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EFFECT OF POLYVINYL ACETATE AND BIOFERTILIZERS ON THE PRODUCTIVITY OF SUGAR BEET AND SOIL PROPERTIES UNDER SALINE IRRIGATION WATER

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A field study was done at Ras Sudr Experimental Station of the Desert Research Center during 1998-1999 winter season to evaluate the effect of polyvinyl acetate synthetic soil conditioner and /or biofertilizers on the properties of calcareous soil as well as yield and mineral contents of sugar beet plants irrigated by saline water. The treatments include polyvinyl acetate (PVAc) as synthetic soil conditioner at three rates; *i.e*, 0.2, 0.4 and 0.6 L/m^2 and biofertilizers; either in the individual form of phosphate dissolving bacteria (Bio_1) or in a mixture form of both PDB and nitrogen fixing bacteria (Bio_2). The rates of (PVAc) were equivalent to 840, 1680 and 2520 L/fed.

Results indicated that the yields of roots and leaves of sugar beet plants were significantly increased when soil was treated either with PVAc individually or in combination with biofertilizers. The combination between $PVAc_2$ and Bio_2 resulted in greater values of sugar beet yield than those obtained when each applied individually. Also, the N,P,K, Fe, Mn and Zn contents of both roots and leaves were remarkably increased with different magnitudes by the application of either soil conditioners and/ or biofertilizers. The highest uptake and concentration of such nutrients were associated in most cases with ($PVAc_2$ +Bio_2) treatment.

The application of biofertilizers emphasized the role of PVAc on reducing soil pH and soil salinity while it increased the availability of N, P, Fe, Mn and Zn as well as increased the counts of *Azotobacter* sp., *Azospirillium* sp., phosphate dissolving bacteria and microbial activity.

Keywords: calcareous soil, polyvinyl acetate, biofertilization, sugar beet plants, nutrient availability, total soluble solids, microbial activity.

It is well known that calcareous soil have low nutrients particularly micronutrients and inferior soil/ water relations and high content of calcium carbonate that results in high soil pH. The reclamation of such soils require the addition of soil conditioners such as synthetic soil conditioners including long chain hydrocarbon derivatives such as Polyacryl amide, polyvinyl acetate, hydrogel and petroleum by-products (Abd El Fattah *et al.*, 1990; Hashem, 1997; Wassif *et al.* 1997; El Maghraby and Wassif,1999 and El Maghraby,2000). Such materials may have a role in raising the buffering capacity of the soils and lead to increase the productivity (Balogh, 1970). Also, biofertilization is considered the most important factor in reducing the required chemical fertilizers, improving soil fertility and increasing soil productivity (Abd El-Ghany *et al.*, 1997 and El Kholy, 1998). However, the use of such materials is more efficient on the use of good quality water. Information on the efficiency of such materials with the use of saline irrigation water is still limited.

Therefore, the aim of present work is to study the effect of individual or combined application of polyvinyl acetate as soil conditioner and /or biofertilizers on the properties of calcareous soil and the productivity of sugar beet grown under saline irrigation water.

MATERIALS AND METHODS

A field experiment was carried out during 1998-1999 winter season in the Agriculture Experimental Station of the Desert Research Center at Ras Sudr, South Sinai. The experimental soil is highly calcareous (54.3 % $CaCO_3$) and loamy sand in texture with high salt content. The physical and chemical properties of the experimental site (0-30cm) are given in table (1a). The experiment was conducted in a complete randomized block design and consisted of 12 treatments and each treatment was replicated four times. The treatments were :

1- Non treated soil (control).
2- Seed inoculation with phosphate dissolving bacteria (Bio_1).
3- Seed inoculation with phosphate dissolving bacteria and nitrogen fixing bacteria (Bio_2).
4- Polyvinyl acetate at rate of 0.2 L /m^2 $PVAc_1$.
5- Polyvinyl acetate at rate of 0.4 L /m^2 $PVAc_2$
6- Polyvinyl acetate at rate of 0.6 L /m^2 $PVAc_3$
7- $PVAc_1 + Bio_1$.
8- $PVAc_2 + Bio_1$.
9- $PVAc_3 + Bio_1$.
10- $PVAc_1 + Bio_2$.
11- $PVAc_2 + Bio_2$.
12- $PVAc_3 + Bio_2$.

Sugar beet seeds (*Beta Vulgaris L.)* were sown in 15th November 1998 in rows 30 cm apart and 20 cm between plants. Before sowing the seeds of the biofertilizer treatments were mixed with a paste of biofertilizers culture using Arabic gum (20%) as adhesive agent. After a day of sowing and irrigation, polyvinyl acetate was sprayed on the soil surface as a film for their plots. Irrigation was carried out every 10 days using the saline well water (8332ppm). Table (1b) depict some of the chemical analysis of well water used in irrigation.

All treatments received the basal rates of N, P and K fertilizers as follows:

- 30 Kg P_2O_5 / fed. as super phosphate (15.5%) applied during soil preparation.
- 70 Kg N/fed. as NH_4NO_3 (33.5%) at two equal doses applied at one and three months from planting.
- 48 Kg K_2O/fed. as K_2SO_4 (48%) at two equal doses applied at the same time with nitrogen.

