The goal was to evaluate the response of pomegranate cultivar transplants “Manfaluty” and “Wonderful” for salinity stress. A pot investigation was conducted during (2016 and 2017) seasons in a glasshouse, Faculty of Agriculture, Ain Shams Univ., Shoubra El-Kheima, Egypt. Pots were arranged in a randomized complete design with two factors, the first one was pomegranate cultivars which included two cultivars namely (Manfaluty and Wonderful) and the second factor was NaCl levels whereas, transplants were irrigated with five levels of water salinity (0, 20, 40, 60, and 80 mM NaCl). It could be summarized results in some main points:

- Both pomegranate cultivars were moderately resistant to salinity up to 40 Mm NaCl with slight growth reduction.

- More increase in salinity level up to 60 and 80 mM NaCl reduction growth around 50-70% compared with untreated transplants. Generally, “Manfaluty” had a slightly higher reduction in growth than “Wonderful”.

- Increasing salinity levels caused a significant reduction in leaf K content otherwise Na was accumulated in the leaves of both pomegranate cultivars.

- Proline leaves content, increased gradually by the increase in salinity levels up to (60 mM NaCl), and the highest significant values of proline content were obtained when combing (60mM NaCl) with “Wonderful”.

So it could be concluded that, increasing salinity level more than 40 mM NaCl will inhibit pomegranate growth and make an imbalance of nutrient status in pomegranate transplants with slight differences between the response of two cultivars.

Keywords: Growth reduction, Ion accumulation, Manfaluty pomegranate, Nacl, Proline, Salt stress, Transplants, Wonderful pomegranate.
Famous pomegranate cultivars were found in many continents all over the world, including Europe, Asia, and North Africa (Holland et al., 2009). In Egypt, new reclamation land mainly cultivated by “Wonderful” cv while the local pomegranates cultivars were grown at the Assuit governorate. The common Egyptian pomegranate cultivars called ‘Arabi’, ‘Manfaloty’, ‘Nab ElGamal’, and ‘Wardy’ (Abo-Taleb et al. 1998; Saeed 2005). ‘Manfaloty’ (or ‘Manfaloot’) trees have large & juicy dark-red arils and ripe from the end of August or the beginning of September (Van der Wiel 2000). “Wonderful” cultivar is considered the most important cultivar in the USA (LaRue 1980). “Wonderful” cultivar has large fruit with red arils, sweet-sour taste, and semi hard seeds (Stover and Mercure 2007). Few literatures reported that pomegranate trees were relatively tolerant to salinity stress with a difference between cultivars (Bhantana and Lazarovitch, 2010 and El-Khawaga et al., 2013) In general, fruit trees were very sensitive to soil salinity whereas, (EC) = 4 mS cm$^{-1}$ of soil extract is considered as critical level in fruit orchards.

An electric conductivity (EC) of 4 mS cm$^{-1}$ of soil extract is considered as critical in fruit orchards. From many research papers it was notable that fruit trees were irrigated with water should not exceed 2 mS cm$^{-1}$. However, pomegranate is considered to be moderately sensitive to salinity (EC = 3 mS cm$^{-1}$). (Elias et al., 2011)

Consequently, pomegranate growers interest to increase his planting area by introducing new cultivars such as “Wonderful” to replace the old local ones. Therefore, the present investigation aimed to evaluate and compare the salinity tolerance between the most common traditional Egyptian pomegranate cultivar namely, “Manfaluty” and the newly introduced cultivar “Wonderful” to determine the most promising cultivar for salinity.

Materials and Methods

A pot investigation was conducted (2016 and 2017) seasons in a glasshouse, Faculty of Agriculture, Ain Shams Univ., Shoubra El- Kheima, Egypt. Pots were arranged in a randomized complete design with two factors, the first one was pomegranate cultivars included two cultivars namely (Manfaluty and Wonderful) and the second factor was NaCl levels whereas, transplants were irrigated with five levels of water salinity (0, 20, 40, 60, and 80 mM NaCl). Each treatment had 5 replicates and each replicate included one transplant. In the second week of February from each season, 25 one-year-old transplants from each cultivar were planted in plastic containers (35 cm in diameter and 30 cm in length), filled with sand which was previously treated with 10% commercial hydrochloric acid for 24 hours, then thoroughly washed with a tap to free it from all solutes and any trace of acid. At planting, for each transplant 2-3 stems were selected and shortened into 50 cm. Transplants were fertilized at 10-day intervals with a commercial fertilizer (19-19-19 NPK) + micro nutrients. The different salinity levels (20, 40, 60, and 80 mM NaCl) were started in late May by adding NaCl to irrigated water used except for control. All treatments were irrigated every other day by a rate of 1 liter/plant.

Measurements

**Soil samples:** At the end of each growing season (September) soil samples were taken from root system zoon then air-dried and kept in plastic bags. Electrical conductivity was determined in the extract of saturated soil paste according to the method mentioned by Jackson (1973). The pH values were measured in (1:2.5) soil suspension using pH meter according to the method mentioned by Black et al (1965).

