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Effect of Foliar Application With Calcium, Boron And Zinc on The Yield And Quality of Strawberry Fruits And Post-Harvest Diseases

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ABSTRACT

A field experiment was designed in a split plot with three replicates and were carried out at PICO farm (Om Saber), EL-Beheira Governorate, Egypt. Soil is light loamy to examined the role of Ca:B:Zn levels on growth, fruit yield and fruit quality of the three Strawberry cultivars (Red merlin (029), Elyana and Fortuna (116)) plants during the two successive seasons of 2016/2017 and 2017/2018.The data indicated that all strawberry growth, fruit yield and fruit quality traits significantly affected by cultivars, treatments and their interactions in both seasons. Fortuna cv. had the highest; leaves number/plant, average leaf area, leaves content of; phosphor and calcium, average fruit weight, fruit yield/plant, fruit yield/fad, early fruit yield, exported fruit yield, fruit content of TSS, reducing sugar and total sugar in both seasons and highly desirable leaves content of Zinc in the 2nd season. Elyana cv gave the highest; root length leaves fresh weight,leaves contents of; potassium and Boron in both seasons and leaves content of zinc in the second season. The results also revealed that Redmerlln cv expressed the highest leaves dry weight, root dry weight, leaves contents of; nitrogen, potassium, calcium and fruit acidity in both seasons. The result also confirmed that strawberry plant that sprayed with Ca: B: Zn (1:0.25:1g) showed the highest leaves fresh weight and fruit acidity in both seasons. In the same way strawberry plants that sprayed with Ca: B: Zn (1.50: 0.50 :1.50 g) showed highly desirable significant values for; leaves number/plant average leaf area, root length, average fruit weight, fruit yield/plant, fruit yield/fad, early fruit yield and exported yield in both seasons. Strawberry plant that sprayed with 2:0.75:2 g Ca: B: Zn showed the highest leaves contents of; nitrogen, phosphor, potassium, calcium and boron in both seasons and zinc in the first season. Also, the same treatment gave the highest fruit content of TSS, non-reducing sugar, reducing sugar and total sugar in both seasons. The presented data indicated that the three strawberry cultivars differed in their responses to Ca: B: Zn levels. Fortuna cv under Ca: B: Zn (2:0.75:2 g) gave the highest number of leaves/plant, leaf content of phosphor, calcium fruit contents of; TSS, non-reducing sugar, reducing sugar and total sugar in both seasons. Also, Fortuna cv under Ca: B: Zn (1.5: 0.5 :1.5g) had the highest averages for leaf area, root length, average fruit weight, fruit yield/plant, fruit yield/fad, early fruit yield and exported yield in both seasons.Elyana cv under Ca: B: Zn at the rate of 2:0.75:2g had the highest leaves fresh weight, leaf content of potassium and boron in both seasons. In the same way, Elyana cv under 1:0.25:1 g of Ca: B: Zn had the highest leaf content of zinc in both seasons.Redmerlln cv under 2:0.75:2 g of Ca: B: Zn had the highest leaves dry weight, root dry weight and leaves content of nitrogen in both seasons. Also, Redmerlln cv under Ca: B: Zn (1: 0.25:1 g) had the highest fruit acidity in both seasons.

