



Trends in **Horticultural Research**

ISSN 1996-0735



Academic
Journals Inc.

www.academicjournals.com

Physiological Studies on the Effect of Foliar Sprays with Some Micronutrients on Leaf Mineral Content, Yield and Fruit Quality of "Florida Prince and Desert Red" Peach Trees

¹A.A. El-Shewy and ²A. Iman Abdel-Khalek

¹Department of Agricultural Botany,

²Department of Horticulture, Faculty of Agriculture, Fayoum University, Egypt

Corresponding Author: A. Iman Abdel-Khalek, Department of Horticulture, Faculty of Agriculture, Fayoum University, Egypt

ABSTRACT

The present investigation was carried out during the two successive seasons of 2010 and 2011 using 8 years old "Florida Prince and Desert Red" peach trees budded on nemagrad rootstock grown on sandy soil under drip irrigation system. The trees of the first experimental treatment were sprayed once, the second were sprayed twice and the third one were sprayed thrice a year using a combinations of Fe, Zn and Mn at the rate of 0.6 g L⁻¹ in chelated form or combinations of Zn, Mn, Fe at 0.6 g L⁻¹ in the non-chelated form (sulphate). The trees received one spray (on the 15th of February), or two sprays (on the 15th of February and the 15th of March), or three sprays (on the 15th of February, the 15th of March and the 15th of April). Leaf mineral content, yield and fruit quality were studied. Results indicated that spraying the trees twice or thrice yearly was more effective than spraying once a year and the control, in improving leaf mineral content (N, P, K, Zn, Mn and Fe) as well as chlorophyll a, b content of both Florida Prince and Desert Red peach trees. All studied treatments produced a considerable increase in yield, fruit weight, fruit size and fruit firmness of both Florida Prince and Desert Red peach fruits. Moreover, such studied treatments improved most of fruit quality parameters. Generally the combination of Fe, Zn and Mn in chelated form was the superior than the non-chelated one and the control of both Florida Prince and Desert Red peach fruits. It is clear also that, spraying the trees twice or thrice a year was more effective than once a year in improving different studied parameters on this investigation (leaf mineral content, leaf plastid pigments, yield and its components and fruit quality parameters).

Key words: Peach trees, foliar application, micronutrients, leaf mineral content, fruit quality and yield

INTRODUCTION

Peach trees are considered as one of the most important fruit trees in Egypt and the world. The fruit may be consumed in fresh form or processed into jam or jelly. Peach tree is known to give intensive growth with somewhat weak wood. In the meantime, peach trees are self fruitful and set fruits from about 9% of the flowers. Moreover, peach trees are going to be widespread in the newly reclaimed areas, which are characterized by micronutrients deficiency especially Zn, Mn and Fe. For this reason, foliar application of micro nutrients in peach orchards is the ideal solution to correct their deficiency. In this respect, many investigators reported that foliar application of microelements was very effective in improving nutritional status, yield and fruit quality of pears and peach

Gobara (1998), Thomidis *et al.* (2006), El-Sheikh *et al.* (2007) and Humair *et al.* (2012). Many studies revealed that micronutrients foliar sprays enhanced nutritional status of plants and improved the yield and quality of different fruit crops. These studies were supported by Zarrouk *et al.* (2005), El-Sheikh *et al.* (2007) and Humair *et al.* (2012) on peach.

This investigation was carried out to study the effect of foliar sprays combination with zinc, manganese and iron in non-chelated form (sulphate) or spraying zinc, manganese and iron in chelated form at once, twice or thrice applications yearly on leaf minerals content, yield and fruit quality parameters of "Florida Prince and Desert Red Peach trees".

MATERIALS AND METHODS

This investigation was carried out at a private orchard at Kafr Shoker city Qalubia Governorate, during the seasons of 2010 and 2011. Healthy and with similar vigor two peach varieties, CVS (Florida Prince and Desert Red) trees of 8 years old budded on Nemagrad rootstock were grown on sandy soil under drip irrigation system. The trees were planted at 3.5 meters apart. All the plants received the conventional horticultural practices The trees were sprayed with the following solutions:

- Control (sprayed with water)
- Combinations with chelate at the rate of (0.6 g L⁻¹ for Fe, Zn and Mn)
- Combinations with the non-chelated form (sulphate) of Zn, Mn and Fe-at the rate of 0.6 g L⁻¹ for each of them

In this respect, the selected trees were sprayed during both seasons of the study, once during the 15th of (February) twice during the 15th of February and the 15th of March and thrice during the 15th of February, the 15th of March and the 15th of April. All treatments were sprayed separately confined with plastic sheets to avoid any combination between each treatment. The same cultural practices were applied to all trees with different treatments. Each treatment were replicated thrice and the RCBD was used.

