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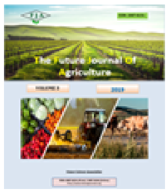

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IMPROVING FRUIT QUALITY OF WONDERFUL POMEGRANATE BY USING FOLIAR APPLICATION OF POTASSIUM, IRON AND BORON

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ABSTRACT: This study was carried out during 2017 and 2018 seasons, in order to investigate the effect of single and combined application of potassium sulphate (K_2SO_4), ferrous sulphate ($FeSO_4$) and boric acid (H_3BO_3) on fruit physical, chemical properties and maturation of Wonderful pomegranate trees grown in sandy soil under Minia Governorate conditions. Results showed that increasing the concentration of K_2SO_4 from 0.5 to 1.5%, $FeSO_4$ from 100 to 200 ppm or/and H_3BO_3 was very effective in fruit weight (g). While, the three examined compounds significantly decreased fruit cracked (%) and fruit sunburned (%) during the two experimental season. Application of the three examined compounds together significantly surpassed than untreated control or each compound alone terms of improved fruit physical and chemical properties, while, juice total acidity was significantly decreased. For producing favorable fruit physical properties of Wonderful pomegranate grown under sandy soil, it is necessary to spray the trees with mixture of potassium sulphate at 1.5%, ferrous sulphate at 200 ppm and boric acid at 100 ppm three times yearly during the fruit growth cycle.

Key words: Wonderful pomegranate, quality, potassium, iron, boron, fruit cracked and sunburned.

INTRODUCTION

Pomegranate is a highly valuated fruit crop for its health-promoting effects and it is mainly cultivated in semi-arid areas **(Catola *et al*., 2016)**. Wonderful is a newly introduced pomegranate cultivar grown under Egyptian condition, still needs additional studies about fruit ripening and quality. This cultivar has great advantages and good opportunity to succeed under Egyptian conditions due to its tolerance to drought, salinity and various pests, besides the disappearance of fruit cracking. On the other hand, some recent trials carried out under Minia Governorate conditions noted that the some important parameters of wonderful fruits, such as fruit and grains colour remarkably decreased as a compared to the local cultivar "Manfalouty" (**Omar, 2015 and Abo-Ali, 2019**).The total acreage of pomegranate in Egypt reached 34450 fad. out of them 11752 fad., is fruitful producing about 106260 tons with an average of 9.42 tons/ fad. **(Statistics of the Ministry of Agriculture, 2015)**.

Improving the most important quality parameter of fruit is the foundation for success in producing pomegranate fruits. A wide range of environmental and genetic factors affects pomegranate fruits quality, where nutrition plays an important role. Potassium (K), ferrus (Fe) and boron (B) are the key nutritional factors controlling fruit development and maturation **(Marschner, 1995).**

Potassium is an essential plant element that has important influence on many vital functions like carbon assimilation, translocation of proteins and sugars, enhancing fruit quality by maintaining desirable TSS/ acid ratio and ripening of fruit. Thus, it is the most important mineral regulating the quality of fruit by helping to move starches and sugars between plant parts (**Lavon and Goldschmidt, 1996, Kumar *et al*., 2006 and Ganeshamurthy *et al*., 2011).** In addition to the role of potassium in plant tolerance of biotic and abiotic stress **Mengl (1985); Marschner (1997); Havlin *et al*., (2005); Khalil and Aly (2013); Kow and Nabwami (2015)** and **Abo-Ali (2019)**.

Iron plays a fundamental role in several physiological processes. Iron is the third most limiting nutrient for plant growth and metabolism, primarily due to the low solubility of the oxidized ferric form in aerobic environments **(Zuo and Zhang, 2011; Samaranayke *et al*., 2012).** Particularly in fruit crops, Fe deficiency causes serious decreases in tree growth, fruit yield, and quality **(Tagliavini *et al*., 2000).** Iron uptake by plants is fastest when iron is present in the ferrous form **(Chaney *et al*., 1972).**

Foliar B application to B deficient trees increases Ca mobility as well as Ca concentration of the fruit **(Shear and Faust, 1971).** Boron is an essential trace element required for optimal growth and development of higher plants and B shortage is believed to be the most widespread of micronutrient deficiencies in plants **(Sparr, 1970)**. Production of fruit crops is adversely affected much more than vegetative growth with a low supply of available B in soil. Boron amelioration of fruit quality could be directly or indirectly related to an interaction of B and cation nutrition **(Davis *et al*., 2003)**.

The current investigation aimed to examine the Wonderful pomegranate fruit quality responses of foliar sprayusing potassium, iron and boron in sandy soil under Minia Governorate conditions.

MATERIALS AND METHODS

The present investigation was conducted during two seasons 2017 and 2018 on one hundred-eight uniform in vigor Wonderful pomegranate trees grown in private orchard located at the Cairo-Assiut Eastern Desert Road, facing Minia Distract, El-Minia Governorate (250 km southern Cairo city), Egypt where the soil texture is sandy and water table depth is not less than two meters. The chosen pomegranate trees are ten-years old and planted at 4 x 4 meters apart and irrigated by drip system using underground well. The formation of the chosen trees is multi trunk (3 trunk/tree) an open vase system with 4 to 6 principal branches and at least two principal layers of production. Winter pruning was followed at the first week of January.

The chosen trees are subjected to regular horticulture practices that were commonly applied in the orchard including fertilization, (namely: 80 g/tree nitrogen applied in the form of ammonium nitrate "33% N", 245 kg/feddan, calcium superphosphate "15.5% P_2O_5" 200 kg/feddan and 150 kg/feddan potassium sulphate, as well as irrigation, hoeing and pest management.

A composite sample of experiment soil collected and subjected to Physical and chemical analysis according to the procedures outlined by **Walsh and Beaton (1986)**. The data of soil sample analyses are shown in Table (1).

Table 1. Physical and chemical analysis of experiment soil

Constituents	Values
Sand %	79.4
Silt %	12.50
Clay %	8.10
Texture	Sandy
EC(1:2.5 extract) mmhos/cm	5.20
Organic matter %	0.45
pH (1 : 2.5 extract)	8.29
$CaCO_3$ (%)	9.00
N (mg/kg)	185.00
Phosphorus (ppm)	8.80
Available Ca (meq/100g)	19.90
Available Mg (meq/100g)	2.33
Available K (meq/100g)	0.56
C/N Ratio	17.20

In order to study the effect and the suitable concentration of spraying K_2SO_4 (potassium sulphate), $FeSO_4$ (Ferrous sulphate) and H_3BO_3 (Boric acid) compounds were tested on Wonderful pomegranate. K_2SO_4 was sprayed at four concentrations namely 0.0, 0.5, 1.0 and 1.5% single or companied with $FeSO_4$ at 100 & 200 ppm or/and H_3BO_3at 50 & 100 ppm were tested on Wonderful pomegranate cultivar of the present experiment. The trees were sprayed with K_2SO_4 on the first of April, May and June, while $FeSO_4$ and H_3BO_3 on mid of April, May and June each season.