Plants were harvested at maturity in15 th June 1999 and the total yield of roots and leaves of every treatment were recorded and statistically analyzed. (Snedecor and Cochran, 1967). The concentration of total soluble solid (TSS) in roots was determined according to (A.O.A.C, 1965). Also, N, P, K, Fe, Mn and Zn contents of sugar beet roots and leaves were determined (Chapman and Pratt, 1961 and Cottenie, 1980).

After harvesting, soil samples from the experimental plots (0-30cm) were collected for the determination of EC, pH, soluble ions of soil paste extract, total nitrogen and available P, DTPA-Fe, Mn and Zn using the methods described by Page *et al.* (1982). Also, Rizosphere soil sample taken after one, two months and after harvesting for the determination of the biological activities that included CO_2 evolution (Shehata, 1972), *Azotobacter* sp. and *Azospirillium* sp. by nitrogen deficient medium according to Dobereiner (1978), and phosphate dissolving bacteria (PDB) using methods described by Mahmoud (1988).

RESULTS AND DISCUSSION

Sugar Beet Yields

The yield of sugar beet roots and leaves as affected by PVAc and /or biofertilization are given in table (2). Obviously, the individual application of PVAc resulted in a significant increase in both sugar beet roots and leaves. The rate of increase is depended on the rate of applied PVAc. The highest rate of increment was associated with the $PVAc_2$ treatment, as it reached 46.85% for roots and 93.33 % for leaves over the control. Similar trend was obtained for the application of biofertilizers, as the yields of both roots and leaves were significantly increased. The highest rate of increment in roots and leaves amounted to 43.36 % and 77.33 % due to Bio_2 treatment.

TABLE (1a). Physical and chemical properties of the experimental site at Ras Sudr.

Particle size distribution (%)			Textural class	$CaCO_3$ (%)	O.M. (%)	ESP
Sand	Silt	Clay				
74.47	10.90	14.63	Sandy Loam	54.30	0.60	13.18

pH (soil paste)	EC (dS/m)	Soluble cations (meq/L)				Soluble anions (meq/L)				Total N (ppm)	Available nutrients (ppm)				
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		K	P	Fe	Mn	Zn
7.28	16.36	55.40	32.98	75.83	0.54	n.d.	8.00	114	42.75	392	29.5	1.4	3.2	2.7	0.5

TABLE (1b). Chemical composition of the used saline well water during the growing season.

pH	EC (dS/m)	Soluble cations (meq/L)				Soluble anions (meq/L)				SAR	Micronutrients (ppm)		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$		Fe	Mn	Zn
7.98	13.02	25.8	27.66	79.86	0.42	n.d.	3.4	93.1	37.24	15.45	0.17	0.1	0.02

n.d. = not detected

The favorable effect of PVAc and biofirtilizers on increasing sugar beet yield may be rendered to their effect on enhancing some physical and chemical properties of soil. Such effects were reducing soil pH, EC values and increasing the availability of certain plant nutrients (Table 4). These results were in agreement with those reported by Wassif *et al.* (1997), Hashem (1997) and El Maghraby (2000).

The above mentioned results were confirmed by the combined application of the imposed treatments as the yield of both roots and leaves were significantly increased due to the combined application of any rate of PVAc and any type of biofertilizers. Generally, the efficiency of the imposed treatment on increasing sugar beet yields could be arranged in the following order: $PVAc_2$ + Bio_2 > $PVAc_1$+ Bio_2 > $PVAc_3$+ Bio_2 > $PVAc_2$ + Bio_1> $PVAc_2$ >$PVAc_3$ + Bio_1> Bio_2 > $PVAc_3$ > $PVAc_1$+Bio_1 > Bio_1 > $PVAc_1$ > control.

Total Soluble Solids (TSS)

Data in table (2) show that the percentages of TSS in sugar beet roots were greatly affected by the application rate of PVAc soil conditioner and / or the type of biofertilization. In the control treatment, the percentages of TSS were so much higher as compared to the other treatments. This fact may be due to the relatively low yields and higher soil EC values of the control treatment which makes sugar plants grown under relatively high salt stress consequently the concentration of TSS were increased. On the other hand, the percentages of TSS were decreased by 7.07%, 13.78% and 7.77% relative to the control treatment due to $PVAc_1$ and $PVAc_2$ and $PVAc_3$ respectively, while the respective decrement referring to Bio_1 and Bio_2 amounted to 21.20% and 20.49% respectively. This may be due to the dilution effect resulted from increasing the yield of sugar beet roots as a result of applying PVAc and biofertilization. However, calculating the total contents of TSS (TSS percent x Total root yield ton /fed.) could be emphasize the role of such materials on increasing TSS of sugar beet roots. The positive effect of PVAc and / or biofertilizers on increasing the total contents of TSS may be due to their role on increasing the uptake of certain plant nutrients by plant roots (Table3). Also, due to the role of such materials on increasing plant growth. Such results were confirmed by the combined action between PVAc and biofertilizers as the highest total contents of TSS were associated with the combined treatment of $PVAc_2$ + Bio_2. Such results were stood in agreement with those reported by Hashem (1997).

