The Effect of Potassium Silicate on The Chemical Parameters of *Prunus Armeniaca* C.V Qaisi Seedlings Irrigated with Salty Water

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Abstract
Current study was carried out to examine the effect of spraying the vegetative parts of apricot (*Prunus armeniaca* L.) c.v Qaisi seedlings with potassium silicate, irrigated with salty water and their interaction on chemical growth parameters. Seedlings were sprayed with three concentrations of potassium silicate (0, 1, and 2 $ml.L^{-1}$) during 2022 season and irrigated with three levels of salty water (1.5, 2 and 2.5 dsm^{-1}). Results showed that treated apricot seedlings with potassium silicate that irrigated by salty water was affected leaves content of chlorophyll, carbohydrates, proline and the percentage of mineral elements (N, P, K, Si). The outcomes of current study indicated that using studied factors was improved the vegetative growth of seedlings and the readiness of the important nutritional elements which will be reflected on the quality of apricot fruits.

Keywords: *Prunus armeniaca*, potassium silicate, salty water, phosphorus, nitrogen.

Introduction

Apricot (*Prunus armeniaca* L.) is considered deciduous stone fruit that belong to *Prunus* genus and Rosaceae family, its native home is China and Siberia and from there moved to Italy then to the rest of the world (Westwood 1989). The nutritional importance of apricot fruits presented in its high content of A vitamin and niacin in comparison with other fruits as it used as fresh food or to make jam or juice, it can also be dried and canned as well as sweet apricot kernels are used in making sweets and in extracting oil from bitter seeds (El-Issa and Batha 2012). Salinity of soils is considered one of the main problems that face plant production in arid and semi-arid regions causing a significant decrease in the growth and yield of plants growing in those soils. Among the most dissolved salts common in Iraqi soils are sodium, magnesium and calcium chlorides, sodium and magnesium sulfates as sodium chloride salt is the most common and widespread in most Iraqi saline soils. Also, the salinity of irrigation water is one of the most important reasons that impede agricultural development in areas that do not adopt rain-fed irrigation as a main method in agriculture (Al-Zubaidy 1989). Silicon is one of the important elements as it has a role in many physiological processes of the plant including improving the effectiveness of photosynthesis, protein and carbohydrate content, increasing the effectiveness of the roots to absorb nutrients, and reducing the toxicity of the sodium ion by reducing its flow from the soil solution to the plant then reducing the osmotic pressure inside the cells in addition to increasing the ratio of potassium to sodium, increasing the effectiveness of antioxidant enzymes and reducing toxic elements (Guerriero et al.

2016). Potassium is considered one of macro nutritional elements which is necessary for plant and its concentration can be increased in the dry matter of plant, also plants need its single positively charged ion in greater quantities than other nutrients except nitrogen (Bergmann 1983). The addition of potassium to the plant increases its ability to tolerate salinity (Jiping and Jian 1997). Thus, current study is conducted to determine the role of spraying potassium silicate on reducing the damages of different levels of salty water on the chemical parameters of apricot seedlings.

Materials and methods

Experiments were conducted in 2022 season in the nursery of certified seedlings, Directorate General for Horticulture and Forestry, Hindia/ Karbala province from 15/3/ 2022 to 15/9/2022. 135 of two years old apricot seedlings c.v Qaisi were selected, homogeneous in height and size inlaid on 2kg plastic bags. Seedlings were shifted into 32cm diameter (10kg) plastic pots contain loamy soil mixed with peat moss in 3:1 ratio and put under woody shade. Samples of soils from these pots were collected and mixed well then analyzed to determine its chemical and physical properties (Table 1) and also samples of irrigation water were analyzed for its chemical properties (Table 2). All service operations were carried out on seedlings including irrigation, removing of weeds and pest control periodically throughout the experiment period.

Table 1. Chemical and physical characteristics of soil before planting.

