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Impact of Foliar Spray with Some Nutrients on Growth and Nutritional Status of Pomegranate Trees

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Abstract

This investigation was carried out during both the 2018 and 2019 seasons to study the influence of the two investigated factors i.e., pomegranate cultivars (Manfalouty and Wonderful) and some nutrient solutions and their possible combinations on growth and nutritional status (leaf chlorophyll and mineral content). Data revealed that the Wonderful cultivar was better than Manfalouty cultivar in all vegetative growth measurements. Foliar spray with potassium citrate at 2.0g/ l. + Fe, Mn, and Zn at 100 ppm for each or potassium citrate at 2.0g/ l. + Fe, Mn, and Zn at 50 ppm for each was superior in this respect. The same treatments were it was able to increase leaf chlorophyll and mineral content as compared with the other different investigated treatments especially (control) during both seasons of study. Referring to the interaction effect of the two investigated factors on vegetative growth and nutritional status of pomegranate trees, data show the highest values were obtained with the combination between Wonderful cultivar and foliar spray with potassium citrate at 2.0g/ l. + Fe, Mn, and Zn at 100 ppm for each or potassium citrate at 2.0g/ l. + Fe, Mn, and Zn at 50 ppm for each.

Keywords: pomegranate, foliar spray, potassium citrate, Fe, Mn, and Zn.

Introduction

Pomegranate *(Punica granatum*, L.,) belongs to the Punicaceae family and is one of the oldest known edible fruits. It has been cultivated extensively in Mediterranean countries. The fruit is consumed fresh, or it can be processed into juice. The edible part of the fruit contains considerable amounts of acids, sugars, vitamins, polysaccharides, polyphenols, and important minerals. The pomegranate area in Egypt (80515) feddans, according to the annual of the **Ministry of Agriculture (2020).**

Manfalouty pomegranate cultivar is one of the most common cultivation grown in Assiut governorate, Upper Egypt region **(Hamouda *et al.*, 2016)**. Wonderful pomegranate is a late cultivar with high yield, large fruit, rich red aril, high juice, and good palatability **(Palou *et al.*, 2007).** Wonderful is currently one of the most desired planted pomegranate cultivars in Egypt since it offers the best balance combination of yield and quality (**Abd-Elghany *et al.*, 2012**).

The nutrients play the main role in improving plant growth and fruit quality incidence in pomegranate fertilization is considered the main agricultural practices which had significant effects on fruit quality, in this context potassium, magnesium and manganese are essential to plant mineral nutrients having a significant influence on many human- health-related quality compounds in fruits and vegetable (**Usherwood, 1985**).

Phosphorus is an essential nutrient as a part of several key plant structure compounds and as catalysts in the conversion of numerous key biochemical reactions in plants. Phosphorus is noted especially for its role in capturing and converting the sun's energy into useful plant compounds. Also, phosphorus is a vital component of DNA and RNA. The structures of both DNA and RNA are linked together by phosphorus bonds. Moreover, phosphorus is a vital component of ATP. The ATP forms during photosynthesis have phosphorus in their structures. Thus, phosphorus is essential for the general health and vigor of all plants. Some specific growth factors that have been associated with phosphorus are stimulating root development, flower formation, and seed production, as well as nitrogen-fixing capacity **(Bill, 2001)**.

Potassium is an essential element in many plant metabolic processes. In spite, K does not become a part of plant compounds; it plays many important regulatory roles in the development of different tissues. Disease resistance with optimal K nutrition may be attributed to increasing energy used to offset the impact of plant diseases. In addition, K may also increase disease resistance by increasing the thickness of outer walls in epidermal cells (**Mengel *et al.*, 2001**).

Micronutrients such as Fe, Mn, and Zn play a great role in plant growth as a result of affecting many physiological processes in plant life. For example, iron (Fe) has a role in the formation of chlorophyll molecules which leads to the high growth of green parts and by then leads to high production of yield. The important role of manganese (Mn) in the plant came from its involvement in photosynthesis, and membrane function, as well as an activator of numerous enzymes in the cell **(Marschner, 1995 and Wiedenhoeft, 2006)**. In addition, zinc activated large numbers of enzymes such as alcohol-dehydrogenase, Cu-Zn superoxide

dismutase, carbonic anhydrase (CA) and RNA, and is very important for photosynthetic CO_2 fixation in plant leaves **(Romheld and Marschner, 1991)**.
Zinc from the micro-nutrient deficiency, which causes an imbalance in plant growth through several enzymes to activate up to 300 enzymes which Peptidase, Proteinase, Enolase, also need a plant in the formation of the amino acid Tryptophan, which consists of hormone indole acetic acid (IAA) is essential for cell elongation **(Barker and Pilbeam, 2007)**.