The Mineral Content of Sugar Beet Plants

Data presented in table (3) and figs (1and2) show the effect of adding PVAc and / or biofertilization in the N, P, K, Fe, Mn and Zn contents of sugar beet roots and leaves. The increase in the concentration of N in sugar beet roots due to the application of PVAc reached 45.45%, 49.09% and 47.27% with $PVAc_1$, $PVAc_2$ and $PVAc_3$ relative to the control treatment, respectively. While the respective increment in the sugar beet leaves reached

31.96%, 34.02% and 38.14%. Also, the increment in such property due to biofertilization amounted 38.18% and 70.91% in roots and 61.86% and 64.95% with Bio_1 and Bio_2 treatments relative to the control, respectively. Similar trends were obtained in the case of P, K, Fe, Mn and Zn contents in both roots and leaves of sugar beet plants. The application of PVAc supported to biofertilization emphasized the role of biofertilization on increasing the concentrations of N, P, K, Fe, Mn and Zn. This may be due to that the PVAc treatment increased the soil moisture content of the soil (Abd El-Ghany, 1996) and enhancing the formation of water stable aggregates (Tayel and Anter, 1978 and Hashem, 1997). This creates a good medium for the soil microorganisms and / or the applied biofertilizers to the decay of soil organic matter. Consequently the availability of certain plant nutrients increase. This will reflect in increasing the concentrations of N, P, K, Fe, Mn and Zn due to the combinations between the studied treatments. Generally, the highest values in the concentrations of such nutrients were associated in most cases with the combined treatment of $PVAc_3 + Bio_2$.

TABLE (2). Effect of polyvinyl acetate (PVAc) and biofertilizers application on yield and total soluble solids (TSS) of sugar beet.

Treatments	Roots	Leaves	TSS (%)	TSS Ton/fed.
	Ton/fed.			
Control	8.58	1.50	28.30	2.43
$PVAc_1$	11.60	2.60	26.30	3.05
$PVAc_2$	12.60	2.90	24.40	3.07
$PVAc_3$	11.90	2.80	26.10	3.11
Bio_1	11.60	2.58	22.30	2.59
Bio_2	12.30	2.66	22.50	2.77
$PVAc_1+Bio_1$	11.70	3.00	20.90	2.45
$PVAc_2+Bio_1$	13.50	3.20	22.00	2.97
$PVAc_3+Bio_1$	12.40	2.95	26.70	3.31
$PVAc_1+Bio_2$	13.80	2.23	21.30	2.94
$PVAc_2+Bio_2$	14.20	3.33	23.60	3.35
$PVAc_3+Bio_2$	13.60	2.95	24.00	3.26

Factor	Statistical analysis	
	LSD at 5% level	
	Roots	Leaves
PVAc	1.18	0.55
Bio	0.97	0.64
PVAc x Bio	1.37	0.45

TABLE (3). Effect of polyvinyl acetate (PVAc) and biofertilizers on mineral content of sugar beet plants.

Treatments	N	P	K	Fe	Mn	Zn	N	P	K	Fe	Mn	Zn
	(%)			(ppm)			uptake (Kg/fed.)					
Roots												
Control	0.55	0.14	0.40	82.00	18.00	51.00	47.19	12.01	34.32	0.70	0.15	0.44
PVAc1	0.80	0.26	0.53	288.00	34.00	94.00	89.60	29.12	59.36	3.23	0.38	1.09
PVAc2	0.82	0.26	0.58	158.00	27.00	57.00	103.32	32.76	73.08	1.99	0.34	0.72
PVAc3	0.81	0.27	0.60	303.00	28.00	80.00	96.39	32.13	71.40	3.61	0.33	0.95
Bio1	0.76	0.20	0.54	186.00	26.00	69.00	88.16	23.20	62.64	2.16	0.30	0.80
Bio2	0.94	0.24	0.55	207.00	21.00	68.00	115.62	29.52	67.65	2.55	0.26	0.84
PVAc1+Bio1	0.87	0.26	0.79	154.00	20.00	66.00	101.79	30.42	92.43	1.80	0.23	0.77
PVAc2+Bio1	0.62	0.27	1.20	158.00	26.00	58.00	83.70	36.45	162.00	2.13	0.35	0.78
PVAc3+Bio1	0.59	0.36	0.65	146.00	15.00	43.00	73.16	44.64	80.60	1.81	0.19	0.53
PVAc1+Bio2	0.87	0.34	0.63	350.00	25.00	87.00	120.06	46.92	86.94	4.83	0.35	1.20
PVAc2+Bio2	0.92	0.28	0.88	219.00	21.00	60.00	130.64	39.76	124.96	3.11	0.30	0.85
PVAc3+Bio2	1.10	0.36	1.00	196.00	26.00	64.00	149.60	48.96	136.00	2.67	0.35	0.87
Leaves												
Control	0.97	0.17	2.60	613.00	40.00	85.00	14.55	2.55	39.00	0.92	0.06	0.13
PVAc1	1.28	0.18	3.10	562.00	33.00	98.00	33.28	4.68	80.60	1.46	0.09	0.25
PVAc2	1.30	0.31	4.30	1592.00	59.00	161.00	37.70	8.99	124.70	4.62	0.17	0.47
PVAc3	1.34	0.56	3.90	418.00	40.00	66.00	37.52	15.68	109.20	1.17	0.11	0.18
Bio1	1.57	0.26	3.30	533.00	39.00	73.00	40.51	6.71	85.14	1.38	0.10	0.19
Bio2	1.60	0.35	3.60	2116.00	57.00	154.00	42.56	9.31	95.76	5.63	0.15	0.41
PVAc1+Bio1	1.50	0.30	3.40	589.00	34.00	96.00	45.00	9.00	102.00	1.77	0.10	0.29
PVAc2+Bio1	1.55	0.37	3.90	605.00	36.00	72.00	49.60	11.84	124.80	1.94	0.12	0.23
PVAc3+Bio1	1.62	0.45	3.90	757.00	45.00	84.00	47.79	13.28	115.05	2.23	0.13	0.25
PVAc1+Bio2	1.00	0.30	3.75	955.00	44.00	119.00	22.30	6.69	83.63	2.13	0.10	0.27
PVAc2+Bio2	1.27	0.44	4.35	1294.00	50.00	84.00	42.29	14.65	144.86	4.31	0.17	0.28
PVAc3+Bio2	1.46	0.20	4.10	1351.00	70.00	107.00	43.07	5.90	120.95	3.99	0.21	0.32