Texture		**Value**	**Unit**
Sand		720	$g.kg^{-1}$
Silt		110	
Clay		170	
Soil texture		Loamy-Sandy	
pH of soil		7.1	----
Electric conductivity (EC)		0.56	$dS.m^{-1}$
Dissolved cat-ions	K^+	0.22	$ml.mol.L^{-1}$
	Na^+	1.23	
	Ca^{++}	0.39	
Dissolved an-ions	Cl^-	0.12	
	CO_3^{-2}	Nill	----
Exchange Capacity CEC		38.4	----
Organic material		6.5	$g.kg^{-1}$

A factorial experiment with three blocks was carried out in 15/3/2022 using Randomized Complete Block Design (RCBD) with two main factors, the first factor was spraying three concentrations of potassium silicate fertilizer (0, 1 and 2 $ml.L^{-1}$) and the second factor was three levels of irrigation by salty water (1.5, 2 and 2.5 $dS.m^{-1}$) then treatments were applied as follows:

T1: Salty irrigation water (1.5 $dS.m^{-1}$) + no spraying with potassium silicate (control)

T8: Salty irrigation water (2.5 dS.m^{-1}) + spraying with 1 ml.L^{-1} of potassium silicate
T9: Salty irrigation water (2.5 dS.m^{-1}) + spraying with 2 ml.L^{-1} of potassium silicate

Means were compared using the least significant difference (L.S.D.) at 5% level of significance (P>0.05) (AL–Rawi and Khalf 2000).
Leaves content of chlorophyll, carbohydrates, proline and the percentage of mineral elements (N, P, K, Si). were measured.

T2: Salty irrigation water (1.5 dS.m^{-1}) + spraying with 1 ml.L^{-1} of potassium silicate
T3: Salty irrigation water (1.5 dS.m^{-1}) + spraying with 2 ml.L^{-1} of potassium silicate
T4: Salty irrigation water (2 dS.m^{-1}) + no spraying with potassium silicate
T5: Salty irrigation water (2 dS.m^{-1}) + spraying with 1 ml.L^{-1} of potassium silicate
T6: Salty irrigation water (2 dS.m^{-1}) + spraying with 2 ml.L^{-1} of potassium silicate
T7: Salty irrigation water (2.5 dS.m^{-1}) + no spraying with potassium silicate

Table 2. Some chemical characteristics of irrigation water used in the study.

Chemical characteristic	**Unit**	**Treatment (salinity of irrigation water dS.m^{-1})**		
Electrical conductivity (EC)	dS.m^{-1}	1.5	2	2.5
pH	-	7.92	7.52	8.1
Calcium	mmol.L^{-1}	0.42	3.78	4.4
Magnesium	mmol.L^{-1}	0.14	1.62	3.6
Sodium	mmol.L^{-1}	2.48	3.14	6.2
Potassium	mmol.L^{-1}	0.21	0.12	0.16
Chloride	mmol.L^{-1}	3.60	3.88	6.21
Sulphate	mmol.L^{-1}	3.13	4.47	8.12
Bicarbonate	mmol.L^{-1}	-	2.15	3.81
Sodium adsorption ratio (SAR)	(mmol.L^{-1})$^{2/1}$	1.14	1.35	2.36

significant differences in the leaves content of chlorophyll when it treated with different levels of salty irrigation water as the 1.5 dS.m^{-1} was exceeded and gave the highest average of chlorophyll in leaves amounted 32.81 mg^{-1} fresh weight compared to the lowest average 25.66 mg^{-1}