Measurements and determinations

Leaf samples: Samples of thirty leaves from the middle part of the non fruiting branches were taken randomly from each replicate at the first week of July (Chuntanaparb and Cummings, 1980). The leaves were cleaned from dust particles and then washed several times with tap water, then washed again by HCL 0.1 N and rinsed by distilled water to remove any residues. The leaf samples were air dried, then transferred to a muffle furnace at 70°C until a constant weight and grounded in a stainless steel knife mill and digested according to the methodology by Chapman and Pratt (1961).

Nitrogen was determined using Micro Kjeldahl method (Jackson, 1964), phosphorus according to the method described by Truog and Meyer (1979) and potassium was determined by the flamephotometer according to the method of Brown and Lilleland (1946). Micronutrients (Fe, Zn and Mn) were determined colorimetrically using the Sp, 1900 atomic absorption spectrophotometer. The determined macro-nutrients were expressed as percentages for N,P and K and as ppm for the micronutrients Zn, Mn and Fe. Leaf plastid pigments were determined spectrophotometrically according to method described by Beckett *et al.* (2005).

Yield and fruit quality: Number of fruits per tree and yield (kg tree⁻¹) were recorded at harvesting time (mid of July). Samples consisting of twenty fruits were randomly taken from each

replicate for the following; average fruit weight (g), fruit length (cm), fruit diameter (cm), fruit size (cm), firmness (kg cm^{-2}), total soluble solids% (TSS), total acidity (%) according to AOAC (1990) and TSS acid ratio. The obtained data were statistically analyzed using the analysis of ANOVA one way method as reported by Snedecor and Cochran (1980) and the differences between means were differentiated using the Duncan (1955) multiple range test.

RESULTS AND DISCUSSION

Leaf nutrient contents: Data regarding the effect of spraying trees with some micronutrients on leaf nutrients content (N, P and K) of "Florida Prince and Desert Red" peach trees during the two successive seasons of 2010 and 2011 are tabulated in Table 1. Data shows that no significant differences were noticed among different treatments in both seasons of the study as well as the mean of the two seasons, regarding leaf N, P and K contents.

Data in Table 2 revealed obviously that in both seasons foliar application three times/year with (Zn+Mn+Fe) chelates compound or non-chelated ones (Zn+ Mn+ Fe, as sulphate) recorded the highest values of leaf Zn content of Florida Prince followed by spraying trees twice a year as compared with one spray and the control treatment. It is also clear that, in both seasons, foliar application three times/year with combinations of chelated form recorded the highest values of leaf Mn content followed by two sprays/year with chelated compound followed with combinations of Zn+Mn +Fe in the non-chelated form compared with the other used treatments and the control for the mean of both seasons of the study. Meanwhile, leaf Fe content was superior when trees were sprayed three times/year with combinations of chelated form compared with other studied treatments and the control of "Florida Prince and Desert Red" peach trees of both seasons of the study and the mean of both seasons as well. Generally, no significant difference was obtained between all studied treatments and the control o regarding the leaf N, P and K contents for both

Table 1: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on some leaf macro- nutrient content (N, P and K) of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		N (%)			P (%)			K (%)		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		2.75	2.87	2.810	0.23	0.24	0.235	1.38	1.40	1.390
Chelated form	One	2.75	2.88	2.815	0.24	0.24	0.240	1.39	1.42	1.405
	Two	2.79	2.70	2.845	0.25	0.25	0.250	1.40	1.42	1.410
	Three	2.83	2.89	2.860	0.27	0.26	0.265	1.42	1.44	1.430
Non-chelated form	One	2.79	2.86	2.825	0.24	0.24	0.240	1.39	1.41	1.400
	Two	2.81	2.88	2.845	0.24	0.25	0.245	1.41	1.42	1.415
	Three	2.83	2.89	2.860	0.25	0.25	0.250	1.41	1.42	1.415
LSD at 5% level		NS	NS		NS	NS		NS	NS	
Desert red										
Control		2.72	2.61	2.665	0.22	0.23	0.225	1.36	1.38	1.370
Chelated form	One	2.74	2.62	2.680	0.23	0.24	0.235	1.38	1.40	1.350
	Two	2.74	2.64	2.690	0.23	0.24	0.235	1.39	1.41	1.400
	Three	2.75	2.65	2.705	0.24	0.25	0.245	1.40	1.43	1.415
Non-chelated form	One	2.73	2.61	2.670	0.22	0.23	0.225	1.36	1.39	1.375
	Two	2.74	2.63	2.685	0.23	0.24	0.235	1.38	1.40	1.390
	Three	2.74	2.63	2.680	0.23	0.24	0.235	1.38	1.41	1.395
LSD at 5% level		NS	NS		NS	NS		NS	NS	

