Role of mineral fertilizers with and without two bio-fertilizers on some soil properties, behaviour of nutrients in rice plant and rice productivity under newly reclaimed saline soil conditions

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ABSTRACT

A field experiment was conducted during two successive summer seasons of 2016 and 2017 at Sahl El-Houssinia Agriculture Research Station in El-Shakia Governorate, Egypt. Its lies between 32^{o} 00/00 to 32^{o} 15/00/ N latitude and 30^{o} 50 / 00// to 31^{o} 15 00// E longitude (map 1). The combined effect of bio-fertilizers inoculated with *Rhizobium radiobacter* sp strain (salt tolerant PGPR); *Bacillus megatherium* (dissolving phosphate) and *Bacillus circulans* (enhancing potassium availability) and yeast strains (*Saccharomyces cerevisiae*) combined with different rates of N, P and K fertilizers (50, 75 and 100 %) was evaluated on some soil properties, such as, nutrient content in rice plants and rice productivity under newly reclaimed saline soils conditions. From the crop field of the Agricultural Research Institute (ARC), Egypt, 101 grain kernels from rice (*Oryza sativa) var*. Sakha were selected. The experiment was conducted in randomized complete blocks with three replicates.

The results indicated that soil pH and EC were decreased for soil treated with bio-fertilizers combined with different rates of mineral fertilizers in comparison with soil treated with yeast and control. The increases in available N, P, K, Fe, Mn and Zn in the soil increased with the use of bio-fertilizers. The application of three treatments i.e. mineral fertilizers (N, P and K) alone or combined with bio-fertilizers (bacteria and yeast) to the soil cultivated with rice resulted in increased yield grains and straw of rice plant. The different rates of mineral fertilizers were examined for the plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/fed) and straw yield (ton/ha) with soil treated with bacteria + 75 % N+P+K fertilizers and compared with other treatments. The increase in macro- and micronutrients concentration and uptake in grain and straw of rice plants for soil treated with bacteria + 75 % N+P+K fertilizers compared with other treatments.

Recommendation: we can use the bacteria *Rhizobium radiobacter* **(**fixed N**),** *Bacillus megatherium* (dissolving phosphate) and *Bacillus circulans* (enhancing potassium availability) combined with 75% mineral fertilizers (N,P and K) improved soil properties and healthy grown rice production under saline soil conditions.

Key word: saline soil; rice crops; nutrients contents in soil and rice plant.

INTRODUCTION

Today the increasing food demand is one of the major issues of global concern for food security with rising populations and restricted lands under cultivation which is a result of increasing land use for urbanization and industrialization. With the advent of green revolution in 1960, intensive agricultural practices that came into existence, including use of high-yielding, disease-resistant crop varieties, and constant input of agrochemicals such as chemical fertilizers, pesticides etc. Application of such chemicals adversely affects the dynamic equilibrium of soil and affects agro-biodiversity by destroying non-target useful soil flora and fauna **Bambaradeniya and Amerasinghe (3003) and Galhano et al (2011).**

The average nutrient content of rice grain is 80% starch, 7.5% protein, 0.5% ash and 12% water. The proportion of amylose and amylopectin in starch determines the cooking and eating qualities of the rice. Rice is a primary source of carbohydrate and the essential amino acids in sufficient amounts for good health **Wu et al (2003).**

Yeast *(Saccharomyces cerevisiae)* is rich in amino acid, proteins, carbohydrates, minerals, vitamins, hormones and other growth regulating substances **(Omran, 2000). Marzauk et al (2014)** indicated that the application of yeast extract treatments concentration of 6 ml/L foliar increased plant growth, expressed as plant length (cm), number of leaves and branches as well as fresh and dry weight (g) of leaves, branches and whole plant in two seasons as compared with the control in the study.

