Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864

THE ROLE OF MAGENTIC IRON AND SODIUM SELENATE IN MINIMIZING SOIL SALT HAZARDS ON GROWTH AND QUALITY OF *JACARANDA ACUTIFOLIA* HUMB. & BONPL. SEEDLINGS

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Scientific J. Flowers & Ornamental Plants, 1(3):187-198 (2014).

Received:
22/10/2014

Revised by:
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ABSTRACT: The purpose of this study is exploring the role of some chemicals, namely magnetic iron (Fe_3O_4) and sodium selenate (Na_2SeO_4) on avoiding or minimizing soil salt hazards on growth and quality of *Jacaranda acutifolia* Humb. & Bonpl. seedlings. Thus, a pot experiment was conducted under the full sun at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during 2011 and 2012 seasons, where one-year-old seedlings of Jacaranda were planted in 30 cm diameter plastic pots filled with about 7 kg of sand and clay mixture (1:1, v:v) salinized with an equal mixture of NaCl and $CaCl_2$ pure salts (1:1, w:w) at the concentrations of 0, 1000, 2000 and 4000 ppm. Magnetic iron was applied three times as soil drench at the rate of 4 g/pot, while sodium selenate was added 3 times as foliar spray at 2 ppm. The effect of a combination between Fe_3O_4 at 4 g/pot and Na_2SeO_4 at 2 ppm was also studied.

The obtained results revealed that means of vegetative and root growth characters were progressively decreased with increasing soil salinity level with significant differences relative to control means in the two seasons, but they were significantly increased as a result of applying magnetic iron, selenate or both in the combined treatment. The best vegetative and root growth, however was attained by planting in unsalinized soil mixture with the addition of both Fe_3O_4 (4 g/pot) and Na_2SeO_4 (2 ppm), as this interaction treatment gave the tallest plants, the longest root, the highest number of leaves and the heaviest fresh and dry weights of aerial parts and roots compared to all other interactions in both seasons. It was also noticed that leaf content of chlorophyll a and b and percentage of nitrogen, phosphorus and potassium were gradually decreased as the soil salinity level was increased, while they were significantly increased by drenching the soil with magnetic iron or spraying the foliage with the sodium selenate solution, or by adding these two chemicals in together. The opposite was the right regarding leaf content of carotenoids, sodium %, chloride % and free proline, as these constituents were progressively increased with rising salinity level, but were decreased by the two used chemicals when applied either individually or in combination. In general, applying magnetic iron alone or combining with Na-selenate gave better results than the sole application of Na-selenate, whereas the mastery in all previous measurements was for the interaction of planting in unsalinized soil plus application of Fe_3O_4 (4 g/pot) + Na_2SeO_4 (2 ppm) that recorded the utmost high means in both seasons.

From these results, it is recommended to drench the soil mixture with 4 g/pot of magnetic iron, alone or plus spraying of Na-selenate 2 ppm on the foliage to get the best growth and quality of *Jacaranda acutifolia* seedlings planted in either salinized or unsalinized soil.

Key words: *Jacaranda acutifolia*, soil salinity, magnetic iron, sodium selenate, vegetative and root growth, chemical composition and active constituents.

INTRODUCTION

Jacaranda acutifolia Humb. & Bonpl. (Fam. Bignoniaceae) is a delicate deciduous, medium-sized tree up to 15 m height or more with its bipinnate, fern-like leaves giving it a feathery appearance. Flowers are blue, in large, loose, pyramidal clusters appearing in March when the tree is leafless and lasting till after the development of new leaves, at this time, the bell-shaped, 2-lipped flowers amongst the feathery crown gives the tree a very attractive appearance. It is widely used in tropics and subtropics as flowering and shading tree. Propagated by seeds and cuttings (El-Hadidi and Boulos, 1979).

