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EFFECT OF SOME SOIL AMENDMENTS ON SOIL PROPERTIES AND WHEAT CROP GROWN ON A SALT AFFECTED SOIL

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ABSTRACT : A field experiment was conducted in Nabteet area, Al-Sharkia governorate to evaluate the effect of application of four soil amendments singly or in different combination. They were (phosphogypsum (PG), sulfur (S), farmyard manure (FYM) and sand). They were applied to a saline sodic clayey soil preleached to decrease its salinity. Application of amendment was followed by growing wheat crop (*Triticum aestivum*) c.v. Sakha 93.

Soil salinity decreased due to applying amendments, the maximum reduction occurred when the treatment of (PG + S + FYM + Sand), whereas the minimum occurred when PG was applied alone. A slight reduction was observed of soil pH due to applying amendments and PG caused a reduction of pH more than the others.

Exchangeable sodium percentage (ESP) decreased due to amendments with PG giving the most effect and sulfur was the least efficient to minimize ESP.

Soil bulk density decreased and soil total porosity increased due to applying amendments. All amendments increased water stable aggregates and mean weight diameter (MWD) with PG being the most efficient.

Grain yield increased due to addition of amendments. The maximum grain yield (3284 kg/fad) was observed when PG was applied alone at the rate of 100 % of gypsum requirement (G.R), whereas the minimum grain yield (1082 kg/fad) was observed when sulfur was applied alone.

Regarding the overall effect of reclamation of the soil, PG was the most efficient.

Key words : Soil salinity, amendments, physical and chemical properties, wheat productivity.

INTRODUCTION

Salt-affected soils exist under a wide range of hydrological, physiographical conditions, soil types, rainfall and irrigation regimes and different socio-economic settings. Therefore, there is no single technique or agricultural system that will be applicable to all areas and conditions.

Management of salt-affected soils requires a combination of agronomic and operational practices, that depend on careful definition of the main production constraints and requirements. These are based on detailed, comprehensive investigations of soil characteristics, water monitoring (rainfall, irrigation water and water table), and local conditions including climate, crops, economic, social, political and cultural environment. Management of salt-affected soils for agricultural use is largely dependent on water availability, climatic conditions and availability of resources (FAO, 2007).

The majority of salt-affected soils in Egypt are located in the Northern-Central part of the Nile Delta and on its Eastern and Western sides. Other areas are found in Wadi El- Natroun, El- Kebeir, the Oases, many parts of the Nile Delta and Valley and El-Fayoum province. About nine hundred thousand hectares suffer from salinization in Egyptian irrigated lands; of which 60 % are in Northern Delta, 20 % in Southern Delta and Middle Egypt and 25 % in Upper Egypt (FAO, 2007).

Abd El-Kawey (2002) pointed out that land degradation processes, especially water logging and subsequent salinization and sodification occur broadly in irrigated soils of the arid and semi-arid regions.

Land degradation is mainly due to changes in the environment, as well as to human mismanagement of the natural resources, including over intensive cultivation, destructive irrigation and farming practices (FAO, 1983). El-Gazzar et al. (1996) reported that soil aggregation status in clay soils was affected by soil salinity and sodicity.

Zein El-Abedine *et al.* (2004) concluded from the statistical analysis of obtained soil data that soil structure of the clay soils at the north western Nile Delta began to deteriorate at EC value of 7.14

dS/m and SAR value of 15.4 in the soil paste extract.

As a dynamic system, soil condition can be modified by human management. Reclamation of salt affected soils is done by executing the suitable agro-management practices. Many studies were carried out to investigate the beneficial effects of adding organic manures and gypsum. Logan *et al.* (1996) and Hassanien (2007) found that organic amendments reduced soil bulk density and increased soil porosity. Gypsum is the main material used for ameliorating soil sodicity. It was found to be more effective when added in combination with organic manure to ameliorate salt affected soils and improve their bulk density, total porosity and hydraulic conductivity (Belal, 2004 and Wahdan *et al.*, 2006).

Ibrahim (2004) reported that applied organic compost and gypsum as soil amendment improved the characteristics of the salt affected soils, including soil bulk density, total porosity, total aggregates, pore size distribution and hydraulic conductivity. Other researchers Beheiry *et al.* (2007) obtained favorable conditions achieving a suitable air-moisture regime and fertility, and enhanced removal of Na^+ with a higher rate than Ca^{++} + Mg^{++}, and decreased soil salinity and sodicity by applying gypsum and organic manure.

The main objective of this study is to determine the most hopeful combination of some soil amendments including their proper ratios of application to a saline sodic soil and to evaluate the effect of soil amendments and conditioners on soil physical and chemical properties and on productivity of wheat crop.

MATERIALS AND METHODS

This study involves 16 treatments using different materials oriented to obtain the most efficient treatment in reclamation. The materials used as soil amendments are phosphogypsum (PG) (a by product of super-phosphate manufacture which is mainly gypsum with some phosphate rock), sulphur (S), farmyard manure (FYM) and sand. The 16 treatments are the different combinations of those 4 materials (considered as 4 factors). Such combinations range from addition of none to addition of one or more of the materials.

Preparation of Soil

The experimental field was prepared for a leaching operation to decrease its salinity. An open drain was dug to support the leaching process. Leaching was conducted by adding water to soil basins until the water reaches a height of 15 cm above the soil surface. Such height of water was kept constant for 3 days; the collected drainage water was removed using a pump. Such process is called continuous leaching. One week after the leaching process was terminated the land was divided into plots 16 m^2 and then soil amendments were added, followed by cultivation. Table 2 shows main properties of the soil.

The experimental design was a randomized complete block, treatments being replicated 3 times.

Application of Amendments (Amending Materials)

The 4 materials were phosphogypsum (PG), sulphur (S), farmyard manure (FYM) and sand.

The 16 treatments are the different combinations of adding or no adding the materials starting from no-addition of any material to addition of one or more or all the four materials. There were 4 treatments each receiving the full dose of only one material. There were 6 treatments each receiving only two of the amendments so as half the dose of each of the two amendments were applied. There were four treatments where 3 different amendments were applied together in each treatment, so as to apply one-third of the full dose of each. There was one treatment which received the 4 amendments, so as to give one-quarter of the full dose of each amendment. The full dose for each material being as follows: 16000 kg FYM/fad; 18120 kg PG/fad; 3440 kg S/fad; 65000 kg sand/fad. Amount of PG and S were equivalent in their gypsum requirement (aimed at decreasing ESP from being 42 to 5) (Richard, 1958).

