IMPACT OF GYPSUM AS A SOIL AMENDMENT AND BIOFERTILIZERS ON SUGAR BEET PRODUCTION UNDER IRRIGATION WITH SALINE WATER

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Abstract

A field experiment was conducted in South Sinai Government at wadi Sudr Experimental Station, Desert Research Center, in a calcareous soil during the winter growing season of 2001 - 2002. The aim of this experiment was to evaluate the effect of gypsum as a soil amendment and bio-fertilization on the production of sugar beet grown under calcareous soil and saline irrigation water conditions. The experiment was carried out in a split plot design, where the main plots received gypsum (in two rates; 0 and 100 % of gypsum requirements of the soil). Meanwhile four treatments of bio-fertilizers, i.e. control, Bio-N (N-fixing diazatrophs), Bio- P (phospho-bacterein "PDB") and mixed treatment (Bio-N + Bio-P) were the sub plots.

Results showed that, the yields of roots and leaves increased significantly due to the addition of gypsum or bio-fertilizers, while the percent of total soluble solids (TSS) significantly decreased. The concentrations and uptake of N, P, K, Mn, Zn and Fe of roots and leaves were increased with the addition of gypsum or bio-fertilizers. The highest rate of increment in the uptake of these nutrients was associated with the combined treatment of [Gyp. (+) + (Bio-N + Bio-P)].

On the other hand, soil pH values as well as concentrations of soluble Na^+ and Cl^- were decreased in the gypsum or bio-fertilizers treated plots. Opposite trend was obtained for EC, ESP values as well as concentration of soluble Ca^{++}, Mg^{++}, K^+, HCO_3^- and SO_4. The interaction between gypsum and bio-fertilizers indicated that gypsum amendment in presence of bio-fertilizers is more effective in improving soil chemical properties as shown in reducing soil pH, EC and ESP values. In addition, the addition of gypsum and bio-fertilizers led to increase the values of total N, available P, Mn, Zn and Fe. The combined treatments [Gyp. (+) + (Bio-N + Bio-P)] had the highest effect on increasing *Azotobacler* and *Azospirillum* counts among all other treatments.

In conclusion, the application of gypsum with inoculating the sugar beet seeds with bio-fertilizers (Bio-N + Bio-P) c be recommended to increase the calcareous soil productivity of sugar beet when using saline water in irrigation.

INTRODUCTION

Soils of arid regions such as Ras Sudr Soils, South Sinai Government, are usually characterized by the presence of Na^+ ion at various levels due to the uses of saline well waters, which causes the problems of soil salinity and alkalinity; especially when such waters are used for irrigation. Using natural soil amendments has become one of vital importance. In this respect, agricultural gypsum has been used for reclaiming sodic soils through improving their physical and chemical properties and consequently, enhancing its productivity. Mohammed *et al.* (1993) reported that the dry matter yields of tomato as well as its concentration of N, P, K, Mn, Zn and Fe were increased by adding gypsum at the rate equivalent to 100 % of Gypsum requirements. Mohammed *et al.* (1997) found an improvement in some soil properties (ESP and pH) by the application of 100 % gypsum requirements compared with the respective lower doses. On the other hand, bio-fertilization technology have been used either in single or mixture forms of bacterial species for increasing activity of such microorganisms, and hence improving soil productivity in the newly reclaimed soil (Abd El- Ghany *et al.*, 1997; Hashem, 1997 and El- Maghraby and Wassif, 1999).

The present investigation aims to clarify the role of gypsum as a soil amendment in presence of the bio-fertilizers on sugar beet productivity as well as their effect on the chemical and the biological properties of a calcareous soil irrigated with saline water.

MATERIALS AND METHODS

A field experiment was conducted during the winter growing season of 2001 - 2002 at Wadi Sudr Experimental Station of the Desert Res. Center, South Sinai Governorate. The aim of this experiment was to evaluate the effect of gypsum, as a soil amendment, and bio-fertilization on the productivity parameters of a calcareous soil under saline water irrigation conditions.

