

Effect of Foliar Application with Some Micronutrients, Ascorbic Acid and Vitamin B complex on Leaf Nutrients Content, Fruiting and Fruit Quality of Anna Apple Trees

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ABSTRACT

Anna apple trees of 15 years old budded onto MM 106 rootstock grown in clay soil, were sprayed during 2005 and 2006 seasons with Zn, Mn and Fe sulfate at 1.0% as well as Boric acid at 400 ppm, Ascorbic acid at 1000 ppm and Vitamin B complex at 100 ppm. The trees received three sprays in March, April and May. Leaf nutrient contents, fruiting and fruit quality parameters were recorded. Spraying with FeSO₄, Boric acid and Vitamin B complex increased leaf N and P. Also, all treatments under study increased leaf Fe, Zn and Mn content while all tested treatments produced a considerable increase in fruit set, yield number of fruits and fruit weight and decrease in fruit drop parameters. Generally, Boric acid, Ascorbic acid and Vitamin B complex treatments were superior than the other treatments and control. Meanwhile, spraying the trees with Ascorbic acid or Vitamin B complex was more effective in increasing TSS, acidity, total sugar and starch as compared with the other used treatments and the control.

Keywords: Foliar application, micronutrients, rootstock, leaf nutrients content, fruiting and fruit quality.

INTRODUCTION

Apple fruit (*Malus domestica* Borkh) has a great economical and commercial importance. Production of apple cultivars (Anna and Ein-Shamir) is suitable for the Egyptian climate. These cultivars have high yielding ability, good fruit quality, tolerance to most stresses in newly reclaimed soils and high profitable net return which encourage horizontal extension of apple plantings. Nowadays, foliar application of micronutrient in fertilization programs of apple orchards, especially those in new reclaimed areas in Egypt is a principal goal of most of apple growers to recover the micronutrients deficiencies and to improve yield and fruit quality (Awad and Atawia, 1995; Gobara, 1998).

Foliar applications with Zinc, Manganese and Iron sulfate either solely or in combinations on Anna apple trees twice or thrice yearly increased yield, number of fruits/tree, fruit weight and improved most trees (Awad *et al.*, 2002).

The aim of this investigation is to study the effect of spraying some micronutrients, Ascorbic acid and Vitamin B complex on nutrients content, fruiting and fruit quality.

MATERIALS AND METHODS

This study was carried out at El-Qanater region, Qalubia Governorate during seasons of 2005 and 2006 on healthy and nearly uniform Anna apple trees of 15 years old budded onto Malling Merton 106 rootstock and grown in clay soil (table 1) at 3.5 x 5.0 meters apart and irrigated with closed basin surface system. The selected trees were subjected to the same agricultural practices. The following treatments were used: spraying Zn SO₄ at 1.0 %, Mn SO₄ at 1.0 %, FeSO₄ at 1.0 %, Boric acid at 400 ppm, Ascorbic acid at 1000 ppm, and Vitamin B complex at 100 ppm, in comparing with control (sprayed with water only).

All treatments were sprayed three times yearly on the 15th of March, 15th of April and 15th of May in both seasons. The other cultural practices were the same for all trees. All micronutrients treated plots were isolated from each side with plastic sheets to avoid any combination between them. The data were subjected to statistical analysis according to Snedecor and Cochran (1969).

Table (1): Mechanical and chemical analysis of the experimental soil.

Mechanical analysis	
Clay	61.9%
Sand	11.3%
Silt	26.7%
Texture	Clay
Chemical analysis	
pH	8.89
EC	1.05 mmhos/cm
Ca	0.93 mg/100gm
N	0.31 ppm
P	0.03 ppm
K	109 mg/100gm
Mg	1.64 mg/100gm
Na	3.54 mg/100gm
Fe	1.39 ppm
Mn	4.01 ppm
Zn	2.32 ppm