Table 1. Chemical composition of FYM

Properties	Value
pH 1: 2.5	7.13
O.C g/kg	157
O.M g/kg	271
Total N g/kg	12
Total P mg/kg	1593
C/N ratio	13

In order to achieve the effect of the applied soil amendments on soil, plots were planted with wheat (*Triticum aestivum*) c.v. Sakha 93 at November 25^{th} 2005. The crop was harvested on May 25th 2006 (180 days after cultivation). Samples of soil and plants were taken after harvest for analysis. The percentage change (PC) in soil and crop due to amendments was calculated as follows :

$$PC = \frac{\text{result of treated} - \text{result of non-treated}}{\text{result of non-treated}} \times 100$$

The 16 treatment designations are as follows :

1. Non-treated
2. T_1 = phosphogypsum (PG)
3. T_2 = sulphur (S)
4. T_3= Farmyard manure (FYM)
5. T_4 = Sand
6. T_5 = PG + S
7. T_6 = PG + FYM
8. T_7 = PG + Sand
9. T_8 = S + FYM
10. T_9 = S + Sand
11. T_{10} = FYM + Sand
12. T_{11} = PG + S + FYM
13. T_{12} = PG + S + Sand
14. T_{13} = S + S and + FYM
15. T_{14} = PG + FYM + Sand
16. T_{15} = PG + S + FYM + Sand

Methods Used for Analysis

1. Mechanical analysis was determined according to the international pipette method. (Piper, 1950).
2. Physical and chemical analysis were carried out according to Black *et al.* (1965) and Jackson (1967)
3. Water stable aggregates were determined according to Yoder (1936) modified by Ibrahim (1964).
4. Bulk density, particle density, total porosity and maximum water holding capacity) were determined according to Baruah (1997).
5. Exchangeable and water soluble sodium, potassium, calcium and magnesium were measured using Atomic absorption spectrometer Perken Elmer (A. Analyst 200).

RESULTS AND DISCUSSION

Effect of Leaching Process on Some Chemical Properties of Soil

The soil salinity decreased since EC of the soil paste extract decreased from 18.52 to 15.30 dS/m, exchangeable sodium percentage (ESP) decreased from 42.81 to 41.29 %. Also values of soluble sodium and soluble chloride decreased from 115.70 and 100.25 $mmol_c/L$ for Na and Cl to 95.73 and 85.97 $mmol_c/L$ for each respectively. Moreover soluble calcium decreased from 40.30 to 31.44 $mmol_c/L$ and pH value increased from 7.92 to 7.98 Table 3 and Figs. 1, 2 and 3.

Effect of Soil Amendments on Soil Physical and Chemical Properties after Wheat Season

EC of soil

All treatments receiving amendments reduced the EC of the soil which was measured after harvesting of wheat crop. The data in Table 4 and Figs. 4 and 5 represent the effect of amendments on soil salinity. The highest percent change as a decrease of EC occurred with T_{15} (- 48.06 %). Two treatments caused an increase : T_1 (+ 9.89 %) and T_7 (+ 8.83%) as for soluble Ca^{++}, some amendments caused increases of up to +133.99 % for Ca^{++} (T_1) and some gave decreases down to

Table 2. Some physical and chemical properties of the initial soil and chemical properties of the water used in irrigation.

Properties	Soil	Water
A- Physical properties		
Particle Size Distribution (%)		
* Sand	18.07	
* Silt	34.33	
* Clay	47.60	
* Texture class	clay	
Saturation percent (%)	71.23	
Real density (Mg/m^3)	2.25	
Bulk density (Mg/m^3)	1.21	
Porosity %	46.22	
B- Chemical Properties		
EC ($dS.m^{-1}$) soil paste extract	18.52	0.54
pH (1:2.5)	7.92	7.68
Soluble Ions ($mmol_c$ /L)		
* Ca^{2+}	40.30	3.69
* Mg^{2+}	30.90	1.73
* Na^+	115.70	2.00
* K^+	1.65	0.20
* CO_3^{2-}	0.00	0.00
* HCO_3^-	10.25	5.66
* Cl^-	100.25	1.60
* SO_4^{2-}	78.05	0.36
* SAR	19.39	1.22
Exchangeable Cations ($cmol_c$/ kg soil)		
* Ca^{2+}	10.16	
* Mg^{2+}	7.74	
* Na^+	14.49	
* K^+	1.28	
* CEC ($cmol_c$/ kg soil)	33.85	
* ESP	42.81	
$CaCO_3$ g/kg	50.3	
Organic Matter g/kg	27.7	

-44.99 % (T_4). As for soluble Na^+, all treatments caused a decrease and the highest was -54.74 % (T_{15}). Also soluble Cl^- decreased by all treatments, the highest was -83.78 % occurred with T_{11}. Such findings are similar to those obtained by Liang, *et al.* (1995) and Abou Youssef, (2001) who found that salinity of brine contaminated soils was decreased by phosphogypsum as evidenced by reduced EC, SAR and exchangeable Na^+ level in 0 – 15 cm depth of the columns.

Exchangeable Sodium Percentage (ESP)

All materials reduced exchangeable sodium percentage.

The data in Table 5 and Fig. 6 indicated that the ESP had low values for all materials compared with the non-treated. The maximum decrease in ESP occurred with the T_1 of phosphogypsum. These results are similar to those obtained by Somani *et al.* (1987) who found that phosphogypsum applied to sodic soils followed by leaching caused a reduction in ESP. Also El-Missiry (1996) found that acid gypsum treatments, resulted in a sharp decrease in ESP.

The highest decrease in ESP occurred with T_1 (-56.48 %), whereas the lowest occurred with T_2 (-12.29 %). The former treatment was phosphogypsum while the latter was sulfur. Thus using sulphur only has very little effect probably due to low oxidation of sulfur in this soil.