This experiment included thirty six treatments from two factors and its interactions. The first factor (A) comprised from four K_2SO_4 concentrations. The second factor (B) comprised from nine concentrations of $FeSO_4$ and H_3BO_3. Each treatment was replicated three times, one tree per each. Then the present study included one hundred eight trees. Treatments were arranged in a complete randomized block in a split plot design (the factor A ranked in main plot and the factor B ranked in split plot). Triton B (at 0.05 g/liter) as a wetting agent was added to all spraying solutions, even control trees.

The responses of the tested trees to foliar spray treatments were evaluated through the following parameters:

Fruit physical properties: The fruits were harvested when fruits become fully colored and the TSS/acid ratio in the juice of the check treatment reached 3 to 3.5 in the two experimental seasons. The percentage of cracking fruits and sunburned fruits per tree were recorded as follow:

$$\text{Cracking fruits \%} = \frac{\text{No. of cracked fruits/tree}}{\text{Total no. of fruits/tree}} \times 100$$

$$\text{Sunburned fruits \%} = \frac{\text{No. of sunburned fruits/tree}}{\text{Total no. of fruits/tree}} \times 100$$

From each tree, five fruits/ tree were randomly picked at maturation date (Last week of September) to estimate the physio-chemical characteristics of fruits as follows:

- Fruit weight (g).
- Fruit dimension [length (L) and diameter (D)(cm)] by using Vernier caliper.
- Peel thickness (cm).
- Grains weight and Juice weight percentages (%), mathematically calculated according the following equations:

$$\text{Grains weight \%} = \frac{\text{Fruit grains weight (g)}}{\text{Fruit weight (g)}} \times 100$$

$$\text{Juice weight \%} = \frac{\text{Fruit juice weight (g)}}{\text{Fruit grains weight (g)}} \times 100$$

Chemical characteristics of juice: After extracting the arils by hand, 200 g of each replicate were randomly chosen from homogenized sample, pressed by Electric Extractor for extracting the juice, the following chemical characteristics were determined:

- Total soluble solids (TSS %) was determined in juice using a hand refractometer.
- Total titratable acidity (TA %), expressed as grams citric acid per 100 g of juice, by titration against 0.1 N NaOH solution, using 1 ml diluted juice in 10 ml distilled H2O in the presence of phenolphythalein index as indicator and the total acidity percentage was calculated **(A.O.A.C., 2006).**
- Reducing and non-sugars percentages in the juice, determined by using Lane and Eynone volumetric method, according to **Ranganna (1977).**
- Total anthocyanin content in peel and fruit juice was estimatedaccording to the methods described by **Geza *et al* (1983).**

Statistical analysis: All the obtained data were tabulated and subjected to analysis of variance (ANOVA) according to **Snedecor and Cochran (1980)** by using the statistical package MSTAT program. Comparisons between means were made by the F-test and least significant differences (New L.S.D) at P value ≤ 5% level.

RESULTS AND DISCUSSION

Fruit physical properties

Fruit weight (g)

It is noticed from the obtained data in Table (2) that, treating Wonderful pomegranate trees with K_2SO_4 (at 0.05% to 1.5%), $FeSO_4$ (at 100 and 200 ppm), and H_3BO_3 (at 50 and 100 ppm) had significantly improved the fruit weight in the two seasons compared with untreated trees. The trees were sprayed with high concentration of K_2SO_4 (1.5%) recorded highest fruit weight (g) compared to untreated trees with any compound which gave the least values in the two seasons.

The interactions between K_2SO_4, $FeSO_4$, and H_3BO_3 treatments were significant on fruit weight (g) in the two seasons. The highest fruit weight (449 and 431 g) was produced from spraying trees with K_2SO_4 at higher level (1.5%) in combination with $FeSO_4$ at 200 ppm plus H_3BO3 at 100 ppm. While, the least values were recorded from trees sprayed with K_2SO_4 at 0.0% x H_3BO_3 and $FeSO_4$ at 0.0 ppm (329 g) in the first season and those sprayed with K_2SO_4 at 0.0% x H_3BO_3 at 50 ppm and 0.0 ppm $FeSO_4$ (335 g) in the second one.

The obtained results concerning the effect of K, Fe and B on fruit weight are in accordance with those obtained by **Mengle, 2007; Omar (2015); Ibrahim and Al-Wasfy (2014); Mohamed (2014) and Abo-Ali (2019)**.

Fruit dimensions

The data in Table (2) showed that fruit length and diameter significantly improved with using K_2SO_4, $FeSO_4$ and H_3BO_3 either applied singly or used in different combinations compared with untreated control. Remarkable and gradual Increasing in fruit length and diameter were parallel to increasing potassium sulphate concentration from 0.0 to 1.5%. Combined application of the three examined compounds was preferable than using each compound alone in enhancing fruit length and diameter (cm). However, the highest values of fruit length (8.12 & 7.99 cm) and fruit diameter (7.27 &7.33 cm) were produced in the trees treated with K_2SO_4 at 1.5%, $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm .

The beneficial effect of potassium, iron and boron on the biosynthesis and translocation of carbohydrates as well as N metabolism and activation some important enzymes could be explained improving fruit length and diameter (**Marschner, 1997; Mengel, 2007 and Abd El-Gabber, 2009**).

Table 2. Effect of spraying potassium sulphate, ferrous sulphate, and boric acid on fruit weight (g), fruit length (cm) and fruit diameter (cm) of Wonderful pomegranate fruits during 2017 and 2018 seasons

