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Effect of Foliar Application Boron and Calcium on Yield and Fruit Quality of 'Desert Red" Peach Trees.

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ABSTRACT

The present experiment has been conducted during the season 2016 on 5-years old 'Desert Red' peach trees budded on 'Nemagurd' rootstock, grown in sandy new reclaimed at El-Nubaria, Behera Governorate, treatments included 0.05% H_3BO_3 + 0.1% chelated Ca, 0.05% H_3BO_3 + 0.2% chelated Ca, 0.1 % H_3BO_3+ 0.1% chelated Ca and 0.1 % H_3BO_3 + 0.2% chelated Ca, were sprayed after fruit set starting and after five weeks to fruit setting. The results mentioned that all treatments increased significantly shoot length leaf area compared to the control (unsprayed trees). Also, the highest fruit yield was resulted from the application of 0.1% H_3BO_3 + 0.2% chelated Ca, while the lowest fruit yield was gained from control trees.

Furthermore, in general, all treatments increased weight, dimensions, firmness, TSS, Vitamin C and total sugar in fruits of 'Desert Red' peach. However, the most effective treatment for increasing growth and yield as well as improving fruit quality was found from 0.1% H_3BO_3 + 0.2% chelated Ca in 2016 season of study as compared with control treatment which recorded lowest growth, fruit yield and quality values.

تأثير الرش بالبورون والكالسيوم على المحصول وجودة ثمار أشجار الخوخ صنف "دزرت رد"

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الخلاصة

تم إجراء هذا البحث خلال موسم الدراسة (2016) على أشجار الخوخ صنف "دزرت رد" المطعومة على أصل الخوخ "النيماجارد" عمرها 5 سنوات والنامية فى تربة رملية بالنوبارية والتابعة لمحافظة البحيرة وقد تم استعمال مخلوط من حمض البوريك 0,05 % والكالسيوم المخلبى 0,1% وحمض البوريك بتركيز 0,05% والكالسيوم المخلبى 0,2% وحمض البوريك بتركيز 0,1% والكالسيوم المخلبى 0,1% وحمض البوريك 0,1% والكالسيوم المخلبى 0,2% (وقد تم الرش مرة بعد العقد مباشرة والثانية بعد 5 أسابيع من عقد الثمار).

وقد أشارت النتائج أن كل المعاملات أدت إلى زيادة معنوية فى طول النموات الخضرية والمساحة الورقية بالمقارنة بمعاملة المقارنة (الأشجار غير مرشوشة). أيضاً لوحظ أن الرش بمعاملة 0,1% حمض البوريك + 0,2% من الكالسيوم المخلبى أعطت أعلى إنتاجية من الثمار بالمقارنة بمعاملة المقارنة. كما أظهرت النتائج عموماً أن كل المعاملات أدت إلى زيادة وزن أبعاد صلابة الثمار، المواد الصلبة الذائبة الكلية، نسبة الحموضة، فيتامين ج، والسكريات الكلية فى ثمار الخوخ صنف (دزرت رد) بالمقارنة بمعاملة المقارنة.

وعلى أى حال، كانت أفضل المعاملات الأكثر تأثيراً في زيادة النمو الخضري والمحصول كماً ونوعاً بالمقارنة بمعاملة المقارنة خلال موسم الدراسة وهى معاملة رش 0,1% حمض البوريك + 0,2% الكالسيوم المخلبى.

الكلمات المفتاحية:
الخوخ ، البورون ،الكالسيوم ، المحصول ، جودة الثمار.

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Introduction:

Peach (*Prunuspresica* L.) fruit is one of the favorite fruits temperate zone and considered AS one of the most important deciduous fruit trees growing rapidly in the world.

In Egypt, it is known that most spread local peach done is 'MitGhamer', fortunately, during the last three decades, several peach cultivars have been introduced to Egypt by the Agricultural Development System **(Stino*et al*., 1982; Mansour and Stino, 1986 and Shaltout, 1987 and 1995)**. These cultivars were achieved by selecting a profitable cultivar at the right time, it is an important factor determining success in each production due to increase marketing period of peach fruits, such as florida prince, Desert Red, Tropic Snow, Tropic Sweet and Swelling. Therefore, the area of peach orchards increased and attained about 59374 feddans with a production of about 281119 tons **(Statistics of Ministry of Agriculture, Egypt,2013)**.