For the sake of clarity, the uptake of such nutrients were calculated (concentration of nutrient x yield of sugar beet) and the data are given in table (3). The result indicates the beneficial use of the PVAc and/or biofertilizer on increasing the uptake of macro and micronutrients by sugar beet plants. The favorable effect of PVAc and / or biofertilizers on increasing the uptake of such nutrients may be refer to their role on decreasing the soil EC and soil pH values and increasing the availability of certain plant nutrients as was found in this study (Table 4). Sugar beet plants appeared to have a better environmental condition with low salt stress to achieve high growth yields. Consequently the uptake of the studied nutrients increased in both roots and leaves of sugar beet plants.

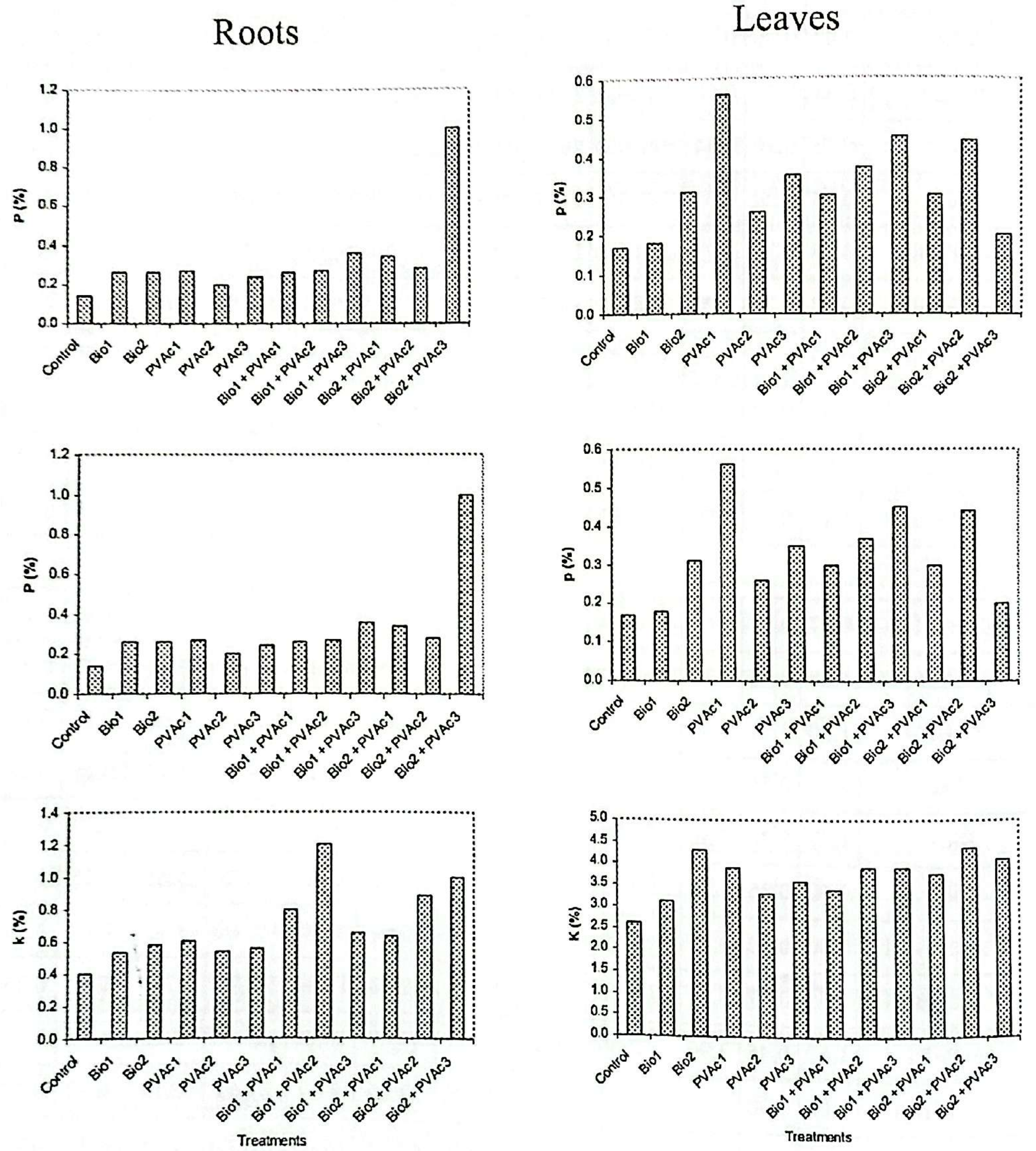

Fig. (1). Effect of polyvinyl acetate (PVAc) and biofertilizers on macronutrients concentration in sugar beet.

