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Saline Water Effects on the Growth and Nutrient Contents of Pomegranate

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ABSTRACT

A pot experiment was carried out to investigate the effect of saline water treatments on the growth and nutrient contents of Early 116 and wonderful pomegranate seedlings as new foreign varieties which can be cultivated in newly reclaimed soils in Egypt. One year old seedlings of pomegranate varieties were grown in pots filled with sandy soil, where they subjected to three saline water stress (1500, 3000, 4500 ppm) as well as tap water as a control treatment (288 ppm). In general, increasing salinity levels led to decrease all tested growth parameters and nutrient contents as compared with control treatment while, the contents of Na^+, Cl^- and proline were increased. Also, the results indicated that, under different salinity levels wonderful cultivar gave higher values of shoot growth, leaf area, number of new sprouted shoots, leaf proline content and leaf nutrient contents as compared with Early 116 cultivar. Therefore, cultivation of pomegranate Wonderful cultivar in newly reclaimed soils (that contains high salinity and low quality of irrigation water) is highly recommended as compared with Early 116 taken into consideration ionic balance and suitable fertilization program to avoid the hazard effects of salinity**.**

Keywords: *Saline water, nutrient contents,* growth, proline content. *Punica granatum* L. Wonderful, Early 116.

INTRODUCTION

Salinity of irrigation water is one of the most severe biotic limiting factors on nutrients uptake and plant growth. Salinity affects negatively on seedlings by different ways such as osmotic effects, ionic balance and ion toxicity (Munns and Tester, 2008). Imbalance of nutrients may result from the salinity effect on the availability of nutrients, competition between nutrients during absorption process, and the translocation or partition of nutrients within the plant (Marschner, 1995).In most cases, salinity problems are correlated with excess of NaCl in the irrigation water, but sometimes other salts such as Na_2SO_4 and KCl are present. In general, the negative effect of salinity on plant growth depending on concentration and exposure time of salt, physiological stage of plant, plant genotypes and environmental factors (Mastrogiannidou *et al.,* 2016).On the other hand, under the influence of overpopulation and lack of available irrigation water, sustainable agriculture requires the use of unconventional sources of water such as natural saline water. Saline water was previously considered not usable for irrigation, especially for sensitive plants. But now it can be used successfully to grow many crops under certain conditions, where ionic balance and suitable fertilization program must be taken into consideration.

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 (Maas and Hoffmann, 1976 and Holland *et al.,* 2009). There are many local varieties of pomegranates such as Nab El-Gamal, Wardy, El-Arabyand Manfalouty also foreign varieties like Early 116 (Spain) and wonderful (American), which recently introduced to Egypt. Under newly reclaimed soils in Egypt and deficit or high salinity of irrigation water, the crops which can be cultivated in such soils must be tolerance to salinity. The data about foreign pomegranates varieties which recently introduced to Egypt is not sufficient.

New varieties of pomegranate are considered to be agricultural expansion crops especially in sandy soils, therefore the present study aims to investigate the effects of three saline water stress on growth and nutrient contents of Early 116 and wonderful pomegranate seedlings as new foreign varieties in Egypt.

MATERIALS AND METHODS

A pot experiment was carried out at the farm of Faculty of Agriculture, Al- Azhar University, Nasr city, Cairo Egypt during seasons of 2015 and 2016. It aims to study the effect of different saline water stress (1500, 3000 and 4500 ppm) and non-saline water treatment (control) on growth, nutrient contents (N, P, K, Ca, Mg, Fe, Zn, Mn, Cu, and Cl) and Na in the Early 116 and wonderful pomegranate seedlings as new foreign varieties grown in a sandy soil. The soil was mixed with compost (100 g pot^{-1}) before cultivation. The seedlings were one year old at the start of the experiment, where the uniform and healthy seedlings of two pomegranate varieties (Early 116 and wonderful) were chosen as plant material for this study. The pomegranate seedlings were irrigated with tap water for two weeks before starting the main treatments of saline water. The natural saline water (from Qarun Lake 23920 ppm) was diluted with tap water to reach 1500, 3000 and 4500 ppm which represents the salinity treatments under study, as well as tap water as control treatment, respectively. Each treatment of saline water was replicated three times, each replicate contains one plant/pot. The pomegranate seedlings were planted in pots capacity of 8 kg on 15^{th} February of 2015 and 2016 and fertilized with ammonium nitrate, calcium super phosphate and potassium sulfate according to the general recommendation dose of Ministry of Agriculture. Calcium super phosphate and compost were mixed together and added before cultivation, while ammonium nitrate and potassium sulfate were added as soil application in three equal doses at March, April and May. On the first March, the cultivated pomegranate seedlings were treated by saline water treatments. The moisture content of all pots was kept approximately at field capacity by weighing the pots every three days. The analysis of soil, compost, tap water and natural saline water used were done according methods described by Chapman and Pratt (1961) and presented in Table1and 2(a, b,c).