Boron deficiency causes fruit disorders and cracking of seaming **(Benson *et al*., 1983)**. Boron synthesis, sugar transport, hormone anabolism and catabolism and growth of pollen tube **(La Rue and Johnson, 1989). Kilany and Kilany (1991)** working on "Anna" apple reported that boron sprays significantly increased the shoot length and diameter. Boron has been recognized as an essential element for plant growth for more than later sixty years, the low concentrations and narrow range of boric acid were used to cure deficiency and prevent toxicity and obtain higher fruit yield on mango (**Haggag*et al*., 1995**). Also, on 'Anna' apple trees, boric acid caused insignificant effect on fruit diameter, length volume and weight, but sprays increased acidity, total sugar and anthocyanin content **(Mostafa*et al*., 1999).** Boron applications increased vegetative growth, yield and fruit quality of 'LeConte' pear trees **(Aly*et al*., 2012).** Calcium and Boron application increased vegetative growth, yield and fruit quality of 'Anna' apple trees **(Aly*et al*., 2014)**. The importance of Ca in the regulation of fruit ripening and vegetative maturation is well established **(Ferguson, 1984 and Amiri*et al*., 2008)**. Studies on leaf senescence **(Ferguson, 1984; Poovaiah and Leopold, 1973)** and fruit ripening **(Poovaiah, 1986)** showed that tissue Ca content often influence various senescence characteristics, e.g., protein and chlorophyll content **(Poovaiah and Leopold, 1973)** or rate of respiration **(Bangerth*et al*., 1972)**. Calcium has been applied before and after harvest to prevent physiological disorders and to delay ripening of various fruits **(Poovaiah, 1986)**. Most Ca entering the tissues accumulates in cell walls and membranes that are thought to be sites of its antisenescence action **(Glenn *et al*., 1988)**.

There has been extensive research on the use of Ca to delay ripening of various fruits **(Paliyath*et al*., 1984; Richardson and Al-Alani, 1982; Tingwa and Young, 1974 and Aly*et al*., 2014)**.

So, this work was carried out on 'Desert Red' peach cv. To study the effect of Boric acid and chelated calcium treatments on shoot length, leaf area, leaf chlorophyll, yield and fruit quality.

Materials and Methods:

This investigation was conducted during 2016 season at a commercial orchard located at El-Nubaria, Behera Governorate on 5-year-old 'Desert Red' peach trees (*Prunuspersica*, L.) on 'Nemagurd' peach rootstock. The trees were, uniform as possible, planted at 5 × 4 m apart and growing in sandy soil under drip irrigation system. Trees were of normal growth uniform in vigour and received normal fertilization and cultural practices as scheduled in the farm. The orchard was fertilized as recommended. The experiment was complete randomized block design on 25 trees as 5 treatments were applied and each treatment comprised of five trees. Each tree was considered a replicate; five replicate per each treatment were used. Treatments sprayed with the specified solutions till run off on trees after fruit set and five week after fruit setting.

The following foliar sprays were performed:

1. Control (untreated).
2. 0.05% H_3BO_3 (Boric acid) + 0.1% chelated Ca (chelated calcium).
3. 0.05% H_3BO_3 (Boric acid) + 0.2% chelated Ca (chelated calcium).
4. 0.1% H_3BO_3 (Boric acid) + 0.1% chelated Ca (chelated calcium).

5. 0.1% H_3BO_3 (Boric acid) + 0.2% chelated Ca (chelated calcium).

Four main branches as similar as possible were chosen at the four cardinal points of each treated was counted, the lengths were measured with (cm) on, June, in 2016 season. Leaf area was determined using leaf area meter (Model CL-203, CID. Inc, and USA).

In late May, leaf chlorophyll was recorded as the average of ten reading was taken on the middle of leaves from all over the tress circumference using Minolta SPAD chlorophyll meter model **(Yadava, 1986)**.

Yield:

At harvest time, yield of each treatment was weight/ tree by the multiplying number of fruits × average weight of fruit. Also, yield produced as ton/ feddan was expressed by multiply the weight of fruits/ tree × number of trees/ feddan.

Twenty mature fruits of each treatment were taken to determine the fruit characteristics including the average fruit weight (gm), fruit dimensions (cm) and fruit shape index (L/ D ratio). Fruit firmness was measured at two opposite sides on the equator to each fruit (Skin removed) using pressure tester at 5/16 plunger **(Magness and Taylor, 1952)**. In fruit juice, total soluble solids percentages (TSS%) was determined using a hand refractometer.