Soil pH

Soil pH is an important parameter which reflects the overall status of soil chemical properties. It is obvious that the maximum reduction in pH occurred when the phosphogypsum applied at a full dose (T_1) where it was reduced to the safe. Such a decrease in pH reflects a removal of excess sodium from the soil. Concerning the treatments which include FYM the decrease in pH reflects a release of organic acids causing mobilization of native calcium carbonate in the soil. These results are similar to those obtained by Okorkov and Kurbatov (1999) who reported that application of 2000, 5000 and 10000 kg/ha phosphogypsum to soil in a crop rotation of oats sown over grass decreased pH of soil. Also Anwar Zaka *et al.* (2003) stated that application of gypsum caused the maximum reduction in soil pH. The current results show that the highest reduction occurred with T_1

(-6.32%), whereas the lowest occurred with T_{14} (-3.28 %).

Water Stable Aggregates and Mean Weight Diameter

The high water stable aggregates in soil is an effective index for assessing structure stability and movement of water and air through soil. Data presented in Table 6 and Fig. 8 indicated that all amending materials increased water stable aggregates. The maximum increase mean weight diameter (MWD) was observed when T_1 treatment was applied (+76.03 %), whereas the minimum occurred when T_2 and T_9 treatments were applied (+0.83%) for both treatments . It is obvious that treating the soil by phosphogypsum in combination with FYM (T_6) was the most effective treatment. These results are in agreement with those obtained by Abou Youssef (2001) who found that the application of phosphogypsum at the rate of about 1000 kg/fad increased the MWD by 8%. The T_3 treatment followed the T_1 treatment for improving water stable aggregates and this emphasizes the important role of FYM for increasing water stable aggregates. The combination between FYM and PG amendments with or without any or more of the others had the most effect in soil structure and water retention.

Soil Bulk Density and Soil Porosity

The effect of amendments on soil bulk density and soil porosity are shown in Table 7 and Fig. 9. All amendments decreased bulk density. The maximum decrease occurred with T_1, T_{12} and T_{14} (-8.46 %), whereas the minimum occurred with T_2, T_4 and T_7 (-2.31 %).

Concerning soil porosity, data presented in Table 7 and Fig. 10 show that there was an increase in soil porosity. In this respect, Ramirez *et al.* (1997) found that application of phosphogypsum on an onion crop caused remarkable decrease in soil bulk density. Marcano *et al.* (1997) showed that phosphogypsum improved soil tilth by decreasing soil bulk density and increasing total porosity. Also results obtained by El-Shanawany *et al.* (2000), showed decreased bulk density and increased soil porosity.

El-Maddah (2000) and El-Sersawy (2002) found that the fineness of farmyard manure helped in homogenous distribution of its constituents in soil.

Grain and Straw Yield of Wheat Crop

Data represented in Table 7 and illustrated in Fig 11 indicated that the grain yield increased due to the application of soil amendments. The maximum grain yield (3284 kg/fad) was observed when phosphogypsum only was applied (T_1), whereas the minimum grain yield (1082 kg/fad) was observed when sulfur only was applied (T_2). These results agree with those obtained by Abou El-Defan *et al.* (1999) and Hassanien (2007).

Increasing of straw yield was also observed due to application of amendments.

Data in Table 7 and Fig 12 indicated that the maximum positive increase in straw yield occurred with T_{12} (+169.53 %), whereas the minimum occurred with T_{15} (+52.44 %). These results are similar to results obtained by Derar and Eid (1996) and Hassanien (2007).

Table 3. Effect of leaching of the soil

	EC dS/m soil paste extract	Soluble Ions, mmolc/L								Exch. Cations, $cmol_c$ / kg soil				CEC $cmol_c$ / kg soil	pH	ESP
		Ca^{2+}	Mg^{2+}	Na^+	K^+	CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+			
Before	18.52	40.30	30.90	115.70	1.65	0.00	10.25	100.25	78.05	10.16	7.74	14.49	1.28	33.85	7.92	42.81
After	15.30	31.44	25.50	95.73	1.31	0.00	6.87	85.97	61.14	9.13	7.15	13.40	1.21	32.45	7.98	41.29