Biofertilizers play a very significant role in improving soil fertility by fixing atmospheric nitrogen, both, in association with plant roots and without it, solubilize insoluble soil phosphates and produce plant growth substances in the soil. They are in fact being promoted to harvest the naturally available, biological system of nutrient mobilization **(Venkatashwarlu, 2008).** The improvement of plants' growth in response to the foliar application of yeast extract may be attributed to its contents of different nutrients, i.e. (P, K, Mg, Ca, Fe, Ba, Mn and Zn), higher percentage of proteins, higher values of free amino acid and vitamins which may play an important role in improving growth and controlling the incidence of fungal diseases **(Bevilacqua, et al., 2008)**. The soluble protein content increases as a result of yeast action. On the one hand, the yeast releases amino acids from the soluble protein, **(Anca, et al, 2011).**

This study aims to investigate the evaluation of applying bio-fertilizers and yeast combined with different rates of mineral fertilizers on some soil properties and macro-micronutrient contents in rice plant and rice productivity under saline soil conditions

MATERIALS AND METHODS

Study area:

The study area is located at Sahl El-Houssinia Agriculture Research Station in El-Sharkia Governorate, Egypt, between 32^{o} 00/00 to 32^{o} 15/00/ N latitude and 30^{o} 50 / 00// to 31^{o} 15 00// E longitude (map 1). Salinity took place, mainly due to high evaporation under dry hot climate. El-salam canal (1:1 mixed of Nile and agricultural drainage water is the main source of irrigation water.

Before the experiment, some preparation processes were carried out including the following:

a) Levelling the soil surface using lazer technique;
b) Deep sub-soil plough;
c) Establishment of the required surface drains and irrigation canal network systems;
d) Collecting representative surface soil samples for conducting some physical and chemical analysis according to **Page et al (1982) and Cottenie (1982).** Data in the table (1) show some physical and chemical properties of the initial soil.

Table 1 Physical and chemical properties in the soil of the study site before the rice was established

Coarse sand (%)	Fine sand (%)	Silt (%)	Clay (%)		Texture	O.M (%)		$CaCO_3$ (%)
4.57	33.95	15.58	45.90		Clay	0.58		9.33
F.C.	W.P.	A.W.	B.D (g/cm^3)			T.P (%)		
28.39	10.56	12.90	1.45			43.00		
Chemical properties								
pH (1:2:5)	EC (dS/m)	Cations (meq/l)				Anions (meq/l)		
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO^{-}_3	Cl^{-}	SO^{2-}_4
8.12	9.90	12.50	20.31	65.40	0.79	7.49	48.38	43.13
Macronutrients (mg/kg)			Micronutrients (mg/kg)					
N	P	K	Fe	Mn	Zn	Cu		
32.55	3.64	170	4.58	1.07	0.60	1.11		

Experimental work:

The current experiment was conducted during two successive summer seasons (2016 and 2017) respectively, in saline clay soil.

Fertilizer treatment:

Minerals and bio-fertilizer treatments are given in Table 2.

Treatment	Rate of N^* kg/ ha	Rate of $P_2O_5^{**}$ kg/ ha	Rate of K_2O kg/ha
Mineral	0.0	0.0	0.0
	119	35.7	83.3
	178.5	59.5	130.9
	238	73.78	166.6
***Bacteria	0.0	0.0	0.0
	119	35.7	83.3
	178.5	59.5	130.9
	238	73.78	166.6
***Yeast	0.0	0.0	0.0
	119	35.7	83.3
	178.5	59.5	130.9
	238	73.78	166.64

*Urea 46% N is a source of N

**Super phosphate 15.5% P_2O_5 is a source of P

Potassium sulphate_ (48 % K_2O) source of K

****Bacteria and yeasts were obtained from microbiology Department, SWERI, Agric. RES. centre, Giza, Egypt.

***** Kernels of rice cultivar Giza 104 were obtained from Crop Institute Agriculture Research Center, Giza, Egypt.

Experimental Design:

The experiment was conducted in randomized complete blocks with three replicates. Two bio-fertilizers (i.e. yeast and bacteria) were randomly arranged as the main plot, where the rates of N, P and K were distributed randomly as sub-plot. The experimental unit area was 5 m long x 10 and m wide.This was divided into three treatments (mineral fertilizers, yeast and bacteria). Super phosphate rates were applied during soil tillage and plots were ploughed twice after super phosphate application.

