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Prospect of Biofertilizer Inoculation for Increasing Saline Irrigation Efficiency.

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ABSTRACT

This article discusses the potential of seawater as a source of irrigation to salt tolerant plants (halophytes) and study the effect of biofertilizers inoculation as proper management techniques for improvement the productivity and physiochemical characteristics of sporobuls under saline irrigation. To achieve the aforementioned objectives, two pot experiments were conducted in the halophytic green house of the National Research Centre, Dokki, Giza to study the effect of biofertilizer inoculation with either vesicular-arbuscular mycorrhizas, *Azotobacter chroococcum* or soil yeast (*Rhodotorula glutinis*) on biomass production, biochemical composition and some physiological aspects of *Sporbolus virginicus Dixi* grown under different levels of seawater irrigation (Tap water, 12.5%, 25.0%, 37.5%, and 50.0%). Increasing saline irrigation level generally increased the content of soluble carbohydrates, proline, sodium, calcium and the value of succulence and osmotic potential (OP) particularly under 50.0% seawater concentration. On the other hand, reversal magnitude was detected for K, K/Na and Ca/Na ratio as the concentration of salinity in the seawater used for irrigation increased. However, moderate concentration of seawater produced reasonable above ground biomass production, crop growth rate (CGR), the content of chlorophyll a+b and crude protein as well as salinity tolerance index (STI). Biofertilizer inoculation positively affected productivity and physiological criteria as well as salinity tolerance of the tested plants. *Azotobacter chroococcum* surpass the other two inoculums especially at high levels of saline irrigation.

Key words: Seawater irrigation, *Sporobolus virginicus Dixi*, biofertilizer inoculation, biomass production.

Introduction

Halophytes are plants that are able to grow in habitats excessively rich in salts, such as salt marshes, sea coasts, and saline or alkaline semi deserts. These plants have special physiological adaptations that enable them to grow in salt affected soils under seawater irrigation and can produce relatively high consumable biomass in saline areas where non-halophytic species cannot grow or have low dry matter yields. Therefore, halophytes may be considered as a supplementary feed source under arid and semi-arid conditions.

Sporobolus virginicus (Poaceae) is a perennial, rhizomatous, C4 chloridoid grass with a broad distribution along subtropical shorelines (Naidoo and Naidoo, 1995). It is a low-growing vigorous perennial grass. The only practical way to propagate it is by vegetative rhizomatous slips. It acts very well as a dune stabilizer. It has the potentiality for stream bank stabilization and also roadside slope stabilization. *Sporobolus virginicus* is well adapted to low rainfall and high salinity habitats (Marcum and Murdoch ,1992).

Biofertilizer is a material containing microorganisms added to a soil to directly or indirectly make certain essential elements available to plants for their nutrition through synthesis of growth promoting substances or by enhancing the decomposition of plant residues. Various sources of biofertilizers include nitrogen fixers, phytostimulators, phosphate solubilizing bacteria, plant growth promoting rhizobacteria etc. Considerable progress has been made over the past two decades in evaluation of these technologies and development of application methods (Afzal and Asghari, 2008). Kaci *et al.*, (2005) added that, these microorganisms are known to deliver a number of benefits including plant nutrition, disease resistance, and tolerance to adverse soil and climatic conditions like Azotobacters chroococcum. Mycorrhiza is the mutualistic symbiosis (non-pathogenic association) between soil-borne fungi with the roots of plants. Their function ranges from stress

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alleviation to soil bioremediation or as a biological tool for sustainable agriculture. The main goal of the current trial is looking for the best biological treatments could be applied to get a high biomass production in addition to keep our environment clean and safe to live in.

Material and methods

Two pot experiments were conducted in the halophytic green house of the National Research Centre, Dokki, Giza during the two successive seasons of 2007 and 2008 to study the effect of biofertilizer inoculation on biomass production, biochemical composition and some physiological aspects of *Sporobolus virginicus* Dixi *plants* grown under different levels of seawater irrigation. Pots were arranged in complete randomize design with three replicates, and included 20 treatments which were the combination of four biofertilizer treatments [control i.e. without inoculation, inoculation with vesicular-arbuscular mycorrhizas, *Azotobacter chroococcum* and soil yeast (*Rhodotorula glutinis*)] X five levels of saline irrigation (Tap water, 12.5%, 25.0%, 37.5% and 50.0 % seawater concentration). Rhizomes of *sporobolus virginicus* were transplanted on May 17thand 15th in the first and second seasons, respectively in plastic pots 40 cm in diameter and 40 cm in height filled with mixture of peat-moss and sand (1: 3). The mechanical and chemical analysis of the soil was carried out by using the standard method described by klute (1986). Data of soil analysis are given in Table (1).

