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Minimizing salinity hazard of Valencia orange trees through manipulation of anti-salt stress substances

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ABSTRACT

Vegetative growth and some leaf physiological characteristics of drip irrigated Valencia orange trees with saline irrigation water. In relation to K-silicate, Nile Fertile and Magnetic Iron as anti-salt stress substances were investigated during 2014-2015 and 2015-2016 experimental seasons. Results revealed that sprayed trees with K-silicate or Nile Fertile or Magnetic Iron or triple treated trees were highly responded as most of vegetative growth salinity symptom were disappeared as well as leaf physiological characteristics. The best results in this regard were obtained when the trees were received K-silicate at 10ml/L + Nile Fertile at 500 g/tree + Magnetic Iron at 300 g/tree as such treatments enhanced vegetative growth and leaf physiological characteristics as well as minimized leaf osmotic pressure.

Key words: potassium silicate, Nile Fertile, magnetic iron, vegetative growth, leaf physiological characteristics, saline irrigation water and Valencia orange trees.

Introduction

Citrus is a major fruit crop cultivated in Egypt as its acreage, production and exportation potentialities are concerned. It is the largest horticultural industry, during the last few years, and harvested area increased rapidly from year to another (533885 fed. in 2015 from the total fruit crops area, which estimated to be 1609189 fed.) The fruiting acreage of citrus occupies about 449601 fed. And produced about 4646579 tons with average of 9.83 tons/fed. (According to Ministry of Agriculture and Land Reclamation of Egypt, 2015).

Salinity is one of the most serious and oldest environmental problems affecting approximately one third of earth's irrigation land. There are many factors affecting the salinity yield relationship such as the physical and chemical condition of the soil, climate and farming practices.

Also, the possibility of using saline water for irrigation, especially underground water is considering as a limiting factor and great value for the success of the projects of new land reclamation, which it is still very limited source until now, however many problems are expected to arise. These problems would be related to the excessive accumulation of salts in the soil because this water contains considerable amounts.

As alternative strategy for overcoming the negative effects of salinity on plant growth and yield could be attempt to treat the trees with some anti-salt stress substances as silicon, Nile Fertile and magnetic iron, where irrigation water is known to be or may become saline.

Silicon is the second most abundant element in the earth's crust, has not yet received the title of essential nutrient for higher plants, as its role in plant biology is poorly understood (Epstein, 1999). However, various studies have demonstrated that Si application increased plant growth significantly (Alvarez and Datnoff, 2001). The function of Si as a protective agent is one of the most important for plants. Improved Si nutrition has been shown to increase plant tolerance to a biotic stress such as Al, Mn, heavy metal toxicities, salinity, frost and drought (Epestein, 1999). In this respect, grove studies conducted in Russia on citrus responses to Si fertilizers showed 30 to 80% accelerated growth, (Taranovskaia, 1939) In addition to, (Wutscher, 1989) mentioned that, citrus trees treated with Si absorbed more nutrients than the untreated trees. In plants growing under salt- stress conditions,

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added silicon helps in maintain an adequate supply of essential nutrient and reduce sodium uptake and its transport to shoots (Tuna *et al.,* 2008).

Nile Fertile (N.F) is oxidized by soil microorganisms, such as *Thiobacillus spp*. Bacteria which, consider as the most important microorganisms involved in the bioleaching of sulphide compounds to sulphuric acid in amount enough to decrease soil PH, improve availability of most soil nutrients and uptake by plant, enhancing root development and increasing the activity of soil microorganisms (Kassem *et al.,* 1995).

Magnetite (M. I), is one of the most important factors affecting plant growth and it is a natural row rock that has very high iron content, Magnetite has a black or brownish-red, and it has hardness about 6 on the Mohs hardness scale, it is one of two natural row rocks in the world that is naturally magnetic (Mansour, 2007). Application of magnetic iron increased vegetative growth, yield and on pepper plant grow under saline irrigation conditions, Taha *et al.* (2011). Also, magnetic iron increased plant growth and leaf mineral content on cauliflower (Mansour, 2007). Magnetite may be play an important role in cation uptake capacity and has a positive effect on immobile plant nutrient uptake (Esitken, 2003).

The present study aimed to minimize the adverse effects of salinity irrigation water on tree growth and leaf physiological characteristics of Valencia orange trees through manipulation with some anti-salt stress substances (potassium silicate, Nile Fertile and magnetic iron).

Materials and Methods

The present study was conducted during two successive experimental seasons (2014–2015) and (2015–2016) on Valencia orange trees Olenda cv. grown in a private orchad, which was located at El Bustan district, El Behera Governorate, Egypt. Five – year old trees of Valencia orange "Olenda "cv. budded on Volkamer lemon rootstock (*citrus volkameriana*). Were the plant materials in this investigating. 81 healthy fruitful trees were carefully selected and devoted for achieving this work. The selected trees were nearly uniform as possible as we could in their growth, grown in calcareous soil, planted at (5 X 5) m apart, irrigated through drip salted water and the trees were subjected to the same annual regular horticulture management. Water chemical analysis was done and listed in Table (1).

Table 1: chemical analysis of irrigation water:

Soluble cations mg/L				Soluble anions mg/L				PH	EC	TSS
Ca^{++}	Mg^{++}	K^+	Na^+	HCO_3^-	CO_3^-	SO_4^-	Cl^-			
128	43.04	43.04	450	131.15	15	600	491.84	7.4	4.4	2816

The Different anti-salt stress substances which have been suggested to build up the Skelton of such investigation were as follow:

1) Potassium Silicate**,** contained 10% K_2O, 25% SIO_2 were applied as foliar spray at 3 levels (0, 5, 10) ml / L at spring cycle emerging in once/month starting from the 1st week of march until July late during 2014 and 2015 experimental seasons.
2) Nile Fertile (NF), contains 38% S, some essential elements, (2.7% N, 3.5% P, 1.2% K, 5% Ca, 2.7% Mg and 1% Fe) and Sulphur bacteria; *Thiobacillus spp*. (10^6 CFU/gm), and soil applied as a single dose at 3 levels (0, 250, 500) gm/ tree) in the first of January around root spread area for both seasons.
3) Magnetic Iron ore (MIO), contained 48.8% Fe_3O_4,17.3% Fe O, 26.7% Fe_2O_3, 2.6% MgO, 4.3% SiO_2 and 0.3% CaO, it was once soil applied at 3 levels (0, 300, 600) gm/ tree in the first of January around root spread area for both seasons.

The experiment involved three factors (A, B and C). The first factor (A) consisted of three levels (0.0, 5.0, 10.0 ml/L) of Potassium Silicate, the second one (B) comprised from three levels (0.0, 250, 500 g/tree) of Nile Fertile and the third factor (C) contained three levels (0.0, 300, 600 g/tree) of

Magnetic Iron. Furthermore, the three levels of Potassium Silicate, Nile Fertile and Magnetic Iron were selected up to be the main, sub and sub sub plots, respectively.

The complete randomized block design (factorial experiment) was used for arranging the above mentioned twenty-seven anti-salt stress treatments. Each treatment was replicated three times, whereas each replicate was represented by a single tree.

