

Effect of Spraying Some Mineral Elements on Fruit Quality and Yield of Pomegranate (Wonderful) Cultivar.

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ABSTRACT

The study was carried out during 2014 and 2015 growing seasons on pomegranate (Wonderful cv.) with five years old grown under sandy soil conditions in a private farm located at Egypt – Alexandria desert road (EL-Alamain in El-Behera governorate). The study aimed to investigate the influence of foliar spray with K, Ca, B and Ca combined with B nutrients on fruit yield and quality. Foliar spraying treatments were done two times at completely fruit set of June and August in trees both seasons with the following concentrations: calcium chloride at (1.5%, 3%), Potassium sulphate at (2%, 4%), Boric acid at (0.3 %) and combination between (calcium chloride at 1.5% + Boric acid at 0.3 %). The results of all treatments showed significantly increase fruit peel and grains but decreased percentage of splitting fruits compared with control (water spray). Also, all treatments increased significantly the average fruit yield whereas [calcium chloride (1.5%) + Boric acid (0.3 %)] scored the highest significant values for yield and physical and chemical characteristics of fruits. It could be recommended to use either calcium chloride (1.5%) plus boric acid to reduce fruit splitting and for giving the best yield and high fruit quality for pomegranate Wonderful cv. under the study conditions.

Keywords: pomegranate cv. Wonderful; Cracking; CaCl₂; K; Yield; Fruit quality.

INTRODUCTION

Pomegranate (*Punica granatum* L., Punicaceae), a popular fruit and ornamental of Mediterranean cultures for centuries, it is concerned as important minerals and is one of the most favorable fruits of tropical and subtropical regions. Pomegranate losses due to fruit cracking are quite high. The fruit have this problem to improper water management and deficiency of micronutrients. So it may be used among different elite horticulture practices, growth regulators have been suitable in the recent time to increase the fruit production and to improve the quality of several fruit crops. Ali and Saeed (2009) found that pomegranate trees application spray plants with three potassium (0, 1.5, 3 g/lit potassium metalosate) and three boron (0, 1500, 3000mg/lit boric acid) as sprays doses during fruit development stage led to significantly increased the content of potassium and boron in their leaves ($p \leq 0.01$) and the peel and juice of fruit ($p \leq 0.05$). The fruit fertilized at the highest potassium dose had higher titrable acidity and total soluble solid than other treatments and significantly increased the content of anthocyanin, phenolic compound and antioxidant activity of fruit juice. Lal. and Ahmed (2012) reported that trees sprayed with CaSO₄ (2000, 3000, 4000 ppm),

Borax (25, 50, 75ppm;), GA3 (40, 80, 120 ppm) and control (water spray) at fruit set and at active fruit development resulted in increased their yield and quality except fruit weight and fruit quality parameters such as TSS, TSS/acid ratio, reducing sugar, total sugar and juice content was recorded in plant sprayed with Borax (50 ppm). Ahmed *et al.*, (2014). That boric acid at 0.05% and calcium chloride at 2% either singly or in all possible combinations was very effective in minimizing fruit splitting and improving yield as well as physical and chemical characteristics of the fruits. Sheikh and Manjula (2012) reported that calcium is a cell binding material, and spraying of calcium chloride (1 kg/100 l water) or calcium ammonium nitrate (2 kg/100 l of water) reduces fruit cracking. Dry heat accomplished by

dry hot wind at the time of fruit ripening in pomegranate was the main cause of cracking, during the rapid flesh growth, temperatures higher than 38°C combined with less than 60% humidity favored cracking. Sharp fluctuation in day and night temperatures coupled with heavy irrigation after dry spell also cause cracking. Nutrients like boron, zinc, calcium, copper, molybdenum manganese and potash are involve in physiological processes during fruit growth period, and their deficiencies cause cracking. Boron and copper help to increase the growth rate by stimulating enzymatic action in the peripheral tissue which otherwise could not be due to their inherent deficiency in the area. Boron application may probably help in translocation of sugars and synthesis of cell wall.

