B Vitamin at 500 ppm	64.5	65.5	64.0	212.5	214.0	215.0
B Vitamin at 1000 ppm	65.0	66.0	64.5	213.0	215.0	216.0
B Vitamin at 2000 ppm	65.0	66.0	65.0	215.0	215.5	217.0
New L.S.D. at 5 %	2.9	3.0	3.0	6.1	7.0	6.2

Table 3 : Effect of some antioxidants on some physical and chemical characters of the fruits of Taimour mango trees during 2006, 2007 and 2008 seasons.

Treatment	Fruit thickness (cm)			Pulp %		
	2006	2007	2008	2006	2007	2008
Control	4.9	4.8	4.9	70.5	71.3	72.2
Citric acid at 500 ppm	6.7	6.8	7.1	76.9	77.2	77.8
Citric acid at 1000 ppm	6.8	6.8	7.2	77.0	77.9	78.1
Citric acid at 2000 ppm	6.8	6.8	7.3	77.2	78.0	78.2
Ascorbic acid at 500 ppm	6.0	6.1	6.2	73.9	74.1	75.2
Ascorbic acid at 1000 ppm	6.1	6.1	6.3	74.0	74.8	75.6
Ascorbic acid at 2000 ppm	6.1	6.1	6.4	74.0	74.9	75.7
B Vitamin at 500 ppm	5.3	5.2	5.4	72.5	73.0	74.0
B Vitamin at 1000 ppm	5.4	5.2	5.4	72.6	73.2	74.1
B Vitamin at 2000 ppm	5.4	5.3	5.4	72.8	73.5	74.2
New L.S.D. at 5 %	0.4	0.3	0.3	1.1	1.0	1.0
	Edible to non edible portions			T.S.S. %		
Control	1.9	2.0	2.0	14.8	15.0	15.0
Citric acid at 500 ppm	2.9	2.9	3.0	16.5	16.9	16.7
Citric acid at 1000 ppm	3.0	3.0	3.0	16.5	17.0	16.8
Citric acid at 2000 ppm	3.0	3.0	3.1	16.6	17.0	16.8
Ascorbic acid at 500 ppm	2.5	2.6	2.7	15.8	16.4	15.9
Ascorbic acid at 1000 ppm	2.5	2.6	2.7	15.8	16.4	16.0
Ascorbic acid at 2000 ppm	2.6	2.6	2.8	15.9	16.5	16.0
B Vitamin at 500 ppm	2.2	2.3	2.3	15.3	15.5	15.4
B Vitamin at 1000 ppm	2.2	2.4	2.3	15.4	15.5	15.5
B Vitamin at 2000 ppm	2.3	2.4	2.3	15.4	15.6	15.5
New L.S.D. at 5 %	0.2	0.2	0.2	0.3	0.3	0.3

Table 4 : Effect of some antioxidants on some chemical characters of the fruits of Taimour mango trees during 2006, 2007 and 2008 seasons.

Treatment	Total acidity %			Total sugars %		
	2006	2007	2008	2006	2007	2008
Control	0.410	0.420	0.415	12.9	13.0	12.8
Citric acid at 500 ppm	0.324	0.347	0.345	14.7	14.9	15.0
Citric acid at 1000 ppm	0.320	0.345	0.341	14.7	15.0	15.0
Citric acid at 2000 ppm	0.318	0.440	0.340	17.8	15.0	15.1
Ascorbic acid at 500 ppm	0.349	0.370	0.369	14.1	14.1	14.4
Ascorbic acid at 1000 ppm	0.347	0.369	0.364	14.2	14.2	14.5
Ascorbic acid at 2000 ppm	0.346	0.369	0.362	14.3	14.2	14.6
B Vitamin at 500 ppm	0.371	0.399	0.392	13.6	13.5	13.5
B Vitamin at 1000 ppm	0.371	0.397	0.390	13.7	13.6	13.6
B Vitamin at 2000 ppm	0.370	0.396	0.390	13.7	13.6	13.7
New L.S.D. at 5 %	0.021	0.018	0.020	0.4	0.5	0.5
	Reducing sugars %			Ascorbic acid content (mg/ 100ml, juice)		
Control	3.5	3.4	3.6	35.0	36.0	35.3
Citric acid at 500 ppm	4.4	4.3	4.8	39.9	41.1	40.9
Citric acid at 1000 ppm	4.5	4.3	4.9	40.0	41.2	41.0
Citric acid at 2000 ppm	4.5	4.4	4.9	40.0	41.2	41.0
Ascorbic acid at 500 ppm	4.1	4.0	4.3	38.0	39.0	38.2
Ascorbic acid at 1000 ppm	4.1	4.0	4.3	38.2	39.4	38.2
Ascorbic acid at 2000 ppm	4.2	4.0	4.4	38.2	39.5	38.3
B Vitamin at 500 ppm	3.8	3.7	4.0	36.5	37.5	37.0
B Vitamin at 1000 ppm	3.8	3.8	4.0	36.6	37.7	37.1
B Vitamin at 2000 ppm	3.8	3.8	4.1	36.7	37.8	37.1
New L.S.D. at 5 %	0.3	0.2	0.2	1.1	1.1	0.9

