COULD PHOSPHORENE HELP *FICUS BENJAMINA* L. PLANT TO TOLERATE THE DELETERIOUS EFFECTS OF SALINE WATER?

Gehan [1] H. Abdel-Fattah , S.M. Shahin [1] and Soad A.M.Khenizy [2]

[1] *Bot. Grs Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.*
[2] *Flori. Res. Dept., Hort. Res. Inst., ARC, Giza, Egypt.*

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ABSTRACT

A study was carried outunder plastic house at the nursery of Hort. Res. Inst., Giza, Egypt during 2010 and 2011 seasons to find out the role of fertilization with phosphorene (a biofertilizer contains a specific clone of bacteria that transfers the unavailable triphosphate to available monophosphate) at the rates of 0, 50 and 100 ml/pot in reducing the deleterious effects of saline water at the levels of 0, 2000, 4000, 6000, 8000 and 10000 ppm (prepared from an equal mixture of NaCl and $CaCl_2$ salts, 1:1 by weight) on growth and quality of Waringin fig (*Ficus benjamina* L.) transplants (one-year-old) grown in 30-cm-diameter plastic pots filled with 7 kg of a sand + clay mixture (1:1, v/v).

The obtained results indicated that survival (%) was significantly reduced at the high salinity levels (8000 and 10000 ppm), and the percent of mortality was 100% for plants irrigated with 10000 ppm saline water and dressed with either zero or 50 ml phosphorene/pot. All vegetative and root growth parameters were progressively decreased with increasing salinity level, except for fresh and dry weights of roots which improved on account of 2000 and 4000 ppm levels. On the other hand, all of these parameters were significantly improved in response to phosphorene treatments, with the superiority of 100 ml/pot treatment that gave the highest means in this regard. The percentage of salt resistance index (SRI%) was more than 100% for control plants and those ones irrigated with 2000, 4000 and 6000 ppm saline water in the presence of either 50 or 100 ml phosphorene/pot. Leaf content of chlorophylls a and b, as well as N, P

and K was gradually decreased with increasing salinity level, but was significantly augmented in response to phosphorene application, especially at the rate of 100 ml/pot, which gave the highest content at all. The opposite was the right concerning carotenoids, Na, Cl and proline content.

In conclusion, the previous results reveal that one-year-old transplants of Waringin fig (*Ficus benjamina* L.) grown in 30-cm-diameter plastic pots can tolerate salinity of irrigation water up to 6000 ppm, with good performance and healthy growth if fertilized monthly with 100 ml phosphorene/pot, three times throughout the growing season.

INTRODUCTION

The need to more of tolerant plants to salinity is still one of the most important demands necessary for beautification of coastal areas and surround lakes, as the tourist villages and new communities increase day by day. Among pot plants may serve in this concern *Ficus benjamina* L. Waringin fig (Fam: Moraceae). It is one of the most commonly grown indoor plants, native to tropical and sub-tropical regions, tree or shrub, epiphytic when young (**Bailey, 1976**). Its shape, canopy, deep green and brilliant leaves with wide-spreading, conical crown of drooping, slender branches make it graceful for landscaping (**Chin, 2000**). Most of ficus species considered sensitive to salt stress (**Hattatt, 2001**), but a good nutrition may play a role in reducing such sensitivity (**Handreck and Black, 2002**).

Salinity, on the other hand, affects almost all aspects of plant growth and development. In this regard, **Devecchi and Remotti (2004)** reported that the first damage effects of a high salt yellowings, necroses, presence of dry leaves, malformations and anomalies on the leaves of *Berberis candidula, Pyracantha coccinea* and *Viburnum davidii.* The typical symptoms were also observed on the leaves of *Cotoneaster salicifolius* due to the root absorption of salts containing Cl ions, which causes partial or total destruction of chlorophylls, and therefore the death of these parts. In addition, **Devecchi *et al.,* (2005)** claimed that NaCl caused a progressive browning in the leaves of *Lonicera pileata* from the end of the leaf to its base, while in *Euonymus fortunei* and *Hedera helix* caused a progressive and diffused yellowing on all the leaf followed by withering. Besides, some physiological disturbances may occur in stomatal conductance, transpiration, enzymatic activities, photosynthesis and leaf and root activity. Consequently reduction of vegetative and root growth, flower quality and yield, as well as biomass decrement might be observed. These disorders were already registered by **Al-Qubaie *et al.*, (2003)** on *Bougainvillea glabra, Jasminum azoricum* and *Conocarpus erectus,* **Zhang *et al.*, (2004)** on *Nitraria sibirica,* **Cabrera *et al.*, (2005)** on *Rosa spp.,* **Jou *et al.*, (2006)** on *Mesembryanthemum crystallinum,* **Giri *et al.*, (2007)** on *Acacia nilatica* and **Mahmoud *et al.*, (2008)** who demonstrated that increasing salinity of diluted sea water up to 50% greatly reduced survival (%), vegetative and root growth, salt resistance index (%) and pigments content in the leaves of both *Dovyalis caffra* and *Lantana camara* transplants, while Na, Cl and proline content in the leaves of both plants was markedly increased.