The soil of the experimental site is sandy loam in texture, highly calcareous (52.7 % $CaCo_3$), highly saline (EC of 12.26 dS/m), ESP (11.82), pH (7.92) and having 0.40 % organic matter. Available soil P is 2.5 ppm, total N is 0.1 %, and Fe, Zn and Mn are 2.1, 1.15 and 1.58 ppm, respectively. The experiment was carried out in a split plot design. The main plots received gypsum (in two rates; 0 and 100% of gypsum requirements of the soil), meanwhile four treatments of bio-fertilization, i.e. control, Bio-N (N_2- fixing diazatrophs), Bio-P (phosphor-bacteria PDB) and mixed treatment (Bio-N + Bio-P), occupied the sub plots. The experiment was consisted of 8 treatments and each treatment was replicated four times. The area of each plot was 3 x 3.5 m (1/400 feddan). The treatments were as following:

1) Non treated soil (control)
2) Gypsum at rate of 100 % from gypsum requirement, denoted as Gyp. (+)
3) Bio-fertilizer N-fixing diazatrophs bacteria, denoted as Bio-N
4) Bio-fertilizer treatment was phosphate dissolving bacteria(PDB), denoted as Bio-P
5) Mixture of (Bio-N + Bio-P)
6) Combined treatment of (2 & 3), denoted as (Gyp. (+) + Bio-N)
7) Combined treatment of (2 & 4), denoted as (Gyp. (+) + Bio-P)
8) Combined treatment of (2 & 5), denoted as [Gyp. (+) + (Bio-N + Bio-P)]

Sugar beet seeds *(Beta Vulgaris* L.*)* were sown in 15th November 2001 in rows 30 cm apart and 20 cm in between plants. Seeds were firstly mixed with a paste of the bio-fertilizers using 20 % gum as an adhesive agent. However, gypsum treatments were mixed with the soil surface two weeks prior to cultivation.

All plots received P, N and K fertilizers at rates of 30 kg P_2O_5/fed as super phosphate before cultivation, 70kg N/fed as NH_4 NO_3 (33.5 N %) at two equal doses (applied after one and three months from cultivation) and 48 kg K_2O/fed as K_2 SO_4 (48 K_2o %) at the same time of N fertilization. Saline well water having 7846 (mg/L total soluble salt) were applied weekly until maturity.

At harvest, plant samples were collected, and the yield of roots and leaves was recorded and statistically analyzed according to Snedecor and Cochran (1967). The concentration of total soluble solids (TSS) in roots was determined according to A.O.A.C. (1965). Samples of roots and leaves were dried, ground and wet ashed for determination of N, P, K, Fe, Mn and Zn according to Chapman and Pratt (1961).

At harvesting, surface soil samples (0 - 30 cm) were collected for the determination of pH, EC, soluble cations & anions, organic matter content, total N, available P, Fe, Mn and Zn (Page *et al.*, 1982). Biological activities, including CO_2 evolution were determined according to Shehata (1972). Meanwhile, nitrogen deficient medium was used to determine *Azotobacler sp.* (Abd El-Malek and Ishac, 1968) and *Azospirillum sp.* (Dobereiner, 1978).

RESULTS AND DISCUSSION

Effect of the experimental treatments on the yield of sugar beet and total soluble solids (TSS)

The effect of gypsum and bio-fertilizers additions on the yield of sugar beet (roots and leaves) is shown in Table 1. Regarding gypsum treatment [(gyp. (+)], it is noticed that the yield of roots and leaves increased significantly due to the application of gypsum. The rate of increase in roots and leaves relative to control reached 33.9 and 106.9 %, respectively. Such effect may be related to the better nutritional status of the plants upon gypsum application that reduced soil pH (Table 3) which increased the nutrient availability to the plant as was found from the data of uptake (Table 2). In this respect, Mohammed *et al.* (1993) found that, adding gypsum has resulted in decreasing soil pH and ESP values and thereby improved soil physicochemical conditions which reflected in increasing crop yields. Such results stand in agreement with those obtained by Abrol and Bhumbla (1979) on several crops.

