

EFFECT OF FOLIAR SPRAY SOME MICRONUTRIENTS MIXTURE AND BIOFERTILIZERS (EM) ON GROWTH, YIELD AND FRUIT QUALITY ON SULTANI FIG IN NORTH WEST COAST

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This work was carried out during the two successful seasons (2018 and 2019) on the “Sultani” fig trees cultivated in a private orchard located in the Burg Al-Arab region (about 70 km to the west Alexandria, Egypt). This work aims to study the impact of application of sprays with a mixture of chalets (iron, zinc, and Mn) at 50, 100 mg.l⁻¹ and ascorbic acid at 500 and 1000 mg.l⁻¹ with EM at 500 and 1000 mg.l⁻¹ alone or combined in growth, productivity and fruit quality of fig trees planted in calcareous soil. The results showed that all the study parameters led to a significant increase in the measurements of vegetative growth, yield, quality and leaf mineral content for both seasons. Furthermore, a gradual increase in the studied growth parameters of “Sultani” fig trees was quite obvious with increasing the concentrations of both mixtures of microelements and ascorbic acid with Effective Microorganisms (EM) in both seasons. On the other hand, the treatment of spraying the “Sultani” fig trees with ascorbic acid at 1000 mg.l⁻¹ or EM at 1000 mg.l⁻¹ gave the highest values of total chlorophyll, leaf area, yield, fruit quality and leaf mineral contents in both seasons, compared to other treatments. However, the interaction between all treatments was given the best effective results in terms of affecting the fig tree studied parameters in the both seasons.

Keywords: *Ficus carica*, chalets, ascorbic acid, EM

INTRODUCTION

One of the oldest fruits known to humans *Ficus carica* L., is known commercially as fig plant and is a member of the Moraceae family and considers an important tree in many countries, especially Egypt. Egypt stands among one of the largest fig producing countries in the world. According to the statistics of the Egyptian Ministry of Agriculture (2018), the total area devoted for fig was 82865 feddans, while the fruiting area of it was 82372,

which produced about 300 thousand tons with an average of 2.5 tons/feddan. Major main fig area based in western north coast of Egypt, which it occupies 93.3% of the total area of fig. Sultani fig cultivar could be considered the local standard variety in Egypt (Afify, 2006). Most micronutrients are readily fixed in the calcareous soil having alkaline pH, which leads to plant roots are unable to absorb these nutrients adequately from the dry topsoil (Foth and Ellis, 1996). Foliar fertilization is particularly useful under conditions where the absorption of nutrients is through the soil and this difficult situation to be present in the micronutrients such as manganese (Mn), zinc (Zn) and iron (Fe). Since the micromineral elements is needed by plants in small amounts, so spraying them at the right time is the correct way to save the plant requirements (Kuepper, 2003).

The micronutrients function in plant such as; Mn plays an important role in many processes in plants as oxidation and reduction processes in plants, such as the electron transport in photosynthesis, in chlorophyll production, as an activating for more 35 different enzymes and carbohydrate synthesis (Mousavi et al., 2011). Zn influences the activity of plant enzymes; hydrogenase, carbonic anhydrase and synthesis of cytochrome, Zn involves in plant carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis and pollen formation, Zn has a positive effect on water uptake and transport in plants and also reduces the adverse effects of short periods of heat and salt stress. Zn is required for the synthesis of the growth hormone auxin, IAA and integrity of cellular membranes (Hafeez et al., 2013). Fe involves for many processes in plant such as the process of absorption from the soil through the roots, control transfers from the roots to the parts of the plant above soil surface, the intensification of the iron concentration in the mitochondria and chloroplasts and during seed germination and reduces the presence of Fe in the wood (Conte and Walker, 2011). Fe deficiency leads to facilitate the transfer of heavy metal such as Mn, Zn, cobalt, and cadmium, while sufficient level or above of Fe prevents it (Barberona et al., 2014). Some work has been carried out concerning the effect of microelements spray on deciduous fruits (El-Shobaky et al., 2001; El-Seginy et al., 2003; Chatzissavvidis et al., 2004; Maksoud et al., 2004; Naiema, 2006 and Abd-Ella and El-Sisi, 2006). Also, Havlin et al. (2005), Al-Rawi et al. (2012) and Shamkhi et al. (2018) reported that, foliar application of Anna apple trees with GA₃ and/or a mixture of chelated (Fe, Zn, and Mn) is recommended to increase fruit set, yield quantity and fruit quality of trees grown in calcareous soil. Regarding the effect of mineral fertilization on the fruits of figs and olive plants, Yousef et al. (2011) stated that the most effective treatment for yield components and nutrient content of olive trees was when microelements (Zn, Mn and Fe) foliar applied at 0.25% with amino acids at 0.5%. Jagtap et al. (2012) stated that the application of FeSO₄, ZnSO₄ and B to fig trees recorded significantly higher yield parameters like number of fruits per plant, fruit weight and yield.