Treatments	Fruit weight (g)					Fruit length (cm)					Fruit diameter (cm)				
	First Season (2017)					First Season (2017)					First Season (2017)				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	329.00	339.00	365.00	374.00	**351.80**	6.89	6.94	7.11	7.20	**7.04**	6.39	6.48	6.47	6.49	**6.46**
Fe 100 ppm + B 0.0 ppm	359.00	365.00	371.00	389.00	**371.00**	6.90	7.08	7.14	7.29	**7.10**	6.45	6.56	6.71	6.79	**6.63**
Fe 200 ppm + B 0.0 ppm	369.00	388.00	403.00	412.00	**393.00**	7.17	7.17	7.28	7.32	**7.24**	6.48	6.66	6.83	6.91	**6.72**
B 50 ppm + Fe 0.0 ppm	345.00	361.00	387.00	389.00	**370.50**	6.90	6.99	7.19	7.23	**7.08**	6.33	6.50	6.69	6.71	**6.65**
B 100 ppm + Fe 0.0 ppm	349.00	379.00	399.00	403.00	**382.50**	7.03	7.19	7.23	7.28	**7.18**	6.45	6.59	6.78	6.83	**6.66**
Fe 100 + B 50 ppm	369.00	387.00	392.00	415.00	**390.80**	7.25	7.41	7.69	7.77	**7.53**	6.69	6.72	6.81	6.71	**6.73**
Fe 100 ppm + B 100 ppm	377.00	411.00	409.00	414.00	**402.80**	7.42	7.76	7.77	7.89	**7.71**	6.71	6.74	6.88	6.92	**6.81**
Fe 200 ppm + B 50 ppm	389.00	420.00	431.00	439.00	**419.80**	7.58	7.80	7.84	7.99	**7.80**	6. 92	7.03	7.19	7.19	**7.08**
Fe 200 ppm + B 100 ppm	406.00	423.00	443.00	449.00	**430.30**	7.69	7.77	7.93	8.12	**7.88**	6. 82	7.09	7.25	7.27	**7.13**
Mean A	**365.30**	**384.90**	**400.00**	**409.30**		**7.20**	**7.35**	**7.46**	**7.57**		**6.59**	**6.71**	**6.84**	**6.87**	
New LSD 5%	**A= 13.20 ; B= 15.30 ; AB= 22.30**					**A= 0.03 ; B= 0.05 ; AB= 0.07**					**A= 0.04 ; B= 0.05 ; AB= 0.06**				
Treatments	**Second Season (2018)**					**Second Season (2018)**					**Second Season (2018)**				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	339.00	349.00	355.00	364.00	**351.80**	6.79	6.81	6.88	6.91	**6.85**	6.36	6.49	6.51	6.62	**6.50**
Fe 100 ppm + B 0.0 ppm	348.00	355.00	371.00	389.00	**365.80**	6.89	6.98	7.15	7.21	**7.06**	6.49	6.66	6.72	6.82	**6.67**
Fe 200 ppm + B 0.0 ppm	359.00	378.00	403.00	412.00	**388.00**	6.99	7.08	7.29	7.33	**7.17**	6.52	6.69	6.91	6.97	**6.77**
B 50 ppm + Fe 0.0 ppm	335.00	355.00	387.00	389.00	**366.50**	6.82	6.93	7.19	7.22	**7.04**	6.43	6.57	6.72	6.72	**6.61**
B 100 ppm + Fe 0.0 ppm	340.00	369.00	389.00	398.00	**374.00**	6.93	7.19	7.21	7.37	**7.18**	6.49	6.69	6.77	6.89	**6.71**
Fe 100 + B 50 ppm	352.00	377.00	390.00	406.00	**380.80**	7.09	7.26	7.49	7.51	**7.34**	6.71	6.79	6.92	6.77	**6.80**
Fe 100 ppm + B 100 ppm	362.00	399.00	411.00	418.00	**397.50**	7.19	7.39	7.51	7.61	**7.43**	6.78	6.82	6.99	7.12	**6.93**
Fe 200 ppm + B 50 ppm	377.00	401.00	421.00	429.00	**407.00**	7.45	7.65	7.88	7.91	**7.72**	6.86	7.11	7.18	7.22	**7.09**
Fe 200 ppm + B 100 ppm	381.00	412.00	429.00	431.00	**413.30**	7.58	7.77	7.85	7.99	**7.80**	6. 99	7.16	7.29	7.33	**7.19**
Mean A	**354.80**	**377.20**	**395.10**	**404.00**		**7.08**	**7.23**	**7.38**	**7.45**		**6.63**	**7.78**	**6.89**	**6.94**	
New LSD 5%	**A= 14.40 ; B= 13.90 ; AB= 20.30**					**A= 0.05 ; B= 0.06 ; AB= 0.08**					**A= 0.02 ; B= 0.05 ; AB= 0.07**				

Fruit peel thickness (mm)

The obtained data in Tables (3) showed that single or combined application of K_2SO_4, $FeSO_4$ and H_3BO_3caused a significant decrement of peel thickness (mm) relative to the control treatment in the two seasons. Increasing potassium sulphate concentration from 1.0% to 1.5% had a negligible effect on fruit peel thickness. The least peel thickness was from K_2SO_4 at 1.5% (0.36 & 0.30 cm) in the first and second seasons, respectively.

However, combined application of $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm were preferable than using each compound alone in reducing peel thickness. Furthermore, these decrements were clearer for boric acid separation than those of ferrous sulphate. Using both compounds together significantly surpassed the application of each compound alone in this concentration. However, the lowest peel thickness values were recorded on the trees that received both materials together at highest concentrations (0.35 and 0.34 cm) in the both seasons, respectively. In the contrary, untreated trees, the maximum produced values.

The interaction between potassium sulphate, ferrous sulphate and boric acid had significant effect on peel thickness of Wonderful pomegranate fruits. Treating the trees with potassium sulphate at 1.5 %, ferrous sulphate at 200 ppm and boric acid at 100 ppm give the minimum values of fruit peel thickness (0.31 and 0.30 cm) compared with untreated trees which recorded the highest values (0.59 & 0.58 cm) during the two seasons respectively.

Grains weight (%)

Data in Table (3) showed that concerning the three examined compounds were capable of causing significant promotion in average grains weight % of fruit over the control treatment in the two seasons.

Gradual promotion on average grains weight was associated with increasing potassium sulphate from 0.0 to 1.5%. However, the higher concentration of potassium sulphate remarkably and significantly enhanced grains weight percentage than the lower concentrations. The data takes the similar trend during the two seasons. Except those between the two highest concentration of potassium sulphate (namely 1.0% and 1.5%) during the second season, however non-significant differences were observed.

Subjecting Wonderful pomegranate trees three times of different concentration of $FeSO_4$ or/and H_3BO_3 significantly were responsible for enhancing the percentage grains weight/fruit rather than the chick treatment. There was a gradual promotion on grains weight % with increasing concentrations of $FeSO_4$ from 100 to 200 ppm or/and H_3BO_3 from 50 to 100 ppm. However, regardless the concentration used the combined application of $FeSO_4$ and H_3BO_3 exhibited more effective on grains weight % than sprayed each one alone.

Regarding the interactions between the three examined compounds, increasing potassium sulphate concentration companied with ferrous sulphate or/and boric acid enhanced grains weight% significantly during the two seasons. Furthermore, the highest grains weight% (68.8% and 61.1%) were obtained from the fruit of the trees received potassium sulphate at 1.5% accompanied with $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm in the two seasons respectively. While, unfavorable effects on grains weight% (53.4% and 50.2%), during the two experimental seasons respectively, were produced by untreated trees.

