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Tolerance of two pomegranates *cultivars* (*Punica granatum L.*) to salinity stress under hydroponic culture conditions.

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ABSTRACT

A hydroponic culture experiment was carried out during two successive seasons (2013/2014 and 2014/2015) on two pomegranates *cvs* (Wounderful and Manfalouty) to study the effect of salinity on growth and leaf chemical composition of pomegranate seedlings**.** The plants were two years old at the start of the experiment. The experiment was conducted under controlled conditions in greenhouse, with temperature fixed at 25 ± 3C°, relative humidity between 75 – 85% and 14 hours light exposure. The Wounderful cultivar exhibited higher tolerance to high salinity as compared to Manfalouty cultivar. higher values of shoot length, chlorophyll contents and growth ratio at high salinity concentrations (1500 and 1750 ppm) were recorded for Wounderful cultivar as compared to Manfalouty cultivar.

The chemical analysis of mature leaves of the two pomegranate cultivars indicated that Wounderful *CV* showed significantly higher ratio of N, K, Mg, Fe and Zn than Manfalouty *CV*. On the other hand, the Manfalouty *CV* exhibited higher levels of P and Mn contents as compared to Wounderful *CV*. No significant differences were observed between the two cultivars in Ca and B contents. In the two tested cultivars, Fe, Zn and Mn contents were decreased significantly as a result of increasing the salinity of nutrient solution from 500 ppm to 1750 ppm. This decrement was more pronounced for iron. On the other hand, leaf contents of phosphors and boron were found to be markedly higher in the plants grown under high salinity level (1500 and 1750 ppm NaCl) than those grown in low salinity level (500 ppm NaCl).

Generally, pomegranates Wounderfoul *CV* was found to be tolerant to high salinity than Manfalouty *CV*. Therefore, cultivation of Wounderfoul *CV* in newly reclaimed soils of high salinity is highly recommended to avoid the harmful effect of salinity

KEY WORDS: Pomegranates, Punica granatum L., Wounderfoul, Manfalouty, high pH, Salinity, Hydroponics culture.

INTRODUCTION

Pomegranates (*Punica granatum L.*) belongs to the family *Punicaceae*, widely grown in the moderate climate of the Mediterranean region and it is well adapted to arid and semi-arid soils, and their trees grow successfully under unfavorable climatic and soil conditions. Some investigators classified the pomegranate under salinity resistant plants.

Hydroponics is a recent technology for growing plants using a nutrient solution without soil. Terrestrial plants may grow well in the mineral nutrient solutions only, or in inert medium, such as perlite, gravel, mineral wool, or coconut husk. Actually, hydroponics is an established branch of horticulture (Douglas, 1975). The advantage of hydroponic can be summarized in the following points: a) No soil is needed for the hydroponic system. b) The water in this system can be reused. c) It is possible to control the nutrition levels in their entirety. d) No nutrition pollution is released into the environment because of the controlled system, and e) Easy to control both pests and diseases in the system than the soil culture. Therefore, rapid and accurate results can be achieved via hydroponic technology (Huett, 1994 and Morard, 1995).

Salinity tolerance is a complex feature depends on both genetical and physiological properties. The effects of salinity appear to be dependent on the species and cultivars and on the stage of the plant development West (1978) and Grattana and Grieve (1999). Ibrahim (2011) stated that pomegranate growth did not affect by salinity in the range of 500 – 750 ppm.

Plant performance may be adversely affected by salinity-induced nutritional disorders. These disorders may result from the effect of salinity on nutrient availability, competitive uptake, transport or partitioning within the plant, Marschner (1995), Grattana and Grieve (1999), Magen (2000), Mazher *et al*., (2007) and Chuanhe and Jiezhong (2014) reported that high salinity depressed growth of plants mainly by inhibiting uptake of cations (such as Mg^{++}) and anion (such as NO_3^-), and hence Mg as well as nitrogen deficiencies were observed.

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Furthermore, the salinity tolerance of the plant is not a simple attribute, but it is outcome of various features that depend on different physiological interaction, which are difficult to determine (Grattana and Grieve 1999, Munns, 2002 and Abdul Qados, 2011).