Key words : calcium, boron, zinc, strawberry, growth, fruit yield, fruit quality

الملخص

تم إجراء تجربة حقلية صممت فى نظام القطع المنشقة من ثلاث مكررات في مزرعة بيكو (أم صابر) بمحافظة البحيرة ، مصر ،ذات تربة طينية خفيفة لإختبار دور مستويات مختلفة من الكالسيوم: البورون: الزنك على نمو و محصول وجودة الثمار لأصناف الفراولة الثلاثة ، ريد ميرلين (٠٢٩) ، إليانا وفورتونا (١١٦) خلال الموسمين الزراعيين لعامى ٢٠١٧/٢٠١٦ و ٢٠١٨/٢٠١٧. و قد أكدت البيانات تأثر النمو ومحصول الثمار و جودتها فى الفرولة بإختلاف الصنف المستخدم والمعاملات و التفاعل بينهما فى كلا الموسمين. أعطى صنف الفراولة فورتونا أعلى: عدد أوراق للنبات, مساحة للورقة, محتوى للأوراق من الفوسفور و الكالسيوم, أعلى متوسط لوزن الثمرة, أعلى محصول ثمار للنبات, أعلى محصول ثمار للفدان, أعلى محصول مبكر, أعلى محصول تصدير فى كلا الموسمين بالإضافة لقيم عالية مرغوبة لمحتوى الأوراق من الزنك فى الموسم الثانى.فى حين أعطى صنف الفراولة إليانا أعلى القيم لكل من طول الجذر,الوزن الطازج للأوراق, محتوى الأوراق من البوتاسيوم و البورون فى كلا الموسمين . كذلك محتوى الأوراق من الزنك فى الموسم الثانى. كما أظهرت النتائج أيضا أن الصنف ريدميرلين أظهر أعلى القيم لكل من: الوزن الجاف للأوراق و الجذور, محتوى الأوراق من النيتروجين و البوتاسيوم و الكالسيوم و كذلك حموضة الثمار فى كلا الموسمين. بالنسبة لتاثير معاملات الرش فقد اكدت النتائج أن رش نباتات الفرولة ب ١:٠,٢٥:١ جم من الكالسيوم: البورون: الزنك أظهر أعلى وزن طازج للأوراق و حموضة الثمار فى كلا الموسمين. على نفس الطريق فإن نباتات الفرولة التى تم رشها ب ١,٥:٠,٥:١,٥ جم من الكالسيوم و البورون و الزنك أظهرت قيم عالية مرغوبة من عدد الأوراق للنبات, متوسط مساحة الورقة, طول الجذر, متوسط وزن الثمرة, محصول الثمار للنبات, محصول الثمار للفدان, محصول الثمار المبكر و محصول ثمار التصدير فى كلا الموسمين. أعطت نباتات الفراولة التى تم رشها ب ٢:٠,٧٥:٢ جم من الكالسيوم : البورون : الزنك أعلى القيم لمحتوى الأوراق من النيتروجين, الفوسفور , البوتاسيوم , الكالسيوم و البورون فى كلا الموسمين بالإضافة إلى الزنك فى الموسم الأول. بالنسبة لتأثير التفاعلات فقد أكدت النتائج وجود تباين كبير فى إستجابة أصناف الفراولة الثلاثة لمعاملات الرش. كان للصنف فورتونا تحت الرش ب ٢:٠,٧٥:٢ جم من الكالسيوم : البورون : الزنك أعلى القيم لعدد الأوراق للنبات, محتوى الأوراق من الفوسفور و الكالسيوم, فى كلا الموسمين. كما أعطى الصنف فورتونا أيضا تحت الرش ب ١,٥:٠,٥:١,٥ جم من الكالسيوم و البورون و الزنك أعلى القيم لمساحة الورقة, طول الجذر, متوسط وزن الثمرة, محصول الثمار للنبات و الفدان, المحصول المبكر للثمار و محصول التصدير فى كلا الموسمين. أعطى الصنف إليانا تحت معاملة الرش ب ٢:٠,٧٥:٢ جم من الكالسيوم : البورون : الزنك أعلى القيم لكل من الوزن الطازج للأوراق, محتوى الأوراق من البوتاسيوم و البورون فى كلا الموسمين. كما أظهر الصنف نفسه تحت الرش ب ١:٠,٢٥:١ جم من الكالسيوم: البورون: الزنك أعلى محتوى للأوراق من الزنك فى كلا الموسمين. أعطى الصنف ريدميرلين تحت الرش ب ٢:٠,٧٥:٢ جم من الكالسيوم : البورون : الزنك أعلى القيم لكل من وزن الأوراق و الجذور جاف و محتوى الأوراق من النيتروجين فى كلا الموسمين. كما أظهر ريدميرلين تحت الرش ب ١:٠,٢٥:١ جم من الكالسيوم: البورون: الزنك أعلى حموضة للثمار فى كلا الموسمين. **التوصية :** يمكن القول بأنه للحصول على أعلى محصول و جودة من ثمار الفرولة ينبغى على مزارعى الفراولة فى محافظة البحيرة زراعة الصنف فورتونا مع الرش ب ٢:٠,٧٥:٢ جم من الكالسيوم : البورون : الزنك ثلاث مرات من بداية مرحلة التزهير.