Methodology regarding the influence of the investigated treatments on growth, nutritional status and fruiting of Valencia orange trees was being determined as follows:

Vegetative Growth Measurements:

The impact of the different investigated anti-salt stress substances on some vegetative growth measurements has to be evaluated, thus four main branches well distributed around the periphery of each replicate (tree) were labeled. On each selected branch ten newly emerging shoots were tagged and the aforementioned growth parameters were estimated in late of October during both seasons, as follow:

Shoot length (cm)
Shoot diameter (cm) at the base of shoot
Number of leaves / Shoot
Average leaf area (cm^2)
Tree canopy volume (m^3)

Tree volume was calculated according to the following equation reported by Morse and Robertson, (1987).

$TV = 0.5236 \times HD^2$, Where H = tree height, D= tree diameter.

Leaf Physiological characteristics:

Leaf relative turgidity (L.R.T).

Discs of about 1 cm in diameter, were removed from each fresh leaf sample to determine their fresh weight immediately (F.W), then placed in a closed container (petri dishes) until they become constant in weight (after 24 hours) at room temperature (20$\pm$2 ^oC) in shade, The discs were surfuce dried with plotting paper and weighed for their turgid weight (Tr.W) . Dry weight (Dr.W) of each 10 discs was determined after 24 hours. Leaf relative turgidity was estimated according to the following equation Nomir (1994).

$$(L.R.T) = \frac{\text{Fresh wt.-Dry wt.}}{\text{Turgid wt. - Dry wt.}} \text{ x } 100$$

Leaf succulence grade (L.S.G): was estimated according to the following equation:

$$(L.S.G) = \frac{\text{Leaf water content (in g) *}}{\text{Leaf area (Dec.)}^2} = \text{(g) } H_2O/dec^2 \text{ of leaf}$$

*Whereas, leaf water content (in g) =

$$\frac{\text{Total fresh weight – total dry weight of the leaves at the end of experiments}}{\text{Total number of leaves at the end of experiments}}$$

According to Nomir (1994).

Leaf water potential (L.W. P):

$$(L.W.P) = \frac{\text{Fresh weight - dry weight}}{\text{Fresh weight}} \text{ x } 100$$

The method followed and the equation for the calculations have been suggested by Halma (1934) and confirmed by Draz (1986).

Leaf Osmotic pressure (in bar).

Adequate fresh leaf samples were immediately frozen, and then the cell sap was extracted in the laboratory with a piston pressure when the frozen tissue has been thawed. The sap total soluble solids were determined by refractometer and the equivalent values of the osmotic pressure (in bars) were estimated according to Gusov (1960).

Statistical analysis:

All data of the present investigation were subjected to analysis of variance and significant difference among mean were determined according to Snedecor and Cochran, (1980). In addition; significant differences among means were distinguished according to the Duncan's, multiple test range (Duncan 1955), whereas capital and small letters were used for differentiating the values of specific and interaction effects of the investigated factors, respectively.

Results and Discussion

Vegetative growth

The response of drip irrigated Valencia orange trees with saline water irrigation to some anti-salt stress substances (potassium silicate at 0.0, 5.0 and 10 ml/L, Nile Fertile at 0.0, 250 and 500 g/tree and Magnetic Iron at 0.0, 300 and 600 g/tree) was studied through the determination of some vegetative growth parameters (shoot length, shoot diameter, number of leaves/shoot, average leaf area and tree canopy volume).

Shoot length

A. Specific effect:

Regarding the specific effect of the three investigated anti-salt stress substances (potassium silicate, Nile Fertile and Magnetic Iron) on shoot length of Valencia orange trees data presented in Table (2) reveal that, the highest significant value of shoot length was obtained when the trees where sprayed with potassium silicate at 10ml/L. Meanwhile Nile Fertile alone at 250 g/tree was more effective in this respect than 500 g/tree or untreated trees.

Concerning the specific effect of Magnetic Iron, it was clear that the higher dose 600 g/tree was better than the lower dose (300 g/tree) in enhancing shoot elongation.

B. Interaction effect:

With referring to the interaction between potassium silicate and Nile Fertile on shoot length, data indicated that the maximum shoot length was detected with the combination between potassium silicate at 10 ml/L and Nile Fertile at 500 g/tree.

Regarding the interaction between K-Silicate and Magnetic Iron on shoot length, data refer that K-Silicate at 10 ml/L combined with either 300 or 600 g/tree of Magnetic Iron reflected an increment in shoot elongation as compared with Magnetic Iron omitted combination.

With respect to the interaction effect between Nile Fertile and Magnetic Iron on shoot length, data clear that the soil addition of Nile Fertile at the two levels has no effect on shoot length parameter specially when Magnetic Iron was used alone at 600 g/tree as it was capable to achieve the highest value of shoot elongation, in addition, the maximum shoot elongation was recorded with the combination between Nile Fertile at 250 g/tree and Magnetic Iron at 300 g/tree.

On the other hand, the least value of shoot elongation was observed when the Valencia orange trees were not received neither Nile Fertile nor Magnetic Iron.

Regarding the interaction between the three investigated factors on shoot length, it is clear that the maximum value of shoot length was recorded with three different combinations in the first season:

1- K-Silicate at 10 ml/L + Nile Fertile at 500 g/tree + 0.0 Magnetic Iron
2- K-Silicate at 10 ml/L with Nile Fertile either at 500 or 250 g/tree + Magnetic Iron at 300 g/tree
3- K-Silicate at 10 ml/L + Magnetic Iron at 600 g/tree

Meanwhile, in the second season, the highest value of shoot elongation was associated with the combination between K-Silicate at 10 ml/L + Nile Fertile at 500 g/tree + Magnetic Iron at 600 g/tree.

On the other way around, the least value of shoot elongation was recorded with the trees which were not received any of the three investigated anti-salt stress substances.

Table 2: Shoot length (cm) of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments	Parameter	Shoot length (cm)							
		(2014 – 2015)				(2015 – 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	10.38jk	12.89f-i	16.17bc	**13.15E**	9.89j	13.33gh	15.76de	**12.86F**
	250	12.08h-j	14.82b-f	13.98d-h	**13.63E**	11.53i	14.33e-h	13.78gh	**13.22F**
	500	15.11b-e	11.53ij	13.31e-i	**13.32E**	15.01e-g	13.58gh	14.08e-h	**14.22E**
Mean (A x C)**		**12.52E**	**13.08DE**	**14.49C**		**12.01F**	**13.75E**	**14.54DE**	
5	0	12.73g-i	13.58d-h	13.73d-h	**13.25E**	13.75gh	14.52e-g	14.85e-g	**14.37E**
	250	14.35c-g	14.03d-h	16.43b	**14.94D**	15.63d-f	14.85e-g	15.65d-f	**15.38D**
	500	9.56k	13.58d-h	13.10f-i	**12.08F**	12.63hi	14.01e-i	13.383f-h	**13.49EF**
Mean (A x C)**		**12.11E**	**13.73CD**	**14.42C**		**14.00DE**	**14.46DE**	**14.78D**	
10	0	14.22d-g	15.55b-d	18.33a	**16.04C**	15.01e-g	17.03cd	17.58bc	**16.54C**
	250	16.20bc	19.57a	18.71a	**18.16B**	17.14b-d	18.86b	18.18bc	**18.06B**
	500	19.22a	19.11a	19.83a	**19.39A**	18.33bc	18.25bc	21.08a	**19.22A**
Mean (A x C)**		16.55B	**18.08A**	**18.96A**		**16.83C**	**18.05B**	**18.95A**	
Mean (B x C)***		**12.34D**	**14.01C**	**16.08A**		**12.75E**	**14.96CD**	**16.06AB**	
		14.21C	**16.14A**	**16.38A**		**14.77D**	**16.01AB**	**15.87A-C**	
		14.63BC	**14.74BC**	**15.41AB**		**15.32B-D**	**15.28B-D**	**16.33A**	
Mean (A)#		**13.36B**	**13.342B**	**17.86A**		**13.43C**	**14.41B**	**17.94A**	
Mean (B)##		**14.14C**	**15.57A**	**14.93B**		**14.59B**	**15.55A**	**15.64A**	
Mean (C)###		**13.73C**	**14.96B**	**15.96A**		**14.28C**	**15.42B**	**16.09A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