In Egypt, the newly reclaimed desert soils may contain high salt concentrations. Since, the crops which can be cultivated in such soils must be of high tolerance to salinity. Since there is not much data in the literature about the tolerance of the main pomegranate cultivars to salinity stress, the present investigation aimed to study the tolerance of two pomegranate *CVS* (Wounderful and Manfalouty) to high salinity levels. These cultivars are the major pomegranate cultivars in Egypt. Wounderful was introduced recently to Egypt from USA and Manfaluty is the main Egyptian cultivar and well adapted in middle Egypt region.

MATERIALS AND METHODS

This study was carried out during two successive seasons (2013/2014 and 2014/2015) on two pomegranate cultivars *(Punica granatume L.*), namely Manfalouty and Wounderful. This study was conducted under controlled conditions in a greenhouse. The temperature adjusted to 25 ± 3C°, relative humidity ranged between 75 – 85 % and 14 hours exposure to light.

Plant material:

The used seedlings of the two pomegranate cultivars were two years old and own rooted. In January, the seedlings were pruned leaving two main branches and each one shorted at 50 cm, then they cultivated on sandy soil and irrigated with nutrient solution of pH 6.5 and 500 ppm NaCl (Morard, 1995) until the end of February, then the plants were transported to the hydroponic solution culture of the different salinity levels.

Nutrient solutions:

Standard nutrient solution reported by Sarafi *et al*., (2014), supplemented with the nutrients requirements of pomegranates was prepared. The nutrient solution contained Macro-nutrients (meq/L) 8.5 NO_3, 1.0 H_2PO_5, 1.3 SO_4, 1.0 NH_4, 2.1 K, 6.7 Ca, 2.0 Mg and Micro-nutrients (meq/L); 5.9 Fe, 2.0 Mn, 0.05 Mo, 1.5 B, 0.5 Zn, 0.25 Cu. pH was adjusted to 6.5 using HCl or KOH solutions and salinity was adjusted to 500, 750, 1000, 1250, 1500 and 1750 ppm using analar grade NaCl. Aeration system was used for 5 hours / day and the nutrient solution was changed weekly.

Experimental work:

Under greenhouse conditions, the plants were fixed in plastic covers in 10 liter plastic pots, each filled with 7L nutrient solution. Each pot was supplied by two plants, the total number of pots used were 36 (eighteen pots for each *CV*).

Measurements of Vegetative Growth:

After the bud burst, the lengths of shoots (in Cm) were recorded at intervals of 10 days until the end of the experiment (3 Months), and then the growth ratio (Cm/day) was calculated. At the end of the experiment the leaf area of the mature leaves was measured by an area meter (Area Meter Cl, 202)

Chlorophyll contents:

One gram of fresh tissue was taken from the mature leaves and extracted by grinding in a mortar using 20 ml acetone, a small amount of pure silica quartz and 0.5 g calcium carbonate to neutralize the cellular sap acidity. The extract was filtered using a glass funnel and collected in a conical flask. The residue was re-extracted as described above until it became colorless. The extract was collected in a standard flask and the volume completed to a specific amount by adding acetone. The optical density (O.D.) of the extract was measured at wave lengths 663 and 645 nm to estimate chlorophyll a and b, respectively (Smith and Benitez, 1955) using a Spectrophotometer (Spectronic 21D). Three replicates for each treatment were employed, and the amount of Chlorophyll a and b present in each sample was calculated according to the following equations:

chlorophyll a (mg/g fresh weight) $$= 12.7(OD)663 - 2.69(OD)645x\frac{v}{w\ x\ 1000}$$

chlorophyll b (mg/g fresh weight) $$= 22.9\ (OD)\ 645 - 4.68\ (OD)\ 663\ x\frac{v}{w\ x\ 1000}$$

whereas: W the fresh weight by grams for extracted tissue; V, the final size of the extract in 80% acetone; O.D., optical density at specific wave length.