Moreover, antioxidants such as ascorbic acid, citric acid have auxinic action and also synergistic effect on flowering and fruiting of fruit trees of most fruit trees, recently antioxidants used instead of auxins and other chemicals for enhancing flowering, growth and fruiting of various fruit trees Ragab (2002). Therefore, Samra et al. (2010) showed that spraying 500 ppm of ascorbic acid, salicylic acid and chelated zinc after fruit set and one month later were beneficial to obtain an economic yield with quality of Balady mandarin fruits. On the other hand, Mansour et al. (2010) recorded that application of ascorbic acid at 0.1% or citrine at 0.3% three times started for the first week of March with one-month intervals, considered a promising treatment for improving yield and fruit quality of Zebda, Awase, Alphonso and Taimour mango cultivars.

Effective Microorganisms (EM) has been used widely as inoculants to change the microbial diversity and interaction in soils and plants (Xu, 2000). In turn, EM has been shown to improve soil health, and the growth, yield and quality of crops over a wide range of agro-ecological conditions (Iwaishi, 2000 and Yamada and Xu, 2000). Foliar application of EM appears to suppress the occurrence of plant diseases and facilitates the uptake of simple organic molecules that can increase plant growth and yield in a relatively short time (Wididana and Higa, 1998). Through foliar application, microorganisms in EM appear to suppress the development of harmful plant pathogens at the surface, thereby providing a measure of plant protection through biocontrol. Another example of the beneficial effect of phyllosphere microorganisms was reported by Atlas and Bartha (1981). They found that pigmented yeast and bacteria that colonized on the leaf surfaces could afford some protection to the plant from excessive exposure to direct sunlight. Chamberlain and Daly (2005) reported that the metabolites developed by microorganisms are directly absorbed into plant surface. In addition, photosynthetic bacteria play the leading role in the activity of EM. They synthesize useful substances and increase the number of other bacteria and act as nitrogen binders. Similar results were recorded by Sangakkara and Nissanka (1998), Joo et al. (1999), Higa and Wididana (1999) and Yousaf et al. (2000). The results were in line with those obtained by El-Sabagh and Ahmed (2004) on apple, Abd-Ella and El-Sisi (2006) on fig and Malaka (2008) on pear. Likewise, Wood et al. (1997) reported that foliar spray with EM produced plant hormones, beneficial bioactive substances, and antioxidants which solubilize nutrients. Similarly, Shou-Song et al. (2002) suggested that EM can be used as a regulation substance to improve metabolism of crop plants for yield promotion and quality improvement. The previous results have agreed with those obtained by Abd El-Messeih et al. (2005), who indicated that added EM to the soil decreased acidity as compared with the untreated of Le-Conte pear tree.

The objective of the present investigation was to study the effect of foliar applications of mixture micronutrients (Fe, Zn and Mn), ascorbic acid

and EM on growth, yield, and fruit quality and leaf mineral content of Sultani fig trees under calcareous soil conditions.

MATERIALS AND METHODS

This investigation was carried out through two successive seasons; 2018 and 2019 on about 10-years old Sultani fig trees, grown in a calcareous soil in a private farm located at Burg El Arab region, about 70 kilometers west of Alex. and spaced at 5x5 a part meters under drip irrigation system. Some physical and chemical properties of such soil are listed in Table (1).

Table (1). Physical and chemical characters of experimental orchard soil.

Particle size distribution (%)			Soil texture	Ec (dS/ml)	pH	Soluble cations (meq.l ⁻¹)				Soluble anions (meq.l ⁻¹)			
Sand	Silt	Clay				K ⁺	Na ⁺	Ca ⁺²	Mg ⁺²	CO ₃ ⁻²	HCO ₃ ⁻³	Cl ⁻	SO ₄ ⁻²
70	12.5	17.5	Sandy loam	0.76	7.6	0.51	6.09	6.35	3.81	20.26	17.27	5.5	4.1

The selected trees were uniform in growth and vigor. Fertilization program and other agricultural practices were the same for all trees. The experiment was carried out using spilt plot randomized complete block design with the main plots being a mixture of microelements (Mn, Zn and Fe) at 50 and 100 mg.l⁻¹, ascorbic acid at 500 and 1000 mg.l⁻¹ and sub-plots EM at 500 and 1000 mg.l⁻¹ with three replicates and two trees per each replicate. Trees were labeled and treatments were undertaken. The trees were sprayed three times; at the vegetative growth stage, at the beginning of flowering and after fruit set. In early March of each season, four branches, one year old were chosen on each tree, on toward each direction and labeled to estimate growth parameters.