As for bio-fertilization, application of bio-fertilizers leads to significant increases in the yield of both roots and leaves of sugar beet plants. The rate of increase depended upon the type of applied bio-fertilizer. The highest values were obtained with (Gyp. (-) + (Bio-N + Bio-P) treatment, as it reached 61.19 and 88.46 % over the control for roots and leaves, respectively. In general, the efficiency of bio-fertilizer addition on increasing the yields of roots and leaves could be arranged, for Gyp. (-), in the following order: (Bio-N + Bio-P) > Bio-N > Bio-P > Control. The positive effect of bio-fertilizers on increasing sugar beet yields could be referred to its role in increasing the availability of N, P, K, Fe, Mn and Zn due to increasing the symbiotic N fixation in the soil (El- Maghraby and Wassif, 1999).

The treatment, [Gyp. (+) + (Bio N+ Bio P)], gave the highest yields of roots and leaves which reached 15.17 and 5.11 ton/fed., respectively. This may be due to the mutual effect of both Gypsum and bio-fertilizers on enhancing soil properties as well as their role on increasing the availability of certain plant nutrients and consequently sugar beet plants had a good environmental condition to achieve high yields.

Table 1. Effect of gypsum treatment as soil conditioner and bio-fertilization treatments on sugar beet yields.

Treatments		Roots	Leaves	TSS	
		(Ton/ fed)		(%)	(Ton/ fed)
GYP. (-)	Control	7.55	1.56	24.00	1.81
	Bio-N	11.78	2.56	21.67	2.55
	Bio-P	11.39	2.39	23.33	2.66
	Bio (N+P)	12.17	2.94	21.00	2.56
GYP. (+)	Control	10.11	3.22	21.33	2.16
	Bio-N	13.44	4.89	18.33	2.46
	Bio-P	12.82	4.51	19.67	2.52
	Bio (N+P)	15.17	5.11	18.00	2.73
LSD	Bio (N+P)	2.08	0.67	2.35	
at 5%	GYP	1.47	0.94	1.79	
	Bio (N+P) + GYP	ns	ns	ns	

The percent of total soluble solids (TSS) significantly decreased by the application of gypsum or bio-fertilizers (Table 1). The reduction rate averaged at 11.13 % below the control for the gypsum treated plots, while it reached 12.5 % for the (Bio-N + Bio-P) treatment. In contrast, the values of total yield of total soluble solids, [TSS % x total yield of roots (ton/fed), and expressed as TSS in ton/fed] increased by gypsum and/or bio-fertilizer addition. These increases could be attributed to the yield of roots. The interaction effects between gypsum and bio-fertilizer emphasized the role of both treatments on increasing the contents of total soluble solids of sugar beet roots. Such positive effect of both materials may be rendered to their role on increasing the uptake of plant nutrients by plant roots (Table2).

Effect of the experiment treatments on nutrient content and uptake

Data in Table 2 show the nutrients content of sugar beet roots and leaves as affected by the addition of gypsum and/or bio-fertilizers. Apparently, the concentrations of N, P and K of sugar beet (roots and leaves) were remarkably increased in the gypsum treated plots. These increases averaged at 19.18 and 7.53 % for nitrogen, 100 and 23.5 % for P and 5.1 and 40.0 % for K, over the control value for roots and leaves, respectively. The uptake of the macro nutrients followed the same trend of nutrient concentrations. In this respect, Mohammed *et al.* (1993) reached the same conclusion; they added that gypsum increased the nitrogen content of plants. Such response was expected because of reclamation processes operating on sodic conditions and was only significant at 100 % of gypsum requirements (Tisdale *et al.* 1990). Also gypsum application led to increase the micronutrients Mn, Zn and Fe by 9.52, 4.88 and 29.96 % for roots; 270, 7.14 and 105.28 % for leaves for GYP. (+) over control GYP. (-), respectively. Such results agree well with Mohammed *et al.* (1993) as well as Olsen and Watanabe (1979) on tomato plants. Lindsay (1979) reported that the gypsum amendment increased Fe, Zn and Mn content in plants due to the reduction in both soil pH and ESP as a result of the reclaiming action of gypsum which would increase the uptake of these nutrients by sugar beet plants.

