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Effect of Calcium, Zinc and Boron Treatments on Flowering, Yield and Fruit Quality of Mango Ewais Cultivar

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ABSTRACT

This experiment was carried out during 2015/2016 and 2016/2017 seasons on 15 years old of mango Ewais cultivar trees grown in the Mansoura Horticulture Research Station Experimental Farm located at(latitude 31°07'47.7"N,longitude 31°28'13.7"E)to investigate the efficacy of calcium,cinc and boron foliar application individually or in combinations at different times and concentrations on flowering, yield and fruit quality.The results indicated that,all tested treatments increased reproductive parameters,yield and fruit quality compared with control.Spraying 2.5 ml/L of each calcium,zinc and boron combination increased panicle length and sex ratio,while spraying 2.5 ml/L of boron alone led to an increase in the male and total number of flowers,but,spraying 2.5 ml/L of zinc alone increased the hermaphroditic flowers.Trees sprayed with 2.5 ml/L of calcium individually produced the highest number of fruits and yield per tree followed by boron treatment,but trees sprayed with the combination of three elements gave the highest fruit height,width and volume.Meanwhile,the individual zinc treatment was superior for fruit weight followed by the high level of combination treatment.Foliar application of individual boron or in combination with calcium and zinc improve fruit TSS and TSS/acid ratio and decrease the acidity.Trees sprayed with 2.5ml/L of calcium,zinc and boron in combination resulted the highest values of leaf Ca, Zn and B content followed by1.25ml/Lof the same combination.On the other side, the individual tested elements leads to increasing the corresponding leaf content of each one. It could be recommended that spraying calcium,zinc and boron combination at 2.5ml/L four times is the best treatment for increasing yield and fruit quality

***Keywords**:* Mango, Calcium, Zinc, Boron, Reproductive growth, Yield, Fruit quality.

INTRODUCTION

Mango (*Mangifera indica L.*) is one of the most important, prominent and earliest cultivated tropical fruits, grown in more than 100 countries for both the local consumption and exportation levels (Masroor *et al.*, 2016). It belongs to family Anacardiaceae and it is also considered as the queen of fruit crops as it is very popular and ranked the second place of tropical fruits and sixth partner fruit crops worldwide (Abbasi *et al.*, 2011). In Egypt, mango considered one of the most favorable fruits comes in the second place after citrus. The total cultivated area reached 304845 fedd., the fruitful area reached 272483 fedd.producing about 1095381.66 tons of fruits annually, the Egypt's mango exports have risen to 42299 tons according to the statistics of (Ministry of Agriculture and Land Reclamation Statistics, Egypt, 2018).

Mango fruits has a high cropping potential ,nutritional and therapeutic values, it has abundant source of vitamins, minerals, excellent flavour, and attractive fragrance. Mango production faces some challenges, such as biotic and abiotic stresses, micronutrients deficiency, alternate bearing as well as low fruit set and fruit retention are the main reasons of low fruit yield and quality (Kumar and Kumar, 2016).

Foliar application of nutritional elements on mango trees considered a key factor affecting growth, yield ,fruit quality and even some diseases control. Overcoming the problem of mango yield deficiency by foliar application of some nutrients was found to be useful for improving fruit setting, yield and fruit quality. Many attempts were made by several researchers to increase productivity and improve fruit quality of mango via foliar applications of macro and micro nutrients (Khattab *et al.*, 2016).

Calcium is crucial and important nutrient element for protecting the plant against stresses and playing vital role in several physiological functions (Bhatt *et al.*, 2012). Calcium foliar application increased productivity by reducing fruit abscission and improved the quality of mango fruits by increasing the firmness through maintaining of the middle lamella cells. (Karemera *et al.*, 2013).

Micronutrients provide special requirements for energy transfer mechanism within the plants, they are usually in association with larger molecules such as cytochromes, proteins (enzymes) and chlorophyll. Fruit trees including mango are highly susceptible to micronutrients deficiency disorders. Hence, foliar application of microelements specially zinc and boron proved an effective tool for fruit production (Patil *et al.*, 2018).