Growth measurements: At the end of each season (September) transplants were measured for stem diameter at 5 Cm above the ground surface, stem length, and the total number of leaves. Four leaves from 5-7th leaves from plant top were taken to measure total chlorophyll content by using a Soil Plant Analysis Division (SPAD) – 502 MINOLTA). Plants were taken out and cut into three parts (roots, stem, and leaves). The different fresh samples were washed with distilled water, oven-dried at 60-70°C until constant weight, and then the dry weight of each part was recorded. Thereafter, the dry weight of the total plant was calculated.

**Chemical analysis:** In mid-June, samples were collected from the 5-7th nodes from the plant top, five leaves from each replicate in each season. The leaf samples were and dried at 70°C. Dry leaves were grounded and digested according to (Jackson, 1973). Leaf mineral content of N, P, K, Na, Fe, Zn, and Mn was determined according to (Cottenie et al., 1982).

Total carbohydrates content: in each season, total carbohydrates content was determined in
stem samples by the phenol sulfuric method according to Dubois et al. (1956) then C/N ratio was calculated as follows: C/N ratio = Total carbohydrates of stem/ total nitrogen of stem.

Proline content: free proline amount (ppm) was measured according to Bates et al. (1973).

Statistical analysis
The obtained data were analyzed of variance by ANOVA techniques was performed using CoStat program Computer Software. Significant differences of the mean values (P<0.05 for F-test) were determined by Duncan multiple range tests (Duncan, 1955).

Results and Discussion
Effect on some chemical characteristics of soil samples at the end of experiment
Results in Table 1 show the effect of pomegranate (Punica granatum L.) cultivars, salinity levels and their interaction on some chemical characteristics of soil samples at the end of the experiment during 2016 and 2017. Data revealed that in the first season only soil pH and EC were affected significantly by pomegranate cultivars whereas, Wonderful cultivar gave the highest significant value of soil pH and the least value of soil EC. On the other hand, control and low level of salinity L1 (20 mM NaCl) gave the least significant values of pH, other salinity levels gave more or less pH values with the same statistical standpoint. Regarding the interaction, it seems that the least significant values of pH were recorded by control under two pomegranate cultivars other combinations gave higher values than control treatment but without any significant difference between them. Soil EC was gradually increased by increasing salinity level up to L5 (80 mM NaCl). Meanwhile, salts accumulated in the root zone of pomegranate transplants irrigated with high salinity levels compared with those with control and low levels of saline water. Values of interaction showed that in the two seasons untreated transplants from two cultivars gave the least significant values of EC. In the two seasons, EC values were increased by increasing salinity levels irrespective of the cultivar. Nevertheless, when combined the high level of salinity L5 (80 mM NaCl) with any cultivar gave higher significant EC values than other combinations. El-Khawaga et al. (2013) noticed that saline groundwater irrigation at EC 1.8 dS∙m−1 and 6.0 dS∙m−1 increased salt accumulation in the root zone at a soil depth of 60-90 cm from 3.7 dS∙m−1 to 4.8 dS∙m−1 and 7.7 dS∙m−1 respectively, when pomegranate trees were grown in sandy clay loam soil.

TABLE 1. Effect of pomegranate cultivars and salinity levels on some chemical characteristics of soil samples at the end of the experiment during 2016 and 2017 seasons.

| Salinity levels | Cultivars | Soil pH | Soli EC (dS/m) |
|-----------------|-----------|---------|---------------|
|                 | M*        | W**     | Mean          | M*          | W**     | Mean          |
|                 | 2016 season |         |               | 2017 season |         |               |
| L1:0 (control) | 8.50b-d   | 8.43cd  | 8.46B         | 8.70ab      | 8.92A   | 2.84A         |
| L2:20 mM NaCl  | 8.20d     | 8.87a-c | 8.53B         | 8.37c       | 8.97ab  | 2.25cd        |
| L3:40 mM NaCl  | 9.00a     | 9.13a   | 9.06A         | 8.90ab      | 9.23a   | 3.77b         |
| L4:60 mM NaCl  | 8.90ab    | 9.94ab  | 8.92A         | 9.00ab      | 9.27a   | 4.89a         |
| L5:80 mM NaCl  | 9.00ab    | 9.94ab  | 8.92A         | 9.33a       | 9.34a   | 4.74a         |
| Mean           | 8.70B     | 8.92A   | 2.84A         | 2.76A       | 2.64A   |

M*: Manfaluty W**: Wonderful

In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
**Effect on some vegetative growth parameters**