Kernels were inoculated with *Rhizobium radiobacter* sp strain (salt tolerant PGPR) biofertilizer deposited in the Gen bank under the number of HQ395610 Egypt; *Bacillus megatherium* (dissolving phosphate) and *Bacillus circulans* (enhancing potassium availability) and yeast strains

(*Saccharomyces cerevisiae*) by Bio-fertilizers Production Unit, Department of Microbiology, Soils, Water and Environment Research Institute, Agricultural Research Center, Giza, Egypt.

Rice (*Oryza sativa)* var. Sakha 101 grains were obtained from the crop field of the Agric. Res. Inst. (ARC), Egypt. Sowing of rice grains was carried out on 28 April (2016 and 2017). Untreated and treated seeds were applied seperately. In the bacteria or yeast treatments, the rice kernels were inoculated at sowing. The coating processes were carried out using Arabic gum solution. As well as, has been added more bio-fertilizers were added at three periods, at 30, 55 and 75 days after sowing in the form of liquid foliar application on plants at a rate of 47.6L/952Lwater /ha.

Nitrogen fertilizer was added as urea (46 % N) at three times, namely 21, 45 and 65 days after sowing. Potassium sulfate (48 % K_2O) was applied as base fertilizer for all treatments at a rate of 119 kg K_2O /ha was applied in two doses at 21 and 55 days after sowing.

All experimental plots were irrigated with El-Salam Canal (1:1) Nile water mixed with agricultural drainage water. To control soil salinity, water was applied immediately after sowing for 7 hours and then the excess water was drained. The same process was repeated on the second day. Irrigation water was applied every 12 days until the end of growing season.

Rice was harvested on 5 September 2016 and 2017 respectively. At harvest, the following parameters were recorded on a random sample of ten plants from each plot: seed yield (ton/ha), pod yield (ton/ha), the mass of 100 seeds (g)

A sample of rice grain samples was dried in the oven at 70 C^o then wet ash using of H_2SO_4 mixed with $HClO_4$ acids than in aliquots of the digested solution, macro– and micronutrient concentration was determined using a method by **Cottenie et al (1982)** and **Chapman and Pratt (1961)**.

Photosynthetic chlorophyll (a+b) was estimated in fresh leaves as described by **Witham et al (1971**). Proline content was estimated according to a method described by **Bates et al (1973).**

The obtained data were statically analyzed using the COSTAT program and LSD test at probability levels of 5 % calculated according to **Gomez and Gomez (1984).**

Results and Discussion

Soil pH.

Soil pH is one of the most important parameters which reflect the overall changes in soil chemical properties. Data presented in Table (2) show the high pH value of 8.25 in the soil surface. The soil pH tends to increase slightly after the rice harvested under all treatments. Soil pH is also known to be affected by bio-fertilizers. The soil pH of all experimental ranged was slight to moderately alkaline conditions. The soil pH value ranged from 7.95 to 8.25. Reduction in soil pH may be related to the residual organic matter after different biochemical and chemical changes. In addition, the activity of microorganisms led to the production of organic acid that was released from the bio-fertilizers. From this data, it is observed that the soil pH decreased as results of using bacteria followed by yeast and mineral fertilizer, respectively compared with the initial state of the soil. These results are in agreement with a study by **Shaban and Omar (2006) and Hafez (2014)** who indicated that the reducing effect of biofertilizer combined with mineral nitrogen might be attributed to associated increase in activity of dehydrogenase enzyme as well as the release of carbon dioxide in the rhizosphere due to exhalation of the microorganisms. **Shaban and Attia (2009)** found that bacteria that fixed N_2, dissolved P and available K led to a decrease in soil pH when added alone or in combination with chemical fertilizers.

Soil salinity (EC dSm^{-1}).

Data in Table (3) reveal that the EC values of studied in all studied tended to decrease when soil was treated with mineral fertilizers combined with bio-fertilizers compared to soil treated with mineral fertilizers alone. The effect of all treatments on soil salinity was not significant while the different rates of mineral fertilizers were significantly decreased with increasing rate of mineral fertilizers. The interaction between bio-fertilizers combined with mineral fertilizers was significant a slight increase on decrease soil salinity after rice harvest.