A biofertilizer phosphorene was suggested since years ago for improvement soil properties and enhancing plant growth. In this connection, **Hussien (2004)** found that phosphorene, ascobene and rhizobacterene biofertilizers increased vegetative growth and bulb productivity of *Iris tingitana* cv. Wedgwood, as well as pigments content in the leaves, and total carbohydrates, N, P and K in the leaves and bulbs. **Shahin (2005)** stated that a combination of enciabene + phosphorene + k-sulphate improved growth, density and colour of *Paspalum vaginatum* turf grown in either sandy or loamy soil. On *Iris tingitana* cv. Wedgwood, **Ahmed and El-Tayeb (2008)** postulated that fertilization with 5g/pot nitrobene + 5g/pot phosphorene + 2g/pot NPK (1:2:1) gave the best growth, flowering, bulb productivity and chemical composition. Similarly, were those results revealed by **Abdel-Fattah (1998)** on globe artichoke, **Salem *et al.*, (2006)** on flax and **El-Sirafy *et al.*, (2006)** on Egyptian winter wheat.

Such trial, however aims to explore the role of phosphorene in alleviating the harmful effects of irrigation with saline water on growth, quality and chemical composition of the salt-sensitive Waringin fig (*Ficus benjamina* L.) plant.

MATERIALS AND METHODS

A series of pot experiments was consummated under plastic house at the nursery of Hort. Res. Inst., Giza, Egypt throughout the two consecutive seasons of 2010 and 2011 to find out the effects of saline water, phosphorene and their interaction on growth behaviour and chemical composition of Waringin fig (*Ficus benjamina* L) transplants, and determining the most favorite level of phosphorene suitable for improving growth under salt stress.

So, one-year-old homogenous transplants of *F. benjamina* L. (25-27 cm height, 4-5 mm stem diameter and 5-6 branches) were planted on March, 1st in the two seasons in 30-cm-diameter plastic pots (one transplant/pot) filled with about 7 kg/pot of a mixture consisted of sand and clay at the ratio of 1:1, by volume. The physical and chemical properties of the used sand and clay in both seasons are shown in Table (a).

Table (a): Some physical and chemical properties of the used sand and clay during 2010 and 2011 seasons.

Soil type	seasons	Particle size distribution (%)				S.P	pH	E.C. (ds/m)	Cations (meq/L)				Anions (meq/L)		
		Coarse sand	Fine sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{--}
Sand	2010	89.03	2.05	0.40	8.52	23.00	7.92	3.72	7.50	1.63	33.60	0.50	3.20	22.00	18.03
	2011	90.10	1.95	0.50	7.45	22.86	7.89	3.75	19.42	8.33	7.20	0.75	1.60	7.00	27.10
Clay	2010	7.54	22.28	30.55	39.63	55.00	8.17	2.26	7.82	2.12	15.40	0.75	6.60	8.20	11.29
	2011	7.64	22.50	30.15	39.71	51.00	8.09	2.38	7.50	2.20	15.50	0.75	6.78	8.02	11.15

Immediately after planting, the transplants were irrigated once every three days with 500 ml of fresh water/pot until first of April, as the following treatments were applied:

A. Saline water treatments:

A pure salt of NaCl was mixed well with a pure one of $CaCl_2$ at the ratio of 1:1, by weight. Thereafter, saline water was prepared from the salts mixture at the levels of 0, 2000, 4000, 6000, 8000 and 10000 ppm, and each pot was irrigated with 750 ml of the different saline water treatments twice a week till the end of experiment on October, 30th.

B. Phosphorene treatments:

As phosphorene (a biofertilizer contains a specific clone of bacteria which changes the unavailable triphosphate to available monophosphate) was added to the soil mixture in a liquid form at the rates of 0, 50 and 100 ml/pot, three times commencing from April, 15th (i.e. after irrigation with saline water by two weeks) with one month interval.

C. Saline water and phosphorene interaction treatments:

As each treatment of saline water was combined with each one of phosphorene to form eighteen interaction treatments.