Table 2: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on some leaf micro-nutrient content (Fe, Zn and Mn) of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		Fe (ppm)			Zn (ppm)			Mn (ppm)		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		55.62	54.08	54.850	15.95	18.04	16.995	23.42	44.20	23.810
Chelated form	One	67.98	69.34	68.660	24.63	23.22	23.925	38.41	43.41	40.910
	Two	76.79	75.68	76.235	33.41	38.86	36.135	53.41	58.44	35.925
	Three	89.20	91.30	90.250	44.09	44.51	44.300	76.04	80.29	78.165
Non-chelated form	One	61.76	62.38	62.070	21.31	23.45	22.380	30.29	32.39	31.340
	Two	68.50	73.82	71.160	29.27	28.42	28.845	40.30	44.00	42.150
	Three	75.76	78.98	77.370	33.76	32.30	33.030	47.51	53.49	50.500
LSD at 5% level		4.56	3.63		3.16	2.53		4.08	3.89	
Desert red										
Control		57.83	61.42	59.625	17.65	18.32	17.985	22.53	24.37	23.550
Chelated form	One	66.68	74.82	70.850	22.97	21.98	22.475	34.30	42.29	38.295
	Two	78.03	85.25	81.640	34.19	33.41	33.800	51.64	56.44	54.290
	Three	95.60	97.79	96.695	43.21	46.18	44.695	71.21	82.92	77.065
Non-chelated form	One	61.16	66.82	63.990	20.49	20.78	20.635	29.42	28.15	28.785
	Two	70.04	78.98	74.510	27.86	27.91	27.885	37.63	39.52	38.575
	Three	78.20	86.02	82.110	34.63	34.80	34.715	20.06	54.95	52.505
LSD at 5% level		6.79	5.65		3.59	2.14		3.44	2.02	

peach trees. Meanwhile, most of the tested treatments tended to increase leaf Zn, Mn and Fe contents over the control. Moreover, spraying the trees thrice or twice a year were more effective than spraying once a year in improving leaf mineral Zn, Mn and Fe contents.

Data regarding the mean of the two seasons revealed that spraying both peach trees with chelates compound increased leaf Zn, Mn and Fe content than spraying with non-chelated compound and the control one. It is also clear that, leaf N, P and K contents were not affected by the form of the used nutrient elements (chelated or non-chelated). These results are in agreement with those obtained by Awad and Atawia (1995), Gobara (1998), Awad *et al.* (2000), Thomidis *et al.* (2006), El-Sheikh *et al.* (2007), Shah and Shahzad (2008), Al-Bamarny *et al.* (2010) and Humair *et al.* (2012) using different fruit crop trees. They found that spraying the trees twice or thrice a year was more effective than spraying once a year in improving nutritional status of the trees beside correcting Zn, Mn and Fe deficiencies. Meanwhile, Nazif *et al.* (2006), Thomidis *et al.* (2006), El-Sheikh *et al.* (2007), Bell and Dell (2008), Ahmad *et al.* (2010), Humair *et al.* (2012) and Bastos de Matos *et al.* (2013) on different fruit crops including peach they pointed out that foliar application of a 25% zinc sulfate 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.

Perhaps these increases in fruit yield might be due to the significant increase in leaf Zn concentration which in turn induced more flowering and minimized the fruit drop in sweet orange trees. It was also reported that fruit drop decreased as leaf Zn and Mn content increased (Garcia *et al.*, 1984). Similar results were also reported by Parveen and Rehman (2000) obtaining 95.70% increase in yield over control.

Leaf chlorophyll contents: Data in Table 3 shows that, chlorophyll (a, b) and total chlorophyll (a and b) were increased with increasing number of sprays, regardless of treatments studied Prince

Table 3: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on some leaf plastid pigments content (mg g⁻¹ dry matter) (chlorophyll "a", chlorophyll "b" and total chlorophyll) of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		Chlorophyll a			Chlorophyll b			Total chlorophyll		
		-----			-----			-----		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		28.15	29.63	28.895	32.09	32.59	32.340	60.24	62.22	61.230
Chelated form	One	29.68	32.47	30.575	32.60	33.88	33.240	62.40	65.35	63.875
	Two	31.74	37.89	32.815	33.72	34.51	34.115	65.46	68.40	66.930
	Three	33.71	36.41	35.060	36.13	35.39	35.760	69.84	71.80	70.820
Non-chelated form	One	30.53	31.74	31.135	33.52	34.78	34.150	64.05	66.52	65.285
	Two	32.68	35.66	34.170	36.00	37.74	36.870	68.68	73.40	71.040
	Three	37.48	39.31	38.395	39.42	38.25	38.835	76.90	77.56	77.230
LSD at 5% level		2.660	2.71		2.81	2.45		4.65	4.56	
Desert red										
Control		29.40	28.92	29.160	31.36	31.48	31.420	60.77	60.40	60.585
Chelated form	One	30.80	29.52	30.160	32.38	33.23	32.805	63.18	62.75	62.965
	Two	32.68	30.44	31.560	35.28	35.39	35.385	67.96	65.83	66.895
	Three	34.00	32.94	33.470	37.12	37.48	37.300	71.12	70.62	70.870
Non-chelated form	One	30.95	31.27	31.110	32.42	32.36	32.390	63.37	63.63	63.500
	Two	34.06	34.32	34.190	36.75	37.29	37.020	70.81	71.61	71.210
	Three	36.01	37.31	36.660	37.18	37.53	37.365	73.19	74.84	74.015
LSD at 5% level		3.38	2.92		2.96	2.70		4.08	4.72	