Shoot diameter (cm)

A. Specific effect:

Regarding the specific effect of the three investigation factors (anti-salt stress substances) on shoot diameter of Valencia orange trees, data tabulated in Table (3) indicated that, the lower level of the three investigated factors (K-Silicate at 5 ml/L, Nile Fertile at 250 g/tree and Magnetic Iron at 300 g/tree) was better than the higher level in stimulating shoot diameter and subsequently achieved higher value of such parameter.

Table 3: Shoot diameter (cm) of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments / Parameter		Shoot diameter (cm)							
		(2014 – 2015)				(2015 – 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	0.337i-m	0.377ef	0.363fg	**0.359D**	0.303ij	0.343e-g	0.313hi	**0.320D**
	250	0.403cd	0.367fg	0.353g-i	**0.374C**	0.340e-g	0.340e-g	0.327gh	**0.336C**
	500	0.360f-h	0.350g-j	0.417bc	**0.376C**	0.327gh	0.327gh	0.357de	**0.337C**
Mean (A x C)**		**0.367C**	**0.365C**	**0.378B**		**0.323EF**	**0.337D**	**0.332DE**	
5	0	0.377ef	0.423b	0.390de	**0.397B**	0.357de	0.357de	0.367d	**0.360B**
	250	0.433ab	0.427b	0.447a	**0.436A**	0.400c	0.383c	0.443a	**0.409A**
	500	0.373ef	0.353g-i	0.340i-l	**0.355DE**	0.337fg	0.333fg	0.340e-g	**0.337C**
Mean (A x C)**		**0.394A**	**0.401A**	**0.392A**		**0.365B**	**0.358BC**	**0.383A**	
10	0	0.363fg	0.403cd	0.320m	**0.362D**	0.347ef	0.417b	0.337fg	**0.367B**
	250	0.323lm	0.390de	0.333j-m	**0.349E**	0.293j	0.397c	0.327gh	**0.339C**
	500	0.330k-m	0.343h-k	0.367fg	**0.347E**	0.307ij	0.327gh	0.390c	**0341C**
Mean (A x C)**		**0.339D**	**0.379B**	**0.340D**		**0.316F**	**0.380A**	**0.351C**	
Mean (B x C)***		**0.359E**	**0.401A**	**0.358E**		**0.336CD**	**0.372A**	**0.339C**	
		0.386BC	**0.395AB**	**0.378CD**		**0.344C**	**0.373A**	**0.366AB**	
		0.354E	**0.349E**	**0.375D**		**0.324E**	**0.329DE**	**0.362B**	
Mean (A)#		**0.370B**	**0.396A**	**0.353C**		**0.331C**	**0.369A**	**0.349B**	
Mean (B)##		**0.373B**	**0.386A**	**0.359C**		**0.349B**	**0.361A**	**0.338C**	
Mean (C)###		**0.367B**	**0.381A**	**0.370B**		**0.335B**	**0.358A**	**0.356A**	

Values followed by the same letter/s are not significantly different at 5% level.
*, **, *** refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

B. Interaction effect:

Concerning the interaction between K-Silicate and Nile Fertile, data reveal that the combination between K-Silicate at 5 ml/L and Nile Fertile at 250 g/tree was the best combination to produce the highest value of shoot diameter during both seasons of study.

With respect to the interaction between K-Silicate and Magnetic Iron, it was clear that the maximum shoot diameter value was detected with the combination between K-Silicate at 5 ml/L combined with Magnetic Iron at either 300 or 600 g/tree or without Magnetic Iron addition in the first seasons. While in the second season, the highest value of shoot diameter was recorded with either the combination between K silicate at 5 ml/L + Magnetic Iron at 600 g/tree or K-Silicate at 10 ml/L + Magnetic Iron at 300 g/tree.

In relation to, the interaction between Nile Fertile and Magnetic Iron, the maximum shoot diameter was detected with the addition of Nile Fertile at 250 g/tree or without addition along with

Magnetic Iron at 300 g/tree i.e. Nile Fertile addition to Magnetic Iron is not beneficial for encouraging shoot diameter.

Referring to the interaction between three investigated factors on shoot diameter, date in Table (3) reveal that the combination between K silicate at 5 ml/L + Nile Fertile at 250 g/tree + Magnetic Iron at 600 g/tree significantly improved shoot diameter and it was the promising combination in this respect.

On the other was way around, the least value of shoot diameter was associated with either those Valencia orange trees which not received any of the three investigated anti-salt stress substances, or those trees subjected to K-Silicate at 10 ml/L combined Nile Fertile at either 250 or 500 g/tree.

Number of leaves / shoot.

A. Specific effect:

With respect to the specific effect of the three investigated factors (K-Silicate, Nile Fertile and Magnetic Iron) on number of leaves/shoot of drip irrigated Valencia orange trees with saline water irrigation, data presented in Table (4) indicated that the higher level of both K silicate (10 ml/L) and Magnetic Iron (600 g/tree) as well as the lower level of Nile Fertile (250 g/tree) were effective in this respect as the three abovementioned levels significantly increased the number of leaves/shoots.

B-Interaction effect:

As for the interaction between K-Silicate and Nile Fertile on no. of leaves/shoot, data indicated that the highest significant value of number of leaves/shoot was obtained with the combination between the higher level of K-Silicate (10 ml/L) and Nile Fertile (500 g/tree), followed in descending order by K-Silicate at 10 ml/L + Nile Fertile at 250 g/tree and K-Silicate at 10 ml/L alone (with Zero Nile Fertile).

In case of the interaction between K-Silicate and Magnetic Iron, the maximum number of leaves/shoot was detected with the combination between the higher level of both K-Silicate (10 ml/L) and Magnetic Iron (600 g/tree), followed in descending order by the union between the higher level of K-Silicate (10 ml/L) and the lower level of Magnetic Iron (300 g/tree) and the addition of K-Silicate at 10 ml/L alone.