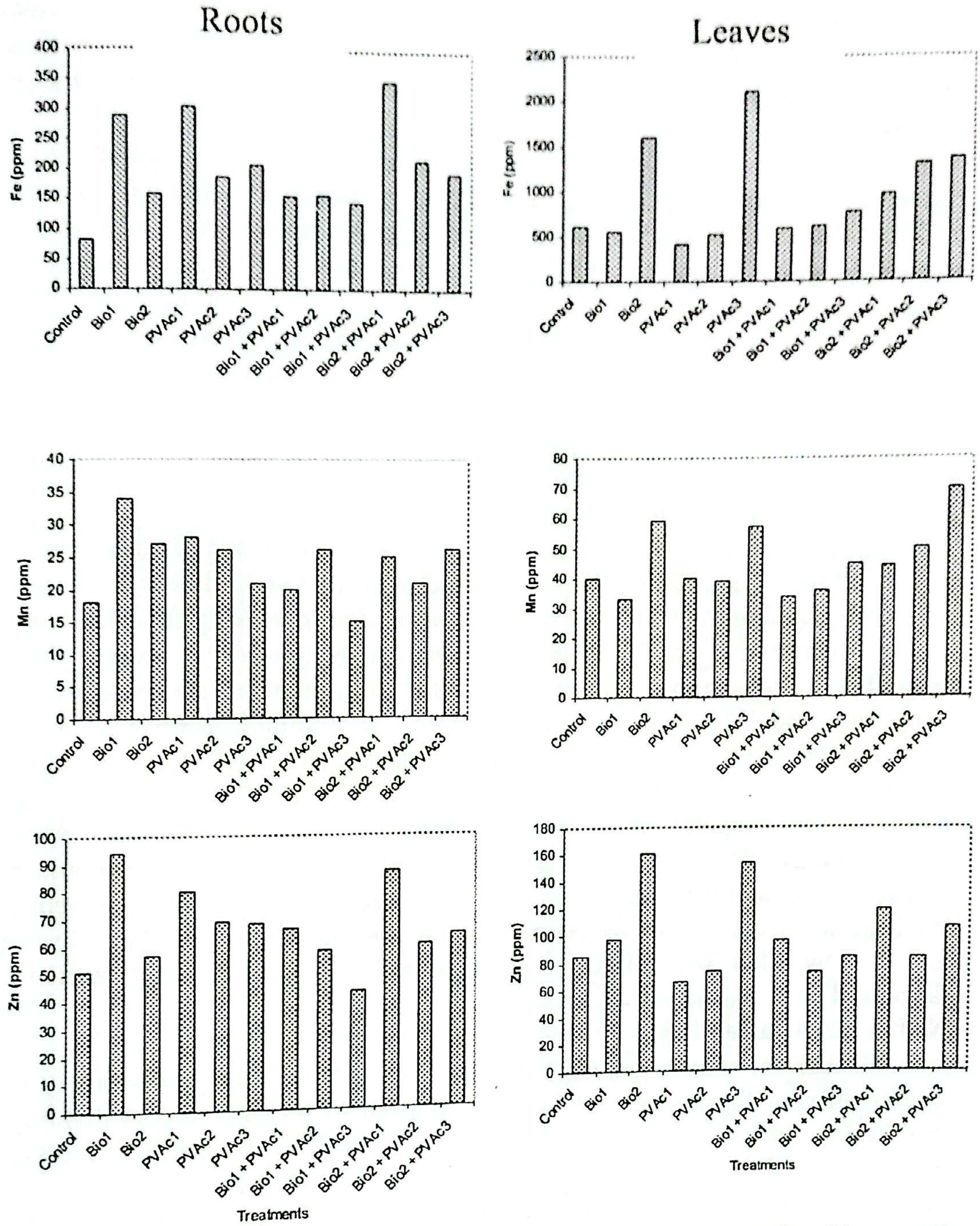

Fig. (2). Effect of polyvinyl acetate (PVAc) and biofertilizers on micronutrients concentration in sugar beet.

Soil Chemical Properties

Data in table (4) clearly appear that the soil pH and EC values were remarkably decreased affecting by soil conditioners and / or biofertilizers. With respect to polyvinyl acetate, data show that, the EC values were decreased below the control in the soil samples taken after harvesting by 44.42%, 63.55% and 66.65% due to $PVAc_1$, $PVAc_2$ and $PVAc_3$, respectively. This may be due to increasing the ability of calcareous soil to hold water against evaporation.