Table 1. Soil physical and chemical analysis.

Particle size distribution			Soil texture	Field capacity (%)	Wilting point (%)	pH (1:2.5)	EC (dS m^{-1})	OM (%)	CEC (meq/100g soil)	Soluble ions meq L^{-1} (1:2.5)							
										Cations				Anions			
Sand%	Silt%	Clay%								Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$
88.50	4.90	6.60	Sandy	10	5.1	7.30	1.65	0.31	2.51	1.95	3.00	10.53	0.35	0.00	2.12	9.21	4.15

Table 2a. Some chemical analysis of the used compost.

pH (1:2.5)	EC dS m^{-1}	OC %	OM %	C/N ratio	N %	P %	K %	Fe $mgkg^{-1}$	Mn $mgkg^{-1}$	Zn $mgkg^{-1}$	Cu $mgkg^{-1}$
6.87	2.51	17.50	30.10	12.96	1.35	0.53	1.00	120	85	70	12

Table 2b. Some chemical analysis of the used tap water

pH	EC dS m^{-1}	Cations (meq L^{-1})				Anions (meq L^{-1})			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$
7.20	0.45	1.25	1.02	1.10	0.45	0.00	2.34	1.04	0.45

Table 2c. Some chemical analysis of the used natural saline water

pH	EC dS m^{-1}	Cations (meq L^{-1})				Anions (meq L^{-1})			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}_3$	HCO^{-}_3	Cl^{-}	$SO^{=}_4$
7.76	29.90	17.5	38.7	227	6.65	0.00	6.30	240.6	42.95

Measurements:

Shoot length: Shoot length of two pomegranate verities (Early 116 and Wonderful) was measured by calculating the difference between shoot length at the starting of spring and at the end of growth season.

Number of new sprouted shoots: Number of the growing shoots per plant was recorded at end of growth season.

Leaf area: The fourth distal leaf from the top was selected to determine leaf area as described by the equation of Ahmed and Morsy (1999) as follows:

Leaf area (cm^2) = 0.41 (Leaf length × width) +1.83

Proline content: Proline content (%) was extracted from leaves and calorimetrically measured at 520 nm using spectrophotometer according to method described by Bates *et al.,* (1973).

Some macro and micronutrients in leaves:

The content of N, P, K, Ca and Mg (%), Fe, Zn, Mn, and Cu (mg/kg), Cl and Na (%) were determined in leaves of two pomegranate verities (Early 116 and Wonderful). Leave samples were washed by distilled water and dried at 70°C in an air forced oven for 48 hours. Dried plant samples were ground and wet digested using both $HClO_4$ and H_2SO_4 acids mixture .The content of N, P, K, Ca, Mg, Fe, Zn, Mn, Cu and Na were estimated in the acid digested solution. Total N was determined by micro Kjeldahe technique and phosphorus content was determined by colorimetric method (ascorbic acid) using spectrophotometer according to methods described by Page *et al.* (1982). Potassium and sodium were estimated photometrically by using Flame photometer according to Chapman and Pratt (1961).The content of Fe, Zn, Mn, Cu, Ca and Mg were determined using Inductively Coupled Plasma (ICP) plasma 400 according to the procedure of EPA (Environmental Protection Agency, 1991). Total chloride was measured according to method described by Greenway (1963), where chloride was extracted from plant samples in water and boiling for one hour. The boiled extract was allowed to cool at room temperature and then filtered through Whatman No.1filter paper and determined according to Jackson (1973).

Statistical Analysis: The obtained results were subjected to analysis of variance (ANOVA) using Co-stat software program according to Stern (1991).