Zinc is known to be one of the most essential micronutrient involved in many physiological functions. It is important for various metabolic processes and enzymatic and oxidation reduction reactions occurring in plant cell. Zinc deficiencies causing stunted growth, chlorosis and smaller leaves, increased maturity period and inferior quality of harvested fruits (Hafeez *et al.*, 2013).

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Boron is an essential element has several functions in metabolism for higher plants and its function includes vegetative growth and reproductive processes required for pollen germination, pollen viability, pollen tube growth, flowering, fruit set, cell elongation and cell division of olive trees (Stellacci *et al.,* 2010). The mechanism of boron action for increasing fruit yield may be due to its function in sugar and nucleic acid metabolism, carbohydrates translocation, cell wall structure and function and flowering hormone synthesis which stimulate growth, flowering, fruit set and yield (Ibrahim 2017).

Balanced nutrient application of Ca, Zn and B ensures optimum concentrations in leaves lead to increase yield and improve quality of mango trees. In this respect, Bhatt *et al.* (2012) used foliar application of Calcium as macro nutrients as well as zinc and boron as micro nutrients singly or in combination for rapid correction of deficiencies of mineral nutrients and maintenance of mango fruit quality. They found that foliar application of Ca, B and Zn in combination is beneficial for accelerating development of growth characters, flowering, fruiting and quality of fruits. In addition, Merwad *et al.* (2016) with mango trees sprayed with Zn + Ca + B in combinations had a positive effect on fruit set and fruit retention, also in reducing fruit drop and malformed panicles percentage. They proved that the previous materials increased tree yield of Alphonso mango trees .

Foliar spray of Ca, B and amino acids at beginning of flowering, full blooming stage and at two weeks after setting, were the most effective treatment for increasing yield (Kg/tree) of Ewais and Fagry Kelan mango cultivars (Khattab *et al.,* 2016). From the study of Lakshmipathi *et al.,* (2015), it was found that foliar application of zinc sulphate and borax is beneficial for increasing the nut yield through improvement fruit set and fruit retention in cashew trees. It had a positive effect in increasing the number of hermaphrodite flowers and sex ratio. Mango fruit yield and quality parameters respond to soil and foliar applications of zinc and boron reported by (Ahmad *et al.,* 2018). Their results suggested that, combined application of B and Zn mitigates leaf mineral deficiencies and improves the yield and fruit quality of Chaunsa white mango cultivar.

Efficacy of boron as boric acid on Zebda mango cultivar indicated that fruit yield and quality was increased under high concentration. Foliar application of boron correlated with high activity of antioxidant enzymes (superoxide dismutase, catalase and peroxidase) as well as, high contents of free auxin, and reducing sugars, but low contents of free phenolic and free amino acids in fruit petiole. Also, chlorophyll concentration, pulp (%), TSS (%) and TSS/TA ratio in fruit was increased and decreased fruit firmness under treated with boron (Ali *et al*., 2017).

Nowadays it was observed that, unbalanced fertilization, tree management and application of primary nutrients only could not prove successful to produce high yield and good fruit quality of mango tress. Keeping these views in mind, the main purpose of this work is to investigate the efficacy of calcium, zinc and boron foliar application individually or in combinations at different times and concentrations on flowering, reproductive growth, yield and fruit quality of Ewais mango trees. Hence, to identify the best treatments for achieve the highest return for the growers under the experiment conditions.