Growth measurements were made on each replicate as follows: the average of leaf area (cm²) was estimated as follows: Leaf area (cm²) = (diameter) 2 x 3.14 according to Sourial et al. (1985), Average total chlorophyll content (in fresh leaves) was measured in the field by using Minolta chlorophyll meter SP AD-502. At harvest time, the following parameters were recorded; fruit yield kg/tree = number of fruit/tree X fruit weight per g (the fruits were harvested as soon as they reached the maturity indices and a number of fruits per tree was counted and then weighted in g and recorded), physical properties i.e. fruit length, diameter (cm), volume (cm³) and chemical properties i.e. total soluble solids (TSS) content by using a hand refractometer, total acidity, total sugars, reducing sugar and leaf nutrient contents i.e. N, P, K, Ca and Mg% were determined according to method of A.O.A.C. (2000). All the obtained data during both 2018 and 2019 experimental seasons were subjected to analysis of variances (ANOVA) according to Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

1. Effect of Foliar Application Mixture of Micronutrients, Ascorbic acid and EM on Total Chlorophyll and Leaf Area

Results in table (2) show that total chlorophyll percentage and leaf area were significantly affected by all treatments in both seasons.

Table (2). Effect of foliar mixture micronutrients and EM on total chlorophyll and leaf area of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
	Total chlorophyll							
Control	36.16	39.66	41.75	39.19	38.26	41.76	43.89	41.30
Micro elements (50 mg.l⁻¹)	37.43	42.73	44.76	41.64	40.35	46.09	48.09	44.84
Micro elements (100 mg.l⁻¹)	38.92	45.39	46.63	43.65	42.12	49.36	50.77	47.42
Ascorbic acid (500 mg.l⁻¹)	38.41	43.80	46.15	42.79	43.08	48.30	50.81	47.40
Ascorbic acid (1000 mg.l⁻¹)	40.45	45.24	46.90	44.19	45.46	50.34	51.85	49.22
Mean	38.27	43.36	45.23		41.86	47.17	49.08	
LSD	0.3699, 0.4775 = 0.1204				0.4645, 0.5997 = 0.143			
Leaf area (cm²)								
Control	390.67	411.9	421.80	408.12	383.73	425.93	432.43	414.03
Mix micro element (50 mg.l⁻¹)	397.13	426.9	436.90	420.31	416.33	443.57	453.70	437.87
Mix micro element (100 mg.l⁻¹)	407.00	446.7	456.70	436.80	425.70	462.70	475.73	454.71
Ascorbic acid (500 mg.l⁻¹)	402.23	431.8	451.80	428.61	420.97	448.93	467.67	445.86
Ascorbic acid (1000 mg.l⁻¹)	417.00	441.8	461.70	440.17	441.73	466.13	485.53	464.47
Mean	399.26	429.3	441.80		417.69	449.45	463.01	
LSD	2.9227, 3.7752 = 0.7463				2.6393, 3.4074 = 0.8928			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

However, ascorbic acid at 1000 mg.l⁻¹ gave the best total chlorophyll percentage and leaf area in the first and second seasons. Furthermore, total chlorophyll percentage and leaf area were affected significantly by spraying EM in both seasons. EM at 1000 mg.l⁻¹ produced the highest total chlorophyll percentage and leaf area in both seasons. On the other side, control treatment gave the least total chlorophyll percentage and leaf area in both seasons. Moreover, the interactions between spraying the mixture of microelements (50 and 100 mg.l⁻¹), ascorbic acid (500 and 1000 mg.l⁻¹) and EM (500 and 1000 mg.l⁻¹) cleared that, ascorbic acid at 1000 mg.l⁻¹ and EM at 1000 mg.l⁻¹ recorded the highest total chlorophyll percentage and leaf area in both seasons. In addition, the control treatment recorded the least total chlorophyll percentage and leaf area in both seasons.

