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UTILIZATION EFFICIENCY OF DIFFERENT INDUSTRIAL BYPRODUCTS IN AMELIORATION OF SALINE-SODIC SOILS

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ABSTRACT

A field experiment was conducted during two successive years (2011/2012 and 2012/2013) in a clay saline soil located at South of El-Hussynia plain, Research Station ,Port-Said Governorate, Egypt. This study aims to evaluate the utilization efficiency of some industrial byproducts i.e. Sugar lime, vinasse, by-pass, pyrite (FeS_2) and aluminum sulfate ($Al_2 (SO_4)_3 18H_2O$) individual and interaction among them as a soil amendments and their effects on improving some chemical and physical properties of saline sodic soils, comparing with gypsum application, under Intermittent leaching technique was adopted using El-Salam canal water. The results showed that the chemical and physical properties of the studied soil were clearly improved due to amendments addition. The common parameters of saline sodic soil *i.e.,* EC, pH, ESP, RSE, B.D, P.R, and WTD were clearly improved. The superior improvement of these parameters was resulted from T_8, T_9 andT_7. The amendment can be arranged, ascending as follows: $T_1 < T_2 < T_{10} < T_6 < T_3 < T_5 < T_4 < T_{11} < T_{13} < T_{12} < T_7 < T_9 < T_8$ for both surface and subsurface layers. The final aim is to displace Na from an exchange complex and replace it with Ca, leading to a decrease of exchangeable sodium percentage (ESP) or increased removal sodium efficiency (RSE) consequently improvement of soil structure. An additional advantage to this strategy is that any mixture is inexpensive and ready available in large quantities in contrast to gypsum in this study.

Keywords: Saline sodic soils; amelioration, soil amendments, sugar lime, vinasse, By-pass, pyrite, gypsum, alternative gypsum.

INTRODUCTION

Saline-Sodic soils reclamation will be one of the main problems for humans in the future. The reclamation of saline uses many different methods such as physical amelioration (deep ploughing, sub-soiling, sanding and etc.) ,chemical amelioration(amending soil i.e.: gypsum, calcium chloride, sulphuric acid and sulphur,) electro-reclamation (treatment with electric current).The most effective procedures are based on the removal of exchangeable and soluble sodium as well as modification of the ionic composition of soils by adding chemicals paralleled with leaching of sodium salts out of the soil profile (Mahdy,2011).The worldwide occurrence of such soils on 560 $\times 10^6$ ha^{-1} emphasizes the need for efficient, inexpensive, and environmentally acceptable management. These soils can be ameliorated by providing a source of calcium (Ca^{2+}) to replace excess sodium (Na^+) from the cation exchange sites. (Shainberg &Letey 1984). The 62000 feddans of south EL-Hassanyia plain is situated in the North part of the river Nile Delta. The entire area is devoid of vegetation because of the extremely high salinities. These areas irrigated from EL-Salam canal. This brings water to the area from the river Nile, mixed with water from the Haddous and the lower Sirw outfall drains in as much as 1: 1.25. Grattan and Oster, (2003) reported that leaching is the only effective way to decrease excessive salts from the root zone of the salt affected soils. This is the process of dissolving and transporting soluble salts by downward movement of water through the soil surface. Its efficiency can be defined as the quantity of soluble salts leached per unit volume of water applied to the soil. Keren, (1990) showed that intermittent leaching is based on giving a set amount of water to the leaching plot and allowing this set amount to be drained completely to the drains. Sometimes intermittent leaching is combined with mulching to improve its performance. Leaching efficiency increased under intermittent leaching. It allowed more time for the movement of water through pores and improved the leaching efficiency.

Abdalla *et al.* (2010) concluded that the drainage installation is the most important tool to conserve or reclaim the harmful effect of salty clayey soils to a feasible one. This process must be under taken with gypsum requirements. The application of gypsum enhances leaching by improving soil hydraulic conductivity (Ghafoor *et al*.2001). The application of gypsum for the reclamation of sodic soils enhanced the removal of soluble Na^{+}, decreased salinity, ESP and pH and increased soluble and exchangeable calcium and hydraulic conductivity of the reclaimed soil. Hussain *et al*. (2000) observed that the applications of amendments before leaching improved permeability better than leaching before the application of amendments. The use of sugar lime and vinasse, which are final by-product of the sugar industry, is of great interest because of their low costs and the large quantities that are being produced. Mansour (2002) showed that adding sugar lime to saline sodic soils increased total porosity, water holding capacity, quickly drainable and water holding pores, consequently soil hydraulic conductivity increased. On the other hand, soil bulk density and fine capillary pores were decreased by increasing the application rate. Reda *et al.* (2006) found that the application of sugar lime with sulphur to saline sodic soil improved soil structure**.**

Vinasse also is a final by-product of the sugar industry. It is produced after removal of the fermentation products from molasses, it can be characterised by high organic carbon (350-830 g kg^{-1}) and nutrient contents (30-53 g N kg^{-1} and 30-95 g K kg^{-1}) in this by-product make it potentially useful as a fertilizer, although with some constraints to its salinity, low C: N ratio and low phosphorus content. Addition of such by-product as an amendment to soil led to improve the physical, chemical and biological properties of soils, as well as the reduction of disposal costs (Parnaudea *et al.* 2008 and Habib *et al*. 2009).