This study was aimed to investigate the effect of spraying some mineral elements (K, Ca, B and Ca combined with B) on fruit quality and yield of pomegranate (Wonderful) cultivar.

MATERIALS AND METHODS

The present investigation was carried out on five years old Wonderful pomegranate trees. Trees were planted in a private orchard at El-Alamain in El-Behera governorate. Trees were planted 5×4 m in sandy soil with drip irrigation system of two 8 l emitters each used. Management practices recommended by Ministry of Agriculture were applied. For this experiment 21 trees were selected uniformly as much as possible. The following foliar applications were carried out on three trees i.e. each acting as a replicate. Each treatment was sprayed on 1st of June (after fruit set) and once again on 1st August. The dotted treatments were:

- 1) Control (water spray).
- 2) 1.5% calcium chloride
- 3) 3% calcium chloride
- 4) 2% Potassium sulphate
- 5) 4% potassium sulphate
- 6) 0.3% boric acid
- 7) 0.3% boric acid +3% calcium chloride

To assess the comparative effect of the applied treatments the following attributes have been measured at commercial harvest (1st of October):

- 1) Yield/ tree in terms of both number of fruits/tree and fruit weight/tree.
- 2) Physical fruit characteristics measured on 10 representing fruits from each tree as following: average fruit weight (gm), average fruit volume (cm³), average fruit height (cm), average fruit diameter (cm), percentage of juice, percentage of aril and peel weight to total fruit weight. Percentage of cracked fruits to total No.of fruits /tree was also calculated.
- 3) Chemical characteristics of fruits: Total soluble solids (T.S.S.), Juice acidity percentage and T.S.S./acidity ratio as describable in (A.O.A.C., 1985).

Statistical analysis:

All data were tested for treatments effects on analyzed parameters by the analysis of variance (ANOVA). Difference between treatments were compared by Duncan's Multiple Range Test (Duncan, 1955), according to Snedecor and Cochran (1990)

RESULTS AND DISCUSSION

1. Yield

The average values obtained for yield/tree and no. of fruits/tree under study are shown in Table (1)

• **Yield / tree (Kg)**

Yield expressed as kg/tree was also enhanced positively by all the tested treatments in comparison with control (12.50 & 13.64 Kg/tree for both seasons

respectively). The Combined calcium chloride and boric acid treatment showed the utmost significant effect which amounted to 22.64 & 23.55 Kg/tree for both seasons respectively.

• **Number of fruits/tree**

Number of fruits/tree was significantly increased by all of the test treatments compared with control untreated trees (56.67 & 63.67 fruits/tree for both seasons respectively). Significantly the highest No.of fruits/tree was attributed to application of boric acid at 0.3% resulted in increasing the amount of fruits / tree 86.00 fruits/tree in both seasons, respectively.

These results are in harmony with the finding of Hegazi, *et al.* (2014) that reported that the highest values of yield/tree and fruit number / tree were recorded when Manfaloty and Wonderful pomegranate trees treated with cacl₂ 4% spraying. In addition Hoda and Hoda (2013), Abou EL-Wafa (2006) and Korkmaz, (2015) used calcium chloride, boron spraying to increased the yield/tree. Meanwhile, Mohsen., (2013) found that calcium in 2 levels (2.5 and 5 mM) spray on strawberry affected on vegetative and reproductive growth, significantly. Mean comparisons indicated yield, generally calcium chloride application can be helpful for yield improvement and prevent of decreasing yield. In addition, Walid *et al.*, (2015). Finding that foliage spraying on Ann apple cv. with potassium sulphate (2% K), calcium chloride (0.2% ca), boron (0.2%) umic acid (5%) single or combination led to highest positive effect to improve the percentage of yield.

Table (1): Effect of some nutrients on Yield/tree (kg) and no. of fruits/tree of Wonderful pomegranate Cultivar in 2014 and 2015 seasons.