RESULTS AND DISCUSSION

Saline water effects on vegetative growth parameters of pomegranate

Shoot length

The shoot length of two pomegranate varieties (Early 116 and Wonderful) as affected by saline and non-saline water treatments are shown in Table 3. Data show that, shoot length significantly decreased by increasing the levels of saline water as compared with non-saline water (control treatment). Seedlings that irrigated with non-saline water (control treatment) recorded the maximum values of shoot length followed by 1500, 3000 and finally 4500 ppm of saline water treatments. On the other hand, under different treatments of study (saline or non-saline water), Wonderful seedlings gave the highest values of shoot length in comparison with Early 116. Therefore, Wonderful variety was more tolerant than Early 116 at different salinity levels in the two seasons of study. These results could be supported by Khayyat *et al*., (2014), they found that plant height, number of leaves, and stem diameter of pomegranate seedlings significantly decreased with increasing soil salinity.

Number of sprouted shoots

Data in Table 3 indicate that pomegranate seedlings that supplied with non-saline water (control treatment) possessed the highest values of sprouted shoots as compared with saline water treatments, where these values were decreased by increasing the salinity levels up to 4500 ppm, which recorded the lowest values. On the other hand, Wonderful variety was more tolerant than Early 116 at all different saline water treatments in the two studied seasons. These results could be enhanced with those obtained by Mastrogiannidou *et al.,* (2016), they found that salinity affected negatively on plant growth parameters of pomegranate including number of lateral shoots, number of leaves and dry weight of leaves. Also, Munns and Tester (2008) reveled that moderate salinity inhibits lateral shoot development that becomes apparent over weeks and this is a result to the osmotic effect of NaCl in the irrigation water.

Table 3. Saline water effect on some vegetative growth parameters of Early 116 and Wonderful pomegranate seedlings.

Varieties	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful
Character	Shoot length (cm)		Number of new sprouted shoots		Leaf area (cm^2)	
Season Treatments			2015			
(control)	19.0b	26.0a	8.90b	11.00a	8.10b	9.50a
1500 ppm	13.0c	21.0b	6.00d	7.30c	6.25d	7.12c
3000 ppm	10.0d	13.5c	6.30d	6.50d	4.91e	6.00d
4500 ppm	5.8e	9.5d	4.80e	5.30e	4.63e	4.90e
Mean	11.9B	17.5A	6.50B	7.53A	5.97B	6.88A
			2016			
(control)	23.0b	28.5a	9.00b	10.70a	8.50b	9.80a
1500 ppm	15.0c	23.5b	6.50d	7.80c	6.55d	7.45c
3000 ppm	11.8d	15.3c	6.80d	7.00d	5.15e	6.30d
4500 ppm	6.3e	10.5d	5.00e	5.80e	4.85e	5.15e
Mean	14.0B	19.4A	6.8B	7.8A	6.26B	7.17A

Means followed by the same letter (s) are not significantly different at 5%.

Leaf area

Data in Table 3 show that, leaf area (cm^2) of tested pomegranate varieties (Early 116 and Wonderful) was decreased by increasing the salinity levels up to 4500 ppm. Seedlings treated with non-saline water exhibited the highest leaf area, while the seedlings that irrigated with saline water at 4500 ppm gave the lowest values. These results could be supported by those obtained by Munns and Tester (2008), Khayyat *et al.,* (2014) where the vegetative growth parameters (leaf area and leaf growth rate) of pomegranate seedlings grown under high salinity levels were decreased as the end result of the osmotic effect of the salt accumulation (NaCl) around the roots which led to decrease in water absorption. On the other hand, the values of leaf area with Wonderful pomegranate variety were higher than Early 116 under all treatments (saline or non-saline water). The differences between two studied pomegranate varieties in leaf area under saline water treatments may be due to unbalance hormone (cytokinin and abscisic acid). Under stress conditions, the amount of leaf abscisic acid increased, while cytokinin transport from root to shoots deceased, where imbalances of these hormones caused a reduction in shoot growth and leaf enlargement and expansion (Webster *et al.,* 2000).