MATERIALS AND METHODS

The present study was carried out during the two successive seasons of 2015/2016 and 2016/2017 on Ewais mango cultivar (*Mangifera indica L.*). The tested trees were 15 years-old and approximately uniform in vigor and healthy in appearance grown at 5 × 5 m apart in well drainage clay loam soil of the Mansoura Horticulture Research Station Experimental Farm located in 31°07'47.7"N, 31°28'13.7"E Kafr Al Baramon, Mansoura, Dakahlia Governorate Egypt. This experiment consists of six treatments arranged in a randomized complete block design. Three replicates were chosen ,each represented by two trees. The tested trees were selected randomly and as uniformity as possible and received all the recommended normal agricultural practices ordinary adapted in the commercial mango orchards in this area. The tested treatments which arranged in Table 1 applied four times, at half of November, end of March, end of April and end of May, respectively. Triton B 0.2 % was added to all spraying solution before application as a wetting agent. Spraying was done till run off point by hand pressure sprayer. The control trees were sprayed with tap water containing Triton B.

Table 1. Foliar application of different concentrations on mango trees.

Number	Treatment
1	Control
2	Chelated Calcium 13% at 2.5 ml/L
3	Chelated Zinc 13% at 2.5 ml/L
4	Chelated Boron 10% at 2.5 ml/L
5	Calcium at 2.5 ml/L+ Zinc at 2.5 ml/L + Boron at 2.5 ml/L
6	Calcium at 1.25 ml/L+ Zinc at 1.25 ml/L + Boron at 1.25 ml/L

Measurement of Experimental data:

To study the responses of tested trees to different treatments, some fruiting parameters along with yield and fruit quality were measured as follow:

A. Reproductive growth parameters:

To determine the flowering parameters including panicle length, number of flowers, mail flowers, hermaphrodite flowers and sex ratio percentage along growth season, the emerged flowers per panicle on four labeled branches at different tree directions were counted at full bloom stage in both seasons.

B. Yield and its component:

At harvesting time the remained fruits on tested tree were picked and the average number of fruits per tree and yield were determined as (Kg/tree).

C. Fruit quality parameters:

A representative fruit samples was picked from each tested tree. Each sample counted 10 fruits, nearly uniform in size and free from obvious defects.

Physical characteristics:

Twenty mature fruits were taken from each replicate to determine the average fruit weight (g), Seed weight (g), fruit dimensions (width and height cm), fruit volume (ml^3).

Chemical characteristics:

Samples of fruits juice filtered to determine the chemical characteristics represented by the percentage of total soluble solids (TSS), which was expressed by using Carl-Zeiss hand Refractometer. Total acidity percentage determined by titrating 10 ml juice from each sample against NaOH (0.1N) using phenolphthalein (ph.ph) as indicator and the acidity was expressed as gram citric acid in 100 ml juice according to (AOAC 1995). Total Soluble Solids (TSS)/acid ratio was calculated by [TSS/Total acid contents].

D- Leaves chemical estimation

Leaves sample were picked from the 3rd and 4th node below panicle at 1st of August in two seasons. The samples were washed, dried, grounded and digested to determine calcium, boron and zinc according to the method described by (Cottenie *et al.,* 1982).

Statistical analysis:

The treatments were arranged in a completely randomized block design with three replicates represented by two trees for each. The obtained data were subjected to analysis of variance according to the method described by (Gomez and Gomez, 1984). Differences between treatment means were statistically analyzed using Duncan Multiple Range Test at 5 % level of probability (Duncan 1965). Statistical analyses were performed using CoStat Computer Software.

RESULTS AND DISCUSSION

Effect of calcium, zinc, boron and its combinations spraying on flowering parameters:

The effect of tested treatments on flowering parameters of Ewais mango trees presented in Table 2. From the obtained results, it could be observe that all treatments significantly increased panicle length, male flowers, hermaphrodite flowers, number of flowers and sex ratio compared to control. The highest Panicle length reached to 31.5 and 31.97 Cm on trees sprayed with the high concentration 2.5 ml/L of each calcium, zinc and boron combination solution in first and second seasons, respectively. While, trees sprayed with the low concentration 1.25 ml/L of the former combination and individual zinc treatments came in the second order without any significant between them. On the other hand, the individual calcium treatment surpassed its counterpart of boron with respect to the Panicle length during two seasons.