Table 1: Mechanical and chemical analysis of the soil (Average data of 2007 and 2008 seasons).

Mechanical analysis		Chemical analysis			
Sand	98.36	P^H	8.45	Mg (mg/100g)	22.85
Silt	0.91	$CaCo_3$	1.15	Na (mg/100g)	8.39
Clay	0.73	Organic matter	0.24	Fe (ppm)	2.49
Texture class	Sandy soil	N (mg/100g)	38.12	Mn (ppm)	4.22
		P (mg/100g)	1.12	Zn (ppm)	1.28
		K (mg/100g)	9.05	Cu (ppm)	1.11

Each pot was fertilized with 6.2 g. calcium superphosphate (15.5% P_2O_5) and 1.5 g. potassium sulphate (48.0 % K_2O) and 6.75 g. urea (46.5% N) at the rate of 32 kg. P_20_5/fed., 24 kg. K_2O/fed. and 105 kg N/fed. respectively. Biofertilizers inoculation treatments were done by mixing the specified inoculums with the soil at the rate of 300 g /fed. Each pot was irrigated three times per week with the specified seawater concentration. The chemical analysis of the irrigation water is given in Table (2). Three cuttings were taken at 42 days intervals. Three replicates were taken for each seawater treatment to determine biomass production (g), total productivity of the three cuttings (g) and crop growth rate CGR=[(W2-W1)/(T2-T1) g/week] Where W_1 and W_2 refer to dry weight of the whole plant at time T_1 and T_2 in week, respectively.

Table 2: Chemical analysis of diluted seawater irrigation (Averge data of 2007 and 2008 seasons).

Characters	Tap water	12.50 %	25.00 %	37.50 %	50.00 %
P^H	7.56	8.02	8.06	8.26	8.36
EC (ds/m)	0.88	10.36	12.36	18.25	23.58
Na (mg/L)	76.36	1869.00	3136.25	5864.36	6589.26
K (mg/L)	3.24	65.36	115.25	151.35	181.65
Cl (mg/L)	561.02	3659.25	6555.48	7842.36	8947.26
Ca (mg/L)	94.36	98.36	111.36	122.36	131.36
Mg (mg/L)	11.03	33.35	66.58	81.56	974.25

Salt tolerance index was calculated as total plant dry weight obtained from different seawater irrigation compared to total plant dry weight obtained from plants irrigated with tap water, STI = [(TDW at Sx / TDW at S1) x 100], whereas STI = salt tolerance index, TDW = total dry weight, S1 = control treatment, Sx = x treatment (Seydi *et al.*, 2003). The following physiochemical measurements were determined in the fresh harvested shoot of the second cutting: chlorophyll a+b (mg/g fresh weight) according to von Wettstein (1957), proline (µg/g) according to Bates *et al.*, (1973), osmotic potential were then obtained from the corresponding values of cell sap concentration tables given by Gusev (1960). Then the harvested shoots were then dried to constant weight at 70° and the values of succulence (ratio of fresh weight/dry weight) were calculated according to Tiku equation (1975). The dried plants were then thoroughly ground to fine powder and total nitrogen percentage was determined according to the method described by A.O.A.C. (1975) and the crude protein content was calculated by multiplying total nitrogen concentration by factor of 6.25. Soluble carbohydrates content was also determined by the method described by Dubois *et al*., (1956). The content of sodium and potassium were determined in the digested material using Jenway flame photometer as described by Eppendrof and Hing (1970). Calcium was determined by versinte method according to Jackson (1967). K/Na, Ca/Na ratio was also calculated for each treatment. Phosphorus was also determined according to

Chapman and Pratt (1978). The obtained results were subjected to statistical analysis of variance according to method described by Snedecor and Cochran (1982) since the trend was similar in both seasons the homogeneity test Bartlet's equation was applied and the combined analysis of the two seasons was calculated according to the method of Steel and Torrie (1980).