Based on the above results, the reduction in plant growth mainly attributed to reduced water absorption due to osmotic effect, nutritional deficiency on account of ionic imbalance and decrease in many metabolic activities such as transpiration and photosynthetic rate (Kumar *et al.,* 2005)

Proline content (%)

Leaf proline content of the two pomegranate seedlings increased significantly with increasing salinity levels (Fig.1), as compared with control treatment. Therefore, the maximum amount of proline was observed at the highest level of saline water (4500 ppm), while the lowest one was related to control treatment (non-saline water). These results could be enhanced with those obtained by Yang *et al.*, (2005) on young apple tree and Ibrahim (2016) on pomegranate. They found that, apple and pomegranate plants produced highest values of proline as a result of high salinity treatments, where under salinity conditions, the plants makes and accumulate some materials to adjust osmotic pressure of plant cells. These materials including hormones, sugars and amino acids, where proline is among the amino acids, which plays a vital role in osmotic adjustment of plant cells. One the other hand, Wonderful cultivar in two seasons possessed higher leaf proline content at all salinity levels than those obtained with the cultivar of Early 116. In this concern, high accumulation of proline in the leaves of plants under salinity stress indicates that such plants are more tolerant to salinity stress than that of low proline content. It could be concluded that, Wonderful cultivar more tolerant to salinity stress than Early 116.

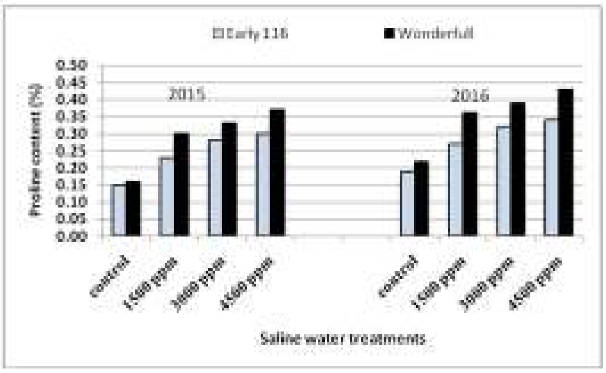

Fig. 1. Saline water effect on proline content (%) in Early 116 and Wonderful pomegranate seedlings.

Leaf macronutrient (N, P and K) contents:

Nitrogen content (%)

Data in Table 4 indicate that saline water affected negatively on nitrogen content in leaves of two pomegranate seedlings . In other words, the highest significant values of leaf nitrogen content were obtained at control treatment, while the lowest significant nitrogen values were obtained at high saline water effect (4500 ppm). The above trend was recorded with two pomegranate seedlings (Early 116 and Wonderful) and for two seasons of study. Furthermore, Wonderful cultivar presented the higher significant values of leaf nitrogen content than Early 116 at all saline water effects (4500, 3000 and 1500 ppm) or at control treatment (non-saline water). Similar findings were obtained by Kulkarni *et al.*, (2007) they found that N content in leaves of pomegranate decreased as a result of salinity increased. The reduction of N content in leaves of pomegranate seedlings under saline water effect may be due to reduced water use efficiency and some form of competition between Cl^- and NO_3^- ions in the growth media (the main dominate anions in saline water is Cl).The competition between Cl^- and NO_3^-

uptake can be occur between two nutrients where, high concentration of Cl^- in growth media may inhibit the low affinity nitrate transport system. On the other hand, under saline condition the decrease in nitrogen uptake was attributed to lower water use efficiency than the nitrogen-chloride interaction in the growth media (Grattan and Grieve, 1992 and Chatzissavvidis *et al.*, 2008). Finally, salinity might interfere with N metabolism in a number of ways starting with the uptake of nitrate and ammonium N.

Table 4. Saline water effect on the contents of nitrogen, phosphorus and potassium (%) in leaves of Early 116 and Wonderful pomegranate seedlings.

Varieties	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful
Character	N %		P %		K %	
Season			2015			
Treatments						
(control)	2.83b	3.22a	0.24b	0.27a	2.00b	2.80a
1500 ppm	2.17c	2.20c	0.18c	0.23b	1.40d	1.79c
3000 ppm	1.95d	2.02cd	0.12d	0.16c	1.10e	1.50d
4500 ppm	1.45e	1.65e	0.07e	0.08e	0.85e	1.00e
Mean	2.10B	2.27A	0.15B	0.19A	1.34B	1.77A
			2016			
(control)	2.97b	3.38a	0.24b	0.28a	2.05b	2.90a
1500 ppm	2.28c	2.31c	0.17c	0.22b	1.38d	1.70c
3000 ppm	2.00d	2.12cd	0.13d	0.17c	1.00e	1.47d
4500 ppm	1.52f	1.73e	0.08e	0.08e	0.87e	0.95e
Mean	2.19B	2.39A	0.16B	0.19A	1.33B	1.76A

Means followed by the same letter (s) are not significantly different at 5%.