Tejada *et al*. (2007) found that beet vinasse was a positive effect on soil's physical structural stability increased and bulk density decreased with respect to control. (Kosmatka *et al*., 2002) found that the cement kiln dust (CKD)"By-pass" is a fine grained material generated as a by-product of cement manufacturing. Raw materials are fed into cement Kiln and heated to temperatures ranging between 1400 and 1550 °C. The main raw material used to produce cement is lime stone ($CaCO_3$) with approximately ten

percent of the raw mix made up of a silica source (*e.g.,* sand or clay), an alumina source and an iron source. Abd El-Hamid *et al*. (2011) concluded that the usage of any amendments gypsum, sugar lime, By-pass, mixture (1) and mixture (2) could be positively affect on about reclamation of saline clay soil in Sahall El-Tina district. Mansour *et al*.(2014) concluded that using a suitable amendments mixtures under suitable application method (surface +subsurface) with intermittent leaching cycles, were the best which led to short time for reclamation of clay saline sodic soils. Dahlya *et al.* (1981) observed that leaching intermittently allowed more time for the movement of water through pores and improved the leaching efficiency. Al-Sibai *et al.* (1997) concluded that intermittent leaching could improve leaching efficiency.
Iron pyrites waste products from mining operations and are also mined products, they have been used with varying success to supply Fe and S to plants. Furthermore, ameliorate sodic soils when oxidized to acid. Several forms of pyrite exist depending upon origin and crystallinity.((Wallace &Wallace 1992).Ahmed *et.al.*(1986) and Mace *et al*,(1999) found that a comparison of gypsum, pyrite, aluminum sulfate and sulfuric acid in reclamation of sodic soils indicated good possibilities of utilizing pyrite and sulfuric acid for sodic soil amelioration, as well as pyrite can be also used as a source of micronutrients needed for plant growth. Gulsen *et al.* (2014) reported that the application of waste pyrite or sulfuric acid to calcareous sodic soil with dose of 44.7 and 35.3 $Mgha^{-1}$ superior to the gypsum of 55.2 Mg ha^{-1}in terms of ESP in 42 and 26 weeks respectively.

The aim of this experiment was to improve the efficiency of some industrial byproducts i.e. Sugar lime, vinasse, by-pass, pyrite (FeS_2) and aluminum sulfate ($Al_2(SO_4)_3 18H_2O$) individual and interaction among them as soil amendments (alternative gypsum) in saline sodic soils, as well as, to evaluate their effects on improving some soil chemical and physical properties.

MATERIALS AND METHODS

A field experiment was conducted at South-El-Hussynia plain, Agricultural Research Station, Port Said Governorate, during two successive years 2011/2012 and 2012/2013 to study the utilization efficiency of some industrial by-products materials, as soil amendments on improving the properties of saline sodic soils .Characteristics of the studied experimental soil are presented in Table (1). In addition, the chemical composition of sugar lime, vinasse and By-pass is tabulated in Table (2). The composition and chemical properties of the four mixtures of amendments used are presented in Table (3)

Table 1: Characteristics of the studied experimental soil

Soil properties	Value
Particle size distribution (%)	
Coarse sand	2.7
Fine sand	14.3
Silt	22.6
Clay	60.4
Texture class	Clay
Chemical analysis	
pH (1:2.5)	9.17
EC $dS.m^{-1}$	38.2
ESP(%)	28.7

Table 2: Chemical composition of sugar lime, vinasse and by-pass used.

Characteristics	Sugar lime	Vinasse	Cement kiln dust (By-pass)
Density (Mg m^{-3})	0.74	1.14	0.63
pH (1:2.5)	8.30	4.50	12.0
SP	70.0	--	209
O.M (%)	3.42	38.3	-
Total elements (%)			
Nitrogen	0.94	0.20	0.02
Potassium	0.06	0.71	1.36
Calcium	28.5	0.65	4.51
Phosphorus	0.28	0.21	0.09
Manganese	3.42	0.60	0.35
Iron	0.007	0.0006	0.011
Copper	0.21	0.0073	2.02
Zinc	0.003	0.0024	0.003

The experimental layout:

The studied soil has a shallow water table (40 cm. from the soil surface) which caused lower hydraulic conductivity (0.09 cmh^{-1}) and higher EC =38.2 dSm^{-1} in saturated paste extract, pH = 8.7 in 1:2.5 soil water suspension.