Results

Results of tables 3, 4, 5, 6 and 7 showed that different treatments of salty irrigation water, spraying potassium silicate and their interaction were affected the chemical parameters of apricot seedlings (c.v Qaisi) and decreased it rapidly. There were weight compared to 1.5 $dS.m^{-1}$ of salty water + spraying with $2ml.L^{-1}$ of potassium silicate which gave the lowest average reached $5.94mg^{-1}$ dry weight. There were significant differences in the average of leaves content of proline when the seedlings were irrigated with different levels of salty water (Table 5). The treatment 2.5 $dS.m^{-1}$ of salty water was gave the highest average of proline amounted 4.08mmol/g compared to the lowest average 0.99mmol/g in control. Spraying potassium silicate was achieved significant differences in proline content in leaves as the treatment of control $1ml.L^{-1}$ of potassium silicate gave the highest average reached 2.mmol/g compared to $2ml.L^{-1}$ of potassium silicate treatment which gave the lowest average of proline amounted 2.15mmol/g. The interaction treatment 2.5 $dS.m^{-1}$ of salty water + spraying with $2ml.L^{-1}$ of potassium silicate gave the highest average of proline content in leaves amounted 4.74mmol/g compared to 2.5 $dS.m^{-1}$ of salty water + no spraying with potassium silicate which gave the lowest average reached 0.69mmol/g. There were significant differences in the average of nitrogen in leaves when the seedlings were irrigated with different levels of salty water. The treatment 2.5 $dS.m^{-1}$ of salty water was gave the highest average amounted 2.18% compared to the lowest average 1.52% in control treatment. Spraying potassium silicate was achieved significant differences in nitrogen average in leaves as the treatment of $2ml.L^{-1}$ of potassium silicate gave the highest average reached 1.98% compared to 1.63% in control treatment. The interaction treatment 2.5 $dS.m^{-1}$ of salty water + spraying with $2ml.L^{-1}$ potassium silicate gave the highest average of nitrogen content in leaves amounted 2.46% fresh weight recorded in 2.5 $dS.m^{-1}$ treatment (Table 3). There were also significant differences in leaves content of chlorophyll when it sprayed with potassium silicate as 2ml.L-1 concentration was exceeded and gave the highest average of chlorophyll amounted $29.56mg^{-1}$ fresh weight compared to the lowest average 29.09 mg^{-1}fresh weight in control treatment. The interaction between spraying potassium silicate and salty irrigation water was significantly affected leaves content of chlorophyll when the treatment 1.5 $dS.m^{-1}$ of salty water + no spraying with potassium silicate gave the highest average of chlorophyll reached $36.14mg^{-1}$ fresh weight compared to the lowest average $24.36gm^{-1}$ fresh weight recorded in the treatment 1.5 $dS.m^{-1}$ of salty water + spraying with $2ml.L^{-1}$ of potassium silicate. Table 4 results also showed that there were significant differences in leaves content of carbohydrates when the seedlings irrigated with different levels of salty water as the treatment of 1.5 $dS.m^{-1}$ was gave the highest content of carbohydrates in leaves amounted $8.61mg^{-1}$ dry weight compared to $4.87mg^{-1}$ dry weight in control. Spraying potassium silicate also achieved significant differences in carbohydrates content in leaves when the treatment of $2ml.L^{-1}$ of potassium silicate was gave the highest average of amounted $7.38mg^{-1}$ dry weight in comparison with the lowest average $6.21mg^{-1}$ dry weight in control treatment. The interaction between spraying potassium silicate and salty irrigation water was significantly affected the leaves content of carbohydrates in apricot seedlings. The treatment 1.5 $dS.m^{-1}$ of salty water + no spraying with potassium silicate gave the highest average of carbohydrates amounted $7.47mg^{-1}$ dry differences in potassium content in leaves as the treatment of 2ml.L^{-1} of potassium silicate gave the highest content reached 2.90% compared to 2.11% in control treatment. The interaction treatment 1.5 dS.m^{-1} of salty water + spraying with 2ml.L^{-1} of potassium silicate gave the highest content of potassium in leaves amounted 3.97% compared to 1.02% in control treatment. Table 9 results indicated that there were significant differences in leaves content of silicon when the seedlings were irrigated with different levels of salty water. The treatment 1.5 dS.m^{-1} of salty water was gave the highest content of silicon in leaves amounted 3.08% compared to the lowest average 2.47% in 2 dS.m^{-1} treatment. Spraying potassium silicate was achieved significant differences in dry weight of total vegetative as the treatment of 2ml.L^{-1} of potassium silicate gave the highest content of silicon reached 3.08% compared to 2.41% in control treatment. The interaction treatment 1.5 dS.m^{-1} of salty water + spraying with 2ml.L^{-1} of potassium silicate gave the highest content of silicon in the leaves of apricot seedlings amounted 4.13% compared to 1.30% in control treatment.

compared to 1.26% in control treatment. Table 7 results indicated that there were significant differences in the phosphorus content in leaves when the seedlings of apricot were irrigated with different levels of salty water. The treatment 1.5 dS.m^{-1} of salty water was gave the highest content of phosphorous in leaves amounted 0.42% compared to the lowest content 0.36% at 2.5 dS.m^{-1} of salty water. Spraying potassium silicate was achieved significant differences in leaves content of phosphorous as the treatment of 2ml.L^{-1} of potassium silicate gave the highest content reached 0.43% compared to 0.37% in control treatment. The interaction treatment 1.5 dS.m^{-1} of salty water + spraying with 2ml.L^{-1} potassium silicate gave the highest average of leaf content of phosphorus amounted 0.59% compared to 0.22% in control. There were significant differences in the leaves content of potassium when the seedlings were irrigated with different levels of salty water (Table 8). The treatment 1.5 dS.m^{-1} of salty water was gave the highest content of potassium in leaves amounted 2.73% compared to the lowest content 2.63% at 2 dS.m^{-1} of salty water. Spraying potassium silicate was achieved significant

Table 3. The role of potassium silicate, salty water and their interaction on the average of chlorophyll in leaves (mg^{-1} fresh weight) of apricot seedlings c.v Qaisi.