In conclusion, treating Taimour mango trees three times (at the start of Spring growth cycle 1st week of Feb. just after fruit setting 1st week of April and at one month later 1st week of May) with citric acid at 500 gave the best results with regard to yield and fruit quality.

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التأثير المحسن لبعض مضادات الأكسدة على إنتاجية أشجار المانجو التيمور

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تم رش أشجار المانجو التيمور ثلاثة مرات فى بداية دورة نمو الربيع (الاسبوع الاول من فبراير) بعد مرحلة عقد الثمار مباشرة (الاسبوع الاول من أبريل) ثم بعدها بشهر (الاسبوع الاول من مايو) بثلاثة مواد مضادة للأكسدة هى حامض الستريك وحامض الاسكوربيك وفيتامينات ب (ب١+ ب٦ + ب ١٢) كل بتركيز ٥٠٠ ، ١٠٠٠ ، ٢٠٠٠ جزء فى المليون ولقد تركزت الدراسة على التعرف على تأثير هذه المواد المضادة للأكسدة على مساحة الورقة ومحتواها من عناصر النيتروجين والفوسفور والبوتاسيوم والماغنسيوم، النسبة المئوية للثمار الباقية على الشجرة، كمية محصول

الشجرة، وزن وسمك الثمرة، النسبة المئوية للب ، النسبة ما بين الجزء الصالح (وزن اللب) والغير صالح للاكل(وزن البذرة والقشرة)، النسبة المئوية للمواد الصلبة الذائبة الكلية، النسبة المئوية للسكريات الكلية والمختزلة، النسبة المئوية للحموضة الكلية ومحتوى الثمرة من فيتامين ج (ملليجرام لكل ١٠٠ ملى عصير).

أشارت النتائج المتحصل عليها ان استخدام مضادات الأكسدة الثلاثة بتركيز ما بين ٥٠٠ الى ٢٠٠٠ جزء فى المليون كان مصحوبا بحدوث تحسن فى مساحة الورقة ومحتواها من عناصر النيتروجين والفوسفور والبوتاسيوم والنسبة المئوية للثمار الباقية على الشجرة، كمية محصول الشجرة، وزن وسمك الثمرة والنسبة ما بين الجزء الصالح والغير صالح للأكل والنسبة المئوية للمواد الصلبة الذائبة الكلية والنسبة المئوية للسكريات الكلية والمختزلة ومحتوى الثمار من فيتامين ج وتقليل النسبة المئوية للحموضة الكلية وذلك بالمقارنة بمعاملة الكونترول. ولم يكن لهذه المعاملات أية تاثير على محتوى الورقة من عنصر الماغنسيوم ، ولم يؤد استخدام تركيز أعلى من ٥٠٠ جزء فى المليون من هذه المواد الى اية تحسن ملحوظ على هذه الصفات لهذا فإنه من وجهة النظر الاقتصادية فإن التركيز الموصى به هو ٥٠٠ جزء فى المليون من هذه المواد وكان رش حامض الستريك وحامض الاسكوربيك وفيتامينات ب مرتبة ترتيبا تنازليا مفيدا فى هذا الصدد.

أمكن الحصول على أفضل النتائج بخصوص المحصول وجودة الثمار فى أشجار المانجو التيمور النامية فى التربة الرملية عند رش الاشجار ثلاثة مرات بحامض الستريك بتركيز ٥٠٠ جزء فى المليون.