Regarding the interaction between Nile Fertile and Magnetic Iron, it is clear that using Magnetic Iron at 600 g/tree alone or 300 g/tree + Nile Fertile at 250 g/tree significantly maximized the investigated parameter.

Dealing with the interaction effect between the three anti-salt stress substances on number of leaves/shoot data indicated that the highest value of the investigated parameter in the 1st season was obtained either with using

- K-Silicate at 10 ml/L + Magnetic Iron at 600 g/tree or
- K-Silicate at 10 ml/L + 250 or 500 g/tree of Nile Fertile + 300 g/tree Magnetic Iron or
- K-Silicate at 10 ml/L + 500 g/tree Nile Fertile and 0.0 addition of Magnetic Iron

Meanwhile, the best result regarding the number of leaves/shoot in the second season, was detected when the trees received the higher level of each investigated three factors.i.e. 10 ml/L of K-Silicate + 500 g/tree Nile Fertile + 600 g/tree of Magnetic Iron.

On the other hand, the least value of number of leaves/shoot was cleared with those Valencia orange trees which did not receive any of the three investigated anti-salt stress substances.

Average leaf area (cm^2).

A-Specific effect:

Regarding average leaf area of drip irrigated Valencia orange trees with saline water irrigation as effected by the specific of the three investigated anti-salt stress substances data presented in Table (5) refer that the higher level of each individual investigated factors (10 ml/L of K-Silicate or 500 g/tree Nile Fertile or 600 g/tree Magnetic Iron) caused highly significant improvement in average leaf area, followed by the lower level of each investigated factors, as compared with untreated trees which reflect the least value of the investigated parameter.

Table 4: Number of leaves/branches of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments	Parameter	Number of leaves/branches							
		(2014 – 2015)				(2015 – 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	4.37m	5.43jk	6.79d	**5.53E**	4.12n	5.79k	6.84e	**5.58G**
	250	5.14kl	6.20e-g	5.89g-i	**5.74E**	4.98m	6.23h-j	5.97jk	**5.73FG**
	500	6.33ef	4.81l	5.60h-j	**5.58E**	6.53e-h	5.85k	6.12i-k	**6.17E**
Mean (A x C)**		**5.28FG**	**5.48F**	**6.09G**		**5.21F**	**5.96E**	**6.31D**	
5	0	5.20k	5.68h-j	5.77h-j	**5.55E**	5.99jk	6.28h-j	6.44g-i	**6.24E**
	250	5.9f-h	5.90gh	6.88d	**6.26D**	6.77e-g	6.43g-i	6.80ef	**6.67D**
	500	4.07m	5.68h-j	5.48i-k	**5.08F**	5.46l	6.07jk	5.93jk	**5.82F**
Mean (A x C)**		**5.09G**	**5.75E**	**6.04D**		**6.07E**	**6.26D**	**6.39D**	
10	0	5.97f-h	6.55de	7.70c	**6.74C**	6.47f-h	7.38d	7.62cd	**7.16C**
	250	6.79d	8.21ab	7.86bc	**7.62B**	7.41d	8.17b	7.86bc	**7.81B**
	500	8.07a-c	8.04a-c	8.32a	**8.14A**	7.92bc	7.90bc	9.13a	**8.32A**
Mean (A x C)**		**6.94C**	**7.60B**	**7.96A**		**7.27C**	**7.82B**	**8.20A**	
Mean (B x C)***		**5.18E**	**5.89D**	**6.75A**		**5.53D**	**6.48BC**	**6.97A**	
		5.97CD	**6.77A**	**6.88A**		**6.39C**	**6.94A**	**6.88A**	
		6.16C	**6.18C**	**6.47B**		**6.64B**	**6.61B**	**7.06A**	
Mean (A)#		**5.62B**	**5.63B**	**7.50A**		**5.83C**	**6.24B**	**7.76A**	
Mean (B)##		**5.94C**	**6.54A**	**6.27B**		**6.33B**	**6.74A**	**6.77A**	
Mean (C)###		**5.77C**	**6.28B**	**6.70A**		**6.18C**	**6.68B**	**6.97A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

B- Interaction effect:

Regarding the interaction between K-Silicate and Nile Fertile on average leaf area, it is clear that the addition of K-Silicate at 10 ml/L to Nile Fertile at (250 or 500 or 0.0 g/tree) reflect the highest value of average leaf area, and such values were image of each other and in turn from a commercial view it is preferable to add K-Silicate at 10 ml/L alone.

With respect to the interaction between K-Silicate and Magnetic Iron, the combination between K-Silicate at 10 ml/L and Magnetic Iron either at 0.0 or 300 g/tree reflected the maximum value of average leaf area, and subsequently it is recommended to use K-Silicate at 10 ml/L alone.

The interaction between Nile Fertile and Magnetic Iron on average leaf area, it was obvious that the higher level of both factors (500 g/tree of Nile Fertile + 600 g/tree Magnetic Iron) proved to be the most effective in enhancing average leaf area followed by the higher level of Nile Fertile (500 g/tree) + the lower level of Magnetic Iron 300 g/tree.

Concerning the interaction effect between the three anti-salt stress substances on average leaf area, the obtained data revealed that the highest value of the investigated parameter was detected with either the combination between 10 ml/L K-Silicate + 250g/tree Nile Fertile + 300 g/tree Magnetic Iron or the higher level of K-Silicate 10 ml/L + the higher level of Nile Fertile 500 g/tree.

Table 5: Average leaf area of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Parameter / Treatments		Average leaf area (cm^2)							
		(2014 – 2015)				(2015 – 2016)			
K-Silicate	Nile Fertile	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
ml/L (A)	(g) (B)	**0**	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	15.39m	16.21m	20.87k	**17.49F**	14.06m	19.11l	20.71l	**17.96G**
	250	18.62l	19.64kl	19.37kl	**19.21E**	19.27l	19.92l	19.57l	**19.59F**
	500	24.24j	25.29ij	26.19i	**25.24D**	22.82k	24.62j	27.17hi	**24.87E**
Mean (A x C)**		**19.42G**	**20.38F**	**22.14E**		**18.72H**	**21.22G**	**22.48F**	
5	0	25.82ij	28.57f-h	29.27e-h	**27.89B**	25.74ij	28.05gh	28.65f-h	**27.48C**
	250	30.53b-e	29.52d-g	31.08a-d	**30.38A**	29.44e-g	28.76f-h	29.77ef	**29.32B**
	500	24.57ij	28.07gh	27.76h	**26.80C**	24.57j	26.43i	28.67f-h	**26.56D**
Mean (A x C)**		**26.97D**	**28.72C**	**29.37BC**		**26.58E**	**27.75D**	**29.03C**	
10	0	31.48a-c	30.07c-f	30.20b-f	**30.58A**	30.48de	33.20a	31.50b-d	**31.73A**
	250	29.57d-g	32.30a	29.17e-h	**30.35A**	31.00c-e	33.20a	32.20a-c	**32.13A**
	500	31.78ab	29.40d-h	29.69d-g	**30.29A**	32.30a-c	30.50de	32.93ab	**31.91A**
Mean (A x C)**		**30.94A**	**30.59A**	**29.68B**		**31.26B**	**32.30A**	**32.21A**	
Mean (B x C)***		**24.23D**	**24.95D**	**26.78BC**		**23.43C**	**26.79B**	**26.95B**	
		26.24C	**27.15A-C**	**26.54C**		**26.57B**	**27.29B**	**27.18B**	
		26.86BC	**27.59AB**	**27.88A**		**26.56B**	**27.18B**	**29.59A**	
Mean (A)#		**20.64C**	**28.35B**	**30.41A**		**20.81C**	**27.79B**	**31.92A**	
Mean (B)##		**25.32C**	**26.64B**	**27.44A**		**25.72C**	**27.01B**	**27.78A**	
Mean (C)###		**28.78C**	**26.56B**	**27.07A**		**25.52C**	**27.09B**	**27.91A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

Tree canopy volume (m^3).

