

# Effect of Foliar Spraying with B ,Zn and Fe on Flowering , Fruit Set and Physical Traits of the Lemon Fruits ( Citru Meyeri )

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## Abstract

The experiment was conducted during the two seasons (2015 , 2016 ) on the Lemon trees cv (Meyer ) aiming at studying the effect of the foliar spraying with the nutrients ( boron , zinc and iron ) in flowering , fruit set and the physical traits of the fruits .These nutrients were sprayed separately or as a mixture .The percentage of each of ( viable pollen , hermaphrodite flowers , flowers with aborted ovary as well as the total flowers , fruit set and the initial fruit set ) in both seasons was calculated , in addition to the physical traits of the fruit (length , width , volume , weight , firmness and rind thickness of the fruit ),and the fruits` juice volume and the dry matter .The result of the statistical analysis showed the overpass of the treatment of the three elements ( iron chelate + boron oxide + zinc chelate ) of all treatments in the most of the studied figures followed by the treatments in which the spraying with more one element of the micronutrients was used , while the lowest values were recorded in the control treatment .

**Key words :** foliar spray , micronutrients , flowering , fruit set , fruit weight , juice volume .

## 1- INTRODUCTION

Citrus has an important rank among the fruit trees worldwide due its economical , nutritional , medical and esthetic as well as ecological importance . The origin of the genus citrus and its related species is, believed to be in the tropical and the sub-tropical regions then it moved to be planted around the world .While the Lemon " Meyer " , it is believed that it is a hybrid of lemon , orange and mandarin . it was found by the botanist explorer Frank Nicholas Meyer in the early of the 20th century . Meyer trees are known of being dwarf and almost free of thorns with wide spreading branches , medium vegetative density of growth . They are multi-season trees and resistant to cold as well as the disease Citrus tristeza virus [17] . Citrus are considered one of the important fruits in Syria with

30% of the total fruit production .97% of the planted area with citrus is distributed in the coastal area .It is considered the pillar of the agricultural production in lattakia with more than 76 % of the total cultivated area which produces nearly 80% of the region total production . The planted area with citrus was (43751) ha with a production (1289808) ton in 2015 , in which ( 7299) ha were planted with Lemon with production (156962)ton [3] .

The absorption of the nutritional elements by leaves is usually more rapid and efficient than the absorption by roots especially when the soil conditions are not suitable for absorbing the elements such as PH , and the presence of calcium carbonate and the loss during the washing . most micronutrients under Syrian conditions and the soil`s high alkaline are not available for plant , thus it is difficult to be treated . Some of the foliar application advantages are the increase in the plant utilization of the sprayed nutritional elements , less fertilizers consumption , overcome the soil problems and rapid treating of the nutritional element deficiency especially the micro ones and the easiness of applying it on the vegetative . The Zn involved in composing or activating more than 150 enzymes and hormones such as growth hormones and the respiration enzymes, also involved in synthesizing enzymes that manufacture the plant auxins , generating Chlorophyll and the photosynthesis . Zinc activates many enzymes that specialized in synthesizing Carbon Dioxide . The most activated enzymes in the presence of this element are the Fructose- 1.6 biphosphatase which is an important enzyme for distributing Six-carbon sugars in chloroplast , cytoplasm and the Carbonic Anhydrase enzyme which stimulates The CO<sub>2</sub> hydrogenation and dismantle the Carbonic Acid to both the CO<sub>2</sub>and H<sub>2</sub>O. The zinc has a constructive role in some enzymes such as Alcohol dehydrogenase and DNA Polmerase [27] .Zinc is one of the significant micro- elements for synthesizing protein as well as it affects pollination through its effect in generating the Pollen tube [18].

Also it is necessary for synthesizing the tryptophan amino acid which transforms to auxin which is Indol Acetic (IAA) that helps in the plant growth [4].

Boron has an efficient role in the growth and production which increases the pollen germination and pollen tube elongation as well as increases the fruit set, the seeds, the fruit development and then the production [1] Boron increased and changed sugars composition that exists in the nectar where the flowers attract more insects and it influences the pollen production and their viability [24, 7].