Soil application of Mn is problematic since its efficiency depends on many soil factors, including soil pH. A suitable method for the correction and /or prevention of Mn deficiency in plants is the foliar application of ionic or chelated solution forms of this nutrient **(Papadakis *et al.*, 2007)**.

Thus, this study aimed to investigate the effect of the foliar spray with some nutrients on the growth and nutritional status of Manfalouty and Wonderful pomegranate cultivars.

Materials and Methods

This study was carried out during the two successive seasons (2018 and 2019) on uniform vigor trees of two named pomegranate CVS. Manfalouty and Wonderful (*Punica granatum* L.), of 15 years old in a private orchard at Megres village, Sedfa, Assuit Governorate Egypt.

The soil was heavy loam. Regular agricultural management was applied to all experimental trees as recommended. The trees space was 3.5 x 3.5 apart. Thirty-sex uniform trees were selected and divided into twelve treatments including control, each treatment was executed on three trees (Replicates). All trees were fertilized with 2.0 kg organic manure + 2.0 kg superphosphate calcium per tree in January then 0.5 kg nitrate ammonium + 0.5 kg potassium sulphate in March and June. The surface irrigation system was followed in the orchard.

The study aimed to investigate the influence of foliar spraying with K, P, Fe, Mn and Zn nutrients on vegetative growth, nutritional status and yield of Manfalouty and Wonderful pomegranate cultivars.

Before the experiments had been conducted in the first season, both soil mechanical and chemical analyses were done as shown in **Table 1(a & b)** according to the methods described by **Jackson, (1967)** and **A. O. A. C. (1985)**.

Table (1-a): Physical properties of soil (%):

Partial distribution		
Sand	Silt	Clay
20.00	35.00	40.00

Table (1-b): Chemical properties of soil:

Soluble cations mg/L				Soluble anions meg/L				Ca Co_3	PH	EC
Mg^{++}	$^{++}$ Ca	K^+	Na^+	HCO_3^-	CO_3^{--}	$SO4^{--}$	Cl^-			
2.11	8.79	0.60	7.71	3.20	-	9.0 0	6.7 0	1.32	8.70	1.88

This experiment involved twelve treatments:

1- Spraying tap water (control).
2- Spraying potassium sulphate at 2g/l.
3- Spraying mono-potassium phosphate at 2.0 g/l.
4- Spraying potassium citrate at 2.0g/l.
5- Spraying Fe-Mn-Zn at 50 ppm.
6- Spraying Fe-Mn-Zn at 100 ppm.
7- Spraying potassium sulphate at 2g/l.+ Fe-Mn-Zn at 50 ppm.
8- Spraying potassium sulphate at 2g/l.+ Fe-Mn-Zn at 100 ppm.
9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm.
10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm.
11- Spraying potassium citrate at 2.0g/ l. + Fe-Mn-Zn at 50 ppm.
12- Spraying potassium citrate at 2.0g/ l. + Fe-Mn-Zn at 100 ppm.

Trees were sprayed three times: in the first week of March, May and July in both seasons. Each tree was sprayed with five liters of nutrient solution. In the first March 2018 and 2019, four main branches well distributed around each tree periphery were carefully selected and tagged during the 1^{st} and 2^{nd} seasons, respectively. Moreover, 10 newly spring-developed shoots were also labeled.

Experimental layout:

The complete randomized block design with three replications (each replicate was represented by one tree of both studied CVS.) was used for arranging the differential investigated treatments. The response of Pomegranate trees to differential treatments of the experiment was investigated by determining of the following measurements:

1-Vegetative growth measurements:

In the last week of August during both seasons of study, the effect of different treatments on some vegetative growth measurements was evaluated by the following growth parameters during both seasons:

a - Number of lateral shoots/branches.

b - Shoot length.

c - Number of leaves/shoot.

d -Leaf area: average leaf area of the apical 5th leaf was estimated, in cm^2 using a CI-203- Laser Area-meter made by CID, Inc., Vancouver, USA.

2- Chemical analysis:

A-Total chlorophyll:

In the last week of August during both seasons of study leaf total chlorophyll content was recorded by using a portable chlorophyll meter spade 502 according to **Wood *et al.*, (1992).**

B-Leaf mineral determination:

Representative samples of fourth and fifth leaves from the base of spring shoots were collected from each replicate in August during both seasons. The samples were thoroughly washed with tap water, rinsed twice with distilled water, and oven dried at 70°C till a constant weight and finely ground for determination of:

-Total Nitrogen: Total leaf N was determined by the modified micro Kjeldahl method mentioned by **(Pregl,1945).**

-Total phosphorus: Total leaf (P) was determined by wet digestion of plant materials after the methods described by using sulphuric and perchloric acid which has been strongly recommended by **(Piper, 1958).**

- Total potassium: Total leaf (K) was determined photometrically in the digested material according to the method described by **(Brown and Lilleland, 1946)**.