الكلمات الدالة : كالسيوم -البورون - الزنك - الفراولة - النمو - محصول الفاكهة - جودة الثمار

1. INTRODUCTION

Strawberry (Fragaria x ananassaDuch.) is one of the most important temperate fruit belongs to the family Rosaceae. It is an aggregate fruit which is highly perishable in nature. Basically, it is herbaceous, perennial and short-day plant. Among all the berries, strawberry gives high return in a shortest time (Boriss et al., 2006). Strawberries are a very rich source of bioactive compounds including vitamin C, E, B-carotene, and phenolic compounds (Oszmianski and Wojdylo, 2009). Due to strawberry's high nutritional value, the demand for it has increased significantly in recent years. In Egypt, the total cultivated area of strawberry is 11772 fed with production of 460245 tons (FAO STAT 2019).

The correct choice of cultivar is one of the most important factors in successfull planning of commercial strawberries cultivation, which must be adapted to environmental conditions of the growing site (Pádua et al., 2015). The main environmental factors that determine the adaptability of strawberry cultivars are the photoperiod, temperature and fertilization statue (Sønsteby and Heide, 2017). The use of sensitive cultivars to grow under environmental stresses resulted in a large decrease in strawberries production, so, strawberry farmer should

use the recommended practices from irrigation and fertilization to elevate tolerant of strawberry plants to bad growth conditions ;(Antunes et al., 2010).

Nutrition status of strawberry plant plays a vital role in determining the growth, yield and quality of fruits since it is a very sensitive plant to nutritional balance (Mohamed et al., 2011). In most cases strawberry farmer fertilize strawberry with macro nutrients only (N, P and K) and ignore the importance of micro nutrients such as calcium, boron and zinc. The reduce of these micro-nutrients seriously affect strawberry growth where it resulted in a large decrease in leaf pigments, leaf and root growth and development and this reduce results in sharply decrease in fruit yield and quality. The foliar nutrition of micro-nutrients have very important role in improving fruit set, productivity and quality of fruits. Foliar nutrition at proper time improved quality and quantity strawberry (Kazemiet al., 2011).

Ca is one of the most important macro nutrients well known to ameliorate plant growth (Bakshiet al., 2005). It plays an important role in maintaining quality of fruits and vegetables. Calcium treatment helps to make plant more healthy by increasing canopy density (leaves number and area), foliage fresh and dry weight and leaves nutrients values. Calcium treatment helps to retain fruit firmness, increase vitamin C content, decreased storage breakdown rotting and browning in apple (Kazemiet al., 2011). The spray of Calcium during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits (Raese and Drake 2000). Also, Vicente et al., (2007) showed that calcium application can significantly reduce postharvest decay by increase TSS, total sugar and strengthening the cell wall matrix and presumably enhancing resistance to attack by fungi and bacteria affecting fruit quality and preservation.

Boron is an essential and important micronutrient in vegetative and reproductive growth of fruit and vegetables. Boron deficiency firstly appear on the terminal younger leaves in plants; plants fail to produce functional flowers and may produce no seeds. Plants subjected to boron deficiency suffered from low germination of pollen. Failure to set fruit is common, and the fruit may be ridged, show corky patches, and ripens unevenly (Gupta, and Philip, 2006). Leaves and stems under low boron availability become brittle as terminal growth arrested and eventually death of the apical meristem occurs. Primary and lateral root growth is inhibited shortly after B becomes depleted, resulting in a stubby, bushy root system (David, 2018). While, the increase of boron level resulted in significant increase of all growth traits; canopy fresh and dry weight, shoot and root length, leaf area/plant in strawberry plants (Wójcik, and Lewandowski2003). Moreover, Mehrajet al. (2015) showed that foliar application of boron-zinc (100 ppm) on strawberry significantly increased leaves number/plant, leaf area index, leaf fresh, and dry weight as well as increased leaf content of NPK.