Both the mail and total number of flowers per each panicle as affected by calcium, zinc, boron and it's combinations in the same table showed significant differences among all tested treatments. It could be arranged in ascending order as boron, zinc, calcium, high, low (its combination) and control treatments in both seasons, respectively. The highest number of male and total number of flowers resulted from trees sprayed with boron. According to the hermaphrodite flowers, the obtained results proved exceeded the individual foliar application treatments on the combinations ones along with control. Zinc foliar application leads to producing the highest number of hermaphrodite flowers followed by boron treatment.

Data in the same table concerning with the sex ratio (hermaphrodite flowers/ total number of flowers), which is primary expressed about the strength of tree fruitfulness. The results indicate that, high concentration of calcium, zinc and boron combination increased the sex ratio followed by the low concentration of them. Whereas, zinc foliar application treatment was the superior one among the rest individual treatments. The control trees recorded the lowest value of the sex ratio in both studied seasons.

Table 2. Effect of foliar application of calcium, zinc, boron and it's combinations on flowering parameters of Ewais mango trees during 2015/16 and 2016/17 seasons.

Treatments	Panicle length (cm)		Male Flowers number		Hermaphrodite Flowers		Total Number of Flowers/Panicle		Sex ratio	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Ca2.5 ml/L	22.13 c	22.4 c	2051.95 c	2065.57 c	1006.1 c	1020.1 c	3058.05 c	3085.68 c	0.33 e	0.33 e
Zn2.5 ml/L	27.17 b	27.47b	2682.5 b	2690.17 b	1902.5 a	1916.4 a	4585 b	4606.57 b	0.41 c	0.42 c
B2.5 ml/L	19.00 d	19.23 d	2927.1 a	2931.5 a	1727.9 b	1741.8 b	4653.33 a	4673.3 a	0.37 d	0.37 d
Ca+Zn+B2.5ml/L	31.5 a	31.97 a	1109.15 d	1113.18 d	950.85 d	964.57 d	2060.00 d	2077.75 d	0.46 a	0.46 a
Ca+Zn+B1.25ml/L	27.17 b	27.63 b	660.00 e	665.00 e	500 e	515 e	1160 .00 e	1180.00 e	0.43 b	0.44 b
Control	15.17 e	15.33 e	572.85 f	578.9 f	212.15 f	215.97 f	785.00 f	794.87 f	0.27 f	0.27 f

Means followed by the same letter in each column are not significantly different at the 0.05 % level of probability according to Duncan's Multiple Range Test.

These results were supported by Zagzog and Gad (2017), they displayed superior values for panicle length, number of flower per panicle and sex ratio of Ewais mango cultivar. as affected by foliar application with nano zinc 1 g/l. Hafeez *et al*. (2013) showed the essential role of Zinc for many enzymes which are needed for plant metabolism, energy transfer and protein synthesis. As Zn is required for the synthesis of tryptophan which is a precursor of IAA, it also has an active role in the production of an essential growth hormone auxin..

Also, It was found by Muengkaew *et al,* (2017) that, spraying high concentration of Ca and B solution increased the number of hermaphrodite flowers of mango cultivar Mahachanok. This maybe due to the calcium boron solution resulted in a longer inflorescence, which cause the number of perfectly formed flowers. Lakshmipathi *et al.,* (2015) came to the same results, they reported that spraying Cashew trees with zinc and borax produced highest number of flowering and it had a positive effect in increasing number of hermaphrodite flowers and male flowers. Improvement in the sex ratio as affected by foliar application of micronutrients was mainly due to increased number of hermaphrodite flowers.