- Iron, Manganese and Zinc were determined using the Atomic absorption spectrophotometer "Perkin Elmer -3300" after **Chapman and Pratt (1975).**

-Statistical analysis:

All data of the present investigation were subjected to analysis of variance and significant differences among means were determined according to **(Snedecor and Cochran, 1990)**. In addition, significant differences among means were differentiated according to the Duncan, s, multiple test range **(Duncan, 1955).**

Results and Discussion

1- Vegetative growth:

- **Number of shoots, shoot length, the number of leaves per shoot and leaf area:**

A. Specific effect:

As for the response to the specific effect of the cultivar, data in **Tables (2 and 3)** revealed that the Wonderful cultivar surpassed statistically Manfalouty cultivar during two seasons of study in this respect. Meanwhile, the specific effect of fertilizer treatments, **Tables (2 and 3)** show that the pomegranate trees spray with potassium citrate at 2.0g/ l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/ l + Fe-Mn-Zn at 50 ppm gave highest values in this respect compared with other treatments especially spray tap water (control).

B- Interaction effect:

Regarding the interaction effect of various (pomegranate cultivar x nutrient treatments) combinations, **Tables (2 and 3)** reveal that Wonderful cultivar and spraying with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm had significantly the highest values in both seasons. Meanwhile, the reverse was true with the Manfalouty cultivar and spray with tap water (control). In addition, other combinations were in between during two seasons.

These results are in harmony with those obtained by **Stalin *et al.*, (1994); Eman-Abd-Ella *et al.*, (2010), and Shazia (2016).**

Table 2. Impact of foliar spray with some nutrients and pomegranate cultivars on number of shoots and shoot length (cm) during the 2018 and 2019 seasons.

Number of shoots/ branch						
Cultivars	**Manfalouty**	**Wonderful**	**Mean***	**Manfalouty**	**Wonderful**	**Mean***
Treatments	**2018**			**2019**		
1	81.33 f	91.00 d	**86.17 D**	73.33e	80.33 d	**76.83 D**
2	82.00 ef	93.00 cd	**87.50CD**	74.00 e	81.66 cd	**76.83 D**
3	83.00 ef	96.00 bc	**89.50 CD**	74.66 e	83.00 cd	**78.33 CD**
4	83.50 e	96.33 bc	**89.95 C**	75.00 de	83.33 cd	**79.17 CD**
5	85.50 de	98.00 b	**91.75 BC**	77.66 de	84.00 cd	**79.83 CD**
6	86.00 de	100.00 b	**93.00 B**	77.66 de	85.66 c	**81.66 BC**
7	87.00 de	112.00 a	**99.50 A**	78.33 de	90.00 b	**84.17 BC**
8	87.66 de	112.00 a	**99.83 A**	79.00 d	92.66 ab	**85.83 AB**
9	88.00 d	113.00 a	**100.50 A**	80.00 d	93.00 ab	**86.50 AB**
10	88.33 d	113.50 a	**100.92 A**	80.33 d	94.00 ab	**87.00 AB**
11	90.00 d	115.00 a	**102.50 A**	84.33 cd	98.00 a	**91.17 A**
12	90.33 d	116.00 a	**103.17 A**	84.66 cd	100.33 a	**92.46 A**
Mean**	**86.05 B**	**95.32 A**		**78.25 B**	**88.83 A**	

			Shoot length (cm)			
1	70.33 g	94.00 c	**82.17 D**	73.33 i	98.33 d	**85.83 D**
2	71.0 g	94.33 c	**84.67 CD**	74.00 hi	98.66 d	**86.33 D**
3	72.66 g	94.66 c	**83.66 CD**	75.00 hi	99.00 d	**87.00 CD**
4	73.00 g	95.00 c	**84.00 CD**	75.33 hi	100.33 d	**87.83 CD**
5	75.66 fg	98.33 bc	**86.99 CD**	77.33 gh	104.66 c	**90.10 BCD**
6	76.66 efg	99.66 bc	**88.16 BC**	77.66 gh	105.00 c	**91.33 BC**
7	77.00 efg	100.33 b	**88.67 BC**	78.33 gh	107.00 bc	**92.67 BC**
8	78.33 ef	100.66 b	**89.50 BC**	79.00 g	107.33 bc	**93.17 AB**
9	79.00 e	100.66 b	**89.33 BC**	80.00 fg	108.00 bc	**94.00 AB**
10	80.66 de	105.00 a	**92.83 B**	81.33 f g	110.33 b	**95.83 AB**
11	83.66 de	110.33 a	**97.00 A**	84.66 ef	114.00 a	**99.33 A**
12	84.66 d	110.66 a	**97.66 A**	86.66 e	115.50 a	**101.08 A**
Mean**	**76.89 B**	**91.91 A**		**78.55 B**	**105.67 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

Table 3. Impact of foliar spray with some nutrients and pomegranate cultivars on the number of leaves and leaf area (cm^2) during the 2018 and 2019 seasons.