Measurements and Determinations

Pomological Studies

1- Leaf samples

Twenty full expanded leaves (6 months old) of the third and fourth nodes from the base of tagged non fruiting shoots of the spring flush around each tree were picked in mid August for determining leaf nutrients content. The leaves were wiped with a damp cloth, washed with 0.1 N hydrochloric acid then rinsed in distilled water and oven dried at 70°C till constant

RESULTS

weight and ground in a stainless steel knife mill and digested according to Chapman and Pratt (1961). The nutrients were determined by the following methods and expressed as percentages for, N, P, K, Mg and Ca and ppm for Zn, Mn and Fe. Nitrogen was determined by the Micro Kjeldahl Method of Jackson (1967). Phosphorus was determined by the method of Murphy and Riely (1962). Potassium was determined photometrically using the method of Brown and Lilleland (1946). Calcium and Magnesium was determined by titration against versenate solution (Na-EDTA) method described by Chapman and Pratt (1961). Iron, Zinc and Manganese were spectrophotometrically determined using SP.1.900 Atomic absorption spectrophotometer.

2- Fruiting

(a) Fruit Set and Fruit Dropping

In mid March, four branches nearly uniform in diameter at the different directions of the tree were labelled. All inflorescences of each labelled branch were counted during full bloom then number of fruitlets was counted and then fruit set percentage was calculated. Number of fruitlets was counted every fifteen days starting from mid March till mid May, and fruit drop percentage was calculated.

(b) Yield

When fruits reached maturity they were harvested on the 15th of July then number of fruits per tree was counted and weighed in kg.

3- Fruit Quality

Twenty fruits from each tree were randomly sampled for determining both physical characteristics and chemical properties. Fruit weight (gm), fruit volume (cm³), fruit firmness (Kg/cm³), total soluble solids %, total acidity %, total sugars % and starch % were assessed according to A.O.A.C (1990). TSS/acid ratio and starch/sugars were studied.

All the previous treatments were arranged in a complete randomized block design with three replicates for each treatment and each replicate was represented by three trees. The obtained data was statistically analyzed according to Snedecor and Cochran (1980). The means were differentiated using Duncan (1955)

Pomological Studies

1- Leaf Nutrient Contents

Table (2) shows that no significant differences were noticed among different treatments under study in the second season regarding leaf Nitrogen and Phosphorus contents. Also, similar results appeared in leaf Magnesium in the first season and in Potassium in both seasons. However all treatments under investigation increased leaf Nitrogen content during the first season except the control, MnSO₄ and Ascorbic acid treatments. Meanwhile, foliar application of Boric acid was the most promising treatment in increasing leaf Calcium content during the first season and Ascorbic acid in the second season in comparison with other treatments and control. Also, all treatments under investigation increased leaf Magnesium content during the second season as compared with the control.

Dealing with micronutrients as affected by spraying treatments, it is clear that spraying with FeSO₄ during both seasons surpassed all tested treatments in increasing leaf Fe content, while spraying with ZnSO₄ during the first season and Vitamin B complex in the second season surpassed all other test treatments in increasing leaf Zn content. The highest significant content of leaf Mn was noticed in MnSO₄ treatment during both seasons.

2- Fruiting

(a) Fruit Set and Dropping

It is clear from table (3) that spraying with ZnSO₄ and FeSO₄ treatments gave the highest percentage of fruit set and the lowest percentage of fruit drop followed by spraying with MnSO₄ and the control treatments of both seasons. Meanwhile, spraying with ZnSO₄ treatment in both seasons and both FeSO₄ and the control treatments in the second season surpassed the other used treatments in increasing fruit set and decreasing fruit drop. However, as well as Vitamin B complex increased significantly fruit drop and decreased significantly fruit set as compared with the other used treatments and the control.

Generally, in both seasons spraying Anna Apple Trees with Boric acid, Ascorbic acid and Vitamin B

Table (2): Effect of micronutrients, ascorbic acid and vitamin B complex sprays on leaf nutrients content of Anna Apple trees during 2005 and 2006 seasons.