The increase in total chlorophyll percentage and leaf area that is clearly obvious from the previous results could be due to the use of antioxidants such as ascorbic acid, citric acid that has auxinic action and also synergistic effect on flowering and fruiting of most fruit trees, recently antioxidants used instead of auxins and other chemicals for enhancing growth and fruiting of various fruit trees (Ragab, 2002). Furthermore, the enhancement of plant growth by the EM bio stimulant application may be attributed to the profound effect of natural plant growth regulator substances produced by the effective microorganisms (bacteria, fungi, and yeast) as reported by Joo et al. (1999). Moreover, Higa and Wididana (1999) reported that when EM applied to soil or plant leaf surface, the population of photosynthetic bacteria and nitrogen fixing bacteria dramatically increased. This phenomenon was associated with the growth of more vigorous plants and enhanced the plant's photosynthetic rate, efficiency and its nitrogen fixing capacity. In addition to the activation effect of these micronutrients that play an important role in the representation of critical auxins that increase cell division and increase the chlorophyll content in the leaf, which works to increase the leaf area. Also, due to that Zn helps in building the chlorophyll through its direct impact in the composition of amino acids and carbohydrates and energy compounds used in the construction chlorophyll. As well as, its importance in building the necessary RNA in protein synthesis and stimulating the enzymes that participate in biological processes for the formation of chlorophyll (Havlin et al., 2005).

These results agree with Samra et al. (2010), who showed that spraying 500 ppm of ascorbic acid, salicylic acid and chelated Zn after fruit set and the one month later were beneficial to obtain an economic yield with quality of Balady mandarin fruits. In addition, El-Sheikh et al. (2007) on peach trees, Naiema (2008) on pear trees and Al-Rawi et al. (2012) on apricot trees found that the leaf area and chlorophyll percentage were positively correlated to Mn and Zn spray.

2. Effect of Foliar Application Mixture of Micronutrients, Ascorbic Acid and EM on Yield Components

Data in table (3) show that the effect of foliar application of the mixture of microelements (Mn, Zn and Fe) at 50 and 100 mg.l⁻¹, ascorbic acid (500 and 1000 mg.l⁻¹) and EM (500 and 1000 mg.l⁻¹) on Sultani fig trees yield as number of fruit per tree and fruit weight (g) was significantly increase compared to the control in both seasons; 2018 and 2019. Furthermore, the results indicated that, ascorbic acid at 1000 mg.l⁻¹ followed by the mixture of microelement at 100 mg.l⁻¹ was significantly superior, compared to other treatments in both seasons. In addition, EM at 1000 mg.l⁻¹ gave the highest number of fruits, fruit weight (g) and yield in both season. While, the interaction between ascorbic acid at 1000 mg.l⁻¹ and EM at 1000 mg.l⁻¹ was given the highest values of fig tree yield in 2018 and 2019, compared to other treatments.

Micronutrients involved in many biological processes in the plant, especially the antioxidant formation processes in the plant, where the micronutrient application increased the enzyme activity which formed the antioxidants. Besides, the function of Fe, Mn, Zn, and B micronutrients in plants were reported by Barberona et al. (2014), Mousavi et al. (2011) and Hafeez et al. (2013). Moreover, antioxidants such as ascorbic acid, citric acid have auxinic action and also synergistic effect on fruiting of most fruit trees, recently antioxidants were used instead of auxins and other chemicals for enhancing growth and fruiting of various fruit trees (Ragab, 2002). Therefore, Samra et al. (2010) showed that spraying 500 ppm of ascorbic acid, salicylic acid and chelated Zn after fruit set and one month later were beneficial to obtain an economic yield with quality of Balady mandarin fruits. On the other hand, Mansour et al. (2010) recorded that application of ascorbic acid at 0.1% or citrine at 0.3% three times started from the first week of March with one-month intervals, considered a promising treatment for improving yield and fruit quality of Zebda, Awase, Alphonso and Taimour mango cultivars. These results can be explained as the EM biostimulant contains more than 60 strains of microorganisms as bacteria, yeast, actinomycetes and various fungi. Similar results were recorded by Yousaf et al. (2000) on groundnut, they clearly indicated that the foliar solution of EM at certain concentrations and time intervals caused a significant increase in yield. Additionally, EM can be used as a regulation substance to improve metabolism of crop plants for yield promotion and quality improvement.