Results in Table 2 show the effect of pomegranate (*Punica granatum* L.) cultivars, salinity levels and their interaction on some vegetative growth parameters during 2016 and 2017. Data revealed that in the two growing seasons all vegetative growth parameters of the two pomegranate cultivars (Manfaluty and Wonderful) responded similarly without any significant difference to different saline solution applied. Regarding salinity levels, in most cases L₁ (control) gave the highest significant values of most growth parameters followed closely by L₂ (20 mM NaCl) in the two seasons (2016 and 2017). On the other hand, in the two growing seasons increasing salinity levels up to L₅ (80 mM NaCl) resulted in adverse effects in all growth parameters with some foliar salt damage like leaf burn and necrosis. The interaction revealed that L₁ (control) and L₅ (20 mM NaCl) treatments increased all vegetative growth parameters of two pomegranate cultivars (Manfaluty and Wonderful) in the two seasons followed closely by L₄ (40 mM NaCl) treatment with both pomegranate cultivars. On the other hand, L₆ (60 mM NaCl) and L₅ (80 mM NaCl) treatments had their worst prominent effects on all vegetative growth parameters in both cultivars of pomegranate (Manfaluty and Wonderful) in the two seasons. So it could be concluded that, there were insignificant effect on most vegetative growth parameters of Wonderful cultivar especially in the first season with increasing salinity level up to L₅ (40 mM NaCl), but a decline in vegetative growth occurred at salinity levels higher than L₅ (40 mM NaCl).

In this respect, Sivritepe et al., 2010 observed that leaf chlorophyll content of all grafted grapevines was reduced by salinity. Salt stress was well-known to decrease the life-span of leaves. This reasoning accelerated senescence as a consequence, chlorophyll degradation (Yeo and Flowers, 1984).

Results in Fig.1 show the effect of salinity levels on stem length reduction % of Manfaluty and Wonderful cultivars depending upon the average of the interaction in the two seasons compared with the control. It could be safely concluded that the least reduction in stem length were 3% and 7% for Wonderful and Manfaluty, respectively after exposure to L₁ (20 mM NaCl) whereas, stem length was decreased by 14% and 18% when transplants were supplied with L₄ (40 mM NaCl). Increasing salt stress up to L₅ (60 mM NaCl) reverse the response of two cultivars whereas, stem length was decreased by the rate of 47% and 52% for Manfaluty and Wonderful, respectively. More increase in salt stress L₅ (80 mM NaCl) gave the greatest reduction in stem length by the rate of 61% and 70% for Manfaluty and Wonderful, respectively. The foregoing data showed that when treated with L₅ (80 mM NaCl) stem length reduction % decreased by a 60-70% when compared with untreated plants (control).

These results are in line with, Naeini et al. (2006) who observed that ‘Malas Torsh’ and ‘Alak Torsh’ pomegranate cultivars had reduced stem length, internode length & number, and leaf surface after exposure to different salinity levels (40, 60, and 80 Mm NaCl). Net productivity and crop yield of pomegranate would be reducing as growth reduction occurred due to salinity. previous work that proved that increasing salinity level would inhibit pomegranate vegetative growth parameters such as shoot length, leaf area and, shoot biomass. (El-Khawaga et al., 2013) worked on seven-year-old ‘Manfalouty’, ‘Wonderful’, and ‘Nab-Elgamal’ pomegranate trees grown in upper Egypt, and they found that higher reduction in growth, flowering, and yield when trees irrigated with saline groundwater at an EC of 6.0 dS∙m⁻¹ than at an EC of 1.8 dS∙m⁻¹ (El-Khawaga et al., 2013). While Hasanpour et al. (2015) indicated that high salinity treatment decreased the chlorophyll index and chlorophyll fluorescence of pomegranate trees.

**Effect on dry weight of different organs and total plant**

Results in Table 3 indicated that, in most cases different organs and total plant dry weight were significantly affected by cultivars, salinity levels, and their interaction in both seasons. The cultivars showed some variation in response to different salinity levels special in the first season whereas, Wonderful superior on Manfaluty pomegranate cultivar in Leaves, stem and total plant dry weights. In both seasons, L₁ (control) gave the highest significant values of different organs and total plant dry weight. It is noticed that different organ and total plant dry weights were decreased gradually by increasing the salinity level up to L₅ (80 mM NaCl). Combing cultivars and salinity levels in both seasons had a significant effect on all dry weight characters. It is observed that, dry weight characters of the two cultivars negatively affected by high salinity levels L₅ and L₆ whereas, moderate levels L₂ and L₃ gave intermediate values between control and high salinity levels L₄ and L₅ treatments.
Results in Fig. 2 show the effect of salinity levels on total plant dry weight reduction % of Manfaluty and Wonderful cultivars depending upon the average of the interaction in the two seasons compared with the control. It could be safely concluded that, the least reduction % in total plant dry weight was 15% for Wonderful and 23% for Manfaluty cultivar after exposure to L2 (20 mM NaCl). The greatest reduction % was 67% for Wonderful and 69% Manfaluty cultivar after exposure to L5 (80 mM NaCl). The foregoing data showed that, when treated with L5 (80 mM NaCl) total plant dry weight reduction % decreased by approximately 70% when compared with untreated plants (control).

So it could be concluded that increasing salinity level more than 40 mM NaCl will inhibit pomegranate growth in term of stem length, number of leaves, dry weight of each organ and total plant. Furthermore, in most cases “Manfaluty” pomegranate cultivar had a slightly higher reduction in growth than “Wonderful” pomegranate cultivar when they were irrigated with saline water spiked with 40, 60 or 80 Mm NaCl.