The effect of calcium, zinc, boron and its combinations on yield and its components:

Yield and its components of Ewais mango trees in this work can be expressed as number of fruits per tree and fruit weight in addition to yield as kilograms per tree as well as, fruit height, fruit width, fruit volume and seed weight were presented in Table 3. Concerning the effect of foliar application of calcium, zinc, boron and its combinations on the number of fruits per tree, the results showed the superiority of individual calcium treatment followed by the individual boron one compared with the rest treatments. It is also clearly indicated that, zinc treatment gave the lowest number of fruits per tree.

Data in the same table revealed that, all studied materials were significantly increased fruit weight comparing with control. The heaviest fruits resulted from trees sprayed with zinc, followed by these resulted from boron then calcium treatments in the two seasons. Fruits of trees sprayed with high and low rates of calcium, zinc and boron combinations recorded medium weights with values of 193.67 and 186.00 gram in the first season and 195.67 and 188 gram in the second season. On the other hand, the lightest fruits resulted in untreated trees.

Table 3. Effect of foliar application of calcium, zinc, boron and it's combinations on Ewais mango yield and its components during 2015/16 and 2016/17 seasons.

Treatments	fruits umber/ tree		fruit weight(g)		Yield/Tree (Kg)	
	2016	2017	2016	2017	2016	2017
Ca2.5 ml/L	247.667 a	249 a	199 c	200.33 c	49.3 a	49.9 a
Zn2.5 ml/L	100 f	102.333 f	226.33 a	258.67 a	25.63 e	26.47 d
B2.5 ml/L	170 b	175 b	215 b	217.33 b	36.57 b	38.03 b
Ca+Zn+B2.5ml/L	150 c	154.667 c	193.67 d	195.67 d	29.07 c	30.23 c
Ca+Zn+B1.25ml/L	141.333 d	143.333 d	186.00 e	188.00 e	26.3 d	26.97 d
Control	135.667 e	132.667 e	160.67 f	162.67 f	21.8 f	21.6 e

Means followed by the same letter in each column are not significantly different at the 0.05 % level of probability according to Duncan's Multiple Range Test.

As for the total yield per tree, data in Table 3 illustrate that, the highest yield as kilogram per tree was correlated with the highest number of fruit per tree, which obtained from trees sprayed with individual calcium treatment 49.3 and 49.9 kg/tree followed by those sprayed with boron 36.57 and 38.03 kg/tree in the first and second seasons, respectively. According to the total yield as kilogram per tree, the results take similar trends with those obtained with the number of fruits per trees.

Our aforementioned results are in conformity with those reported by Saher (2014) with Ewais mango cultivar with respect to number of fruits and fruit yield per tree. He mentioned that foliar application of Calcium at 4000 ppm gave highest values comparing with zinc at 2000 ppm. This observation also is in agreement with findings of Singh *et al,.* (2017) with mango var. Amrapali they recorded that, the highest number of fruits, fruit weight and fruit yield per tree from trees sprayed with 1% of multi micronutrients. An increase in fruit yield per tree might be due to cumulative effect of starch formation and rapid transportation of carbohydrates which activated by foliar spray of zinc and boron. It is also clear that, the severity of fruit set and fruit yield in fruit trees including mango is greatly affected by status of phytohormones levels. The nutrients (calcium, boron and zinc) are correlated with flower initiation and induction causing vigorous flowering and increasing yield. Micronutrients have a close relation with phytohormones and carbohydrates in plant tissues (Souri and Hatamian, 2018).

The effect of Calcium, Zinc, Boron and its combinations on fruit quality:

Fruit height, width, volume and seed weight measurements as affected by foliar application of Calcium, Zinc, Boron and its combinations presented in the Table 4. The tabulated data proved that, both fruit height and fruit width were taking the same trend of fruit volume in both seasons under study. The high rate of calcium, zinc and boron combination treatment recorded higher values followed by individual calcium treatment. There is insignificant differences between low rate of calcium, zinc and boron combination and individual zinc treatments with respect to fruit height, fruit width.

Table 4. Effect of foliar application of calcium, zinc, boron and it's combinations on Ewais mango fruit quality during 2015/16 and 2016/17 seasons.

