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IMPACT OF CERTAIN AMENDMENTS ON SOIL CHEMICAL PROPERTIES AND GROWTH OF COTTON PLANT UNDER SALINE SODIC CONDITION

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ABSTRACT: ***El-Hosinia plain is well known as a salt affected soils located in the northeastern part of the Nile Delta, Sharkia Govemorate, Egypt. it is considered one of the main promising areas for agriculture, irrigated with Wastewater. wastewater mostly without pretreatment, has been used in some locations such as Bahr El-Baqar drain area. This wastewater transport a high amounts of salts and potential toxic substances including trace elements. PH, EC, SAR, ESP and soluble ions were determined in a tested soil from Bahr El- Baqar area treated with a gypsum, citric acid, by product rich in Ca from citric acid company. Yield and elemental composition of cotton plant irrigated with Bahr El- Baqar drain were also estimated. Results showed that the studied soil chemical characteristics were improved by application of each amendment under irrigation either with tap water or Bahr El-Baqar drain water. A better effect under irrigation with tap water was observed. The above mentioned amendments appeared a significant enhancement on the dry weight, weight of 1000 seeds and seed NPK content of cotton plant. A positive effect for gypsum was followed byproduct of citric acid and citric acid application was obviously occurred. This amendment could be used in improving sodic soils.***

Key Words: ***Improvement - Industrial byproducts - Salt affected soils - Low quality water - Cotton plants.***

INTRODUCTION

Salinity problems are wide-spread in Egypt. Almost 30% of the irrigated farmlands are salt-affected. It is estimated that 60% of the Northern cultivated land, in sequence, are salt-affected soils. These soils are characterized by excess soluble salts with sodium chloride in substantial quantity. Consequently, soils accumulate sodium on the exchange complex causing poor soil physical and chemical properties. Salt-affected soils may contain an excess of water-soluble salts (saline soils), exchangeable sodium (sodic soils) or both an excess of salts and exchangeable sodium (saline-sodic soils). Periodic soil testing and treatment, combined with proper management procedures can improve the conditions of salt-affected soils that contribute to poor plant growth (James *ei al.,* 1982). El-Toukhy (1995) in his studies on the northern Delta region, reported that soil salinity varied widely from one locality to another. Ramadan and El-Fayoumy (2002) indicated that the application of sewage and industrial wastewater decreased sandy loam soil pH from 8.44 to 7.47 while slightly increased with agricultural drainage water. The electrical conductivity values significantly increased from 2.75 to 8.24 dSm^{-1} with tested agricultural drainage water. Perez *et al.* (2003) found that reuse of poorly purified and industrial waters in semi arid areas lead to progressive desertification. The salinisation, occasionally and alkalinisation increased with increasing salt concentrations of the water used. Abou El-Defan *et al.* (2005) studied the effect of farmyard manure, gypsum and mix of them on some soil characteristics irrigated with drainage water and found that both EC and ESP values significantly decreased with different treatments, especially with application of farmyard manure mixed with gypsum. The use of drainage water is an important strategy for supplementing water resources. It's normally of interior quality compared to the original irrigation water. Adequate attention need to be paid to minimize harmful effects on crop production. Salt tolerant crops of wheat, cotton and sugar beet. etc. are irrigated directly with drainage water.

Kumar *et al.* (1999) mentioned that gypsum application increased sugar yield and juice extraction percentage of sugarcane. Gypsum also increased yield of corn and alfalfa up to 50%. This yield response was partially attributed to higher exchangeable Ca and a complementary reduction in exchangeable Na (Toma *et al.,* 1999). Favorable effects due to gypsum application on increasing N, P and K contents in wheat were also noticed by Abou El-Defan *et al.* (1999). Gypsum application exhibited significant effect on grain and straw yields of barley and wheat grown on some salt affected soils at north Delta of Egypt due to improving soil physical and chemical properties (Shams Eldin *et al.,* 2000). Reviews on the use of gypsum in agriculture have been published. However, these reviews mostly discuss the effects on agronomic crops rather than the effects on soil properties.

Thus, this study aims to improve some chemical characteristics of El-Hosinia soil (salt-affected soil) through equilibration column experiment by applying certain traditional and non-traditional amendments to the tested soil as well as yield and elemental composition of cotton plants under irrigation with tap water or wastewater.