In this respect, Sivritepe et al. (2010) found that salt stress consequential in a reduction in the dry biomass of shoots leaves, and roots of all grapevines scion-rootstock combinations. This results could be explained by Munns (1993), who pointed out that the reduction in plant biomass due to salt stress maybe related to low external water potential, ion imbalance and, toxicity. Grapevines were decreased transpiration and biomass production due to the effect of salt stress on osmotic potential of soil solution. The chemical potential of the saline media primarily created a water potential imbalance between the apoplast and symplast, which lead to a decrease in pressure potential, may be causing a growth reduction (Bohnert et al., 1995).

Effect on some macronutrients content

Results in Table 4 show the effect of pomegranate (Punica granatum L.) cultivars, salinity levels and their interaction on some macronutrients content in leaves during 2016 and 2017 seasons.

Effect on nitrogen content: The cultivars differed in their response to salinity from season to another whereas; Wonderful gave lower values of nitrogen content than Manfaluty in the first season only while in the second season the two cultivars gave insignificant difference between them. Data indicated that, salinity levels affected significantly on leaves N content during the two seasons. The least values of N content were observed by the highest levels of salinity during the two seasons, other salinity levels gave more or less similar values without any significant difference between them except L4 (60 mM NaCl) in the first season. The interaction pointed out that, with increasing salinity level, leaves N content of the two cultivars affected insignificantly up to L4 (60 mM NaCl) but more increase in salinity level L5 (80 mM NaCl) reduced N content and gave the least significant values of leaves N content under the two cultivars.

Effect on phosphorus content: Results showed that in the two growing seasons phosphorus content was affected significantly by salinity levels only. Control gave the least significant values of P content followed by L3 (40 mM NaCl) and L5 (80 mM NaCl). On the other hand, the second and the fourth levels of salinity (20 and 60 mM NaCl) gave the highest significant values of P content during the two growing seasons.

Effect on potassium and sodium content: In general, cultivars caused no significant differences in the accumulation of K and Na ions in the leaves after exposure to different salinity levels. Increasing salinity levels caused a significant reduction in leaf K content otherwise Na was accumulated in the leaves of both ‘pomegranate cultivars.

In this respect, high salinity levels increased sodium content and decreased potassium and calcium content in the cytosol. So, plants suffer from high Na connect due to disruption of ionic balance, damaging of enzyme function, osmotic impairment, membrane damage, growth reducing by inhibiting cell division and expansion. Also, high Na content leads to a reduction in photosynthesis (Mahajan and Tuteja, 2005). Moreover, reduction in leaf K content may be a strategy for trees to decrease salt stress as K plays an essential role in adjusting the osmotic potential of plant cells and also activating enzymes controlled on respiration and photosynthesis (Taiz and Zeiger, 2015).
TABLE 2. Effect of pomegranate cultivars and salinity levels on some vegetative growth parameters during 2016 and 2017 seasons.

| Cultivars | Stem diameter (Cm) | Stem length (Cm) | Leaves number | Leaf chlorophyll (SPAD) |
|-----------|--------------------|------------------|---------------|-------------------------|
|           | M^*               | W**              | Mean          | M^*                    | W**                | Mean          | M^*           | W**          | Mean             |
| Salinity levels |                  |                  |               |                        |                    |               |               |               |                  |
| L_1:0 (control) | 0.62ab            | 0.68a            | 0.64A^1       | 132.0ab                | 142.7a             | 137.0A^1      | 251.7ab       | 275.7a       | 263.7A^1         | 66.0a           | 62.9a           | 64.4A^1       |
| L_2:20 mM NaCl   | 0.54b             | 0.59ab           | 0.56B^1       | 122.3b                | 142.3a             | 132.3A^1      | 220.7b        | 248.0ab      | 234.3B^1         | 62.8a           | 59.5a           | 61.2AB^1      |
| L_3:40 mM NaCl   | 0.51b             | 0.61ab           | 0.56B^1       | 115.0b                | 122.7b             | 118.8B^1      | 233.3b        | 242.7ab      | 238.0B^1         | 60.4a           | 61.1a           | 60.8B^1       |
| L_4:60 mM NaCl   | 0.35c             | 0.33c            | 0.34C^1       | 79.7c                 | 76.0c              | 77.8C^1       | 172.7c        | 174c         | 173.3C^1         | 41.3bc          | 44.0b           | 42.7C^1       |
| L_5:80 mM NaCl   | 0.23cd            | 0.20d            | 0.21D^1       | 55.0d                 | 46.7d              | 50.8D^1       | 96.3d         | 89.7d        | 93.0D^1          | 37.3c           | 35.7c           | 36.5D^1       |
| Mean          | 0.45A             | 0.48A            | 100.8A        | 106.0A                 | 194.9A             | 206.0A        | 53.6A         | 52.6A        |                  |                  |                  |