Treatments	Fruit height(cm)		Fruit width(cm)		Fruit Volume(ml^3)		Seed Weight(g)	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Ca2.5 ml/L	9.16 ab	9.66 b	5.67 b	6.167 a	240 b	244.33 b	25.9 c	26.3 c
Zn2.5 ml/L	8.30 bc	8.67 c	5.10 c	5.3 b	230 c	235 c	29.6 a	29.8 a
B2.5 ml/L	7.83 c	8.66 c	4.00 d	4.133 c	208.33 d	211.33 d	27.57 b	27.77 b
Ca+Zn+B2.5ml/L	10.00 a	11.00 a	6.17 a	6.433 a	273.33 a	275.33 a	24.53 d	24.63 d
Ca+Zn+B1.25ml/L	8.167 c	9.16 bc	4.83 c	5.133 b	213.33 d	214.33 d	18.03 e	18.23 e
Control	6.00 d	6.66 d	3.07 e	3.2 d	189.33 e	190 e	16.73 f	16.9 f

Means followed by the same letter in each column are not significantly different at the 0.05 % level of probability according to Duncan's Multiple Range Test

Fruit volume could be arranged in descending order as high rate of calcium, zinc and boron combination, calcium, zinc, low rate of calcium, zinc and boron combination, boron and control treatments respectively. On the other hand, the seed weight in ascending order was zinc, boron, calcium, high and low rates of calcium, zinc and boron combinations along with control treatments respectively.

The obtained results are in accordance with those of El-Kosary *et al*. (2011) on Keitt and Ewais mango cultivars, they indicated that spraying microelements containing zinc and boron combined with amino and Humic acids improved weight, height, width, size, firmness of Keitt and Ewais mango fruits. In this concern, El-Boray *et al.*, (2015) with Anna apple trees, they found that foliar application of mixture of calcium nitrate , zinc sulphate borax and humic or fulvic acids after fruit set increased the values of fruit height, fruit width, fruit weight and fruit volume.

The increased of fruit volume as a result of foliar application of micro element combinations including boron can be explained by cell division and elongation through the formation of borate esters with residues of rhamnogalacturonan complex which is essential for cell wall structure and function and contributes significantly to the control of cell wall porosity and strength (Juan *et al.*, 2008).

Regarding the chemical quality parameters, data in Table 5 presented the total soluble solid content percentage, acidity and TSS/acid ratio in Ewais mango fruit juice. The obtained results show an obvious increasing in TSS as affected by tested foliar application treatments compared with control . The highest TSS percentage recorded in fruit juice resulted from trees sprayed with 2.5 ml/L of boron. It was 20.07 and 21.58% followed by these sprayed with 2.5 ml/L of calcium, boron and zinc combinations which gave 18.03 and 19.75 % in the first and second seasons, respectively.

Table 5. Effect of foliar application of calcium, zinc, boron and it's combinations on Ewais mango TSS, Acidity and TSS/Acidity during 2015/16 and 2016/17 seasons.

Treatments	TSS (%)		Acidity (%)g/100 ml juice		TSS/Acidity ratio	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Ca2.5 ml/L	16.1 d	17.267 d	0.512 c	0.515 c	35.222 d	38.325 d
Zn2.5 ml/L	17.07 c	18.167 c	0.704 b	0.708 b	24.255 e	25.325 e
B2.5 ml/L	20.07 a	21.583 a	0.318 e	0.319 e	63.174 a	67.73 a
Ca+Zn+B2.5ml/L	18.03 b	19.75 b	0.393 d	0.396 d	40.829 b	43.600 b
Ca+Zn+B1.25ml/L	15.03 e	16.333 e	0.383 d	0.385 d	39.287 c	42.426 c
Control	14.03 f	15.067 f	1.335 a	1.342 a	10.518 f	11.355 f

Means followed by the same letter in each column are not significantly different at the 0.05 % level of probability according to Duncan's Multiple Range Test.