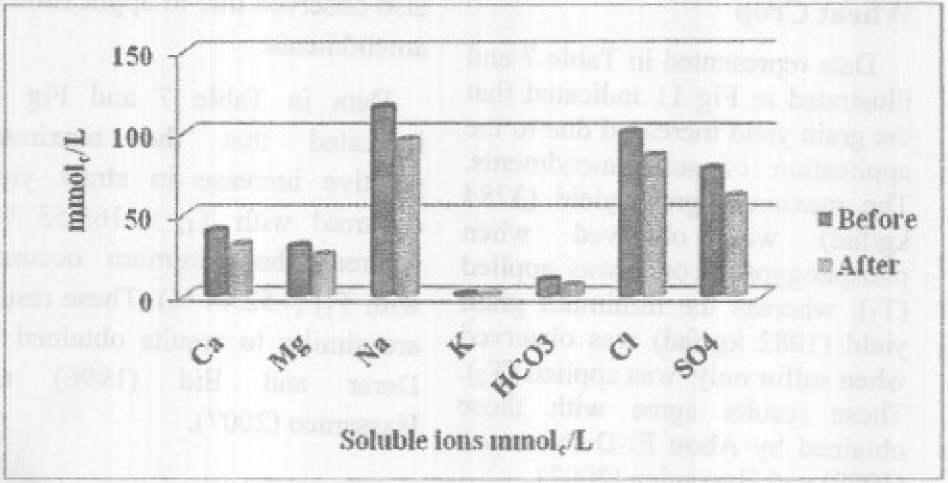

Fig. 1. Soluble ions as affected by leaching process

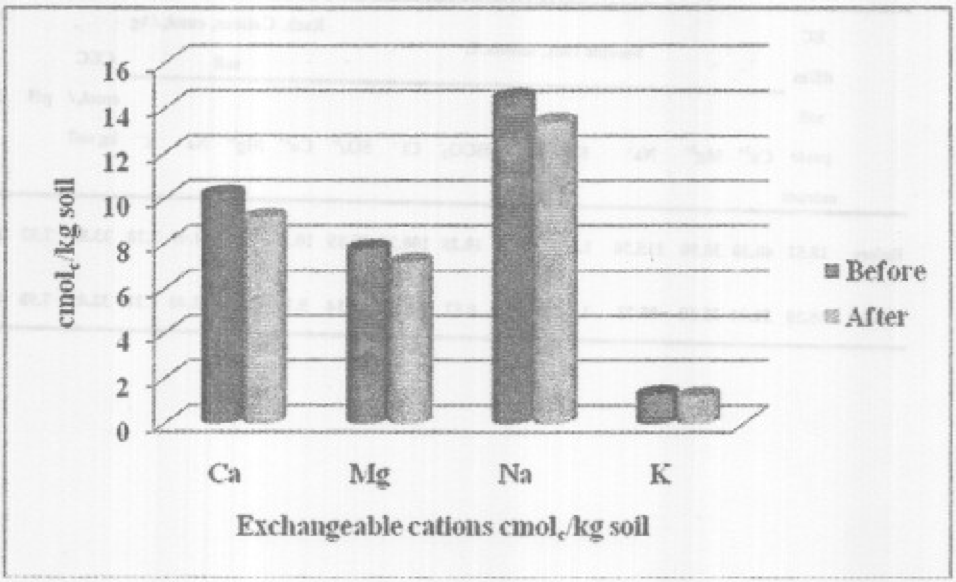

Fig. 2. Exchangeable cations as affected by leaching process

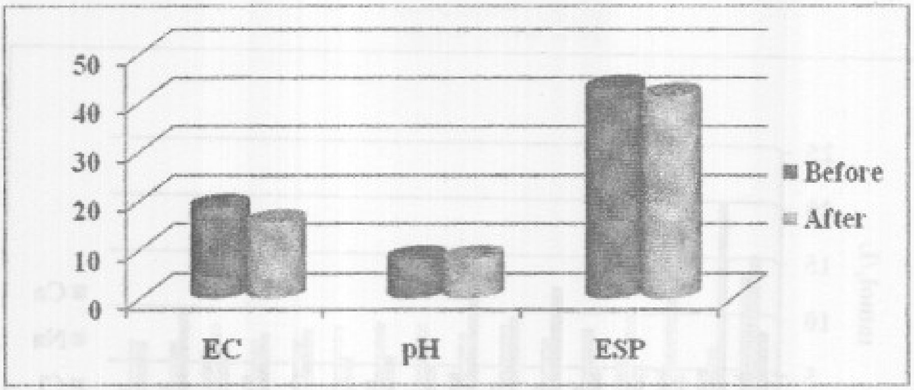

Fig. 3. EC, pH and ESP as affected by leaching process

Table 4. Effect of treatments on EC and soluble ions in 1:5 soil water extract after wheat harvest and the percentage change (PC) caused by amendments in relation to non-treated soil

Treats.**	Soluble ions mmol$_c$/L after wheat								EC dS/m 1:5 soil/water extract	PC of Ca^{2+}	PC of Na^{+}	PC of Cl^{-}	PC of EC
	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}					
Non-treated	8.65	4.79	15.51	0.67	0.00	4.32	13.50	11.8	2.83	0.00	0.00	0.00	0.00
T_1	20.24	5.29	7.13	0.75	0.00	1.97	5.08	26.36	3.11	+133.99	-54.03	-62.37	+9.89
T_2	4.76	4.45	13.75	0.82	0.00	2.20	5.24	16.34	2.18	-44.97	-11.35	-61.19	-22.97
T_3	5.45	4.12	10.56	0.98	0.00	4.91	5.83	10.37	2.06	-36.99	-31.91	-56.81	-27.21
T_4	4.76	3.45	8.76	0.93	0.00	4.76	3.50	9.64	1.59	-44.97	-43.52	-74.07	-43.82
T_5	12.38	5.20	7.76	0.83	0.00	1.98	3.54	20.65	2.60	+43.12	-49.97	-73.78	-8.13
T_6	9.65	4.66	8.92	0.85	0.00	2.55	3.62	17.91	2.32	+11.56	-42.49	-73.19	-18.02
T_7	14.66	6.75	8.11	0.94	0.00	2.35	4.59	23.52	3.08	+69.48	-47.71	-66.00	+8.83
T_8	5.12	4.56	8.94	0.87	0.00	4.83	3.01	11.65	1.86	-40.81	-42.36	-77.70	-34.28
T_9	5.93	5.23	8.97	0.78	0.00	3.38	3.87	13.66	2.07	-31.45	-42.17	-71.33	-26.86
T_{10}	5.78	3.76	8.65	0.81	0.00	4.61	2.78	11.61	1.76	-33.18	-44.23	-79.41	-37.81
T_{11}	8.36	6.83	7.43	0.88	0.00	4.29	2.19	17.02	2.22	-3.35	-52.10	-83.78	-21.55
T_{12}	7.88	6.31	7.26	0.75	0.00	2.34	4.02	15.84	2.05	-8.90	-53.19	-70.22	-27.56
T_{13}	6.79	6.84	8.68	0.93	0.00	2.27	6.26	14.71	2.36	-21.50	-44.04	-53.63	-16.61
T_{14}	9.65	4.23	7.05	0.82	0.00	7.20	3.18	11.37	1.82	+11.56	-54.55	-76.44	-35.69
T_{15}	6.98	1.39	7.02	0.77	0.00	2.92	2.72	10.52	1.47	-19.31	-54.74	-79.85	-48.06
LSD $_{0.05}$	0.935	0.966	0.935	NS	----	0.935	0.966	0.935	0.870	n.d	n.d	n.d	n.d

** Treatment codes : T_1 (phosphogypsum "PG"); T_2 (sulfur "S"); T_3 (Farmyard manure "FYM") ; T_4 (Sand); T_5 (PG + S); T_6 (PG + FYM); T_7 (PG + Sand); T_8 (S + FYM); T_9 (S + Sand); T_{10} (FYM + Sand); T_{11} (PG + S + FYM); T_{12} (PG + S + Sand); T_{13} (S + Sand + FYM); T_{14} (PG + FYM + Sand); T_{15} (PG + S + FYM + Sand).