Consequently, more soluble salts will have the chance to the downward movement by the frequent irrigation. Such results were stood in agreement with the findings of Wassif *et al.* (1997), Hashem (1997) and El-Maghraby *et al.* (2000).

Regarding the effect of biofertilizers, data show very similar trends to those obtained with PVAc. As the respective decrement, EC values reached 51.27% and 61.43 % due to Bio_1 and Bio_2, respectively. Such results were in a harmony with Hashem (1997).The application of PVAc supported to biofertilizers greatly affected soil salinity. As, the EC values were sharply decreased with increasing the rate of PVAc application at any type of the used biofertilization. The combined treatment of Bio_2+$PVAc_2$ gained the highest EC reduction. Generally, the efficiency of the used materials on decreasing soil EC values could be arranged in the following order: $PVAc_2$+Bio_2 > $PAVc_3$+Bio_2 > $PVAc_3$+Bio_2 > $PVAc_3$+Bio_2 > Bio_2 > $PAVc_2$ +Bio_2 > $PVAc_3$+Bio_1 > $PVAc_1$+ Bio_1 > Bio_1 > $PVAc_1$ > $PVAc_1$ > control.

On the other hand, the decrement in the concentrations of the soluble ions of Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^-,HCO^-_3 and $SO^=_4$ in the conditioning plots may be refer to increasing the solubility of such ions due to increasing the ability of soil to hold water due to PVAc applications. Also, improving some physical properties of calcareous soil as water stable aggregates and structure (El-Maghraby and Wassif, 1999). Accordingly, more soluble salts will have the chance to be moved deeply to the lower soil depths with the following irrigation. The application of biofertilizers emphasized the role of PVAc soil conditioner in reducing the concentrations of such ions, such findings indicates that the application of PVAc with any type of biofertilizers specially Bio_2 could be a good management practices for improving calcareous soil properties as reducing the hazard effects created by Na and Cl ions; reducing soil salinity and soil pH values. The latter will reflect on the availability of certain plant nutrients as discussed later.

Nutrients Availability

Table (4) shows that the applications of PVAc either individually or in combination with any type of biofertilizers led to increase the availability of N,P,Fe,Mn and Zn. For example the rate of increase in total N average at 13.78%, 24.22% and 26.67% due to $PVAc_1$ $PVAc_2$ and $PVAc_3$ respectively. Also, the respective increments due to Bio_1 and Bio_2 reached to 25.56% and 73.32 %. The highest rate of increment was associated with the combined treatment of ($PVAc_2$ and Bio_2). The positive effect of the experimental treatments on increasing total N in soil could be refer to the higher root mass from the previous crops or improving the capacity of the soil to retain the applied chemical fertilizers and /or fixed nitrogen as in the case of PVAc and biofertilizers (Abd El-Ghany, 1996 and Hashem, 1997). The application of PVAc supported by any type of biofertilizers resulted also, in increasing the availability of soil P,Fe,Mn and Zn (Table 4). The highest rate of increment in the availability of such nutrients was associated with the combined treatment of ($PVAc_2$ and Bio_2). This may be due to the positive effect of such materials on reducing soil pH values as previously mentioned (Table 4).

TABLE (4). Soil chemical properties as affected by the experimental treatments.

Treatments	pH (soil paste)	EC dS/m (soil paste)	Soluble cations (meq/L)				Soluble anions (meq/L)				Total N (ppm)	Available nutrients (ppm)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	CL^{-}	$SO_4^{=}$		P	Fe	Mn	Zn
Control	7.84	25.10	8.66	5.90	236.16	0.30	-	2.64	242.46	5.92	450	3.5	3.0	1.2	0.4
$PVAc_1$	7.60	13.95	5.78	2.93	130.53	0.23	-	0.79	104.94	33.73	512	4.3	1.6	2.2	0.3
$PVAc_2$	7.62	9.15	3.99	2.22	85.12	0.21	-	0.93	68.31	22.29	559	5.5	2.5	2.0	0.4
$PVAc_3$	7.50	8.37	3.47	1.56	78.52	0.19	-	0.53	62.97	20.24	570	7.6	3.2	2.6	0.7
Bio_1	7.74	12.23	9.49	9.03	103.51	0.27	-	2.47	104.01	15.82	565	3.8	5.2	2.9	1.5
Bio_2	7.72	9.68	3.44	3.72	89.39	0.26	-	1.32	80.85	14.63	780	4.2	6.3	3.5	1.7
$PVAc_1+Bio_1$	7.70	11.34	5.91	1.60	105.56	0.37	-	1.96	84.00	27.47	545	5.0	4.5	3.0	1.2
$PVAc_2+Bio_1$	7.66	10.11	3.03	3.58	94.30	0.16	-	1.38	71.31	28.37	555	5.7	4.7	3.2	1.2
$PVAc_3+Bio_1$	7.62	11.06	3.69	5.72	100.98	0.24	-	0.83	94.86	14.94	570	8.1	4.6	3.3	1.5
$PVAc_1+Bio_2$	7.60	7.99	4.68	1.83	73.28	0.13	-	1.06	51.78	27.07	810	6.6	5.1	3.0	1.3
$PVAc_2+Bio_2$	7.40	7.38	2.89	1.74	69.07	0.16	-	0.55	49.52	23.79	903	7.9	6.7	4.4	1.8
$PVAc_3+Bio_2$	7.55	7.44	2.35	1.19	70.73	0.25	-	0.58	70.30	3.65	898	7.5	6.5	4.3	1.5

