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Improving Valencia Orange Trees Status with Zinc Application

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ABSTRACT

This investigation was carried out for two seasons (2018 and 2019) on Valencia orange trees grown in sandy soil at Salhia area in Sharkia Governorate, Egypt, including three levels of chelated zinc compound. Each level was added at 1, 2, and 3 applications during the growing season. The recommended treatment with chelated zinc at 2g/l in March and June that caused a significant increase in yield and fruit size as compared with the other treatments. N, K, and Fe concentrations were decreased as the rate of a chelated zinc spray increased regardless number of sprays in general. Phosphorus contents showed insignificant differences between different levels of chelated zinc spray or number of applications. Mn and Zn contents were increased either level or by increasing the number of zinc sprays.

Keywords: Valencia orange - Zinc deficiency - Foliar application - Yield – Mineral Content

INTRODUCTION

Citrus is one of the most important fruits in the world. Egypt is the world’s sixth largest orange (Citrus sinensis L.) producer and the largest exporter. The total Egyptian exports of citrus fruits reached 1.8 million tons, with a cash value of 3420 million dollars. Egypt accounts for 38% of the world's orange exports at a value of 662 million dollars (Ministry of Agriculture and Land Reclamation of Egypt, 2019).

Valencia oranges is the most widely planted variety in the world. In Egypt, Valencia orange rank the second position after Navel orange, since it's cultivated area reached 126429 fed., this area represents about 26% of the total citrus area (Abobatta, 2019). Fruit size is one of the most important parameters determining the profitability of citrus production. Markets have specific demands for fruit size and offer higher rewards for fruit of optimum size (El-Otmani *et al*., 1993; Guardiola & García-Luis, 2000).

Zinc is an essential microelement, important for plants as it participates in tryptophan synthesis, which is a precursor of IAA synthesis. Zn is required for different enzyme activities such as aldolases, transphosphorylases, dehydrogenases, isomerases, RNA and DNA polymerases (Swietlik, 1999 and Sasirekha *et al*., 2012). In addition, acts as a co-factor for different enzymes, plays an important role in starch metabolism, enhances photosynthesis, nucleic acid metabolism and protein biosynthesis (Alloway, 2008). The deficiency of Zn considered the most common nutritional alteration in all citrus producing areas. It is especially observed in sandy soils but can be seen also in alkaline soils, it can be aggravated by the high level of fertilizing with phosphate or nitrogen (Khan *et al*. 2012, Boaretto *et al*., 2002).

Fruits quality improvements (more saccharose contents, better rind texture) are reported due to zinc application (Langthasa and Bhattacharyya, 1991; Quin *et al*., 1996).

Foliar spray of micronutrients such as Zn, Cu, B and Fe has multiple advantages over soil application due to its high efficacy, rapid plant response, comfort and elimination of toxicity symptoms resulting from excessive accumulation of soil for such nutrients (Obreza *et al*., 2010). Considering the unfavorable physical and chemical conditions of our soil, it is very important to provide micronutrients in adequate quantities by spraying the leaves and increasing citrus production (Khan *et al*. 2012). Therefore, an attempt has been made to find the limit of improvement of Valencia orange trees by using foliar spray under Salhia area in Sharkia Governorate conditions.

MATERIALS AND METHODS

This investigation was carried out on an orchard of Valencia orange (Citrus sinensis L. Osbeck) located at Elsalam farm, Salhia area, Sharkia Governorate. The treatmens included three levels of chelated zinc compound during 2018 and 2019 season. The trees were 20-year-old grafted on sour orange (Citrus aurantium L.) rootstock planted 6 m apart in sandy soil. The soil was sandy in texture with pH ranged between 7.2 and 7.8. The experiment was conducted using trees showed Zn deficiency symptoms including chlorotic leaf pattern which is known as "mottle leaf". In addition, it shows up irregular green bands develop along midribs and lateral veins, leaves become small and narrow, and twinges tend to die back (Chapman, 1973). The experimental trees received the same field practices adopted in the orchard (i.e. irrigation, pest and weed control… etc.) except for the treatments.