Table 3. Effect of different rates of mineral N, P and K fertilizers combined with bio-fertilizer on pH, EC and macro-micronutrients in the soil after rice harvested.

Treatments	Rate of NPK $kgha^{-1}$	pH (1:2.5)	EC (dSm^{-1})	Macronutrients ($mg\ kg^{-1}$)			Micronutrients ($mg\ kg^{-1}$)		
				N	P	K	Fe	Mn	Zn
Mineral	0	8.05	6.89	38.99	3.51	180.00	5.90	1.33	0.79
	119	8.03	6.45	41.45	3.66	186.00	5.97	1.38	0.83
	178.5	8.01	5.80	42.30	3.80	195.00	6.05	1.45	0.86
	238	8.00	5.30	44.28	3.95	198.00	6.12	1.56	0.87
Mean		8.02	6.11	41.76	3.73	189.75	6.01	1.43	0.84
Bactria	0	8.03	6.40	40.55	3.75	187.00	5.93	1.40	0.84
	119	8.01	5.98	43.58	3.90	195.00	6.04	1.65	0.88
	178.5	7.98	5.27	44.23	4.05	202.00	6.10	1.70	0.97
	238	7.95	4.75	46.88	4.17	205.00	6.15	1.79	0.99
Mean		7.99	5.60	43.81	3.97	197.25	6.06	1.64	0.92
Yeast	0	8.04	6.73	40.00	3.65	185.00	5.91	1.38	0.82
	119	8.02	6.35	41.65	3.80	189.00	5.98	1.50	0.85
	178.5	8.00	5.75	42.90	3.93	194.00	6.06	1.63	0.88
	238	7.98	5.22	44.89	3.98	198.00	6.13	1.75	0.93
Mean		8.01	6.01	42.36	3.84	191.50	6.02	1.57	0.87
LSD. 5% treatment		--	ns	ns	ns	ns	ns	0.021	ns
LSD. 5 %Rates		--	0.51	ns	ns	ns	ns	0.024	0.016
Interaction		--	**	*	ns	ns	ns	**	**

The corresponding relative decrease of mean values (EC dSm^{-1}) was 8.34% for soil treated with bio-fertilizers combined with different rates of mineral fertilizers and 0.16% for soil treated with yeast combined with mineral fertilizers rates compared with soil-applied mineral fertilizers different rates. These results confirmed the results reported by **Vishal et al. (2013) and Ali et al (2014)** who suggested that organic acids like indole acetic acid, gibberellic acid, and abscisic acid etc. are produced by the bacterial endophytes. These acids support plant growth by solubilization of minerals and by root growth promotion and lowering the EC in the rhizosphere and these organic acids can potentially provide a substantial modification of soil physical and chemical properties.

It is necessary to mention the superiority of bacteria combined with different mineral fertilizers rates as compared to the other treatments is probably more related to the occurrence of active organic acids that are released from the activity of microorganisms. These bio-fertilizers provided a substantial modification of soil physical properties, especially soil structure as well as soil aggregation and drainable pores. Consequently, these favourable conditions can positively affect soil permeability and encourage the downward movement of leaching water.

Macronutrients available in the soil.

Data presented in Table (3) show that the bacteria and yeast bio-fertilizations combined with mineral fertilizers at different rates increased the N, P and K availability in soil. Moreover, the soil treated with bacteria combined with mineral N, P and K fertilizers at the high rates gave higher values of available N, P and K in soil than other treatments. On the other hand, the effect of different rates of mineral fertilizers on available N, P and K content in soil and bio-fertilizers were not significant, while the interaction between mineral fertilizers and bio-fertilizers had a significant effect on N availability in soil. Also, the relative increases of mean values were 4.91 % for N; 6.43 for P and 3.95 % for K contents in the soil as affected by bacteria combined with different rates of mineral fertilizers compared to mineral fertilizers alone. Also, the relative increases of mean values N, P and K available in the soil as affected by yeast combined with different rates of mineral fertilizers were 1.44 % for N; 2.95% for P and 0.92 for K respectively compared with mineral fertilizers alone. These results are in agreement with **Abeer and Hanaa (2008)** who found that the bio-fertilizer inoculation generally increased the concentration of N, P and K in the soil when compared to control. **Hafez (2014)** indicated that the application of bio-fertilizers on available contents of N, P and K in the soil after harvest did not show a significant effect. **Rifat et al. (2010)** reported that PGPR as a bio-fertilizer helps in fixing N_2, solubilizing mineral phosphates and other nutrients as well as enhancing tolerance to stress.