A. Specific effect:

With regard to the specific effect of three anti-salt stress substances on tree canopy volume of drip irrigated Valencia orange trees with saline water irrigation, data presented in Table (6) reflect that tree canopy volume was associated with the applied dose of each investigated factor i.e. the higher response of tree canopy volume was recorded with the higher dose of the three investigated factors. Meanwhile, the lower dose of each factor reflected also lower tree canopy volume. Furthermore, the least value of tree canopy volume was noticed also with untreated trees.

B- Interaction effect:

With respect to the interaction effect between K-Silicate and Nile Fertile, data indicated that the best increment in tree canopy volume was achieved when the trees received the higher level of both K-Silicate (10 ml/L) + Nile Fertile (500 g/tree) followed by K-Silicate at 10 ml/L + Nile Fertile at 250 g/tree. On the other hand, the least value of tree canopy volume was recorded with untreated trees.

The interaction between K-Silicate and Magnetic Iron, data reflect that K-Silicate at 10 ml/L combined with either dose of Magnetic Iron (0.0 or 300 or 600 g/tree) reflect the highest value of tree canopy volume, as each response was an image of each other. Hence, it is recommended in such case to spray the trees with K-Silicate alone at 10 ml/L.

Regarding, the interaction effect between Nile Fertile and Magnetic Iron on tree canopy volume, data revealed that the highest value was obtained with the combination between Nile Fertile at 500 g/tree with either 0.0 or 600 g/tree of Magnetic Iron during both seasons of study. Therefore, the Magnetic Iron application was not necessary in such case.

Table 6: Tree canopy volume of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Parameter / Treatments		Tree canopy volume (m^3)							
		(2014 – 2015)				(2015 – 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	15.83j	19.52i	20.69hi	**18.68G**	15.87l	21.14h-j	19.54jk	**18.85E**
	250	19.48i	20.50hi	22.08f-h	**20.69F**	19.23k	19.57jk	20.33i-k	**19.71E**
	500	22.40e-h	21.49gh	22.90d-g	**22.26E**	22.01f-i	21.30g-j	23.93c-f	**22.41D**
Mean (A x C)**		**19.24E**	**20.50D**	**21.89C**		**19.04E**	**20.67D**	**21.27D**	
5	0	25.30c	23.07d-g	24.75cd	**24.37C**	24.23cd	22.27d-h	24.23cd	**23.58C**
	250	24.10c-f	22.81d-g	24.42c-e	**23.78CD**	24.30c	23.90c-f	23.42c-f	**23.87C**
	500	24.20c-e	21.27g-i	24.30c-e	**23.26DE**	23.17c-g	22.50c-h	24.03c-e	**23.23CD**
Mean (A x C)**		**24.53B**	**22.38C**	**24.49B**		**23.90C**	**22.89C**	**23.89C**	
10	0	26.04c	22.67e-g	23.10d-g	**23.94CD**	24.07c-e	22.82c-h	22.08e-i	**22.99CD**
	250	22.77d-g	28.29b	28.07b	**26.38B**	22.48c-h	27.63b	28.53ab	**26.21B**
	500	31.26a	28.50b	30.48a	**30.08A**	30.04a	28.50ab	30.13a	**29.56A**
Mean (A x C)**		**26.69A**	**26.49A**	**27.22A**		**25.53B**	**26.32AB**	**26.61A**	
Mean (B x C)***		**22.39DE**	**21.75E**	**22.85CD**		**21.39C**	**22.08C**	**21.95C**	
		22.12DE	**23.87BC**	**24.86B**		**22.00C**	**23.70B**	**24.09B**	
		25.95A	**23.75C**	**25.89A**		**25.07A**	**24.10B**	**26.03A**	
Mean (A)#		**20.54C**	**23.80B**	**26.80A**		**20.32C**	**23.56B**	**26.25A**	
Mean (B)##		**22.33C**	**23.61B**	**25.20A**		**21.81C**	**23.27B**	**25.07A**	
Mean (C)###		**23.49B**	**23.12B**	**24.53A**		**22.82B**	**23.29B**	**24.02A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

The interaction between K-Silicate, Nile Fertile and Magnetic Iron on tree canopy volume, data show that, the maximum value of such parameter was remarked with two combinations:
1- K-Silicate at 10 ml/L + Nile Fertile at 500 g/tree.
2- K-Silicate at 10 ml/L + Nile Fertile at 250 g/tree + either 300 or 600 g/tree Magnetic Iron.

On the other hand, the least value of tree canopy volume was recorded with untreated trees with any of the three anti-salt stress substances during both seasons of study.

Our results regarding the impact of K-Silicate on vegetative growth of Valencia orange trees are in harmony with those reported by some investigators. Silicon had two different impacts on plant growth either through soil fertility or its effect on plant tolerance to stress. Silicon rich substances applied to the soil enhanced the initial growth of grapefruit seedlings (Matichenkove *et al.,* 1999). In this respect Silicon nutrition was responsible for a significant increase in root dry and green mass of Valencia orange and grape fruit seedling (Matichenkove *et al.,* 2001). Meanwhile, Ibrahim and El-wasfy, (2014), revealed that treating Valencia orange trees with a mixture of boric acid + K-Sulphate at 0.5% + K-Silicate at 0.1% gave the best results of growth parameters. Similar results have been gotten with some other fruit trees, Abdel Aal and Oraby (2013); Abd El-Rahman (2015); Mohamed *et al.,* (2015) on mango trees, Al-Wasfy, (2013); Gad El-Kareem *et al.,* (2014) on date palm, Roshdy (2014) on banana, Al-Wasfy (2014) on flame seedling, Akle *et al.,* (2015) on pomegranate, Zaen El-Deen *et al.,* (2015) on mango trees cv. Keitt and Sa *et al.,* (2015) on papaya plants and Abd El-Rahman, Amira, (2016) on two grape cvs. Transplant. They pointed out that shoot length, number of leaves/shoot, leaf area and stem diameter were positively affected by spraying with K-Silicate.