Regarding the effect of bio-fertilization, data show that similar trends to those obtained due to gypsum application was observed. The concentration of macro and micro nutrients was increased due to the application of bio-fertilizers. The highest values of increment (% over the control) were associated with [GYP. (-) + (Bio-N + Bio-P)] Over control treatment; it reached 35.62, 164.71, 30.77, 57.14, 19.51 and 149.82 % for N, P, K, Mn, Zn and Fe in roots, respectively. Similar trend was obtained for leaves. Also similar trend was obtained for macro and micro nutrient uptakes in roots and leaves of sugar beet. Such results were in a harmony with those obtained by Ali *et al.* (2002).

Table 2. Effect of gypsum addition as soil conditioner and bio-fertilization treatments on concentrations and uptake of nutrients of sugar beet.

Treatments		Roots						Leaves					
		macro nutrients			micro nutrients			macro nutrients			micro nutrients		
		N	P	K	Mn	Zn	Fe	N	P	K	Mn	Zn	Fe
		Concentration											
		%			ppm			%			ppm		
GYP. (-)	Control	0.73	0.17	0.39	21.00	41.00	277.00	1.46	0.34	1.00	10.00	42.00	322.00
	Bio-N	0.96	0.24	0.49	24.00	45.00	580.00	1.60	0.42	3.30	52.00	54.00	451.00
	Bio-P	0.84	0.29	0.44	27.00	48.00	540.00	1.57	0.47	3.10	47.00	59.00	406.00
	Bio (N+P)	0.99	0.45	0.51	33.00	49.00	692.00	1.71	0.64	3.90	64.00	60.00	621.00
Bio (N+P) over control %		35.62	164.71	30.77	57.14	19.51	149.82	17.12	88.24	290.0	540.0	42.86	92.86
GYP. (+)	Control	0.87	0.34	0.41	23.00	43.00	360.00	1.57	0.42	1.40	37.00	45.00	661.00
	Bio-N	1.01	0.36	0.58	35.00	50.00	681.00	1.64	0.44	1.70	66.00	50.00	848.00
	Bio-P	0.91	0.42	0.53	27.00	47.00	550.00	1.62	0.54	2.10	53.00	54.00	933.00
	Bio (N+P)	1.04	0.55	0.54	37.00	55.00	778.00	1.79	1.13	3.00	66.00	62.00	1268.00
GYP. (-) over control GYP. (+) X %					9.52	4.88	29.96				270.0	7.14	105.28
GYP. (+) + Bio (N+P) over control GYP. (-) X %		42.47						22.60					
Uptake (kg/fed)													
GYP. (-)	Control	55.14	12.84	29.46	0.16	0.31	2.09	22.73	5.29	15.57	0.02	0.07	0.50
	Bio-N	113.09	28.27	57.72	0.28	0.53	6.83	40.91	10.74	84.37	0.13	0.14	1.15
	Bio-P	95.65	33.02	50.10	0.31	0.55	6.15	37.52	11.23	74.09	0.11	0.14	0.97
	Bio (N+P)	120.45	54.75	62.05	0.40	0.60	8.42	50.33	18.84	114.79	0.19	0.18	1.83
GYP. (+)	Control	79.26	30.97	37.35	0.21	0.39	3.28	50.61	13.54	45.13	0.12	0.15	2.13
	Bio-N	135.78	48.40	77.97	0.47	0.67	9.15	80.20	21.52	83.13	0.32	0.24	4.15
	Bio-P	116.66	53.84	67.95	0.35	0.60	7.05	73.06	24.35	94.71	0.24	0.24	4.21
	Bio (N+P)	157.73	83.42	81.90	0.56	0.83	11.80	91.47	57.74	153.30	0.34	0.32	6.48
GYP. (+)+ Bio (N+P) over control GYP. (-) X %		186.05						302.42					

The application of gypsum combined with any type of bio-fertilizers led to increase the macro and micronutrients content. The highest value of increment was associated with the combined treatment of [Gyp. (+) + (Bio-N + Bio-P)]. For example, the rate of increase in total N average at 42.47 and 22.60 % in roots and leaves, respectively due to [GYP.(+) + Bio (N+P) over control GYP.(-) treatment], while it reached in N uptake 186.05 and 302.42 % for roots and leaves, respectively compared to the control. The application of gypsum emphasized the role of bio-fertilizers on increasing the concentration and uptake of nutrients. This may be due to the positive effect of such materials on reducing soil pH values (Table 3).