Nutrients	N (%)		P (%)		K (%)		Ca (%)		Mg (%)		Fe (%)		Zn (%)		Mn (ppm)	
	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Control	1.20 ^b	1.32 ^a	0.31 ^b	0.32 ^a	1.24 ^a	1.57 ^a	3.74 ^d	3.85 ^d	1.47 ^a	0.34 ^e	153.00 ^d	98.00 ^e	43.66 ^{cd}	31.00 ^c	26.30 ^e	24.60 ^e
ZnSO ₄ 1%	1.48 ^{ab}	1.30 ^a	0.33 ^b	0.33 ^a	1.32 ^a	1.31 ^a	4.94 ^{bc}	4.08 ^{bc}	1.32 ^a	0.63 ^b	140.33 ^e	131.33 ^e	82.33 ^a	57.00 ^{ab}	29.00 ^f	55.01 ^b
MnSO ₄ 1%	1.38 ^b	1.33 ^a	0.36 ^b	0.33 ^a	1.28 ^a	1.24 ^a	3.65 ^d	3.87 ^c	1.16 ^a	0.74 ^a	140.33 ^e	142.33 ^d	46.60 ^{cd}	53.33 ^b	61.30 ^a	68.00 ^a
FeSO ₄ 1%	1.55 ^a	1.28 ^a	0.86 ^a	0.38 ^a	1.39 ^a	1.72 ^a	3.92 ^d	3.58 ^d	1.56 ^a	0.72 ^a	190.67 ^a	172.00 ^a	31.67 ^d	35.33 ^c	49.00 ^e	25.63 ^e
Boric Acid 400 ppm	1.67 ^a	1.27 ^a	0.87 ^a	0.36 ^a	1.41 ^a	1.73 ^a	5.76 ^a	4.39 ^{ab}	1.33 ^a	0.60 ^b	162.60 ^c	142.30 ^d	47.33 ^{cd}	21.67 ^d	33.67 ^e	29.36 ^d
Ascorbic Acid 1000	1.46 ^{ab}	1.33 ^a	0.38 ^b	0.38 ^a	1.34 ^a	1.54 ^a	5.44 ^{ab}	4.62 ^a	1.30 ^a	0.63 ^b	170.33 ^b	150.00 ^c	60.67 ^{bc}	56.33 ^{ab}	40.33 ^d	35.30 ^c
Vitamin B 100 ppm	1.75 ^a	1.33 ^a	0.63 ^{ab}	0.36 ^a	1.28 ^a	1.51 ^a	5.51 ^{ab}	4.08 ^b	1.09 ^a	0.72 ^a	172.33 ^b	158.33 ^b	72.33 ^{ab}	62.67 ^a	65.60 ^b	55.00 ^b

Means followed by the same letter within each column for each category are not significantly different at 5% level.

complex increased significantly fruit drop and decreased fruit set. These results assured the findings of Woycik and Cieslinski (2000) found that Boron increased apple cultivars fruit set only when sprayed after bloom. In addition, Hassan (2000) reported that the improvement in fruit set % of live could be explained as a result increase pollen grains germination and pollen tube elongation due to Boron treatments. Also, Abd-Allah (2006) found that Boric acid at 300 ppm was sprayed once at full bloom stage, either as a single or in combination treatments, increased fruit set and decreased fruit drop of Washington Navel Orange Trees.

(b)Yield

Results revealed obviously table (4) that in both seasons spraying Anna apple trees with ZnSO₄ or MnSO₄ as well as Ascorbic acid or Vitamin B complex increased significantly number of fruits per tree and yield (Kg) compared with other used treatments and the control except Vitamin B spray in the second season. On the other hand, spraying with Boric acid or the control treatment produced the lowest number of fruits per tree and yield (Kg) in both seasons.

3- Fruit Quality

(a)Physical Characteristics

Data tabulated in table (5) disclosed that fruit weight was increased by spraying with Vitamin B complex in both seasons followed by Ascorbic acid in the first season and FeSO₄, Boric acid and Ascorbic acid in the second season as compared with the other used treatments and the control. However, spraying with ZnSO₄, MnSO₄, Ascorbic acid and Vitamin B complex treatment gave the highest fruit size in the first season as well as spraying with FeSO₄ in the second season. Besides, fruit firmness showed irregular trend in both seasons as different treatments under investigation were considered. It appeared that spraying with Boric acid in seasons as well as ZnSO₄ and Vitamin B complex in the first season treatments maximized fruit firmness while the reverse was true with the control treatment in both seasons.