Zinc acts as a cofactor for many enzymes and influences many biological processes such as photosynthesis, nucleic acid metabolism, and protein and carbohydrate biosynthesis (Marschner, 1995). It is a component of many enzymes and proteins, and it is an essential mineral for normal plant growth and development. It is also necessary for the synthesis of Tryptophan, which is a precursor to IAA that acts as a substance that promotes growth (Nasiriet al. 2010). Zinc deficiency is most widespread after nitrogen (N) and phosphorous (P) in alkaline and calcareous soils (Rashid and Ryan, 2004). Zinc deficiency can be corrected by adding soil or foliar spray. Zinc applied in soil is less available to plants due to its less mobility and high fixation in the soil. Hence, foliar spray appears to be an effective method in light of severe zinc deficiency. Early foliar application of zinc is considered one of the important means to compensate for its deficiency in fruits and increase yield (Boarettoet al., 2002). among all micro-nutrients, zinc (Zn) plays an important role in promoting vegetative growth and leaf chemical properties (N,P,K, Ca, Mg, Zn and B contents) of strawberry (Chaturvediet al., 2005). In another study, Manjitet al., (2015) revealed that, the vegetative growth parameters in strawberry cv. Chandler viz., plant height, plant spread, leaf number per plant and leaf area

presented significantly increased with iron and zinc sprays. In the same line, Chandrakaret al. (2018 a) revealed that, foliar application of zinc sulphate at 0.35 % in strawberry gave best result in increased ascorbic acid content, decreased acidity, increased TSS content, total sugar, reducing sugar and also enhanced shelf life of fruits.

The main objectives of this study were:

1- Comparison of some vegetative growth, fruit yield and fruit quality of three strawberries cultivars to determine the best one of these cultivars and the most suitable for planting under El-Beheira Governorate conditions.
2- Examined the effect of three different levels of calcium: boron: zinc on vegetative growth, fruit yield and fruit quality of strawberry.

2. MATERIALS AND METHODS

2.1. Plant materials

Three cultivars, Red merlin (029), Elyana and Fortuna (116) Strawberry plants (*Fragaria*X *ananassa*Duchesne) were used in this study to examined the role Ca:B:Zn levels on growth, fruit yield and fruit quality during the two successive seasons of 2016/17 and 2017/18.

For this purpose a field experiments, designed in a split plot design with three replicates were carried out at PICO farm (Om Saber), Beheira Governorate, Egypt, where soil is light loamy soil. Nile water is available in this area with drip irrigation system. Each plot was 1.2 x 5 m contains 100 strawberry seedlings. All strawberry seedlings receive the same fertilizers and irrigation as recommended. The experimental soil physical and chemical properties are presented in Table 1.

Table 1: Physical and chemical properties of the experimental site

Physical properties											
Cors Sand %			Fine sand		Very fine sand					Texture	
2 MM	1 MM	0.5 MM	0.25 MM	0.04 MM	<0.04 MM						
13.13	30	10.5	0.0	0.0	39.4					Sandy	
Chemical properties											
PH	EC mmhos/cm	Soluble salts (mg/kg)									
		Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^{--}	CO_3^{--}	SO_4^-	O.M	CO_3%
8.3	0.23	16.1	7.8	16	7.5	42.6	48.8	0	9.6	0.58	1.9

2.2 Treatments

2.2.1. The three combinations of calcium, boron and zinc i.e.

- 1g Calcium - 0.25g Boron - 1g Zinc / liter of water.
- 1.5g Calcium - 0.5g Boron - 1.5g Zinc / liter of water.
- 2g Calcium - 0.75g Boron - 2g Zinc / liter of water.

Were applied as foliar spray three times started at the beginning of flowering stage with 15 days intervals between each oneand the three elements combinations were used as g / l Litter of water.

Where: Calcium compound content 12% calcium, Zinc compound content 6% Zn and Boron compound content 6% Boron.

2.3. Data Recorded

10 guarded plants chosen randomly from plots in the three replicates , then were used after 120 days from transplanting for the two growing seasons to measure the vegetative growth, and leaf chemical properties as follows:

2.4. Vegetative growth parameters:
Number of leaves/plant, average leaf area (cm^2), root length (cm), leaves fresh weight (g), leaves dry weight (g) and root dry weight (g).

2.5. Leaf chemical properties:
Leaf content of nitrogen, phosphor, potassium and calcium (mg/100g fw) in addition to leaf content of boron and zinc (ppm).