Juice weight percentage (%)

The obtained data in Table (3) shows that, the three examined compounds were capable of causing significant promotion in fruit juice weight % over the control treatment, during the two experimental seasons. Gradual promotion on average juice weight % was associated with increasing K_2SO_4 from 0.0 to 1.5%. However, the higher concentration remarkably and significantly enhanced juice weight percentage than the lower one. Except those between the two highest concentration of potassium sulphate (namely 1.0% and 1.5%) during the two seasons, however non-significant enhancement were observed between them. Subjecting trees to H_3BO_3 at 50 or 100 ppm significantly was responsible for enhancing the percentage juice weight %, rather than the untreated control. While, increasing $FeSO_4$ concentration from 100 ppm to 200 ppm failed to vary the juice weight % significantly during the two experimental seasons. Further, regardless the concentration used the combined application of $FeSO_4$ and H_3BO_3 exhibited more effective on juice weight % than sprayed each one alone.

Regarding the interactions between the three examined compounds, increasing K_2SO_4 concentration companied with $FeSO_4$ and H_3BO_3 enhanced juice weight % significantly during the two seasons. However, the highest juice weight% (50.9 and 47.1 %) were obtained from the trees received potassium sulphate at 1.5% accompanied with $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm in the two experimental seasons respectively. While, unfavorable effects on juice weight % (36.0 and 36.2 %), during the two experimental seasons respectively, were produced by untreated trees.

Table 3. Effect of spraying potassium sulphate, ferrous sulphate, and boric acid on fruit peel thickness (cm), grains weight % and Juice weight % of Wonderful pomegranate fruits during 2017 and 2018 seasons

Treatments	Fruit peel thickness (cm)					Grains weight %					Juice weight %				
	First Season (2017)					First Season (2017)					First Season (2017)				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	0.59	0.49	0.41	0.39	**0.47**	53.4	56.4	58.9	60.5	**57.30**	36.00	37.00	38.90	39.10	**37.75**
Fe 100 ppm + B 0.0 ppm	0.49	0.45	0.42	0.41	**0.44**	53.8	58.9	59.8	62.8	**58.89**	37.90	40.90	42.00	43.30	**41.03**
Fe 200 ppm + B 0.0 ppm	0.46	0.42	0.40	0.38	**0.42**	55.3	59.8	61.4	63.4	**59.98**	39.30	40.90	42.00	43.30	**41.38**
B 50 ppm + Fe 0.0 ppm	0.47	0.42	0.42	0.37	**0.42**	52.9	59.7	61.9	61.6	**59.03**	40.40	42.80	43.90	45.30	**43.10**
B 100 ppm + Fe 0.0 ppm	0.45	0.44	0.40	0.37	**0.42**	54.4	60.7	64.1	64.6	**60.95**	41.80	45.40	44.50	45.90	**44.40**
Fe 100 + B 50 ppm	0.44	0.39	0.37	0.35	**0.39**	56.9	61.3	62.9	65.6	**61.68**	43.20	45.70	47.10	47.80	**45.95**
Fe 100 ppm + B 100 ppm	0.42	0.37	0.35	0.33	**0.37**	58.7	62.8	63.8	66.9	**63.05**	44.10	46.10	47.90	48.20	**46.58**
Fe 200 ppm + B 50 ppm	0.40	0.36	0.34	0.33	**0.36**	59.4	64.5	66.9	66.9	**64.43**	45.40	47.30	49.20	49.70	**47.90**
Fe 200 ppm + B 100 ppm	0.40	0.36	0.32	0.31	**0.35**	59.9	66.6	67.8	68.8	**65.78**	45.90	47.50	50.10	50.90	**48.60**
Mean A	**0.46**	**0.41**	**0.38**	**0.36**		**56.08**	**61.19**	**63.06**	**71.74**		**41.56**	**43.63**	**44.96**	**45.94**	
New LSD 5%	**A=0.03 ; B= 0.02 ; AB=0.09**					**A = 3.17 ; B = 4.42 ; AB= 6.45**					**A= 1.02 ; B=0.93 ; AB=1.49**				
Treatments	**Second Season (2018)**					**Second Season (2018)**					**Second Season (2018)**				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	0.58	0.51	0.43	0.36	**0.47**	50.2	54.4	57.9	59.5	**55.50**	36.20	36.80	37.40	38.20	**37.15**
Fe 100 ppm + B 0.0 ppm	0.50	0.49	0.44	0.39	**0.46**	52.8	56.9	58.5	61.8	**57.50**	36.40	37.70	37.90	38.10	**37.73**
Fe 200 ppm + B 0.0 ppm	0.47	0.43	0.40	0.35	**0.41**	54.3	58.8	60.4	62.1	**58.90**	36.00	38.20	38.50	38.90	**37.9**
B 50 ppm + Fe 0.0 ppm	0.47	0.41	0.40	0.34	**0.41**	52.2	61.0	62.1	63.8	**59.78**	37.10	37.90	39.10	40.20	**38.58**
B 100 ppm + Fe 0.0 ppm	0.44	0.43	0.41	0.34	**0.41**	53.5	60.3	63.9	64.1	**60.45**	37.80	38.60	39.90	41.70	**39.50**
Fe 100 + B 50 ppm	0.44	0.41	0.36	0.33	**0.38**	56.8	62.1	62.9	63.4	**61.30**	38.30	39.20	40.40	41.90	**39.95**
Fe 100 ppm + B 100 ppm	0.43	0.38	0.34	0.31	**0.37**	58.9	61.9	63.6	65.8	**62.55**	39.10	40.30	40.90	42.20	**40.63**
Fe 200 ppm + B 50 ppm	0.41	0.37	0.32	0.30	**0.35**	59.2	64.4	66.5	67.3	**64.35**	39.90	41.90	42.80	46.90	**42.88**
Fe 200 ppm + B 100 ppm	0.41	0.37	0.30	0.29	**0.34**	59.7	66.0	67.7	66.1	**64.87**	40.80	44.50	46.30	47.10	**44.68**
Mean A	**0.46**	**0.42**	**0.38**	**0.30**		**55.29**	**60.65**	**62.61**	**63.77**		**37.95**	**39.45**	**40.36**	**41.68**	
New LSD 5%	**A= 0.01 ; B= 0.02 ; AB=0.03**					**A= 3.99 ; B= 4.01 ; AB= 5.85**					**A= 1,14 ; B= 0.99 ; AB= 1.44**				

Fruit cracked and fruit sunburned percentages

It is well known that, pomegranate losses due to fruit cracking and fruit sunburn are quite high. Fruit cracking problem was due to improper water management and deficiency of some mineral nutrients. Furthermore, fruit cracked and fruit sunburned percentages are two of the most important factors limiting marketable value of pomegranate fruits. These two studied characters (Table, 4) were significantly reduced as a result of treating the trees with the three examined compounds (K_2SO_4, $FeSO_4$ and H_3BO_3). Spraying of K_2SO_4 at 1.5 % recorded lowest value of fruit cracked (9.78 and 7.97 %) and fruit sunburned (8.58 and 8.66%) in the two seasons respectively. Such reduction of both seasons was generally parallel to the gradual increase in potassium sulphate concentration, with the highest values being produced due to sprayed the trees by water, control treatment, (19.6 and 18.2% for fruit cracked percentage and 19.9 and 22.2% for fruit sunburned percentage), during the two seasons respectively. The lowest cracked fruit (7.9 and 5.0 %) and sunburned fruit (7.1 and 6.6%) were obtained from interaction with to spraying potassium sulphate at 1.5% plus ferrous sulphate at 200 ppm and boric acid at 100 ppm together, during the two seasons respectively.