MATERIALS AND METHODS

PVC columns, 60 cm long and 20 cm internal diameter, were packed with the surface soil sample (0-20 cm), some physical and chemical characteristics of Bahr El-Baqar drain soil in El-Hosinia plain which located in the northeastern part of the Nile Delta, Sharkia Governorate are given in table (1). The columns were vibrated during packing and the soil was packed to a height of 55 cm. The columns were arranged in a randomized block design with three replicates for each treatment. Four treatments were applied as follows:

- Control (soil without amendments).
- Gypsum, 16.12 $g.kg^{-1}$ soil.
- Byproduct from citric acid company rich in Ca, 16.12 $g.kg^{-1}$soil.
- Citric acid, at a rate of 0.98 $g.kg^{-1}$ soil. The amounts of citric acid were dissolved in irrigation water giving a solution of pH 6.5.

Byproduct of citric acid company in 10th of Ramadan City, has a soluble calcium 640 $mg.kg^{-1}$ soil equivalents of almost 20.6 percent. it contains also a trace amounts of P along with Mg and K plus plant micronutrients. However, calcium content of the byproduct material has the most research attention. The amounts of applied amendments were the recommended rates to reduce the ESP of soil. Some characteristics of the used amendments are shown in table (2).

Firstly, gypsum and byproduct treatments were applied through mixing with soil in the columns. Moisture content of treated soil columns was kept at field capacity. Then 45 days later, citric acid treatment was added to the other soil in the columns through irrigation water i.e. tap water or Bahr El-Baqar drain water. Chemical composition of the collected irrigation water samples are shown in table (3). The washed columns were cultivated with cotton {*Gossypium hirsutum* L., c.v Giza 85) in summer season (April/2006).

Table (1a): Some physical characteristics of Bahr El-Baqar drain soil (0-20 cm).

Particle size distribution, %			Texture class	$CaCO_3$	O.M
Clay	Silt	Sand		%	
50.7	36.3	13.0	Clay	6.10	1.51

Table (1b): Some chemical characteristics of Bahr El-Baqar drain soil (0-20 cm).

pH (soil paste)	EC_e, $dS.m^{-1}$	Soluble ions, $meq.L^{-1}$								SAR	ESP %
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}		
7.36	7.34	4.51	7.55	53.5	1.10	0.00	5.88	54.9	5.88	21.8	31.0

Soil samples were collected after plant harvest (185 day from sowing) at depth of 0 to 15, 15 to 30 and 30 to 55 cm. The collected samples were air dried, crushed, sieved through a 2 mm sieve and stored for their chemical characteristics determination.

Plant samples (seeds) were collected at the same time of soil sampling, prepared and kept for N, P, and K determination.

The pH and EC values were measured according to the method of Richards (1954). Soluble calcium, magnesium, sodium, potassium, carbonate, bicarbonate, chloride and sulfate were determined according to the method of Jackson, 1958. The mechanical soil analysis was carried out by the pipette method using sodium hexametaphosphate as a dispersing agent as described by Baruah and Barthakur (1997). Organic matter content was determined by the chromic acid method of Walkely and Black as described by Baruah and Barthakur (1997). Total carbonates were determined volumetrically using Collin's calcimeter and calculated as calcium carbonate (Richards, 1954). Total nitrogen in plant was determined by the Kjeldahl method (Chapman and Pratt, 1961). Total phosphorus in plant was determined colorimetrically using ascorbic acid method described by Watanabe and Olsen (1965). Total potassium in plant was determined by Flame photometer (Jackson, 1958).

Data were statistically analyzed using the analysis of variance adopting a SAS software package (SAS Institute, 1996).

Table (2): Some characteristics of the used amendments.