Micronutrients available contents in soil after rice harvest.

The recorded data presented in Table (3) show that the different fertilization sources had a positive effect on micronutrients availability in soil (Fe, Mn and Zn, mg kg^{-1} soil). It was also shown that the soil treated with bacteria and yeast combined with mineral fertilizers rates gave higher increased values of available Fe, Mn and Zn than when treated with mineral fertilizers alone. The effect of bio-fertilizers combined with mineral fertilizers on Fe and Zn were not significant, while it was significant for Mn. Moreover, the application of mineral fertilizers at different rates to soil led to significant increases for Mn and Zn contents in soil. The interaction between bio-fertilizer and mineral fertilizers on available Mn and Zn contents in soil was significant, while, while the effect on Fe was not significant. These results suggest the important role of bio-fertilizers in improving soil nutrient status due to microorganisms activity in N fixation, P solubilization and K availability. These results are in agreement with those reported by **Wu et al (2006)** who found that the activity of bacteria *Azotobacter chroococcum*, *Bacillus megatherium* and *Bacillus mucilaginosus*, led to an increase in water dissolved organic carbon concentration and a decreased pH value, which enhanced metal mobility and bio-availability. **Shaban and Attia (2009)** found that the bio-fertilizers including *Azospirillum brasilense NO 40*, *Bacillus megatherium* and *Bacillus circularns* in combination with chemical fertilizers, may have a positive impact on bio-availability and mobility of micronutrients in the soil, depending on the chemical nature of metals.

Yield and yield components.

The effect of mineral fertilizers and bio-fertilizers or yeast on yield and yield components i.e. plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/ha) and straw yield (ton/ha) were presented in Table (4). Results showed that applied of three treatments i.e. mineral fertilizers (N, P and K) alone or combined with bio-fertilizers (bacteria and yeast) to the soil cultivated with rice were not significant for yield and yield components of rice growth. The different rates of mineral fertilizers caused a significant increase for the plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/ha) and straw yield (ton/ha) with increasing rates without bacteria. **Liang et al (2007)** suggested that the mineral nutrient status of plants plays a crucial role in increasing plant resistance to environmental stresses including salinity. The effect of different applied mineral fertilizer rates either with or without yeast application gave marked increases in the plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/ha) and straw yield (ton/ha) with increasing rates, while the decrease of mineral fertilizers combined with bacteria led to an increase in the plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/ha) and straw yield (ton/ha). The relative increases of mean values were 6.18% for plant height (cm) 20.18% for panicle length (cm) 11.46% for 1000 kernel mass (g) 44 for grain yield ton/ha and 59.69 for straw yield ton/ha for soil treated with mineral fertilizers combined with bacteria compared to soil treated with mineral fertilizers alone. The relative increases of mean values were 4.63, 5.13, 4.87, 3.40 and 12.23% for the plant height (cm), panicle length (cm), 1000 kernel mass (g), grain yield (ton/ha) and straw yield (ton/ha) respectively, as affected by mineral fertilizers combined with yeast application compared to mineral fertilizers alone. **Shaban et al (2009)** found that the increase of grain and straw rice yields to be due to the production of material with bio-fertilizers which may have activated microorganisms and improved soil fertility.

Table 4. Yield and yield components of rice as affected by bio-fertilizer and different fertilization under saline soil conditions.