Iron has physiological role in the plant in spite of the little need for it. Most of the iron in the plant is located in chloroplasts and has a role in formation chlorophyll (the green substance) although it is not involved in its composition which is a mediator in the vital operation for any plant. Iron is involved in the composition of the some enzymes especially the oxidation enzymes such as cytochromes, which are the most important enzymes that contain iron.

[6] found that the foliar spray with boron before flowering is very important which caused a significant increase in the number of hermaphrodite flowers and the fruit set percentage therefore an increase in the production by 20% comparing with the control treatment.

[31] elaborated in their study on peach trees cv. Sharbati at age of seven years that the foliar spray with (0.1% H<sub>3</sub>BO<sub>3</sub> + 0.5% ZnSO<sub>4</sub>, 7H<sub>2</sub>O + 0.5% FeSO<sub>4</sub>, 7H<sub>2</sub>O) for one time during the final week of February and repeating the spray after 15 days from the first one gave the fruit the highest weight (51.60) g, the highest length (5.59) cm, the biggest diameter (5.08)cm, and the greatest volume (44.57)cm<sup>3</sup>, the highest firmness (2.24) kg/cm<sup>2</sup> as well as the highest production (25.39)kg /tree. [22] studied the effect of spraying with different sources of iron fertilizers on Orange and they didn't notice differences among the treatment in the fruit rind thickness.

In a study conducted by [2] for studying the effect of the foliar spray with zinc sulphate (0.5, 10 mg / l) and iron sulphate (0.5, 10 mg / l) on the quantity and the quality of the sweet lime fruit at the age of 5 years during June, it showed that the spray with iron sulphate with an average 10 mg / l is the best to improve the quantitative and qualitative traits for sweet lime.

[11] in their study to find the effect of the foliar spray with zinc, copper and boron in three different levels (0.1, 0.2, 0.3)% of each B, Cu, and Zn respectively on the trees of Citrus reticulata Blango var. kinnow, results showed that adding, Zn 0.3%, Cu 0.1% and B 0.2% were the best in improving

the production criterion (fruit weight, the juice volume, the production of fruit /tree). In an experiment conducted by [28] on the Assami Lime the results showed that the foliar spraying with zinc as chelate or sulfate clearly increased (the fruit set, the fruit number on the tree, fruit volume, the fruit weight and the production) comparing with the control. also found that treatment of Zinc sulfate (0.4%) was the best one.

[9] noted that the foliar spraying with some micronutrients (iron, manganese, zinc), especially when they are sprayed together, improved the fruit weight (237.10)g, the sugar content and iron and manganese content in the orange fruits (Citrus reticulata) as well as recorded the heights content of the dry matter (22.5)%.

[13] found that spraying with 0.3% boric acid and 0.5% zinc sulphate at the stage of fruit set improved the growth and productivity, also caused an increase in the fruit weight (145.3)g and the percentage of the juice weight 37.4% when spraying on the trees of Citrus reticulata Blanco cv. Feutrell's early at the age of 15 years.

In an experiment on six year old mandarin trees [16] found that spraying the trees with the micro-nutrients ZnSO<sub>4</sub> (0.2%) + H<sub>3</sub>PO<sub>4</sub> (0.2%) + MnSO<sub>4</sub> (0.3%) + CuSO<sub>4</sub> (0.4%) caused a significant increase in the production criterion (fruit set (52.49)%, fruit number of the tree (81.05)%, productivity (7.82)kg/tree, fruit weight (96.43)g, and fruit length (6.24)cm.

[30] found in an experiment on Mandarin trees (kinnow) that foliar spraying with boron at the stage of the fruit set has increased the production and improved the fruit weight while they didn't observe significant differences in the fruit rind thickness and the total number of the seeds.