Foliar diagnoses:

The mature leaves were collected at the end of the experiment, as described by Morard (1995) and Garcia *et al.,* (1984). The Ca, K, mg and micro-nutrients were determined by atomic absorption spectrophotometry (Perkin Elmer 280). After overnight dehydration at 80C°, the leaves were grinded to fine powder. The total nitrogen was determined by Kjeldhal method and the phosphorus was determined calorimetrically as described by Wilde *et al*. (1979).

Statistical design:

The experiment was arranged in a randomized complete blocks design, with four replicates. Each replicate comprised two plants. The main plots were allocated to cultivars, the sub plots were assigned to salinity levels. Data were subjected to analysis of variance and means were compared according to Snedecor and Cochran, (1990).

RESULTS AND DISCUSSION

1- Growth characters (Shoot lengths and Growth ratio):

The shoot lengths and growth ratio of Wounderful and Manfalouty varieties grown hydroponically at different salinity levels were studied. As shown in Table (1) and figure (1 and 2) a gradual decrease in shoot length was observed with increasing the salinity level from 500 to 1750 ppm. This reduction is pronounced in the plants grown in the highest salinity level (1750 ppm). The shoot length of Manfalouty cultivar is markedly affected by high salinity levels than those of Wounderful cultivar. Moreover, the interaction between the cultivars and salinity levels had a significant effect on shoot length in the two seasons as shown in Table (1).

Table (1): Effect of salinity levels on the main shoot lengths (cm) of Wounderful and Manfalouty pomegranate cultivars grown hydroponically.

Salinity level	2013/2014			2014/2015		
	Wounderful (A1)	Manfalouty (A2)	Mean B	Wounderful (A1)	Manfalouty (A2)	Mean B
B1(500ppm)	109.8	115.3	112.5	103.9	107.5	105.7
B2(750ppm)	107.2	102.1	104.7	101.4	102.3	101.4
B3(1000ppm)	104.7	99.3	102.0	88.5	82.9	85.7
B4(1250ppm)	100.3	78.6	89.5	82.9	70.8	76.9
B5(1500ppm)	85.1	62.2	79.6	71.3	53.1	62.2
B6(1750ppm)	35.7	22.1	28.9	55.9	42.6	49.3
Mean A	90.5	79.9		83.9	76.3	
L.S.D 5%	a= 10.2	b= 9.5	ab= 13.4	A= 6.2	b = 10.2	ab14.3

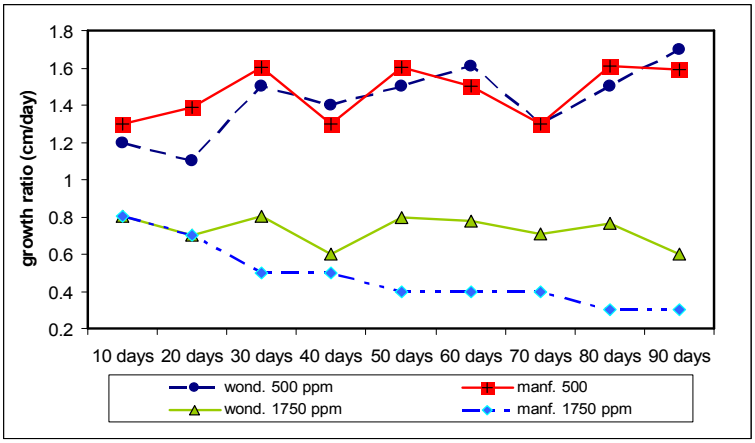

Figure (1): Effect of low (500 ppm) and high (1750 ppm) salinity levels on the growth ratio (cm/day) of the main shoot lengths of Wounderful and Manfalouty pomegranate cultivars grown hydroponically (Data calculated as a mean of the two experimental seasons).