Results and discussion

Effect of Saline Irrigation on Dry Weight, Crop Growth Rate and Biomass Production:

Data presented in Table (3) show that Sporobolus behave like a true halophytes, highly tolerant of salinity. Growth performance seemed to appear significant tolerance to saline irrigation up to 25% seawater concentration. This response was apparent as the RGR and biomass production in the three cuttings. However, higher saline irrigation levels adversely affect the previous characters. Similar results were obtained by Akhter *et al.,* (2004) who reported that low NaCl concentrations stimulate growth of some halophytic species. Such stimulatory effect of moderate salinity on growth of some halophytic plants may be attributed to improved shoot osmotic status as a result of increased ions uptake metabolism (Naidoo *et al.,* 1995). On the other hand, the reduction in growth and yield under high salinity levels could be attributed to the reduction in photosynthesis, disturbance in mineral uptake, protein synthesis or carbohydrate metabolism (Al-Garni, 2006). He added that in most halophytic species growth decreases gradually with the increase of salt rate in the culture medium above a critical threshold specific to each species. In addition, Ashour *et al*., (2004) attributed the reduction in growth at higher salinity level to reduced turgor and high energy cost of massive salt secretion and osmoregulation. Similar results were obtained by Tawfik *et al.,* (2008) who reported that low NaCl concentrations stimulate biomass productivity of *leptochloa fusca*.

Table 3: Effect of saline irrigation on fresh weight, crop growth rate (g/week) and the total biomass production. (Combined analysis of 2007 and 2008 seasons).

Seawater Concentration	First cutting		Second cutting		Third cutting		Total biomass production
	Fresh wt.	CGR	Fresh wt.	CGR	Fresh wt.	CGR	
Tap water	59.54	12.09	74.53	12.42	89.90	14.99	237.02
12.50%	75.18	12.53	75.78	12.64	91.62	15.26	242.59
25.00%	91.32	15.22	93.12	15.53	98.16	16.36	282.63
37.50%	64.17	10.70	66.70	11.13	69.71	11.61	200.58
50.00%	54.38	9.08	56.88	9.47	63.53	10.60	174.78
LSD 5%	3.98	0.66	3.88	0.81	4.65	0.98	13.56

Effect of Biofertilization Treatments on Fresh Weight, Crop Growth Rate and Biomass Production:

Table (4) cleared that, all biofertilizer treatments significantly increased fresh weight and crop growth rate (CGR) in the three cuttings and consequently biomass production. However, the increment percentages of the total productivity were 4.11, 7.64 and 10.79 for vesicular-arbuscular mycorrhizas, soil yeast (*Rhodotorula glutinis*) or *Azotobacter chroococcum* respectively compared with control plants. Our results are in agreement with those obtained by Tawfik *et al*., (2006). The stimulatory effect of biofertilizers is proposed to be mainly due to the bacterial production of nitrogen, phosphorus and indole-3-acetic acid in the rhizosphere (Rothballer *et al.,* 2005). Moreover, Microbial inoculums not only increased the nutritional assimilation of plant but also improved soil properties and total N in soil (Wu *et al.,* 2005). Moreover, Egamberdiyeva (2007) added that such inoculation could compensate for nutrient deficiency and improve a plant development through production of plant growth regulators by microbes at the root interface, which stimulated root development of plants and resulted in better absorption of water and nutrients from the soil and the most commonly reported direct plant growth promotion mechanism by bacteria is the production of plant growth substances such as auxins, gibberellins.

Table 4: Effect of biofertilization treatments on fresh weight, crop growth rate (g/week) and total biomass production.(Combined analysis of 2007 and 2008 seasons).

Biofertilizer treatment	First cutting		Second cutting		Third cutting		Total biomass production
	Fresh wt.	CGR	Fresh wt.	CGR	Fresh wt.	CGR	
Control	63.81	10.63	66.10	11.02	75.36	12.56	205.29
vesicular-arbuscular mycorrhizas	68.57	11.43	70.42	11.74	79.32	13.22	218.31
Rhodotorula glutinis	73.53	12.26	74.53	12.44	84.79	14.14	232.85
Azotobacter chroococcum	77.57	12.91	79.58	13.27	88.22	14.69	245.38
LSD 5%	4.36	0.77	4.62	0.80	5.02	0.87	13.35

Effect of Interaction Between Saline Irrigation and Biofertilization Treatments on Fresh Weight, Crop Growth Rate and Biomass Production:

Data in table (5) shows that, the highest values for the biomass production (307.58 g/pot) was recorded in *sporobolus virginicus plants* treated with A. *chroococcum and* irrigated with 25.0% seawater concentration .On the other hand, the lowest values were recorded in the untreated plants (control) at the level of 50.0% seawater irrigation. Similar result were obtained by Hamdia *et al*., (2005) who proved that biofertilizer inoculation reduced the deleterious effects of saline irrigation on growth.It was concluded from this part of the study that biofertilzation treatment produce a satisfactory biomass production especially under high salinization level of irrigation. These results coincide with those obtained by Tawfik *et al*., (2006) who stated that, biofertizer inoculation with bacteria alleviated the sea salt effects in *leptochloa fusca*..