Parameter Treatments	Yield / tree (kg)	No. of fruits/tree
2014 season		
1. Control (spray water)	12.50 D	56.67 E
2. Calcium chloride at 1.5%	17.00 B	73.33 C
3. Calcium chloride at 3%	17.52 B	70.00 D
4. Potassium sulphate at 2%	16.49 C	73.33 C
5. Potassium sulphate at 4%	17.75 B	71.00 D
6. Boric acid at 0.3 %	21.16 A	83.00 B
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	22.64 A	86.00 A
2015 season		
1. Control (spray water)	13.64 E	63.67 F
2. Calcium chloride at 1.5%	16.03 D	69.33 E
3. Calcium chloride at 3%	17.53 C	77.33 C
4. Potassium sulphate at 2%	15.97 D	76.33 D
5. Potassium sulphate at 4%	17.28 C	73.33 D
6. Boric acid at 0.3 %	21.26 B	86.0 A
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	23.55 A	88.67 B

2. Physical characteristics of fruits

The average values obtained for physical characteristics of fruit analyzed under study are shown in Tables (2 and 3).

• **Fruit length (cm)**

There was a slightly significant effect between all foliar treatments whereas the combination treatment between (Chloride calcium at 1.5% + Boric acid at 0.3 %) gave the longest fruit length (9.47 cm) in both

seasons of the study compared to other treatments while control gave the lowest one (6.80 and 7.33 cm) respectively in 2014 and 2015 seasons. The rest of treatments hadn't any significant differences especially in the second season of the study.

• **Fruit diameter (cm) and volume (cm³)**

The same trend was observed between the fruit diameter (cm) and fruit volume (cm³). whereas, Boric acid 0.3% treatment produced the best values of

diameter and volume significantly in 2014 season while Chloride calcium at 3% gave the best ones in 2015 season.

- **Percentage of grain**

Average grains (%) was at the highest percentage significantly with the combination treatment of Chloride calcium at 1.5% + Boric acid at 0.3 % (75.3 and 74.3%), followed by Potassium sulphate at 2% (71.7 and 70.9 %) respectively in the both seasons of the study while, the control treatment had statistically the lightest grains.

- **Percentage of peel**

The peel (%) was statistically increased by all applied treatments. Statistically the best peels (%) were obtained from those fruits which treated with Boric acid at 0.3 % (41.0 and 38.3%) respectively in both seasons of the study. However, control treatment gave the lowest peel (%).

- **Fruit weight (gm)**

There was a significant increment in fruit weight as affected by the foliar application treatments, the heaviest fruit weight was produced by the combination treatment of calcium chloride at 1.5% + Boric acid at 0.3 % (263.3 and 265.7 gm) followed by Boric acid at 0.3 % (255 and 247 gm) respectively, in both seasons of the study. While, Average fruit weight was significantly at the least in control treatment (220.7 & 214.3 gm) for both seasons respectively).

- **Percentage of cracking fruits**

Slightly significant effect was observed in cracking fruits (%), which was at the best percentage with the control treatment which recorded (25.14 and 22.52%) respectively, in both seasons of the study. While the least percentage of cracked fruits was observed in calcium chloride at lower concentration (3%) which recorded (6.95 and 9.99 %) respectively, in both season.

- **Percentage of fruit juice**

Fruit juice% was significantly the highest percentage when treated with 4% potassium sulphate (33.4& 38.67% for seasons respectively) when compared with control fruits and those treated with remaining treatments. Juice% of fruits treated with 2% potassium sulphate comes next with significant difference.