2016 season

| Cultivars | Stem diameter (Cm) | Stem length (Cm) | Leaves number | Leaf chlorophyll (SPAD) |
|-----------|--------------------|------------------|---------------|-------------------------|
|           | M^*               | W**              | Mean          | M^*                    | W**                | Mean          | M^*           | W**          | Mean             |
| L_1:0 (control) | 0.58a             | 0.68a            | 0.62A^1       | 151.7a                | 147.7a             | 149.7A^1      | 265.0a        | 273.3a       | 269.0A^1         | 68.3a           | 69.3a           | 68.8A^1       |
| L_2:20 mM NaCl   | 0.61a             | 0.60a            | 0.60A^1       | 141.3ab               | 140.0ab             | 140.7A^1      | 230.7bc       | 250.0ab      | 240.3B^1         | 65.7ab          | 64.0a-c         | 64.8B^1       |
| L_3:40 mM NaCl   | 0.56a             | 0.62a            | 0.56A^1       | 117.7c                | 125.0bc             | 121.3B^1      | 220.0c        | 218.3c       | 219.1C^1         | 60.5bc          | 58.8c           | 59.7C^1       |
| L_4:60 mM NaCl   | 0.36b             | 0.27b            | 0.28B^1       | 72.0d                 | 62.0d              | 67.0C^1       | 103.0d        | 103.0d       | 103.0D^1         | 44.3d           | 43.0d           | 43.6D^1       |
| L_5:80 mM NaCl   | 0.32b             | 0.21b            | 0.26B^1       | 55.3de                | 41.3e              | 48.3D^1       | 90.3d         | 85.7d        | 88.0E^1          | 31.0e           | 31.0e           | 31.0E^1       |
| Mean          | 0.47A             | 0.48A            | 107.6A        | 103.2A                 | 181.8A             | 186.0A        | 54.0A         | 53.2A        |                  |                  |                  |

M^*: Manfaluty  
W**: Wonderful

In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
Fig. 1. Effect of salinity levels on stem length reduction % of Manfalut and Wonderful pomegranate cultivars depending upon the average of the interaction in the two seasons compared with the control.

Fig. 2. Effect of salinity levels on total plant dry weight reduction % of Manfalut and Wonderful pomegranate cultivars depending upon the average of the interaction in the two seasons compared with the control.
TABLE 3. Effect of pomegranate cultivars and salinity levels on dry weight of different organs and total plant during 2016 and 2017 seasons.

| Salinity levels | Cultivars | Leaves dry weight (g) | Stem dry weight (g) | Root dry weight (g) | Total plant dry weight (g) |
|-----------------|-----------|-----------------------|---------------------|---------------------|---------------------------|
|                 |           | M*                   | W**                 | Mean                | M*                       | W**                     | Mean                |
| 2016 season     |           |                       |                     |                     |                          |                          |                     |
| L₁:0 (control)  |           | 9.90a                 | 9.11b               | 9.50A₁              | 42.92a                   | 41.29ab                 | 16.81a              | 16.16a              | 16.48A₁          | 69.63a          | 66.56a          | 68.09           |
| L₂:20 mM NaCl   |           | 6.12d                 | 7.28c               | 6.70B₁              | 34.30b                   | 34.64ab                 | 10.30b              | 10.73b              | 10.51B₁          | 50.72b          | 52.66b          | 51.68B           |
| L₃:40 mM NaCl   |           | 6.01d                 | 7.43c               | 6.72B₁              | 17.70c                   | 33.00b                  | 7.14c               | 8.33bc              | 7.73C₁           | 30.85c          | 48.76b          | 39.80C           |
| L₄:60 mM NaCl   |           | 5.00e                 | 5.21e               | 5.10C₁              | 14.61c                   | 16.67c                  | 6.89c               | 7.95bc              | 7.42C₁           | 26.50ed         | 29.83c          | 28.16           |
| L₅:80mM NaCl    |           | 4.73e                 | 4.72e               | 4.72C₁              | 12.67c                   | 11.00c                  | 5.83c               | 6.33c               | 6.08C₁           | 23.23cd         | 22.06d          | 22.64E          |
| Mean            |           | 6.35B                 | 6.75A               | 24.43               | 27.31A                   | 9.39A                   | 9.90A               | 40.18B              | 43.97           |
| 2017 season     |           |                       |                     |                     |                          |                          |                     |
| L₁:0 (control)  |           | 12.00a                | 10.67b              | 11.33               | 46.67a                   | 38.33bc                 | 42.50               | 18.65a              | 17.00a           | 17.82A₁          | 77.31a          | 66.00b          | 71.65           |
| L₂:20 mM NaCl   |           | 8.60cd                | 9.67bc              | 9.13B₁              | 43.67ab                  | 39.00bc                 | 41.30               | 10.47bc             | 11.00b           | 10.73B₁          | 62.73b          | 59.67b          | 61.20B           |
| L₃:40 mM NaCl   |           | 7.33de                | 7.67d               | 7.50C₁              | 36.33cd                  | 31.00d                  | 33.66               | 8.00de              | 8.57cd           | 8.28C₁           | 51.67c          | 47.23c          | 49.45C           |
| L₄:60 mM NaCl   |           | 7.67d                 | 6.16ef              | 6.90C₁              | 13.33e                   | 13.67e                  | 13.50               | 7.08d-f             | 7.62d-f          | 7.34C₁           | 28.08d          | 27.45d          | 27.76           |
| L₅:80mM NaCl    |           | 5.27f                 | 5.27f               | 5.20D₁              | 11.00e                   | 11.00e                  | 11.00               | 6.33ef              | 5.75f            | 6.04D₁           | 22.60d          | 22.02d          | 22.30E          |
| Mean            |           | 8.17A                 | 7.88A               | 30.20A              | 26.60                    | 10.10A                  | 9.98A               | 48.47A              | 44.47B           |