Soil salinity is still a major abiotic stress factor reducing growth, flowering and yield of many varieties of plants all over the world (Tester and Davenport, 2003). Overcoming the negative effects of salinity using magnetite (magnetic iron) becomes one of the most important ways applied recently. In this concern, El-Hifny *et al.* (2008) indicated that increasing magnetite level up to 200 kg/fed led to an increase in all vegetative growth characters, curd weight, yield and content of N, P, K and Fe in leaves and curds of cauliflower, but decreased Na and Cl content in the leaves and curds. Similary, were those results pointed out by Ali *et al.* (2011) on pepper, Ahmed *et al.* (2011) on *Hibiscus sabdariffa*, Shehata *et al.* (2012) on cucumber, Ali *et al.* (2013) on grapevines, Abdel-All and Mohammed (2014) on broccoli and cauliflower and El-Sayed (2014) who found that magnetic water enhanced growth, yield and water content of broad bean plants, as well as chlorophyll a and b, carotenoids, total carbohydrates, protein, total amino acids, proline, total indoles, total phenols, GA_3, RNA, DNA, P, K, Na and Ca in all parts of the plant under greenhouse conditions.

In addition, selenium can regulate the water status of plants under salinity or drought conditions. It can also increase the tolerance of plants to UV-induced oxidative stress, delay senescence and promote the growth of ageing seedlings (Germ and Stibilj, 2007). On maize, Hawrylak-Nowak (2008) reported that P and Ca content increased, while K content decreased with increasing Se treatments. At low level, selenium tended to stimulate the plant growth and root elongation, but at higher one, the dry mass accumulation and root tolerance index were severly decreased. Similar observations were also obtained by Euliss and Carmichael (2004) on canola, Kaklewski *et al*. (2008) on wheat and rape, Lyons *et al*. (2009) on *Brassica rapa*, Lehotai *et al*. (2011) on *Arabidopsis thaliana*, Hajiboland and Keivanfar (2012) on canola and Saffaryazdi *et al*. (2012) who noticed that shoot and root length, shoot and root fresh and dry weights and total dry weight of spinach plants were increased in response to the lowest concentration of Se (1 ppm), while higher concentrations (6 and 10 ppm) reduced these parameters. The low concentration enhanced also contents of chlorophylls a and b, while higher levels exert toxic effects. Total phenols in leaves were linearly increased with increasing Se level to reach the maximum by 10 ppm Se, Na and Ca contents were increased, while K content was decreased by increasing Se level.

The aim of this work was to detect the suitable treatments for alleviating the deleterious effects of soil salinity on growth and quality of the salt-sensitive Jacaranda seedlings of one year old.

MATERIALS AND METHODS

In order to raise tolerance of Jacaranda seedlings to salinity stress, the current study was performed under the open field at the nursery of Hort. Res. Inst., ARC, Giza, Egypt during the two successive seasons of 2011 and 2012, where one-year-old uniform seedlings of *Jacaranda acutifolia* Humb. & Bonpl. at a height of about 30 cm, 4.7 mm stem diameter and 4-5 leaves were planted on mid of February for each season in 30 cm-diameter plastic pots (one seedling/pot) filled with about 7 kg/pot of an equal mixture of sand and clay by volume. Some physical and chemical properties of the sand and clay used in the two seasons were determined and illustrated in Table (1).

The experimental treatments were:

1- Salinization treatments:

Immediately before planting, the soil mixture was salinized with a salt mixture of pure NaCl and pure $CaCl_2$ (1:1, by weight) at the concentrations of 0, 1000, 2000 and 4000 ppm.

2- Chemical substances:

Magnetite (magnetic iron, Fe_3O_4) was applied as soil drench at the rate of 4 g/pot, 3 times; the first batch was added immediately before planting and the other two after 45 days later from the batch previous it.

Sodium selenate (Na_2SeO_4) was added as a thorough foliar spray at the rate of 2 ppm, 3 times. The 1st spray was done 45 days after planting (on April, 1st) and the other two at one month interval (on first of May and first of June, respectively).

A combination of magnetite (4 g/pot) and sodium selenate (2 ppm) was employed at the same times of application mentioned above for each chemical substance.

3- Interaction treatments:

The treatments of both salinization and chemicals were combined factorially to form sixteen interactions.