The behavior of juice acidity measurement throughout the two seasons listed in the same Table showed vice versa trends with those resulted in total soluble solid content. The most acidic juice recorded with fruits resulted from control trees with values of 1.335 and 1.342 g/100 ml juice ,while the lowest one obtained from boron treatment with values of 0.318 and 0.319 g/100 ml juice in the two successive seasons respectively.

The effect of studied foliar applications on TSS/acid ratio of Ewais mango fruit juice as presented in the same Table indicate that TSS/acid ratio of all treated fruits was significantly increased in both seasons comparing with control ones. Such increase makes boron and high rate of calcium, zinc and boron combination treatments take ascendancy place.

Such findings confirm with those of Ahmad *et al.,* (2018) on Chaunsa white mango cultivar, they proved foliar application of boron and zinc resulted in overall increases in fruit quality (highest TSS and lowest acidity) variables as compared to control. Also, Stino *et al,*. (2011) on three mango cultivars, they reported that spraying mango trees with calcium nitrate, zinc sulfate and boric acid increased yield and improved fruit quality as well as physical and chemical fruit properties. The results also are in harmony with those obtained by Merwad *et al.*, (2016), they showed that spraying mango trees with the combination of calcium, boron, zinc and NAA produced higher fruit yield per tree.

Effect of calcium, zinc, boron and its combinations spraying on leaf chemical contents:

Data concerning the chemical constituents of Ewais mango leaves as affected by foliar applications of Calcium, Zinc and Boron presented in Table 6. Generally, all studied treatments were surpassed the control. Spraying the combination of calcium, zinc and boron by the high concentration 2.5 ml/L gave the highest significantly leaves calcium, zinc and boron content followed by the low concentration 1.25 ml/L in both seasons.

Regarding the calcium content of leaves, the results in the same table indicate insignificant differences between the individual calcium treatment and the low concentration 1.25 ml/L of calcium, zinc and boron combination one. Trees sprayed with boron resulted more calcium leaves content than those sprayed with zinc.

Table 6. Effect of foliar application of calcium, zinc, boron and it's combinations on Ewais trees leaf contents of Ca, Zn and B during 2015/2016 and 2016/2017 seasons.

Treatments	calcium(g/kg) Dry weight		zinc(ppm)		boron(ppm)	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Ca2.5 ml/L	17.00 b	20.85 b	21.5 c	21.5 c	33.12 d	34.5 d
Zn2.5 ml/L	13.79 d	15.67 d	21.33 c	21.83 c	29.17 e	30.53 e
B2.5 ml/L	15.97 c	18.03 c	18.23 d	18.97 d	35.42 c	37.3 c
Ca+Zn+B2.5ml/L	18.92 a	22.63 a	28.08 a	29.33 a	42.35 a	43.83 a
Ca+Zn+B1.25ml/L	17.35 b	20.9 b	25.25 b	25.97 b	38.5 b	40.67 b
Control	10.44 e	13.47 e	17.7 d	19.17 d	27.83 f	30.17 e

Means followed by the same letter in each column are not significantly different at the 0.05 % level of probability according to Duncan's Multiple Range Test.

According to Zinc content of leaves as affected by tested treatments the tabulated data reveal that, both calcium and zinc individually treatments did not show any significant values of zinc content in mango leaves in both seasons of study. It is also clear that both boron and control treatments recorded insignificant zinc content. It is evident from the same data that Boron content in mango leaves recorded the highest values with the high concentration of Ca, Zn and B combination treatment. Whereas, individual boron treatment recorded 35.42 and 37.30 ppm in the first and second seasons respectively. Calcium treatment resulted more boron content in Ewais mango leaves compared with zinc one but, the control treatment gave the lowest values in the two season.