Salty water dS.m^{-1}	Potassium silicate (ml.L^{-1})			The average of salty water effect
	0	1	2	
1.5	36.14	26.77	24.36	32.81
2	31.32	28.85	25.17	28.63
2.5	30.96	30.29	27.45	25.66
The average of potassium silicate effect	29.09	28.44	29.56	
LSD (0.05)	Potassium silicate = 0.33 Salty water = 0.33 Interaction = 0.57			

Table 4. The role of potassium silicate, salty water and their interaction on the content of carbohydrates in leaves (mg.g^{-1} dry weight) of apricot seedlings c.v Qaisi.

Salty water dS.m^{-1}	Potassium silicate (ml.L^{-1})			The average of salty water effect
	0	1	2	
1.5	8.26	5.45	4.13	8.61
2	8.72	6.65	4.64	6.60
2.5	8.87	7.72	5.84	4.87
The average of potassium silicate effect	5.94	6.67	7.47	
LSD (0.05)	Potassium silicate = 0.16 Salty water = 0.16 Interaction = 0.27			

Table 5. The role of potassium silicate, salty water and their interaction on the content of proline in leaves (mmol/g) of apricot seedlings c.v Qaisi.

Salty water dS.m^{-1}	Potassium silicate (ml.L^{-1})			The average of salty water effect
	0	1	2	
1.5	1.34	2.79	3.35	0.99
2	0.97	2.14	4.15	1.99
2.5	0.68	1.05	4.74	4.08
The average of potassium silicate effect	2.49	2.42	2.15	
LSD (0.05)	Potassium silicate = 0.13 Salty water = 0.13 Interaction = 0.23			

Table 6. The role of potassium silicate, salty water and their interaction on the percentage of nitrogen in leaves of apricot seedlings c.v Qaisi.

Salty water dS.m^{-1}	Potassium silicate (ml.L^{-1})			The average of salty water effect
	0	1	2	
1.5	1.26	1.78	1.84	1.52
2	1.63	1.77	2.23	1.78
2.5	1.67	1.81	2.46	2.18
The average of potassium silicate effect	1.63	1.88	1.98	
LSD (0.05)	Potassium silicate = 0.031 Salty water = 0.031 Interaction = 0.054			

Table 7. The role of potassium silicate, salty water and their interaction on the percentage of phosphorous in leaves of apricot seedlings c.v Qaisi.

Salty water $dS.m^{-1}$	Potassium silicate ($ml.L^{-1}$)			The average of salty water effect
	0	1	2	
1.5	0.22	0.30	0.59	0.42
2	0.56	0.41	0.26	0.39
2.5	0.50	0.46	0.34	0.36
The average of potassium silicate effect	0.37	0.41	0.43	
LSD (0.05)	Potassium silicate = 0.012 Salty water = 0.012 Interaction = 0.022			

Table 8. The role of potassium silicate, salty water and their interaction on the percentage of potassium in leaves of apricot seedlings c.v Qaisi.

Salty water $dS.m^{-1}$	Potassium silicate ($ml.L^{-1}$)			The average of salty water effect
	0	1	2	
1.5	1.02	1.34	3.97	2.73
2	3.76	2.62	1.07	2.36
2.5	3.43	3.14	2.15	2.39
The average of potassium silicate effect	2.11	2.48	2.90	
LSD (0.05)	Potassium silicate = 0.10 Salty water = 0.10 Interaction = 0.18			

Table 9. The role of potassium silicate, salty water and their interaction on the percentage of silicon in leaves of apricot seedlings c.v Qaisi.