and Desert Red" peach trees have an increasing mean values for both seasons. Moreover, it is obvious that the three spray applications surpassed the two sprays and one spray in both seasons of the study. Meanwhile, leaf chlorophyll (a), (b) and total chlorophyll (a and b) contents reached the highest value after three times spray of Fe+Zn+Mn in non-chelated form followed by the twice then the sprayed once treatments. The data also revealed that the non-chelated sprayed surpassed the chelated one regarding the leaf plastid pigments contents. It is also clear that control treatment and one spray gave the lowest value of leaf chlorophyll content of "Florida Prince and Desert Red" peach trees in both seasons of the study as well as the mean of both seasons. Generally, spraying three times a year of Fe+Zn+Mn in the non-chelated form were superior than the other treatments and the control of both "Florida Prince and Desert Red" peach trees. Meanwhile, spraying the trees twice or thrice a year was more effective than once a year. These results are in agreement with the studies by Zarrouk *et al.* (2005), Nazif *et al.* (2006), El-Sheikh *et al.* (2007), Bell and Dell (2008), Al-Bamarny *et al.* (2010), Abadia *et al.* (2011), Asgharzade and Babaeian (2012), Humair *et al.* (2012), Bastos de Matos *et al.* (2013) and Yadav *et al.* (2013). Results of their studies found that the leaf chlorophyll concentration at 120 DAFB was positively correlated with Fe floral concentration and with K, Zn and Na leaf concentrations of peach.

Yield and fruit quality: Data regarding the effect of micronutrients spray on yield and fruit quality of "Florida Prince and Desert Red" peach trees during seasons 2010 and 2011 as well as the mean of both seasons are tabulated in Table 4 and 5. Data in Table 4 shows that most of the foliar application treatments significantly increased yield/tree compared with the control and one spray for "Florida Prince and Desert Red" trees during the both seasons of the study (mean of both seasons). On the other hand, no significant differences were noticed among different treatments

Table 4: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on fruit length, fruit diameter and yield of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		Fruit length (cm)			Fruit diameter (cm)			Fruit yield (kg tree ⁻¹)		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		4.48	4.49	4.485	4.54	4.55	4.545	58.40	55.38	56.890
Chelated form	One	4.60	4.60	4.600	4.63	4.62	4.625	59.61	59.31	59.460
	Two	4.60	4.62	4.610	4.62	4.60	4.610	61.43	60.91	61.170
	Three	4.61	4.63	4.620	4.62	4.65	4.635	64.58	58.40	61.490
Non-chelated form	One	4.48	4.49	4.485	4.60	4.60	4.600	60.31	58.40	59.355
	Two	4.53	4.60	4.565	4.60	4.54	4.570	61.57	60.15	60.860
	Three	4.60	4.61	4.605	4.62	4.63	4.625	61.66	61.66	61.660
LSD at 5% level		NS	NS		NS	NS		3.26	3.48	
Desert red										
Control		4.60	4.60	4.600	4.62	4.62	4.620	57.45	58.40	57.915
Chelated form	One	4.61	4.61	4.610	4.65	4.63	4.640	58.18	59.97	59.075
	Two	4.62	4.64	4.630	4.65	4.64	4.645	60.14	62.78	61.460
	Three	4.63	4.64	4.635	4.66	4.65	4.655	62.38	64.56	63.740
Non-chelated form	One	4.57	4.61	4.595	4.62	4.62	4.620	57.17	57.39	57.280
	Two	4.60	4.63	4.615	4.64	4.64	4.640	58.29	60.87	59.580
	Three	4.61	4.63	4.620	4.65	4.64	4.645	59.93	64.65	60.790
LSD at 5% level		NS	NS		NS	NS		4.27	2.46	