In another study on Citrus sinensis cv. Blood orange, it was found that the spray with the micro-nutrients (zinc, iron, copper, manganese) provided the highest weight of the fruit 127.10 g and the highest production 90.02 kg/ tree with an increase of 99.02% over the control. there were no significant differences among the treatments in terms of the percentage of both the pulp and the rind thickness [14]. The importance of the research and its objective appears in the study of the effect of the foliar spraying with some micro-nutrients (zinc, boron and iron) independently or as a mixture on the flowers nature, the fruit set and the physical fruit traits as well as the possibility of dealing with the problem of large drop of the first wave of the flowers of lemons trees "Meyer" in the Coastal area in Syria.

**2- MATERIALS AND METHODS**

**2-1) plant material and site experience:** The research was conducted during the two growing seasons 2015 and 2016 on the Lemon trees (Meyer) in Alqallof village ,lattakia ,Syria .The trees are 9 years old budded on ( Citrus aurantium L.) rootstock spaced 5\*5 meter in a 8 acre field

**2-2) Soil site properties :**

Fertility tests were conducted on samples taken from different places of the soil of the site on depth (0-15)cm . The results were recorded in the table (1) which indicates that the soil was loamy clay , medium alkaline , non-saline , poor nitrogen content ,medium phosphorus content and acceptable

potassium content. The organic substance percentage is good which is a calcareous soil rich in total and effective calcium carbonate with a medium zinc and iron content and high boron content .

**2-3) Experiment design and the treatments**

The experiment was designed in a complete random way where treatments` number was 8 including the control treatment ( without spraying ). Each treatment consists of three replicates ,each replicate contains three trees ,thus the trees number of the experiment was 3\*3\*8=72 trees . Results were analyzed using the Genstat 7 software where the LSD was calculated and the Duncan` test was used at confidence level 5% .

**Table(1): soil characteristics of the research site before foliar application**

Chemical Properties										Physical properties			
Available Nutrients (PPM)										Mechanical Analysis			
B	F e	Zn	K	P	N	Electrical conductivity Melimus/ cm	Effective calcium g /100	Total calcium carbonate g / 100	Organic matter %	pH	silt %	Sand %	Clay (% )
2.53	3.93	1.15	260	11	51	0.32	21.2	62.4	3.15	8.01	27	26	47

The fertilizing treatments were as the following :

- T1: water spray
- T2: boron oxide 0.5 cm<sup>3</sup> / 1 water (69.85 PPM) T3: Zn EDTA 0.05 g / 1 (49PPM )
- T4: Fe EDTA 1 g / 1 (130 PPM )
- T5: boron oxide 0.5cm<sup>3</sup> / l(69.85 PPM) + Fe EDTA 1 g / l(130 PPM) .
- T6: Zn EDTA 0.05 g / 1 (49PPM) + and Fe EDTA 1 g / 1 (130 PPM) .
- T7: boron oxide 0.5 cm<sup>3</sup> / 1 (69.85 PPM) and ZnEDTA 0.05 g / l(49 PPM
- T8: boron oxide 0.5 cm<sup>3</sup> / 1 (69.85 PPM) and ZnEDTA 0.05 g / l(49 PPM)+ Fe EDTA 1 g / 1 (130 PPM )

Boron , zinc ,and iron solution were sprayed twice , the first one was 10 days before flowering in the late of February , while the second one was 15 days after the first one on average of 3 liters /tree knowing that all the trees were giving the same amount of the following fertilizers :

-In the beginning of march , high-phosphorus and rapid absorption fertilizer (15-30- 15) , 150 g / tree .

- A balanced rapid – absorption fertilizer ( 20-20-20) on two batches , the first one is in the beginning of May and the second is after 15 days of the first batch , 150 g /tree.