Salty water $dS.m^{-1}$	Potassium silicate ($ml.L^{-1}$)			The average of salty water effect
	0	1	2	
1.5	1.30	1.81	4.13	3.08
2	4.09	2.25	1.51	2.47
2.5	3.86	3.36	2.02	2.55
The average of potassium silicate effect	2.41	2.61	3.08	
LSD (0.05)	Potassium silicate = 0.10 Salty water = 0.10 Interaction = 0.18			

in chlorophyll occurred due to the lack of its building factors including the water, mineral elements, carbohydrates and the increasing in ABA hormone levels which speeds the degradation of chlorophyll, as well as the salinity damages the cell membranes which affects photosynthesis pigments (Cha-Um et al. 2010). The accumulation of salts in the growth medium leads to reduction of chloroplasts size and slowing down the rate of building chlorophyll (Levitt 1980), it may also attributed to the role of free oxygen radicals that accumulate as a result of exposure to salt stress by oxidizing phospholipids which leads to oxidation of chlorophyll (Ben-Hassine and Lutts 2010). This is consistent with Handi (2016) who found that the response of sour orange seedlings to salt stress by increasing the production of active oxygen radicals (ROS) that lead to disruption of the ionic balance and cellular metabolism and reduction in the size of stomata which in turn reduces the formation of chlorophyll. Salt stress pulls nitrogen that necessary to build the amino acid proline which leads to poor building of chlorophyll (Cha-Um and Kirdmanee 2009). There is a direct significant relationship between the small size of leaf area and the decrease in the percentage of dry matter, as the less the leaf area and chlorophyll pigments, the lower the metabolic rates in the cells (Mostafa et al. 1984). The effect of salinity on the carbohydrate content of the plant occurred due to its inhibitory effect on chlorophyll which leads to a decrease in carbohydrate formation processes, disruption of nitrogen metabolism and inhibition of nitrate absorption (El-Zeiny et al. 2007). The reason for this reduction is due to high levels of salt that lead to reduce the efficiency of carbon synthesis

Discussion

The effect of the salinity of irrigation water on chemical parameters of apricot seedlings c.v Qaisi.

Tables 3, 4, 5, 6, 7, 8 and 9 results indicated that there was significant decreasing in the chemical parameters including leaves content of chlorophyll, carbohydrates, proline and the percentage of mineral elements (N, P, K, Si) when the seedlings of apricot were irrigated with salty water. The use of salty water lead to a decrease in the average of growth as a result of increasing the osmotic pressure which leads to increase the pressure on the cell walls with lack of expansion of their walls, and this affects the formation of protein in the cell walls in addition to the toxic effects of salt ions and disturbances in the absorption and transport of nutrients through the roots (Ates and Tekeli 2007). The outcome also showed that salty water leads to a decrease in leaves content of chlorophyll which may attribute to the high levels of salt that prevent the accumulation of useful ions in leaves particularly those who enter in the formation of chlorophyll such as magnesium as a result of the opposition between magnesium and sodium (Aly et al. 2003). Moreover, the salinity of irrigation water causes a decrease in the biological activities inside the cell such as photosynthesis and respiration as a result of osmotic effect that occur from the accumulation of salts in soil and lead to decrease the absorption of water and nutrients by the plant (Golezani et al. 2011). Salinity also works to destroy chlorophyll, slows down its formation, increasing the effectiveness of the enzyme that degrade chlorophyll and then reduce its content in leaves (Noreen and Ashraf 2008; Sevengor et al. 2011). The reduction chemical parameters as it increase leaves content of chlorophyll, carbohydrates, proline and the percentage of mineral elements (N, P, K, Si) when the concentration of this fertilizer was increased due to the fact that potassium silicate is one of the means that works to increase salt tolerance of the plant by increasing the Na^{++}: K^{+} ratio under salt stress conditions.

The increasing of chlorophyll content in leaves of apricot seedlings at $2ml.L^{-1}$ concentration occurred due to the role of silicon in increasing the absorption of some elements by plant such as iron and magnesium which play important role in building chlorophyll (Datanoff et al. 2001), in addition to its role in improving the vegetative parameters of plant. Silicon also has a role in increasing the effectiveness of ATPase and PPase enzymes in balsamic membranes (Liang et al. 2006). Potassium also contributes in increasing chlorophyll content by increasing the absorption of nitrogen which enter in chlorophyll molecules, build ATP compound and synthesis of CO2 (Mengel and Kirkby 1982). These results are in agreement with Al-Kafaji et al. (2000) and Shu and Liu (2001) who reported that potassium fertilization was increased plant ability to do photosynthesis. The effect of treating apricot seedlings with potassium silicate leads to reduce the concentration of sodium as the silicon works to reduce the permeability of sodium ions Na^{+} into the plant, as well as increasing the effectiveness of ion-carrying proteins presented in the outer plasma membrane (Liang et al. 2005; Liang et al. 2006). Silicon also increases calcium ion Ca^{++} which has a role in increasing the (Berkowitz 1998), Morales-Garcia et al. (2008) mentioned that the high salinity of irrigation water lead to plant toxicity and then lack of carbohydrates accumulation in plant.