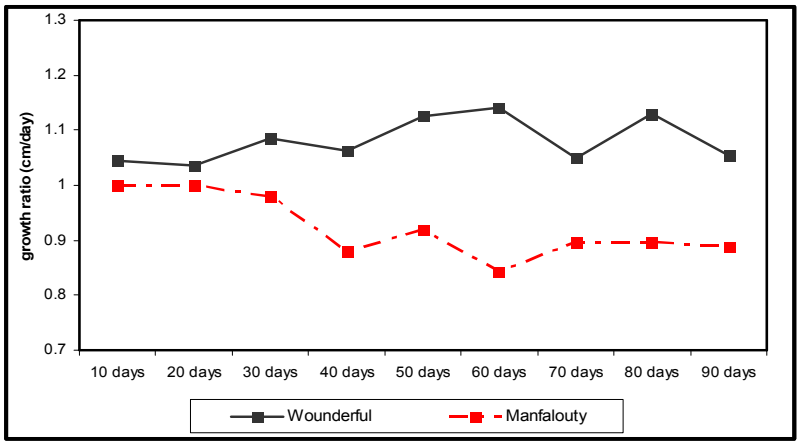

Figure (2): Effect of salinity levels on the growth ratio (cm/day) of the main shoot lengths of Wounderful and Manfalouty pomegranate cultivars grown hydroponically (Data calculated as a mean of the two experimental seasons).

Shoot growth ratio (cm/day) was gradually and consistently decreased as the nutrient solution salinity level was gone upward with the lowest growth ratio being obtained due to the highest salinity level (1750 ppm) for the two cultivars. In addition, Manfalouty cultivar exhibited lower growth ration than Wounderful cultivar, this decrement was remarkable within the last 50 days of experiment (figure 1 and 2). Such results may be due to the low tolerance of Manfalouty to high salinity.

These results are in agreement with those obtained by Grattana and Grieve (1999), Sheldon *et al*., (2005), Beltagi *et al.* (2006), Mustard and Renault (2006), Saffan (2007 & 2008), Sohail *et al.,* (2009), Abdul Qados (2011), Karimi and Hasapour (2014), Sarafi (2014) and Mojtaba *et al.,* (2014), who noticed that the increase in salinity level resulted in decrease in plant length and growth. This reduction in plant growth may be resulted from the effect of salinity on nutrient availability, completion uptake, transport or partitioning within the plant and utilization in the plant. Moreover, the salinity may inhibit uptake of cations (such as Mg^{++}) and anion (such as NO_3^-, SO_4^{2-} and HCO_3^-) and hence Magnesium as well as nitrogen deficiencies can be observed (Cramer and Nowak, 1992, Munns 1995, Grattana Grieve, 1999, Chuanhe and Jiezhong 2014, Muhammad 2004, Mojtaba *et al.,* 2014 and Sarafi 2014).

2- Leaf area:

The effect of high salinity on the leaf area of the two tested pomegranate cultivars (Wounderful and Manfalouty) during the two experimental seasons (2013/2014 and 2014/2015) are presented in Table (2). The obtained results indicated that, the increase in salinity level significantly decreased the leaf area of mature leaves in both cultivars, in a gradual manner as a result of increasing the NaCl concentration in nutrient solution. However, Manfalouty *cv* markedly affected by salinity than Wounderful *cv*.

The interaction between cultivars and nutrient solution salinity levels was significant in both experimental seasons. However, the Manfalouty seedlings grown in high salinity nutrient solution presented the lowest leaf area value in the two experimental seasons as shown in Table (2).

Table (2): Effect of salinity levels on leaf area (cm^2) of Wounderful and Manfalouty pomegranate cultivars grown hydroponically.

Salinity level	2014			2015		
	Wounderful (A1)	Manfalouty (A2)	Mean B	Wounderful (A1)	Manfalouty (A2)	Mean B
B1(500ppm)	12.7	12.9	12.8	11.4	12.1	11.8
B2(750ppm)	12.6	12.8	12.7	11.8	11.4	11.6
B3(1000ppm)	11.6	11.2	11.4	10.7	10.2	10.5
B4(1250ppm)	11.4	10.2	10.8	9.5	8.3	8.9
B5(1500ppm)	10.9	8.1	9.5	9.1	7.6	8.4
B6(1750ppm)	8.9	7.6	8.3	8.2	7.1	7.7
Mean A	11.4	10.5		10.2	9.5	
L.S.D $_{5\%}$	a= 0.5	b= 0.1.1	ab= 1.5	a= 0.4	b= 0.9	ab 1.3