Table 5: Effect of interaction between saline irrigation and biofertilization treatments on fresh weight, crop growth rate (g/week) and total biomass production. (Combined analysis of 2007 and 2008 seasons).

Seawater Concentration	Biofertilizer treatment	First cutting		Second cutting		Third cutting		Total biomass production
		Fresh wt.	CGR	Fresh wt.	CGR	Fresh wt.	CGR	
Tap water	Control	54.67	9.12	56.63	9.44	68.76	11.46	180.04
	vesicular-arbuscular mycorrhizas	58.74	9.79	59.85	9.96	73.19	12.20	191.78
	Rhodotorula glutinis	61.15	10.19	62.31	10.37	76.20	12.70	199.66
	Azotobacter chroococcum	63.79	10.62	66.03	11.00	77.01	12.85	206.83
12.5%	Control	71.13	11.85	74.05	12.33	86.46	14.42	231.63
	vesicular-arbuscular mycorrhizas	73.44	12.24	75.16	12.54	87.53	14.58	236.13
	Rhodotorula glutinis	76.95	12.81	72.98	12.16	92.83	15.48	242.73
	Azotobacter chroococcum	79.30	13.22	81.02	13.50	99.96	16.67	260.28
25.0%	Control	82.06	13.69	82.95	13.82	91.03	15.18	256.04
	vesicular-arbuscular mycorrhizas	89.74	14.97	89.03	14.82	94.15	15.71	272.92
	Rhodotorula glutinis	94.43	15.73	97.51	16.26	101.32	16.88	293.26
	Azotobacter chroococcum	98.84	16.46	102.96	17.17	105.75	17.64	307.58
37.5%	Control	55.22	9.21	60.35	10.04	66.93	11.15	182.47
	vesicular-arbuscular mycorrhizas	58.10	9.69	62.97	10.49	67.04	11.18	188.10
	Rhodotorula glutinis	68.11	11.35	70.15	11.68	71.34	11.90	209.60
	Azotobacter chroococcum	75.83	12.65	73.70	12.28	73.60	12.28	223.13
	Control	46.48	7.76	46.61	7.76	50.55	8.41	143.64
50.0%	vesicular-arbuscular mycorrhizas	53.93	9.01	56.46	9.40	62.80	10.47	173.23
	Rhodotorula glutinis	57.60	9.61	61.04	10.17	69.83	11.63	188.46
	Azotobacter chroococcum	60.16	10.02	64.27	10.71	71.97	12.00	196.41
	LSD 5%	3.99	0.89	4.65	0.98	4.62	0.85	13.65

Effect of saline irrigation on biochemical composition and some physiological aspects:

Saline irrigation affects the studied parameters in different ways. Data presented in Table (6) and Fig (1) show that raising irrigation salinity levels significantly increase the content of soluble carbohydrates, proline, calcium and sodium as well as succulence and osmotic potential values. On the other hand the same treatment decreased the content of potassium, phosphorus and the values of STI as well as the ratio of K/Na and Ca/Na. However moderate saline irrigation up to 25.0 % generally increased chlorophyll a+b and crude protein content. Similar results were obtained by Youssef (2009). In this respect, Murphy *et al.,* (2003) suggested that both proline and soluble carbohydrates act as compatible solutes under high salinity levels. Kusaka *et al.,* (2005) added that, the observed increase in the osmotic potential might be due to the accumulation of inorganic solutes, several organic components such as sucrose, glucose, quaternary ammonium compounds, and amino acids including proline.

Table 6: Effect of saline irrigation on biochemical composition and some physiological aspects. (Combined analysis of 2007 and 2008 seasons).