Total acidity was estimated as malic acid and vitamin C content was determined using 2,6-dichlorophenol indophenol dye according to the **A.O.A.C. (1980)**. TSS/ acid (ratio) were calculated for each replicate of the applied treatments. Carotene (mg/ 100 g fresh weight) was colorimetrically determined according to the procedure outlined by **Wensttein (1957)**. Anthocyanin was determined (mg/ 100 g fresh peel weight) according to **Rabino*et al*. (1977)**.

Total sugar content was determined according to the procedures outlined by **Malik and Singh (1980)**.

Results of the measured parameter were subjected to computerized statistical analysis using MSTAT package for analysis of variance (ANOVA). Means of treatments were compared using LSD at 0.05 according to **Snedecor and Cochran (1990)**.

Results and Discussion:

Vegetative growth and total chlorophyll:

Data in **Table (1)** concerning the effect of Boric acid and chelated calcium treatments on shoot length and leaf area of 'Desert Red' peach trees, revealed that increasing foliar application of different Boron (H_3BO_3) and chelated calcium (chelated Ca) concentrations increased shoot length and leaf area as compared with control.

Generally, control treatment gave the lowest values of shoot length and leaf area, while spraying 0.1% H_3BO_3 + 0.2% chelated Ca significantly increased shoot length and leaf area values compared to the other treatments in 'Desert Red' peach trees.

The same results were reported by several authors, **Aly*et al.*(2012)**on 'LeConte'pear trees showed that all applied H_3BO_3 concentrations increased leaf area of trees because H_3BO_3 stimulate cell division as well as the acceleration on the formation of organic foods and the movement of IAA. Also, **Aly*et al.* (2014)** found that, the application of Ca, K_2SO_4, $ZnSO_4$ or H_3BO_3 on 'Anna' apple trees increased shoot length and leaf area.

As for leaf chlorophyll in 'Desert Red' peach leaves, data revealed that 0.1% H_3BO_3 + 0.2 chelated Ca treatment gave the highest value of leaf chlorophyll compared by all treatments. It was also found that all treatments caused an increasing in leaf chlorophyll in 'Desert Red' peach leaves in **Table (1)**. These results are in line with **Aly*et al.* (2012)** on pear found that spray boron increased total chlorophyll.

Table (1): Effect of Boron and Calcium treatments on shoot length, leaf area and leaf chlorophyll of 'Desert Red' peach trees.

Treatments	Shoot length (cm)	Leaf area (cm^2)	Leaf Chlorophyll (SPAD reading)
1- Control	33.14 e	24.68 e	40.18 e
2- 0.05% H_3BO_3 + 0.1% chelated Ca	36.08 d	27.18 d	42.36 d
3- 0.05% H_3BO_3 + 0.2% chelated Ca	38.19 c	29.64 c	44.31 c
4- 0.1% H_3BO_3 + 0.1% chelated Ca	40.31 b	32.85 b	46.12 b
5-0.1% H_3BO_3 + 0.2% chelated Ca	43.01 a	35.21 a	48.17 a

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability.

Yield:

Number of fruits/tree:

Data in **Table (2)**revealed that increasing applied of Boron and chelated calcium increased number of fruits per tree and at the same time, 0.1% H_3BO_3 + 0.2% chelated Ca treatment gave a higher number of fruits per tree. As for the effects of foliar applied of H_3BO_3 + chelated Ca data showed that all treatments significantly, increased the number of fruits per tree as compared with control treatment. The same trend for the effect of spraying boric acid was reported by **Aly*et al.* (2012) and Aly*et al.* (2014)**as a result to decreased fruit drop of pear and apple.

Average fruit weight (g):

Concerning the applying H_3BO_3+ chelated Ca on the average fruit weight (g/ fruit) of 'Desert Red' peach trees, revealed that all treatments increased average fruit weight as compared with control treatment, and that increase in fruit weight is big enough to be significant as compared with the control be significant as compared with the control treatment **Table (2)**.

The present results are in line with (**Haggag, 1987** in pear and**Haggag*et al.*,1995** on mango) and with **Löpez*et al.* (2004)** on peach.