Cultivars / Treatments	Manfalouty 2018	Wonderful 2018	Mean*	Manfalouty 2019	Wonderful 2019	Mean*
			Number of leaves/ shoot			
1	70.33 d	75.00 c	**72.67C**	65.50 e	72.66 c	**69.08 D**
2	71.00 d	75.00 c	**73.00C**	66.00 de	73.00 c	**69.50 D**
3	72.00 cd	76.33 c	**74.17C**	67.00 de	75.00 c	**70.00 D**
4	72.33 cd	76.66 c	**74.47C**	67.33 d	75.00 c	**70.17 D**
5	78.00 c	80.66 bc	**79.33**	69.33 cd	78.00 b	**74.67 C**
6	80.00 b	81.00 b	**80.50B**	70.00 cd	78.33 b	**74.17 C**
7	80.33 b	83.00 b	**81.67B**	71.00 c	79.00 b	**75.00 C**
8	80.66 b	84.00 b	**82.33B**	71.50 c	80.66 b	**75.75C**
9	85.00 b	90.00 a	**87.50A**	71.50 c	83.00 b	**78.25 BC**
10	86.33 ab	91.00 a	**88.67A**	72.00 c	86.00 b	**79.00 AB**
11	87.00 ab	94.00 a	**90.50A**	75.00 c	90.00 a	**82.50 A**
12	88.00 ab	95.00 a	**91.50A**	75.33 c	91.00 a	**83.17 A**
Mean**	**79.24 B**	**83.47 A**		**70.12 B**	**80.13 A**	
			Leaf area (cm^2)			
1	6.75 g	9.50 e	**8.13 D**	7.20 d	9.72 cd	**8.46 D**
2	6.83 fg	9.60 e	**8.22CD**	7.30 d	9.75 cd	**8.53 D**
3	6.85 fg	9.65 e	**8.25CD**	7.35 d	9.80 cd	**8.58 CD**
4	6.90 fg	9.72 de	**8.31CD**	7.40 d	9.88 cd	**8.78 CD**
5	7.15 efg	10.05 de	**8.51CD**	8.00 d	10.70 bc	**9.35 CD**
6	7.30 ef	10.50 d	**8.90BC**	8.10 d	10.90 b	**9.50 C**
7	7.50 e	11.50 c	**9.50BC**	8.40 d	11.50 b	**9.95 BC**
8	8.00 d	12.00 c	**10.00 B**	8.80 cd	12.90 ab	**10.35 BC**
9	8.45 c	13.30 bc	**11.37A**	9.00 cd	13.50 ab	**11.25 AB**
10	9.00 b	13.60 b	**11.30A**	9.15 cd	14.00 ab	**11.58 A**
11	9.40 a	15.50 a	**12.45A**	9.80 cd	15.85 a	**12.84 A**
12	9.50 a	15.60 a	**12.55A**	9.85 c d	15.90 a	**12.85 A**
Mean**	**7.80 B**	**10.91 A**		**8.36 B**	**12.03 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. The means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

2- Nutritional status:

- Leaf total chlorophyll content:

A. Specific effect:

Concerning the specific effect of the two investigated factors on leaf total chlorophyll contents, data presented in **Table (4),** show that, no significant differences between Manfalouty Wonderful pomegranate cultivars of total chlorophyll during two seasons.

Regarding the specific effect of the different nutrients spray on leaf total chlorophyll content of pomegranate trees, data tabulated in **Table (4)** indicate that the spray of pomegranate trees with potassium citrate at 2.0g/ l + Fe-Mn-Zn at 100 ppm **or** potassium citrate at 2.0g/l + Fe-Mn-Zn at 50 ppm treatments increase total chlorophyll contents in the leaves.

B. Interaction effect:

Concerning the interaction effect of the two investigated factors i.e., pomegranate cultivars (Manfalouty and Wonderful) and different nutrient solutions on total chlorophyll contents, data in **Table(4)** indicate that, spray Wonderful cultivar with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l + Fe-Mn-Zn at 50 ppm gave the highest values at the total chlorophyll content. On the other hand, the lowest value of total chlorophyll content was detected with Manfalouty cultivar spray with tap water (control) during both seasons of study.

Such results are in general agreement with **Sheikh and Manjula, 2009.**

Table 4. Impact of foliar spray with some nutrients and pomegranate cultivars on leaf total chlorophyll and nitrogen content during 2018 and 2019 seasons.