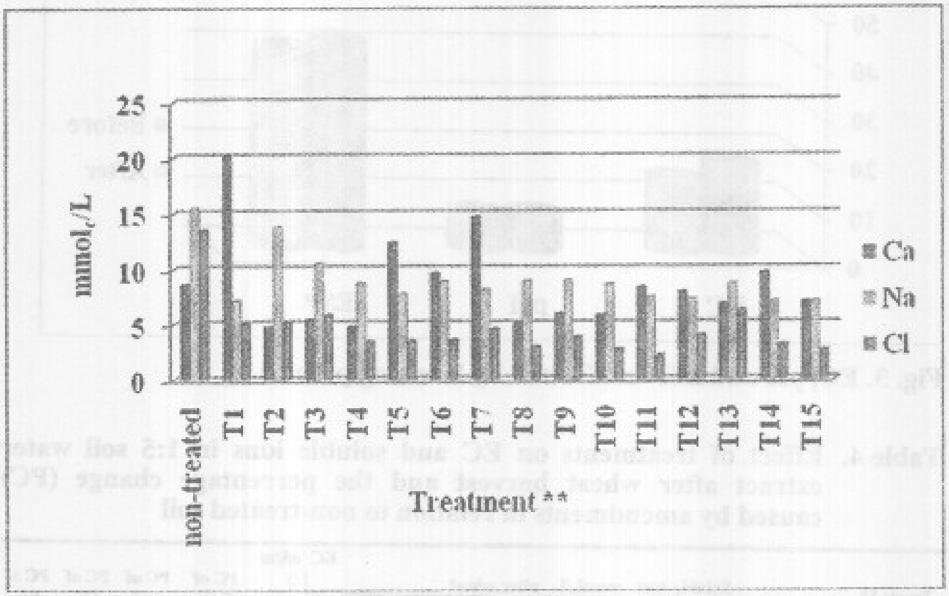

Fig. 4. Effect of treatments on soluble Ca^{++}, Na^{+} and Cl^{-} in 1:5 soil/water extract after wheat harvest

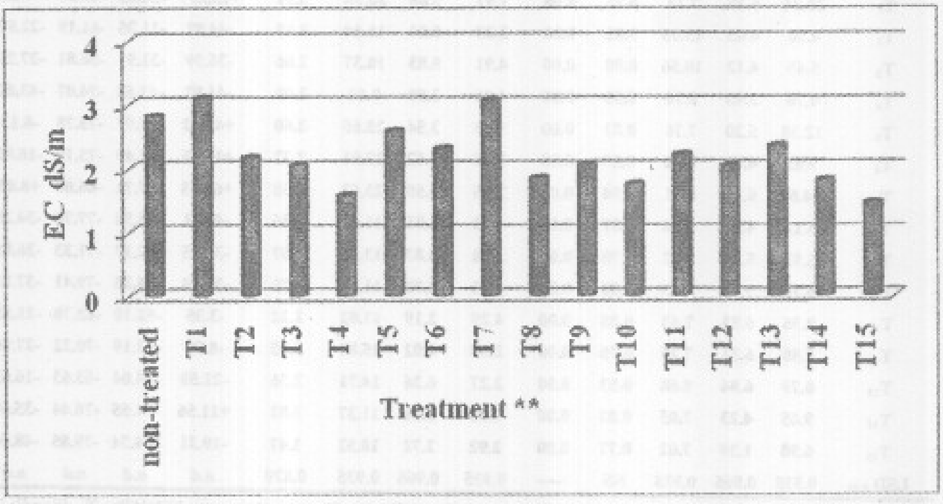

Fig. 5. Effect of treatments on EC in 1:5 soil/water extract after wheat harvest

** Refer to foot note of Table 3 for treatment designation

Table 5. Exchangeable cations, ESP and pH after wheat harvest and the percentage change (PC) caused by treatments in relation to non-treated soil.

Treats.**	Exch. Cations (cmol$_c$/kg soil) after Wheat				CEC cmol$_c$/kg soil	ESP	pH	PC of ESP	PC of pH
	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}					
Non-treated	8.87	6.79	12.15	1.24	29.05	41.82	8.23	0.00	0.00
T_1	15.98	8.32	5.65	1.10	31.05	18.20	7.71	-56.48	-6.32
T_2	9.75	8.23	11.21	1.37	30.56	36.68	7.83	-12.29	-4.86
T_3	11.43	8.50	10.75	1.46	32.14	33.45	7.87	-20.01	-4.37
T_4	9.43	6.45	9.35	1.01	26.24	35.63	7.88	-14.80	-4.25
T_5	14.27	10.29	7.80	1.20	33.56	23.24	7.86	-44.43	-4.50
T_6	12.39	9.32	7.59	1.22	30.52	24.87	7.94	-40.53	-3.52
T_7	13.11	11.49	7.15	1.23	32.98	21.70	7.86	-48.11	-4.50
T_8	12.38	10.29	9.45	1.23	33.35	28.34	7.84	-32.23	-4.74
T_9	13.13	10.12	9.19	1.12	33.56	27.38	7.91	-34.53	-3.89
T_{10}	11.41	9.54	9.94	1.11	32.00	31.06	7.93	-25.73	-3.65
T_{11}	12.46	9.92	8.76	1.23	32.37	27.06	7.85	-35.29	-4.62
T_{12}	13.37	8.73	8.11	1.23	31.44	25.80	7.83	-38.31	-4.86
T_{13}	11.59	9.87	10.17	1.34	32.97	30.84	7.9	-26.26	-4.01
T_{14}	13.39	10.45	8.98	1.01	33.83	26.54	7.96	-36.54	-3.28
T_{15}	13.94	10.38	9.34	1.37	35.03	26.66	7.94	-36.25	-3.52
LSD $_{0.05}$	0.935	0.870	0.975	0.177	n.d	0.975	0.188	n.d	n.d

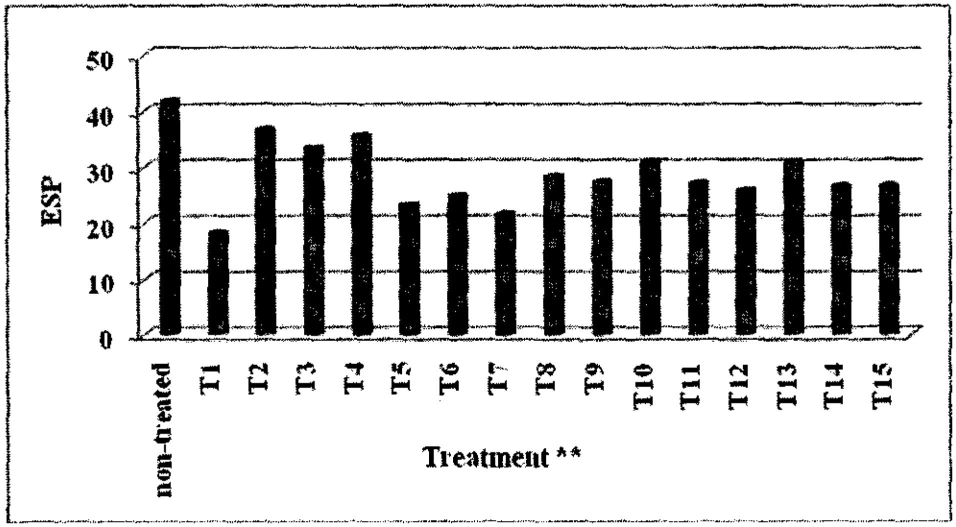

Fig. 6. Effect of treatments on exchangeable sodium percentage (ESP) after wheat harvest