Phosphorus content (%)

Date of Table 4 show that the highest values of leaf phosphorus content were obtained when the seedlings of both pomegranate varieties (Early 116 and Wonderful) were treated with non-saline water, while the lowest values were noticed at high saline water effect (4500 ppm). Differences between the two studied varieties in two seasons were significant at all salinity levels. These results could be supported with those obtained by Kulkarni *et al.,* (2007) on pomegranate (cv. Mrudula), Sen and Bal (2009), on wheat and sunflowers plants and Gomes *et al.,* (2011) on *Salvinia auriculata* Aubl. They found that, phosphorus content in leaves of these plants was significantly decreased by increasing salinity levels. Also, they concluded that the reduction of phosphorus content as affected by salinity treatments may be due to the presence of Cl^- as well as SO_4^- in salinity treatments which interfere with phosphorus absorption by plants. As previously mentioned with nitrogen, also Wonderful seedlings were contained phosphorus more than Early 116 under all saline water treatments or at control treatment (non-saline water). These means that, Wonderful seedlings were more tolerant to salinity stress than Early 116.

Potassium content (%)

Data in Table 4 also show that, leaf potassium content in the two studied pomegranate varieties were sharply decreased by increasing salinity levels. The highest values of potassium content were found with control treatment (non-saline water), while the content of potassium in leaves of two pomegranate varieties as affected by saline water treatments were arranged in the descending order, 1500 > 3000 > 4500 ppm. The above trend was recorded with two pomegranate seedlings (Early 116 and Wonderful) and for two seasons of study. On the other hand, leaves of Wonderful seedlings significantly possessed higher potassium content under all treatments (saline or non-saline water) than those obtained with Early 116. The negative effect of salinity on K^+ content has been found not only with pomegranate but also with other woody species (Renault *et al.,* 2001 and Papadakis *et al.,* 2007).The reduction of K^+ content under salinity levels may be due to the direct competition between ions of Na^+ and K^+ or by osmotic potential of the solution which led to reducing the mass flow of ions such as K^+ with water to the root surface. In the other word, high concentration of Na^+ in the growth media can interfere with K^+ uptake, resulting in K^+ deficiency and stunted growth (Marschner, 1995). It is worth to mentioned that, two ions can be compete for uptake at the plasma membrane level and the reduction in K^+ absorption by plants under high concentration of Na^+ is a competitive process and occurs regardless of whether the solution is dominated by Na^+ salts of chloride or sulphate (Mastrogiannidou *et al.,* 2016). In this concern, the saline water used was dominated by ions of Na^+, Cl^- and SO_4^-.

Calcium and magnesium contents (%)

Calcium and magnesium contents (%) in levees of two pomegranate seedlings as affected by different saline and non-saline water treatments are shown in Table 5. The data reveal that, the content of two nutrients with wonderful pomegranate seedlings was higher than Early 116 under all treatments. Also, the data indicated that the content of calcium and magnesium was decreased by increasing salinity levels. These results could be enhanced by those obtained by Kulkarni *et al.*, (2007); Papadakis *et al.*, (2007) and Karimi and Hasanpour (2014), they found that elevate salinity levels of growth medium led to decrees calcium and magnesium in leaves of pomegranate and cherry plants . It worth to mentioned that, calcium is very important nutrient in cell biology especially during stress condition, where calcium is necessary to preserving plasma membrane integrity and ions uptake (Marschner, 1995). The reduction in calcium uptake and translocation within plant may be due to the high concentration of Na^+ in the growth media, where Na^+ and Ca^{++} are antagonistic effect in their absorption and translocation (Melgar *et al.,* 2008). On contrary, Mg^{++} deficiency as affected by NaCl salinity has been reported by many researchers, although no antagonism has been confirmed between Na^+ or Cl^- and Mg^{++} in absorption and translocation (Doring and Ludders, 1986).