The decrease in the leaf area due to the growth in high sodium chloride solution concentration (1500 and 1750 ppm) could be explained by its negative effect on the rate of photosynthesis, the

changes in enzyme activity (that subsequently affects protein synthesis), and also the decrease in the level of carbohydrates and growth hormones, which could lead to the inhibition of leaf growth (Munns 1993, Grattana and Grieve 1999, Sivritepe and Eris 1999, Munns 2002, Yang *et al.,* 2005, Sohail *et al.,* 2009, Abdul Qados 2011 and Sarafi (2014)

3- Leaf chlorophylls a and b contents:

Results recorded in Table (3) reveal that chlorophyll a and b were significantly decreased by increasing the concentration of NaCl in the nutrient solution, in the two pomegranate cultivars in the two experimental seasons. The highest values of chlorophyll a and b were achieved in the leaves of plants grown in the lowest salinity nutrient solution (500 ppm). With increasing the salinity of nutrient solutions from 500 ppm to 1750 ppm, a gradual decrease in leaf chlorophyll content was observed. The decreased jn chlorophyll contents, as indicated in this study, was also revealed by Krishnamurthy *et al*., (1987) on pomegranate, Sivritepe and Eris (1999) on grapevine seedlings and Yang *et al.,(* 2005) on apple seedlings. This decrement was more pronounced in the Manfalouty cultivar than in Wounderful cultivar in the two experimental seasons.

Furthermore, the interaction between the cultivars and salinity levels was significant in the two experimental seasons.

The reduction in leaf chlorophyll contents of pomegranate grown in high salinity nutrient solutions may be due to the inhibition of nutrient ions uptake and transport or partitioning within the plant such as $NO3^-$ and Mg^{++}, transportation and utilization in the plants, (Sohail *et al.,* 2009).

Table (3): Effect of salinity levels on chlorophyll a and b (mg/100 g) of Wounderful and Manfalouty pomegranate cultivars grown hydroponically.

Salinity level	Chlorophyll a					
	2014			2015		
	Wounderful A1	Manfalouty A2	Mean B	Wounderful (A1)	Manfalouty (A2)	Mean B
B1(500ppm)	7.76	7.81	7.78	8.89	8.33	8.61
B2(750ppm)	7.53	7.01	7.27	7.92	8.19	8.05
B3(1000ppm)	7.36	6.27	6.82	7.22	7.28	7.25
B4(1250ppm)	6.88	5.32	6.10	6.69	6.41	6.55
B5(1500ppm)	6.36	5.03	5.69	6.48	5.28	5.88
B6(1750ppm)	5.42	4.42	4.92	5.45	4.22	4.83
Mean A	6.50	5.97		7.11	6.62	
$L.S.D_{5\%}$	a= 0.49 ; b= 0.72 ; ab= 1.02			a= 0.50 ; b= 0.59 ; ab = 0.84		
	Chlorophyll b					
	214			215		
	Wounderful A1	Manfalouty A2	Mean B	Wounderful A1	Manfalouty A2	Mean B
B1(500ppm)	5,70	5.83	5.77	5.93	5.34	5.64
B2(750ppm)	5.62	4.54	5.08	5.82	5.15	5.49
B3(1000ppm)	4.93	3.08	4.01	4.68	4.27	4.47
B4(1250ppm)	4.09	2.98	3.54	4.39	3.32	3.86
B5(1500ppm)	2.86	2.29	2.58	3.30	2.98	3.14
B6(1750ppm)	2.05	1.78	1.92	2.82	2.09	2.40
Mean A	4.21	3.42		4.51	3.83	
$L.S.D_{5\%}$	a= 0.68 ; b=0.88 ; ab= 1.24			a= 0.61 ; b= 0.59 ; ab= 0.83		

4- Leaf mineral contents:

A- <u>Leaf macro-nutrient contents (N, P, K, Ca and Mg)</u>:

The chemical analysis of the mature leaves of the two pomegranate cultivars showed significant variation in leaf NPK contents. Data presented in table (4) indicate that the plants grown in 500 and 750 ppm of NaCl contained higher values of N and K as compared to those grown in higher salinity levels. However, the Wounderful cultivar exhibited significantly higher contents of the two elements than in Manfalouty cultivar.