Table (3): Effect of micronutrients, Ascorbic acid and vitamin B complex sprays on fruit set and drop percentage of Anna Apple trees during 2005 and 2006 seasons.

Measurement	No. of Fruits/Tree		Yield (Kg)/Tree	
	Season		2005	2006
Treatment	2005	2006	2005	2006
Control	184.00 ^{bc}	148.00 ^d	20.60 ^c	18.67 ^d
ZnSO ₄ 1%	331.33 ^a	309.30 ^a	42.83 ^a	39.93 ^a
MnSO ₄ 1%	324.60 ^a	306.00 ^a	43.70 ^a	38.46 ^a
FeSO ₄ 1%	221.60 ^b	210.67 ^c	22.66 ^b	25.80 ^c
Boric Acid 400 ppm	150.60 ^c	113.33 ^c	20.67 ^c	16.63 ^{de}
Ascorbic Acid 1000 ppm	325.76 ^a	306.00 ^a	43.18 ^a	38.53 ^a
Vitamin B 100 pm	289.00 ^a	245.00 ^b	38.60 ^a	31.02 ^b

Means followed by the same letter within each column for each category are not significantly different at 5% level.

Table (4): Effect of micronutrients, Ascorbic acid and vitamin B complex sprays on fruit number and Yield (Kg) per tree of Anna Apple trees during 2005 and 2006 Seasons.

Measurement	No. of Fruits/Tree		Yield (Kg)/Tree	
	Season		2005	2006
Treatment	2005	2006	2005	2006
Control	21.22 ^{bc}	22.82 ^a	72.74 ^{bc}	70.78 ^b
ZnSO ₄ 1%	23.20 ^a	24.26 ^a	70.23 ^c	69.17 ^b
MnSO ₄ 1%	21.03 ^{bc}	18.73 ^c	76.83 ^{ab}	73.33 ^{ab}
FeSO ₄ 1%	22.46 ^{ab}	22.93 ^a	71.17 ^c	70.45 ^b
Boric Acid 400 ppm	18.01 ^d	20.83 ^b	77.72 ^a	77.69 ^a
Ascorbic Acid 1000 ppm	18.02 ^c	21.90 ^b	77.70 ^a	76.43 ^a
Vitamin B 100 pm	17.56 ^d	20.14 ^b	78.58 ^a	75.42 ^a

Means followed by the same letter within each column for each category are not significantly different at 5% level.

(b) Chemical Properties:

spaying with Ascorbic acid and Vitamin B complex treatments alone gave higher percentages of total soluble solids contents in both seasons table (6). However, spraying with FeSO₄, MnSO₄ in both seasons and ZnSO₄ and the control in the first season treatments gave generally low values of fruit affected by treatments since spraying with FeSO₄ in the first season and MnSO₄ in the second season treatments recoded the highest values in comparison with the other used treatments and the control. As for total sugar, spraying with vitamin B complex treatment solely recorded the highest values in both seasons. Meanwhile, spraying with Boric acid treatment in the first season and vitamin B complex in the second season treatments gave generally higher values of total starch contents as

Table (5): Effect of micronutrients, ascorbic acid and vitamin B complex sprays on fruit physical characteristics of Anna Apple trees during 2005 and 2006 seasons.