Effect of experimental treatments on some chemical soil properties

Soil reaction (pH)

Data in Table 3 show the effect of gypsum and bio-fertilization treatments on some chemical soil properties. Obviously, soil pH values were decreased (from 7.92 to 7.54) relative to control in the gypsum treated plots. Mohammed *et al.* (1997) showed that the decline in soil pH by gypsum application was probably due to a combination of more than one factor, as the role of Ca^{++} produced from applied gypsum could be the main factor where it exchange with Na^{+} on soil complexes and forms neutral $SO_4^{=}$ salts.

Also, differential decreases in soil pH values were observed dependent upon the type of bio-fertilizers. The highest reduction (7.52) was associated with (Bio-N + Bio-P) treatment. Such results were in harmony with those reported by El-Maghraby and Wassif (1999) and Hashem (1997).

The application of gypsum supported by any type of bio-fertilizers had the highest effect in reducing soil pH value. The highest reduction in soil pH (7.1) was associated with the combined treatment of [Gyp.(+) + (Bio-N + Bio-P)]. Generally, the efficiency of the used materials on decreasing soil pH values could be arranged in the following order: [Gyp. (+) + (Bio-N + Bio-P)] > (Gyp. (+) + Bio-P) > (Gyp. (+) + Bio-N) > (Gyp. (+) = (Bio-N + Bio- P) > Bio-P > Bio-N > control

EC values, soluble ions and ESP

The EC values and the concentrations of soluble Ca^{++}, Mg^{++}, K^{+} , HCO_3^{-} and $SO_4^{=}$ were increased with different magnitudes in gypsum treated plots (Table 3). However, opposite trend was obtained for both ESP as well as the concentrations of soluble Na^{+} and Cl^{-}, such results agree with those obtained by Mohammed *et al.* (1997) who found that, the concentrations of soluble Ca^{++} and $SO_4^{=}$ increased, while the concentrations of soluble Na^{+} and Cl^{-} as well as ESP and pH values were decreased by application of l00 % of gypsum requirement.

Treating sugar beet seeds with bio-fertilizers was the most relative effective treatment in reducing EC values as well as concentration of soluble cations and anions. Likewise, the EC values as well as concentration of soluble Ca^{++}, Mg^{++}, Na^{+}, HCO_3^{-}, Cl^{-} and $So_4^{=}$ were decreased with any type of bio-fertilizers. The highest reduction in the EC values was associated with (Bio-N + Bio-P) treatment. The favorable effect of bio-fertilizers treatments on decreasing the concentrations of soluble ions could be due to its role on increasing the formation of water stable aggregates. Consequently, more soluble salts will have the chance to the downward movement by the following irrigation, (Hashem and Wassif, 1997).

The interaction between gypsum and bio-fertilizers addition indicated that the EC and ESP values as well as, the concentrations of soluble Na^+ and Cl^- were decreased with gypsum addition at any type of bio-fertilizers. The magnitudes of reduction EC values reached 13.59, 12.99 and 20.68 % for [Gyp. (+) + Bio N], [Gyp. (+) + Bio-P] and [Gyp. (+) + (Bio-N + Bio-P)] treatments, below the control, respectively. The highest reduction associated with mixed treatment [Gyp. (+) + (Bio-N + Bio-P)]. On the other hand, the concentration of soluble Ca^{++}, K^+, HCO_3^- and $So_4^=$ were increased under the same treatments. This means that gypsum amendments is more effective in presence of bio-fertilizers for improving the physical and chemical soil properties and on increasing the infiltration rate, consequently reduce the soil EC and ESP values.

Effect of soil treatments on total N, available P, Mn, Zn and Fe of soil

Data in Table 3 show that the addition of gypsum led to an increase the values of total N and available P as well as the availability of Mn, Zn and Fe. The increase in total N observed due to gypsum application may be attributed to an increase in microbial activity which enhanced mineralization of N (Mohammed *et al.*, 1997) or and due to improving the permeability and aeration of gypsum amended soil and thus counts of nitrifies and aerobic forms proliferated (Taha *et al.*, 1973). On the other hand, the increase of available P may be rendered to immobilization of soluble P through the formation of less soluble Ca-P compounds, in addition to the effect of Ca which lowers the solubility of Ca-P compounds and lowers soil pH (Table 2) which decreases the solubility of P in soils . These results are in a harmony with those of Mohammed *et al.* (1997). However, increased availability of the aforementioned micronutrients by gypsum application was due to the decrease in soil pH (Table 3) as a result of the reaction of applied gypsum to the soil (Lindsay, 1979).