These results are agreement with those the finding of Hegazi, *et al.*, (2014) when reported that the highest values of fruit weight were recorded when Manfaloty and Wonderful pomegranate trees treated with $CaCl_2$ 4% spraying and the low percentage of fruit cracking compared with the control treatment and the highest fruit length and diameter obtained by $CaCl_2$ 4% treatment. Also, Sheikh and Manjula (2012) reported that, Calcium is a cell binding material, and spraying of calcium chloride or calcium ammonium nitrate reduces

fruit cracking. In addition Hoda and Hoda (2013), Abou EL-Wafa (2006) and Korkmaz and Askin (2015) using calcium chloride and boron spraying on fruit quality. They found that, all treatments improved pomegranate fruit quality in terms of significant reduction of fruit cracking percentage. Meanwhile, the applied treatments significantly increased of fruit length, diameter, volume, weight, grain %, peel %, yield. Aso, Savreet (2014) Reported that, foliar sprays of K_2SO_4 (8%) and Borax (1%), singly and in combinations decrease in fruit cracking and proved to be most effective for minimizing. On the same trend. Habib, *et al.*, (2015), Ahmed, *et al.*, (2014) and Asghar *et al.*, (2009) emphasized previous results when applied boric acid at 0.05% and calcium chloride at 2% either singly or in all possible combinations with different concentration. It may be nutrients like boron and calcium are involved in physiological processes during fruit growth period, and deficiencies cause cracking on pomegranate fruits . With regards to (3% Ca as calcium chloride ,boron as boric acid and after two and eight weeks from full bloom on fruit cracking% and quality in pomegranate. Meanwhile, Mohsen,(2013)found that, calcium in 2 levels (2.5 and 5 mM) spray on strawberry affected on reproductive growth, significantly. Mean comparisons indicated yield, and quality of strawberry plants.

On the other hand, Ganeshamurthy *et al.*, (2010). He thought that several research results suggest the role of K in enhancing the quality of fruits and their keeping and marketable quality. Applied K influences fruit size, appearance, and color and consumer acceptance.

Prakash and Balakrishnan (2014) reported that, spray of chemical substances on fruit characters of pomegranate cv. Bahgw when trees sprayed with $CaCl_2$, improved the fruit weight compared with control trees. Babul and Rahim (2013). Concerning the beneficial potassium they found that applied foliar spray of potassium as a potassium nitrate on harvesting time and increasing quality of nine years old mango (*Mangifera indica* L.) cv. Thirupathi and Ghosh (2015) indicated that foliar application of KNO_3 and K_2SO_4 significantly improved the physical attributes of pomegranate fruits compare to control. The pomegranate cultivars varied significantly for yield and quality traits. Moreover, Sarrwy *et al.*, (2012) reported that Palms were sprayed with boric acid at 250 and 500 ppm and calcium nitrate at 1 and 2% as individual application or in a combination of Amhat date palm had a significant effect on fruit physical characteristics. Also, Walid *et al.*, (2015). Finding that foliage spraying on Ann apple cv. with potassium sulphate (2% K), calcium chloride (0.2% ca), boron (0.2%) humic acid (5%) in combination treatment led to highest positive effect to improve fruit diameter, fruit length, average fruit weight.

Table (2): Effect of some nutrients on some physical characteristics of Wonderful pomegranate fruits in 2014 and 2015 seasons.

Parameter Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cm)	Grain %	Peel %
2014 season					
1. Control (spray water)	6.80 D	6.97 E	191.0 F	61.16 F	38.84 E
2. Calcium chloride at 1.5%	8.60 BC	8.50 C	207.3 E	66.3 D	33.7 B
3. Calcium chloride.at 3%	8.77 B	8.83 B	266.3 C	66.7 C	33.3 C
4. Potassium sulphate at 2%	8.47 C	8.33 CD	204.7 E	71.7 B	28.3 D
5. Potassium sulphate at 4%	8.57 BC	8.50 C	225.7 D	64.0 E	26.00 D
6. Boric acid at 0.3 %	8.73 B	9.47 A	353.7 A	59.0 G	41.0 A
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	9.47 A	8.53 C	333.7 B	75.3 A	24.7 D
2015 season					
1. Control (spray water)	7.33C	6.96C	278.0 F	55.6 F	44.4 F
2. Calcium chloride at 1.5%	8.77B	8.33B	404.3 D	65.3 C	34.7 B
3. Calcium chloride at 3%	8.77B	9.47A	431.3 A	65.7 C	34.3 C
4. Potassium sulphate at 2%	8.20B	7.93B	404.3 E	70.9 B	29.1 C
5. Potassium sulphate at 4%	8.47B	8.17B	412.7 D	64.7 D	35.3 D
6. Boric acid at 0.3 %	8.83B	8.17B	426.3 B	61.7 E	38.3 A
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	9.47A	8.37B	417.7 C	74.3 A	25.7 E