The seedlings of all treatments were fertilized 3 times throughout the course of this study with 5 g/pot of NPK chemical fertilizer (1:1:1) starting from mid March at one month interval and watered every other day. The other agricultural practices were carried out whenever needed.

A randomized block design with factorial concept, replicated thrice with 5 seedlings per replicate (Das and Giri, 1986) was used in the two seasons. At the end of each season (on September, 30th), data were recorded as follows: plant height (cm), stem diameter at the base (cm), number of leaves/plant, leaf length and width (cm), root length (cm) and aerial parts and roots fresh and dry weights (g). In fresh leaf samples, the photosynthetic pigments (chlorophyll a, b and carotenoids, mg/g f.w.) and free proline (mg/g f.w.) were determined using the methods of Saric *et al.* (1976) and Bates *et al.* (1973), respectively, while in dry leaf ones, the percentages of nitrogen (using micro-Kjeldahle method described by Pregl, 1945), phosphorus (Luatanab and Olsen, 1965), sodium (using Flame-photometer set) and chloride (Jackson, 1973) were measured.

Data were then tabulated and subjected to analysis of variance following SAS Institute Program (1994) with Duncan's Multiple Range Test (Duncan, 1955) for means comparison.

RESULTS AND DISCUSSION

Effect of soil salinity, magnetic iron, sodium selenate and their interactions on:

1- Vegetative and root growth parameters:

It is evident from data shown in Tables (2, 3, 4 and 5) that means of all vegetative and root growth traits were progressively decreased with increasing salinity level compared to those of control treatment in the two seasons. Hence, the least averages were recorded by the highest salinity rate (4000 ppm). The opposite was the right regarding the effect of magnetic iron, Na-selenate or both in combination, as these chemicals

Table 1. Physical and chemical properties of the used sand and clay during 2011 and 2012 seasons.

Soil texture	Season	Particle size distribution(%)				S.P.	E.C (ds/m)	pH	Cations (meq/l)				Anions (meq/l)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^+	K^+	HCO_3^-	Cl^-	SO_4^{--}
Sand	2011	81.53	9.55	0.42	8.50	22.88	3.50	7.67	10.50	1.56	30.60	0.57	4.50	23.10	15.63
	2012	80.75	10.30	1.26	7.69	23.10	3.82	7.83	8.96	8.33	17.66	0.75	3.48	18.67	13.55
Clay	2011	7.54	22.28	30.55	39.63	55.00	2.33	8.30	7.82	2.12	15.40	0.75	6.60	8.20	11.29
	2012	7.64	22.50	30.15	39.71	50.00	2.26	8.12	8.12	2.20	15.50	0.75	6.78	8.02	11.15

Table 2. Effect of soil salinity, magnetic iron, selenium and their interactions on some vegetative growth parameters of *Jacaranda acutifolia* Humb. & Bonpl. seedlings during 2011 and 2012 seasons.

Soil salinity (ppm)	Plant height (cm)					Stem diameter (cm)					No. of leaves/plant				
	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean
								1st season							
Cont.	68.31i	86.07b	76.42f	97.54a	82.09a	1.28e	1.71a	1.47d	1.81a	1.57a	27.29h	35.59c	32.36d	38.74a	33.49a
1000	65.77j	80.40d	70.07h	84.98c	75.31b	1.23ef	1.70bc	1.25ef	1.75ab	1.48b	25.65i	35.09c	30.38f	38.01b	32.28b
2000	59.63l	73.84g	62.56k	79.36e	68.85c	1.07g	1.43d	1.17fg	1.62c	1.32c	21.98j	28.93g	25.56i	31.39e	26.97c
4000	39.11p	49.78n	44.05o	51.66m	46.15d	0.79d	1.09g	0.81h	1.27ef	0.99d	14.21n	17.85l	16.97m	19.69k	17.18d
Mean	58.21d	72.52b	63.28c	78.39a		1.10d	1.48c	1.18b	1.62a		22.28d	29.37b	26.32c	31.96a	
								2nd season							
Cont.	74.85f	92.81b	85.45d	101.11a	88.56a	1.60e	1.99b	1.83cd	2.21a	1.91a	32.07ef	38.01c	32.52e	41.30a	35.98a
1000	68.85g	85.73d	78.58e	93.21b	81.56b	1.44f	1.91bc	1.77d	2.14a	1.82b	31.26f	38.43c	34.82d	39.73b	36.06a
2000	62.67i	77.09e	65.47h	89.53c	73.69c	1.19g	1.71de	1.43f	1.90bc	1.56c	26.53h	31.54f	28.77g	34.17d	30.52b
4000	44.78l	51.49j	47.38k	62.06i	51.43d	0.91h	1.22g	1.00h	1.36f	1.12d	17.44l	21.91j	19.62k	24.53i	20.88c
Mean	62.79d	76.78b	69.22c	86.48a		1.29d	1.71b	1.51c	1.90a		26.83d	32.47b	28.93c	34.93a	