The transplants, however were fertilized three times during the course of the study with 5 g/pot of a compound chemical fertilizer (NPK, 1:1:1), as the first dose was drenched in the soil mixture at planting time, while the second and third ones were added bimonthly afterwards.

The layout of the experiment in the two seasons was a complete randomized design of three replicates with six transplants per replicate (**Mead *et al.,* 1993**). At the end of the experiment, data were registered as follows: survival (%), plant height (cm), stem diameter at the base (cm), number of branches and leaves/plant, leaf area (cm^2), the longest root length (cm), number of lateral roots/plant, and aerial parts and roots fresh and dry weights (g).A salt resistance index percentage (SRI%), as a real indicator for salt tolerance, was calculated from the equation described before by **Wu and Huff (1983):**

SRI (%) = Mean root length of the longest root in salt treated plant/Mean root length of the longest root in control × 100

In fresh leaf samples taken from the middle parts of plants, the pigments content (chlorophyll a, b and carotenoids, mg/g F.W.) was determined according to the method of **Moran (1982)**, while in dry samples, the percentages of nitrogen(**Pregl, 1945**), phosphorus (**Luatanab and Olsen, 1965**), potassium and sodium (using Flame photometer set) and chloride (**Jackson, 1973**) were measured. Moreover, content of free proline as mg/g F.W. was assessed in fresh leaf samples using the method explained by **Bates *et al.,* (1973).**

Data were then tabulated and statistically analyzed according to **SAS program (1994)** using **Duncan's Multiple Rang Test (1955)** for verifying the means of various treatments.

RESULTS AND DISCUSSION

Effect of saline water, phosphorene and their interaction on:

1. Vegetative and root growth characters:

Data in Table (1) exhibit that survival (%) was only reduced at the highest salinity concentrations to reach more than 70 and 80% in the first and second seasons, respectively for 8000 ppm level, while for 10000 ppm one, it was slightly more than 16% in both seasons. Phosphorene treatments, however significantly improved such parameters, especially the rate of 100 ml/pot, which gave the highest survival% comparing with zero and 50 ml/pot levels. Mortality was only 100% when plants irrigated with 10000 ppm saline water and dressed with either zero or 50 ml/pot of phosphorene. This means that *F. benjamina* plant can tolerate salinity of irrigation water up to 6000 or 8000 ppm in the presence of a good nutrition. All other vegetative and root growth characters averaged in Tables (1,2 and 3) were progressively decreased in the two seasons with increasing salinity level to reach the least values in plants watered with the highest cncentrations (8000 and 10000 ppm), whereas all of these triats were significantly improved as the rate of phosphorene was elevated, with the superiority of 100 ml/pot treatment, which generally gave utmost high means in the two seasons compared to both zero and 50 ml/pot rates.

The only exception was gained from 2000 ppm saline water treatment, which significantly elevated the roots fresh and dry weights in both seasons, and also from 4000 ppm treatment that gave means of roots fresh and dry weights closely near to or slightly higher than those of control plants. In general, phosphorene application alleviated the deleterious effects of saline water, and consequently improved, to some extent growth and tolerance of *F. benjamina* plant to salt stress. This may be attributed to the role of phosphorene in releasing more available monophosphate that activates various metabolic processes in the cell and involved in energy transfer process. It is also share in building of phospholipids and nucleic acids (**Marschner, 1995**).

Table (1) Effects of saline water, phosphorene and their interaction on some vegetative growth parameters of *Ficus benjamina* L. transplants during 2010 and 2011 seasons