Characteristics	Gypsum	B.C.C.#	Citric acid
pH (1:5)*	4.31	3.78	1.82
EC, $dS.m^{-1}$ (1:5)	2.17	2.90	8.46
Moisture content, %	14.0	16.0	19.0
Solubility point, g/100 g	0.87	1.51	99.0
Real density, $g.cm^{-3}$	2.07	0.78	0.84
Bulk density, $g.cm^{-3}$	1.37	0.74	0.75
Organic carbon, %	n.d.**	3.90	55.3
Organic matter, %	n.d.	6.70	95.3
Total content of macronutrients, %			
Ca	12.7	20.6	0.16
Mg	2.10	2.90	0.04
N	0.04	0.06	n.d.
P	0.02	0.03	n.d.
K	0.10	0.20	0.26
Soluble cations and anions, $mg.kg^{-1}$			

Ca^{2+}	608	644	32.0
Mg^{2+}	48.0	146	9.60
Na^{+}	134	61.2	139
K^{+}	1.33	2.12	8.11
Cl^{-}	211	95.9	217
HCO_3^{-}	246	2.48	90.2
SO_4^{2-}	3155	4351	380
CO_3^{2-}	n.d.	n.d.	n.d.
Chemically available nutrients, $mg.kg^{-1}$			
N	29.3	39.7	n.d.
P	2.33	4.98	n.d.
K	8.91	11.9	12.3

* (1:5)= amendment:water ratio and ** n.d. = not detected
# Byproduct from citric acid company rich in Ca.

Table (3): Chemical composition of the collected water samples from the studied water sources.

Water source	Total suspended solids, $mg.L^{-1}$	pH	EC_w, $dS.m^{-1}$	Soluble cations, $meq.L^{-1}$				Soluble anions, $meq.L^{-1}$				SAR
				Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	
Bahr El-Baqar	1024	7.43	3.57	4.31	5.59	23.6	0.88	0.00	4.63	24.3	5.41	10.6
Nile water	143	7.68	0.41	2.60	0.90	0.40	0.10	0.00	2.70	0.60	0.67	0.29

RESULTS and DISCUSSION

Soil chemical characteristics:

The effects of applied amendments on some chemical characteristics of Bahr El-Baqar soil irrigated with tap water are shown in table (4), and those of the same conditions soil irrigated with Bahr El-Baqar drain water are shown in table (5). It is clear that application of such amendments decreased soil pH values compared to the control, and the lowest values were detected in the soil irrigated with Bahr El-Baqar drain water which has initially higher amounts of soluble HCO3", table (3). Citric acid treatment has a relatively higher effect on lowering pH values, followed by B.C.C. and gypsum. In general, subsurface layers showed a higher values of soil pH compared with the surface one. The positive effect of organic substances on improving soil chemical properties could be due to release of $C0_2$ during the 0-4-degradation process and thus decreased precipitation of Ca and $CO3^{2}$" ions which should lead to decreasing exchangeable Na^{+} percentage (ESP) and subsequently increasing the removal of Na^{+} ions in the drainage water as have been reported by Sekhon and Bejawa (1993).

The obtained data indicate that the application of different amendments under irrigation with tap water or drainage water caused pronounced reductions in the EC_e values as compared to control. The EC_e values were

generally low under irrigation with tap water that contains a very low amounts of soluble salts. Under both irrigation water sources, the highest effect in decreasing EC values was obtained with the treatment of B.C.C, this may be ascribed related to improving the irrigation water which enhances the leaching of soluble and exchangeable Na^{+} from the soil to the drains. Generally, surface layers had higher EC_e values than the subsurface ones, contrarily with the pH values. This may be due to increasing teachability throughout the subsurface layers. Application of different amendments to the soil caused different effects on soluble cations which could be arranged as follows: $Na^{+} > Ca^{2+} > Mg^{2+} > K^{+}$, under irrigation with tap water or Bahr El-Baqar drain water. As expected, the soil irrigated with Bahr El-Baqar drain water contained higher soluble ions than that irrigated with tap water depending on its higher EC_e. The highest values of soluble Ca^{2+} were found with application of the Ca rich byproduct (B.C.C.), followed by gypsum.

Table (4): Effect of different amendments on some chemical characteristics of Bahr El-Baqar soil irrigated with tap water after harvesting of cotton plants