M*: Manfalaty  
W**: Wonderful  
In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
TABLE 4. Effect of pomegranate cultivars and salinity levels on some leaves macronutrients content during 2016 and 2017 seasons.

| Salinity levels | Cultivars | 2016 season | 2017 season |
|-----------------|----------|-------------|-------------|
|                 |          | N %         | P %         | K %         | Na %         |              | N %          | P %          | K %          | Na %         |              |
| L<sub>1</sub>:0 (control) | 1.80a     | 1.91a       | 1.85A       | 0.114a      | 0.118a       | 0.116D<sup>1</sup> | 0.759a-c  | 0.744a-d  | 0.752A<sup>1</sup> | 0.064a     | 0.072a  | 0.068E<sup>1</sup> |
| L<sub>2</sub>:20 mM NaCl | 1.98a     | 1.93a       | 1.95A       | 0.147a      | 0.182a       | 0.165AB      | 0.764a-c  | 0.800a    | 0.782A<sup>1</sup> | 0.090a     | 0.093a  | 0.092D<sup>1</sup> |
| L<sub>3</sub>:40 mM NaCl | 1.82a     | 1.71a       | 1.76A       | 0.163a      | 0.110a       | 0.137C<sup>1</sup> | 0.738a-d  | 0.770ab  | 0.754A<sup>1</sup> | 0.107a     | 0.120a  | 0.114C<sup>1</sup> |
| L<sub>4</sub>:60 mM NaCl | 1.80a     | 1.25b       | 1.52B       | 0.167a      | 0.182a       | 0.175A<sup>1</sup> | 0.676de  | 0.692c-e  | 0.684B<sup>1</sup> | 0.108a     | 0.139a  | 0.124B<sup>1</sup> |
| L<sub>5</sub>:80 mM NaCl | 1.27b     | 1.18b       | 1.22C       | 0.140a      | 0.158a       | 0.149BC<sup>1</sup> | 0.650e    | 0.697b-e  | 0.674B<sup>1</sup> | 0.147a     | 0.146a  | 0.146A<sup>1</sup> |
| Mean            | 1.73A     | 1.59B       | 0.146A      | 0.150A      | 0.752A       | 0.741A       | 0.103B    | 0.114A    |              |             |           |                |

M*: Manfaluty  
W**: Wonderful

In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
Also, this results are similar to previous studies done on pomegranate trees by Okhovatian-Ardakani et al. (2010), Khayyat et al. (2016) and (Karimi and Hassanpour, 2017) they all observed an increase in Na in leaf tissue with increasing NaCl concentration in irrigation water. This result proved that pomegranate trees had high ability to minimize Na transportation into the shoots to decrease foliar salt damage (Karimi and Hassanpour, 2014).

**Effect on some micronutrients content**

Results in Table 5 show the effect of pomegranate (Punica granatum L.) cultivars, salinity levels and their interaction on some micronutrients content in leaves during 2016 and 2017 seasons.

Data revealed that, Manfaluty cultivar gave significant lower values of iron and zinc than Wonderful cultivar in the first season whereas, in the second season two cultivars showed no significant differences in Fe, Zn and Mn leaves content after supplied with different salinity levels. Data indicated that, salinity levels affected significantly on Zn content in the second season and Mn content in the two seasons, whereas the high salinity levels (L₅:80mM NaCl) gave the least significant values of Zn and Mn content. Regarding the interaction in general, NaCl salinity levels did not affect the leaves Fe, Zn and Mn content in two pomegranates cultivars except some exceptions like, Zn content in leaves of two pomegranate cultivars treated by high level of NaCl (L₅:80mM NaCl) which gave the least significant values in the second season.

In this respect, High ions concentration of leaves could be benefit for plants if the ions were compartmentalized. As the vacuole can make up approximately 90% of the mature cell volume, ions could act as “cheap osmolytes” in the vacuole (Cramer et al., 2007). Sivritepe et al., (2010) proved that NaCl salinity lead to significant N, P, Mg, Fe, Mn and Zn accumulation in the leaves of all grafted grapevines.

**Effect on proline content**

Results in Table 7 show the effect of pomegranate (Punica granatum L.) cultivars, salinity levels and their interaction on proline content in leaves during 2016 and 2017 seasons.