Mastrogiannidou et al. (2016) found that the content of chlorophyll and carbohydrates in seedlings of pomegranate (cv. Wonderful) was decreased when it irrigated with salty water, Abdul Wahid (2006) also reported the same results on *Ziziphus* plant. Results of current study showed an increasing of leaves content of proline under salt stress as this amino acid play significant role in osmotic balance, therefore, the content of proline in plant is increased when it exposure to salt and other environments stresses (Jaleel et al. 2007). The salinity of irrigation water also affected leaves content of mineral elements as it decreased in apricot seedlings as a result of increasing osmotic pressure of soil solution and prevent the absorption of water and nutrients by the plant (Al-Zubaidy 1989; Dutt et al. 1991), or disrepute the nutritional and harmonic balance in plant, increase the chloride in soil solution (Kafkafi et al. 1992). The reduction of some mineral elements in plant may be attributed to increasing the concentrations of Na^{+} and Cl^{-} in the soil solution which absorb by plant and lead to decreased the osmotic pressure of soil solution and then decreased the absorption of water and useful ions such as nitrogen and phosphorous by roots, inhibit cell division, elongation, decrease the growth and the process of building carbon (Abbaspour et al. 2006).

The role of potassium silicate on chemical parameters of apricot seedlings c.v Qaisi.

Foliar spraying of potassium silicate on the seedlings of apricot was affected the

Atriplexhalimus L. exposed to salinity and water stress in relation to senescing hormones abscisic acid and ethylene. *Journal of Plant Physiology*, 167: 1448–1456.

Bergmann W (1983). Ernahrungsstorungen beiKulturpflanzen.Veb Gustav Fischer Verlag Jena, DDR.

Berkowitz GA (1998). Water and salt stress. In: Photosynthesis. A Comprehensive treatise Raghavendra, A. S. ed. Cambridge Univ. Press P. 226-237.

Cha-Um S, Yooyongwech S, Supaibulwatana K (2010). Water deficit stress in the reproductive stage of four indica rice (*Oryza sativa* L.) genotypes. *Pak. J. Bot*., 42 (5): 3387-3398.

Datnoff LE, Snyder GH, Korndorfer GH (2001). Silicon in agriculture. Amsterdam, Elsevier Science B. V. 19: 161-183.

Dutt SK, Bal AR, Bandyopadhay AK (1991). Salinity induced chemical changes in Casuarina equisetifoliaforst. *Egypt. J. Soil Sci*. 31: 57-63.

El-Issa E, Batha M (2012). Deciduous Fruit Production. First Edition, Damascus.

El-Zeiny HA, Abou LB, Gaballah MS, Khalil S (2007). Antitranspirant application to sesame plant for salinity stress Augmentation. *Res. J. Agric. Biologic. Sci.* 3: 950–959.

Golezani KG, Salmasi SZ, Dastborhan S (2011). Changes in essential oil content of dill (Anethumgraveolens) organs under salinity stress, *Journal of Medicinal Plants Research* 5(14): 3142-3145.

Guerriero G, Hausman JF, Legay S (2016). Silicon and the plant extracellular matrix. *Frontiers in plant science*, 7: 463.

Handi ZA (2016). Response of sour orange (*Citrus aurantium* L.)seedling in a local class prolin and glycine betaine and sodium chloride in avoid damage to salt

effectiveness of ATPase in plasma membranes (Liang et al. 2003).

References

Abbas pour H, Fallahyan F, Fahimi H, Afshari H (2006). Response of *Pistaciavera* L. in salt tolerance to inoculation with arbuscular mycorrhizal fungi under salt stress. *Actahorticulturae*. 726: 383 – 389.

Abdul Wahid AH (2006). Effect of irrigation water salinity on some physical and chemical characteristics of seedling leaves of *Ziziphus* spp. cv. Zitowni. *Iraqi Journal of Agricultural Sciences* 37(2): 23-32.

Al-Kafajy Sabaa Jawad Abdulkadhim (2007). Influence of scion cultivar and foliar of prosol of growth of budden apricot seedings (*Prunus armeniaca* L.). Master thesis, Technical College- Al-Mussaib, Iraq.