Amendment	Depth (cm)	pH (soil paste)	EC_e, $dS.m^{-1}$	Soluble ions, $meq.L^{-1}$ Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	SAR	ESP %
Control	0-15	7.79	5.14	6.50	7.90	34.2	0.70	3.05	38.8	7.45	12.7	24.8
	15-30	7.82	4.94	5.79	6.66	31.7	0.66	2.63	36.5	5.68	12.7	22.3
	30-60	7.94	4.06	4.20	6.33	28.0	0.63	1.98	32.7	4.48	12.2	22.1
Mean		7.85	4.71	5.50	6.96	32.0	0.66	2.55	36.7	5.87	12.6	23.1
Gypsum	0-15	7.65	4.95	18.4	10.2	18.8	0.81	3.50	20.5	24.2	4.97	8.50
	15-30	7.72	4.28	15.2	8.80	16.6	0.79	2.80	16.1	22.5	4.79	5.90
	30-60	7.77	3.64	12.8	8.04	13.7	0.70	1.97	13.4	19.9	4.24	5.30
Mean		7.71	4.29	15.8	9.01	17.5	0.77	2.73	17.5	22.2	4.67	6.57
B.C.C.#	0-15	7.58	4.86	18.1	10.3	18.6	0.97	3.18	18.0	26.8	4.94	7.50
	15-30	7.68	3.89	16.3	8.31	12.9	0.90	2.35	13.2	22.9	3.68	5.10
	30-60	7.71	3.24	15.4	8.20	12.5	0.79	2.10	12.8	22.0	3.64	4.00
Mean		7.66	3.80	16.6	9.10	15.5	0.89	2.60	15.3	23.9	4.08	5.53
Citric acid	0-15	7.45	5.01	13.9	9.00	25.4	0.98	5.28	25.3	18.7	7.51	10.3
	15-30	7.60	4.81	13.1	8.20	21.9	0.96	4.62	24.5	15.0	6.71	8.40
	30-60	7.63	4.00	11.2	7.70	19.8	0.93	3.30	23.3	13.0	6.44	7.90
Mean		7.56	4.51	12.7	8.30	22.4	0.96	4.40	23.8	15.6	6.89	8.87
$L.S.D_{0.05}$		0.07	0.26	1.38	0.10	2.50	0.05	0.41	2.50	1.71	1.28	1.56

Byproduct from citric acid company rich in Ca.
Carbonate ions not detected.

On the other hand, soluble Na^{+} significantly decreased but Mg increased due to amendments application. Soluble K^{+} slightly increased as a result of amendments application. Values of soluble cations were higher in soil surface layers than the subsurface ones due to the repeated irrigation. This trend went hand by hand with that of EC_e values. The benefiticial effect could be resulted from presence of excess Ca in both B.C.C. and gypsum treatments as well as organic acids in the B.C.C. and citric acid amendments.

As shown in tables (4 and 5), application of such amendments to the soil significantly decreased Cl" ions compared to the control. B.C.C. caused the highest decreases in Cl" concentration. On the other hand, $S0_4^{2}$" and HCO3" in the soil paste extract were significantly increased with application of such amendments to the soil, as have been similarly reported by Ahmed (2007). Soluble anions concentration showed similar trend as EC_e values where they decreased with increasing soil depth. Carbonate ions were not detected. These findings are quite true for the tested soil under irrigation with tap water or Bahr El-Baqar drain water, but soil irrigated with Bahr El-Baqar drain water contained higher amounts of anions than under irrigation with tap water condition.

Table (5): Effect of different amendments on some chemical characteristics of Bahr El-Baqar soil irrigated with Bahr El-Baqar drain water after harvesting of cotton plants.