Treatments	Rate of NPK $kgha^{-1}$	Plant height (cm)	Panicle length (cm)	1000 kernel mass (g)	Grains yield mass (ton/ha)	Straw yield mass (ton/ha)
Mineral	0	54.22	12.85	21.95	1.81	2.13
	119	75.39	15.62	24.63	2.480	8.07
	178.5	80.45	16.32	27.95	5.90	10.20
	238	82.00	16.85	28.12	8.85	9.98
Mean		73.02	15.41	25.66	6.31	7.59
Bacteria	0	61.28	16.58	26.14	2.01	2.84
	119	80.49	17.66	28.69	7.49	9.18
	178.5	84.36	20.52	30.42	10.93	13.54
	238	84.00	19.32	29.14	9.44	12.46
Mean		77.53	18.52	28.60	7.47	9.50
Yeast	0	58.33	14.85	25.41	1.41	2.51
	119	79.85	15.99	26.95	6.28	8.71
	178.5	83.46	16.45	27.34	9.14	10.92
	238	83.95	17.52	27.94	9.23	11.93
Mean		76.40	16.20	26.91	6.52	8.52
LSD. 5% treatment		ns	ns	ns	ns	ns
LSD. 5% Rates		3.522	4.09	3.45	1.29	1.12
Interaction		***	***	**	**	**

Generally, the improved rice growth in soil salinity may be due to the enhancing effect of bio-fertilizers (yeast and bacteria) on plants. The applied yeast and bacteria produced cytokinins, which enhanced the accumulation of soluble metabolites, increasing the levels of endogenous hormones in treated plants, which could be by cell division and cell elongation. This in its turn, will, increase the metabolic process rate and levels of hormones (Indol acetic acid IAA and gibberellins GA3) in addition to the physiological roles of vitamins and amino acids in the bio-fertilizers strains.

Macro-micronutrient concentration and uptake.

Bio-fertilizers (PGPR) have the ability to increase the availability of nutrient concentration in the rhizosphere by fixing N; solubilize phosphate and increase the availability of K. Data presented in Tables 5 and 6 show that the effect of mineral fertilizers alone or bacteria and yeast on N, P, K, Fe, Mn and Zn concentration in grains rice was not significant, while the application of different mineral fertilizer rates combined with bio-fertilizers caused significant increases, expect K concentrations in grains. The interaction between bio-fertilizers and different rates of mineral fertilizers on N, P, Fe, Mn and Zn concentration in grains rice was significant while the effect on K was not significant. On the other hand, the increase in N, Fe and Zn uptake in rice was significant for soil treated with mineral nitrogen fertilizers or bacteria and yeast fertilizers while P, K and Mn were not influenced significantly. The uptake of N, P, K, Fe, Mn and Zn in rice was significant in soil treated with mineral fertilizers rates. The interaction between different mineral fertilizers rates and bio-fertilizers led to a significant increase of N, P, K, Fe, Mn and Zn uptake in rice. The application of bacteria combined with

75 % N, P, K mineral fertilizers caused an increase in N, P, K, Fe, Mn and Zn concentration and uptake in rice plants compared to other treatments.

These results are in agreement the results reported by **Attia (2009)** who suggested that the concentration of N, P, K, Fe, Mn and Zn in maize as affected by bio-fertilizers combined with chemical fertilizers.

Table 5 Effect of different rates of mineral N, P, K fertilizers combined with bio-fertilizer on the concentration of macro-micronutrients in grains of rice harvested.

Treatments	Rate of NPK Kgha^{-1}	Macronutrients (%)			Micronutrients (%)		
		N	P	K	Fe	Mn	Zn
Mineral	119	1.20	0.38	1.95	85.42	65.98	18.94
	178.5	1.26	0.39	2.04	89.24	68.52	22.14
	238	1.34	0.45	2.08	93.40	72.16	25.63
	119	1.39	0.48	2.14	95.34	75.10	28.17
Mean		1.30	0.43	2.05	90.85	70.44	23.72
Bacteria	0	1.48	0.45	2.04	88.65	69.24	20.14
	119	1.52	0.48	2.09	92.14	72.16	25.36
	178.5	1.63	0.58	2.17	99.13	79.25	32.46
	238	1.59	0.52	2.13	95.62	76.34	29.45
Mean		1.56	0.51	2.11	93.89	74.25	26.85
Yeast	0	1.25	0.41	1.98	86.59	68.25	19.58
	119	1.30	0.46	2.04	92.14	70.14	24.34
	178.5	1.35	0.49	2.08	95.24	73.24	27.75
	238	1.45	0.51	2.15	96.24	77.36	30.94
Mean		1.34	0.47	2.06	92.55	72.25	25.65
LSD. %5 treatment		ns	ns	ns	ns	ns	ns
LSD. 5% Rates		0.056	0.022	ns	2.54	2.14	2.19
Interaction		**	**	ns	**	**	**

Table 5. Effect of different rates of mineral N P K fertilizers combined with bio-fertilizers on the uptake of macro-micronutrients in rice harvested.