Data revealed that in most cases, the cultivars showed no significant differences in proline leaves content after supplied with different salinity levels. Proline leaves content, as an important factor affecting the resistance to stress, increased gradually by the increase in salinity levels up to L₄ (60 mM NaCl). On the other, the high level of salt L₅ (80 mM NaCl) significantly decreased proline content. The interaction pointed out that, the least significant values of proline content were obtained when combing L₅ (80mM NaCl) with two pomegranate cultivars followed by control treatment also under two pomegranate cultivars whereas, the highest significant values of proline content were obtained when combing L₄ (60mM NaCl) with Wonderful cultivar during the two growing seasons.

In this respect, Misra and Gupta (2005) noticed that stress-tolerant plants had higher proline concentrations than stress-sensitive plants.
### TABLE 5. Effect of pomegranate cultivars and salinity levels on some leaves micronutrient content during 2016 and 2017 seasons.

| Salinity Levels | Cultivars | 2016 season | 2017 season |
|-----------------|-----------|-------------|-------------|
|                 | Fe (ppm)  | Zn (ppm)    | Mn (ppm)    |
| L<sub>0</sub> (control) | M* | W** | Mean | M* | W** | Mean | M* | W** | Mean |
| L<sub>1</sub>:0 (control) | 136.0ab | 144.7ab | 140.3A<sup>1</sup> | 11.33a | 11.67a | 11.50A<sup>1</sup> | 62.67a-c | 56.67a-c | 59.66A<sup>1</sup> |
| L<sub>2</sub>:20 mM NaCl | 133.3ab | 150.7ab | 142.0A<sup>1</sup> | 10.33a | 12.33a | 11.33A<sup>1</sup> | 65.50a | 53.33a-c | 59.41A |
| L<sub>3</sub>:40 mM NaCl | 139.0ab | 162.3a | 150.7A<sup>1</sup> | 11.00a | 13.00a | 12.00A<sup>1</sup> | 63.67ab | 50.33a-c | 57.00A<sup>1</sup> |
| L<sub>4</sub>:60 mM NaCl | 133.0ab | 154.0ab | 143.5A<sup>1</sup> | 10.67a | 12.33a | 11.50A<sup>1</sup> | 52.00a-c | 51.33a-c | 51.66AB |
| L<sub>5</sub>:80mM NaCl | 110.7b | 155.7ab | 133.2A<sup>1</sup> | 11.00a | 12.83a | 11.92A<sup>1</sup> | 48.33bc | 48.00c | 48.16B |
| Mean | 130.4B | 153.4A | 10.86B | 12.43A | 58.43A | 51.93B |

M*: Manfaluty  
W**: Wonderful

In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
TABLE 6. Effect of pomegranate cultivars and salinity levels on stem total carbohydrate, total nitrogen and C/N ratio during 2016 and 2017 seasons

| Cultivars | Salinity levels | M* | W** | Mean | M* | W** | Mean | M* | W** | Mean |
|-----------|-----------------|-----|-----|------|-----|-----|------|-----|-----|------|
|           |                 | Total Carbohydrates | Total nitrogen % | C/N ratio |
| 2016 season |              |               |                |          |
| L₁:0 (control) | 46.67a | 51.67a | 49.16A¹ | 1.05a | 0.910a-c | 0.980A¹ | 45.89a-c | 57.26a | 51.57A¹ |
| L₂:20 mM NaCl | 36.67b | 46.00a | 41.33B¹ | 0.844a-c | 0.899a-c | 0.872AB¹ | 43.23bc | 51.49ab | 47.36A¹ |
| L₃:40 mM NaCl | 32.67b-d | 35.00bc | 33.83C¹ | 0.899a-c | 0.987ab | 0.943AB¹ | 36.33cd | 35.46cd | 35.89B¹ |
| L₄:60 mM NaCl | 29.57cd | 30.33cd | 29.95D¹ | 0.833a-c | 0.847a-c | 0.840BC¹ | 36.17cd | 36.74cd | 36.45B¹ |
| L₅:80mM NaCl | 20.00e | 27.33d | 23.66E¹ | 0.746bc | 0.724c | 0.735C¹ | 27.14d | 37.85cd | 32.49B¹ |
| Mean | 33.11B | 38.06A | 0.874A | 0.873A | 37.75B | 43.75A |
| 2017 season |              |               |                |          |
| L₁:0 (control) | 49.00a | 51.00a | 50.00A¹ | 1.10a | 0.943ab | 1.02A¹ | 45.71a-c | 54.08a | 49.89A¹ |
| L₂:20 mM NaCl | 52.00a | 50.33a | 51.16A¹ | 0.943ab | 1.03ab | 0.987A¹ | 55.44a | 49.01ab | 52.22A¹ |
| L₃:40 mM NaCl | 32.00c | 37.33b | 34.66B¹ | 0.965ab | 0.965ab | 0.965A¹ | 33.22d | 39.02b-d | 36.11B¹ |
| L₄:60 mM NaCl | 22.24d | 33.67bc | 27.95C¹ | 0.680c | 0.899b | 0.790B¹ | 32.85d | 37.47cd | 35.75B¹ |
| L₅:80mM NaCl | 20.47d | 20.33d | 20.40D¹ | 0.614c | 0.636c | 0.625C¹ | 33.76d | 32.29d | 33.02B¹ |
| Mean | 35.14B | 38.53A | 0.860A | 0.895A | 40.19A | 42.37A |