Table (3). Effect of foliar mixture micronutrients and EM on yield per tree of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
	No. of fruits/tree							
Control	240.96	245.88	244.92	243.92	246.48	252.89	263.08	254.15
Micro elements (50 mg.l ⁻¹)	241.36	240.61	244.62	242.20	256.01	256.82	267.34	260.06
Microelements (100 mg.l ⁻¹)	245.13	249.98	271.27	255.46	258.68	263.85	288.87	270.47
Ascorbic acid (500mg.l ⁻¹)	246.38	239.00	264.95	250.11	255.90	253.67	279.22	262.93
Ascorbic acid (1000 mg.l ⁻¹)	248.00	252.35	289.43	263.26	269.21	260.80	300.90	276.97
Mean	244.36	245.56	263.04		257.26	257.61	279.88	
LSD	5.7046, 7.3646 = 0.4655				4.0376, 5.2125 = 0.49			
Fruit weight (g)								
Control	45.83	48.64	49.87	48.11	49.60	52.23	53.48	51.77
Microelements (50 mg.l ⁻¹)	47.03	51.67	52.52	50.40	51.10	55.37	56.63	54.37
Microelements 100 mg.l ⁻¹)	47.96	54.03	56.34	52.78	52.79	58.52	60.60	57.30
Ascorbic acid (500 mg.l ⁻¹)	47.52	52.19	54.67	51.46	52.55	57.11	59.82	56.49
Ascorbic acid (1000 mg.l ⁻¹)	49.14	53.29	56.83	53.09	55.07	59.19	62.77	59.01
Mean	47.50	51.96	54.05		52.22	56.48	58.66	
LSD	0.5877, 0.7587 = 0.1171				0.5597, 0.7225 = 0.1293			
Yield (kg /tree)								
Control	11.04	11.96	12.21	11.74	12.22	13.26	14.11	13.20
Microelements (50 mg.l ⁻¹)	11.35	12.43	12.85	12.21	13.08	14.22	15.14	14.15
Microelements (100 mg.l ⁻¹)	11.76	13.51	15.28	13.51	13.66	15.44	17.51	15.53
Ascorbic acid (500 mg.l ⁻¹)	11.71	12.47	14.48	12.89	13.45	14.49	16.70	14.88
Ascorbic acid (1000 mg.l ⁻¹)	12.19	13.45	16.45	14.03	14.83	15.42	18.85	16.36
Mean	11.61	12.76	14.21		13.45	14.56	16.46	
LSD	0.4419, 0.5705 = 0.0506				0.3754, 0.4846 = 0.0572			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

3. Effect of Foliar Application Mixture of Micronutrients, Ascorbic Acid and EM on Fruit Physiochemical Characteristics (Fruit quality)

The data presented in table (4 and 5) show that, the experimental treatments on Sultani fig tree at the two seasons generally increased fruit quality and decreased fruit acidity % as compared with the control. In addition, gradual and significant increase of fruit physical and chemical properties occurred, i.e. fruit length, diameter volume, TSS %, total sugar % and reducing sugars %, except the acidity with increasing the concentration of the mixture of microelements and ascorbic acid as compared with control. Moreover, increasing the concentration of EM gave the highest value of all the physical and chemical properties of the fruit except the acidity. Furthermore, the interactions between the mixture of microelements and ascorbic acid with EM showed that high concentration of ascorbic acid with the high concentration of EM gave the best fruit quality and the lowest fruit acidity in both seasons.

The above results agreed with those obtained by Ragab (2002), he found that has a synergistic effect on fruit quality of fruit crops. Therefore, these observations are in accordance with those obtained by Samra et al. (2010) showed that spray 500 ppm of ascorbic acid, salicylic acid and chelated zinc at after fruit set and the one month later were beneficial to obtain an economic yield with quality of Balady mandarin fruits. On the other hand, Mansour et al. (2010) recorded that application of ascorbic at 0.1% or Citrine at 0.3% three times started from the first week of March with one month intervals, considered a promising treatment for fruit quality of Zebda, Awase, Alphonso and Taimour mango cultivars. Foliar application with EM improved fruit quality through increasing flesh TSS percent, and contents of V. C. and sugars. The results were in line with those obtained by El-Sabagh and Ahmed (2004) on apple, Abd-Ella and El-Sisi (2006) on fig and Malaka (2008) on pear.

Likewise, Wood et al. (1997) reported that foliar spray with EM produced plant hormones, beneficial bioactive substances, and antioxidants which solubilize nutrients. Similarly, Shou-Song et al. (2002) suggested that EM can be used as a regulation substance to improve the metabolism of crop plants for quality improvement. The previous results have agreed with those obtained by Abd El-Messeih et al. (2005) indicated that added EM to the soil improved to decreased acidity as compared with the untreated of Le-Conte pear tree.