Amendment	Depth (cm)	pH (soil paste)	EC_e, $dS.m^{-1}$	Soluble ions, $meq.L^{-1}$							SAR	ESP %
				Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}		
Control	0-15	7.73	6.05	6.81	9.10	43.2	0.77	4.45	46.9	8.53	15.3	28.6
	15-30	7.81	5.91	6.13	8.50	41.6	0.75	4.14	44.4	8.44	15.4	28.3
	30-60	7.93	5.72	5.35	8.10	40.7	0.72	3.89	42.8	8.18	15.7	27.3
Mean		7.82	5.89	6.10	8.57	41.8	0.75	4.16	44.7	8.38	15.5	28.1
Gypsum	0-15	7.60	5.90	19.7	12.0	25.7	0.88	4.84	25.9	27.5	6.46	11.1
	15-30	7.70	5.84	18.0	10.0	23.5	0.83	4.79	24.0	23.5	6.27	10.6
	30-60	7.73	5.51	17.1	9.81	22.1	0.81	4.10	23.2	22.5	6.02	10.0
Mean		7.68	5.75	18.3	10.6	20.9	0.84	4.58	24.4	24.5	6.25	10.6
B.C.C.#	0-15	7.56	5.81	21.9	12.6	22.0	1.04	4.81	24.5	28.2	5.29	9.30
	15-30	7.57	5.63	20.7	11.6	20.4	1.00	4.31	23.0	26.4	5.07	8.73
	30-60	7.61	5.30	19.7	11.0	18.0	0.96	3.99	21.3	24.4	4.59	8.30
Mean		7.58	5.58	20.8	11.7	20.1	1.00	4.37	22.9	26.3	4.98	8.78
Citric acid	0-15	7.43	5.94	14.3	10.8	30.4	1.06	6.71	30.6	19.3	8.59	12.6
	15-30	7.49	5.89	13.4	9.97	28.8	1.04	6.53	30.1	16.6	8.42	12.5
	30-60	7.57	5.70	13.0	9.47	27.4	1.00	5.73	29.0	16.1	8.17	12.5
Mean		7.50	5.84	13.6	10.1	28.9	1.03	6.32	29.9	17.3	8.40	12.5
$L.S.D_{0.05}$		0.07	0.20	2.74	0.42	2.80	0.06	0.50	3.20	2.11	1.50	1.81

Byproduct from citric acid company rich in Ca.
Carbonate ions not detected.

The relatively higher mobility and leachability of Na" from soil in comparison with Ca^{2+} and Mg^{ZT} induced a lower values of SAR, with the highest effect by B.C.C. under irrigation with both tap water and Bahr El-Baqar drain water. This could be due to its high content of Ca (Table, 2). SAR values decreased with increasing soil depth. Raza *et al.* (2001) found that gypsum application by broadcasting reduced the SAR of soil by 59% at 0-30 cm depth and 8% at 30-60 cm depth. Ahmed (2007) showed that the decreases in SAR values after four months from incubation due to application of gypsum and B.C.C. recorded 53.2 and 21.3% as compared to the control treatment.

With respect to exchangeable sodium percentage (ESP), data in tables (4 and 5) indicate that values of ESP were markedly decreased with using such amendments, especially B.C.C. The beneficial effect of B.C.C. treatment could be attributed to presence of relatively high amounts from Ca ion as previously mentioned. In general, ESP values decreased with increasing soil depth with similar trend to EC_e and SAR. The present findings agree with that obtained by Moustafa (2005) who found that the application of gypsum, farm yard manure and gypsum + farm yard manure significantly decreased the exchangeable sodium with the maximum value for gypsum + farm yard manure treatment. These findings are observed for the tested soil irrigated with tap water or Bahr El-Baqar drain water, however soil irrigated with tap water generally showed a lower values of ESP.

From the abovementioned results, it can be concluded that application of different amendments improve some chemical properties of the tested soil i.e. pH, EC_e, SAR, ESP and soluble ions. On the other hand, various amendments decreased the percentage of Na adsorption on the soil and increased the free electrolyte concentration; consequently reduced dispersion and ncreased flocculation and aggregation of soil.

Also, these amendments raised the soluble Ca concentrations that induce an enhancement for the flocculation of soil colloids. Gypsum provides both Ca and S for crop nutrition and has long been used as a Ca source for growing plants.

Plant growth and seed quality:

Data in table (6) show the dry weight of whole plant, weight of 1000 seeds and NPK content in seeds of cotton plant cultivated in Bahr El-Baqar soil as affected by such amendments under irrigation with tap water or Bahr El-Baqar drain water. The obtained results show that under irrigation with Bahr El-Baqar drain water, the dry weight matter and weight of 1000 seeds of plants cultivated in the untreated soil (control) were decreased by 10.4 and 15.4% less than that irrigated with tap water, respectively. Similarly, they decreased by 6.6 and 10.6%, 8.0 and 8.9% or 6.1 and 10.9% under gypsum, B.C.C. or citric acid treatment, respectively. Singh *et al.* (1989) reported that application of gypsum reduced pH and improved soil physical properties,

which together were reflected on the yield. The obtained results indicate marked increases in macronutrients concentrations in cotton seeds particularly N content due to treating soil with the listed amendments, especially B.C.C. (Table, 6). This could be due to the effect of B.C.C. on improving physicochemical characteristics of the soil and consequently, improving plant growth conditions. Such improvements include one or more of the following reasons: (1) the improvement of soil physical properties which is reflected on both water and nutrients behaviour. (2) lowering EC_e, SAR and ESP of the treated soil through B.C.C. addition and (3) improving soil chemical, biological and fertility properties. In this respect, soil irrigated with Bahr El-Baqar drain water had lower content of NPK in cotton seeds than those irrigated with tap water.