Seawater concentration	Chlorophyll a+b mg/g dry wt.	Soluble carbohydrates %	Crude protein %	Proline (ug/g dry wt.)	K/Na ratio	Ca/Na ratio	Succulence	Osmotic potential	Salinity Tolerance Index
Tap water	2.67	43.43	8.86	284.46	1.66	0.35	2.24	6.67	103.67
12.50%	2.78	44.21	9.13	366.17	1.23	0.34	2.73	7.84	106.11
25.00%	2.82	46.43	10.08	490.75	0.95	0.30	2.86	9.68	118.01
37.50%	2.72	47.69	9.18	603.48	0.81	0.32	3.04	11.09	78.79
50.00%	2.62	48.67	8.78	719.48	0.64	0.34	3.63	14.07	57.50
LSD 5%	0.14	2.32	0.50	24.54	0.05	0.02	0.14	0.48	5.90

Furthermore, the greatest accumulation of sodium by plants at high salt concentration may be attributed to the damage of the protoplasm of plant cells and as a result of the selective salt absorption is replaced by passive absorption which causes abnormal accumulation of salts in plant organs (Kader and Lindberg, 2005). They added that under saline conditions sodium influx across the plasmalemma to the vacuole might play a major role in permitting turgor maintenance. He *et al.,* (2005) added that the accumulation of sodium ions inside the vacuoles reduce the toxic levels of sodium in cytosol and increase the vacuolar osmotic potential with the concomitant generation of a more negative water potential that favors water uptake by the cell and better tissue water retention under high salinity levels.

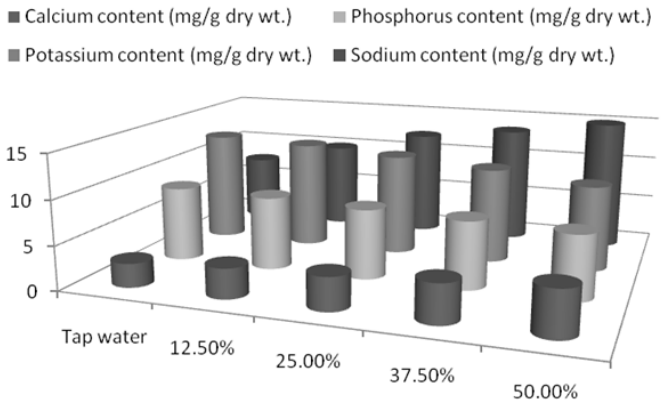

Fig. 1: Effect of saline irrigation on the content of calcium, phosphorus, potassium and sodium of *Sporobolus virgincus* (LSD 5% Ca: 0.19 ,Ph: 0.40 ,K: 0.58 and Na: 0.61) (Combined analysis of 2007 and 2008 seasons).

On the other hand, the depressing effect of salinity on potassium and phosphorus content could be attributed to the difficulty of its uptake due to competition with the high concentration of the sodium in the root medium. Furthermore, Chartzoulakis (2005) recorded that the decrease in P concentration associated with salinity conditions may be ascribed to the high pH values which might hinder P availability to plants. Lacerda *et al*., (2005) reported that the greatest salinity tolerance observed in plants under saline conditions was associated with lower Na/K ratio and greater capacity for osmotic adjustment. Lycoskoufis (2005) stated that the inhibition of photosynthesis under high salinity levels predominantly due to reduced stomatal conductance. Moreover, Rogers (2005) added that, proteins that accumulate in plants grown under saline conditions may provide a storage form of nitrogen that is re-utilized when stress is over and may play a role in osmotic adjustment. Similar results were obtained by Tawfik *et al*., (2008).

Effect of Biofertilization Treatments on Biochemical Composition and Some Physiological Aspects:

Table (7) and Fig (2) cleared that biofertilizer treatments generally increased the content of chlorophyll a+b, crude protein, potassium, STI, calcium and phosphorus as well as the ratio of K/Na and Ca/Na as compared with control (untreated plants). However inoculation with A. *chroococcum* surpassed the other treatments. On the other hand, the previous treatments decreased the content of soluble carbohydrates, proline and sodium as well as the values of succulence and osmotic potential. Our results coincide with those obtained by Tawfik *et al.,* (2006).