Treatments	Rate of NPK $kgha^{-1}$	Macronutrients ($kgha^{-1}$)			Micronutrients (gha^{-1})		
		N	P	K	Fe	Mn	Zn
Mineral	0	21.66	6.90	35.22	154.30	188.45	34.22
	119	31.20	23.09	120.43	526.74	205.49	130.69
	178.5	74.26	39.03	180.64	811.37	230.12	222.65
	238	123.05	42.60	189.66	844.09	248.45	249.40
Mean		83.85	27.92	131.45	584.12	218.13	159.25
Bacteria	0	29.75	9.04	41.17	178.5	243.90	40.55
	119	113.76	35.94	154.7	689.68	261.04	189.83
	178.5	178.02	63.31	237.05	1083.38	307.45	354.76
	238	150.18	49.03	201.35	903.47	261.04	278.27
Mean		49.55	39.34	158.98	713.76	268.37	513.77
Yeast	0	17.61	5.71	27.85	121.99	203.04	27.58
	119	81.63	28.80	128.04	578.27	217.00	152.75
	178.5	123.28	44.74	190.16	870.41	235.31	253.61
	238	133.99	47.12	198.49	888.72	266.96	285.72
Mean		89.13	31.59	136.14	614.85	230.57	179.93
LSD. 5% treatment		7.80	ns	ns	9.71	ns	10.47
LSD. 5% Rates		8.99	7.57	9.88	11.21	9.85	12.14
Interaction		**	**	**	**	**	**

Mishra et al (2013) reported that the bio-fertilizer is a mixture of live or latent cells encouraging nitrogen fixing, phosphate solubilizing, or cellulolytic microorganisms used for applications to soil, seed, roots, or composting areas with the purpose of increasing the quantity of those mutualistic beneficial microorganisms and accelerating those microbial processes, which augment the availability of nutrients that can then be easily assimilated and absorbed by the plants.

Macro-micronutrients concentrations and uptake in straw rice plants.

Data presented in Tables 6 and 7 show that the macro-micronutrients contents in straw rice plants under different bio-fertilizers and mineral fertilizers applied at different rates under soil salinity conditions. The data obtained for N, P, K, Fe, Mn and Zn concentrations and uptake were decreased with treated mineral fertilizers individually. All treatments for studied had no significant effect on N, P, K, Fe, Mn and Zn concentrations in straw while the Zn and Fe uptake had a significant effects of all treatments. The different rates of mineral fertilizers led to significant increases in N, P, K, Fe, Mn and Zn concentrations and uptake in the straw of rice plants. The interaction between mineral fertilizers and bio-fertilizers were Significant increases the uptake and concentration of the elements N, P, K, Fe, Mn and Zn. The highest mean value of N, P, K, Fe, Mn and Zn concentrations and uptake in straw rice plants were soil treated with bacteria combined with mineral fertilizers than other treatments. These results are in agreement with results reported by **Haum et al (2007**), who found that the increase of N, P and K concentrations in rice straw in soil treated with bio-fertilizer combined with mineral fertilizer at different rates could be due to changes in soil chemical properties, microbial population and biochemical soil enzymes' activities in saline soil cultivation. **Ashmaye et al (2008)** indicated that the use of bio fertilizers in combination with

Table 6. Effect of different rate of mineral N, P and K fertilizers combined with bio-fertilizer on macro-micronutrients in the straw of rice harvested.