Saline water treats. (ppm)	Survival (%)				Plant height (cm)				Stem diameter (cm)				No. branches/plant				No. leaves/plant				Leaf area (cm^2)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
	First season: 2010																							
Control	100.0a	100.0a	100.0a	100.0a	66.2b	70.3b	81.6a	72.7a	0.74c	0.75c	0.98a	0.83a	17.6bc	18.5b	20.9a	19.0a	123.3cd	130.5bc	151.4a	135.1a	13.4cd	14.4ab	14.9a	14.2a
2000	100.0a	100.0a	100.0a	100.0a	54.7d	59.4c	67.9b	60.7b	0.63e	0.69d	0.86b	0.73b	15.0de	15.8d	18.4b	16.4b	109.5fg	114.1ef	135.5b	119.7b	13.5cd	13.9bc	14.3ab	13.9a
4000	100.0a	100.0a	100.0a	100.0a	39.6f	48.1e	59.7c	49.1c	0.57fg	0.60ef	0.76c	0.64c	13.4fg	14.2ef	16.2cd	14.6c	94.2h	104.1ig	120.1de	106.1c	11.3fg	12.6de	13.0cd	12.3b
6000	100.0a	100.0a	100.0a	100.0a	29.1jk	34.4gi	38.5fg	34.0d	0.48i	0.53ch	0.71cd	0.57d	10.9ij	11.6hi	12.4gh	11.6d	72.4jk	79.5ij	83.2i	78.4d	9.7hi	11.0fg	11.7ef	10.8c
8000	75.0d	79.0c	82.0b	78.8b	28.3k	32.8ij	36.0fh	32.4d	0.46i	0.48i	0.57fg	0.50e	8.6l	9.0kl	10.1jk	9.2e	55.8l	65.7k	73.3jk	64.9e	8.3j	9.6hi	10.3gh	9.4d
10000	00.0f	00.0f	49.5e	16.5c	0.00l	00.0l	31.2jk	10.4e	0.00j	0.00j	0.50hi	0.17f	0.0m	0.0m	8.9kl	3.0f	00.0m	00.0m	69.0k	23.0f	0.0k	0.0k	8.7ij	2.9e
Mean	79.2c	79.8b	88.6a		36.3c	40.8b	52.5a		0.48c	0.51b	0.73a		10.9c	11.5b	14.5a		75.9c	82.3b	105.4a		9.4c	10.3b	12.2a	
	Second season: 2011																							
Control	100.0a	100.0a	100.0a	100.0a	63.9c	71.0b	78.6a	71.2a	0.87cd	0.93bc	1.10a	0.97a	15.3c	16.7b	19.5a	17.2a	98.8cd	104.2c	132.3a	111.7a	11.2bc	11.9ab	12.7a	11.9a
2000	100.0a	100.0a	100.0a	100.0a	56.3d	58.1d	63.4c	59.3b	0.80ef	0.86d	0.97b	0.88b	14.0d	14.6cd	17.2b	15.3b	91.0d	92.0d	119.6b	100.9b	10.8cd	10.3de	11.2bc	10.8b
4000	100.0a	100.0a	100.0a	100.0a	45.3ef	49.4e	55.7e	50.1c	0.72gh	0.78fg	0.81de	0.77c	11.5e	12.6e	13.9d	12.7c	78.3e	81.1e	90.8d	83.4c	9.3fg	9.7fg	10.5de	9.9c
6000	100.0a	100.0a	100.0a	100.0a	35.7h	41.3fg	43.6f	40.2d	0.67h	0.67h	0.73gh	0.69d	8.5gh	9.2fg	10.2f	9.3d	54.7gh	59.8g	69.7f	61.4d	8.2hi	8.9gh	10.0ef	9.0d
8000	83.0c	87.0b	90.0b	86.7f	30.1i	33.7hi	36.5gh	33.4e	0.52i	0.58i	0.69h	0.60e	6.7i	7.4hi	8.1gh	7.4e	39.0j	45.0ij	55.0gh	46.4e	7.7i	8.3hi	9.3fg	8.4e
10000	00.0e	00.0e	56.0d	18.7c	0.00j	00.0j	30.3i	10.1f	0.00j	0.00j	0.51i	0.17f	0.0j	0.0j	7.4hi	2.5f	00.0k	00.0k	47.5hi	15.9f	0.0j	0.0j	8.9gh	3.0f
Mean	80.5b	81.2b	91.0a		38.6c	42.3b	51.4a		0.60c	0.64b	0.80a		9.3c	10.1	12.7a		60.3c	63.7b	85.8a		7.9b	8.2b	10.4a	

* P: Free from phosphorene, P1: phosphorene at 50 ml/pot and P2: phosphorene at 100 ml/pot.

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

Table (2) Effects of saline water, phosphorene and their interaction on some root growth parameters and SRI % of *Ficus benjamina* L. transplants during 2010 and 2011 seasons