Yield (kg/ tree and ton/ feddan):

Results in **Table (2)** revealed that all treatments increased number of fruits/ tree, average fruit weight and yield (kg/ tree and ton/ feddan) as compared with control treatments. The data also showed that 0.1% H_3BO_3 + 0.2 % chelated Ca gave the best results as for average weight (kg/ tree and ton/ feddan). The present results are in harmony with the previous results of **Haggag*et al.* (1995)** who obtained higher fruit yield on mango by using boron and of **Peryea*et al.* (2003)** on 'Scarlet Gala' apple, who found that mixing Ca with B increased the yield and also, agree with **Löpez*et al.* (2004)** on peach and **Aly*et al.* (2014)** on 'Anna' apple.

Table (2): Effect of Boron and Calcium treatments on number of fruit/ tree, average of fruit weight, yield (kg/ tree) and yield (ton/ feddan) of 'Desert Red' peach trees.

Treatments	Number of fruits/ tree	Average fruit weight (g)	Yield (kg/ tree)	Yield (ton/ feddan)
1- Control	532 e	82.31 e	43.79 e	9.20 e
2- 0.05% H_3BO_3 + 0.1% chelated Ca	541 d	86.14 d	46.60 d	9.79 d
3- 0.05% H_3BO_3 + 0.2% chelated Ca	554 c	91.74 c	50.82 c	10.67 c
4- 0.1% H_3BO_3 + 0.1% chelated Ca	563 b	98.81 b	55.63 b	11.68 b
5-0.1% H_3BO_3 + 0.2% chelated Ca	576 a	110.37 a	63.57 a	13.35 a

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability.

Fruit length (L), fruit diameter (D) and fruit shape index (L/D ratio):

The effect of different foliar spraying concentrations of boric acid and chelated calcium combined together on fruit length, fruit diameter, L/D (ratio and fruit firmness are presented in **Table (3)**. All treatments increased significantly fruit length and fruit diameter as compared with control (unsprayed). The highest significant fruit length and fruit diameter were obtained by the spraying of 0.1% H_3BO_3 + 0.2% chelated Ca followed by 0.1% H_3BO_3 + 0.1% chelated Ca as compared with the control in the 2016 season.Meanwhile, data indicated that all treatments no significant differences were found in fruit shape index (L/ D ratio) as compared with the control.

Fruit firmness (Ib/ inch^2):

Regarding the influence of $H_3BO_3$and chelated Ca concentrations together on fruit firmness (Ib/ inch^2) of 'Desert Red' peach trees,**Table (3)**data showed that 0.1% H_3BO_3 + 0.2% chelated Ca treatment significantly increased the firmness of fruits as compared with the control treatment. **Abd El-Megeed and Wally (2007)** on 'LeConte' pear trees found the same results. Also, chelated Ca increased fruit firmness as compared to the control.

Table (3): Effect of Boron and Calcium treatments on some fruit physical characteristics of 'Desert Red' peach trees.

Treatments	Fruit length (cm)	Fruit diameter (cm)	L/ D (ratio)	Fruit firmness (IB/ inch^2)
1- Control	5.61 e	5.74 e	0.98 a	8.31 c
2- 0.05% H_3BO_3 + 0.1% chelated Ca	5.73 d	5.86 d	0.98 a	8.54 bc
3- 0.05% H_3BO_3 + 0.2% chelated Ca	5.89 c	5.97 c	0.99 a	8.72 bc
4- 0.1% H_3BO_3 + 0.1% chelated Ca	5.98 b	6.12 b	0.98 a	8.86 ab
5-0.1% H_3BO_3 + 0.2% chelated Ca	6.18 a	6.30 a	0.98 a	9.21 a

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability.

Total Soluble Solids (TSS%), Total acidity (%) and TSS/ acid ratio:

Data of **Table (4)** revealed that, foliar application of boric acid and chelated Ca tended to increase TSS% in 'Desert Red' peach fruits, significantly as compared with the control treatment. The increment may be due to the fact that B is know to increase transportation of sugar and increase of carbohydrate movement from leaves into fruit tissue **Wojcik and Wojcik (2003)** on conference pear trees, **Abd El-Megeedand Wally (2007)** on 'LeConte' pear trees and **Aly*et al.* (2014)** on 'Anna' apple trees which sprayed with boric acid at 0.1% and 0.2% chelated Ca found that, all treatments increased TSS%.