The field experimental was tilled by deep plowing (40 cm depth). Calculated the distance between the drainage according to the equation of Hooghoudt (1940) which was identified at 8.0 m. So drainage ditches were drilled on spacing of 8 and 16 m., in the first period (6 months).Where. Intermittent leaching conducted from 1/4/2011 to 31/10/2011.The leaching water was supplied from irrigation canal lie between two drains, as shown in Fig 1. The intention in this case was to apply water on surface to a depth of 200 mm and then allows it to infiltrate and evaporate away until the surface become free or standing water. The soil was then left to dry out for some time before the basins were re-irrigated. Intermittent leaching in which pounded water application is interrupted with rest periods allowing redistribution of the salts held in micro pores. At the end of the first period after leaching process EC was decreased to 19.8 and ESP to 18.7

Table 3: Composition and chemical properties of the nine mixtures of amendments used

Mixtures of amendments	Mixtures composition percent (w/w).						Chemical properties		
	S.L	B.P	V	A	Al.	P.	pH	S.D (g L^{-1})	Aval.Ca %
M_1	-	4	1	2	-	-	7.11	2.86	0.8
M_2	4	-	1	1	-	-	7.07	4.24	2.46
M_3	3	2	1	1	-	-	7.09	1.43	2.96
M_4	-	4	1	2	1	-	6.95	3.76	1.65
M_5	4	-	1	1	1	-	6.85	6.46	4.58
M_6	3	2	1	1	1	-	7.0	2.98	5.38
M_7	-	4	1	2	-	1	7.08	2.96	1.25
M_8	4	-	1	1	-	1	7.02	4.48	3.84
M_9	3	2	1	1	-	1	7.05	1.75	3.76

S.L: Sugar lime V: Vinasse B.P: By-pass A: Commercial Sulfuric acid
Al.: Aluminum sulfate P.: Pyrite
S.D: soluble degree Aval.Ca: available calcium

The experimental design:

After the end of the first leaching cycle the experimental design was laid out as a randomized complete block design with 12 treatments and 3 replications. The field experiment was divided into (36) plots; with plot area of 80 m^2 (1/53 fed). Amendment treatments were applied to the soil on the basis of gypsum requirements (GR), 6.0 Mg fed^{-1} to reduce ESP to 15% at depth 15 cm. (FAO, 1988), uniformly spread and thoroughly mixed in the soil surface by tillage. Then repeating leaching cycle for three periods. At the end of each leaching process soil samples were taken for chemical analysis The amount of any amendment to be applied for amelioration is based on the amount equivalent to that of gypsum (Table 4).

Table 4: Chemical composition and equivalent amount of a chemical amendment that can substitute One Mega (Mg) of gypsum in ameliorating sodic soils.

Amendment	Chemical composition	Amount equivalent to 1Mg of gypsum
Gypsum.	$CaSO_4$ _ $2H_2O$	1.0
Calcium chloride	$CaCl_2$-$2H_2O$	0.85
Calcium carbonate	$CaCO_3$	0.58
Sulfuric acid	H_2SO_4	0.57
Ferrous sulfate	$FeSO_4$ _ $7H_2O$	1.61
Ferric sulfate	$Fe_2(SO_4)_3$ _ $9H_2O$	1.09
Aluminum sulfate	$Al_2(SO_4)_3$-$18H_2O$	1.29
Sulfur	S	0.19
Pyrite	FeS_2	0.63

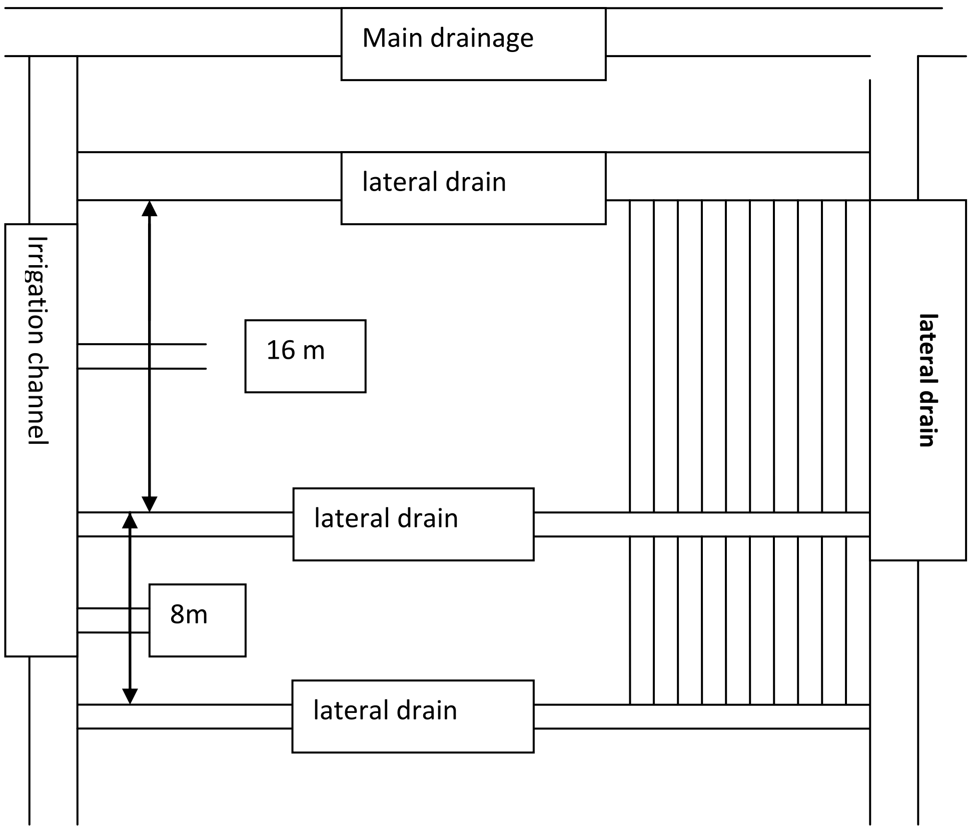

Fig.1: layout of experimental plots in a randomized complete block design

The amount of gypsum needed to ameliorate a specified soil depth is called gypsum requirement (GR).