Chemical analysis of leaf N, P and K mineral contents were determined in fresh leaf. Total nitrogen was assayed according to Chapman and Pratt (1961) and Cottenie*et al.* (1982) using the micro kjeldahle apparatus. Phosphorus was determined spectrophotometery by Cottenie*et al.* (1982). Potassium was determined photometrically, using flame photometer according to Jackson (1965). Boron and zinc were determined by flame photometer as well.

2.7. Yield and its related traits:
At harvest the following measurements were calculated:

Average fruit weight (g), fruit yield / plant (g), fruit yield / faddan (ton), early fruit yield / faddan (ton) and exported fruits (ton).

3. RESULTS AND DISCUSSION

3.1. Effect of cultivars, Ca:B:Zn levels and their interaction on strawberry growth traits during 2016/17 and 2017/18 growing seasons:

The obtained data in table 2 indicated that all strawberry growth traits significantly affected by cultivars, treatments and their interactions in both seasons.

3.1.1 Cultivars effect

The results in Table 2 showed that Fortuna cv. had the highest; leaves number/plant (43.01 and 44.04) and average leaf area (21.83 and 22.08 cm2) but the same cultivar gave the lowest root length (21.34 and 21.88 cm) and leaves fresh weight (68.91 and 68.90 g) in both seasons, respectively. Elyana cv gave the highest; root length (24.63 and 24.83 cm) and leaves fresh weight (79.11 and 78.11 g) and the lowest; leaves dry weigh (30.09 and 30.97 g) and root dry weight (22.92 and 22.52 g) in both seasons, respectively. The results also revealed that Redmerlln cv expressed the highest leaves dry weight (34.02 and 33.58 g) and root dry weight (29.46 and 29.78 g) and the same cultivar had the lowest; leaves number/plant (30.46 and 29.48) and average leaf area (18.05 and 18.34 cm2) in both seasons, respectively.

3.1.2. Ca: B: Zn levels effect:

Data in table 2 cleared that all Ca:B:Zn levels resulted in significant increase in all strawberry growth traits compared to the control treatment in both seasons of the study. All growth traits except average leaf area and root length gradually increase with the increase of Ca: B: Zn levels in both seasons. The result also confirmed that strawberry plant that sprayed with Ca: B: Zn (1:0.25:1g) showed the highest leaves fresh weight with averages of 79.29 and 78.86 g in both seasons, respectively.

3.3. Effect of the interactions:

The presented data in Table 2 indicated that the three strawberry cultivars differed in their responses to Ca: B: Zn levels. Fortuna cv showed the highest response to Ca: B: Zn levels compared with Elyana and Redmerllncvs in both seasons of the study. For leaves number/plant Fortuna cv under Ca: B: Zn (2:0.75:2 g) gave the highest number of leaves/plant (46.10 and 47.90) followed by the same cv under Ca: B: Zn at the rate of 1.5:0.50 :1g (44.83 and 45.70) then the same cv under Ca: B: Zn at the rate of 1:0.25 :1g with averages of 44.10 and 44.57. Respect to average leaf area, Fortuna cv under Ca: B: Zn (1.5: 0.5 :1.5g) had the highest averages for leaf area (26.17 and 27.17cm2) followed by Elyana cv under Ca: B: Zn (1.5 : 0.5 :1.5g) with averages of 23.67 and 24.67 cm2 in both seasons, respectively. With regard to root length Fortuna cv under Ca: B: Zn (1.5 : 0.5 :1.5g) had the longest roots (27.40 and 28.20 cm) in both seasons, respectively but these values did not differ significantly with those of Elyana cv under all Ca: B: Zn levels in both seasons. Regard to leaves fresh weight Elyana cv under Ca: B: Zn at the rate of 2:0.75:2g had the highest leaves fresh weight with averages of 82.73 and 82.77 g but these values did not differ significant with those obtained by the same cv under the lowest rates of Ca: B: Zn and Redmerlln cv under 2:0.65:2 g of Ca: B: Zn in both seasons. For leaves dry weight the results showed that Redmerlln cv under 2:0.75:2 g of Ca: B: Zn had the highest leaves dry weight (37.87 and 37.50g) followed by Fortuna cv under 1.5:0.5:1 Ca: B: Zn with averages of 35.47 and 35.77 g in both seasons, respectively. Redmerlln cv under 2:0.75:2 g of Ca: B: Zn had the highest root dry weight with averages of 34.47 and 34.67 g in both seasons, respectively but these values did not differ significant with those obtained by the same cv under the low rats of Ca: B: Zn and Fortuna cv under 1.5:0.5:1.5g of Ca: B: Zn.