Table 5: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on fruit weight, fruit size and firmness of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		Fruit weight (g)			Fruit size (cm)			Fruit firmness (L inch ⁻¹)		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		52.69	50.58	51.635	58.63	57.06	57.845	14.52	17.71	16.115
Chelated form	One	56.50	55.26	55.880	60.08	61.76	60.920	14.82	18.95	16.885
	Two	62.33	61.21	61.770	64.35	65.69	65.020	14.78	19.16	16.970
	Three	65.35	62.78	64.065	67.37	66.25	66.810	14.82	19.62	17.220
Non-chelated form	One	55.04	54.70	54.870	58.18	61.66	59.920	14.80	18.56	16.680
	Two	56.72	60.30	58.510	60.42	65.13	62.775	14.78	19.04	16.910
	Three	59.64	62.78	61.210	63.56	66.14	64.850	14.74	19.18	16.960
LSD at 5% level		2.16	2.80		2.53	2.42		0.54	0.91	
Desert red										
Control		47.98	46.63	47.305	49.66	54.14	51.905	18.09	18.95	18.520
Chelated form	One	56.45	50.58	53.515	53.92	54.14	54.030	19.39	19.28	19.335
	Two	54.14	55.60	54.870	56.05	57.84	56.945	19.73	19.61	19.670
	Three	61.76	64.12	62.940	63.11	65.81	64.460	20.08	19.92	20.000
Non-chelated form	One	49.54	48.65	49.095	52.69	51.79	52.240	19.17	19.19	19.180
	Two	51.68	51.79	51.735	53.92	53.80	53.860	19.28	18.30	19.290
	Three	55.38	54.82	55.100	57.62	57.28	57.450	19.54	19.42	19.480
LSD at 5% level		6.30	7.52		4.57	7.97		0.97	0.56	

under study in both seasons regarding the parameters in fruit length and fruit diameter of both "Florida Prince and Desert Red" peach trees. As regards the effect of foliar sprays of some micronutrients on fruit weight, fruit size and fruit firmness, data revealed significant differences regarding number of sprays and the form of the micro-nutrient sprays.

Data in Table 5 clearly showed that in both seasons and the mean for both seasons, fruit weight and fruit size increased with increasing the number of sprays/year of "Florida Prince and Desert Red" peach trees. Meanwhile, the highest value of fruit weight and fruit size were produced after three sprays application of chelated form of nutrients used in this study followed by two sprays of chelated ones as well as three sprays of non-chelated form of nutrients compared with the other used treatments and the control. On the other hand, the significant differences among different treatments were nil when fruit firmness was considered of "Florida Prince" peach tree regarding the mean of both seasons. There were no significant differences between the number of applications in each year. Finally all the tested treatments produced a considerable increase in yield, fruit weight, fruit size and fruit firmness parameters. Generally, the application of the chelated form were superior than the non-chelated form and control. These results are congruent with those reported by Awad and Atawia (1995), Gobara (1998), Awad *et al.* (2000), Nazif *et al.* (2006), El-Sheikh *et al.* (2007), Bell and Dell (2008), Ahmad *et al.* (2010), Humair *et al.* (2012) and Bastos de Matos *et al.* (2013) who found that studied parameters of yield and fruit quality of different crop were enhanced and improved by spraying the trees with Zn, Mn and Fe. Meanwhile Zarrouk *et al.* (2005) Thomidis *et al.* (2006), El-Sheikh *et al.* (2007), Ahmad *et al.* (2010), Humair *et al.* (2012), Asgharzade and Babaeian (2012), Bastos de Matos *et al.* (2013), Davarpanah *et al.* (2013) and Yadav *et al.* (2013). Found that foliar application of 25% zinc sulfate solution on the 25th of February and 2% zinc chelate solution on the 20th of May increased fruit yield of peach trees.

The increase in size of fruit as a result of foliar application of micronutrients the present investigation might have been due to the improved internal physiology of the developing fruit in terms of better supply of water, nutrients and other compounds vital for their proper growth and development (Dutta and Banik, 2007).

The increase in fruit weight and volume might be due to increase in cell size and intercellular space (Baker and Davis, 1951). Zinc has been identified as component of almost 60 enzymes and it has a role in synthesis of growth promoter hormone (auxin) which is directly associated with improvement of fresh weight of fruits (Shivanandam *et al.*, 2007). A favorable effect of foliar application of boron might be due to its role in cell division, cell elongation, sugar metabolism and accumulation of carbohydrates (Sourour, 2000). Rana and Sharma (1979) obtained increased berry volume with the application of 0.5% ferrous sulphate in grape. It might be increased chlorophyll content in leaf which is associated with high production of photosynthate in plant.