**2-4) studied parameters:**

**2-4-1) - hermaphrodite flowers :**

**The percentage of the hermaphrodite flowers** =the number of the hermaphrodite flowers)/ the total number of the studied flowers\*100

**2-4-2) - The Percentage of the flowers with aborted ovaries =**

The number of the flowers with aborted ovary/ the total number of the studied flowers\*100[10]

**2-4-3) - Pollen viability :** flowers were dissected where the stamens were put in the laboratory environment until the anther dries and the pollen falls then they were collected and their viability were studied by scattering an amount of them on a clean glass where a drop of Kerman solution was put on it . They were covered with a catheter and incubated in the dark for 60 minutes , then they were observed under the microscope light [8].The

viable pollen under the microscope were bright red with regular walls while the non- viable pollen were not colored or there color was faint with irregular walls . The viable pollen was calculated using the method of [15] where 5 fields of vision were taken from each slid where each field contains more than 50 pollen then the percentage of the pollen was calculated . The percentage of the viable pollen =The number of the viable pollen/the total number of pollen \*100

**2-4-4) - The initial fruit set :**

Four semi-structural branches and randomly distributed on the four sides of each tree were selected and the total number of the flowers of each one was calculated then the fruit set on the marked branches were calculated and the percentage of the fruit set were calculated according to :

The initial fruit set%=The number of the flowers set /total number of flowers \*100

**2-4-5) - The fruit physical traits :**

Ten fruits were randomly taken from the four sides of the tree and for each replicate for doing the following physical tests :

The fruit volume average (cm<sup>3</sup>) by calculating the removed water size , the fruit weight average (g) upon the following equation :

The fruit weight average (g)=the total weight of fruit /the total number of fruit

-The average of the juice volume (ml/fruit ),the average of the firmness of the fruits` pulp (kg/cm<sup>2</sup>)using the apparatus (penetrometer ), in which the results of 10 fruits from the opposite sides of each one were recorded,

the average of the fruit length and width (cm) , the average of the rind thickness (cm ) using the piaquilis apparatus and the percentage of the fruit`s dry matter which was estimated using the method of the weight stability by drying it at 105 C°.

**3-Results and Discussion :**

**3-1- studying flowers:**

Results of table (2) show that foliar spraying with micronutrients resulted in an increase in the

of the study in the seventh treatment (Zn+B) was in the first season with (80.71%) and in the second one (85.15 %) followed by treatment with boron,iron and zinc (73.02, 76.6%) in the two seasons respectively while the control treatment recorded the lowest value (51.23%) as a mean of two seasons . The statistical analysis of these results shows that the whole studies treatment surpassed the control in both seasons , while the numbers in the flowers with aborted ovary were reversed where the highest proportion for the flowers with aborted ovary was in the control (47.62, 49.93%) in both seasons respectively. This results correlated with many researches that confirmed the effective role of adding the micro – nutrients in improving pollination . [18] reported that adding zinc contributes to pollination through its influence on the formation of the pollen tube , [1] found that Boron promote the pollen germination as well as the pollen tube growth . [12] recorded in his study on tomato that the foliar spraying with Zn 100 mg /l and Fe 200 mg/l presented the maximum value in the average of the flowers number in the cluster (18.14 ) .

**3-2- Studying the pollen viability :** It was found when comparing the viable pollen percentage in table (2) that the pollen viability was over 90 % in the whole treatments except in the control treatment and that was a sufficient viability to obtain a good fruit set percentage of the Meyer lemon .The statistical analysis of these results showed that T5

( spraying with Fe ,B) surpassed the other treatments in the first season which recorded (96.73%) and in the second season, there were no significant differences between the treatments except the control treatment .that might be due to the role of boron in pollen germination and the growth of the pollen tube [26]. These results correlate with [20] who observed an increase in growth of the pollen tube , thus an increase in the percentage of the fruit set when spraying orange trees with zinc.

Treatments	viable pollen%		hermaphrodite flowers%		% Flowers with aborted ovaries	
	2015	2016	2015	2016	2015	2016
T1	70 d	70.42 b	52.38 h	50.07 h	47.62 h	49.93 h
T2	91.2 b	91 a	61.50 e	67.02 e	38.5 e	32.98 e
T3	89.90b	92.5 a	55.08 g	57.87 g	44.92 g	42.13 g
T4	90.48 b	90.97 a	62.10 d	66.79 f	37.9 d	33.21 f
T5	96.73 a	92.9 a	67.82 c	74.55 c	32.18 c	25.45 c
T6	89.38 b	91.12a	60.73 f	68.5 d	39.27f	31.5 d
T7	89.86 b	93.65 a	80.71 b	85.15 b	19.29 b	14.85 b
T8	91.67 b	93 a	73.02 a	76.6 a	26.98 a	23.4 a
LSD (P <0.05)	2.475	2.849	0.5344	0.273	0.534	0.273

proportion of the hermaphrodite flowers comparing with the control .The highest percentage of the hermaphrodite flowers during the two years