The obtained results concerning the impact of Nile Fertile on vegetative growth of Valencia orange trees are confirmed by the findings of Mankolah (2017), who reported that treated Washington navel orange trees with Nile Fertile at 750g/tree and Sulphur at 1.0 kg/tree were very effective in enhancing the growth parameters. An analogous result were registered by Ibrahiem, Alia (2003); Rizk-Alla *et al.,* (2006); Ashour *et al.,* (2009) on Balady orange trees, Rizk-Alla, Mervat and Tolba, Hager, (2010) on Black Monukka grapevines and Ali, Mervat *et al.,* (2013) on vineyards. They mentioned that Nile Fertile succeeded to restrict the negative effect of saline water irrigation on shoot length, stem diameter, number of leaves and leaf area.

The present results dealing with the relation between soil Magnetic Iron application and Valencia orange growth, are in agreement with those reported by Ibrahim, (2011) on navel orange trees and Abobatta, (2015) on Valencia orange trees. They found that Magnetic Iron significantly improved shoot length, stem diameter, number of leaves/shoot and leaf area. The same finding was reported by Abd El-Rahman, Amira, (2016) on two own rooted grape cvs. and El-Tarawy, (2017) on picual olive transplants. They cleared that salt stressed transplants subjected to K-Silicate spray and Magnetic Iron soil added as recovering substances were more effective in alleviating the adverse of salinity on growth.

Leaf physiological characteristics:

Leaf relative turgidity percentage (L.R.T):

A-Specific effect

Regarding the specific effect of the three investigated anti-salt stress substances (potassium silicate, Nile Fertile and Magnetic Iron) on leaf relative turgidity percentage, of Valencia orange trees data represented in Table (7) revealed that, the highest significant value of leaf relative turgidity percentage was obtained when the trees where sprayed with potassium silicate at 10ml/L. Meanwhile Nile Fertile at 250 g/tree was more effective in this respect than 500 g/tree.

Concerning the specific effect of Magnetic Iron. It was clear that the higher dose 600 g/tree was better than the lower dose (300 g/tree) in increasing leaf relative turgidity percent..

Table 7: Leaf relative turgidity (%) of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments	Parameter	Leaf relative turgidity (%)							
		(2014 - 2015)				(2015 - 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	46.03l	52.43h-j	61.67a	**53.38D**	53.60gh	55.23e-g	61.97ab	**56.93C**
	250	54.67d-i	58.63a-c	55.00c-h	**56.10BC**	55.30e-g	61.20a-c	57.07d-f	**57.86C**
	500	57.57b-f	52.29h-j	53.38g-i	**54.41CD**	58.63b-e	50.59h-j	52.08g-i	**53.77DE**
Mean (A x C)**		**52.76DE**	**54.45CD**	**56.68B**		**55.84BC**	**55.67BC**	**57.04B**	
5	0	51.08i-k	54.33e-i	55.08c-h	**53.50D**	49.22i-k	53.37gh	54.48fg	**52.36E**
	250	57.12c-g	56.37c-g	58.25a-d	**57.25B**	55.34e-g	54.93fg	61.74a-c	**57.34C**
	500	46.30l	47.79kl	48.37kl	**47.49E**	44.17m	45.26lm	46.39k-m	**45.27F**
Mean (A x C)**		**51.50E**	**52.83DE**	**53.90D**		**49.58D**	**51.19D**	**54.20C**	
10	0	49.57j-l	53.80f-i	57.60b-f	**53.66D**	48.03j-l	57.47d-f	58.37c-e	**54.62D**
	250	57.73b-e	57.77b-e	58.13a-e	**57.88B**	58.83b-d	59.70a-d	61.13a-c	**59.89B**
	500	61.30ab	61.57a	61.70a	**61.52A**	61.40a-c	61.70a-c	62.73a	**61.94A**
Mean (A x C)**		**56.20BC**	**57.71AB**	**59.14A**		**56.09B**	**59.62A**	**60.74A**	
Mean (B x C)***		**48.90D**	**53.52C**	**58.12A**		**50.28E**	**55.36BC**	**58.27A**	
		56.51AB	**57.59A**	**57.13A**		**56.50B**	**58.61A**	**59.98A**	
		55.06BC	**53.88C**	**54.48C**		**54.73BC**	**52.52D**	**53.73CD**	
Mean (A)#		**54.63B**	**52.74C**	**57.69A**		**56.19B**	**51.66C**	**58.82A**	
Mean (B)##		**53.51B**	**57.07A**	**54.47B**		**54.64B**	**58.36A**	**53.66B**	
Mean (C)###		**53.49C**	**55.00B**	**56.58A**		**53.84C**	**55.49B**	**57.33A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

B-Interaction effect:

With referring to the interaction between potassium silicate and Nile Fertile on leaf relative turgidity percentage, data indicated that the maximum leaf relative turgidity percent was detected with the combination between potassium silicate at 10 ml/L and Nile Fertile at 500 g/tree.

Regarding the interaction between K-Silicate and Magnetic Iron on leaf relative turgidity percentage, data referred that K-Silicate at 10 ml/L combined with either 300 or 600 g/tree of Magnetic Iron reflected an increment of leaf relative turgidity percent as compared with Magnetic Iron omitted combination.

As for, the interaction between the soil addition of Nile Fertile and Magnetic Iron, it is clear that the maximum leaf relative turgidity percentage value was detected with the combination between Magnetic Iron at (either 300 or 600 g/tree) + Nile Fertile at (250 g/tree) or Magnetic Iron alone at (600 g/tree) during both seasons of study.

With respect to the interaction effect between the three investigated factors (K-Silicate, Nile Fertile and Magnetic Iron) on leaf relative turgidity percentage, data indicated that the Magnetic Iron alone at 600 g/tree or combination between (K-Silicate at 10 ml/L + Nile Fertile at 500 g/tree + Magnetic Iron at (either 300 or 600 g/tree)) was the best one as it reflected the highest value of leaf relative turgidity percentage during both seasons of study.

Meanwhile, the least value was associated with those untreated trees (control).

Leaf succulence grade percentage (L.S.G) :

A-Specific effect

Regarding the specific effect of the three investigated anti-salt stress substances (K-Silicate, Nile Fertile and Magnetic Iron) on leaf succulence grade of Valencia orange trees data presented in Table (8) revealed that, the highest significant value of leaf succulence grade was maximized with higher dose of each investigated factor.