AL–Rawi KM Khalf AM (2000). Design and Analysis of Agricultural Experiments. College of Agriculture University of Mosel, Iraq.

Aly MM, El-Sabbagh SM, El-Shouny WA, Ebrahim MKH (2003). Physiological response of (*Zea mays* L.) to NaCl stress with respect to Azotobacterchroococcum and Streptomyces niveus. *Pak J BiolSci*, 6(24): 2073-2080.

Al-Zubaidy AH (1989). The salinity of water: Theoretical and practical basis. University of Baghdad, Ministry of Higher Education and Scientific Research of Soil Science Hekma House.

Ates E, Tekeli AS (2007). Salinity tolerance of Persian clover (*Trifoliumresupinatum* Var. MajusBoiss.) lines at germination and seedling stage. *World J. Agric. Sci*, 3(1): 71-79.

Ben Hassine A, Lutts S (2010). Differential responses of salt bush

Mastrogiannidou E, Chatzissavvidis C, Antonopoulou C, Tsabardoukas V, Giannakoula A, Therios I (2016). Response of pomegranate cv. wonderful plants to salinity. *Journal of soil science and plant nutrition*, 16(3): 621-636.

Mengel K, Kirkby EA (1982). Principle of plant nutrition , 3rdedition. International Potash Institute, Bern Switzerland.

Morales-Garcia D, Stewart KA, Seguin P (2008). Effect of saline water on growth and physiology of bell pepper seedling. *International Journal of Vegetable science*, 14(2): 121-138.

Mostafa MB, Awad ARE, Owais MH, Dawh AK (1984). Physiological studies on growth, chemical composition and alkaloids of Datura innoxia .3. Effect of interaction between salinity and growth regulators (Egypt). *Annals of Agricultural science*, Moshtohor.

Noreen Z, Ashraf M (2008). Inter and intra specific variation for salt tolerance in turnip (*Brassica rapa* L.) and radish (*Raphanussativus* L.) at the initial growth stages. *Pakistan Journal of Botany*, 40(1): 229-236.

Sevengor S, Yasar F, Kusvuran S, Ellialtioglu S (2011). The effect of salt stress on growth, chlorophyll content, lipid peroxidation and antioxidative enzymes of pumpkin seedling. *African Journal of Agricultural Research*, 6(21): 4920-4924.

Westwood MN (1989). Temperate Zone Pomology.(Translated by Y.H. Yousif). Mousel University.

stress. *Int. J. Curr. Microbiol. App. Sci*., 5(10): 1066-1071.

Jaleel CA, Gopi R, Sankar B, Manivannan P, Kishorekumar A, Sridharan R, Panneerselvam R (2007). Studies on germination, seedling vigour, lipid peroxidation and proline metabolism in Catharanthusroseus seedlings under salt stress. *South African Journal of Botany*, 73(2): 190-195.

Jiping L, Jian KZ (1997). An Arabidopsis mutan that requires increasedcalcium for potassium nutrition and salt tolerance. *Proc.Nati Acad. Sci*.USA. (23): 14960-14964.

Kafkafi U, Siddiqi MY, Ritchie RJ, Glass ADM, Ruth TJ (1992). Reduction of nitrate (13NO3) influx and nitrogen (13N) translocation by tomato and melon varieties after short exposure to calcium and potassium chloride salts. *Journal of Plant Nutrition*, 15(6-7): 959-975.

Levitt J (1980). Responses of plant to Environment stress. Vol.2. water, Radiation, salt and other stresses. Academic Press, New York. P. 375.

Liang Y, Chen Q, Liu Q, Zhang W, Ding R (2003). Exogenous silicon (Si) increases antioxidant enzyme activity and reduces lipid peroxidation in roots of salt stressed barley (*Hordeum vulgare* L.). *J. Plant Physiol*., 160: 1157-1164.

Liang YC, Su W C, Zhu YG, Christie P (2006). Mechanisms of silicon mediated alleviation of abiotic stresses in higher plants: a review. *Environ. Pollut*., 147: 422–428.

Liang YC, Zhang WO, Chen J, Ding R (2005). Effect of silicon on H + -ATPase and H + -PPase activity, fatty acid composition and fluidity of tonoplast vesicles from roots of salt-stressed barley (*Hordeum vulgare* L.). *Environ. Exp. Bot*., 53: 29–37.