The treatments of soil amendment materials were:

T_1 Leaching only "not amended"
T_2 Gypsum (G) which added at a rate of 6.0 Mg fed^{-1}.
T_3 Mixture (1) at a rate of 3.0 Mgfed^{-1} according to (GR)= 100 % GR .
T_4 Mixture (2) at a rate of 2.5 Mg fed^{-1} according to (GR) = 100 % GR.
T_5 Mixture (3) at a rate of 3.0 Mg fed^{-1} according to (GR) = 100 % GR
T_6 Aluminum sulfate which added at a rate of 7.75 Mg fed^{-1}.
T_7 Mixture (4) at a rate of 3.6 Mg fed^{-1} according to (GR) = 100 % GR
T_8 Mixture (5) at a rate of 3.6 Mg fed^{-1} according to (GR) = 100 % GR
T_9 Mixture (6) at a rate of 3.65 Mg fed^{-1} according to (GR) = 100 % GR
T_{10} Pyrite which added at a rate of 3.8 Mg fed^{-1}.
T_{11} Mixture (7) at a rate of 4.0 Mg fed^{-1} according to (GR) = 100 % GR
T_{12} Mixture (8) at a rate of 3.6 Mg fed^{-1} according to (GR) = 100 % GR
T_{13} Mixture (9) at a rate of 3.7 Mg fed^{-1} according to (GR) = 100 % GR

Table 5: List of published methods used in the determined properties.

Soil properties	References
Particle size distribution (%)	Gee and Bauder, 1986
Bulk density (Mg m^{-3})	Vomocil, 1965
Hydraulic conductivity (cm h^{-1})	VanBeers,1958 (Auger hole method)
Ground water levels	Luthin 1966.
Soil pH and electrical conductivity (dS m^{-1})	Page *et al.* 1982.
Gypsum requirement (Mg fed^{-1})	FAO, 1988.

Removal sodium efficiency (RSE):

Removal sodium efficiency is the percentage of Na-removed from soils at end of the experiment was calculated as follows:

$$RSE = (ESP_i - ESP_f) / ESP_i \times 100$$

Where:

ESP_i = exchangeable sodium percentage before the soil amendments application

ESP_f = exchangeable sodium percentage after the soil amendments application at the end of the experiment

RESULTS AND DISCUSSION

Effect of applied soil amendments and leaching process on soil properties:

a.) Soil salinity (EC_e):

The EC_e values of soil samples at the end of every season, in the studied soil under different application rate of amendments and leaching process are presented in Tables (6 and 7) The data indicate that EC_e decreased to 4.1 and 4.8 dSm^{-1} for both section width of 8.0.and 16 m. in the surface layer., Also, data showed that there were differences in EC_e under treated soils among depths and active desalinization was observed in all the treatments. The sharp decrease in EC_e in all treatments was observed with T_8 and T_9 treatments which were found to be most effective treatments, for section width of 8.m and 16 m. , respectively.

Also, the values of Ec_e can be arranged descending as follows: $\mathbf{T_1>T_2>T_{10}>T_6>T_3>T_5>T_4>T_{11}>T_{13}>T_{12}>T_7>T_9>T_8}$ at section width of 8m.The same trend was observed in the section width of 16m.t subsurface layer. Similar trend was found throughout the three seasons. This could be attributed to one or more of the following reasons, the presence of soil amendments (*i.e.* S.L., B.P., vinasse and sulfuric acid). Vinasse and S.L. can be characterised by high organic carbon (Habib *et al*. 2009). By-pass (B.P.) and sugar lime (S.L.) has high content of $CaCO_3$ and can be used as a source of Ca^{2+}. Sulfuric acid may increase quantities of exchangeable and soluble calcium. Also presence of Al in Aluminum sulfate, Fe in pyrite (FeS_2)

enhanced the leaching process. As well as additional open drainage installations and leaching cycle. (Abd El-Hamid, *et al*. 2011).

Data also, showed, that application of any amendment to soils causes a clear decline in the EC_e values compared to EC_e of initial soil (first period). This effect is more pronounced in the surface layer. Surface applied water would pass through the surface applied amendment and infiltrate the top layers allowing exchange process between Ca^{2+} and Na^+ (El-Sharawy *et al*. 2008).