The improving effect of the three examined compounds on fruit physical properties might be attributed to its effect on enhancing plant pigments formation, building carbohydrates and activating the uptake of mineral nutrition and different enzymes activations, in addition to the role of potassium in plant tolerance of biotic and abiotic stress. Also, it is well known that K has a many functions in plant nutrition and growth that influence both yield and fruit quality. These included regulation of metabolic processes such as photosynthesis; activation of enzymes that metabolized carbohydrate for synthesis of amino acids and proteins; function of cell division and growth by helping to move starches and sugars between plant parts. The aforementioned roles of potassium could be explanted its effect on improve fruit weight and increasing the yield/tree and improving physical properties of fruit (**Mengl (1985); Marschner (1997); Havlin *et al.*, (2005); Khalil and Aly (2013)**; **Kow and Nabwami (2015**) and **Abo-Ali (2019)**.

Boron is much required for cell division and development in the growth region of the plant. It also affects auxin synthesis, sugar transport and appears to be associated with some of functions of calcium (**Sumam *et al.*, 2017**). These functions mentioned above of boron could be explained the remarkable effect of boric acid on enhancing fruit weight, total yield/tree as well as physical properties of fruit. Furthermore as an essential microelement, Fe has important roles in plant growth such as acting as a cofactor of about 140 enzymes and being involved in synthesis of chlorophyll, thylakoid and chloroplast development (**Marschner, 1997 & Mengle, 2007**).

The obtained results concerning the effect of K, Fe and B on fruit physical properties, yield/tree as well as fruit weight are in accordance with those obtained on pomegranate trees and other fruit species by **Arona and Singh (1970); Bambal*et al.* (1991); Alila*et al.* (2004); Meena*et al.* (2014); Davarpanah*et al.* (2013 & 2016); El-Kady (2011); Khalil and Ali (2013); Abou El-Wafa (2015); Omar (2015); Kow and Nabwami (2015); Sumam*et al*. (2017) and Abo-Ali (2019)**.

Fruit chemical properties

TSS%, reducing and non-reducing sugars (%)

It is clear from the obtained data in Table (5) that spraying trees to single and combined applications of K_2SO_4, $FeSO_4$ and H_3BO_3 significantly enhanced the TSS%, reducing sugars% and non-reducing sugars% compared to the control treatment. Spraying K_2SO_4 at the high concentration (1.5%) was significantly favorable on TSS% (15.69 and 15.81%), reducing sugars % (11.40 and 12.0%) and non-reducing sugars % (1.67 and 1.71%) than using K_2SO_4 at lower concentrations (15.03 & 15.08% for the TSS, 10.91 and 11.39% for reducing sugars and 1,56 and 1.50% for non-reducing sugars)during the two seasons respectively. The promotion on such these characteristics was significantly related to mixing K_2SO_4 with $FeSO_4$ and H_3BO_3. Using K_2SO_4 in combined with H_3BO_3 was significantly superior than using each compound alone. Regardless the concentration used, the combined application of $FeSO_4$ and H_3BO_3 in exhibited more effective, on the three studied characters, than sprayed each compound alone. It is worth to mentioned that data presented in same Table that the trees received H_3BO_3 alone or combined with K_2SO_4 produce more pronounced effect on TSS%, reducing and non-reducing sugars than those received $FeSO_4$ alone or combined with K_2SO_4 during the two experimental seasons.

The interactions between the three examined compounds on TSS%, reducing sugars% and non-reducing sugars% were significant. Furthermore, the highest T.S.S.% (16.7 and 16.9%), reducing sugars (12.8 and 13.0%) and non-reducing sugars (1.87 and 1.89%) were produced from the fruit of the trees received potassium sulphate at 1.5% accompanied with $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm in the two experimental seasons respectively. While, the least values of TSS % (13.8 and 14.1%) and reducing (10.0 and 10.8%) non-reducing sugars (1.11 and 1.01%) were produced by untreated trees in the two seasons respectively.

The promotion effect of K, Fe and B on Wonderful pomegranate fruits that showed in the present investigation and noted by some local and strangers authors on pomegranate or other fruit trees (**Singh *et al.*, 2005** on papaya trees, **Singh and Maurya (2004)** on Mango trees and **Sharma *et al.*, 2005** on Litchi trees). The important roles of potassium concerning increasing total soluble solids and sugars in Wonderful pomegranate fruit can be explained by its effect on enzyme activation, cellular membrane transport processes and translocation of assimilates, anion neutralization, which is essential in maintenance of membrane potential and osmotic potential regulation, which is one of the important mechanisms in the control of plant water relations. The promotion effect of potassium on Wonderful pomegranate fruits total soluble solids, reducing sugars and non-reducing sugars was reported by certain authors such as **Mpelasoka *et al.*, (2003); Zhang and Whiting (2011); Khalil and Ali (2013); Omar (2014); Wassel *et al.*, (2015)** on some pomegranate cultivars.Furthermore, boron can plays an important role in plant metabolism including many physiological aspects such as building and translocation of carbohydrates, photosynthesis, membrane function and water uptake. The roles can enhancing TSS and sugar contents in fruit juice (**Marschner 1997**; **Babu and Yadav, 2005; Babu *et al.*, 2007; Lalet *et al.*, 2011; Mehta 2012; Messaoudi *et al.*, 2012;** and **Khalil and Aly 2013**).