Table 8: Leaf succulence grade of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments	parameter	Leaf succulence grade (g H_2o/dec^2 of leaf)							
		(2014 - 2015)				(2015 - 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	1.57kl	1.67h-k	1.87e-g	**1.70EF**	1.33p	1.57l-n	1.97ef	**1.62F**
	250	1.70h-k	1.80e-h	1.73g-j	**1.74DE**	1.63k-m	1.90fg	1.80g-i	**1.78E**
	500	1.80e-h	1.77f-i	1.87e-g	**1.81CD**	1.87f-h	1.80g-i	1.93ef	**1.87D**
Mean (A x C)**		**1.69D**	**1.74CD**	**1.82B**		**1.61D**	**1.76C**	**1.90B**	
5	0	1.70h-k	1.87e-g	1.90ef	**1.82C**	1.70i-k	2.03de	2.13cd	**1.96C**
	250	1.93de	1.93de	2.03cd	**1.97B**	2.33ab	2.23bc	2.37a	**2.31A**
	500	1.60j-l	1.63i-k	1.67h-k	**1.63F**	1.30p	1.40op	1.50no	**1.40G**
Mean (A x C)**		**1.74CD**	**1.81BC**	**1.87B**		**1.78C**	**1.89B**	**2.00A**	
10	0	1.73g-j	1.50l	1.73g-j	**1.66F**	1.53mn	1.60k-n	1.63k-m	**1.59F**
	250	1.73g-j	1.87e-g	1.87e-g	**1.82C**	1.67j-l	1.77h-j	2.13cd	**1.86D**
	500	2.10bc	2.17b	2.57a	**2.28A**	2.13cd	2.23bc	2.27ab	**2.21B**
Mean (A x C)**		**1.86B**	**1.84B**	**2.06A**		**1.78C**	**1.87B**	**2.01A**	
Mean (B x C)***		**1.67D**	**1.68D**	**1.83BC**		**1.52F**	**1.73E**	**1.91BC**	
		1.79C	**1.87B**	**1.88B**		**1.88C**	**1.97B**	**2.10A**	
		1.83BC	**1.86BC**	**2.03A**		**1.77DE**	**1.81D**	**1.90C**	
Mean (A)#		**1.75C**	**1.81B**	**1.92A**		**1.76B**	**1.89A**	**1.89A**	
Mean (B)##		**1.73C**	**1.84B**	**1.91A**		**1.72C**	**1.98A**	**1.83B**	
Mean (C)###		**1.76B**	**1.80B**	**1.92A**		**1.72C**	**1.84B**	**1.97A**	

Values followed by the same letter/s are not significantly different at 5% level.
*, **, *** *refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### *refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.*

B-Interaction effect:

With referring to the interaction between K-Silicate and Nile Fertile on leaf succulence grade percent, data indicated that the maximum leaf succulence grade percentage was detected with the combination between higher level of K-Silicate and Nile Fertile in 1st season. While, the lower dose of both factors was more pronounced in the 2nd season.

Regarding to the interaction between K-Silicate and Magnetic Iron on leaf succulence grade percent, data referred that K-Silicate at (10 ml/L) combined with 600 g/tree of Magnetic Iron reflected the highest increment of leaf succulence grade percentage as compared with Magnetic Iron omitted combination.

As for, the interaction between the soil addition of Nile Fertile and Magnetic Iron, it is cleared that the maximum leaf succulence grade percentage value was detected with the combination between the higher dose Magnetic Iron with either the higher dose of Nile Fertile in the 1st season or the lower level in the 2nd season.

With respect to the interaction effect between the three investigated factors (K-Silicate, Nile Fertile and Magnetic Iron) on leaf succulence grade percentage, data indicated that the best value of such parameter was recorded by combination between the higher doses of the three investigated factors.

On the other way around, the least value of the investigated parameter was associated with untreated trees (control).

Leaf water potential percentage (L.W.P):

A-Specific effect

Regarding the specific effect of the three investigated anti-salt stress substances (K-Silicate, Nile Fertile and Magnetic Iron) on leaf water potential percentage of Valencia orange trees data presented in Table (9) reveal that, the highest significant value of leaf water potential percentage was obtained by K-Silicate at (10 ml/L). Meanwhile, Nile Fertile at (250 g/tree) and Magnetic Iron at 600 g/tree were more effective in this respect.

B-Interaction effect:

With referring to the interaction between K-Silicate and Nile Fertile on leaf water potential percentage, data indicated that the maximum leaf water potential percentage was detected with the combination between the higher level of K-Silicate and Nile Fertile in 1st season. While, the lower level of both factors was predominant in the 2nd season.

Regarding the interaction between K-Silicate and Magnetic Iron on leaf water potential percentage, data referred that, K-Silicate at (10 ml/L) combined with 600 g/tree of Magnetic Iron reflected the highest value of leaf water potential percentage as compared with the other combinations.

As for, the interaction between the soil addition of Nile Fertile and Magnetic Iron, it is clear that the maximum leaf water potential percentage value was detected with the combination between the higher dose of Magnetic Iron and Nile Fertile at 250 g/tree during both seasons.

With respect to the interaction effect between the three investigated factors (K-Silicate, Nile Fertile and Magnetic Iron) on leaf water potential percentage, data indicated that, the combination between the higher level of the three investigators factors (K-Silicate at 10 ml/L + Nile Fertile at 500 g/tree + Magnetic Iron at 600 g/tree) was the superior one in this respect as it reflected the highest value of leaf water potential percentage during both seasons of study.

The opposite was true with untreated trees (control) which exhibited the least value of such parameter.

Table 9: Leaf **water** potential (%) of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments / Parameter		Leaf water potential (%)							
		(2014 - 2015)				(2015 - 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C)				Magnetic Iron (g) (C)			
		0	**300**	**600**	A x B*	**0**	**300**	**600**	A x B*
0	0	47.18m	51.89jk	61.58ab	**53.55D**	54.19j	53.30j	59.73d-f	**55.74E**
	250	56.33d-g	57.75de	57.10d-f	**57.06B**	56.50i	59.09e-g	57.10hi	**57.56CD**
	500	57.74jk	51.74jk	53.14ij	**54.14D**	58.37f-h	57.60g-i	58.31f-h	**58.09BC**
Mean (A x C)**		**53.68C**	**53.79BC**	**57.27A**		**56.35D**	**56.66D**	**58.38BC**	
5	0	51.00kl	54.39g-i	55.29f-h	**53.56D**	57.53g-i	58.61e-h	59.17e-g	**58.44BC**
	250	58.07d	55.48f-h	59.99bc	**57.85B**	64.91b	60.18c-e	64.94b	**63.34A**
	500	46.10m	46.51m	49.25l	**47.29F**	54.50j	54.54j	56.42i	**55.15E**
Mean (A x C)**		**51.72D**	**52.13D**	**54.84B**		**58.98B**	**57.78C**	**60.18A**	
10	0	49.82l	50.66kl	54.16hi	**51.55E**	57.27hi	56.40i	56.50i	**56.72D**
	250	54.72g-i	55.30f-h	55.92e-h	**55.31C**	57.53g-i	58.70e-h	60.13c-e	**58.79B**
	500	57.10d-f	58.28cd	62.57a	**59.32A**	61.00cd	61.57c	66.53a	**63.03A**
Mean (A x C)**		**53.88BC**	**54.75BC**	**57.55A**		**58.60BC**	**58.89B**	**61.05A**	
Mean (B x C)***		**48.33F**	**52.31E**	**57.01AB**		**56.33F**	**56.10F**	**58.47DE**	
		56.37B	**56.18B**	**57.67A**		**59.65BC**	**59.32CD**	**60.72A**	
		53.58D	**52.18E**	**54.99C**		**57.96E**	**57.90E**	**60.42AB**	
Mean (A)#		**54.92A**	**52.90B**	**55.39A**		**57.13C**	**58.98B**	**59.51A**	
Mean (B)##		**52.89C**	**56.74A**	**53.58B**		**56.97C**	**59.90A**	**58.76B**	
Mean (C)###		**53.10B**	**53.56B**	**56.56A**		**57.98B**	**57.78B**	**59.87A**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

Leaf osmotic pressure (L.O.P).