b*) Soil PH:*

Soil pH has a considerable impact on controlling the plant nutrients, particularly the availability of micronutrients (Naidu & Rengasamy 1993). The use of saline-sodic water on soils for agriculture without an amendment application, in general, tends to increase the soil pH that impacts the soil nutrient availability, rendering plants with malnutrition (Curtin & Naidu 1993) In this study, the data in Tables (6 and 7) obtained after four periods revealed differences between the treatments of the soils used .All treatments had the ameliorative potential to decreased the pH value after leaching processes, especially T_8 T_9 and T_7, during reclamation of saline-sodic soil. pH of clay saline-sodic soil was less affected than pH of Sandy soil after amendments application because of the high clay content which acted as a buffer and resisted any appreciable change in soil pH in the alkaline range. In general, a high EC to SAR ratio tends to lower pH and vice versa (Ghafoor *et al*. 2001). Also, the data showed that the using of different forms of soil amendments reduced the pH value. T_8 amendment was the most effective in reducing the pH values than other amendments. in both for section width of 8.m and 16 m. at surface layer compared the pH of initial soil. The pH values can be arranged descending as fallows $\mathbf{T_1>T_2>T_{10}>T_6>T_3>T_5>T_4>T_{11}>T_{13}>T_{12}>T_7>T_9>T_8}$**.** The same trend was observed in both for section width of 8.m and 16 m. for subsurface layers. Similar trend was found throughout the three seasons, this could be attributed to one or more of the following reasons. The presence of soil amendments its constituents (*i.e.* S.L., B.P., vinasse and sulfuric acid). Vinasse and S.L. can be characterised by high organic carbon (Habib *et al*. 2009). By-pass (B.P.) and sugar lime (S.L.) has high content of $CaCO_3$ and can be used as a source of Ca^{2+}. Sulfuric acid may increase quantities of exchangeable and soluble calcium. Also presence of Al in Aluminum sulfate, Fe in pyrite (FeS_2) enhanced the leaching process and the presence of high adsorptive capacity materials like compost adsorb more sodium as well as additional open drainage installations and leaching .

Table 6" Some chemical properties of soil at surface layer (0 -15 cm.) throughout the experimental time.

Treatments	*Periods	Section width of 8 m.				Section width of 16 m.			
		Ec_e (dSm^{-1})	ESP (%)	RSE (%)	pH	Ec_e (dSm^{-1})	ESP (%)	RSE (%)	pH
Intermittent leaching only.	1st	19.8	28.7	-	9.17	19.8	28.7	-	9.17
T_1 Control ((Leaching only)	2nd	15.6	27.3	4.88	8.92	17.8	28.7	1.07	8.94
	3rd	12.8	25.4	11.5	8.96	15.2	28.5	2.67	8.98
	4th	8.7	22.1	23.0	8.99	11.6	28.3	3.74	9.11
T_2	2nd	12.7	23.3	18.8	8.40	14.6	25.6	16.6	8.70
	3rd	10.6	20.1	30.0	8.15	11.7	21.1	40.6	8.60
	4th	8.5	16.6	42.2	8.05	6.8	18.3	36.2	8.45
T_3	2nd	12.5	21.7	24.4	7.95	14.1	25.2	18.7	8.55
	3rd	10.1	19.5	32.1	7.85	11.6	20.6	43.3	8.40
	4th	7.8	15.2	47.1	7.70	5.4	17.5	39.0	8.30
T_4	2nd	12.6	22.5	21.6	7.85	14.4	24.7	21.4	8.45
	3rd	10.2	19.8	31.0	7.75	11.6	21.2	40.1	8.30
	4th	7.1	13.8	51.9	7.60	6.3	18.1	36.9	8.20
T_5	2nd	12.8	24.2	15.7	7.90	13.6	26.5	7.67	8.50
	3rd	10.7	20.7	27.9	7.80	11.4	22.8	20.6	8.35
	4th	7.4	14.8	48.4	7.65	7.5	18.6	35.2	8.25
T_6	2nd	11.2	19.3	32.8	8.00	14.7	22.9	20.2	8.10
	3rd	9.6	16.5	42.5	7.90	11.8	19.3	32.8	8.45
	4th	7.9	15.6	45.6	7.75	5.2	16.6	42.2	8.35
T_7	2nd	11.4	18.4	35.9	7.65	15.6	21.6	24.7	8.26
	3rd	8.6	15.7	45.3	7.50	12.1	18.6	35.2	8.10
	4th	5.3	11.8	58.9	7.35	9.2	16.2	43.6	8.00
T_8	2nd	10.9	19.0	33.8	7.55	15.3	21.5	24.7	8.15
	3rd	7.8	16.0	44.3	7.40	11.6	18.3	31.0	8.00
	4th	4.1	11.3	60.6	7.25	4.8	16.4	42.2	7.90
T_9	2nd	13.4	25.1	12.5	7.60	16.2	27.5	8.56	8.20
	3rd	11.4	21.3	25.8	7.45	9.2	23.8	25.1	8.03
	4th	4.6	11.4	60.4	7.30	7.9	18.3	40.6	7.92
T_{10}	2nd	12.4	21.1	26.5	8.05	16.5	23.6	17.8	8.65
	3rd	9.9	19.0	33.8	7.95	12.2	21.2	26.1	8.51
	4th	8.1	16.4	42.9	7.85	6.2	17.6	38.7	8.40
T_{11}	2nd	11.7	19.7	31.4	7.80	15.9	21.1	26.5	8.40
	3rd	9.7	16.9	41.1	7.70	12.4	19.9	30.7	8.25
	4th	8.6	13.0	54.7	7.50	5.5	16.8	36.9	8.17
T_{12}	2nd	13.7	20.5	28.6	7.70	15.9	23.4	18.5	8.30
	3rd	11.8	18.4	35.9	7.60	12.5	20.5	28.6	8.15
	4th	6.0	12.1	57.8	7.40	7.6	18.0	61.0	8.05
T_{13}	2nd	14.1	26.4	8.01	7.73	15.4	27.3	4.88	8.35
	3rd	12.2	23.2	19.2	7.64	13.7	24.7	13.9	8.20
	4th	6.3	12.6	56.1	7.45	8.2	19.2	33.1	8.10

RSE: Removal sodium efficiency ***Period: 6 months**

Table 7: Some chemical properties of soil at sub-surface layer (15 -30 cm.) throughout the experimental time.