Treatments	Rate of NPK $kgha^{-1}$	Macronutrients (%)			Micronutrients (mg/kg)		
		N	P	K	Fe	Mn	Zn
Mineral	0	1.94	0.23	2.18	72.68	59.47	17.45
	119	1.98	0.27	2.22	77.52	61.30	20.41
	178.5	2.04	0.29	2.29	82.14	65.82	21.69
	238	2.09	0.32	2.35	85.36	69.52	22.74
Mean		2.01	0.28	2.26	79.43	64.03	20.57
Bacteria	0	1.98	0.26	2.23	74.52	63.14	18.20
	119	2.16	0.29	2.28	79.32	69.52	21.35
	178.5	2.22	0.31	2.32	85.20	70.41	24.13
	238	2.28	0.35	2.38	89.14	71.00	25.69
Mean		2.16	0.30	2.30	82.05	68.52	22.34
Yeast	0	1.97	0.24	2.20	72.96	61.38	18.00
	119	2.13	0.28	2.26	80.52	65.24	20.55
	178.5	2.18	0.30	2.28	81.00	69.22	20.95

	238	2.24	0.33	2.31	82.41	70.41	21.05
Mean		2.13	0.29	2.26	79.22	66.56	20.14
LSD. 5% treatment		ns	ns	ns	ns	ns	ns
LSD. 5 %Rates		0.07	0.023	0.031	1.73	2.88	1.64
Interaction		**	**	***	***	***	**

Table 7. Effect of different rate of mineral N, P and K fertilizers combined with bio-fertilizer on macro-micronutrients uptake in the straw of rice harvested.

Treatments	Rate of N PK Kgha^{-1}	Macronutrients (kgha^{-1})			Micronutrients (g/ha^{-1})		
		N	P	K	Fe	Mn	Zn
Mineral	0	41.17	4.99	46.41	154.65	126.54	37.13
	119	159.70	21.90	179.21	625.44	494.59	164.67
	178.5	208.01	29.51	233.48	837.69	671.26	221.20
	238	208.73	31.89	234.67	852.04	693.94	226.98
Mean		154.41	22.09	173.45	617.46	496.59	162.51
Bacteria	0	56.168	7.38	63.31	211.58	179.29	51.67
	119	198.25	26.66	209.20	727.94	638	195.95
	178.5	300.59	41.89	314.16	1153.8	953.50	326.77
	238	284.17	43.55	296.55	111.06	884.96	319.63
Mean		209.80	29.87	220.82	801.11	663.95	223.51
Yeast	0	49.50	5.95	55.22	183.38	154.27	45.24
	119	185.64	24.28	196.83	701.39	568.30	178.99
	178.5	238.24	32.84	249.19	884.86	756.17	228.86
	238	267.27	39.27	275.60	983.04	839.88	251.09
Mean		185.16	25.59	194.21	688.18	579.65	176.05
LSD. 5% treatment		ns	ns	ns	10.42	ns	3.26
LSD. 5 %Rates		7.43	3.33	76.54	12.04	64.52	3.76
Interaction		***	***	**	**	**	**

mineral fertilizer caused increases in the concentrations of Fe, Mn and Zn in straw**.**

Thus, it could be concluded that the concentration and uptake of macro-micronutrients in kernels and straw rice plants reflected the availability in soil and the applied fertilizers sources.

CONCLUSION

Chemical and microbial fertilizers have its advantages and disadvantages in terms of nutrient supply, soil quality and crop growth. Biological fertilization with N_2 fixing bacteria, phosphorus solubilizing bacteria and potassium dissolving bacteria are of great importance in increasing crop production and saving mineral fertilizers. Moreover, inoculation of plants grown in salt-affected soils with salt-tolerant microorganisms offered them tolerance against salinity, thereby increased their production. It can be concluded that bio-fertilization by *Rhizobium radiobacter* sp strain, *Bacillus megatherium* as (dissolving phosphate bacteria) and *Bacillus circulans* inoculants could be applied to rice as a supplement to inorganic NPK-fertilizer. A considerable increase was observed when plants were treated with bio fertilizers + 75% NPK-recommended by the Ministry of Agriculture. It could be recommended that salt tolerant plant growth promoting rhizobacteria (PGPR) should be used to face the problem of salinity or excessive NPK-mineral use for the rice plants.

Pictures: 1- soil treated with mineral fertilizers – 2- yeast combined with mineral fertilizers – 3- bacteria combined with mineral fertilizers

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