Cultivars	Manfalouty	Wonderful	Mean*	Manfalouty	Wonderful	Mean*
Treatments	**2018**			**2019**		
	Total chlorophyll %					
1	7.30 c	7.50 c	**7.40 C**	7.35 b	7.80 b	**7.58 B**
2	7.43 c	7.60 bc	**7.52 C**	7.40 b	7.85 b	**7.59 B**
3	7.70 bc	7.73 bc	**7.72 C**	7.73 b	7.92 b	**7.83 B**
4	7.71 bc	7.75 bc	**7.73 C**	7.75 b	7.96 b	**7.86 B**
5	8.20 b	8.50 b	**8.35 BC**	8.50 b	8.90 b	**8.70 B**
6	8.50 b	8.65 b	**8.58 ABC**	8.55 b	8.99 b	**8.72 B**
7	8.90 b	9.30 ab	**9.10 AB**	9.10 ab	9.60 ab	**9.35 AB**
8	9.30 ab	9.70 ab	**9.50 AB**	9.35 ab	9.85 ab	**9.60 AB**
9	9.70 ab	10.30 ab	**10.00 AB**	9.70 ab	11.00 a	**10.35 A**
10	10.10 ab	11.00 a	**10.55 AB**	10.00 ab	11.30 a	**10.65 A**
11	11.20 a	11.85 a	**11.53 A**	11.30 a	12.80 a	**11.05 A**
12	11.30 a	12.00 a	**11.65 A**	11.50 a	12.83 a	**12.17 A**
Mean**	**8.95 A**	**9.32 A**		**9.02 A**	**9.73 A**	
	N%					
1	1.80 b	1.86 b	**1.83 B**	1.71 b	1.80 b	**1.76 B**
2	1.93 b	1.95 b	**1.94 B**	1.73 b	1.90 b	**1.82 B**
3	1.95 b	2.00 ab	**1.98 B**	1.74 b	1.98 b	**1.86 B**
4	1.95 b	2.15 ab	**2.05 AB**	1.75 b	1.99 b	**1.87 B**
5	1.99 ab	2.20 ab	**2.09 AB**	1.78 b	2.10 b	**1.94 B**
6	2.15 ab	2.25 ab	**2.20 AB**	2.00 b	2.11 b	**2.06 AB**
7	2.60 a	2.69 a	**2.62 A**	2.45 a	2.50 a	**2.48 A**
8	2.65 a	2.78 a	**2.72 A**	2.48 a	2.67 a	**2.56 A**
9	2.66 a	2.80 a	**2.73 A**	2.50 a	2.70 a	**2.60 A**
10	2.70 a	2.84 a	**2.77 A**	2.61 a	2.78 a	**2.70 A**
11	2.71 a	2.85 a	**2.78 A**	2.62 a	2.79 a	**2.71 A**
12	2.71 a	2.87 a	**2.79 A**	2.64 a	2.81 a	**2.73 A**
Mean**	**2.32 A**	**2.44 A**		**2.17 A**	**2.34 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

- Leaf nitrogen content:

A. Specific effect:

Table (4) displays that, leaf nitrogen content did not respond to the investigated cultivar type. Wonderful cultivar gave a high value compared with Manfalouty cultivar without significant differences during two seasons. Concerning the specific effect of the different nutrient solutions on leaf N content, data presented in **Table (4)** show that all treatments increased leaf nitrogen content compared with control, the high values of leaf nitrogen content were observed when pomegranate trees spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. On the other hand, the control treatment decreased significantly N % in leaf.

B. Interaction effect:

Regarding the interaction effect of the two investigated factors i.e., cultivar type and the different solutions on leaf N content, data presented in **Table (4)** clear obviously that, a combination between Wonderful cultivar and spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm gave the high values compare with other combinations during the 2018 and 2019 seasons.

Such results are in general agreement with **Gill *et al.,* (2013) and El Salhy *et al*., (2015).**

- Leaf phosphorus content:

A. Specific effect:

Concerning the specific effect of the two investigated factors involved in this study i.e. cultivar type of pomegranate and the different nutrient solutions on leaf phosphorus content. The results **in Table (5)** revealed that the leaf of Wonderful was richer in its phosphorus content as compared with the Manfalouty cultivar during both seasons of study. The specific effect of the different nutrient solutions on leaf phosphorus content, data in **Table (5)** show that spray pomegranate trees with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l + Fe-Mn-Zn at 50 ppm increased leaf phosphorus content. On the other hand, the control treatment decreased significantly phosphorus % in the leaf during both seasons of the study.

B. Interaction effect:

Results in **Table (5)** show the effect of the interaction between pomegranate cultivars and the different nutrient solutions on leaf phosphorus contents. Results indicate that leaf phosphorus was significantly affected by the interaction between the two investigated factors involved in this study. On the other hand, the highest value of leaf phosphorus content was that combination between Wonderful cultivar and spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. Whereas the lowest value effect on leaf phosphorus content was detected with the Manfalouty cultivar combined with control treatment. These results are congeniality with the findings previously detected by **Gill *et al.,* (2013) and El Salhy *et al*., (2015).**

- Leaf potassium content:

A. Specific effect:

Table (5) show that the leaf of Wonderful was richer in its potassium content as compared with the Manfalouty cultivar during both seasons of study. Concerning the specific effect of the different nutrient solutions on leaf K content, data presented in **Table (5)** clearly that, leaf potassium content increased significantly when pomegranate trees spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. On the opposite, the control treatment decreased significantly K % in leaves during the two seasons of study.