** Refer to foot note of Table 3 for treatment designation

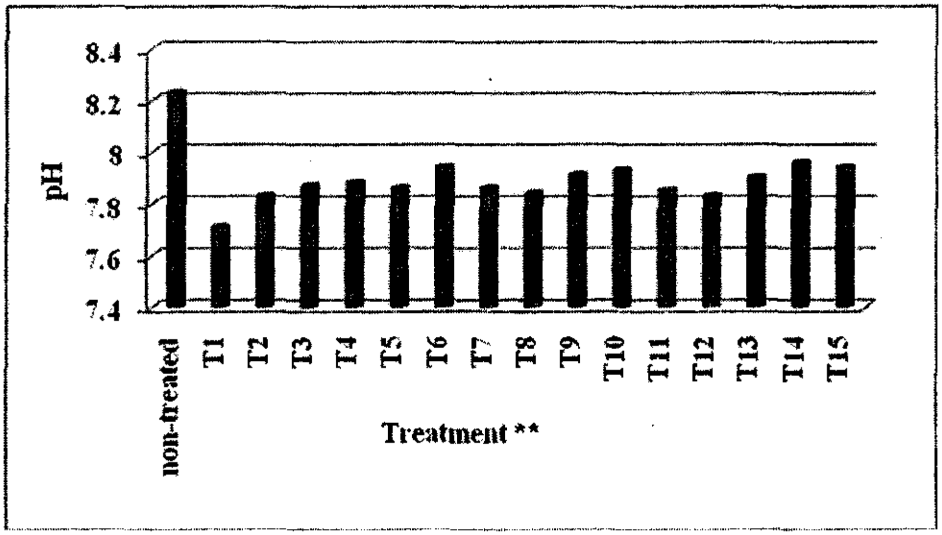

Fig. 7. Effect of treatments on soil pH after wheat harvest

Table 6. Effect of treatments on water stable aggregates and MWD after wheat harvest and the percentage change (PC) caused by treatments in relation to non-treated soil

Treats.**	Water stable aggregates (%) 8 - 2 mm	2 - 1 mm	1 - 0.5 mm	0.5 - 0.25 mm	0.25 - 0.125 mm	0.125 - 0.063 mm	< 0.063 mm	MWD mm	IEP of MWD %
Non-treated	0.54	1.36	3.22	7.33	9.76	2.92	1.66	0.121	0.00
T_1	1.58	2.88	4.53	8.62	10.57	3.82	2.35	0.213	+76.03
T_2	0.55	1.38	3.24	7.35	9.81	2.95	1.68	0.122	+0.83
T_3	1.32	2.58	4.41	8.02	10.04	3.22	1.99	0.190	+57.02
T_4	0.57	1.39	3.28	7.45	9.98	2.99	1.72	0.124	+2.48
T_5	1.24	2.21	4.11	8.34	10.13	3.31	2.05	0.180	+48.76
T_6	1.28	2.26	4.23	8.48	10.24	3.51	2.11	0.185	+52.89
T_7	1.25	2.23	4.13	8.37	10.15	3.37	2.08	0.181	+49.59
T_8	0.76	1.97	3.96	7.89	9.96	3.11	1.76	0.149	+23.14
T_9	0.56	1.37	3.24	7.36	9.85	2.97	1.71	0.122	+0.83
T_{10}	0.77	2.09	3.99	7.88	9.99	3.07	1.78	0.152	+25.62
T_{11}	1.11	2.06	4.05	8.11	10.03	3.16	1.87	0.170	+40.50
T_{12}	0.72	1.93	3.82	7.91	9.91	3.02	1.77	0.145	+19.83
T_{13}	0.69	1.85	3.73	7.81	9.84	2.96	1.67	0.141	+16.53
T_{14}	1.21	2.19	4.12	8.18	10.08	3.39	1.98	0.178	+47.11
T_{15}	0.93	1.99	3.87	7.99	10.01	3.27	2.03	0.158	+30.58
LSD 0.05	0.177	NS	NS	NS	NS	0.195	NS	NS	n.d

** Refer to foot note of Table 3 for treatment designation

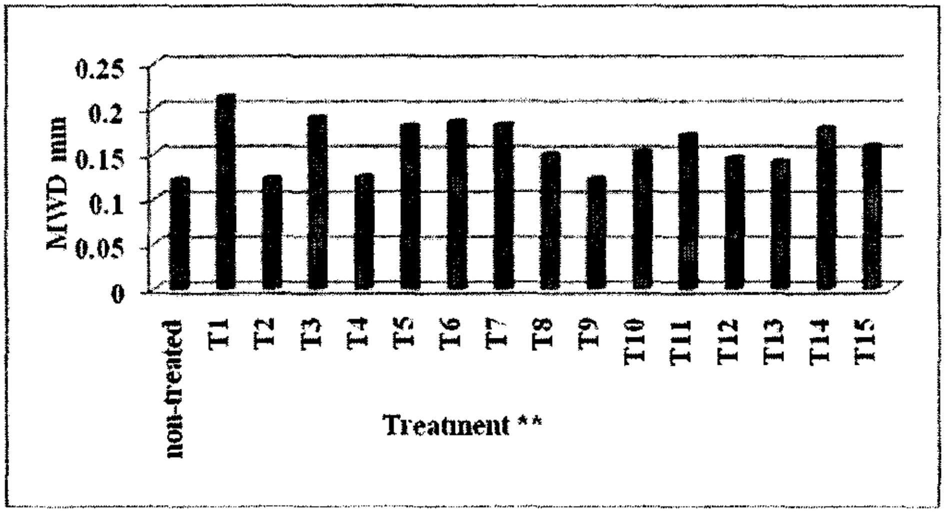

Fig. 8. Effect of treatments on MWD after wheat harvest

Table 7. Effect of treatments on B.D, Tot.Por, grain yield and straw yield after wheat harvest and the percentage change (PC) caused by treatments in relation to non-treated soil