Table 7: Effect of biofertilization treatments on biochemical composition and some physiological aspects. (Combined analysis of 2007 and 2008 seasons)

Biofertilization treatment	Chlorophyll a+b mg/g dry wt.	Soluble carbohydrates %	Crude protein %	Proline (ug/g dry wt.)	K/Na ratio	Ca/Na ratio	Succulence	Osmotic potential	Salinity Tolerance Index
Control	2.62	46.97	9.04	514.86	1.00	0.34	2.79	10.18	87.86
V.A. mycorrhizas	2.67	46.32	9.16	501.55	1.04	0.33	2.85	10.00	91.48
R.glutinis	2.77	45.84	9.26	483.19	1.07	0.32	2.94	9.74	94.58
A.chroococcum	2.82	45.21	9.36	471.89	1.12	0.33	3.01	9.54	97.35
LSD 5%	0.15	2.26	0.47	25.14	0.06	0.02	0.15	0.48	4.87

It is clear that inoculation improves all the tolerance feature of *Sporobolus virginicus* plants and increase plant adaptation to saline irrigation. These results coincide with the results obtained by Zahiroddini *et al.*, (2004) who stated that, the bacterial inoculant clearly enhanced fermentation and consequently reduced soluble carbohydrates. Moreover, Hamdia *et al.*, (2005) added that, biofertilizer inoculation markedly altered the selectivity ions it restricted Na^+ uptake and enhanced the uptake of K^+ and Ca^{++}.

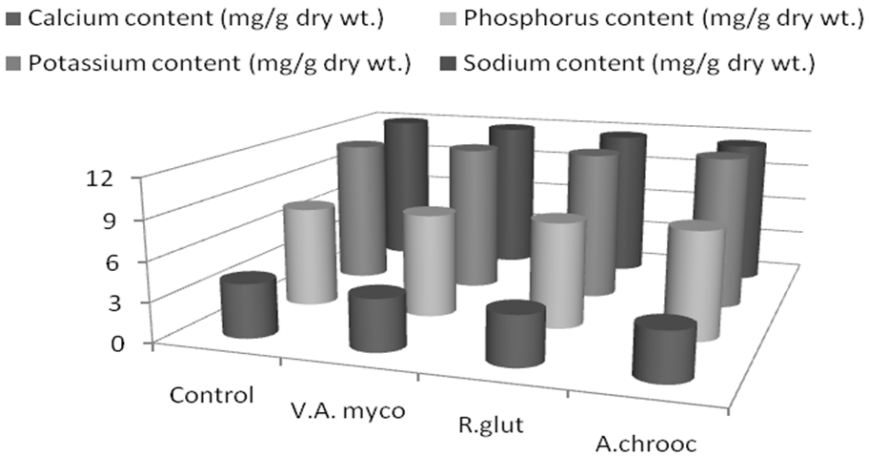

Fig. 2: Effect of biofertilization treatments on the content of calcium, phosphorus, potassium and sodium of *Sporobolus virgincus* (LSD 5% Ca: 0.18, Ph: 0.41, K: 0.59 and Na: 0.57) (Combined analysis of 2007 and 2008 seasons)

Effect of Interaction Between Saline Irrigation and Biofertilization Treatments on Biochemical Composition and Some Physiological Aspects:

As for the interaction effect of between saline irrigation and biofertilizers treatments, Table (8) shows that the highest content of photosynthetic pigments, crude protein and STI were recorded in *Sporobolus virginincus* plants treated with A. *chroococcum* and irrigated with 25.0% seawater, while untreated plants irrigated with 50.0% seawater gave the highest content of soluble carbohydrates, proline and sodium as well as succulence and Osmotic potential values. On the other hand, the treatment A *chroococcum* x tap water gave the highest content of potassium and phosphorus. Similar results were obtained by Reddy *et al.*, (2003) who found that, biofertilizer inoculation has been reported to decrease fertilizers needed, improve the crude protein content and counteract the effects of salinity. It was concluded from this part of the study that accumulation of proline was associated with an increase in the concentration of soluble sugar. In this regard Pardo *et al.*, (2006) reportted that K/Na selectivity is improved by the presence of Ca that plays an important role in the control of Na transport.