B. Interaction effect:

Referring to the interaction effect of the two investigated factors i.e., pomegranate cultivars and different nutrient solutions on leaf potassium content, data presented in **Table (5)** show obviously that, the most spurious combination of enhanced leaf potassium contents was that combination between Wonderful cultivar and spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. Moreover, the lowest decrease in leaf potassium content was detected by Manfalouty cultivar spray with tap water (control) during the 2018 and 2019 seasons.

The present results are in agreement with the findings of **Moawad et *al.,* (2014) and Hamouda *et al.,* (2015).**

Table 5. Impact of foliar spray with some nutrients and pomegranate cultivars on leaf phosphorus and potassium content during the 2018 and 2019 seasons.

Cultivars / Treatments	Manfalouty 2018	Wounderful 2018	Mean*	Manfalouty 2019	Wounderful 2019	Mean*
			P%			
1	0.41 c	0.53 b	**0.47 B**	0.44 c	0.56 c	**0.50 C**
2	0.45 c	0.55 b	**0.50 B**	0.46 c	0.60 c	**0.53 C**
3	0.48 c	0.56 b	**0.51 B**	0.50 c	0.60 c	**0.55 C**
4	0.50 c	0.58 b	**0.54 B**	0.55 c	0.65 bc	**0.60 BC**
5	0.60 b	0.58 b	**0.59 B**	0.67 bc	0.72 bc	**0.70 B**
6	0.60 b	0.60 b	**0.60 B**	0.69 bc	0.72 bc	**0.71 B**
7	0.68 a	0.79 a	**0.74 A**	0.70 bc	0.81 a	**0.76 AB**
8	0.71 a	0.80 a	**0.76 A**	0.75 a	0.83 a	**0.79 AB**
9	0.76 a	0.83 a	**0.79 A**	0.80 a	0.83 a	**0.81 A**
10	0.78 a	0.83 a	**0.81 A**	0.84 a	0.85 a	**0.85 A**
11	0.78 a	0.84 a	**0.81 A**	0.88 a	0.90 a	**0.89 A**
12	0.79 a	0.85 a	**0.82 A**	0.90 a	0.93 a	**0.92 A**
Mean**	**0.63 B**	**0.70 A**		**0.68 B**	**0.82 A**	
			K%			
1	1.10 c	1.22 b	**1.16 B**	1.16 b	1.25 b	**1.20 B**
2	1.11 c	1.24 b	**1.18 B**	1.17 b	1.28 b	**1.22 B**
3	1.11 c	1.24 b	**1.18 B**	1.18 b	1.30 b	**1.24 B**
4	1.11 c	1.24 b	**1.18 B**	1.19 b	1.32 b	**1.25 B**
5	1.13 c	1.30 bc	**1.21 AB**	1.20 b	1.33 b	**1.27 B**
6	1.13 c	1.35 b	**1.23 AB**	1.25 b	1.34 b	**1.29 B**
7	1.22 b	1.45 a	**1.34 A**	1.35 a	1.45 a	**1.40 A**
8	1.23 b	1.46 a	**1.35 A**	1.37 a	1.47 a	**1.42 A**
9	1.25 b	1.48 a	**1.36 A**	1.40 a	1.48 a	**1.44 A**
10	1.30 b	1.50 a	**1.40 A**	1.40 a	1.50 a	**1.45 A**
11	1.34 b	1.53 a	**1.44 A**	1.42 a	157 a	**1.49 A**
12	1.35 b	1.54 a	**1.45 A**	1.43 a	1.60 a	**1.52 A**
Mean**	**1.20 B**	**1.38 A**		**1.30 B**	**1.37 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

- Leaf iron content:

A. Specific effect:

Concerning the specific effect of the pomegranate cultivar on leaf iron content, data in **Table (6)** clearly show that leaf Fe content of Wonderful was higher than that recorded with the Manfalouty cultivar without significant differences during two seasons. As for the specific effect of the nutrient solutions on leaf Fe content, data presented in **Table (6)** revealed that the highest leaf Fe content was remarked with the pomegranate trees spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. Meanwhile, the lowest value in leaf Fe content was associated with the control treatment during the 2018 and 2019 seasons.

B. Interaction effect:

Data in **Table (6)** show that Wonderful cultivar spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm was the best combination where it raised leaf Fe content to the maximum level as compared with the other tested combinations during both seasons of study. On the other hand, leaf Fe content reached the minimum value when Wonderful or Manfalouty cultivars were treated with control.