Table 4. Effect of spraying potassium sulphate, ferrous sulphate, and boric acid on fruit cracked % and fruit sunburned % of Wonderful pomegranate trees during 2017 and 2018 seasons

Treatments	Cracked fruits (%)					Sunburned fruits (%)				
	First Season (2017)					First Season (2017)				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	19.6	15.4	13.5	12.2	**15.18**	19.9	13.1	11.7	11.9	**13.85**
Fe 100 ppm + B 0.0 ppm	13.5	10.8	12.4	11.7	**12.10**	15.4	12.5	10.9	9.1	**11.97**
Fe 200 ppm + B 0.0 ppm	13.1	10.2	11.2	10.3	**11.20**	15.8	11.6	10.1	8.8	**11.58**
B 50 ppm + Fe 0.0 ppm	14.3	11.1	12.4	10.2	**12.00**	14.1	12.4	10.7	9.5	**11.23**
B 100 ppm + Fe 0.0 ppm	13.7	11.2	9.4	8.8	**10.78**	13.4	12.3	10.1	9.1	**11.22**
Fe 100 + B 50 ppm	12.5	10.7	8.9	8.9	**10.25**	13.1	11.8	9.9	8.6	**10.85**
Fe 100 ppm + B 100 ppm	12.0	12.1	9.0	9.9	**10.75**	12.1	10.8	9.6	7.7	**10.05**
Fe 200 ppm + B 50 ppm	11.1	9.9	7.6	8.1	**9.18**	11.7	9.9	8.5	7.4	**9.38**
Fe 200 ppm + B 100 ppm	9.8	9.2	7.0	7.9	**8.13**	11.2	9.7	8.1	7.1	**9.03**
Mean A	**12.68**	**11.82**	**10.16**	**9.78**		**14.08**	**11.48**	**10.91**	**8.58**	
New LSD 5%	**A= 2.03 ; B= 3.34 ; AB= 4.88**					**A= 1.78 ; B= 2.04 ; AB= 2.95**				
Treatments	**Second Season (2018)**					**Second Season (2018)**				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	18.2	13.1	12.4	11.6	**13.83**	22.2	17.1	13.7	10.9	**15.97**
Fe 100 ppm + B 0.0 ppm	13.8	12.1	10.1	9.2	**11.30**	19.4	14.5	11.9	9.9	**13.89**
Fe 200 ppm + B 0.0 ppm	11.6	9.2	8.8	7.6	**9.30**	17.8	13.6	11.1	9.0	**12.88**
B 50 ppm + Fe 0.0 ppm	12.2	9.9	10.3	8.8	**10.30**	16.2	14.3	11.7	10.5	**13.18**
B 100 ppm + Fe 0.0 ppm	10.4	9.2	9.5	8.6	**9.43**	13.7	12.1	10.3	9.2	**11.33**
Fe 100 + B 50 ppm	10.2	8.5	8.2	8.1	**8.75**	12.1	11.5	9.2	8.0	**10.2**
Fe 100 ppm + B 100 ppm	9.8	8.1	7.8	6.7	**8.10**	11.1	9.8	9.0	7.1	**9.25**
Fe 200 ppm + B 50 ppm	8.9	7.0	6.9	6.1	**7.23**	10.8	8.8	8.0	6.8	**8.62**
Fe 200 ppm + B 100 ppm	8.1	6.2	5.7	5.0	**6.25**	10.2	9.1	7.9	6.6	**8.45**
Mean A	**11.47**	**9.30**	**8.29**	**7.97**		**15.01**	**12.31**	**10.60**	**8.66**	
New LSD 5%	**A= 1.98 ; B= 2.41 ; AB= 3.52**					**A= 2.18 ; B= 2.55 ; AB= 3.72**				

Total acidity percentage

Concerning the K_2SO_4 $FeSO_4$ or/and H_3BO_3were capable of causing significant decrement in total acidity % in fruit juice of Wonderful pomegranate over the control trees during the two experimental seasons (Table 6). Total acidity was gradually decreased during the two seasons parallel to the gradual increase in K_2SO_4 and $FeSO_4$ or/and H_3BO_3 concentrations. Spraying trees three times of different concentration of $FeSO_4$ or/and H_3BO_3 significantly was responsible for decreasing the percentage total acidity % rather than untreated trees. There was a remarkable diminishing on total acidity % with increasing concentrations of $FeSo_4$ from 100 to 200 ppm or/and H_3BO_3 from 50 to 100 ppm. However, regardless the concentration use, the combined application of $FeSO_4$ and H_3BO_3 exhibited more effective on total acidity % than sprayed each one alone.

Regarding the interactions between the three examined compounds, increasing K_2SO_4concentration companied with $FeSO_4$ or/and H_3BO_3significantly decreased total acidity % during the two experimental season. Furthermore, the lowest total acidity % (1.320 and 1.339%) were obtained from the trees received K_2SO_4 at 1.5% companied with $FeSO_4$ at 200 ppm and H_3BO_3 at 100 ppm in the two experimental seasons respectively. On the other hand, the maximum total acidity % (1.712 and 1.701%), during the two experimental seasons respectively, were produced by untreated trees.

Furthermore, it worth to mentioned that, regardless the concentration used the treatments included K_2SO_4combined with H_3BO_3were remarkable more effective on the total acidity decrement than those of K_2SO_4 combined plus $FeSO_4$.

The role of spraying potassium sulphate in increasing the total acidity % was illustrated by **Omar, (2015)**; **Abd-El-Rhman *et al.*, (2017); Davarpanh *et al.*, (2017); Ampem (2017) and Abo-Ali (2019)** on different cultivars of pomegranate.

Fruit peel and juice total anthocyanin contents

Data in Table (6) show that the fruit peel and juice total anthocyanin contents (mg/100 g F.W.) in fruit treated with different compounds or the concentrations were significant differences observed in peel and juice total anthocyanin contents during the two seasons. Gradual and significant increment in both peel and juice anthocyanin contents was observed as a result of increasing K_2SO_4 concentration from 0.0 to 1.5%, rather than control treatment. Regarding the concentration used, trees treated with potassium sulphate at 1.5% produced highest peel and juice anthocyanin pigments (84 and 85 mg/100 g F.W. and 109 and 116 mg/100 g F.W. in the two seasons respectively) rather than those treated with other potassium sulphate concentrations. While, increasing potassium sulphate from 1.0% to 1.5% failed to enhanced peel and juice anthocyanin pigments significantly. On the other hand, untreated trees produced the lowest anthocyanin contents in fruit peel (55 and 51 mg/100 g F.W.) and juice (73 and 79 mg/100 g F.W.) during the two experimental seasons respectively.