Table 8: Effect of interaction between saline irrigation and biofertilization treatments on biochemical composition and some physiological aspects. (Combined analysis of 2007 and 2008 seasons)

Seawater concentration	Biofertilization treatment	Chlorophyll dry wt.	Soluble a+b mg/g %	Crude carbohydrates %	Proline protein dry wt.)	Potassium (ug/g (mg/g dry wt.)	Sodium content (mg/g dry wt.)	Calcium content (mg/g dry wt.)	K/Na content	Ca/Na ratio	Phosphorus ratio (mg/g dry wt.)	Succulence content	Osmotic potential	Salinity Tolerance Index
Tap water	Control	2.51	43.98	8.65	296.6	12.42	7.98	2.98	1.56	0.37	8.25	2.15	6.98	100.0
	V.A. mycorrhizas	2.63	43.58	8.88	290.5	12.56	7.81	2.78	1.61	0.36	8.36	2.19	6.74	104.6
	R. glutinis	2.71	43.27	8.91	277.4	12.67	7.56	2.58	1.68	0.34	8.55	2.28	6.55	104.6
	A. chroococcum	2.84	42.87	8.99	273.4	13.05	7.24	2.46	1.80	0.34	8.75	2.34	6.42	105.5
12.5%	Control	2.65	44.89	9.02	392.4	12.08	10.25	3.51	1.18	0.34	8.02	2.68	8.14	103.2
	V.A. mycorrhizas	2.71	44.49	9.12	368.2	12.22	10.12	3.42	1.21	0.34	8.25	2.69	8.02	104.8
	R. glutinis	2.86	44.18	9.15	357.1	12.24	9.88	3.33	1.24	0.34	8.36	2.72	7.65	106.6
	A. chroococcum	2.90	43.27	9.24	347.0	12.65	9.74	3.31	1.30	0.34	8.47	2.83	7.54	109.8
25.0%	Control	2.74	47.31	9.95	506.4	11.22	12.52	3.98	0.90	0.32	7.74	2.71	10.03	112.8
	V.A. mycorrhizas	2.75	46.60	9.99	502.4	11.64	12.36	3.87	0.94	0.31	7.86	2.84	9.87	114.8
	R. glutinis	2.88	46.20	10.15	482.2	11.75	12.22	3.58	0.96	0.29	7.92	2.93	9.65	119.5
	A. chroococcum	2.89	45.60	10.22	472.1	11.88	11.98	3.54	0.99	0.30	8.12	2.94	9.15	124.9
37.5%	Control	2.66	48.72	9.02	630.5	10.60	13.68	4.65	0.77	0.34	7.25	2.98	11.25	73.1
	V.A. mycorrhizas	2.69	47.92	9.12	617.3	10.71	13.58	4.36	0.79	0.32	7.58	2.99	11.14	75.1
	R. glutinis	2.74	47.61	9.22	592.1	10.94	13.44	4.25	0.81	0.32	7.86	3.05	11.02	82.1
	A. chroococcum	2.79	46.50	9.35	574.0	11.28	13.26	4.21	0.85	0.32	7.98	3.14	10.94	84.9
	Control	2.54	49.93	8.54	748.5	9.58	15.82	5.36	0.61	0.34	7.02	3.42	14.51	50.2
50.0%	V.A. mycorrhizas	2.59	49.02	8.69	729.3	9.74	15.36	5.21	0.63	0.34	7.24	3.56	14.25	58.1
	R. glutinis	2.65	47.92	8.88	707.1	9.83	15.12	5.01	0.65	0.33	7.36	3.74	13.85	60.2
	A. chroococcum	2.69	47.81	9.02	693.0	9.94	14.69	4.89	0.68	0.33	7.58	3.81	13.65	61.6
	LSD 5%	0.14	2.28	0.51	23.60	0.59	0.60	0.18	0.05	0.01	0.41	0.15	0.46	6.25

Moreover, Shabala *et al.,* (2005) proved that, the reduction in total potassium concentration has been attributed to displacement of K by Na. K leakage from the root plasmalemma can occur as a result of Ca displacement by Na and for sodium uptake causes plasma membrane depolarization, leading to activation of outward-rectifying K channels and a consequent K loss.

Recently, Park *et al*., (2009) found that most of halophytes which have succulent leave and stems attained higher values of relative water content, free water content, succulence ratio and photosynthetic pigment contents. They added that under severe conditions of moisture stress or physiological dryness of the soil, halophytic species exhibited high RWC values. Succulence is considered as a mechanism through which certain halophytes are adapted to their salt environment.

Conclusion:

It could be concluded from this study the possibility of employing marginal water resources for marginal lands in different parts of the adjacent Egyptian sea cost areas. Halophytes irrigated with seawater represent a considerable potential forage crop plants and it can well tolerate irrigation with saline water up to 25% sea water concentration. Biofertilization with N fixing bacteria like A. *chroococcum* could effectively mitigate the adverse effects of saline water irrigation.

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