Furthermore, data showed that all treatments significantly increased acidity % as compared with the control treatment. Similar results were previously registered by **Aly*et al.* (2014)** on 'Anna' apple trees found that, total acidity were significantly increased. All treatments did not gave a clear or significant effect of TSS/ acid ratio. The highest TSS/ acid ratio value (19.18) in season.

Vitamin C (mg/ 100 ml juice):

The data in**Table (4)** showed that, increasing rates of concentration treatments, gradually, led to increase Vit. C content significantly, as compared with control treatment. Many results are in accordance with previous data such as **Drake and Spayed (1983)** on apple, **Gobara (1998)** on pear trees and **Aly*et al.* (2014)** on 'Anna' apple trees.

Table (4): Effect of Boron and Calcium treatments on some fruit chemical characteristics of 'Desert Red' peach trees.

Treatments	TSS (%)	Acidity (%)	TSS/ acid (ratio)	Vitamin C (mg/ 100 ml juice)
1- Control	11.70 d	0.61 d	19.18 a	14.72 e
2- 0.05% H_3BO_3 + 0.1% chelated Ca	11.80 d	0.64 cd	18.44 ab	15.38 d
3- 0.05% H_3BO_3 + 0.2% chelated Ca	12.00 c	0.67 bc	17.91 ab	17.32 c
4- 0.1% H_3BO_3 + 0.1% chelated Ca	12.30 b	0.71 ab	17.32 b	18.83 b
5-0.1% H_3BO_3 + 0.2% chelated Ca	12.50 a	0.73 a	17.12 b	20.17 a

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability.

Total sugar (%):

Sugar contents in 'Desert Red' peach fruits was affected by spraying with boric acid + chelated Ca, data in **Table (5)** revealed that, as for the effects of 0.05% H_3BO_3 + 0.1% chelated Ca did not affected significantly on total sugar % while foliar application of 0.1% H_3BO_3 + 0.1% chelated Ca and 0.1% H_3BO_3 + 0.2% chelated Ca treatments significantly increased the total sugar % in fruits as comparison with control treatment. The same results reported by **Abd El-Megeed and Wally (2007)**on 'LeConte' pear and**Samia*et al.* (2013)** reported that, foliar application of micronutrients on 'LeConte' pear trees decreased total sugar.

Carotene (mg/ 100 g):

The data as for the effects of different treatments concentrations on carotene content in 'Desert Red' peach fruits in**(Table 5)** showed that, increasing rates of H_3BO_3+ chelated Ca as foliar application gradually led to increasing content of carotene significantly in 'Desert Red' peach fruits as compared with control treatment.

Anthocyanin (mg/ 100g):

Data in **Table (5)** illustrated the effects of H_3BO_3+ chelated Ca on anthocyanin in 'Desert Red' peach fruits, showed that all treatments significantly increased anthocyanin (mg/ 100 g) as compared with control.

Meanwhile, applied of 0.1% H_3BO_3 + 0.2 % chelated Ca as foliar application gave a higher value of anthocyanin (mg/ 100 g) content.

Table (5): Effect of Boron and Calcium treatments on some fruit chemical characteristics of 'Desert Red' peach trees.

Treatments	Total sugar (%)	Total Carotene (mg/ 100 g)	Anthocyanine (mg/ 100 g)
1- Control	6.57 c	6.37 d	13.61 c
2- 0.05% H_3BO_3 + 0.1% chelated Ca	6.63 bc	6.46 cd	14.01 b
3- 0.05% H_3BO_3 + 0.2% chelated Ca	6.74 b	6.58 bcd	14.10 b
4- 0.1% H_3BO_3 + 0.1% chelated Ca	6.91 a	6.70 ab	14.41 ab
5-0.1% H_3BO_3 + 0.2% chelated Ca	6.98 a	6.84 a	14.72 a

Means not sharing the same letter(s) within each column for each are significantly different at 0.05 level of probability.

Conclusion:

It can be concluded from above mentioned data that, all spraying treatments increased vegetative growth as compared with control treatment. Most of spraying treatments also increased yield and improved fruit quality. The most effective treatment for increasing growth and yield and improving fruit quality was markedly clearly using 0.1% H_3Bo_3 + 0.2% chelated Ca (twice

application) in the 2016 season of study as compared with the control trees which recorded the lowest growth, fruit yield and fruit quality.

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