- Leaf manganese content:

A. Specific effect:

Table (6) shows that leaf Manganese content of the Wonderful cultivar was statistically higher than that recorded with Manfalouty cultivar. Regarding the specific effect of the nutrient solutions on leaf Mn content, data presented in **Table (6)** clearly that, leaf Mn content took the same trend, whereas the highest leaf Mn content was remarked with the trees spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. On the other hand, the control treatment decreased significantly N % in leaf. Meanwhile, the lowest value of Mn content in the leaf was associated with the control treatment during the 2018 and 2019 seasons.

B. Interaction effect:

Data in **Table (6)** show that the Wonderful cultivar combined with foliar spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. On the other hand, leaf Mn content reached the minimum value when the Manfalouty cultivar and spray with tap water. This trend of response is in general agreement with the findings of **Ramy *et al.*, (2015) and Shazia (2016)**.

Table 6. Impact of foliar spray with some nutrients and pomegranate cultivars on iron and manganese content during 2018 and 2019 seasons**.**

	Fe (ppm)					
Cultivars	**Manfalouty**	**Wonderful**	**Mean***	**Manfalouty**	**Wonderful**	**Mean***
Treatments	**2018**			**2019**		
1	230.00 c	215.00 c	**222.00C**	235.00 c	218.00 c	**225.50 C**
2	260.00 c	250.00 c	**255.00C**	263.00 b	255.00 c	**259.00 C**
3	265.00 c	248.00 c	**256.50C**	267.00 b	252.00 c	**259.50 C**
4	270.00 c	248.00 c	**259.00C**	270.00 b	255.00 c	**262.50 C**
5	350.00 b	315.00 b	**333.00B**	340.00 a	310.00 b	**325.00 B**
6	350.00 b	310.00 b	**330.00B**	350.00 a	315.00 b	**332.50 B**
7	350.00 b	320.00 b	**335.00B**	356.00 a	315.00 b	**336.00 B**
8	380.00 b	360.00 b	**370.00B**	385.00 a	375.00 a	**380.00A**
9	410.00 a	411.00 a	**410.50A**	425.00 a	420.00 a	**422.50 A**
10	425.00 a	419.00 a	**422.00A**	430.00 a	425.00 a	**427.50 A**
11	440.00 a	425.00 a	**432.50A**	441.00 a	433.00 a	**437.00 A**
12	446.00 a	430.00 a	**438.00A**	450.00 a	436.00 a	**443.00 A**
Mean**	**318.83 A**	**329.25 A**		**351.00 A**	**334.00 A**	
	Mn (ppm)					
1	29.00 c	33.00 bc	**31.00 B**	30.00 b	35.00 b	**32.50 B**
2	29.00 c	35.00 b	**32.00 B**	32.00 b	41.00 a	**36.50 B**
3	29.00 c	35.00 b	**32.00 B**	33.00 b	42.00 a	**37.50 B**
4	30.00 bc	36.00 b	**33.00 B**	33.00 b	42.00 a	**37.50 B**
5	35.00 b	43.00 a	**39.00AB**	40.00 a	51.00 a	**45.05 A**
6	35.00 b	44.00 a	**39.50AB**	40.00 a	52.00 a	**46.00 A**
7	36.00 b	46.00 a	**41.00 A**	40.00 a	53.00 a	**46.50 A**
8	38.00 ab	47.00 a	**42.50 A**	42.00 a	53.00 a	**47.50 A**
9	40.00 a	47.00 a	**43.50 A**	43.00 a	53.00 a	**48.50 A**
10	41.00 a	48.00 a	**44.50 A**	43.00 a	54.00 a	**48.50 A**
11	42.00 a	48.00 a	**45.00 A**	44.00 a	54.00 a	**49.50 A**
12	42.00 a	48.00 a	**45.00 A**	44.00 a	54.00 a	**49.00 A**
Mean**	**35.50 B**	**45.00 A**		**38.67 B**	**48.67 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

- Leaf zinc content:

A. Specific effect:

Data in **Table (7)** clearly show that the Wonderful cultivar was the highest value of leaf zinc content compared with the Manfalouty cultivar during both seasons of study. Concerning the specific effect of nutrient solutions on leaf zinc content, data presented in **Table (7)** show that, spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm gave the highest value in leaf zinc during the two seasons of study. On the contrary, the control treatment decreased significantly Zn in leaf.

B. Interaction effect:

As for the interaction effect of the two investigated factors i.e., cultivar and the nutrient solutions on leaf zinc content of pomegranate trees. Data in **Table (7)** clear that, the highest leaf zinc content was coupled with Wonderful cultivar spray with potassium citrate at 2.0g/l + Fe-Mn-Zn at 100 ppm or potassium citrate at 2.0g/l. + Fe-Mn-Zn at 50 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 100 ppm or mono-potassium phosphate at 2.0 g/l. + Fe-Mn-Zn at 50 ppm during both seasons. On the contrary, the lowest value of both cultivars in leaf zinc content was detected by Manfalouty cultivar spray with tap water (control) treatment during both seasons of study.