Saline water treats. (ppm)	Root length (cm)				No. latereral roots/plant				SRI (%)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
	First season: 2010											
Control	26.22de	37.11b	44.98a	36.10a	7.23de	7.99c	10.21a	8.48a	100.0de	141.5b	171.5a	137.7a
2000	23.65e	32.93c	39.57b	32.05b	7.01ef	7.76cd	9.22b	8.00b	90.0ef	125.6c	150.9b	122.2b
4000	18.73g	30.45c	36.79b	28.66c	6.32gh	7.03e	7.80cd	7.05c	71.4g	116.1c	140.3b	109.3c
6000	13.55h	27.52d	31.34c	24.14d	5.11ij	6.34gh	6.97fg	6.14d	51.7h	104.9d	119.5c	92.05d
8000	12.00h	22.36f	25.41de	19.92e	4.35k	4.91jk	5.77hi	5.01e	45.7h	85.3f	96.9de	76.0e
10000	0.00i	0.00i	14.37h	4.79f	0.00m	0.00m	2.76l	0.92f	0.00i	0.00i	54.8h	18.3f
Mean	15.69c	25.06b	32.08a		5.00c	5.67b	7.12a		59.8c	95.6b	122.3a	
	Second season: 2011											
Control	27.01e	38.54b	46.68a	37.41a	7.01cd	8.31b	9.98a	8.43a	100.0e	142.7b	172.8a	138.5a
2000	26.86e	33.01c	40.81b	33.56b	7.00cd	7.45c	8.22b	7.56b	99.4e	122.2c	151.1b	124.2b
4000	22.66f	30.52cd	38.16b	30.45c	6.12fg	6.71ef	6.92de	6.58c	83.9f	113.0cd	141.3b	112.7c
6000	15.41g	28.45de	30.33cd	24.73d	5.34hi	5.97gh	6.32fg	5.88d	57.1g	105.3de	112.3cd	91.6d
8000	11.50h	23.09f	26.79e	20.46e	4.33j	4.34j	4.93ij	4.53e	42.9h	85.5f	99.2e	75.7e
10000	0.00i	00.00i	13.36gh	4.45f	00.00l	0.00l	2.36k	0.78 f	0.00i	0.00i	49.5gh	16.5f
Mean	17.24c	25.60b	32.69a		4.97c	5.46b	6.46a		63.8c	94.8b	121.0a	

* P: Free from phosphorene, P1: phosphorene at 50 ml/pot and P2: phosphorene at 100 ml/pot.

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

Table (3) Effects of saline water, phosphorene and their interaction on aerial parts and roots fresh and dry weights of *Ficus benjamina* L. transplants during 2010 and 2011 seasons

Saline water treats. (ppm)	Arial parts F.W. (g)				Aerial parts D.W. (g)				Roots F.W. (g)				Roots D.W. (g)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
	First season: 2010															
Control	34.14c	39.58b	45.95a	39.89a	9.65de	10.51bc	11.88a	10.68a	17.67g	25.81bc	27.76b	23.75a	7.13g	11.01c	12.34b	10.16b
2000	33.09cd	34.66c	41.33b	36.36b	9.01ef	9.88cd	10.79b	9.90b	15.81gh	24.75cd	33.48a	24.68a	6.81g	10.90c	15.98a	11.23a
4000	30.65de	31.11de	32.34cd	31.37c	8.31fg	8.63f	9.76de	8.90c	12.37i	22.68de	27.51b	20.85b	5.45h	10.11cd	12.27b	9.28c
6000	25.02f	25.79f	29.88e	26.90d	6.65ij	6.92hi	7.72gh	7.10d	8.93j	19.93f	21.46ef	16.77c	3.63i	8.63ef	9.53de	7.26d
8000	17.69g	18.54g	20.34g	18.86e	5.29k	5.96jk	6.43ij	5.89e	8.25jk	15.12h	17.18gh	13.52d	3.36i	6.81g	7.72fg	5.96e
10000	00.00h	00.00h	19.24g	6.41f	0.00l	0.00l	6.00jk	2.00f	0.00l	00.00l	6.43k	2.14e	0.00k	0.00k	2.36j	0.79f
Mean	23.43c	24.95b	31.51a		6.49c	6.98b	8.77a		10.51c	18.05b	22.30a		4.40c	7.91b	10.03a	
	Second season: 2011															
Control	30.31e	35.78c	44.69a	36.93a	9.71cd	11.02b	12.26a	11.00a	15.01gh	26.63c	28.32bc	23.32b	7.25g	10.73de	12.42c	10.13b
2000	30.11e	33.25cd	39.11b	34.16b	8.77e	9.65cd	11.03b	9.82b	16.53fg	27.99bc	35.01a	26.51a	7.22g	11.44cd	16.75a	11.80a
4000	28.41e	30.89de	34.55c	31.28c	8.33e	9.16de	10.25bc	9.25c	14.33h	23.67d	29.50b	22.50b	5.89h	10.92df	13.42b	10.08b
6000	21.15gh	23.33fg	24.77f	23.08d	7.00fg	7.34f	8.98de	7.77d	9.31i	20.54e	23.21d	17.69c	4.09i	8.76f	9.98e	7.61c
8000	16.97i	18.35hi	20.02h	18.45e	5.67h	6.21gh	6.86g	6.25e	9.10i	16.23gh	17.76f	14.36d	4.00i	7.08g	7.93fg	6.34d
10000	00.00j	00.00j	19.11hi	6.37f	0.00i	0.00i	6.34gh	2.11f	0.00k	00.00k	5.19j	1.73e	0.00k	0.00k	1.91j	0.64e
Mean	21.16c	23.60b	30.38a		6.58c	7.23b	9.29a		10.71c	19.18b	23.17a		4.74c	8.16b	10.40a	