Means within a column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

Table 3. Effect of soil salinity, magnetic iron, selenium and their interactions on leaf length and width of *Jacaranda acutifolia* Humb. & Bonpl. seedlings during 2011 and 2012 seasons.

Soil salinity (ppm)	Leaf length (cm)					Leaf width (cm)				
	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean
						1st season				
Cont.	27.14f	29.29c	28.72cd	31.86a	29.25a	13.30cd	16.51a	14.31b	16.92a	12.25a
1000	26.19g	28.59d	28.30de	31.00b	28.52b	12.79de	14.80b	13.66c	16.66a	14.48b
2000	22.78j	25.11h	23.44i	27.83e	24.79c	11.36fg	13.07cd	11.86f	14.83b	12.78c
4000	17.36l	19.92k	17.91l	22.39j	19.40d	8.91i	10.81g	9.56h	12.57e	10.46d
Mean	23.37d	25.73b	24.59c	28.27a		11.59d	13.80b	12.35c	15.24a	
						2nd season				
Cont.	31.92e	35.51c	35.11c	38.35a	35.22a	17.01d	19.35b	18.35c	20.01a	18.68a
1000	31.71ef	33.87d	31.98e	36.56b	33.53b	16.03f	17.25d	16.55e	18.76c	17.15b
2000	25.55h	29.29g	26.01h	31.17f	28.01c	12.53j	14.37h	14.01h	17.05d	14.49c
4000	20.37k	24.56i	22.22j	25.45h	23.15d	9.52l	13.44i	11.17k	15.17g	12.33d
Mean	27.39d	30.81b	28.83c	32.88a		13.77d	16.10b	15.02c	17.75a	

Means within a column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

Table 4. Effect of soil salinity, magnetic iron, selenium and their interactions on fresh and dry weights of aerial parts of *Jacaranda acutifolia* Humb. & Bonpl. seedlings during 2011 and 2012 seasons.

Soil salinity (ppm)	Aerial parts f.w. (g)					Aerial parts d.w. (g)				
	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean
1st season										
Cont.	76.61h	129.27b	99.33d	142.51a	111.93a	33.51f	56.43b	42.57c	65.32a	49.47a
1000	61.80j	88.70e	78.29g	104.01c	83.20b	25.67j	41.65d	29.64h	42.38c	34.84b
2000	57.32k	76.81h	68.46i	84.55f	71.78c	20.58l	30.92g	26.44i	37.82e	28.94c
4000	38.48n	49.98l	47.31m	56.99k	48.19d	13.65o	19.84m	18.73n	24.15k	19.09d
Mean	58.55d	86.19b	73.35c	97.02a		23.35d	37.22b	29.35c	42.42a	
2nd season										
Cont.	88.01i	129.04c	107.92e	156.64a	120.40a	35.12i	53.72c	44.30f	71.29a	51.11a
1000	76.81k	102.96f	93.53h	131.90b	101.23b	29.76k	45.01e	37.49h	57.35b	42.40b
2000	68.92m	94.78g	81.47j	121.04d	93.55c	24.46m	38.75g	28.99l	50.24d	35.61c
4000	51.72o	56.49n	56.27n	73.54l	59.51d	18.19p	22.67n	21.59o	31.09j	23.39d
Mean	71.36d	95.75b	84.80c	120.78a		26.88d	40.04b	33.09c	52.49a	

Means within a column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

Table 5. Effect of soil salinity, magnetic iron, selenium and their interactions on root parameters of *Jacaranda acutifolia* Humb. & Bonpl. seedlings during 2011 and 2012 seasons.