Table 5. Saline water effect on the contents of calcium, magnesium, sodium and chloride (%) in leaves of Early 116 and Wonderful pomegranate seedlings.

Varieties	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful
Character	Ca %		Mg %		Na %		Cl %	
Season Treatments				2015				
(control)	1.70b	2.00a	1.08b	1.40a	0.36d	0.46d	0.50d	0.60d
1500 ppm	1.20d	1.45c	0.65d	0.80c	0.90c	0.82c	0.87c	0.75c
3000 ppm	0.80e	1.15d	0.45e	0.60d	1.57b	1.37b	1.75b	1.50b
4500 ppm	0.43f	0.70e	0.20f	0.51e	2.20a	2.02a	2.55a	2.35a
Mean	1.03B	1.33A	0.60B	0.83A	1.26A	1.17A	1.42A	1.30A
				2016				
(control)	1.62b	1.93a	1.13b	1.48a	0.33d	0.43d	0.52d	0.61d
1500 ppm	1.17d	1.39c	0.60d	0.86c	1.00c	0.94c	0.93c	0.82c
3000 ppm	0.75e	1.10d	0.49e	0.64d	1.66b	1.48b	1.85b	1.63b
4500 ppm	0.40f	0.71e	0.19f	0.55e	2.27a	2.11a	2.55a	2.42a
Mean	0.99B	1.28A	0.60B	0.88A	1.32A	1.24A	1.46A	1.37A

Means followed by the same letter (s) are not significantly different at 5%.

Sodium and chloride content (%)

Unlike the above results which recorded with other nutrients, the content of Na^+ and Cl^- was increased in the leaves of two studied pomegranate seedlings with increasing saline water treatments as compared with control treatment (data in Table 5).The highest values of Na^+ and Cl^- was recorded at high saline water treatment (4500 ppm), while the lowest values of them was found with control treatment. These results could be enhanced with those obtained by Naeini *et al.,* (2004); Karimi and Hasanpour (2014) on pomegranate varieties grown in saline growth media. They found that the content of Na^+ and Cl^- was increased in the leaves (basal or apical) of pomegranate varieties as a result of increasing NaCl salinity levels. They also, added that Na^+ in roots of pomegranate varieties enhanced significantly up to 30 and 40 mM of NaCl (1755 and 2340 ppm, respectively), where roots accumulate Na^+ up to a determinate concentration and since root capacity for Na^+ accumulation is saturated. Therefore, the inhibition of some cations uptake as affected by Na^+ salinity became high. Also, they added that, increasing Nacl salinity enhanced Cl^- uptake by roots, where root capacity for Cl^- accumulation is saturated at these concentrations. Therefore, the inhibition of some anions uptake as affected by Cl^-salinity became high. It is worth mentioning that, the dominant ions in natural saline water used were Na^+, Cl^- and SO_4^{--}. On the other hand, increasing salinity enhances Cl^- uptake and this is partly due to lower availability of Ca^{++} and as a result, enhanced permeability of root cell membranes as mentioned by Marschner, (1995) and Naeini *et al.,* (2006).

Leaf micronutrient (Fe, Mn, Zn and Cu) contents

The results of Table 6 show that, the two pomegranate seedlings that treated with non-saline water (control treatment) gave the highest significant values of Fe, Zn, Mn and Cu, while saline water treatment at 4500 ppm possessed the lowest significant values of these micronutrients. The effect of saline water treatments on the content of micronutrients can be arranged as follow: 1500 > 3000 > 4500 ppm. The effect of saline water treatments on the content of micronutrients (Fe, Zn, Mn and Cu) of both pomegranate varieties can be explained on the negative effects of salinity on ionic balance and osmotic effects. Nutrient imbalances resulting from salinity effect could be affecting on nutrients availability, nutrients uptake throw competition between nutrients, and nutrients translocation and/or partition within plant (Marschner, 1995). Also, nutrients uptake can be reduced by osmotic effects, where decreased osmotic potential of the soil solution reducing the mass flow of nutrients with water to the root surface (Grattan and Grieve, 1992). The results also showed that, under all treatments (control, 1500, 3000 and 4500 ppm), Wonderful variety contains higher values of micronutrients than Early 116 in the two seasons of study. These results may be due to the ability of Wonderful cultivar on the adaptation and tolerant of stress conditions by make and accumulate some materials such as abscisic acid to adjust osmotic pressure of plant cells, where abscisic acid in roots may maintain root growth and this consequently increased the uptake of nutrients (Liu *et al.,* 2005).