Treats.**	B.D Mg/m^3	Tot.Por. %	G. Yield kg/Fad	S.Yield Kg/Fad	PC of B.D	PC of Tot.Por.	PC of G.Yield	PC of S.Yield
Non-treated	1.30	42.39	987	1047	0.00	0.00	0.00	0.00
T_1	1.19	46.96	3284	2146	-8.46	+10.78	+232.73	+104.96
T_2	1.27	43.61	1082	1766	-2.31	+2.88	+9.63	+68.67
T_3	1.25	44.46	1812	1738	-3.85	+4.88	+83.59	+66.00
T_4	1.27	43.68	2737	2474	-2.31	+3.04	+177.31	+136.29
T_5	1.25	44.42	1789	2567	-3.85	+4.79	+81.26	+145.18
T_6	1.22	45.90	2420	2080	-6.15	+8.28	+145.19	+98.66
T_7	1.27	45.05	2840	2280	-2.31	+6.28	+187.74	+117.77
T_8	1.21	46.26	2482	1966	-6.92	+9.13	+151.47	+87.77
T_9	1.26	43.80	2243	1764	-3.08	+3.33	+127.25	+68.48
T_{10}	1.26	44.18	1618	1901	-3.08	+4.22	+63.93	+81.57
T_{11}	1.22	45.68	1981	1765	-6.15	+7.76	+100.71	+68.58
T_{12}	1.19	46.98	2274	2822	-8.46	+10.83	+130.40	+169.53
T_{13}	1.20	46.83	2897	1910	-7.69	+10.47	+193.52	+82.43
T_{14}	1.19	46.93	3012	2033	-8.46	+10.71	+205.17	+94.17
T_{15}	1.24	44.77	2764	1596	-4.62	+5.61	+180.04	+52.44
$LSD_{0.05}$	NS	0.975	31.7	43	n.d	n.d	n.d	n.d

Note : B.D : Bulk Density, Tot. Por. :Total Porosity, G: Grain, S: Straw.