It is clear from the data in Table 3 that, there is an increase in total N, the availability of P, Mn, Zn and Fe under the bio-fertilizers addition. This increase differed with any type of bio-fertilizers from one to another. The highest value of total N associated with Bio-N treatment, while the highest values of available P was obtained with Bio-P treatment. The highest values of Mn, Zn and Fe were associated with the mixed treatment of (Bio-N + Bio-P). Generally, the positive effect of bio-fertilizers on increasing nutrient availability may be referred to higher microbial counts (Table, 4), and consequently release more available nutrients by increasing of microbial activity (Hashem, 1997).

Table 3. Effect of gypsum addition as soil conditioner and bio-fertilization treatments on chemical soil properties.

Treatments		pH	EC (dS/m)	Soluble cations (me/L)				Soluble anions (me/L)				ESP %	Total N (mg/g)	Available nutrients (ppm)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	CL^{-}	$SO_4^{=}$			P (ppm)	Mn	Zn	Fe
GYP. (-)	Control	7.92	11.7	30.10	24.04	87.74	3.54	0.00	2.61	115.25	24.42	19.10	0.18	3.14	9.65	0.62	3.67
	Bio-N	7.79	9.05	20.12	17.96	67.36	4.60	0.00	2.26	86.92	20.86	17.70	0.42	3.61	11.51	0.75	4.00
	Bio-P	7.72	10.16	24.19	22.16	73.14	4.06	0.00	2.55	100.11	23.62	17.46	0.29	6.08	11.50	0.78	3.92
	Bio-N + Bio-P	7.52	8.09	25.83	20.37	50.23	4.13	0.00	1.41	76.36	20.60	12.40	0.37	4.99	11.54	0.80	4.28
GYP. (+)	Control	7.54	11.97	39.97	30.19	71.41	7.16	0.00	4.65	108.59	35.48	14.18	0.22	3.08	11.42	0.35	3.71
	Bio-N	7.31	10.11	32.62	14.53	69.92	8.59	0.00	5.02	87.87	32.78	16.65	0.56	4.80	13.12	1.08	4.62
	Bio-P	7.27	10.18	32.76	22.33	64.13	7.32	0.00	4.62	87.69	34.23	14.36	0.37	10.65	15.99	1.30	4.42
	Bio-N + Bio-P	7.10	9.28	33.80	18.99	51.42	8.64	0.00	4.04	80.13	28.67	11.90	0.43	10.05	14.87	1.67	4.75

The application of gypsum supported by any type of bio-fertilizers resulted also in increasing the availability of soil P, Mn, Zn, Fe and Total N (Table 3). The highest value of increment in the Total N was associated with the [Gyp. (+) +Bio-N] treatment, while it was the [Gyp. (+) + Bio-P] treatment for available micronutrients (Mn, Zn, Fe). This may be due to the positive effect of gypsum and bio-fertilizer treatments on reducing soil pH values as previously mentioned in Table 3.

Effect of soil treatments on microbial activity:

CO_2 evolution.

Data presented in Table 4 show the effect of gypsum and bio-fertilization on Co_2 evolution which could be taken as indication for microbial activity under such conditions. Apparently, Co_2 evolution was increased by the addition of gypsum, compared to the control. The rate of increment reached 18.63 % over the control for the gypsum treated plots. Also, it is clear that bio-fertilizers addition in case of Gyp. (-) enhanced CO_2 production to be increased by 107.84, 100.98 and 183.92 % over the control, due to the addition of bio-fertilizers [Bio-N, Bio-P and (Bio-N + Bio-P), respectively]. Such results were in agreement with those obtained by Hashem (1997). The application of gypsum supported with any type of bio-fertilizers resulted in more CO_2 productions.