The continuous application of micronutrients (Zn and B) in two years/season increased the nutrient status of foliage and reduced the deficiency symptoms to greater extent as indicated in Table 5. This enhanced vegetative attributes of citrus plants that resulted in maximum fruit production. Parker (1936) in his study obtained a significant increase in fruit yield of citrus trees when treated with Zn compound as foliar spray. The foliar application of Zn and B helps in the use of nutrients and regulate other nutrients. This aids in the production of sugars and carbohydrates which are essential for seed and fruit development. Zn is a part of enzymes system which regulates the plant growth. Thus the foliar spray of Zn and B ultimately decreased the % dieback, %chlorosis and %rosette plant-1. The application of micronutrients including Zn, Fe, Cu and Mn at different concentration curved little leaf (rosette), interveinal chlorosis and twigs dieback (Alam, 1989). The chlorosis problem in mandarin was corrected and recovered more rapidly in plants which were sprayed at monthly intervals with zinc (Dikshit, 1961). The foliar application of zinc sulphate reduced the chlorosis, raised the zinc contents of the leaves but lower the nitrogen, phosphorus and potassium contents (Kanwar and Dhingra, 1963).

Table 6: Effect of foliar application of Fe, Zn and Mn (in chelated and non-chelated forms) on TSS, acidity and TSS/acid ratio of Florida Prince and Desert Red peach trees during 2010 and 2011 seasons

		TSS (%)			Acidity (%)			TSS/Acid ratio		
Nutrients	No. of sprays	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Florida prince										
Control		13.34	13.45	13.395	0.62	0.58	0.600	21.51	23.19	22.350
Chelated form	One	13.79	14.12	13.955	0.64	0.63	0.635	21.54	22.41	21.975
	Two	14.24	14.34	14.290	0.66	0.67	0.665	21.58	21.40	21.490
	Three	14.50	14.90	14.700	0.67	0.71	0.690	21.64	20.98	20.860
Non-chelated form	One	13.56	13.68	13.620	0.61	0.61	0.610	22.23	22.43	22.330
	Two	14.18	13.90	14.040	0.64	0.68	0.660	22.00	22.06	22.030
	Three	14.57	1.24	14.405	0.76	0.66	0.610	19.17	21.58	20.375
LSD at 5% level		0.31	0.96		0.02	0.06		0.16	0.50	
Desert red										
Control		13.12	13.32	13.22	0.67	0.66	0.665	19.58	20.18	19.880
Chelated form	One	13.45	13.47	13.460	0.71	0.70	0.705	18.94	19.24	19.090
	Two	14.02	13.90	13.960	0.73	0.71	0.720	19.21	19.57	19.390
	Three	13.68	14.46	14.070	0.74	0.70	0.740	18.48	19.54	19.080
Non-chelated form	One	13.45	13.34	13.395	0.68	0.66	0.670	19.78	20.21	19.995
	Two	13.68	13.56	13.62	0.72	0.71	0.715	19.00	19.10	19.050
	Three	13.79	13.67	13.730	0.71	0.71	0.710	19.42	19.25	19.335
LSD at 5% level		0.46	0.62		0.02	0.03		0.24	0.32	

Chemical properties: It is clear from Table 6 that both chelates and non-chelated forms of micronutrients spray compounds resulted in a higher percentages of total soluble solids as compared with control of "Florida Prince and Desert Red" peach trees during 2010 and 2011 seasons and the mean of both seasons. However, two and three sprays/year increased significantly TSS of "Florida Prince and Desert Red" peach trees compared to one spray/year and control. On the other hand, the differences between the numbers of sprays were not significant.

Results represented in Table 6 show that spraying peach trees with a combinations Fe+Zn+Mn in the non-chelated form at three times a year gave the highest value of total acidity of "Florida Prince" peach trees, followed by the combinations of Fe+Zn+Mn in the chelated form regarding the mean of the two seasons. On the other hand, no significant differences were recorded regarding the effect of number of sprays on total acidity of "Desert Red" peach fruits as for the mean of the two seasons.

TSS/acid ratio was significantly affected by treatments since combinations of Fe+Zn+Mn in the non-chelated form in three times a year recorded the highest value in "Florida Prince" and "Desert Red" peach trees. It is clear also that, all studied treatments gave the lowest TSS/acid ratios compared with the control in "Florida Prince" and "Desert Red" peach fruits regarding the mean of the two seasons.

Finally, from the above mentioned results, it could be concluded that, two or three sprays yearly were more effective in increasing TSS, acidity percentage and TSS/ acid ratio. These results are in agreement with those obtained by Osman (1999), Shabeen(1995), Hassan (2000), El-Sheikh *et al.* (2007), Celik and Katkat (2007), Nazif *et al.* (2006), Bell and Dell (2008), Ahmad *et al.* (2010), Abadia *et al.* (2011), Humair *et al.* (2012), Asgharzade and Babaeian (2012), Bastos de Matos *et al.* (2013), Davarpanah *et al.* (2013) and Yadav *et al.* (2013). On different fruit crops reported that TSS, acidity percentage and TSS/acid ratio were improved by spraying of micronutrients.