Table (3): Effect of some nutrients on fruit weight (kg), fruit cracking (%) and fruit juice (%) of Wonderful pomegranate cultivar in 2014 and 2015 seasons.

Parameter Treatments	Fruit Weight (g)	Percentage of cracked fruits	Fruit juice%
2014 season			
1. Control (spray water)	220.7 F	25.14 A	27.67 D
2. Calcium chloride at 1.5%	233.7 D	14.98 B	25.70 E
3. Calcium chloride at 3%	250.3 C	6.95 E	28.33 C
4. Potassium sulphate at 2%	225.0 E	10.34 D	32.67 B
5. Potassium sulphate at 4%	250.0 C	9.69 D	33.4 A
6. Boric acid at 0.3 %	255.0 B	12.45 C	27.67 D
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	263.3 A	12.67 C	28.00 C
2015 season			
1. Control (spray water)	214.3 E	22.52 A	24.33 F
2. Calcium chloride at 1.5%	231.7 D	9.99 C	28.33 D
3. Calcium chloride at 3%	227.7 CD	13.25 B	26.33 E
4. Potassium sulphate at 2%	209.3 F	9.58 C	37.67 B
5. Potassium sulphate at 4%	235.7 C	14.16 B	38.67 A
6. Boric acid at 0.3 %	247.3 B	10.22 C	24.67 F
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	265.7 A	9.51 C	30.33 C

2. Chemical characteristics of fruits

The average values obtained for chemical characteristics of fruit analyzed under study are shown in Table (4)

• Percentage of total soluble solids (T.S.S. %)

With regards to TSS% the combined treatment induced statistically the highest percentage amounting to (15.93%), in the second seasons. However, they gave the highest percentage of T.S.S. when applied individually as Boric acid at 0.3 % and calcium chloride at 3% (15.57 and 15.03%) respectively, in the first season of the study.

• Percentage of juice acidity

Statistically, the highest juice acidity was that of fruits treated with the control treatment (1.7 and 1.8%) in 2014 and 2015 seasons. While slightly significant differences was obtained with the rest of foliar applications treatment which had variable effects during the studied seasons.

• T.S.S./acidity ratio

Boric acid at 0.3 % followed by calcium chloride at 3% produced the highest significant ratio of T.S.S./acidity (14.68 and 14.59) respectively, in the first season. While, they swapped their ranking (15.27 and 14.22) respectively, in the second season of the study.

The previous results with harmony with Ali and Saeed (2009): who sprayed three potassium (0, 1.5, 3 g/lit potassium metalosate) and three boron (0, 1500, 3000mg/lit boric acid) significantly increased total soluble solids. Also, Thirupathi and Ghosh (2015). K₂SO₄ significantly improved the chemical attributes of pomegranate fruits compare to control. Also, Hoda and Hoda (2013), Abou EL-Wafa (2006), Korkmaz and Askin (2015) reported that, Ca, boron single or combination between them increased TSS % and acidity %. But Lal and Ahmed (2012) found that, fruit quality parameters such as TSS, TSS/acid ratio, were improved in plant sprayed with Borax (50 ppm) in all the varieties. However fruit quality in terms of TSS and

TSS/acid ratio were better with Borax (50 ppm) in selected varieties under karewa environment of Kashmir valley. Also Darwesh *et al.*, (2015) mentioned that, the contents of TSS % was increased under spraying treatments 0.4 borax + 0.4 % potassium sulphate of date palm cv. Sewi. Also Aly *et al.*, (2015) reported that calcium chloride or potassium sulphate spraying on Navel orange trees improved fruit quality rather than control. On the other hand the juice acidity percentage

led to significant decrease. But the best results on fruit quality were significantly with 2 and 3% potassium sulphate treatments. Walid *et al.*, (2015) found that, foliage spraying on Ann apple cv. with potassium sulphate (2% K), calcium chloride (0.2% ca), boron (0.2%) humic acid (5%), the combination was the best treatment highest improved significantly TSS /acid ratio.