All treatments concerning added $FeSO_4$ or/and H_3BO_3 each alone or in companied caused a significant increase in peel and juice anthocyanin contents during the two seasons, except those of spraying the lowest $FeSO_4$ concentration (100 ppm) alone or in combined with potassium sulphate, during the two seasons. Furthermore, it is clear also from the same Tables that the combined treatments of $FeSO_4$ and H_3BO_3 lead to enhance of fruit peel and juice anthocyanin contents than those produced by the trees treated with each compound alone. The interaction between K_2SO_4, $FeSO_4$ and H_3BO_3 was significant in the two experimental seasons. It was clear that Fe-sulphate at 100 & 200 ppm and boric acid at 50 & 100 ppm accompanied with potassium sulphate at 0.5% to 1.5% higher present and significant peel and juice anthocyanin contents rather than untreated trees. However the highest peel (84 and 85 mg/100 g F.W.) and juice (109 and 116 mg/100 g F.W.) anthocyanin contents were produced from the trees received a mixture of K_2SO_4 at 1% + $FeSO_4$ at 200 ppm + H_3BO_3 at 100 ppm. On the other hand, untreated trees produced the lowest anthocyanin contents in peel (55 & 51 mg/100 g F.W.) and juice (73 and 79 mg/100 g F.W) during the two seasons respectively.

The increase in total anthocyanin contents because of spraying potassium sulphate are in line with the findings of **Tehranifar and Tabar (2009)** and **Moor *et al.*, (2009)**. A positive correlation between K concentration and anthocyanin contents, and also the importance of balance between the concentration of N and K on total anthocyanin contents have been reported. For instance, unbalanced nutrition or excessive nutrition of N and K lead to decrease the contents of total anthocyanin in grape (**Hunsche *et al.*, 2003; Delgado *et al.*, 2006**). It is worth to mention that potassium plays crucial roles in anthocyanin's synthesis through increasing the translocation of sugars into fruits, as well as acting as a cofactor and stimulator of some enzymes like UDP-galactose: flavanoide-3-o-glicosil transferase (**Ju *et al.*, 1999 and Delgado *et al.*, 2006**).

There is a wide variety of reported beneficial effects of single or combined spraying of potassium, iron and boron on the chemical properties of Wonderful pomegranate or other pomegranate cultivars fruit, like increasing juice weight% and TSS% **Kahayyat *et al.*, (2012)** and **Sheikh and Manjula (2012); (Hamouda *et al.*, (2015)** on Manfalouty pomegranate *cv*; **Salama *et al.* (2016)** on Wonderful pomegranate. Increasing TSS% and decreasing total acidity % (**Abd-El-Rhman *et al.* (2017) on** Manfalouty pomegranate**; Parvin *et al.* (2017)** on Kandhari pomegranate cv.**; Davarpanah *et al.*, 2017**, on Malas-e-Saveh pomegranate cv., increasing juice fruit reducing and non-reducing sugars% **Sharma and Belsare (2011)**; **Abo El-Wafa (2015**) on Wondeful pomegranate**; Davarpanah *et al.* (2017)** on Malas-e-Saveh pomegranate cv. and **Abo-Ali (2019)** on Wonderful pomegranate and **Ampem (2017)** on three South African commercial pomegranate cultivars namely: Wonderful, Acco and Herskovitz. It is worth to mention that, their obtained results are in agreement with or findings during present investigation.

Table 5. Effect of spraying potassium sulphate, ferrous sulphate, and boric acid on TSS, reducing and non-reducing sugars percentages of Wonderful pomegranate juice during 2017 and 2018 seasons

Treatments	TSS %					Reducing sugars %					Non-reducing sugars %				
	First season (2017)					First season (2017)					First season (2017)				
	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	13.80	14.20	14.60	14.80	**14.35**	10.00	10.10	10.30	10.40	**10.20**	1.11	1.19	1.29	1.33	**1.23**
Fe 100 ppm + B 0.0 ppm	14.10	14.60	14.80	14.90	**14.60**	10.20	10.40	10.40	10.60	**10.40**	1.19	1.23	1.33	1.39	**1.29**
Fe 200 ppm + B 0.0 ppm	14.40	14.90	15.30	15.40	**15.00**	10.40	10.50	10.70	10.80	**10.60**	1.21	1.39	1.42	1.54	**1.39**
B 50 ppm + Fe 0.0 ppm	14.60	14.90	15.20	15.20	**14.98**	10.50	10.80	10.90	11.10	**10.83**	1.37	1.55	1.59	1.66	**1.54**
B 100 ppm + Fe 0.0 ppm	15.00	15.10	15.50	15.70	**15.33**	10.70	10.90	11.20	11.40	**11.05**	1.47	1.65	1.69	1.78	**1.65**
Fe 100 + B 50 ppm	15.30	15.40	15.60	15.80	**15.53**	10.8	10.90	11.60	11.70	**11.25**	1.55	1.69	1.75	1.79	**1.70**
Fe 100 ppm + B 100 ppm	15.80	15.90	16.00	16.30	**16.00**	10.90	11.30	11.50	11.90	**11.40**	1.66	1.77	1.79	1.80	**1.76**
Fe 200 ppm + B 50 ppm	16.00	16.20	16.40	16.40	**16.25**	11.40	11.50	11.70	11.90	**11.63**	1.69	1.79	1.81	`1.85	**1.79**
Fe 200 ppm + B 100 ppm	16.20	16.40	16.60	16.70	**16.48**	11.70	11.90	12.40	12.80	**12.20**	1.73	1.80	1.84	1.87	**1.81**
Mean A	**15.03**	**15.29**	**15.56**	**15.69**		**10.73**	**10.91**	**11.19**	**11.40**		**1.44**	**1.56**	**1.61**	**1.67**	
New LSD 5%	**A= 0.15 ; B= 0.08 ; AB= 0.12**					**A= 0.19 ; B= 0.23 ; AB= 0.34**					**A= 0.20 ; B=0.12 ; AB= 0.18**				
Treatments	Second season (2018)					Second season (2018)					Second season (2018)				
	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.50%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	14.10	14.20	14.50	14.80	**14.40**	10.20	10.50	10.70	10.80	**10.55**	1.01	1.21	1.31	1.44	**1.24**
Fe 100 ppm + B 0.0 ppm	14.30	14.40	14.80	14.90	**14.60**	10.40	10.60	10.90	11.30	**10.80**	1.11	1.33	1.43	1.51	**1.35**
Fe 200 ppm + B 0.0 ppm	14.60	14.90	15.00	15.20	**14.93**	10.70	10.80	10.90	11.60	**11.00**	1.17	1.39	1.41	1.66	**1.41**
B 50 ppm + Fe 0.0 ppm	14.90	15.20	15.40	15.50	**15.25**	10.80	10.90	11.30	11.70	**11.18**	1.23	1.41	1.53	1.69	**1.47**
B 100 ppm + Fe 0.0 ppm	15.00	15.30	15.70	15.70	**15.43**	10.90	11.50	11.90	12.10	**11.60**	1.33	1.49	1.66	1.73	**1.56**
Fe 100 + B 50 ppm	15.20	15.50	15.90	16.10	**15.68**	11.10	11.60	11.90	12.40	**11.75**	1.39	1.51	1.71	1.77	**1.60**
Fe 100 ppm + B 100 ppm	15.70	15.90	16.30	16.50	**16.10**	11.30	11.90	12.20	12.50	**11.98**	1.51	1.67	1.73	1.81	**1.68**
Fe 200 ppm + B 50 ppm	15.90	16.00	16.40	16.70	**16.25**	11.90	12.10	12.40	12.60	**12.25**	1.55	1.71	1.80	1.85	**1.73**
Fe 200 ppm + B 100 ppm	16.00	16.20	16.50	16.90	**16.4**	12.00	12.60	12.70	13.00	**12.58**	1.67	1.75	1.84	1.89	**1.79**
Mean A	**15.08**	**15.29**	**15.61**	**15.81**		**11.03**	**11.39**	**11.65**	**12.00**		**1.33**	**1.50**	**1.60**	**1.71**	
New LSD 5%	**A= 0.22 ; B= 0.22 ; AB= 0.32**					**A= 0.28 ; B= 0.33 ; AB= 0.48**					**A= 0.10 ; B= 0.10 ; AB=0.15**				