Table (4). Effect of foliar mixture of micronutrients and EM on fruit length, diameter and volume of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
	Fruit length (cm ²)							
Control	3.46	3.72	3.86	3.68	3.37	3.71	3.88	3.66
Microelements (50 mg.l ⁻¹)	3.57	3.91	4.02	3.83	3.58	3.93	4.03	3.85
Microelements (100 mg.l ⁻¹)	3.63	4.15	4.77	4.18	3.65	4.19	4.79	4.21
Ascorbic acid (500 mg.l ⁻¹)	3.58	3.98	4.23	3.93	3.59	4.01	4.27	3.96
Ascorbic acid (1000 mg.l ⁻¹)	3.75	4.10	4.92	4.26	3.78	4.13	4.95	4.29
Mean	3.60	3.97	4.36		3.60	3.99	4.38	
LSD	0.1225, 0.1582 = 0.0153				0.1159, 0.1496 = 0.0154			
Fruit diameter (cm)								
Control	3.67	4.14	4.39	4.07	3.77	3.77	4.45	4.00
Microelements (50 mg.l ⁻¹)	3.73	4.43	4.60	4.26	3.87	3.87	4.70	4.15
Microelements (100 mg.l ⁻¹)	3.96	4.76	4.91	4.54	4.02	4.02	4.96	4.33
Ascorbic acid (500 mg.l ⁻¹)	3.86	4.54	4.87	4.42	3.94	3.94	4.91	4.26
Ascorbic acid (1000 mg.l ⁻¹)	4.31	4.68	5.04	4.68	4.42	4.42	5.16	4.67
Mean	3.91	4.51	4.76		4.00	4.00	4.84	
LSD	0.0589, 0.0761 = 0.0145				0.0449, 0.058 = 0.0165			
Fruit volume (cm ³)								
Control	39.95	44.31	46.20	43.49	38.53	45.06	45.38	42.99
Microelements (50 mg.l ⁻¹)	41.49	47.65	49.15	46.10	41.62	48.54	48.08	46.08
Microelements (100 mg.l ⁻¹)	43.65	52.09	54.43	50.06	44.59	53.29	53.81	50.56
Ascorbic acid (500 mg.l ⁻¹)	42.71	48.79	53.13	48.21	44.05	49.22	49.89	47.72
Ascorbic acid (1000 mg.l ⁻¹)	45.34	51.04	56.00	50.79	47.47	52.57	53.21	51.08
Mean	42.63	48.78	51.78		43.25	49.74	50.07	
LSD	0.3762, 0.9505 = 0.164				0.5222, 0.7742 = 0.1511			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

Table (5). Effect of foliar mixture micronutrients and EM on TSS, acidity, total sugars and reducing sugar of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
	TSS%							
Control	16.23	17.10	17.38	16.90	16.26	17.27	17.32	16.95
Microelements (50 mg.l ⁻¹)	16.66	17.67	18.24	17.53	17.59	18.88	19.16	18.55
Microelements (100 mg.l ⁻¹)	16.94	18.85	19.24	18.34	18.14	20.19	20.26	19.53
Ascorbic acid (500 mg.l ⁻¹)	16.86	17.98	19.03	17.95	18.21	19.31	19.91	19.14
Ascorbic acid (1000 mg.l ⁻¹)	17.18	18.63	19.80	18.54	18.35	19.94	20.79	19.69
Mean	16.77	18.04	18.74		17.71	19.12	19.49	
LSD	0.204, 0.2634 = 0.0358				0.1895, 0.2446 = 0.0457			
Acidity %								
Control	0.22	0.22	0.18	0.20	0.21	0.18	0.17	0.19
Microelements (50 mg.l ⁻¹)	0.20	0.20	0.16	0.19	0.19	0.17	0.16	0.17
Microelements (100 mg.l ⁻¹)	0.19	0.19	0.15	0.18	0.19	0.15	0.15	0.16
Ascorbic acid (500 mg.l ⁻¹)	0.19	0.19	0.15	0.18	0.19	0.17	0.15	0.17
Ascorbic acid (1000 mg.l ⁻¹)	0.19	0.19	0.15	0.17	0.18	0.15	0.14	0.16
Mean	0.20	0.20	0.16		0.19	0.17	0.15	
LSD	0.0023, 0.003 = 0.0053				0.0034, 0.0044 = 0.0075			
T. Sugars %								
Control	12.81	13.75	14.10	13.55	13.02	14.00	14.36	13.79
Microelements (50 mg.l ⁻¹)	13.18	14.30	14.72	14.07	14.17	14.81	15.29	14.76
Microelements (100 mg.l ⁻¹)	13.55	14.93	15.55	14.68	14.41	15.31	15.88	15.20
Ascorbic acid (500 mg.l ⁻¹)	13.36	14.64	15.14	14.38	14.29	15.00	15.88	15.06
Ascorbic acid (1000 mg.l ⁻¹)	13.91	14.83	15.30	14.68	14.65	15.11	16.05	15.27
Mean	13.36	14.49	14.96		14.11	14.84	15.49	
LSD	0.912, 0.1178 = 0.0272				0.952, 0.1195 = 0.0272			
Reducing sugar %								
Control	8.25	9.23	9.59	9.02	8.18	9.62	9.81	9.20
Microelements (50 mg.l ⁻¹)	8.66	9.78	10.20	9.55	8.76	13.07	10.82	10.88
Microelements (100 mg.l ⁻¹)	9.04	10.40	11.04	10.16	8.89	10.96	11.18	10.34
Table (5). Cont.								
Ascorbic acid (500 mg.l ⁻¹)	8.84	10.14	10.63	9.87	9.25	10.77	10.94	10.32
Ascorbic acid (1000 mg.l ⁻¹)	9.39	10.33	10.76	10.16	9.86	11.09	11.25	10.73
Mean	8.84	9.98	10.44		8.99	11.10	10.80	
LSD	0.0888, 0.1146 = 0.0304				0.4222, 0.5451 = 0.0436			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