Many previous studies such as; Andrioloet al., (2010); Kazemiet al. (2011); Dineshkumar, (2016);Aziz et al., 2017; Maheshgowdaet al., (2017)and EL Oualkadi; Hajjaj (2019)and Ahmed et al. (2020) who, evaluated different genotypes of strawberry (Fragaria X ananassaDuch.) for growth, yield and quality and they found that Sabrina genotype to superior Fortuna cultivar in all growth measurements. In this study all Ca:B:Zn levels significantly increase all growth traits (leaves number/plant, leaf area, root length, leaves fresh and dry weight as well as root dry weight) of the three strawberry cultivars compared with control. Our results are in the same line with many previous studies that described the benefit role of calcium, boron and zinc fertilizers in strawberry and other crops.

Regarding to the effect of zinc on strawberry growth, Kazemiet al., (2015); Manjitet al., (2015) and Mishra et al. (2016) revealed that, the maximum plant height (17.00 cm), plant spread (38.34 cm), number of leaves per plant (12.78) and leaf area (106.30 cm2) were shown under the combined treatment of FeSO4 (0.2%) and ZnSO4 (0.3%) sprays, while minimum plant height (10.14 cm), plant spread (20.62 cm), number of leaves per plant (6.11) and leaf area (35.44 cm2) was obtained under the control treatment.Faridet al. (2020); Mahnazet al., (2010); Kazemi (2014) and Kazemiet al., (2015) who revealed that the maximum number of leaves, and leaf area were recorded from (Zn (40g/kg) +Cu (30g/kg)+Mn (2g/kg) +Fe (1g/kg)) at 3.5ml l^{-1}, while fresh weight of leaves, dry weight of leaves, fresh weight of plants, dry weight of plants and canopy size were improved by the foliar spray of (Zn (40g/kg) +Cu (30g/kg)+Mn (2g/kg) +Fe (1g/kg)) at 2.5ml l^{-1}. Thus this finding were simillar to our finding were it proved that using zn and ca as micro element improved the great quality of the yield .At the same time using ca improved the fruit ability to longer storage period which helped during the transpertate of strawberries before and though experty.They

With respect the vital role of boron on strawberry growth,Dawood et al. (2010);Mehrajet al. (2015)and Aziz et al. (2017)showed that foliar application of boron-zinc (100 ppm) on

strawberry significantly increased leaves number/plant, leaf area index, leaf fresh and dry weight. In the same trend, Wójcik, and Lewandowski (2003) and Treebyet al., (2004). Thereby our results considerd with these results and proved the infiuences of applying Boron as falouir to the strawberries plants, where it showed appositive effect on most of growth measurments

Table 2: Effect of cultivars, Ca : B : Zn levels and their interaction on strawberry growth traits during 2016/17 and 2017/18 growing seasons.