CONCLUSION

It was concluded that all studied treatments produced a considerable increase in yield, fruit weight, fruit size and fruit firmness of both Florida Prince and Desert Red peach fruits. Moreover, such studied treatments improved most of fruit quality parameters. Generally the combination of Fe, Zn and Mn in chelated form was the superior than the non-chelated one and the control of both Florida Prince and Desert Red peach fruits. It is also clear that, spraying the trees twice or thrice a year was more effective than once a year in improving different studied parameters on this investigation.

REFERENCES

- AOAC, 1990. Official Methods of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., Arlington, Virginia, USA., ISBN: 0-935584-42-0.
- Abadia, J., S. Vazquez, R. Rellan-Alvarez, H. El-Jendoubi, Abadia, A., A. Alvarez-Fernandez and A.F. Lopez-Millan, 2011. Towards a knowledge-based correction of iron chlorosis. *Plant Physiol. Biochem.*, 49: 471-482.
- Ahmad, H., M.T. Siddique and I.A. Hafiz, 2010. Zinc status of apple orchards and its relationship with selected physico-chemical properties in Murree Tehsil. *Soil Environ. (Pak.)*, 29: 142-147.
- Al-Bamarny, S.F.A., M.A. Salman and Z.R. Ibrahim, 2010. Effect of NAA, KNO₃ and Fe on some characteristics of leaf and fruit of peach (*Prunus persica* L.) cv. early coronet. Proceedings of the World Food System- A Contribution from Europe, Tropentag, September 14-16, 2010, Zurich, pp: 1-5.
- Alam, S., 1989. Lime induced chlorosis. M.Sc. Thesis, NWFP Agriculture University, Peshawar, Pakistan.
- Asgharzade, A. and M. Babaeian, 2012. Foliar application of calcium borate and micronutrients effects on some characters of apple fruits in Shirvan region. *Ann. Biol. Res.*, 3: 527-533.
- Awad, S.M. and A.R. Atawia, 1995. Effect of foliar sprays with some micronutrients on Le Conte pear trees. 1-Tree growth, flowering and leaf mineral contents. *Ann. Agric. Sci. Cairo*, 40: 359-367.
- Awad, S.M., A.A. El-Gazzan and H.F. El. Wakeel, 2000. Effect of Foliar application with some micronutrients on Anna apple trees. *Arab Univ. J. Agric. Sci. Ain. Shoms Univ. Cairo*, 8: 270-303.
- Baker, G.A. and I.D. Davis, 1951. Growth of the cheek diameter of peaches. *Proc. Am. Soc. Hort. Sci.*, 57: 104-110.
- Bastos de Matos, G.S., A.R. Fernandes and J.G. de Carvalho, 2013. Symptoms of deficiency and growth of peach palm seedlings due to omission of micronutrients. *Amazonian J. Agric. Environ. Sci.*, 56: 166-172.
- Beckett, R.R., P. Nosisa, F.V. MiniBayeva and A.J. Alyabyev, 2005. Hardening by partial dehydration on and ABA increase desiccation tolerance in the cyanobacterial lichen peltigera polydactylon. *Ann. Bot.*, 96: 109-115.
- Bell, R.W. and B. Dell, 2008. Micronutrients for Sustainable Food, Feed, Fibre and Bioenergy Production. International Fertilizer Industry Association, Paris, France, pp: 5-30.
- Brown, J.D. and O. Lilleland, 1946. Uptake determination of potassium and sodium in plant material and soil extracts by flamephotometry. *Proc. Am. Soc. Sci.*, 48: 341-346.
- Celik, H. and A.V. Katkat, 2007. Some parameters in relation to iron nutrition status of peach orchards. *J. Biol. Environ. Sci.*, 1: 111-115.