Treatments	periods	Section width of 8 m.				Section width of 16 m.			
		Ec_e (dSm^{-1})	ESP (%)	RSE (%)	pH	Ec_e (dSm^{-1})	ESP (%)	RSE (%)	pH
Intermittent leaching only.	1st	19.5	28.7	-	9.22	19.5	28.7	-	9.22
T_1 Control (Leaching only)	2nd	17.3	28.5	1.07	8.82	18.5	28.6	0.53	8.91
	3rd	14.6	28.2	2.67	8.85	16.8	28.5	1.07	8.93
	4th	11.4	27.9	4.28	8.90	13.5	28.2	2.67	8.97
T_2	2nd	12.8	23.6	17.8	8.65	15.1	26.1	13.9	8.77
	3rd	11.5	19.6	31.7	8.56	10.2	21.6	38.0	8.70
	4th	10.6	16.9	41.1	8.35	7.9	14.7	58.8	8.48
T_3	2nd	11.8	23.0	19.9	8.60	14.6	25.5	17.1	8.75
	3rd	9.2	19.0	33.8	8.50	10.4	21.3	39.6	8.65
	4th	8.4	15.6	45.6	8.30	7.2	14.0	62.6	8.45
T_4	2nd	12.0	23.2	19.2	8.62	14.2	25.8	15.5	8.78
	3rd	8.6	19.3	32.8	8.53	11.1	21.6	38.0	8.65
	4th	7.7	15.2	47.0	8.32	7.0	14.3	61.0	8.47
T_5	2nd	14.7	24.1	16.0	8.55	14.9	25.2	18.7	8.70
	3rd	8.9	19.9	30.7	8.40	11.3	21.1	36.2	8.55
	4th	7.8	15.3	46.7	8.25	7.9	12.6	64.7	8.40
T_6	2nd	10.5	22.0	23.3	8.65	11.3	26.5	11.8	8.77
	3rd	9.7	17.9	37.6	8.60	7.6	22.1	35.3	8.75
	4th	9.5	15.8	44.9	8.37	5.7	16.1	46.0	8.50
T_7	2nd	9.4	21.1	26.5	8.71	10.2	27.5	6.42	8.83
	3rd	6.6	17.1	40.4	8.66	5.8	23.9	25.7	8.80
	4th	5.2	14.9	48.1	8.42	5.2	18.5	49.2	8.56
T_8	2nd	10.1	21.8	24.0	8.72	12.9	27.2	8.02	8.82
	3rd	5.5	17.5	39.0	8.65	7.2	23.0	30.5	8.75
	4th	4.6	14.7	48.8	8.40	6.4	18.0	51.9	8.55
T_9	2nd	15.2	24.7	13.9	8.75	16.3	28.1	16.0	8.85
	3rd	6.4	20.1.	30.0	8.70	13.4	24.8	20.9	8.81
	4th	5.0	14.8	48.4	8.48	10.2	20.5	43.9	8.62
T_{10}	2nd	11.4	22.9	20.2	8.76	13.7	28.3	2.14	8.87
	3rd	10.7	18.8	34.5	8.70	8.6	24.9	20.3	8.81
	4th	10.1	16.0	44.3	8.50	9.8	21.0	41.2	8.65
T_{11}	2nd	10.7	22.3	22.3	8.72	12.0	27.7	5.35	8.83
	3rd	7.7	18.1	36.9	8.68	8.7	24.2	24.1	8.80
	4th	6.8	15.1	47.4	8.45	7.8	18.8	47.6	8.67
T_{12}	2nd	10.9	22.5	21.6	8.75	13.9	27.9	4.28	8.85
	3rd	7.0	18.3	36.2	8.70	9.3	24.5	22.5	8.81
	4th	6.0	15.0	47.7	8.46	7.2	20.1	46.0	8.60
T_{13}	2nd	15.5	25.4	11.0	8.66	16.5	27.1	5.57	8.75
	3rd	7.5	20.3	29.3	8.56	13.4	26.2	8.71	8.65
	4th	6.2	15.0	47.7	8.45	9.8	24.7	13.9	8.55

c) Soil sodicity (ESP):

The sodification phenomenon constitutes a highly complicated problem in the studied clay soil, which constricts its productivity. Data in Table (6 and 7) showed a gradual obvious decline in ESP value with increasing the experimental time, where its value reduced below the safe limit (<15 %) after four periods. Data presented in Tables (6 and 7) showed that exchangeable sodium percentage (ESP) values before application amendments with soil depth (28.7 %) While, after repeatedly leaching cycles and application amendments, ESP values decreased with T_8 and reach about of 14.3 % and 16.4 % with relative decrease (50 and 43 %) for section width of 8.m and 16 m. at surface layer, respectively. Also, the data showed that the using of different forms of soil amendments reduced the ESP values. T_7 amendment was the most effective in reducing the ESP values than other amendments. for section width of 8.m and 16 m. at surface layer compared to initial value of ESP

The ESP values can be arranged descending as fallow **T_1> T_2> T_{10}> T_6> T_3> T_5> T_4> T_{11}> T_{13}> T_{12}> T_7> T_9> T_8.**The same trend was observed in the section width of 8.m and 16 m. for subsurface layers. Similar trend was found throughout the three seasons.