Factors		Leaves number /plant		Average leaf area (cm^2)		Root length (cm)		Leaves fresh weight (g)		Leaves dry weight (g)		Root dry weight (g)	
		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Cultivar:													
Fortuna		43.01 a	44.04 a	21.83 a	22.08 a	21.34 b	21.88 b	68.91 c	68.90 c	32.53 b	32.22 b	25.79 b	26.45 b
Elyana		34.60 b	34.37 b	20.49 b	21.24 b	24.63 a	24.83 a	79.11 a	78.11 a	30.09 c	30.97 c	22.92 b	22.52 b
Redmerlln		30.46 c	29.48 c	18.05 c	18.34 c	21.69 b	21.43 b	73.56 b	74.19 b	34.02 a	33.58 a	29.46 a	29.78 a
LSD 5%		**3.66**	**3.41**	**0.83**	**0.74**	**1.75**	**2.00**	**2.14**	**2.54**	**0.94**	**1.33**	**2.84**	**4.42**
Ca: B: Zn (Levels ppm)													
1-0.25- 1		36.29 b	36.20 b	21.40 b	21.73 b	22.11 b	21.94 b	79.29 a	78.86 a	32.91 b	32.91 b	27.58 b	26.58 b
1.5-0.50-1.5		38.38 ab	38.54 ab	23.63 a	24.63 a	25.50 a	25.91 a	76.74 b	75.94 b	32.04 b	31.80 b	28.02 b	28.79 b
2 -0.75- 2		40.06 a	40.10 a	20.06 c	20.06 c	22.47 b	23.36 b	77.70 ab	77.90 ab	35.31 a	35.34 a	31.76 a	32.73 a
Control		29.37 c	29.00 c	15.40 d	15.79 d	20.13 c	19.63 c	61.70 c	62.23 c	28.57 c	28.97 c	16.87 c	16.90 c
LSD 5%		**3.17**	**2.95**	**0.72**	**0.64**	**1.52**	**1.63**	**2.45**	**2.80**	**1.08**	**1.15**	**2.46**	**3.83**
Cultivar	**Ca: B: Zn (Levels ppm)**												
Fortuna	**1-0.25- 1**	44.10 ab	44.57 a	23.78 b	23.77 bc	19.40 ef	19.30 d	80.60 ab	81.13 a	33.10 cd	33.27 b	27.27 bc	26.57 bcd
	1.5-0.50-1.5	44.83 ab	45.70 a	26.17 a	27.17 a	27.40 a	28.20 a	73.63 cde	72.07 cd	32.53 de	30.93 bc	26.40 bcd	28.57 abc
	2 -0.75- 2	46.10 a	47.90 a	20.27 cde	20.27 e	19.95 def	21.40 c	71.90 def	72.40 cd	35.47 b	35.77 a	31.40 ab	32.57 ab
	Control	37.00 cde	38.00 b	17.10 f	17.10 g	18.60 f	18.60 d	49.50 g	50.00 e	29.00 f	28.90 c	18.10 e	18.10 ef
Elyana	**1-0.25- 1**	34.10 def	34.77 bc	21.57 c	22.57 cd	24.40 abc	24.03 bc	81.90 a	80.20 ab	30.90 e	33.27 b	25.27 cd	22.53 cde
	1.5-0.50-1.5	36.23 cde	36.17 b	23.67 b	24.67 b	26.03 ab	26.60 ab	82.90 a	80.27 ab	31.43 de	31.93 b	26.40 bcd	25.97 bcd

	2 -0.75- 2	38.37 bcd	37.93 b	20.53 cd	20.53 e	25.70 ab	26.20 ab	82.73 a	82.77 a	32.60 de	32.77 b	29.40 bc	30.97 ab
	Control	29.70 f	28.60 d	16.20 f	17.20 g	22.40 cde	22.50 c	68.90 ef	69.20 d	25.42 g	25.90 d	10.60 f	10.60 f
Redmerlln	**1-0.25- 1**	30.67 ef	29.27 cd	18.87 e	18.87 f	22.53 cd	22.50 c	75.37 bcd	75.23 bc	34.73 bc	32.20 b	30.20 ab	30.63 ab
	1.5-0.50-1.5	34.07 def	33.77 bcd	21.07 c	22.07 d	23.07 bc	22.93 c	73.70 cde	75.50 bc	32.17 de	32.53 b	31.27 ab	31.83 ab
	2 -0.75- 2	35.70 c-f	34.47 bcd	19.37 de	19.37 ef	21.77 cde	22.47 c	78.47 abc	78.53 ab	37.87 a	37.50 a	34.47 a	34.67 a
	Control	21.40	20.40 e	12.90 g	13.06 h	19.40 ef	17.80 d	66.70 f	67.50 d	31.30 de	32.10 b	21.90 de	22.00 de
LSD 5%		**6.34**	**5.91**	**1.43**	**1.28**	**3.04**	**2.97**	**5.90**	**5.60**	**1.88**	**2.30**	**4.93**	**7.66**

Table 3: Effect of cultivars, Ca:B:Zn levels and their interaction on fruit yield and its related traits of strawberry during 2016/17 and 2017/18 growing seasons.