Based on the above discussion it may be concluded that, the uptake of water by seedlings grown under saline water effect is quite low as a result of high osmotic potentials existing in the root growth media. Reduced water uptake led to reduced cell division and turgor of leaves and subsequently closure of stomata, leading to a reduction in physiological process such as transpiration, photosynthesis and ions uptake. On the other hand, salinity may increase the energy consumption required for osmotic regulation, competition between ions and subsequently lead to a reduction of metabolically ions (Kwon *et al.,* 1995). In conclusion, cultivation of pomegranate Wonderful variety in newly reclaimed soils (that contains high salinity and low quality of irrigation water) is highly recommended as compared with Early 116 taken into consideration ionic balance and suitable fertilization program to avoid the hazard effect of salinity.

Table 6. Saline water effect on the contents of Fe, Mn, Zn and Cu in leaves of Early 116 and Wonderful pomegranate seedlings.

Varieties	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful	Early 116	Wonderful
Character	Fe mg kg^{-1}		Mn mg kg^{-1}		Zn mg kg^{-1}		Cu mg kg^{-1}	
Season Treatments	2015							
(control)	64.0b	76.0a	43.0b	52.0a	50.0b	60.0a	35.0a	40.0a
1500 ppm	56.0c	72.0a	36.0c	45.0b	39.0c	49.0b	24.0b	29.0b
3000 ppm	43.0d	56.0c	22.0d	36.0c	27.0d	40.0c	16.0c	19.0c
4500 ppm	31.0e	42.0d	15.0e	23.0d	18.0e	27.0d	7.0d	15.0c
Mean	48.5B	61.5A	29.0B	39.0A	33.5B	44.0A	20.5B	25.8A
	2016							
(control)	78.0b	93.0a	36.0b	44.0a	47.0b	61.0a	32.0a	36.0a
1500 ppm	68.0c	88.0a	30.0c	38.0b	36.0d	50.0b	22.0b	25.0b
3000 ppm	52.0d	68.0c	18.0d	30.0c	24.0e	41.0c	15.0c	17.0c
4500 ppm	38.0e	51.0d	12.0e	19.0d	15.0f	28.0e	6.0d	14.0c
Mean	59.0B	75.0A	24.0B	32.8A	30.5B	45.0A	18.8B	23.0A

Means followed by the same letter (s) are not significantly different at 5%.

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تأثيرات الماء المالح على النمو ومحتوى المغذيات في الرمان

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أجريت تجربة اصص لدراسة تأثير معاملات الماء المالح على النمو و محتوى المغذيات فى نباتات الرمان صنفى Wonderful و Early116كأصناف حديثة يمكن زراعتها فى الاراضى المستصلحة حديثاً فى مصر.تم تعريض نباتات الرمان النامية فى تربة رملية الى ثلاث مستويات ملوحة (١٥٠٠، ٣٠٠٠، ٤٥٠٠ جزء فى المليون) بالاضافة الى معاملة الكنترول (ماء الصنبور ٢٨٨ جزء فى المليون).أشارت النتائج الى ان زيادة مستويات الملوحة ادت الى انخفاض قيم النمو الخضرى و كذلك انخفاض محتوى اوراق نباتات الرمان من العناصر الكبرى و الصغرى فى حين زاد محتوى اوراق نباتات الرمان من عناصر الصوديوم و الكلوريد و البرولين و ذلك بالمقارنة بمعاملة الكنترول (ماء الصنبور). أظهرت نباتات الرمان صنف Wonderful تفوقاً معنويا فى قيم النمو الخضرى و العناصر الكبرى والصغرى تحت معاملات الملوحة المختلفة بالمقارنة بالصنف Early 116. اخيراً توصى الدراسة بامكانية زراعة نبات الرمان صنف Wonderful فى الاراضى المستصلحة حديثا (حيث النوعية المنخفضة لمياه الرى و ظروف ملوحة التربة) وذلك بالمقارنة بصنف Early 116.