The Valencia orange trees were treated with four different Zn concentrations including 0.0 (control), 1, 2 and 3 (g/l) at three different times: (1) at the first of March only, just before blooming, one foliar spray (Date 1); (2) at March

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and June, directly after fruit set, two foliar spray (Date 2) and (3) at March, June and at the first of September, three foliar spray (Date 3). These experiment treatments were repeated for two seasons with three replicates for each season.

Treatments were arranged in a complete randomized block in a split plot design (the Zn concentrations factor ranked in main plot (A) and the time of addition factor ranked in sub main plot (B).

A guard row of trees around every sub-plot as well as between the replication was maintained. The chelated Zn compound was used in this experiment with chemical composition of disodium ethylenediamine tetra-acetate dehydrate containing 14.2% Zn or 17.7% ZnO. Chelated urea material was added to each spray at a rate of 10g per liter in order to enhance the absorption of the sprayed nutrients as reported by Wallace (1966) and Labanuskas *et al.* (1969). The control trees were sprayed with only urea at the same concentration. Same treatments were applied for two seasons on the same trees. All trees received ammonium sulphate, calcium superphosphate, and potassium sulphate at the rate 1000 g N, 125 g P2O5 and 140 g K2O/tree/year (March, May, and July). Normal practices were carried out to all trees as recommended and adopted in the Southern Sector of El-Tahreer.

The responses of the different zinc concentrations applied at different times were evaluated on Valencia orange through the following parameters:

Yield: Fruits of each tree was harvested on 10 March for the two seasons and yield per tree as a Kg was recorded for all treatments.

Fruit size: the fruits size was calculated as fruit diameter as follows, small fruits (less than six cm), medium fruits (between six and ten cm) and large fruits (more than ten cm).

Leaf mineral content: The leaf samples were taken in mid-October from non-fruiting spring tagged flushes as recommended by Chaplman (1960). The age of the sample leaves was about seven months. Samples of 200 gm. Of fresh leaves was cleaned and washed several times with tap water, the leaf samples be air dried then put in an electrical furnace at 60-70 C° for 48 h. till constant weight and finally ground. An adequate processed sample was provided to determine different minerals. Methods for analysis were according to Jones *et al*. (1961). N, P, and K elements in leaf tissues were determined according to the method used by Embleton *et al.* (1958). Manganese, iron, and zinc were spectrometrically determined using the atomic absorption spectrophotometer. All the data method was statistically analyzed (Cochran and Cox, 1957).

RESULTS AND DISCUSSION

Yield:

The data in Fig. 1 indicates that the tree yield increased with the increase of zinc spray concentration at all different dates. The highest yield was obtained from Date 2 followed by Date 1, while, the lowest value was observed at Date 3 in both seasons. Using Zn with 2 g/l gave the highest yield as compared with all other treatments in different times of application, while there were insignificant differences observed among other treatments. The highest yield came from the treatment 2 g/l at Date 2 in both seasons, while the lowest values was obtained from control at Date 1.

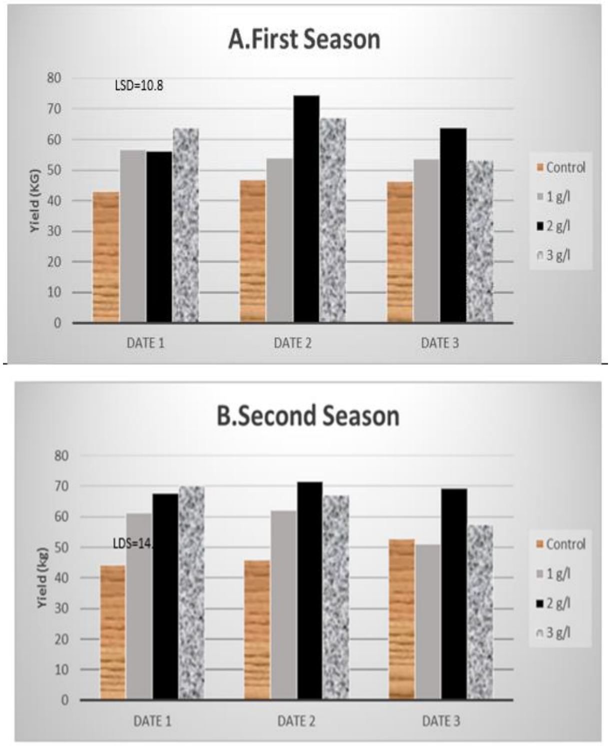

Fig. 1. Effect of chelated zinc sprays on Valencia orange tree yield (Kg) after application in three different times (2018 and 2019 seasons). Date 1: The first of March only just before blooming; Date 2: March and June after fruit set; Date 3: March, June and September.