**3-3- The initial fruit set percentage :**

The flowers of each of the four marked branches on the tree were counted in order to calculate the

fruit set percentage . The figures of Table (3 ) showed that the foliar spraying with the micro-nutrients ( Zn, Fe, B) resulted in an increase in the

foliar spraying with Zn on the form of chelate and sulfate , as well as the results of [16] where he noted that the foliar spraying with the three micro-

Treatments	Total number of flowers		number of flowers set		initial fruit set%	
	2015	2016	2015	2016	2015	2016
T1	3222	4440	40	57	1.24 f	1.28 f
T2	2500	3200	49	155	1.96 e	4.84 d
T3	3000	2520	81	78	2.7 d	3.1 e
T4	2540	3458	149	208	5.87 c	6.02 d
T5	3044	3534	296	668	9.72 b	18.9 b
T6	2552	3600	154	626	6.03 c	17.39 c
T7	3000	2600	174	443	5.8 c	17.04 c
T8	2800	3000	303	607	10.82 a	20.23 a
LSD(P ≤0.05)					0.632	1.278

fruit set percentage comparing with the control trees, where the highest mean of the fruit set during the two seasons of the study were (10.81 , 20.23 %) respectively recorded in the treatment of spraying with the three nutrients together . While the lowest percentage recorded in the control treatment (1.24%) in the first season and ( 1.28%) in the second one . The increase in the mean of the fruit set when spraying with the micro-nutrients might be due to the accumulated effect of adding these nutrients together on increasing the flowers number , improving the pollination and reducing the falling fruit ,therefore an increase in the fruit set which Zn prevents the formation of the separation layer of the fruit then reducing its fall [19].

These results correlate with the results of [28] on Assam lemon where he observed an increase in the percentage of ( fruit set , flowers' number on the tree and the production kg \tree ) when using the

**Table (2) Effect of foliar application of (B,Fe,Zn) on The percentage of viable pollen , hermaphrodite flowers and the flowers with aborted ovary during the seasons ( 2015 ,2016 )\***.

\*There are no significant differences among the common values of the same symbol at the same column.

**Table (3): Effect of foliar application of (B,Fe,Zn) on total number of flowers , number of flowers set and initial fruit set during the seasons ( 2015 ,2016 )\***.

\*There are no significant differences among the common values of the same symbol at the same column.

increasing the tryptophan which is the growth auxin generator especially IAA . That resulted in an increase in the fruit growth in addition to the boron role in the cell division and cell elongation .These results correlated with the results that [31] recorded in their study on peach cv. sharabati which the foliar spraying with B, Fe ,Zn achieved the highest length and width of the fruit as well as with the results that reported by [23] in the study on Kagzi Lim trees where he observed that the

nutrients on the mandarin trees increased ( the percentage of the fruit set , fruits number on the tree and the production kg /tree ) .

**3-4- The physical traits of the fruits :**

**3-4-1-The length and the width of the fruit :** in the first season of the experiment (2015 ) the treatment of boron , iron and zinc (T8 ) recorded the highest length and diameter ( 4.67 , 3.17 )cm respectively while the lowest value of the fruit length and diameter was in the control treatment (3.13, 2.60 cm) respectively . During the second season ,the treatment of spraying with the three nutrients (T8 ) recorded the highest length and width of the fruit (4.41 , 5.033 cm ) respectively followed by the fifth treatment ( spraying with boron and iron ) . These two treatments significantly surpassed other treatments ( table 4 )and the reason may be due to the zinc role in

treatment of spraying with B, Fe and Zn recorded the highest length , width and weight of the fruit .  
**3-4-2-The fresh weight of the fruits and the dry matter percentage :** The statistical analysis of figures of the table (4 ) showed that the foliar spray with micro-nutrients affected the fresh weight and the size of the fruit as well as the dry matter percentage . When comparing the averages , the treatment of spraying with the three elements recorded in the first season (2015 ) the highest



values in terms of fresh weight ( 73.17 )g , the percentage of the dry matter ( 18.07 ) % . Also in the second season (2016) this treatment had the highest value in terms of the fruit weight ( 77.36 ) g and the dry matter percentage ( 18.67 ) % .