* P: Free from phosphorene, P1: phosphorene at 50 ml/pot and P2: phosphorene at 100 ml/pot.
* Means within column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

Moreover, **Darwish (2002)** demonstrated that microorganisms of biofertilizers enhancing mobilization of phosphate and micronutrients, and may secret some growth-promoting factors.

On the other hand, the gradual reduction in vegetative and root growth with increasing salinity rates may be referred to a decrease in cell volume at a constant cell number caused by salinity (**Handreck and Black, 2002**). Likewise, **Devitt *et al.*, (2005)** reported that mechanism of salt may result in cell division inhibitory and hence, reduce the rate of plant development. **Jou *et al.*, (2006)** affirmed that ATPase participates in the endoplasmic reticulum-Golgi mediated protein sorting machinery for both housekeeping function and compartmentalization of excess Na^+ under high salinity.

The previous results are in accordance with those attained by **Devecchi and Remotti (2004)** on *Berberis candidula, Pyracantha coccinea, Viburnum davidii* and *Cotoneaster salicifolious,* **Cobrera *et al.*, (2005)** on *Rosa spp.*, **Giri *et al.*, (2007)** on *Acacia nilotica* and **Mahmoud *et al.*, (2008)** on *Dovyalis caffra* and *Lantana camara.*

In relation to the percent of salt resistance index (SRI%), as a real indicator for salinity tolerance, data in Table (2) indicate that such parameter was more than 100% in the two seasons for control plants and those ones irrigated with 2000, 4000 and 6000 ppm saline water and fertilized with either 50 or 100/ml phosphorene/ pot. The opposite was the right concerning high salinity level (8000 and 10000 ppm), which significantly declined this trait to less than 100%, even for plants dressed with phosphorene at both rates. This result emphasized that *F. benjamina* plant can tolerate salt stress up to 6000 ppm irrespective of fertilization or not.

From the aforementioned results, we have concluded that Waringin fig (*Ficus benjamina* L.) plant can tolerate salinity of irrigation water up to 6000 ppm, with good performance if the soil dressed with 100 ml phosphorene per 30-cm-diameter pot.

2. Chemical composition:

It is evident from data presented in Table (4) that, chlorophylls a, and b content was gradually declined in the leaves as a result of increasing salinity level in irrigation water, but they were significantly increased in response to phosphorene treatments, especially the rate of 100 ml/pot that gave the highest content. Carotenoids content, on the other hand, was augmentatively raised as salinity level was increased, but was decreased with elevating phosphorene rate. This may be related to the root absorption of NaCl from soil solution at high concentration, which causes yellowings and necroses on the leaves (**Devecchi and Remotti, 2004**). Phosphorene repairs, to somewhat this deficiency.

Similarly, were those results of N, P and K percentages, as they were cumulatively decreased with raising salinity concentration, but markedly improved due to fertilization with phosphorene, especially the rate of 100 ml/pot that resulted the highest records. This may indicate the role of phosphorene in activating mobilization of phosphate and micronutrients to be more available for plants (**Darwish, 2002**).

On the other side, the percent of Na and Cl, as well as proline content (mg/g F.W.) were progressively increased with increasing salinity level because the higher salt concentration in the nutrient medium leads usually to an increase in the uptake of some highly hydrophilic ions (e.g. Na or borate) as mentioned by **Mengel and Kirkby (1979)**. It was also suggested that accumulation of some amino acids and amides in the leaves and roots of salinity stressed-plants may be du to *de novo* synthesis and not the result of protein degradation (**Gilbert *et al.,* 1998**). However, contents of the three previous constituents were slightly reduced due to application of phosphorene indicating the reason whereby such biofertilizer alleviates the harmful effects of salinity.