On the other hand, increasing the NaCl concentration in the nutrient solutions from 1000 ppm to 1750 ppm, caused a gradual and significant increase in mature leaves phosphorus content of both cultivars. Whereas, in the lowest concentration (500 and 750 ppm) nonsignificant increase in mature leaves phosphorus contents of both cultivars were observed. Under the soilless culture (Grattana and Grieve 1994 and Yang *et al.,* 2005).or under the field condition (Sohail *et al*., 2009, Andreu *et al*., 2011 and Balal *et al*., 2011), same results for the phosphorus content were confirmed.

With increasing NaCl concentration in the nutrient solutions gradual and consistent decrease in leaves potassium content was recorded. Increasing the NaCl concentration in the nutrient solutions from 1000 ppm to 1750 ppm, caused a gradual and significant decrease in mature leaves potassium content of both pomegranate cultivars. Whereas, in the lowest NaCl concentrations (500 and 750 ppm)

nonsignificant decrease in mature leaves potassium content of both pomegranate cultivars was observed. However, the leaves of Wounderful cultivar present high and significant contents in potassium than those of Manfaluty cultivar. Some studies with a wide variety of horticulture crops have shown that K^+ concentration in plant tissue declines as a result of increasing Na-salinity in the root media (Garcia and Charbji 1993, Grattana and Grieve 1994 and 1999, Graifenberg *et al*., 1995, Sheldon *et al*., 2005 and Yang *et al.,* 2005,). The existence of large quantity in Na^+ ion in culture medium can obstruct the absorption and translocation of K^+ ion, that can be explained the significant decline in potassium contents.

Table (4): Effect of salinity levels on leaf N P K contents (% dray mater) of Wounderful (Won.) and Manfalouty (Manf.) pomegranate cultivars grown hydroponically.

	Season 2014								
	N %			**P%**			**K %**		
	Won. A1	**Manf. A2**	**Mean B**	**Won. A1**	**Manf. A2**	**Mean B**	**Won. A1**	**Manf. A2**	**Mean B**
B1(500ppm)	2.9	2.8	2.85	0.36	0.36	0.36	2.21	1.99	2.10
B2(750ppm)	2.7	2.8	2.75	0.34	0.36	0.36	2.23	1.89	2.06
B3(1000ppm)	2.4	2.3	2.35	0.34	0.38	0.36	2.01	1.79	1.90
B4(1250ppm)	2.3	1.9	2.10	0.37	0.39	0.38	1.95	1.71	1.83
B5(1500ppm)	2.0	1.7	1.85	0.40	0.43	0.42	1.88	1.58	1.73
B6(1750ppm)	1.8	1.4	1.60	0.41	0.45	0.43	1.57	1.39	1.48
Mean A	2.35	2.15		0.36	0.39		1.98	1.73	
L.S.D$_{5\%}$	a= 0.19 ; b= 0.22 ab= 0.33			a=0.02 ; b= 0.06; ab= 0.085			a= 0.21 ; b= 0.22; ab=0.31		
	Season 2015								
	N %			**P %**			**K %**		
	Won. A1	**Manf. A2**	**Mean B**	**Won. A1**	**Manf. A2**	**Mean B**	**Won. A1**	**Manf. A2**	**Mean B**
B1(500ppm)	2.8	2.8	2.8	0.32	0.34	0.33	1.99	1.87	1.93
B2(750ppm)	2.9	2.7	2.8	0.33	0.35	0.34	2.02	1.90	1.96
B3(1000ppm)	2.8	2.4	2.6	0.35	0.37	0.36	1.91	1.88	1.90
B4(1250ppm)	2.6	2.3	2.4	0.36	0.39	0.38	1.79	1.61	1.65
B5(1500ppm)	2.2	2.0	2.1	0.39	0.41	0.40	1.60	1.49	1.55
B6(1750ppm)	1.9	1.6	1.7	0.42	0.44	0.43	1.43	1.32	1.37
Mean A	2.57	2.30		0.36	0.38		1.79	1.68	
L.S.D$_{5\%}$	a= 19 ; b =0.30 ; ab= 0.42			a= 0.01 ; b=0.02 ; ab 0.03			a= 0.10 ; b= 0.11 ; ab=0.16		