**3-4-3-The fruit volume :** The foliar spray with the micro- nutrients had a major role in increasing the fruit volume in both seasons where all treatments surpassed the control treatment which recorded the lowest values (71.33,75cm<sup>3</sup>) in 2015 , 2016 respectively .

The statistical analysis of these results showed that T8 surpassed the other treatments

( 93 .67 )cm<sup>3</sup> followed by T5 ( spraying with boron and iron ) with (87.33 )cm<sup>3</sup> . But the fruit volume in the second season recorded (105.67 ) cm<sup>3</sup> in T8 followed by T7 (spraying with boron and zinc ) with a fruit volume (94.33 )cm<sup>3</sup> . table (5) . The increase in the fruit weight ,the fruit volume and the dry matter percentage may be due to the role of the micro nutrients in activating the Enzymes of photosynthesis as well as increasing the concentration of Chlorophyll especially Chlorophyll A , and that leads to a greater

Treatments	Fruit length(cm)		Fruit width(cm)		Fruit weight(g)		Dry matter of fruit%	
	2015	2016	2015	2016	2015	2016	2015	2016
T1	3.13f	4.42b	2.60 b	4.33b	58.56ad	59.64f	12.70e	12.70f
T2	3.75d	5.15a	3.14 a	4.13 c	64.67d	66.69d	13.18d	13.79d
T3	3.56e	5.02a	3.15 a	4.05 d	59.76ac	62.68e	12.68e	13.38e
T4	3.72d	5.13a	3.08 a	4.17c	63.49ab	66.65d	13.32d	13.39e
T5	4.02b	5.22a	3.28 a	4.90a	73.42a	74.50b	17.76b	18.07b
T6	3.91c	5.10a	3.33 a	4.00 d	70.29c	71.65c	16.28c	16.81c
T7	3.92c	5.20a	3.27 a	4.38 b	71.67b	74.21b	17.90 b	18.05b
T8	4.07a	5.20a	3.32 a	5.03a	73.17a	77.36a	18.07a	18.67a
LSD(P ≤0.05)	0.381	0.352	0.2324	0.2398	0.230	0.124	0.254	0.243

**Table(4): Effect of foliar application of (B,Fe,Zn) on the average length, width , weight ,Dry matter of the fruit during the seasons ( 2015 , 2016 )\***.

\*There are no significant differences among the common values of the same symbol at the same column.

accumulation of food such as sugars , water in the expanded cells in addition to an increase in the fruit fresh weight and volume as well as the dry matter production .These results correlate with the results of [5] who observed an increase in the weight and size of the guava fruit when spraying with (0.5% zinc sulphate + 0.3% borax + 0.5% iron sulfate) . Also they are correlate with [14] who observed an increase in the volume of orange fruit when spraying with Iron and zinc.

**3-4-4-The firmness of the fruit pulp kg /cm<sup>2</sup> :** Concerning the fruit firmness, it has been observed during the two years of the experiment that the treatments of spraying with more than one element of the micro –nutrients caused an increase in the fruit pulp firmness which recorded higher values than when spraying with one element. The treatment of spraying with three elements recorded the highest firmness (0.93 ) kg/cm<sup>2</sup> in the first season followed by the treatment of spraying with zinc and iron with a firmness of (0.88 )kg/cm<sup>2</sup> . But in the second season there were no significant differences between the treatment of spraying with each elements separately and the control treatment. The treatments of spraying with more than one element surpassed the control treatment , table(5) . These results correlated with the results of [31] in his study on the peach where he found that spraying with boron , iron and zinc recorded the highest firmness of the fruits with ( 2.24 ) kg/cm<sup>2</sup> .