Soil salinity (ppm)	Root length (cm)					Roots f.w. (g)					Roots d.w. (g)				
	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean
								1st season							
Cont.	34.45e	42.70b	38.65cd	45.11a	40.23a	36.37f	47.48b	40.51d	50.82a	43.80a	15.83e	21.49b	17.54d	23.85a	19.68a
1000	30.19g	39.46c	34.39e	42.78b	36.71b	32.47h	39.71de	36.52f	45.39c	38.52b	13.64g	18.88c	16.03e	21.75b	17.58b
2000	26.48h	34.29e	30.64fg	38.44d	32.46c	25.41j	34.65g	28.82i	39.45e	32.08c	11.21h	16.32e	13.61g	19.25c	15.01c
4000	22.72i	31.20f	26.57h	33.99e	28.62d	20.70l	29.57i	24.39k	37.08f	27.94d	9.80i	14.64f	10.98h	18.91c	13.58d
Mean	28.46d	36.91b	32.56c	40.08a		28.74d	37.85b	32.56c	43.19a		12.62d	17.83b	14.54c	20.94a	
								2nd season							
Cont.	37.28g	46.67b	36.68gh	49.85a	43.36a	38.01f	50.23c	46.51d	53.27a	47.01a	16.15h	22.65c	20.33d	24.75a	20.97a
1000	36.01h	43.73c	30.89k	47.16b	40.90b	34.61h	42.30e	35.71g	51.46b	41.02b	13.63l	19.57e	15.53ij	23.68b	18.10b
2000	39.62e	38.06f	32.24j	40.37d	35.39c	27.35j	35.74g	32.25i	37.41f	33.19c	10.83m	15.92hi	14.24k	18.16f	14.79c
4000	25.11m	35.27i	29.11l	36.85g	31.59d	21.93l	32.08i	25.34k	34.65h	28.50d	8.63n	15.05j	11.37m	16.97g	12.01d
Mean	32.32d	40.93b	34.41c	43.56a		30.48d	40.09b	34.95c	44.20a		12.31d	18.30b	15.37c	20.90a	

Means within a column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

significantly improved vegetative and root growth of treated plants over untreated ones, with the superiority of the combined treatment between magnetic iron at 4 g/pot and Na-selenate at 2 ppm which gave the highest values in both seasons, this was followed by the sole application of Fe_3O_4 that gave means occupied the second rank in most cases of the two seasons. Generally, the best vegetative and root growth in both seasons were found due to planting in unsalinized soil mixture plus drenching with Fe_3O_4 at 4 g/pot and foliar spraying with Na_2SeO_4 at 2 ppm, as this interaction gave the utmost high averages over all other interactions in the two seasons. The combining between planting in the soil free from salination and drenching with magnetite alone at 4 g/pot came in the second position after the above mentioned super interaction.

Salinity depresses the growth of plants by affecting water absorption and biochemical processes, such as N, CO_2 assimilation and protein biosynthesis or accumulating high concentration of potentially toxic ions such as Na and Cl (Gunes *et al*., 1999). Chartzoulakis and Klapaki (2000) attributed the reduction in growth by salinity to the effect of osmotic stress and the inhibition of cell division rather than cell expansion plus the marked inhibition in photosynthesis. They added also that high salinity levels led to decrease in leaf number due to leaf abscission as a result of ion accumulation in the leaves, particularly old ones. Moreover, Jou *et al*. (2006) suggested that ATPase participates in endoplasmic reticulum-Golgi mediated protein sorting machinery for both house keeping function and compartmentalization of excess Na^+ under high salinity.