Table (4): Effect of some nutrients on some chemical characteristics of Wonderful pomegranate fruits in 2014 and 2015 seasons.

Parameter Treatments	TSS %	Total acidity %	TSS/ acid ratio
2014 season			
1. Control (spray water)	13.35 D	1.7 A	7.85 E
2. Calcium chloride at 1.5%	14.43 B	1.34 B	10.67 F
3. Calcium chloride at 3%	15.03 A	1.03 D	14.59 B
4. Potassium sulphate at 2%	13.37 C	0.99 D	13.86 C
5. Potassium sulphate at 4%	14.20 B	1.20 C	11.83 E
6. Boric acid at 0.3 %	15.57 A	1.06 D	14.68 A
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	14.13 B	1.16 C	12.18 D
2015 season			
1. Control (spray water)	13.57 E	1.80 A	7.53 D
2. Calcium chloride at 1.5%	13.97 D	1.40 B	9.97 E
3. Calcium chloride at 3%	15.27 B	1.00 C	15.27 A
4. Potassium sulphate at 2%	14.37 C	1.20 C	11.97 C
5. Potassium sulphate at 4%	14.07 D	1.23 C	11.43 D
6. Boric acid at 0.3 %	14.37 C	1.01 C	14.22 B
7. Calcium chloride at 1.5% + Boric acid at 0.3 %	15.93 A	1.13 D	14.09 B

CONCLUSION

Regarding to the previous results, it could be concluded that, the treatments of Boric acid 0.3% and the combination treatment (calcium chloride at 1.5% + Boric acid at 0.3 %) gave the best results in most of quantity and quality parameters of pomegranate fruits Wonderful cv. under the same conditions of the study.

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تأثير الرش ببعض العناصر المعدنية علي صفات الجودة والمحصول لثمار الرمان صنف (وندر فول)

كمال جرجس جورجيوس

قسم بحوث الزيتون وفاكهة المناطق شبه الجافة – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر

أجريت هذه الدراسة خلال ٢٠١٤, ٢٠١٥ في مزرعة خاصة على طريق مصر اسكندرية الصحراوى (العلمين - محافظة البحيرة) على أشجار رمان عمر ٥ سنوات . وكانت مزرعة علي أبعاد ٥ × ٥ متر في تربة رملية تحت نظام الري بالتنقيط . لدراسة تأثير الرش ببعض العناصر المعدنية (البوتاسيوم - الكالسيوم - البورون منفردا او مركب من الكالسيوم والبورون) على المحصول وجودة الثمار . وكانت المعاملات هي : حمض البوريك بتركيز ٣% (بورون) منفردا أو مع كلوريد الكالسيوم بتركيز ١,٥% و أيضا كلوريد الكالسيوم بتركيز ١,٥% و تركيز ٣% منفردا كلا على حدة - و كبريتات البوتاسيوم بتركيزين ٢, ٤% . وتم الرش لجميع المعاملات في ميعادين مختلفين (اول يونيو و أول أغسطس). وقد أظهرت النتائج أن رش جميع المعاملات أدى الي نتائج ايجابية بالنسبة لكمية المحصول للشجرة وتحسين صفات الجودة للثمار مقارنة بمعاملة الكنترول. وكانت أفضل النتائج المتحصل عليها هي المعاملة : حمض البوريك بتركيز ٣,٥% (بورون مع كلوريد الكالسيوم بتركيز ١,٥%).