The present results are in agreement with the findings of **Hasani *et al.*, (2012) and Eiada and Al-Hadethi (2013)**

Table 7. Impact of foliar spray with some nutrients and pomegranate cultivars on leaf zinc content during 2018 and 2019 seasons.

Cultivars / Treatments	Zn (ppm) Manfalouty 2018	Wonderful 2018	Mean*	Manfalouty 2019	Wonderful 2019	Mean*
1	23.00 c	40.00 b	**31.50B**	25.00 c	43.00 ab	**34.00 B**
2	25.00 c	42.00 b	**33.50B**	26.00 c	44.00 ab	**35.00 B**
3	25.00 c	42.00 b	**33.50B**	27.00 c	45.00 ab	**36.00 B**
4	26.00 c	43.00 b	**34.50B**	28.00 c	45.00 ab	**36.50 B**
5	35.00 b	50.00 a	**42.50AB**	38.00 b	52.00 a	**45.00 A**
6	37.00 b	51.00 a	**44.00 A**	40.00 ab	53.00 a	**46.50 A**
7	39.00 b	51.00 a	**45.00 A**	41.00 ab	54.00 a	**47.50 A**
8	40.00 b	51.00 a	**45.50 A**	44.00 ab	56.00 a	**50.00 A**
9	43.00 b	52.00 a	**47.50 A**	48.00 a	57.00 a	**51.50 A**
10	44.00 a	54.00 a	**49.00 A**	49.00 a	57.00 a	**52.00 A**
11	46.00 a	55.00 a	**50.50 A**	49.00 a	58.00 a	**52.50 A**
12	46.00 a	56.00 a	**51.00 A**	50.00 a	58.00 a	**53.00 A**
Mean**	**35.75 B**	**48.92 A**		**38.75 B**	**51.83 A**	

*, ** refer to the specific effect of treatments and cultivars, respectively. Means of each investigated factor or their combinations followed by the same letter/s are not significantly different at the 5% level.

1- Spraying tap water (control). 2- Spraying potassium sulphate at 2g/l. 3- Spraying mono-potassium phosphate at 2.0 g/l. 4- Spraying potassium citrate at 2.0g/ l. 5- Spraying Fe, Mn and Zn at 50 ppm for each. 6- Spraying Fe, Mn and Zn at 100 ppm for each. 7- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 50 ppm for each. 8- Spraying potassium sulphate at 2g/l. + Fe, Mn and Zn at 100 ppm for each. 9- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 50 ppm for each. 10- Spraying mono-potassium phosphate at 2.0 g/l. + Fe, Mn and Zn at 100 ppm for each. 11- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 50 ppm for each. 12- Spraying potassium citrate at 2.0g/ l. + Fe, Mn and Zn at 100 ppm for each.

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تاثير الرش الورقى ببعض المغذيات على النمو والحالة الغذائية لاشجار الرمان

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تم إجراء هذه الدراسة خلال موسمي 2018 و 2019 لدراسة تأثير صنفي الرمان (المنفلوطي والوندرفول) وبعض المحاليل المغذية على النمو والحالة الغذائية (محتوى الأوراق من الكلوروفيل الكلى وبعض العناصر المعدنية).

أظهرت النتائج أن صنف الوندرفول كان أفضل من الصنف المنفلوطي في جميع قياسات النمو الخضري. كما ان الرش الورقي بسترات البوتاسيوم بمعدل 2.0 جم / لتر + الحديد والمنجنيز والزنك بمعدل 100 جزء في المليون لكل منهم أو سترات البوتاسيوم بمعدل 2.0 جم / لتر + الحديد والمنجنيز والزنك بمعدل 50 جزء في المليون لكل منهم كان الافضل في هذا الصدد مقارنة بباقي المعاملات. كما اوضحت النتائج ان نفس المعاملات السابق ذكرها ادت الى زيادة محتوى الاوراق من الكلوروفيل والعناصر التي تم تقديرها مقارنة مع بالمعاملات المختلفة الأخرى خلال موسمي الدراسة. وبالإشارة إلى تأثير التفاعل بين العاملين المدروسين على النمو الخضري والحالة الغذائية لأشجار الرمان ، أظهرت النتائج ان اعلى القيم تم الحصول عليها عند رش اشجار الرمان صنف الوندرفول بسترات البوتاسيوم بمعدل 2.0 جم / لتر + الحديد والمنجنيز والزنك بمعدل 100 جزء في المليون لكل منهم أو سترات البوتاسيوم بمعدل 2.0 جم / لتر + الحديد والمنجنيز والزنك بمعدل 50 جزء في المليون لكل منهم مقارنة بباقي التفاعلات.