4. Effect of foliar application of micronutrients mixture, ascorbic acid and EM on leaf mineral contents

Data presented in table (6 and 7) indicate that all leaf minerals content of Sultani fig trees that cultivated under foliar spray treatments resulted from microelements mixture (50 and 100 mg.l⁻¹), ascorbic acid (500 and 1000 mg.l⁻¹) and EM (500 and 1000 mg.l⁻¹) conditions were significantly increased with the increasing of foliar application rates when they were sprayed either singly or in combinations. The results show that all tested foliar sprays of microelements mixture, ascorbic acid and EM were significantly increased the understudied leaf mineral content with superiority for spraying Sultani fig trees by ascorbic acid and EM at 1000 mg.l⁻¹ as compared with the other sprayed treatments in both seasons.

In general, it was noticed that the highest levels of leaf mineral contents of Sultani fig trees were obtained from trees sprayed with the highest concentration of microelements mixture, ascorbic acid and EM in both seasons, compared to the control and other treatments. Mixture microelements and ascorbic acid with bio-fertilize EM application indicated a higher increase of the leaf mineral contents of Sultani fig trees than single application and control. Regarding interaction effect among the all studied factors achieved, the highest leaf mineral contents. The effect on plant nutrient status resulted from spraying different solutions might be attributed to quick absorption via leaves and the limited loss of the nutrients when they were sprayed (Marschner, 1995). As for the reduction in leaf P content, it might be attributed to the antagonism between Fe and P (Nawar 1991). These results agreed to some extent with those of El-Seginy et al. (2003), Chatzissavvids et al. (2004), Maksoud et al. (2004) and Abd-Ella et al. (2006). Nowadays, there is a widespread use of antioxidants especially ascorbic acid for enhancing the growth and productivity of fruit trees as well as controlling the incidence of most fruit disorders (Prestamo and Arroyo, 1999). The promoting effect of natural bio stimulant on the nutritional status of the leaves could be related to the role of the effective microorganisms in improving the availability of nutrients. Similar findings were recorded by Sangakkara and Nissanka (1998), who found that foliar application of EM significantly increased leaf chlorophyll content of beans due to greater rates of photosynthesis.

Table (6). Effect of foliar mixture micronutrients and EM on N, P and K of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
N								
Control	1.09	1.37	1.53	1.33	1.39	1.35	1.51	1.42
Microelements (50 mg.l ⁻¹)	1.15	1.56	1.59	1.43	1.15	1.56	1.59	1.43
Microelements (100 mg.l ⁻¹)	1.32	1.66	1.78	1.59	1.32	1.66	1.78	1.59
Ascorbic acid (500 mg.l ⁻¹)	1.27	1.58	1.70	1.52	1.27	1.58	1.70	1.52
Ascorbic acid (1000 mg.l ⁻¹)	1.48	1.62	1.92	1.67	1.48	1.62	1.92	1.67
Mean	1.26	1.56	1.70		1.32	1.55	1.70	
LSD	0.0344, 0.0444 = 0.0088				0.0628, 0.081 = 0.0087			
P								
Control	C	Mn1	Mn2		0.21	0.31	0.34	0.29
Microelements (50 mg.l ⁻¹)	0.22	0.30	0.33	0.28	0.24	0.35	0.38	0.32
Microelements (100 mg.l ⁻¹)	0.24	0.34	0.37	0.32	0.29	0.41	0.43	0.37
Ascorbic acid (500 mg.l ⁻¹)	0.28	0.40	0.43	0.37	0.27	0.36	0.42	0.35
Ascorbic acid (1000 mg.l ⁻¹)	0.27	0.35	0.42	0.35	0.32	0.39	0.45	0.39
Mean	0.31	0.39	0.44	0.38	0.26	0.36	0.40	
LSD	0.0079, 0.0103 = 0.0057				0.0073, 0.0094 = 0.0056			
K								
Control	1.33	1.50	1.58	1.47	1.33	1.52	1.59	1.48
Microelements (50 mg.l ⁻¹)	1.37	1.62	1.71	1.57	1.40	1.64	1.72	1.59
Microelements (100 mg.l ⁻¹)	1.42	1.79	1.86	1.69	1.44	1.82	1.88	1.71
Ascorbic acid (500 mg.l ⁻¹)	1.39	1.66	1.83	1.63	1.43	1.71	1.87	1.67
Ascorbic acid (1000 mg.l ⁻¹)	1.55	1.75	1.90	1.73	1.61	1.81	1.94	1.78
Mean	1.41	1.66	1.77		1.44	1.70	1.80	
LSD	0.029, 0.03374 = 0.0072				0.0286, 0.0369 = 0.0063			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