- Chapman, H.D. and P.E. Pratt, 1961. Methods and Analysis of Soil, Plant and Water. Division of Agricultural Sciences, University of California, Berkeley, pp: 3-9.
- Chuntanaparb, N. and G. Cummings, 1980. Seasonal trends in concentration of nitrogen, phosphorus, potassium, calcium and magnesium in leaf portions of apple, blueberry, grape and peach. *J. Am. Soc. Hortic. Sci.*, 105: 933-935.
- Davarpanah, S., M. Akbari, M.A. Askari, M. Babalar and M.E. Naddaf, 2013. Effect of iron foliar application (Fe-EDDHA) on quantitative and qualitative characteristics of pomegranate CV. Malas-e-Saveh. *World Sci. J.*, 4: 179-187.
- Dikshit, N.N., 1961. Effect of microelement sprays and irrigation on the occurrence of chlorosis. *Hort. Abst.* 29: 155-155.
- Duncan, D.B., 1955. Multiple range and multiple F test. *Biometrics*, 11: 1-42.
- Dutta, P. and A.K. Banik, 2007. Effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of Sardar guava grown in West Bengal. *Acta Hort.*, 335: 407-411.
- El-Sheikh, M.H., S.A.A. Khafagy and N.S. Zaied, 2007. Effect of foliar application with some micronutrients on leaf mineral content, yield and fruit quality of Florida prince and desert red peach trees. *Res. J. Agric. Biol. Sci.*, 3: 309-315.
- Garcia, A., N.E. Haydar and C. Ferrer, 1984. Influence of Zn and Mn on the Physiological Behavior and Yields of Valencia Oranges. Institute Superior Agricola Ciego de Avila, Cuba, pp: 57-58.
- Gobara, A.A., 1998. Response of lecont pear trees of foliar application of some nutrients, Egypt. *J. Hort.*, 25: 55-70.
- Hassan, S.A., 2000. Morphological and physiological studies on flowering, pollination and fruiting of picual olive tree. Ph.D. Thesis, Faculty of Agriculture, Cairo University, Egypt.
- Humair, A., M.T. Siddique, S. Safdar Ali, A. Khalid and N.A. Abbasi, 2012. Mapping of Fe and impact of selected physico-chemical properties on its bioavailability in the apple orchards of Murree region. *Soil Environ.*, 31: 100-107.
- Jackson, M.L., 1964. Solchemical Analysis. Mahiya Effect Press, New Delhi, India, pp: 183-192.
- Kanwar, J.S. and D.R. Dhingra, 1963. Effect of micronutrient sprays on the chemical composition of citrus leaves and incidence of chlorosis. *Indian J. Agric. Sci.*, 32: 309-314.
- Nazif, W., S. Perveen and I. Saleem, 2006. Status of micronutrients in soils of District Bhimber (Azad Jammu and Kashmir). *J. Agric. Biol. Sci.*, 1: 35-40.
- Osman, L.H., 1999. Response of Piculaolive trees to soil fertilization with borax and magnesium sulphate. *Minufiya J. Agric. Res.*, 24: 277-287.
- Parker, E.R., 1936. Experiment on trace elements of mottle leaf of citrus. *Proc. Am. Soc. Hort. Sci.*, 34: 213-216.
- Parveen, S. and H. Rehman, 2000. Effect of Zn, Mn and B in combination with urea on the yield of sweet orange. *Pak. J. Agric. Res.*, 16: 135-141.
- Rana, R.S. and H.C. Sharma, 1979. Effect of iron sprays on growth, yield and quality of grapes. *Punjab Hort. J.*, 19: 31-34.
- Shabeen, S.A.A., 1995. Effect of foliar sprays of some nutrients on flowering and fruiting of olive trees. M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.
- Shah, Z. and K. Shahzad, 2008. Micronutrient status of apple orchards in Swat valley of North West frontier province of Pakistan. *Soil Environ.*, 27: 123-130.
- Shivanandam, V.N., S.L. Pradeep, K.M. Rajanna and Sivappa, 2007. Effect of zinc sulphate on growth and yield of mango varieties and hybrids. *J. Soil Crops*, 17: 225-229.

- Snedecor, G.W. and W.G. Cochran, 1980. Statistical Methods. 7th Edn., Iowa State University Press, Ames, Iowa, USA., Pages: 507.
- Sourour, M.M., 2000. Effect of foliar application of some micronutrient forms on growth, yield, fruit quality and leaf mineral composition of Valencia orange trees grown in North Sinai. Alexandria J. Agric. Res., 45: 269-285.
- Thomidis, T., C. Tsipouridis, Z. Michailides and E. Exadaktylou, 2006. Effect of zinc on the mineral content, yield, zinc on the leaf mineral content, yield, fruit weight and susceptibility of peaches to *Monilinia laxa*. J. Exp. Agric., 46: 1203-1205.
- Truog, E. and A.H. Meyer, 1979. Improvements in the deniges colorimetric method for phosphorus and arsenic. Ind. Eng. Chem. Anal. Ed., 1: 136-139.
- Yadav, V., P.N. Singh and P. Yadav, 2013. Effect of foliar fertilization of boron, zinc and iron on fruit growth and yield of low-chill peach cv. Sharbati. Int. J. Scient. Res. Publ., Vol. 3, No. 8.
- Zarrouk, O., Y. Gogorcena, J. Gomez-Aparisi, J.A. Betran and M.A. Moreno, 2005. Influence of almond X peach hybrids rootstocks on flower and leaf mineral concentration, yield and vigour of two peach cultivars. Scientia-Horticulturae, 106: 502-514.