A- Specific effect:

Regarding the specific effect of the three investigation factors (anti-salt stress substances) on leaf osmotic pressure percentage of Valencia orange trees, data tabulated in Table (10) indicated that, the lowest level of the three investigated factors were achieved the highly leaf osmotic pressure percent during both seasons of study.

The addition of either one of the three anti-salt stress substances had a positive effect on reducing leaf osmotic pressure regardless its level, as compared with the neglected ones.

B- Interaction effect:

With referring to the interaction between K-Silicate and Nile Fertile on leaf osmotic pressure percentage, data referred that the least value of the investigated parameter was detected with the combination between K-Silicate at 5 ml/L with either the higher dose of Nile Fertile in the 1st season or the lower one in the 2nd season. Meanwhile, the highest leaf osmotic pressure was presented in the absence of both factors.

Concerning, the interaction between K-Silicate and Magnetic Iron on leaf osmotic pressure percent, data refer that the minimum value of the investigated parameter was associated with using K-Silicate at 5 ml/L combined with either Magnetic Iron at the lower level in the 1st season or the higher level in the 2nd season. The reverse was true with using K-Silicate at 10 ml/L alone as it caused a sharp increment in leaf osmotic pressure.

In relation to, the interaction between the soil addition of Nile Fertile and Magnetic Iron, it was clear that any combination between the lower and higher levels both factors reflected an acceptable reduction in the investigated factor as compared with untreated trees with neither of both.

Table 10: Leaf osmotic pressure (in bar) of drip irrigated Valencia orange trees with saline water as impacted by specific and interaction effects of three anti-salt stress substances during (2014 – 2015) and (2015 – 2016) experimental seasons.

Treatments	Parameter	Leaf osmotic pressure (in bar)							
		(2014 - 2015)				(2015 - 2016)			
K-Silicate ml/L (A)	Nile Fertile (g) (B)	Magnetic Iron (g) (C) 0	300	600	A x B*	Magnetic Iron (g) (C) 0	300	600	A x B*
0	0	21.80a	18.88b	14.42e	**18.37A**	22.45a	19.78b	11.44k	**17.89A**
	250	19.13b	14.10e	12.53fg	**15.25BC**	19.53b	14.75fg	16.04de	**16.77B**
	500	10.79ij	15.39d	12.39fg	**12.86E**	15.07ef	13.18hi	13.04hi	**13.76C**
Mean (A x C)**		**17.24B**	**16.12C**	**13.11D**		**19.02A**	**15.9**	**13.51E**	
5	0	14.11e	10.03j	17.14c	**13.76D**	14.76fg	12.88hi	11.77jk	**13.14D**
	250	12.23fg	10.67ij	16.46c	**13.12E**	10.68k	11.32k	9.18i	**10.40F**
	500	11.12hi	8.83k	15.38d	**11.68F**	17.79c	17.11cd	16.03de	**16.98B**
Mean (A x C)**		**12.49E**	**9.74G**	**16.33C**		**14.41D**	**13.77E**	**12.33F**	
10	0	14.76de	16.88c	13.10f	**14.91C**	15.41ef	20.26b	19.63b	**18.43A**
	250	19.61b	15.48d	11.90gh	**15.66B**	17.53c	16.13de	16.11de	**16.59B**
	500	18.98b	15.46d	10.10j	**14.85C**	13.75g-i	12.55ij	10.75k	**12.53E**
Mean (A x C)**		**17.78A**	**15.94C**	**11.70F**		**15.56A**	**16.32B**	**15.50C**	
Mean (B x C)***		**16.89A**	**15.26B**	**14.89B**		**17.54A**	**17.64A**	**14.28C**	
		16.99A	**13.42C**	**13.63C**		**15.91B**	**14.07C**	**13.78CD**	
		13.63C	**13.13CD**	**12.62D**		**15.54B**	**14.28C**	**13.28D**	
Mean (A)#		**15.49A**	**12.85C**	**15.14B**		**16.14A**	**13.50C**	**15.79B**	
Mean (B)##		**15.84A**	**13.94B**	**13.71B**		**16.14A**	**14.59B**	**14.36B**	
Mean (C)###		**15.68A**	**14.68B**	**13.13C**		**16.33A**	**15.33B**	**13.78C**	

Values followed by the same letter/s are not significantly different at 5% level.
, **, * refer to the interaction effect between K-silicate & Nile Fertile and Magnetic Iron, respectively.*
#, ##, ### refer to the specific effect of K-silicate & Nile Fertile and Magnetic Iron respectively.

With respect to the interaction effect between the three investigated factors (K-Silicate, Nile Fertile and Magnetic Iron) on leaf osmotic pressure percentage, data indicated that the combination between the lower level of K-Silicate (5 ml/L) combined with either the higher level of Nile Fertile (500 g/tree) + the lower level of Magnetic Iron (300 g/tree) in the 1st season, or with the lower level of Nile Fertile (250 g/tree) + the higher level of Magnetic Iron (600 g/tree) in the 2nd season, was able to reduce leaf osmotic pressure to the minimum value. The reverse was true with untreated trees with neither one of the three investigated factors, as the absence of such factors led to increase the osmotic pressure in the leaves, during both seasons of study. Drought tolerance brought about by the application of silicon may result from decreased transpiration (Epstein, 1999) and the presence of silicified structure in plants suggested a reduction of leaf heat load, providing plant tolerance to high temperature (Wang *et al.,* 2005). The resistance to salt stress has been found to be duo to the enhancement of catalase, preventing membrane oxidative damage (Moussa, 2006).

The present results regarding the response of four leaf physiological properties are supported by the early findings of Gucci *et al.,* (1997) on two olive cvs. and Hassan, (2005) on some olive cvs. all reported that the rate of water entry into plants depends on both water potential gradient and root resistance, whears the water diffusion gradient between medium and roots decreased appreciably as the salt of irrigation water was increased and this certainly will be reflected on leaf water content and the related leaf physiological characteristics like as (leaf water potential and leaf succulent grade). Moreover, findings of El- Hefnawi, (1986) on Guava found the same trend with leaf succulence and Nomir, (1994) on Kaki go in line with our results regarding the response of leaf succulence grade to the saline irrigation water. Meanwhile, the increase in leaf osmotic pressure character resulted by saline irrigation water is confirmed with findings of Hassan, (2005) on some olive cvs., Sawrsan, Madlen, (2006) on some pomegranate cvs.. As for the effect of some anti-salinity substances on leaf water potential, leaf osmotic pressure and leaf succulence grade, the present results are on harmony with those found by Abdel Aal and Oraby, (2013) on Mango transplants who reported that silicon application increased leaf water content of salt stressed transplants. As well as Abd El-Rahman, Amira (2016) on two grape cvs. Transplants and El-Tarawy, (2017) on Picual Olive transplants, cleared that both potassium silicate and Magnetic Iron application resulted in increasing leaf water potential and leaf succulence grade.

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