Nitrogen fixing bacteria

Data in Table (4) show that the addition of gypsum increased the counts of N-fixing bacteria (measured as *Azotobacter* and *Azospirillum).* The highest count obtained due to gypsum addition increased by 100 and 75 % over control for *Azotobacter* and *Azospirillum,* respectively. Also, *Azotobacter* counts were increased with any type of bio-fertilizers. In case of Gyp. (-) the highest counts were associated with the (Bio-N + Bio-P) treatment, as the rate of increment over the control reached 1225 and 1600 % for *Azotobacter* and *Azospirillum,* respectively.

Generally, the efficiency of bio-fertilizer could be arranged as follows: (Bio-N + Bio-P) > Bio-N > Bio-P for *Azotobacter* and *Azospirillum.* Similar results were found by Abd El Ghany *et al.* (1997) and Hashem (1997).

Table 4. Effect of gypsum addition as soil conditioner and bio-fertilization treatments on biological activity of the studied soil.

Treatments		CO_2	*Azotobacter*	*Azospirillum.*
GYP. (-)	Control	10.2	80	100
	Bio-N	21.2	620	920
	Bio-P	20.5	540	780
	Bio (N+P)	28.96	980	1600
GYP. (+)	Control	12.1	160	175
	Bio-N	28.9	950	1600
	Bio- P	25.6	680	1450
	Bio (N+P)	29.7	1600	1780
Initial counts		8.65	33	42

The application of gypsum with any type of bio-fertilizers had the higher effects in increasing *Azotobacter and Azospirillum* counts among all other treatments. The combined treatment of [Gyp. (+) + (Bio-N + Bio-P)] gave the highest rate of increases over the control (1900 and 1680 %) for *Azotobacter and Azospirillum,* respectively.

CONCLUSION

The application of gypsum as a soil amendment and inoculating sugar beet seeds with non-symbiotic nitrogen fixing bacteria and phosphorous dissolving bacteria could be recommended to:

1) increase the calcareous soil productivity,

2) decrease the values of pH and ESP of soil,

3) increase nutrients availability and uptake and

4) enhance the microbial activity of such soil under irrigation with saline water.

Consequently, sugar beet plants will have a better environmental condition to achieve high yields.

REFERENCES

1. Abd El-Ghany, B. F., M. O. Salem and M. A. F. El-Sibaie. 1997. Effect of bacterial inoculation, P and organic fertilization on microbiological properties, growth and production of *fenugreek* plant under saline calcareous soil conditions. Desert Inst. Bull., Egypt. 47(1): 1 - 13
2. Abd El-Malek, Y. and Y. Z. Ishac. 1968. Evaluation of methods used in counting Azotobacter. J. Appl. Bacterial., 31: 26 - 28.
3. Abrol, I. P. and D. K. Bhumbla. 1979. Crop responses to differential gypsum applications in a highly sodic soil and the tolerance of several crops to exchangeable sodium under field conditions. Soil Sci. 127: 79 - 85.
4. Ali, M. H., F. A. Hashem and M. M. Wassif. 2002. Effect of polyvinyl acetate and bio-fertilizers on soil properties and the productivity of sugar beet under saline irrigation water. Desert Inst. Bull., 52 (1)
5. A. O. A C. 1965. "Official Methods of Analysis." 12th ed. Association of Official Agriculture Chemists. Washington, D. C. C. 2004.
6. Chapman, H. D. and P. F. Pratt. 1961. Methods of analysis for soils, plants and water. California Univ., Div. Agric. Sci., California, U.S.A., pp. 150 - 152.
7. Dobereiner, J. 1978. Influence of environmental on the occurrence of *spirillum lipferum* in soil and roots. Ecol. Bull., (Stockholm) 26: 343 - 352.

8. El-Maghraby, S. E. and M. M. Wassif. 1999. Mutual effect of mulching materials and bio-fertilization on the properties and productivity of calcareous soil. Desert Inst. Bull. 49 (2): 567 - 484.

9. Hashem, F. A. and M. M. Wassif. 1997. Effect of the interaction between elemental sulphur and bio-fertilizer applications on forage production of calcareous soils. Desert Inst. Bull., 47 (2): 303 - 322.