In general, zinc foliar application with its different levels in March and June, increased yield of Valencia orange trees. These results matched with those obtained on Valencia oranges (Labanauskas *et al*., 1963), and Washington navel oranges in sandy soil (Nasser, 1982). They all found that spraying zinc at various rates at different periods during the year, increased the yield of citrus trees. Zinc involved directly in different enzymatic activity and physiological processes. Participation of zinc in auxin synthesis resulted into photosynthesis enhancement, starch accumulation in fruits, balance of plant auxin controls the fruit drop or retention in plants, which adjusted the control of fruit drop and enhanced the total number of fruits per plant. Similar results were also observed by (Banik *et al*., 1997 and Saraswathy *et al*., 2004).

Fruit size:

The effect of different treatments on fruit size was clear especially at the second year (Table 1). Total yield was increased with increasing Zn concentration. The number of small fruits in the control treatment was higher than other treatments. Moreover, the volume of fruits increased with increasing Zinc concentration. The number of medium fruits significantly increased by using 1 g/l zinc as compared to control. Among all treatments, using 3 g/l gave the highest number of large fruits. Zinc is required for the synthesis of tryptophan, a synthesis precursor of IAA, which is involved in fruit growth and development (Swietlik, 1999). These results are in line with the work of Sahota and Arora (1981) on Sweet orange, which declared that foliar application of Zn enhanced the fruit yield by increasing the fruit weight.

Table 1. Effect of chelated zinc sprays on fruit size per tree (calculated as number of fruits per every size) of Valencia orange trees

Chelated zinc % (A)	Date of applications							
	2018				2019			
	Small	Medium	large	Total	Small	Medium	large	Total
Control	52.4 a	33.2 c	26.8 b	112.4	50.6 a	34.1 a	26.5 b	111.2
1 g/l	45.7 b	40.3 b	26.7b	112.7	33.4 b	25.6 c	38.4 c	95.4
2 g/l	34.9 c	38.8 b	32.7 a	106.4	31.5 b	26.4 bc	65.7 b	123.6
3 g/l	33.4 c	48.1 a	37.2 a	118.7	20.2 c	28.5 b	92.1 a	140.8

Averages with the same letter in the row don't have significantly differences, according with Tukey test at 5% significance level

Mineral content:

Data In Table (2) showed that zinc concentrations 2 and 3 g/l significantly decreased nitrogen leaf content as compared with control in the second season only. No significant differences were observed between the three Zinc concentrations at the second season. Concerning the number of applications, nitrogen concentration was significantly increased as the number of zinc application times increased in the second season. The interaction between 3 g/l of chelated zinc at Date 1 gave the lowest nitrogen leaf content, while control in the Date 1 gave the highest nitrogen content. This may be attributed to the extensive productivity of flowering and fruits in the second season rather than in the first season (Selim *et al*., 1976). However, it is apparent from the same table that spraying chelated zinc, caused reduction in the leaf nitrogen contents with increasing the rate of zinc. This reduction in N leaf content not attained to critical levels (ranged from 1.7 to about 2%), as reported by Jones and Embleton (1968).

No significant differences were obtained in the phosphorus leaf content between all zinc concentrations, times and the interaction between them in both seasons. The results are in agree with those of Labanuskas (1969).

No significant differences were observed in the potassium leaf content between the three zinc concentrations and during all times, while the interaction between them was significant in the first and second seasons. The interaction between control and Date 1 gave the highest potassium content in both seasons, while lowest values obtained from the interaction between 3g/l chelated zinc, Date 1 and Date 2, in the first and second seasons, respectively.