Factors		Average fruit weight (g)		Fruit yield/plant (kg)		Fruit yield/fad (ton)		Early fruit yield/fad (ton)		Exp. Fruit (ton)	
		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Cultivar:											
Fortuna		31.50 a	31.23 a	350.83 a	348.17 a	12.66 a	12.58 a	6.50 a	6.44 a	37.78 a	37.92 a
Elyana		26.58 c	26.56 c	238.58 c	235.42 c	8.18 c	8.22 c	4.00 c	4.15 c	25.90 c	26.03 c
Redmerlln		28.83 b	30.08 b	274.75 b	273.42 b	10.46 b	10.40 b	5.85 b	5.54 b	31.17 b	31.04 b
LSD 5%		**0.68**	**0.74**	**11.70**	**15.64**	**0.58**	**0.56**	**0.30**	**0.25**	**1.91**	**1.82**
Ca: Zn: B (Levels)											
1-0.25- 1		28.67 c	28.47 c	288.33 b	287.78 b	10.38 c	10.36 c	5.54 b	5.28 c	30.95 c	31.32 c
1.5-0.50-1.5		32.11 a	32.81 a	322.00 a	325.67 a	11.61 a	11.48 a	6.05 a	6.17 a	36.40 a	36.16 a
2 -0.75- 2		29.78 b	30.51 b	319.78 a	317.56 a	10.94 b	10.85 b	5.76 b	5.57 b	33.72 b	33.69 b
Control		25.33 d	25.37 d	241.11 d	237.67 c	8.81 d	8.93 d	4.46 c	4.49 d	25.40 d	25.48 d
LSD 5%		**0.59**	**0.64**	**10.09**	**13.54**	**0.50**	**0.44**	**0.26**	**0.22**	**1.65**	**1.59**
Cultivar	**Ca: Zn: B (Levels)**										
Fortuna	**1-0.25- 1**	30.33c	28.80 de	352.00 b	349.67 a	12.67 a	12.58 b	6.74 ab	6.22 bc	36.77 bc	37.51 bc
	1.5-0.50-1.5	34.67 a	35.33 a	375.67 a	380.67 a	14.25 a	14.06 a	7.08 a	7.48 a	41.62 a	41.35 a
	2 -0.75- 2	32.00 b	33.07 b	374.00 a	373.33 a	13.46 a	13.45 ab	6.91 a	6.55 b	40.58 a	40.85 ab
	Control	29.00 d	27.70 ef	311.67 cd	309.00 bc	10.26 c	10.25 d	5.28 d	5.50 d	32.15 d	31.98 de
Elyana	**1-0.25- 1**	26.33 e	26.03 g	230.67 hi	227.67 fg	8.30 d	8.20 ef	3.65 fg	3.96 fg	25.54 fg	25.39 f
	1.5-0.50-1.5	29.33 cd	29.57 cd	244.33 gh	244.00 ef	8.80 d	8.79 e	4.81 de	4.69 e	28.79 ef	29.36 e
	2 -0.75- 2	28.67 d	28.83	264.33 fg	262.00	8.53 d	8.43 e	4.16 f	4.27 ef	26.78 f	25.98 f

			de		de						
	Control	22.00 g	21.80 h	215.00 ij	208.00 gh	7.10 e	7.47 f	3.38 g	3.68 g	22.48 gh	23.38 fg
Redmerlln	**1-0.25- 1**	29.33 cd	30.57 c	282.33 ef	286.00 cd	10.16 c	10.29 d	6.23 bc	5.66 d	30.54 de	31.07 de
	1.5-0.50-1.5	32.33 b	33.53 b	299.00 de	294.33 bc	11.77 b	11.59 c	6.27 bc	6.33 bc	38.79 b	37.79 b
	2 -0.75- 2	28.67 d	29.63 cd	321.00 c	317.33 b	10.83 bc	10.66 d	6.20 c	5.88 cd	33.78 cd	34.24 cd
	Control	25.00 f	26.60 fg	196.67 j	196.00 h	9.08 d	9.07 e	4.72 e	4.27 ef	21.55 h	21.06 g
LSD 5%		**1.14**	**1.28**	**21.29**	**27.09**	**1.00**	**0.93**	**0.52**	**0.46**	**3.31**	**3.35**

4. CONCLUSION

It could be concluded that to obtaine highly strawberry fruit yield and fruit quality, strawberry farmers in El-Beheira Governorate must use Fortuna cultivar with the foliar spray three times with 2:0.75:2 g/l of Ca:B:Zn starting at the beginning of flowering stage.

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