The aforesaid findings, however are in line with those gained by **Al-Qubaie *et al.,* (2003)** on *Bougainvillea glabra, Jasminum azoricum* and *Conocarpus erectus*, **Zhang *et al.,* (2004)** on *Nitraria sibrica,* **Devecchi *et al.,* (2005)** on *Lonicera pileata, Euonymus fortunei* and *Hedera helix* and **Mahmoud *et al.,* (2008)** on *Dovyalis caffra* and *Lantana camara.*

Briefly, it is clear from the previous results that one-year-old transplants of Waringin fig (*Ficus benjamina* L.) grown in 30-cm-diameter plastic pots filled with 7 kg of a sand + clay mixture (1:1, v/v) can tolerate salinity of irrigation water up to 6000 ppm, with good performance and healthy growth if fertilized monthly with 100 ml of phosphorene/pot for three times throughout the growing season.

Table (4) Effects of saline water, phosphorene and their interaction on chemical composition of *Ficus benjamina* L. transplants during 2010 and 2011 seasons

Saline water treats. (ppm)	Chlorophyll a (mg/g F.W.)				Chlorophyll b (mg/g F.W.)				Carotenoids (mg/g F.W.)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
Control	1.33cd	1.87a	1.93a	1.71a	0.677c	0.945a	0.969a	0.863a	0.743e	0.702e	0.537f	0.661e
2000	1.21de	1.58b	1.63b	1.47b	0.591d	0.752b	0.786b	0.709b	0.830d	0.763de	0.598f	0.730d
4000	1.16ef	1.26de	1.38c	1.27c	0.423gh	0.630cd	0.635cd	0.562c	0.943bc	0.913c	0.735e	0.864c
6000	0.87hi	0.94gh	1.04fg	0.95d	0.352i	0.472f	0.536e	0.453d	1.003b	0.911c	0.820d	0.912b
8000	0.76i	0.91h	0.93gh	0.87e	0.267j	0.418gh	0.447fg	0.377e	1.110a	1.000b	0.936bc	1.015a
10000	0.00j	0.00j	0.78i	0. 26f	0.00k	0.00k	0.393hi	0.130f	0.000g	0.000g	0.956bc	0.319f
Mean	0.89c	1.09b	1.28a		0.385c	0.536b	0.627a		0.772a	0.715b	0.764a	
	N (%)				P (%)				K (%)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
Control	2.56b	2.78a	2.95a	2.76a	0.733b	0.837a	1.040a	0.870a	1.57b	1.63b	1.73a	1.64a
2000	2.13ef	2.44bc	2.51bc	2.36b	0.710ef	0.810bc	0.920bc	0.813b	1.24c	1.29c	1.33c	1.29b
4000	1.87gh	2.03fg	2.34cd	2.08c	0.670gh	0.770fg	0.860cd	0.767c	0.80e	0.92d	0.96d	0.89c
6000	1.62i	2.00fg	2.21de	1.94d	0.587i	0.723fg	0.770de	0.693d	0.49gh	0.55fg	0.63f	0.56d
8000	1.00j	1.57i	1.76hi	1.44e	0.420j	0.577i	0.650hi	0.549e	0.33i	0.39hi	0.59fg	0.44e
10000	0.00k	0.00k	1.70hi	0.57f	0.00k	0.000k	0.630hi	0.210f	0.00j	0.00j	0.51g	0.17f
Mean	1.53c	1.80b	2.25a		0.520c	0.619b	0.812a		0.74c	0.80b	0.96a	
	Na (%)				Cl(%)				Free proline (mg/g F.W.)			
	P	P1	P2	Mean	P	P1	P2	Mean	P	P1	P2	Mean
Control	1.27f	1.23f	1.21f	1.24c	0.79g	0.75g	0.73g	0.76d	0.159j	0.140j	0.112j	0.137f
2000	1.28f	1.24f	1.20f	1.24c	0.93e	0.91e	0.87ef	0.90c	0.394g	0.275i	0.247i	0.305d
4000	1.31ef	1.27f	1.24f	1.27c	0.95e	0.92e	0.86ef	0.91c	0.487e	0.389g	0.333h	0.403c
6000	1.50cd	1.45cd	1.42de	1.46b	1.21cd	1.19cd	1.14d	1.18b	0.686b	0.534d	0.459f	0.560b
8000	1.63a	1.55ab	1.53ab	1.57a	1.33a	1.30ab	1.27ab	1.30a	0.925a	0.631c	0.553d	0.703a
10000	0.00g	0.00g	1.57b	0.52d	0.00h	0.00h	1.30ab	0.43e	0.000k	0.000k	0.634c	0.211e
Mean	1.17b	1.12b	1.36a		0.87b	0.85b	1.03a		0.442a	0.328c	0.390b	

* P: Free from phosphorene, P1: phosphorene at 50 ml/pot and P2: phosphorene at 100 ml/pot.
* Means within column or row having the same letters are not significantly different according to Dancan's Multiple Range Test (DMRT) at 5% level.