M*: Manfaluty  W**: Wonderful
In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.
TABLE 7. Effect of pomegranate cultivars and salinity levels on Proline leaves content during 2016 and 2017 seasons.

| Salinity levels | Cultivars | Proline (ppm) |
|-----------------|----------|---------------|
|                 |          | M*            | W**            | Mean          |
| 2016 season     |          |               |               |               |
| L₁:0 (control)  | 100.3f   | 107.7ef       | 104.0D         |
| L₂:20 mM NaCl   | 123.3cd  | 119.0de       | 121.2C         |
| L₃:40 mM NaCl   | 134.3c   | 123.7cd       | 129.0B         |
| L₄:60 mM NaCl   | 150.0b   | 163.3a        | 156.9A †       |
| L₅:80 mM NaCl   | 85.0g    | 82.7g         | 83.8E ‡        |
| Mean            | 118.6A   | 119.3A        |               |
| 2017 season     |          |               |               |               |
| L₁:0 (control)  | 111.7de  | 102.3e        | 107.0C         |
| L₂:20 mM NaCl   | 120.0d   | 112.4de       | 116.2B †       |
| L₃:40 mM NaCl   | 135.3c   | 106.7e        | 121.0B †       |
| L₄:60 mM NaCl   | 146.0b   | 160.5a        | 153.3A †       |
| L₅:80 mM NaCl   | 89.0f    | 91.2f         | 90.1D         |
| Mean            | 120.4A   | 114.6B        |               |

In each season, means of each of cultivars and salinity levels or their interactions having the same letters are not significantly different at 5% level.

Conclusion

In the context of this investigation, the pomegranate was moderately resistant to salinity up to 40 Mm NaCl with slight growth reduction. More increase in salinity level up to 60 and 80 Mm NaCl reduction growth around 50-70% compared with control (untreated transplants). Furthermore, in most cases, “Manfaluty” pomegranate cultivar had a slightly higher reduction in growth than “Wonderful” pomegranate cultivar when they were irrigated with saline water spiked with 40, 60, or 80 Mm NaCl. Increasing NaCl caused a significant reduction in leaf K content otherwise Na was accumulated in the leaves of both 'pomegranate cultivars. the highest significant values of proline content were observed when combing L₄ (60mM NaCl) with a Wonderful cultivar during the two growing seasons. So it could be concluded that, increasing salinity level more than 40 mM NaCl will inhibit pomegranate growth and make an imbalance of nutrient status in pomegranate transplants with slight differences between two cultivars.

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Conflicts of Interest

No conflicts of interest during this research

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مقارنة نسبية للتحمل للاجهاد الملحى لشتلات صنفى الرمان "المفلوطي" و "وندرفول".

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قسم البساتين - جامعة عين شمس - كلية الزراعة - شبرا الخيمة - القاهرة - مصر.

تهدف هذه الدراسة لتقييم تحميل لاصطياد الرمان صنف "المفلوطي" و "وندرفول" للاجهاد الملحى في زراعات زهور النباتات، فأجريت تجربة أصغر باصدار الأسودية في زراعاتيك بها زهور النباتات، حيث تم استخدام النباتات النموذجية في صف المفلوطي بدرجة أكبر من الوندرفول، ولكن النباتات النموذجية كان لها خفيفة.

زيادة مستويات الصوديوم كجزء من اضطراب النباتات في محتوى الأوراق من الوندرفول، زيادة تركيز الصوديوم بها الورقة كلا الصنفين.

زيادة محتوى الورقة من الوندرفول، وزيادة محتوى الصوديوم كجزء من اضطراب النباتات في صف الوندرفول (60 mM NaCl).

ولهل ذلك يمكن استنتاج أن ارتفاع مستويات الصوديوم كجزء من انسيج النباتات النموذجية في صف الوندرفول، وزيادة محتوى الورقة من الوندرفول، وزيادة تركيز الصوديوم كجزء من اضطراب النباتات النموذجية في صف الوندرفول، وزيادة تركيز الصوديوم كجزء من اضطراب النباتات النموذجية في صف الوندرفول.

وعلي ذلك يمكن استنتاج أن ارتفاع مستويات الصوديوم كجزء من انسيج النباتات النموذجية في صف الوندرفول، وزيادة محتوى الورقة من الوندرفول، وزيادة تركيز الصوديوم كجزء من اضطراب النباتات النموذجية في صف الوندرفول، وزيادة تركيز الصوديوم كجزء من اضطراب النباتات النموذجية في صف الوندرفول.

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