Measurement	Fruit Weight (gm)		Fruit Size (cm ³)		Fruit Firmness (kg/cm ³)	
	Season		2005	2006	2005	2006
Treatment	2005	2006	2005	2006	2005	2006
Control	122.50 ^{de}	114.36 ^c	149.00 ^c	140.63 ^c	10.10 ^c	8.63 ^d
ZnSO ₄ 1%	132.18 ^{bc}	110.40 ^{cd}	165.27 ^a	160.89 ^{ab}	12.80 ^a	8.17 ^d
MnSO ₄ 1%	134.03 ^{bc}	110.46 ^{cd}	165.63 ^a	130.40 ^{de}	11.37 ^b	9.00 ^b ^{cd}
FeSO ₄ 1%	130.20 ^{cd}	128.70 ^b	160.10 ^a ^b	163.23 ^a	11.37 ^b	9.32 ^b ^{cd}
Boric Acid 400 ppm	127.10 ^{cd}	126.00 ^b	150.63 ^{bc}	136.73 ^{cd}	11.67 ^{ab}	11.86 ^a
Ascorbic Acid 1000 ppm	156.96 ^b	136.63 ^b	168.90 ^a	169.63 ^a	11.36 ^b	10.67 ^b
Vitamin B 100 ppm	183.67 ^a	145.18 ^a	170.13 ^a	155.63 ^b	12.57 ^a	8.67 ^{cd}

Means followed by the same letter within each column for each category are not significantly different at 5% level.

Table (6): Effect of micronutrients, Ascorbic Acid and vitamin B complex sprays on fruit chemical properties of Anna Apple trees during 2005 and 2006 Seasons.

Measurement	TSS (%)		Acidity (%)		TSS/Acid ratio		Total Sugars (%)		Starch (%)		Starch/Sugars ratio	
	Season		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Treatment	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Control	10.13 ^d	10.03 ^d	0.65 ^c	0.71 ^f	15.58 ^c	14.13 ^d	4.07 ^c	5.73 ^c	6.48 ^d	8.10 ^{dc}	1.59 ^c	1.41 ^d
ZnSO₄ 1%	10.80 ^{abc}	11.00 ^b	0.62 ^c	0.76 ^d	17.71 ^b	16.42 ^b	8.17 ^b	6.36 ^{bc}	10.84 ^{bc}	8.00 ^c	1.33 ^d	1.26 ^f
MnSO₄ 1%	10.89 ^{abc}	10.50 ^{cd}	0.62 ^c	0.60 ^g	17.56 ^b	17.50 ^a	7.93 ^b	6.53 ^{bc}	11.92 ^{abc}	11.30 ^c	1.50 ^c	1.73 ^b
FeSO₄ 1%	11.00 ^{ab}	11.00 ^{bc}	0.48 ^d	0.73 ^f	22.92 ^a	15.07 ^{cd}	6.53 ^{bc}	6.50 ^{bc}	12.84 ^{abc}	13.90 ^b	1.97 ^b	2.14 ^a
Boric Acid 400 ppm	10.20 ^{cd}	10.13 ^d	0.68 ^{bc}	0.88 ^a	15.00 ^d	11.51 ^f	8.67 ^b	6.63 ^{bc}	13.66 ^a	9.23 ^d	1.58 ^c	1.39 ^e
Ascorbic Acid 1000 ppm	11.36 ^a	11.67 ^{ab}	0.91 ^a	0.84 ^b	12.48 ^f	13.89 ^e	4.08 ^c	5.72 ^c	10.38 ^c	9.43 ^d	2.54 ^a	1.65 ^c
Vitamin B 100 ppm	11.33 ^a	11.67 ^{ab}	0.85 ^{ab}	0.76 ^c	13.33 ^c	15.36 ^c	8.68 ^a	8.21 ^a	10.91 ^{bc}	15.07 ^a	1.26 ^d	1.84 ^{ab}

Means followed by the same letter within each column for each category are not significantly different at 5% level.

compared with the other used treatments and the control. However, starch/sugars ratio was significantly affected by treatments since spraying with Ascorbic acid treatment in the first season and spraying with FeSO₄ in the second season recorded the highest value as compared with the other used treatments and the control.