The process of leaching was effective in presence of amendments. However, ESP decreased by leaching without using amendments and the soil remained sodic with highly ESP values. However, the final ESP obtained after leaching with amendments *i.e.*, highest R.D% in the values of ESP. The use of the T_8, T_9 proved to be more effective than other treatments. Also, the removal of sodium efficiency (RSE) or percentage of Na-removed from the soil in the end of the experiment was increased after the application of the amendments, particularly T_8 where RSE each to 50 and 43 % for both the section width 8.0 and 16m.respectively.The RSE values can be arranged descending as fallow: T_8> T_9> T_7> T_{12}> T_{13}> T_{11}> T_5> T_4> T_3> T_6> T_{10}> T_2> T_1. Similar trend was found throughout the three seasons and in both section width of 8 m and 16 m. This could be attributed to the dominance of soluble calcium on the exchange complex which encourage decreasing of both soluble and exchangeable sodium hence decreasing the ESP values. These results are in agreement with Mansour *et.al* (2011), Abd El-Hamid *et.al* (2011).

Soil physical properties

Soil physical properties are a fundamental part of soil quality assessment, as they often cannot be easily improved. Of special important, is porosity and pore size distribution. Thereby, it affects the water retention and soil hydraulic conductivity. Soil bulk density is a major product of the changes in the soil and field conditions. It is affected by the variations in soil texture, soluble salts, and exchangeable sodium percentages, all of which govern the structural status.

a) Soil hydraulic conductivity (Ks):

The distinguishing characteristics of slowly permeable saline sodic and sodic soils are due to high contents of exchangeable sodium and low hydraulic conductivity. The hydraulic conductivity measurement provides an indication of relative water transmission rate of the soil and depends on many factors, especially the volume of drainable pores. Data in Tables (8 and 9) showed that the effect. amount of soluble calcium and organic matter from previous mixtures which enhanced the soil aggregates of different treatments of the tested soil amendments under leaching cycles on hydraulic conductivity (Ks). Data reveal that the values of hydraulic conductivity (Ks),increased as a result of repeatedly leaching cycles with different amendments. The data showed that the mean values of Ks are response to the application of different soil amendments. The data reveal that the most effective treatments were T_8, T_9 and T_7 for section 8.m.and 16 m. for surface layer.

Table 8: Some physical properties of soil at surface layer (0 -15 cm.) throughout the experimental time.

Treatments	Periods	Section width of 8 m.			Section width of 16 m.		
		B.D (kgm^{-3})	**P.R .($kg\ cm^{-2.}$)**	**Ks ($cm\ hr^{-1}$)**	**B.D (kgm^{-3})**	**P.R ($kg\ cm^{-2}$.)**	**Ks ($cm\ hr^{-1}$)**
Intermittent leaching only.	1st	1.49	53.4	0.50	1.50	51.7	O,48
T_1 Control (Leaching only)	2nd	1.46	50.7	0.56	1.47	51.2	0,51
	3rd	1.42	48.5	0.65	1.43	46.8	0,56
	4th	1.40	44.4	0.72	1.41	42.9	0.62
T_2	2nd	1.44	48.7	0,64	1.46	50.1	0.60
	3rd	1.39	46.3	0.66	1.41	46.6	0,77
	4th	1.38	42.5	0.80	1.38	41.9	0.85
T_3	2nd	1.31	41.5	0.90	1.39	44.1	0.88
	3rd	1.28	39.8	1.20	135	42.2	0.96
	4th	1.26	38.4	1.40	1.30	38.6	1.01
T_4	2nd	1.33	38.1	1.06	1.35	40.9	0.96
	3rd	1.28	36.2	1.35	1.30	38.6	1.03
	4th	1.23	33.4	1.55	1.26	32.7	1.20
T_5	2nd	1.29	39.4	0.95	1.36	41.6	0.90
	3rd	1.27	37.5	1.25	1.32	38.8	0.99
	4th	1.25	35.9	1.50	1.28	35.4	1.16
T_6	2nd	1.35	44.4	0.82	1.41	46.7	0.78
	3rd	1.30	43.2	0.93	1.38	43.6	0.85
	4th	1.29	40.3	1.10	1.34	39.6	0.96
T_7	2nd	1.34	34.2	1.35	1.26	34.5	1.20
	3rd	1.25	33.8	1.54	1.23	31.1	1.25
	4th	1.15	30.1	1.72	1.20	30.1	1.38
T_8	2nd	1.30	31.6	1.48	1.23	31.9	1.23
	3rd	1.19	30.2	1.60	1.19	30.0	1.38
	4th	1.13	29.5	1.80	1.15	29.0	1.46
T_9	2nd	1.33	32.2	1.43	1.25	32.4	1.24
	3rd	1.20	30.9	1.55	1.21	30.3	1.30
	4th	.1.13	29.6	1.76	1.19	29.2	1.40
T_{10}	2nd	1.44	46.8	0.60	1.46	50.0	0.68
	3rd	1.40	44.3	0.69	1.42	45.1	0.83
	4th	1.36	42.3	0.82	1.36	40.6	0.92
T_{11}	2nd	1.32	36.9	1.72	1.32	38.4	1.06
	3rd	1.26	34.6	1.41	1.28	46.4	1.12
	4th	1.20	32.3	1.60	1.25	32.0	1.26
T_{12}	2nd	1.26	35.8	1.30	1.28	36.3	1.18
	3rd	1.21	32.6	1.50	1.24	34.3	1.21
	4th	1.16	30.5	1.70	1.21	31.1	1.32
T_{13}	2nd	1.30	36.0	1.25	1.30	37.6	1.15
	3rd	1.23	34.0	1.50	1.26	34.8	1.20
	4th	1.18	31.3	1.65	1.23	31.5	1.30