No significant differences in leaf calcium content were observed between the two tested pomegranate cultivars in both experimental seasons. No significant effect in leaf calcium content was observed with increasing the salinity levels in the nutrient solutions. Whereas, significant decrease in leaf calcium contents in plants grown in the highest salinity was recorded.

Manfalouty cultivar was found to contain significant higher amount of magnesium as compared to the Wounderfoul cultivar. In respect to the salinity level in nutrient solutions plants grown in the highest salinity level (1750 ppm) were found to contain the lowest magnesium content in both experimental seasons. This decrement was more pronounced in Wounderfoul cultivar than in Manfalouty cultivar.

The effect of salinity in nutrient solutions on leaf N, K. and Mg contents, which observed in this study, was in accordance with the results obtained by Yang *et al.,* **(**2005), Abud Al Qados (2011), Tzortzakis (2010), Chunhe and Jiezhong (2014) and Sarafi (2014).

Table (5): Effect of salinity levels on leaf calcium and magnesium contents (% dray mater) of Wounderful and Manfalouty pomegranate cultivars grown hydroponically.

	Season 2014					
	Ca %			**Mg %**		
	Wonderful A1	**Manfalouty. A2**	**Mean B**	**Wonderful A1**	**Manfalouty A2**	**Mean B**
B1(500ppm)	2.9	2.8	2.85	0.82	0.84	0.83
B2(750ppm)	2.7	2.8	2.75	0.72	0.81	0.77
B3(1000ppm)	2.6	2.8	2.70	0.65	0.63	0.64
B4(1250ppm)	2.7	2.5	2.60	0.50	0.59	0.54
B5(1500ppm)	2.6	2.5	2.55	0.51	0.55	0.53
B6(1750ppm)	2.6	2.6	2.60	0.34	0.42	0.38
Mean A	2.68	2.66		0.59	0.64	
L.S.D $_{5\%}$	a= ns ; b= ns ; ab= ns			A= ns ; b= 0.22 ; ab= 0.32		
	Season 2015					
	Ca %			**Mg %**		
	Wonderful A1	**Manfalouty. A2**	**Mean B**	**Wonderful A1**	**Manfalouty A2**	**Mean B**

B1(500ppm)	2.7	2.7	2.7	0.79	0.83	0.81
B2(750ppm)	2.8	2.6	2.7	0.75	0.79	0.77
B3(1000ppm)	2.8	2.6	2.7	0.59	0.65	0.62
B4(1250ppm)	2.4	2.2	2.3	0.51	0.55	0.53
B5(1500ppm)	2.5	2.3	2.4	0.43	0.57	0.50
B6(1750ppm)	1.6	1.4	1.5	0.40	0.49	0.45
Mean A	2.5	2.3		0.57	0.65	
L.S.D$_{5\%}$	a= ns ; b= 0.51 ; ab= 0.72			a= 0.07 ; b= 0.09 ; ab= 0.12		

A- <u>Leaf micro-nutrient contents (Fe, Mn, Zn and B)</u>:

Results presented in Table (6). indicate that higher levels of salinity decrease mature leaves contents of Fe, Mn and Zn throughout the two experimental seasons. A gradual decrease in the these micro elements was accompanied with the increase in salinity level. Moreover, no significant differences were observed between the two cultivars in Zn content in the first season.

The interaction between the two pomegranates cultivars and the NaCl concentrations in nutrient solution significantly affected the leaf Fe, Mn and Zn contents in both experimental seasons as indicated in Table.(6). The lowest content of leaf Fe, Mn and Zn were recorded in Manfalouty seedlings grown in nutrient solution contained 1750 ppm NaCl.