On the other side, application of either magnetic iron or selenate markedly alleviate the harmful effect of salinity resulting in rising tolerance of Jacaranda seedlings to salt stress. This may indicate the role of magnetite in enhancing of N, P, K and Fe uptake which stimulate plant growth against the harmful effect of Na and Cl which inhibit plant growth. It induces cell metabolism and mitosis of meristematic cells (Belyavskaya, 2001). It is believed that new protein bands are formed in plants that are treated with magnetite and these proteins are responsible for increased growth (Hozyan and Abdul-Qados, 2010). Besides, it decreases the hydration of salt ions and colloids, having a positive effect on salt solubility leading finally to leaching of salts. So, it is successfully used to reclaim soils with high cations and anions content, such as Ca, Na and HCO_3 (Mostafazadeh *et al*., 2012). As for selenate, it can increase the tolerance of plants to UV-induced oxidative stress, delay senescence, promote the growth of ageing seedlings and has the ability to regulate the water status of plants under conditions of salinity or drought (Germ and Stibilj, 2007).

The previous results were supported by those of Euliss and Carmichael (2004) on canola, El-Hifny *et al.* (2008) on cauliflower, Lyons *et al.* (2009) on *Brassica rapa*, Lehotai *et al*. (2011) on *Arabidopsis thaliana*, Ali *et al*. (2013) on grapevines, Abdel-All and Mohammed (2014) on broccoli and cauliflower.

2- Chemical composition of the leaves:

Data presented in Table (6) exhibit that chlorophyll a and b content (mg/g f.w.), as well as the percentages of nitrogen, phosphorus and potassium were gradually decreased in the leaves with increasing salinity level in the soil to reach the minimum values at the highest salinity level (4000 ppm) compared to the control means. However they were significantly increased as a result of drenching the soil with magnetic iron or spraying the foliage with Na-selenate, with the prevalence of Fe_3O_4 alone or combined with Na_2SeO_4, as these two treatments recorded alternately the highest content. This may indicate the role of magnetite and selenate in repairing the decline in these important constituents caused by salinity.

Table 6. Effect of soil salinity, magnetic iron, selenium and their interactions on chemical composition of *Jacaranda acutifolia* Humb. & Bonpl. seedlings during 2012 season.