No significant differences were observed in the potassium leaf content between the three zinc concentrations and during all times, while the interaction between them was significant in the first and second seasons. The interaction between control and Date 1 gave the highest potassium content in both seasons, while lowest values obtained from the interaction between 3g/l chelated zinc, Date 1 and Date 2, in the first and second seasons, respectively.

Table 2. Leaf N, P and K content of Valencia orange trees sprayed with chelated zinc(2018 and 2019 seasons)

Element	N				P				K			
Chelated zinc (%)	Date 1	Date 2	Date 3	AV.	Date 1	Date 2	Date 3	AV.	Date 1	Date 2	Date 3	AV.
First season												
control	2.56	2.71	2.84	2.71	0.208	0.217	0.238	0.22	2.01	1.65	2.04	1.90
1 g/l	2.55	2.68	2.88	2.70	0.187	0.119	0.193	0.19	1.84	1.81	1.90	1.85
2 g/l	2.54	2.57	2.73	2.61	0.194	0.196	0.174	0.19	1.85	1.76	1.88	1.83
3 g/l	2.42	2.53	2.68	2.55	0.186	0.174	0.163	0.17	1.73	1.83	1.76	1.77
AV.	2.50	2.59	2.76		0.19	0.16	0.18		1.81	1.80	1.85	
LSD 0.05	A= NS, B= NS and A×B= NS				A= NS, B= NS and A×B= NS				A= NS, B= NS and A×B= 0.22			
Second season												
control	2.65	2.83	2.91	2.80	0.231	0.225	0.226	0.23	2.13	2.07	2.13	2.11
1 g/l	2.62	2.73	2.87	2.74	0.214	0.202	0.193	0.20	1.94	1.90	1.93	1.92
2 g/l	2.57	2.61	2.81	2.66	0.188	0.197	0.176	0.19	1.91	1.74	1.76	1.80
3 g/l	2.53	2.61	2.76	2.63	0.193	0.188	0.185	0.19	1.78	1.74	1.78	1.77
AV.	2.57	2.70	2.81		0.20	0.20	0.18		1.88	1.79	1.82	
LSD 0.05	A= 0.13, B= 0.10 and A×B= 0.10				A= NS, B= NS and A×B= NS				A= NS, B= NS and A×B= 0.27			

***LSD (0.05): Levels of Zinc spray (A), No. of applications (B) and Interaction (Date × concentration): (A× B)**

As shown in Table 3, the content of Fe was the highest in control as compared to other treatment in the first season only, while it was significantly higher than 2g/l treatment in the second season. No significant differences obtained between all times in both seasons. The highest value of Fe came from the control treatments at Date 2, while the lowest value came from the treatment 3 g/l at Date 2 in the two seasons. The reduction in iron content was explained as due to disturbance such as physiological antagonism or differential translocation of iron within the plant tissues resulting from sprays of zinc (Labanuskas, 1969).

The manganese content was gradually increased by increasing the level of zinc. The lowest content of manganese was from control treatment, while the highest was observed at Zinc 3 g/l. The manganese content was gradually increased with increasing the number of applications to be the highest in the Date 3. The highest manganese content was from the interaction between the treatment 3 g/l and the Date 3, while the lowest value obtained from the interaction between control treatment and the Date 1.

Zinc content gradually increased significantly with increasing in Zinc levels in both season, the highest leaves content of Zinc was obtained by spraying 3 g/l, while the lowest value was the control in both seasons. Zinc leaf content increased with the advance in the number of applications to be the highest in the Date 2, then decreased again in Date 3. The highest level zinc leaf content observed from the interaction between the treatment 3 g/l and the Date 2 in both seasons. While, the lowest values from the interaction between control and the Date 2 in the first season, and the same treatment and the Date 1 in the second season.