Nitrogen Fixing Bacteria

Data in table (5) indicate that the application of PVAc soil conditioner greatly increased the counts of N_2-fixing bacteria *Azotobacter* and *Asospirillum*. The rate of increase was depended up on the rate of PVAc application. For example, $PVAc_1$, $PVAc_2$ and $PVAc_3$ resulted in 1067%, 1233% and 983% increase over the control in *Azotobacter* counts after one month of application while the respective increment reached 692%, 817% and 650% after two months from application. However, it was 1344%, 1567% and 1233% in soil samples taken after harvesting sugar beet plants. On the other hand, a treating sugar beet seeds by biofertilizers resulted in increasing the *Azotobacter* counts by 1400 %and 1900 % due to Bio_1 and Bio_2 after one month from cultivation; and 942% and 1150 % after two months from cultivation; and 1900% and 2511% after harvesting sugar beet plants. The application of PVAc supported by biofertilizers affected favorably the *Azotobacter* counts as the highest counts (940 x 10^5 cfu/g dry soil) was associated with the combined treatment of ($PVAc_2$ +Bio_2) after harvesting. Such result was in agreement with those found by Hashem (1997) and El-Maghraby *et al.* (2000) who found that treating calcareous soil with 0.4 L/m^2 PVAc emphasized the role of (N+P) biofertilization on increasing the total count of N-fixing bacteria. Similar trends were also obtained in the *Azospirillium* counts due to the individuals and / or the combined treatments of PVAc and biofertilizers. The highest counts in such property (770 x 10^5 cfu/g dry soil) was attained with ($PVAc_2$ +Bio_2) after harvesting sugar beet plants. The favorable effect of PVAc on increasing the bacterial counts could be due to its influence on increasing the ability of the soil to hold water against evaporation, along with enhancing the management and distribution of water and air which means a better environmental conditions for increasing such microbial counts (Hashem and Wassif, 1997).

Phosphate Dissolving Bacteria (P.D.B.)

Data in table (5) show similar trends to those obtained for *Azotobacter* and *Azospirillium* either due to the rate of applied PVAc soil conditioner and / or type of biofertilization except that the highest counts obtained for phosphate dissolving bacterium were recorded in the soil samples obtained after two months from cultivation. For example, the individual treatments of $PVAc_1$, $PVAc_2$ and $PVAc_3$ increased the P.D.B. by 215%, 180% and 195 % over the control after one month of application while the respective increments reached 65%, 46% and 50 % after two months from application. However, it was 100%, 77% and 71 % in soil samples taken after harvesting sugar beet plants. On the other hand, the respective increment due to treating sugar beet seeds by the individual applications of biofertilizers Bio_1 and Bio_2 resulted in increasing the P.D.B. by 163% and 186 %, respectively after harvesting. Such results were confirmed by the combined applications of biofertilizers and PVAc soil conditioner as the combined application of

$PVAc_2$ plus Bio_2 resulted in greater counts of P.D.B. than those obtained when each applied singly. Generally the efficiency of the experimental treatments could be arranged in the following order: $PVAc_2$+Bio_2 > $PVAc_1$+Bio_2 > $PVAc_3$+Bio_2 > $PVAc_2$+Bio_1 > $PVAc_3$+Bio_1 > $PVAc_1$+Bio_1 > Bio_2 > Bio_1 > $PVAc_1$ >$PVAc_2$ > $PVAc_3$ > control after harvesting sugar beet plants.

TABLE (5). Effect of polyvinyl acetate (PVAc) and biofertilizers on microbiological activity in soil.

Treatments	After one month			After two months			After harvesting		
	Control	Bio_1	Bio_2	Control	Bio_1	Bio_2	Control	Bio_1	Bio_2
	1- *Azotobacter* counts (*10^5 cfu/g dry soil) (initial 3*10^5)								
Control	12	180	240	24	250	300	18	360	470
$PVAc_1$	140	270	450	190	440	560	260	630	720
$PVAc_2$	160	320	520	220	450	720	300	650	940
$PVAc_3$	130	250	280	180	400	400	240	560	650
	2- *Azospirillum* counts (*10^5 cfu/g dry soil) (initial 20*10^5)								
Control	80	170	200	68	210	260	76	270	310
$PVAc_1$	140	280	380	180	370	570	240	520	700
$PVAc_2$	160	340	450	200	480	560	250	570	770
$PVAc_3$	120	260	340	170	300	460	210	410	560
	3- Phosphate dissolving counts (*10^4 cfu/g dry soil) (initial *10^4)								
Control	20	80	107	48	100	120	35	92	100
$PVAc_1$	63	96	115	79	116	155	70	105	140
$PVAc_2$	56	100	124	70	135	152	62	120	148
$PVAc_3$	59	98	118	72	120	148	60	110	126
	4- CO_2 evolution (mg/100g soil /24 hr) (initial 2)								
Control	3.3	9.2	9.9	4.5	13.6	14.0	5.9	19.2	21.0
$PVAc_1$	8.1	11.4	15.9	10.1	14.0	19.6	14.2	24.0	31.8
$PVAc_2$	8.5	12.5	17.0	12.2	18.7	21.2	16.4	28.2	36.0
$PVAc_3$	8.4	12.2	13.5	12.1	18.1	20.0	16.0	27.1	33.0