Regarding leaf iron (Fe) contents, a gradual decreasing in leaf iron content as a result of increasing salinity concentration in nutrient solution was observed. This decrement was more pronounced in Manfalouty cultivar than in Wonderful one. Moreover, the interaction between the two cultivars and salinity levels was significant.

Mon-significant differences were observed in leaves boron contents neither between the cultivars nor between the salinity levels (except those between the salinity levels in the second season).

If the salinity is not the proper level, the plants lose some of their ability to absorb certain essential elements required for the growth. The optimum salinity level varies according to the species, but in general most pomegranates *CVS* resist the moderate salinity (500: 750 ppm). When the salinity concentration raises above 1000 ppm the absorption of nutrients markedly decreased. This phenomenon could be due to the effect of salinity on inhibition of nutrient uptake, transportation and utilization in the plant and accumulation in the leaf apoplasm as an important component of salt toxicity, leading to dehydration and turgon loss and death of leaf and tissues (Flowers 1988, Munns 1993 and 2002, Yang *et al.,*. 2005**,** Tzortzakis 2010, Abdul Qados 2011 and Sarafi 2014).

Table (6): Effect of salinity levels on leaf micro nutrient contents (ppm in dray mater) of Wounderfoul (Wond.) and Manfalouty (Manf.) pomegranate cultivars grown hydroponically.

Salinity Level	**Season 2014**											
	Fe (ppm)			**Mn (ppm)**			**Zn (ppm)**			**B (ppm)**		
	Wond. A1	**Manf. A2.**	**Mean B**	**Wond. A1**	**Manf. A2.**	**Mean B**	**Wond. A1**	**Manf. A2.**	**Mean B**	**Wond. A1**	**Manf. A2.**	**Mean B**
B1 500 ppm	69	65	67	53	59	56	67	69	68	32	34	33
B2 750 ppm	63	61	62	50	56	53	63	61	62	34	35	35
B3 1000ppm	54	50	52	44	56	50	59	53	56	40	43	42
B4 1250ppm	49	47	48	33	47	43	54	51	52	44	46	47
B5 1500ppm	45	35	40	31	41	36	46	44	45	46	50	48
B6 1750ppm	40	30	35	30	34	32	42	36	44	44	54	49
Mean A	53	48		40	49		55	52		40	43	
LSD $_{5\%}$	a= 5 ; b= 9 ; ab = 13			a= 5 ; b= 12 ; ab = 17			a= ns b= 4 ; ab = 5.7			a= ns ; b=ns ; ab= 20		
Salinity Level	**Season 2015**											
	Fe (ppm)			**Mn (ppm)**			**Zn (ppm)**			**B (ppm)**		
	Wond. A1	**Manf. A2.**	**Mean B**	**Wnnd. A1**	**Manf. A2.**	**Mean B**	**Wond. A1**	**Manf. A2.**	**Mean B**	**Wond. A1**	**Manf. A2.**	**Mean B**
500 ppm	64	62	63	52	58	55	62	60	61	35	35	35
750 ppm	64	58	61	48	57	52	61	55	58	37	39	38
1000ppm	56	49	52	48	54	51	61	48	54	40	46	43
1250ppm	50	42	46	40	49	44	54	41	47	47	46	46
1500ppm	46	36	41	36	40	38	48	34	41	48	55	51
1750ppm	43	34	38	32	36	34	37	29	33	53	56	54
Mean A	54	46		42	49		54	44		43	46	
LSD $_{5\%}$	a=8 ; b= 12 ; ab = 19			a= 6 : b= 10 ; ab = 14			a= 8 ; b= 16 ; ab = 22			a= ns ; b= 11 ; ab = 15		

CONCLUSION

On the basis of the obtained results it could be concluded that Wounderfoul pomegranate cultivar was found to be highly resistant to high salinity levels. Since, most of newly reclaimed desert soils in Egypt, contain high salinity, cultivation of Wounderfoul cv in such soils is highly recommended to avoid the harmful effect of salinity.

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