Soil salinity (ppm)	Chlorophyll a (mg/g f.w.)					Chlorophyll b (mg/g f.w.)					Carotenoids (mg/g f.w.)				
	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean	Cont.	Fe_3O_4 (4g/pot)	Na_2SeO_4 (2ppm)	Fe_3O_4 + Na_2SeO_4	Mean
Cont.	1.40e	2.19a	1.44d	1.91b	1.74a	1.63d	2.05a	1.93bc	2.04a	1.91a	0.16h	0.10j	0.13i	0.10j	0.12d
1000	0.97i	1.76c	1.07h	1.32f	1.28b	1.44e	1.94b	1.26f	1.90c	1.64b	0.29e	0.22g	0.24f	0.22g	0.24c
2000	0.84j	1.10h	0.85j	1.22g	1.00c	0.62i	0.87g	0.69h	0.85g	0.76c	0.39b	0.23fg	0.30de	0.24f	0.29b
4000	0.53i	0.99i	0.75k	0.83j	0.78d	0.37k	0.69h	0.51j	0.66h	0.56d	0.43a	0.31cd	0.39b	0.32c	0.36a
Mean	0.94d	1.51a	1.03c	1.32b		1.02d	1.39a	1.10c	1.36b		0.32a	0.22c	0.27b	0.22c	
	N (%)					P (%)					K (%)				
Cont.	2.46f	3.26a	3.15b	3.30a	3.04a	0.69de	0.82b	0.77c	0.87a	0.79a	1.28i	1.75d	1.60f	2.13a	1.68a
1000	2.61e	2.97c	2.73d	3.11b	2.86b	0.64fg	0.71d	0.69de	0.72d	0.69b	1.38h	1.80c	1.62f	1.97b	1.69a
2000	2.17h	2.73d	2.56e	3.11b	2.64c	0.55h	0.68de	0.60g	0.71d	0.63c	1.02k	1.67e	1.54g	1.73d	1.49b
4000	2.96i	2.37g	2.19h	2.41fg	2.23d	0.46i	0.60g	0.54h	0.66ef	0.57d	0.98k	1.20j	1.18j	1.51g	1.22c
Mean	2.30d	2.83b	2.66c	2.98a		0.59d	0.70b	0.65c	0.74a		1.16d	1.61b	1.49c	1.84a	
	Na (%)					Cl (%)					Free proline (mg/g f.w.)				
Cont.	0.57h	0.48l	0.55i	0.49kl	0.52d	0.31h	0.24j	0.27i	0.19k	0.25d	0.10g	0.12g	0.11g	0.11g	0.11d
1000	0.64f	0.50k	0.61g	0.52j	0.57c	0.38f	0.34g	0.37f	0.33g	0.36c	0.32e	0.25f	0.29e	0.23f	0.27c
2000	0.78b	0.58h	0.71d	0.63f	0.68b	0.59b	0.45e	0.51d	0.54c	0.52b	0.46c	0.40d	0.43cd	0.41d	0.43b
4000	0.82a	0.68e	0.76c	0.68e	0.74a	0.70a	0.55c	0.69a	0.59b	0.63a	0.84a	0.73b	0.82a	0.75b	0.79a
Mean	0.71a	0.56c	0.67b	0.58c		0.50a	0.40d	0.46b	0.41c		0.43a	0.38b	0.41a	0.38b	

Means within a column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

The opposite was right concerning carotenoids and free proline content (mg/g f.w.) and the percent of sodium and chloride which progressively increased with elevating salinity level, but decreased in response to magnetic iron and selenate, applied either individually or in combination. In general, the maximum content of chlorophylls a and b, as well as of N, P and K% was attained by planting in nonsalinized soil plus addition of Fe_3O_4 alone or with SeO_4. That was true for the content of carotenoids, Na, Cl and free proline when Jacaranda seedlings were planted in high salinized soil (4000 ppm) with the absence of either magnetic iron or Na-selenate. This means that magnetic iron and Na-selenate play a vital role in reducing the harmful effect of salinity through decreasing the absorption of Na and Cl from soil solution under high salinity conditions.

In this regard, El-Hifny *et al.* (2008) noted that the favourable influence of magnetite application on increasing the content of N, P, K and Fe with reducing that of Na and Cl may be attributed to creating a high energy magnetic field in the root media of the growing plants, and this in turn, may stimulate the absorption of these elements and decrease that of Na and Cl. Furthermore, magnetate solubolises NaCl salt and leaches it out of the soil. Thus, the plants do not uptake higher amounts of either Na or Cl.

The aforestated gains, however are in great parallel with those elicited by Germ and Stibilj (2007) on maize, Kaklewski *et al.* (2008) on wheat and rape, Ahmed *et al.* (2011) on *Hibiscus sabdariffa*, Shehata *et al.* (2012) on cucumber, Saffaryazdi *et al.* (2012) on spinach and El-Sayed (2014) on *Vicia faba*.

From the above mentioned discussion, it is advised to drench magnetic iron at the rate of 4 g/pot, alone or with spraying of Na-selenate on the foliage at the rate of 2 ppm for the best growth and quality of *Jacaranda acutifolia* seedlings cultivated either in salinized or nonsalinized soil.