CO_2 Evolution

CO_2 evolution is a universal index used as a criterion for microbial activity, as the carbon mineralization pattern based on the values of CO_2 evolved from the soils amended with soil conditioners in combination with biofertilizers (El Maghraby and Wassif, 1999). It is evident from table (5) that all of the experimental treatments enhanced CO_2 production. However, the amounting CO_2 yield found in the soil samples taken after harvesting sugar beet plants were higher than those found in the other two soil samples. This means that the CO_2 evolved from the conditioning soil increased with time. The application of $PVAc_2$ supported by Bio_2 gave the highest CO_2 production (36mg/100g soil/ 24 hr). Such results were stood in agreement with those obtained by Hashem (1987).

From the above-mentioned results it could be concluded that the application of PVAc individually or in combination with Bio_2 can be successfully used for improving calcareous soil properties as reducing soil pH and EC values; avoiding the hazard effects created by Na and Cl ions; increasing the availability of certain plant nutrients; improving the activity of soil microorganisms and increasing sugar beet yields. However, the combination of $PVAc_2+Bio_2$ (polyvinyl acetate at rate of 0.6 L /m^2 plus phosphate dissolving bacteria and nitrogen fixing bacteria) was the superior treatment in this respect.

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تأثير بولي فينيل أسيتات و التسميد الحيوي على خواص التربة وإنتاجية بنجر السكر تحت ظروف الري بمياه مالحة

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أقيمت تجربة حقلية في محطة بحوث رأس سدر التابعة لمركز بحوث الصحراء خلال الموسم الشتوي ١٩٩٨ــ ١٩٩٩بهدف دراسة أثر التداخل بين محسنات التربة الصناعية والتسميد الحيوي على خواص الأراضي الجيرية وإنتاجيتها من بنجر السكر النامي تحت ظروف الري بمياه مالحة٠ اشتملت الدراسة على ١٢ معامله مرتبة في تصميم قطاعات كاملة العشوائية مع تكرار كل معاملة ٤ مرات وهى كما يلي:

١- معاملات المحسنات: شملت ٤ معاملات من محسنات التربة الصناعية هي (بدون محسنات -بولي فينيل أسيتات ($PVAc_1$) بمعدل ٠،٠٢ لتر/ م٢ - بولي فينيل أسيتات ($PVAc_2$) بمعدل ٠،٠٤ لتر/ م٢ - بولي فينيل أسيتات ($PVAc_3$) بمعدل ٠،٠٦ لتر /م٢)٠

٢ – معاملات التسميد الحيوى: شملت ٣ مستويات من التسميد الحيوي هي (بدون سماد حيوي - سماد حيوي فوسفاتي Bio_1 - خليط من السماد الحيوي النيتروجيني والفوسفاتي Bio_2)

وقد أشارت النتائج المتحصل عليها إلى ما يلي:

١- زيادة إنتاجية جذور وأوراق بنجر السكر زيادة معنوية بمعاملة التربة إما بالبولي فينيل أسيتات بصورة منفردة أو بصورة مجتمعة مع التسميد الحيوي ٠ وكانت أعلى قيمة للمحصول
(١٧،٥٣ طن للفدان) في المعاملة المركبة (فينيل أسيتات بمعدل ٠،٠٤ لتر /م٢ مع خليط من التسميد الحيوي النيتروجيني و الفوسفاتي)٠ وقد أنعكس ذلك على زيادة محتوى الجذور والأوراق من عناصر النيتروجين والفوسفور والحديد والمنجنيز والزنك زيادات متفاوتة باختلاف معاملات الدراسة حيث كان للمعاملة المركبة المشار إليها الأثر الأكبر في زيادة محتوى الجذور والأوراق من العناصر المذكورة ٠

٢- أدت معاملات الدراسة إلى انخفاض في قيم pH التربة وملوحة التربة EC وكذلك تركيز الأيونات الذائبة $Ca, Mg^{++}, K^+, Na^+, HCO_3^-$ and CL^- وكان للمعاملة المركبة ($PVAc_2$ & Bio_2) الأثر الأكبر في خفض هذه القيم٠ وعلى العكس من ذلك أدت معاملات الدراسة خاصة المعاملة المركبة المشار إليها إلى زيادة تيسر عناصر النيتروجين والفوسفور والحديد والمنجنيز والزنك لجذور وأوراق بنجر السكر ٠

٣- حدوث زيادة في أعداد البكتريا المثبتة للنيتروجين و المذيبة للفوسفات بالإضافة إلى زيادة انطلاق ثاني أكسيد الكربون وذلك في عينات التربة المأخوذة من معاملات الدراسة المختلفة حيث كان للمعاملة المركبة ($PVAc_2$& Bio_2) الأثر الأكبر في معظم الحالات لزيادة قيم الخواص المشار إليها وبالتالي تحسين خواص الأراضي الجيرية وزيادة إنتاجيتها من بنجر السكر تحت ظروف الري بمياه ملحيه٠