**3-4-5- The fruit rind thickness (cm) :** Statistical analysis of the experiment `s results in the table (5) showed the absence of the significant differences among the in the table

(5) showed the absence of the significant differences among the studied treatments , therefore the foliar spraying of the micro- nutrients has no effect on the rind thickness .

These results completely correlated with the results that reported by [22] who found that the foliar spraying with iron did not affect the rind thickness of the orange fruit , while it contradicts the outcomes that reported by [25] who found an increase in the rind thickness of the Valencia fruit when spraying with zinc chelate .

**3-4-6-The juice volume** : The juice volume in the fruit of the eighth treatment **T8** (28.67 ) ml/fruit in the first season followed by the treatment with boron and iron with a juice volume recorded ( 26.33 ) ml/fruit and the

Treatment s	Fruit volume(cm <sup>3</sup> )		fruit pulp firmness kg / cm <sup>2</sup>		rind thickness (cm)		Juice volume(ml)	
	2015	2016	2015	2016	2015	2016	2015	2016
<b>T1</b>	71.33d	75.00 h	0.67 g	0.84e	0.2067 a	0.2067a	16.33f	18.33f
<b>T2</b>	75.33d	81.33 e	0.77 e	0.85e	0.2133 a	0.2033a	22.33d	23.33e
<b>T3</b>	74.33d	79.33 g	0.67 g	0.87e	0.2067a	0.2067 a	21.67e	22.33e
<b>T4</b>	75.67d	80.67 f	0.73 f	0.84e	0.2033 a	0.267 a	23.33d	23.67e
<b>T5</b>	87.33b	90.00 c	0.83 c	1.23b	0.2100 a	0.1967 a	26.33b	27.67b
<b>T6</b>	82.33c	87.00 d	0.88 b	1.00d	0.2033 a	0.1967 a	23.67c	24.33d
<b>T7</b>	81.67c	94.33 b	0.79 d	1.20c	0.2033 a	0.1967 a	22.33d	26.33c
<b>T8</b>	93.67a	105.67 a	0.93 a	1.29a	0.2067 a	0.1967 a	28.67a	31.00a
<b>LSD (P ≤0.05)</b>	4.756	5.403	0.058	0.070	N	N	1.767	2.495

same results also reported in the second season .The highest juice volume was reported in the treatment of spraying with the three elements

( 31 )ml/fruit, while the lowest value of the juice volume was in the control treatment with ( 16.33 , 18.33 ) ml/fruit in the two seasons respectively . Table ( 5 ) .

These outcomes correlated with the results of both [21] who found that the foliar spraying with ( B , Cu ,Mg ,Zn ,Fe ) increased the mandarin fruits content of juice . Also correlate with [29] who observed an increase in the percentage of the juice of the sweet orange fruits when spraying with boron , as well as the results of [11] where he found that adding Zn 0.3 % , Cu 0.1 % and B 0.2 % presented the highest content of juice in the mandarin fruit .

**Table (5) : Effect of foliar application of (B,Fe,Zn) on the average of fruit volume and firmness , the rind thickness and the juice volume during the seasons ( 2015 , 2016 )\***.

\*There are no significant differences among the common values of the same symbol at the same column.

N:represents not significant at P ≤0.05

#### 4- CONCLUSION:

According to the aforementioned results we present the following conclusions :

- The foliar spraying with micro- nutrients ( Zn ,B, Fe ) contributed to the increase of the percentage of each of ( viable Pollen , hermaphrodite flowers and initial fruit set ) in both seasons 2015 , 2016 in addition to improving the fruit traits the length , the width , the weight ,the firmness and the volume of the fruit as well as the dry matter percentage.

- The eighth treatment **T8** ( spraying with the solution of boron oxide (69.85 PPM), zinc chelate(49PPM) and iron chelate (130 ppm) significantly surpassed the other treatments in most studied figures followed by the treatments of spraying with more than one element , while the lowest value was in the control treatment in all traits except the flowers with aborted ovary where the control treatment recorded the highest value (48.775) as an average of two seasons.

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