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هل يستطيع الفوسفورين مساعدة نبات الفيكس بنجامينا على تحمل الآثار الضارة للمياه المالحة؟

جيهان حسن عبد الفتاح [1] و سيد محمد شاهين [1] وسغاد عبد الله محمد خنيزى[2]

[1] قسم بحوث الحدائق النباتية، معهد بحوث البساتين، مركز البحوث الزراعية – الجيزة- مصر.
[2] قسم بحوث الزينة، معهد بحوث البساتين، مركز البحوث الزراعية – الجيزة – مصر.

أجريت هذه الدراسة تحت ظروف احدى الصوبات البلاستيك بمشتل معهد بحوث البساتين، الجيزة، مصر خلال موسمي ٢٠١٠ ، 2011 و ذلك لمعرفة دور التسميد بالفوسفورين (سماد حيوي يحتوي على سلالة معينة من البكتيريا لها القدرة على تحويل الفوسفات الثلاثي الغير ميسر الى فوسفات أحادي ميسر) بمعدلات: صفر، ٥٠ ، ١٠٠ مل/أصيص في خفض التأثيرات الضارة لملوحة مياه الري عند اضافتها بمعدلات صفر، ٢٠٠٠، ٤٠٠٠، ٦٠٠٠، ٨٠٠٠ و ١٠٠٠٠ جزء في المليون (و الذي تم تحضيرها من مخلوط متساوي من أملاح كلوريد الصوديوم و كلوريد الكالسيوم بنسبة ١:١ وزناً) على نمو و جودة شتلات الفيكس بنجامينا (*Ficus benjamina* L.) عمر سنة النامية في أصص بلاستيك قطرها ٣٠سم ملأت بحوالي 7 كجم من مخلوط الرمل و الطمي (بنسبة ١:١ حجماً).

و لقد أوضحت النتائج المتحصل عليها أن النسبة المئوية للنباتات الحية انخفضت معنوياً عند المستويات المرتفعة من الملوحة (٨٠٠٠، ١٠٠٠٠ جزء في المليون) حتى بلغت النسبة المئوية للنباتات الميتة ١٠٠% عند الري بمياه ملوحتها ١٠٠٠٠ جزء في المليون و ذلك في غياب التسميد بالفوسفورين أو عند التسميد به بمعدل ٥٠ مل/أصيص. و لقد انخفضت تدريجياً جميع قياسات النمو الخضري و الجذري بزيادة مستوى الملوحة، باستثناء الوزن الطازج و الجاف للجذور و اللذان تحسنا معنوياً نتيجة للري بمستويي ٢٠٠٠، ٤٠٠٠ جزء في المليون. على الجانب الآخر، فان جميع هذه القياسات قد تحسنت معنوياً استجابة لمعاملات التسميد بالفوسفورين، مع تفوق المعدل ١٠٠ مل/أصيص و الذي أعطى أعلى المتوسطات في هذا الخصوص. أما النسبة المئوية لمعامل تحمل الملوحة (SRI%) فقد كانت أكبر من ١٠٠% لنباتات المقارنة و تلك التي رويت بتركيزات ملوحة ٢٠٠٠، ٤٠٠٠ و ٦٠٠٠ جزء في المليون و سمدت بالفوسفورين بمعدل ٥٠ أو ١٠٠ مل/أصيص. كذلك انخفض محتوى الأوراق من كلوروفيللي أ ، ب ، النيتروجين ، الفوسفور و البوتاسيوم بشكل متصاعد كلما زاد تركيز الملوحة، بينما زاد محتوى هذه المكونات بزيادة معدل التسميد بالفوسفورين. و لقد كان العكس صحيحاً فيما يتعلق بمحتوى الأوراق من الكاروتينويدات، الصوديوم، الكلوريد و البرولين.

باختصار، فان النتائج السابقة توضح أن شتلات الفيكس بنجامينا عمر سنة النامية في أصص بلاستيك قطرها ٣٠سم تستطيع تحمل ملوحة مياه الري حتى ٦٠٠٠ جزء في المليون، مع امكانية تحسن مظهرها و نموها بشكل أفضل اذا سمدت بالفوسفورين بمعدل ١٠٠ مل/أصيص ثلاث مرات بفاصل زمني شهر بين كل مرتين متتاليتين خلال موسم النمو.