Table 3. Leaf Fe, Mn and Zn content of Valencia orange trees sprayed with chelated zinc (2018 and 2019 seasons)

Element	Fe (ppm)				Mn (ppm)				Zn (ppm)			
Chelated zinc (%)	Date 1	Date 2	Date 3	AV.	Date 1	Date 2	Date 3	AV.	Date 1	Date 2	Date 3	AV.
						First season						
Control	136.22	138.98	133.14	136.13	17.34	17.92	18.17	17.81	14.80	13.02	15.03	14.28
1 g/l	128.85	122.07	121.17	124.04	18.15	17.92	25.17	20.41	27.89	30.16	27.18	28.40
2 g/l	121.57	120.61	128.15	123.44	24.24	25.17	19.01	22.80	35.17	38.06	32.55	35.26
3 g/l	117.89	112.65	123.17	117.91	25.17	21.07	28.01	24.74	40.56	44.62	38.78	41.32
AV.	122.77	118.44	124.16		22.52	21.39	24.06		34.54	37.61	32.84	
LSD 0.05	A= 10.09, B= NS and A×B= 9.77				A= 3.19, B= 2.72 and A×B= 1.65				A= 13.63, B= 14.19 and A×B= 10.05			
						Second season						
Control	128.17	141.07	127.09	132.09	19.03	18.15	18.15	18.44	13.39	14.39	16.03	14.06
1 g/l	128.14	133.15	128.15	131.48	17.35	20.23	22.17	19.92	26.57	29.93	28.91	28.47
2 g/l	133.15	114.56	133.14	121.87	20.23	19.01	23.24	20.83	33.17	41.62	37.33	37.37
3 g/l	126.99	117.89	122.07	122.38	20.15	22.17	25.56	22.63	39.18	47.08	42.17	42.81
AV.	129.43	121.87	127.79		19.24	20.47	23.66		32.97	39.54	36.14	
LSD 0.05	A= 10.03, B= NS and A×B= 9.10				A= 2.89, B= 2.09 and A×B= 2.15				A= 14.05, B= 13.71 and A×B= 12.55			

***LSD (0.05): Levels of Zinc spray (A), No. of applications (B) and Interaction (Date × concentration): (A× B)**

Foliar application of chelated zinc diminished Zn-deficiency symptoms on the leaves, but kept the following spring-flush leaves free from Zn deficiency symptoms for only a few months. This indicated that, the Zn from subtending Zn-sprayed leaves was not translocated extensively into the new flesh. The level of zinc markedly increased in leaves by increasing Zn concentration. In this respect, chelated zinc sprays in March and June gave the highest values as compared with the other treatments. It seems from the values of zinc obtained during the present study that one annual foliage spray of zinc on the leaves is sufficient to increase the yield in case of zinc deficiency. However, it appeared that under the conditions of the present study, March and June applications proved to be the most effective dates for zinc application.

This could be due to the fact that foliar absorption rates for most nutrients are greater for younger leaves than for older ones. In March and June, citrus trees in Egypt usually carry greater percentage of younger leaves resulting from the spring growth cycle and the trees during this period will have relatively greater surface area of mostly young leaves. Similar results were obtained in Washington navel orange and Balady mandarin by Nawar (1977).

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تحسين حالة أشجار البرتقال الصيفي بإضافة الزنك

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أجريت هذه الدراسة لمدة موسمين (2018 و2019) علي أشجار برتقال صيفي منزرعة فى منطقة الصالحية، محافظة الشرقية، مصر، مشتملة على ثلاث مستويات من مركب الزنك المخلبي. تمت الاضافة أثناء موسم النمو مرة واحدة، مرتين وثلاث مرات لكل مستوى من مستويات الزنك. كانت المعاملة الموصى بها هي رش أشجار البرتقال الصيفي بالزنك المخلبي بمعدل 2 جم/لتر فى مارس ويونيو والتى أدت الى زيادة معنوية فى المحصول وحجم الثمرة بالمقارنة بالمعاملات الأخري. انخفضت تركيزات النيتروجين، البوتاسيوم والحديد بزيادة تركيز رش الزنك المخلبي مع عدم أخذ عدد مرات الاضافة عموما فى الاعتبار. أظهر محتوي الفوسفور فروق غير معنوية مع مستويات الزنك المخلبي المختلفة أو عدد مرات الاضافة. زاد تركيز المنجنيز والزنك مع زيادة مستوي رش الزنك أو عدد مرات الاضافة.