Table (6): Dry weight of whole plant, weight of 1000 seeds and NPK content in seeds of cotton plant cultivated in Bahr El-Baqar soil as affected by different amendments under irrigation with tap water or Bahr El-Baqar drain water.

Amendment	Dry weight of whole plant (g/plant)	Weight of 1000 seeds, g	N	P	K
				%	
		Irrigation with tap water			
Control	93.7	92.1	1.54	0.24	1.31
Gypsum	102	100	2.00	0.31	1.54
B.C.C.#	108	103	2.60	0.36	1.62
Citric acid	99.6	96.8	1.56	0.28	1.39
$L.S.D_{0.05}$	3.28	2.07	0.11	0.04	0.14
		Irrigation with Bahr El-Baqar drain water			
Control	84.9	79.8	1.26	0.23	1.29
Gypsum	95.7	90.4	1.44	0.32	1.46
B.C.C.#	100	94.6	1.68	0.34	1.59
Citric acid	93.9	87.3	1.40	0.29	1.38
$L.S.D_{0.05}$	2.91	2.10	0.09	0.03	0.07

Byproduct from citric acid company rich in Ca.

From the above mentioned results it can be noticed that the application of B.C.C. was the most superior one in improving the studied soil chemical characteristics, and can be used as soil amendment in saline sodic or sodic soils in Egypt.

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تاثير بعض المحسنات علي الخواص الكيميائية للارض و نمو نبات القطن تحت الظروف الملحية القلوية

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الملخص العربي

تعتبر منطقة الحسنية واحدة من أشهر الأراضي المتأثرة بالأملاح فى مصر. و يقع سهل الحسنية فى الجزء الشمالى الشرقى من دلتا النيل والتابع لمحافظة الشرقية والذى يعتبر من أهم المناطق التى تبشر بمستقبل جيد فى الزراعة. و يتم استخدام مياة مصرف بحر البقر غير المعالجة فى رى بعض المواقع مثل منطقة بحر البقر، وهذه النوعية من المياه تنقل معها الأملاح والمواد السامة ومنها العناصر الثقيلة.

أقيمت تجربة أعمدة لدراسة بعض الصفات الكيميائية لتربة مصرف بحر البقر متضمنة درجة الحموضة، درجة التوصيل الكهربى للأملاح، الأيونات الذائبة، نسبة ادمصاص الصوديوم والنسبة المئوية لادمصاص الصوديوم، والعمل على تحسين تلك الصفات بتطبيق بعض المصلحات التقليدية مثل الجبس وحمض الستريك، وكذلك غير التقليدية مثل مخلف صناعى غنى بالكالسيوم ناتج من شركة لإنتاج حمض الستريك. وكذلك تاثير تلك الاضافات على نمو نباتات القطن النامية بهذه التربة، فى حالة الرى بمياه الصنبور أو مياه مصرف بحر البقر.

أوضحت النتائج أن خواص التربة الكيميائية تحت الدراسة قد تحسنت نتيجة إضافة المعاملات سابقة الذكر، وأعطت أفضل النتائج فى حالة الرى بمياه الصنبور. أما الوزن الجاف لنباتات القطن، (وزن الألف بذره) وكذلك محتوى البذور من النيتروجين، الفوسفور والبوتاسيوم قد زاد معنوياً تحت تأثير هذه المعاملات بالمقارنة بالكنترول، وكما هو متوقع انخفضت هذه التقديرات نتيجة الرى بمياه مصرف بحر البقريالمقارنة بالرى بمياه الصنبور.

وقد دلت النتائج على ان المخلف الصناعى كان الاكثر تأثيراً فى تحسين الخواص الكيميائية للتربة وعلى نمو نباتات القطن وكذلك محتوى بذورها من العناصر المغذية الكبرى، وعلى ذلك يمكن إستخدامه فى إصلاح الأراضي الملحية القلوية أو القلوية.