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دور الحديد الممغنط وسيلينات الصوديوم في خفض أضرار ملوحة التربة وتاثيرهما على نمو وجودة شتلات الجكرندا

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تهدف هذه الدراسة إلى تحديد دور بعض المواد الكيماوية، و هي الحديد الممغنط (Fe_3O_4) وسيلينات الصوديوم (Na_2SeO_4) على تفادي أو تقليل أضرار ملوحة التربة وأثرهما على نمو و جودة شتلات الجكرندا. لذلك أجريت تجربة أصص تحت ظروف الحقل بمشتل معهد بحوث البساتين، مركز البحوث الزراعية، الجيزة، مصر. خلال موسمي ٢٠١١، ٢٠١٢ حيث زرعت شتلات جكرندا عمر سنة في أصص بلاستيك قطرها ٣٠ سم ملئت بحوالي ٧ كجم من مخلوط الرمل والطين (١:١ بالحجم) تم تمليحها قبل الزراعة مباشرة بمخلوط متساوي من أملاح كلوريد الصوديوم وكلوريد البوتاسيوم النقية (١:١ بالوزن) بتركيزات: صفر، ١٠٠٠، ٢٠٠٠، ٤٠٠٠ جزء في المليون. أضيف الحديد الممغنط ثلاث مرات، كإضافة أرضية بمعدل ٤ جم/إصيص، بينما أضيفت سيلينات الصوديوم ثلاث مرات رشاً على الأوراق بمعدل ٢ جزء في المليون. تم أيضاً دراسة تأثير الجمع بين إضافة الحديد الممغنط و سيلينات الصوديوم بنفس المعدلات المذكورة آنفاً.

وقد أوضحت النتائج المتحصل عليها أن متوسطات جميع قياسات النمو الخضري و الجذري قد إنخفضت بشكل متزايد بزيادة تركيز ملوحة التربة و بفروق معنوية عند مقارنتها بمتوسطات الكنترول في كلا الموسمين، بينما زادت هذه المتوسطات معنوياً نتيجة للإضافة الفردية لكل من الحديد الممغنط أو سيلينات الصوديوم أو إضافتهما معاً في المعاملة المشتركة. إلا أن أفضل معدلات النمو الخضري و الجذري تحققت بزراعة الشتلات في تربة غير ملحية مع إضافة كلٍ من الحديد الممغنط (٤ جم/أصيص) و سيلينات الصوديوم (٢ جزء في المليون)، حيث أعطي هذا المزيج أطول النباتات، أطول جذر، أكبر عدد للأوراق و أثقل أوزان طازجة و جافة للنموات الخضرية والجذرية مقارنة بجميع التفاعلات الأخرى بكلا الموسمين. لوحظ أيضاً أن محتوى الأوراق من كلوروفيللي أ، ب، النتروجين، الفسفور و البوتاسيوم قد إنخفض تدريجياً كلما زاد مستوى الملوحة، بينما زاد معنوياً بإضافة الحديد الممغنط إلى التربة أو رش الأوراق بسيلينات الصوديوم أو بإضافة هذين المركبين في توليفة مشتركة. و لقد كان العكس صحيحاً فيما يتعلق بمحتوى الأوراق من الكاروتينويدات، الصوديوم، الكلوريد والبرولين الحر، حيث زاد محتوى الأوراق من هذه المكونات بشكل متصاعد كلما زاد مستوى الملوحة، لكنها إنخفضت بفعل المركبين الكيماويين المستخدمين عند إضافتهما إما بشكل فردي أو معاً في توليفة. وبصفة عامة، أعطى الحديد الممغنط عند إضافته فردياً أو مع سيلينات الصوديوم نتائج أفضل من الإضافة الفردية للسيلينات، بينما كانت السيادة والتفوق في جميع القياسات السابقة للتفاعل بين الزراعة في تربة غير مملحة وإضافة الحديد الممغنط بمعدل ٤ جم/إصيص + سيلينات الصوديوم بمعدل ٢ جزء في المليون و الذي سجل أعلى المتوسطات على الإطلاق في الموسمين.

من هذه النتائج، يمكن التوصية بإضافة الحديد الممغنط تكبيشاً للتربة بمعدل ٤ جم/أصيص مع رش محلول سيلينات الصوديوم على الأوراق بتركيز ٢ جزء في المليون على ثلاث دفعات للحصول على أفضل نمو و أعلى جودة لشتلات الجكرندا عند زراعتها في تربة ملحية أو غير ملحية.