Table 6. Effect of spraying potassium sulphate, ferrous sulphate, and boric acid on total acidity %, peel and juice total anthocyanin (mg/100g F.w.) of Wonderful pomegranate fruits during 2017 and 2018 seasons

Treatments	Total acidity %					Peel anthocyanin (mg/100g F.W.)					Juice anthocyanin (mg/100g F.W.)				
	First season (2017)					First season (2017)					First season (2017)				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	1.712	1.711	1.682	1.651	**1.691**	55.00	61.00	66.00	68.00	**62.50**	73.00	79.00	80.00	82.00	**78.50**
Fe 100 ppm + B 0.0 ppm	1.700	1.692	1.683	1.641	**1.679**	56.00	61.00	69.00	71.00	**64.30**	75.00	81.00	84.00	87.00	**81.80**
Fe 200 ppm + B 0.0 ppm	1.688	1.641	1.625	1.603	**1.639**	58.00	62.00	71.00	72.00	**65.80**	76.00	81.00	87.00	96.00	**85.00**
B 50 ppm + Fe 0.0 ppm	1.613	1.611	1.581	1.509	**1.578**	58.00	64.00	75.00	77.00	**68.50**	79.00	83.00	89.00	96.00	**86.80**
B 100 ppm + Fe 0.0 ppm	1.601	1.590	1.497	1.470	**1.539**	59.00	65.00	76.00	78.00	**69.50**	83.00	87.00	94.00	98.00	**90.50**
Fe 100 + B 50 ppm	1.569	1.522	1.401	1.399	**1.472**	61.00	64.00	78.00	80.00	**70.80**	84.00	88.00	95.00	102.00	**92.30**
Fe 100 ppm + B 100 ppm	1.531	1.502	1.391	1.372	**1.449**	62.00	66.00	80.00	82.00	**72.50**	86.00	90.00	93.00	104.00	**93.30**
Fe 200 ppm + B 50 ppm	1.501	1.489	1.372	1.360	**1.431**	63.00	67.00	81.00	84.00	**73.80**	90.00	93.00	97.00	106.00	**96.50**
Fe 200 ppm + B 100 ppm	1.471	1.422	1.351	1.320	**1.391**	65.00	71.00	82.00	84.00	**75.50**	92.00	96.00	101.00	109.00	**99.50**
Mean A	**1.599**	**1.573**	**1.509**	**1.481**		**59.70**	**64.60**	**75.30**	**77.30**		**81.57**	**86.40**	**91.10**	**97.80**	
New LSD 5%	**A= 0.026 B= 0.055 AB= 0.079**					**A= 3.63 ; B=2.11 ; AB= 3.08**					**A= 4.32 ; B= 3.50 ; AB= 4.35**				

Treatments	Second season (2018)					Second season (2018)					Second season (2018)				
	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B	K_2SO_4 0.0%	K_2SO_4 0.5%	K_2SO_4 1.0%	K_2SO_4 1.5%	Mean B
Fe 0.0 + B 0.0 ppm	1.701	1.699	1.663	1.662	**1.681**	51.00	57.00	63.00	65.00	**59.00**	79.00	79.00	82.00	86.00	**81.50**
Fe 100 ppm + B 0.0 ppm	1.691	1.684	1.678	1.659	**1.678**	52.00	59.00	64.00	68.00	**60.80**	80.00	82.00	87.00	89.00	**84.50**
Fe 200 ppm + B 0.0 ppm	1.671	1.644	1.631	1.622	**1.642**	54.00	61.00	67.00	69.00	**62.00**	82.00	84.00	89.00	93.00	**87.00**
B 50 ppm + Fe 0.0 ppm	1.651	1.630	1.629	1.620	**1.633**	55.00	66.00	69.00	70.00	**63.80**	79.00	85.00	90.00	99.00	**88.30**
B 100 ppm + Fe 0.0 ppm	1.601	1.582	1.562	1.533	**1.568**	57.00	66.00	72.00	73.00	**67.00**	86.00	89.00	97.00	103.00	**93.70**
Fe 100 + B 50 ppm	1.599	1.581	1.571	1.566	**1.577**	59.00	67.00	75.00	77.00	**69.50**	88.00	93.00	97.00	106.00	**96.00**
Fe 100 ppm + B 100 ppm	1.512	1.501	1.488	1.438	**1.485**	62.00	69.00	78.00	80.00	**71.50**	91.00	95.00	99.00	109.00	**98.50**
Fe 200 ppm + B 50 ppm	1.499	1.487	1.463	1.446	**1.473**	66.00	71.00	80.00	82.00	**74.80**	92.00	98.00	103.00	111.00	**101.00**
Fe 200 ppm + B 100 ppm	1.488	1.467	1.410	1.339	**1.421**	67.00	73.00	83.00	85.00	**77.00**	93.00	102.00	105.00	116.00	**104.00**
Mean A	1.602	1.586	1.566	1.531		**58.10**	**65.40**	**72.30**	**74.30**		**85.60**	**89.70**	**94.30**	**101.30**	
New LSD 5%	**A= 0.045 ; B= 0.034 ; AB= 0.049**					**A= 4.31 ; B= 1.97 ; AB= 2.87**					**A= 3.43 ; B= 3.82 ; AB= 5.28**				

CONCLUSION

In conclusion, for improve fruit physical and chemical properties of Wonderful pomegranate; it is necessary spraying the trees with potassium sulphate at 1.5%, ferrous sulphate at 200 ppm and boric acid at 100 ppm three times on during growth cycle.

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