DISCUSSION

Spraying Anna apple trees with FeSO₄, Boric acid and Vitamin B complex increased leaf N and P content in the first season. On the contrary leaf K was not affected. These results are in agreement with those obtained by Thomidis *et al.* (2006) on peach found that foliar application of 25% zinc sulphate solution on the 25th of February and 2% zinc chelate solution on the 20th of May increased the zinc content of leaves and no toxicity was observed. On the contrary, foliar application of 6% Zinc sulphate and soil application of zinc sulphate at a rate of 200g/tree on the 15th of February did not affect the zinc content of leaves. Boric acid, Ascorbic acid and vitamin B complex increased significantly fruit drop and decreased fruit set.

These results assured the findings of (Woycik and Cieslinski 2000) who found that Boron increased apple cultivars fruit set only when sprayed after bloom. In addition, Hassan (2000) reported that the improvement in fruit set % of olive could be explained as a result increase pollen grains germination and pollen tube elongation due to Boron treatments. Also, (Abd-Allah 2006) found that Boric acid at 300 ppm was sprayed once at full bloom stage, either as a single or in combination treatments, increased fruit set and decreased fruit drop of Washington Navel orange trees.

Generally, most treatments on Anna Apple Trees increased number of fruits/tree and yield parameters compared with the control trees and spraying with Boric acid treatments in both seasons. The above results are in harmony with the findings of Awad & Atawia (1995) and Gobara (1998) who found that most parameters of yield and number of fruits/tree of apple and pear trees enhanced and improved due to spraying the trees with Zn, Mn and Fe. On the other hand, Woycik and Cieslinski (2000) on Canino apricot. They found that

foliar spray with Boric acid, Ascorbic acid and vitamin B resulted in the highest yield.

Woycik and Cieslinski (2000) who found that Boron sprays after bloom increased fruit Ca concentration which resulted in increased apple firmness. Naseri *et al.* (2001), and showed that Boron sprays had no effect on fruit quality of Apple trees. On the other hand, (Elham and Shahin 2006) found that using Magnesium, Boron, Ascorbic acid and vitamin B complex in descending order was very effective in improving fruit quantity and quality of Canino apricot.

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تأثير الرش ببعض المغذيات الصغرى وحمض الأسكوربيك وفيتامين ب المركب على المحتوى المعدنى للأوراق والأثمار وصفات جودة الثمار على أشجار التفاح الأنا

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الملخص العربى

أجريت هذه الدراسة خلال عامين متتالين 2005 و 2006 على أشجار التفاح أنا عمر 15 سنة متماثلة فى نموها ومطعمومة على أصل التفاح مولنج مورتون 106 نامية فى أرض طينية بمنطقة القناطر بمحافظة القليوبية. حيث تم رش الأشجار ببعض العناصر الغذائية الصغرى (زنك – منجنيز – حديد) فى صورة معدنية (كبريتات) بتركيز 1%، والبورون فى صورة حمض البوريك بتركيز 400 جزء فى المليون وفيتامين سى فى صورة حمض الأسكوربيك بتركيز 1000 جزء فى المليون وفيتامين ب المركب بتركيز 100 جزء فى المليون وتم الرش ثلاث مرات خلال السنة فى (فبراير، مارس، إبريل) لدراسة تأثير هذه المعاملات المختلفة على المحتوى المعدنى لأوراق أشجار التفاح الأنا وكذلك التأثير على الأشجار وصفات الجودة للثمار.

وأوضحت نتائج البحث أن معظم المعاملات المُختبرة أدت إلى زيادة محتوى الورق من العناصر بوجه عام كما أدى الرش بـ حمض البوريك 400 جزء فى المليون وسلفات الحديد 1% وفيتامين B 100 جزء فى المليون زيادة عنصرى النتروجين والبوتاسيوم. وقد أدت معظم المعاملات إلى زيادة ملحوظة فى تقليل نسبة التساقط وزيادة نسبة العقد وتحسين معظم صفات جودة الثمار. كما أدى الرش بـ حمض الأسكوربيك بتركيز 1000 جزء فى المليون وفيتامين B بتركيز 1000 جزء فى المليون إلى زيادة ملحوظة فى كل من المواد الصلبة الذائبة الكلية والحموضة والسكريات الكلية والنشا.