These results are in harmony with those obtained by Baiea et al., (2015) on Keitt Mango trees, they reported that applied micro-nutrients combinations increased all chemical composition of mango leaves as compared with individual or control trees .Also, Merwad et al., (2016) with Alphons mango trees, who concluded that the foliar spray of more than two spraying materials(zinc, calcium and boron combination) gave higher values of each element more than those included single material or control.

From the obtained results it could be recommended that best treatment for improving reproductive growth parameters, increasing yield and gave high fruit quality was spraying mango Ewais cultivar with calcium, zinc and boron combination with 2.5ml/L four times, especially in the same conditions to experimental area.

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تأثير المعاملة بالكالسيوم والزنك والبورون على التزهير والمحصول وجودة الثمار في المانجو صنف العويس

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تم إجراء تجربة حقلية خلال موسمي 2016/2015 و2017/2016على أشجار المانجو صنف عويس في المزرعة البحثية لمحطة بحوث البساتين بالمنصورة بقرية كفر البرامون - مركز المنصورة - محافظة الدقهلية - مصر ، لدراسة تأثير فاعلية الرش ببعض العناصر الغذائية (الكالسيوم والزنك والبورون) بصورة منفردة او في مخلوط على النمو الزهري والمحصول و صفات الجودة وكذلك المحتوى الكيماوي للأوراق من هذه العناصر في المانجو صنف العويس ، وتم إجراء التجربة باتباع تصميم القطاعات كاملة العشوائية. أوضحت النتائج المتحصل عليها تفوق جميع معاملات الرش في كل الصفات المدروسة على الكنترول. دللت النتائج على اهمية الرش بمخلوط العناصر السابقة لزيادة طول الشمراخ الزهري وكذلك النسبة الجنسية في حين ان الرش بالبورون منفردا ادى الى زيادة العدد الكلي للأزهار وعدد الازهار المذكرة بينما الرش بالزنك منفردا ادى الى زيادة عدد الازهار الخنثى. الاشجار التي تم رشها بالكالسيوم منفردا انتجت اكثر عدد من الثمار وكذلك اعلى محصول بالكيلو جرام لكل شجرة وكانت الاشجار المرشوشة بالبورون فقط في المرتبة الثانية لهتين الصفتين السابق ذكرهم ، لكن الاشجار المرشوشة بمخلوط العناصر الثلاثة بالتركيز الاعلى انتجت اعلى قياسات لصفات ارتفاع وعرض وحجم الثمار. في حين ان الاشجار التي تم رشها بمحلول الزنك منفردا اعطت اثقل الثمار وزنا تلتها في ذلك معاملة الرش بالتركيز الاعلى من مخلوط العناصر المختبرة. أدت معاملة الرش بمحلول البورون منفردا وكذلك معاملة مخلوط العناصر بالتركيز الاعلى الى تحسين صفات الجودة الكيماوية للثمار متمثلة في زيادة نسبة المواد الصلبة الكلية و معدل المواد الصلبة / الحموضة وتقليل نسبة الحموضة على التوالي خلال موسمي الدراسة ، ومن ناحية أخرى أدت باقي المعاملات إلى زيادة نسبة المواد الصلبة الكلية وتقليل نسبة حموضة العصير مقارنة بمعاملة الكنترول. ادت معاملة الرش بمخلوط العناصر الثلاثة بالتركيز الاعلى الى زيادة محتوى الاوراق من هذه العناصر ثم تلتها معاملة المخلوط بالتركيز الاقل. وعلى الجانب الاخر فقد ادت معاملات الرش بالكالسيوم و الزنك و البورون في صورة منفردة الى زيادة محتوى الاوراق من العنصر المقابل بالمقارنة بالعناصر الأخرى.من خلال نتائج الدراسة يمكن التوصية برش أشجار المانجو العويس بمخلوط الكالسيوم بتركيز 13% والزنك بتركيز 13% مع البورون بتركيز 10% وذلك بمعدل 2.5مل /لتر للحصول على أعلى محصول وأفضل صفات جودة وذلك تحت ظروف التجربة والظروف المشابهة لها.