**** Refer to foot note of Table 3 for treatment designation.**

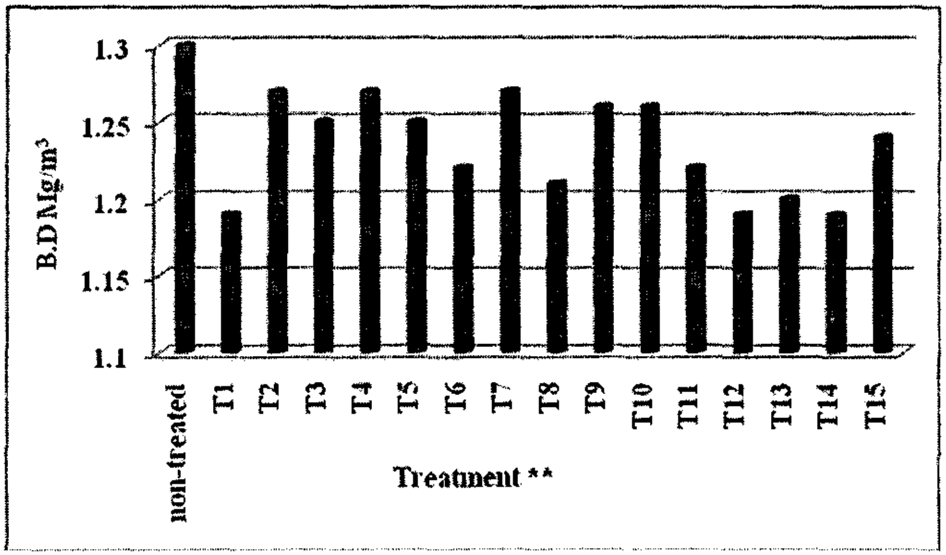

Fig. 9. Effect of treatments on soil bulk density after wheat harvest

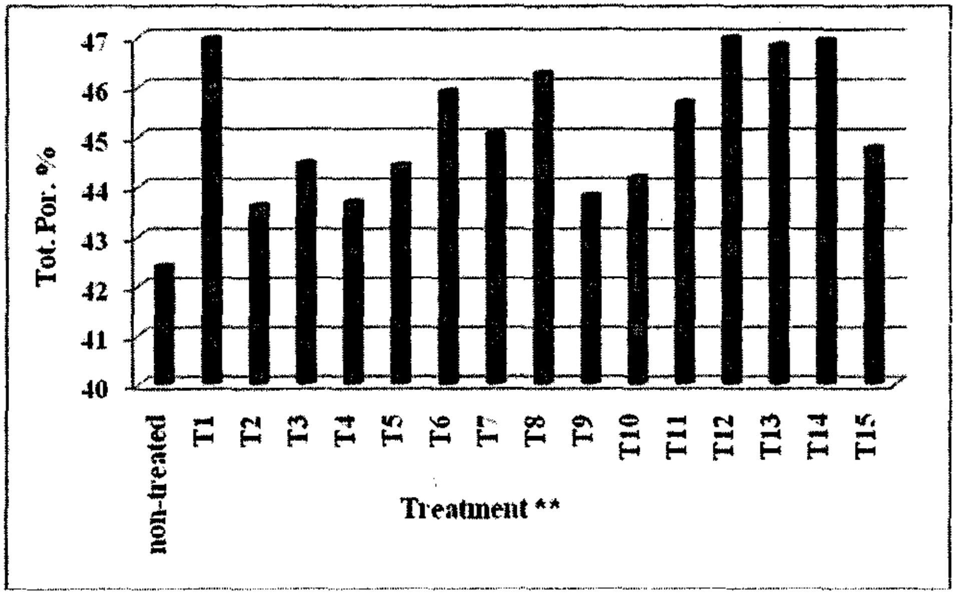

Fig. 10. Effect of treatments on total porosity after wheat harvest

**** Refer to foot note of Table 3 for treatment designation**

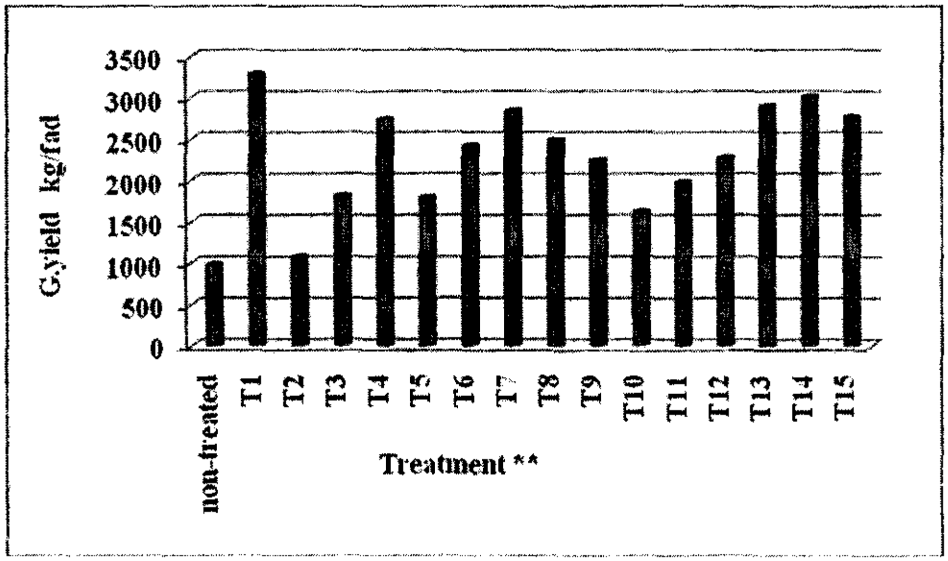

Fig. 11. Effect of treatments on grain yield after wheat harvest

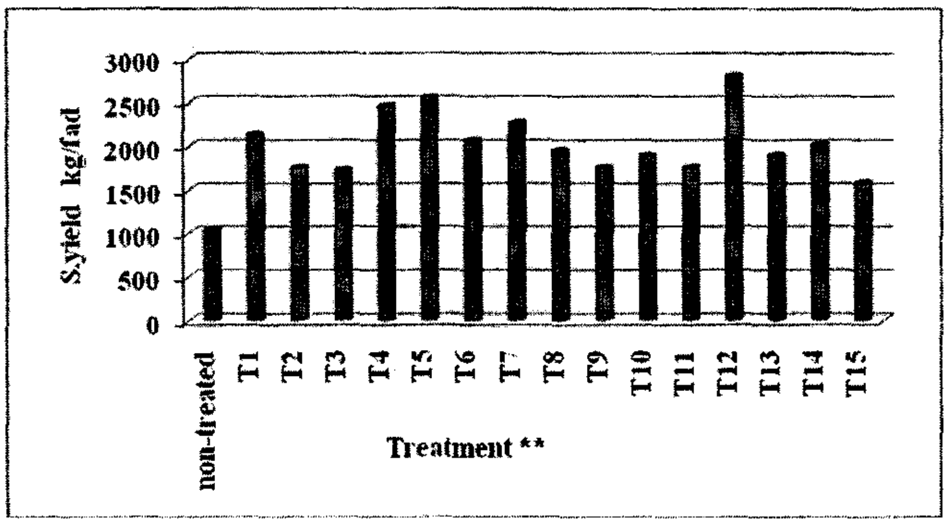

Fig. 12. Effect of treatments on straw yield after wheat harvest.

*** Refer to foot note of Table 3 for treatment designation**

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تأثير بعض المصلحات الأرضية على خصائص التربة المتأثرة بالأملاح وإنتاجيتها من محصول القمح

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أقيمت تجربة حقلية فى منطقة نبتيت ، بمحافظة الشرقية لتقييم أثر الإضافة المنفردة و المخلوطة لأربعة من محسنات ومصلحات التربة (وهى الجبس المفسفر، الكبريت الزراعي، السماد البلدي والرمل) على بعض خواص الأراضي الطينية الملحية القلوية وكذلك على إنتاجيتها من محصول القمح (سخا ٩٣).

أوضحت النتائج المتحصل عليها انخفاض ملوحة التربة فى جميع المعاملات مقارنة بالكنترول حيث حدث أعلى انخفاض عند إضافة (PG + S + FYM + Sand) بينما حدث أقل انخفاض عند إضافة الجبس المفسفر فقط. كذلك حدث انخفاض طفيف فى قيم الـــ pH في جميع المعاملات وقد أدت إضافة الجبس المفسفر (PG) فقط الى خفض رقم الـــ pH بدرجة أعلى من باقى المعاملات.

كذلك أوضحت النتائج انخفاض النسبة المئوية للصوديوم المتبادل فى جميع المعاملات مقارنة بالكنترول إلا أن اضافة الجبس المفسفر (PG) فقط كان أكثرها كفاءة فى خفض قيمة الـــ ESP بينما كانت إضافة الكبريت الزراعي أقلها كفاءة فى خفض قيمة الـــ ESP.

كما أوضحت النتائج اختلاف بسيط فى قيم كل من الكثافة الظاهرية والمسامية الكلية نتيجة للمعاملات المختلفة. كذلك أدت جميع المعاملات الى زيادة درجة ثبات التجمعات فى الماء وزيادة متوسط القطر الوزني حيث كانت معاملة الجبس المفسفر فقط أفضل المعاملات في هذا الخصوص.

كذلك أوضحت النتائج زيادة فى محصول الحبوب حيث تحقق أعلى محصول (٣٢٨٤ كجم / فدان) عند إضافة الجبس المفسفر فقط بمعدل ١٠٠ % من الاحتياجات الجبسية ، بينما أعطت معاملة الكبريت فقط أقل محصول (١٠٨٢ كجم / فدان) .

مما سبق يتضح أن استخدام الجبس المفسفر بمعدل ١٠٠ % من الاحتياجات الجبسية هو أفضل المعاملات فى تحسين خواص مثل هذه الأراضي (عدا الملوحة) وكذلك فى تعظيم انتاجيتها من محصول القمح .