Table (7). Effect of foliar mixture micronutrients and EM on Ca and Mg of fig trees during 2018 and 2019 seasons.

Treatments	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean	Control	EM (500 mg.l ⁻¹)	EM (1000 mg.l ⁻¹)	Mean
	Season 1				Season 2			
Ca								
Control	1.57	1.85	1.96	1.79	1.66	1.93	2.05	1.88
Microelements (50 mg.l ⁻¹)	1.68	2.00	2.10	1.92	1.77	2.08	2.18	2.01
Microelements (100 mg.l ⁻¹)	1.79	2.18	2.33	2.10	1.88	2.27	2.42	2.19
Ascorbic acid (500 mg.l ⁻¹)	1.74	2.06	2.23	2.01	1.82	2.17	2.32	2.10
Ascorbic acid (1000 mg.l ⁻¹)	1.90	2.14	2.28	2.11	1.98	2.23	2.34	2.19
Mean	1.73	2.04	2.18		1.82	2.13	2.26	
LSD	0.0244, 0.0314 = 0.0068				0.0245, 0.0317 = 0.0082			
Mg								
Control	0.65	0.76	0.80	0.74	0.66	0.78	0.72	0.72
Microelements (50 mg.l ⁻¹)	0.69	0.82	0.88	0.79	0.70	0.84	0.77	0.77
Microelements (100 mg.l ⁻¹)	0.74	0.91	0.96	0.87	0.77	0.92	0.85	0.85
Ascorbic acid (500 mg.l ⁻¹)	0.71	0.86	0.93	0.83	0.74	0.88	0.81	0.81
Ascorbic acid (1000 mg.l ⁻¹)	0.78	0.89	0.97	0.88	0.81	0.91	0.86	0.86
Mean	0.71	0.85	0.91		0.74	0.87	0.80	
LSD	0.0103, 0.0133 = 0.0068				0.007, 0.0091 = 0.0067			

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level.

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تأثير الرش بمخلوط العناصر الصغرى والحيوي (EM) على نمو ومحصول وجودة ثمار التين السلطاني بالساحل الشمالي الغربي

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تم إجراء هذه الدراسة خلال الموسمين ٢٠١٨ و٢٠١٩ على أشجار التين "سلطاني" المزروعة في منطقة برج العرب (حوالي ٧٠ كم غرب الإسكندرية، مصر). وذلك لدراسة تأثير الرش بمزيج من العناصر (الحديد والزنك والمنجنيز) بتركيز ٥٠ و ١٠٠٠ مجم/لتر وحمض الأسكوربيك عند ٥٠٠ و ١٠٠٠٠ مجم/لتر مع الرش بالكائنات الدقيقة الفعالة EM (٥٠٠ و ١٠٠٠٠ مجم/لتر) وحدها أو مجتمعة على النمو والإنتاجية وجودة الثمار على أشجار التين المزروعة في التربة الجيرية. أظهرت النتائج أن جميع المعاملات أدت إلى زيادة معنوية في قياسات النمو الخضري والمحصول والجودة والمحتوى المعدني للأوراق لكلا الموسمين. علاوة على ذلك، كانت الزيادة التدريجية في قياسات النمو لأشجار التين "سلطاني" واضحة تمامًا مع زيادة تركيزات كل من مخلوط العناصر وحمض الأسكوربيك مع EM في كلا الموسمين. من ناحية أخرى، أعطت معاملة رش الأشجار بحمض الأسكوربيك عند ١٠٠٠٠ مجم/لتر أو EM عند ١٠٠٠٠ مجم/لتر أعلى قيمة للكوروفيل الكلي، مساحة الأوراق، المحصول، جودة الثمار والمحتوى المعدني للأوراق من العناصر المعدنية في كلا الموسمين مقارنة بالمعاملات الأخرى. أما التفاعل بين جميع المعاملات فقد أعطى أفضل النتائج لكل الصفات في الموسمين.