10. Hashem, F. A. 1997. The efficiency of combined application of soil conditioners and biofertilization on properties and productivity of newly reclaimed soil. Desert Inst. Bull. 47 (1): 149 - 167.

11. Lindsay, W. L. 1979. Chemical Equilibira in soil. John Wiley & Sons. New York.

12. Mohammed, S. S., A. A. Abou-Hussein and A. S. Ahmed. 1993. Gypsum as an amendment against soil alkalinization in relation on tomato plants. I- Effects on growth and chemical composition. Egypt. J. App. Sci. 8(1): 73 - 84.

13. Mohammed, S. S., M. A. Negm and M. G. Rehan. 1997. Gypsum amendment against alkalinity in relation to tomato plants. II. Changes in agro-chemical properties and nutrient availability of the soil. Egypt. J. Soil. Sci., 37 (1): 93 - 109.

14. Page, A. L., R. H. Miller and D. R. Keeney. 1982. "Methods of soil analysis". Part 2, Soc. of Agron, Madison., Wis., USDA.

15. Shehata, S. M. 1972. Evaluation of some biological tests as parameters for microbial activities related to soil fertility. Ph. D. Thesis, Fac. Agric., Cairo Univ., Egypt.

16. Snedecor, G. W. and W. G. Cochran. 1967. "Statistical Methods" 6th ed. Iowa State Univ. Press, Amr., Iowa, U.S.A.

17. Taha, S. M., Y. Z. Ishac and S. H. H. Ahmed. 1973. Reclamation of alkali calcareous soils in Egypt. II- The application of gypsum and compost. Egypt. J. Microbiol., 8: 57 - 68.

18. Tisdale, S. L., W. L. Nelson and I. D. Beaton. 1990. "Soil fertility and fertilizers". 4th ed. Macmillan Pub. Co., New York.

تأثير الجبس كمصلح للتربة والتسميد الحيوى على إنتاجية بنجر السكر تحت الرى بمياه مالحة

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أقيمت تجربة حقلية خلال الموسم الشتوى ٢٠٠١ – ٢٠٠٢ بهدف تقييم إضافة الجبس (بدون إضافة، ١٠٠% من الاحتياجات الجبسية للتربة) مع معاملة البذور بالتسميد الحيوى النتروجينى والفوسفاتى سواء منفردا أو خليط لتوضيح أثر ذلك على إنتاجية بنجر السكر تحت ظروف الاراضى الجيرية المروية بمياه ملحية فى أراضى رأس سدر.

وقد أشارت النتائج إلى حدوث زيادة معنوية فى إنتاجية بنجر السكر سواء للجذور أو الأوراق نتيجة لإضافة الجبس مع التسميد الحيوى بينما قلت نسبة المواد الصلبة الكلية معنويا. وقد ادى ذلك إلى زيادة العناصر الكبرى (النيتروجين والفسفور والبوتاسيوم) والصغرى (الحديد والمنجنيز والزنك) فى الجذور والأوراق وكانت أفضل المعاملات التى سجلت أعلى زيادة فى امتصاص كل من العناصر الغذائية الصغرى والكبرى تلك المعاملة المختلطة بين الجبس والتسميد الحيوى النتروجينى والفوسفاتى.

وجد ان إضافة الجبس كان له أثرا فعالا فى خفض قيم pH التربة و تركيز الصوديوم والكلوريد بينما أدت إلى زيادة قيم كل من ال ESP, EC وتركيز الكالسيوم والمغنسيوم والبوتاسيوم والبيكربونات والكبريتات فى التربة.

أكد التفاعل بين معاملة الجبس ومعاملات التسميد الحيوى إلى زيادة فاعلية الجبس فى وجود التسميد الحيوى فى تحسين خواص التربة الكيمائية حيث أدى إلى زيادة خفض قيم ال ESP, EC, pH للتربة، و أدى أيضا إضافة الجبس والتسميد الحيوى إلى زيادة قيم النتروجين الكلى وكذلك الفوسفور والمنجنيز والحديد والزنك الميسر. كما أدت المعاملة المختلطة للتسميد الحيوى إلى تحسين النشاط الميكروبى بالتربة متمثلا فى زيادة أعداد بكتريا الأزوتوبكتر والأزوسبرليم.