Ks: Hydraulic conductivly($cm\ hr^{-1}$) B.D: soil bulk density (gcm^{-3}) P.R: Penetration resistance $kgcm^{-2}$

Table 9: Some physical properties of soil at sub-surface layer (15-30 cm.) through out the experimental time.

Treatments	Periods	Section width of 8 m.			Section width of 16 m.		
		B.D (kgm^{-3})	P.R (kg cm^{-2}.)	Ks (cm hr^{-1}) (	B.D (Mgm^{-3})	P.R (kg cm^{-2}.).	Ks (cm hr^{-1})
Intermittent leaching only.	**1st**	**1.51**	**52.4**	**0.38**	**1.53**	**53.7**	**0.35**
T_1 Control (Leaching only)	2nd	1.49	50.7	0.45	1.50	51.7	0.42
	3rd	1.46	49.5	0.52	1.48	52.8	0.50
	4th	1.42	48.4	0.58	1.44	47.9	0.54
T_2	2nd	1.45	48.7	0.55	1.46	48.1	0.53
	3rd	1.36	46.3	0.63	1.38	48.6	0.57
	4th	1.32	41.5	0.69	1.35	43.9	0.60
T_3	2nd	1.38	42.5	0.75	1.43	45.7	0.71
	3rd	1.29	40.8	0.91	1.31	41.2	0.87
	4th	1.27	38.4	1.05	1.29	40.6	0.95
T_4	2nd	1.31	40.2	0.85	1.35	43.9	0.67
	3rd	1.26	37.2	0.97	1.32	41.6	0.81
	4th	1.25	35.4	1.15	1.30	38.7	0.96
T_5	2nd	1.34	40.4	0.80	1.36	42.6	0.76
	3rd	1.28	38.0	0.95	1.30	41.8	0.90
	4th	1.27	36.1	1.10	1.28	38.4	1.00
T_6	2nd	1.40	44.4	0.62	142	46.7	0.60
	3rd	1.32	44.2	0.80	1.35	48.6	0.74
	4th	1.29	41.3	0.84	1.32	43.6	0.77
T_7	2nd	1.26	36.2	0.58	1.32	38.5	0.81
	3rd	1.22	31.8	1.18	1.26	33.9	0.93
	4th	1.18	25.7	1.35	121	28.1	1.17
T_8	2nd	1.23	32.6	0.56	1261	36.5	0.52
	3rd	1.20	30.2	0.70	1.23	32.6	0.66
	4th	1.13	29.5	0.87	1.14	30.2	0.80
T_9	2nd	1.25	34.2	1.05	1.27	36.4	0.86
	3rd	1.21	30.9	1.11	1.24	33.3	0.95
	4th	1.16	29.6	1.40	1.20	33.2	1.18
T_{10}	2nd	1.42	46.8	0.57	1.44	48.3	0.44
	3rd	1.34	44.7	0.78	1.36	49.1	0.51
	4th	1.31	41.3	0.72	1.32	46.6	0.65
T_{11}	2nd	130	39.9	0.92	1.33	43.4	0.60
	3rd	1.26	36.6	1.05	1.31	39.0	0.80
	4th	1.24	33.3	1.22	1.27	36.9	0.92
T_{12}	2nd	1.28	37.1	1.05	1.30	39.3	0.99
	3rd	1.25	32.6	1.12	1.32	34.0	0.98
	4th	1.20	30.5	1.30	1.25	32.1	105
T_{13}	2nd	1.29	37.5	0.96	1.32	39.2	0.75
	3rd	1.25	34.3	1.10	1.28	36.4	0.92
	4th	1.22	31.6	1.25	1.26	32.8	0.96

Ks: Hydraulic conductive B.D: soil bulk density P.R: Penetration resistance

The Ks values can be arranged ascending as follows $\mathbf{T_1 < T_2 < T_{10} < T_6 < T_3 < T_5 < T_4 < T_{11} < T_{13} < T_{12} < T_7 < T_9 < T_8}$ in subsurface layers either section width of 8m.or 16m.take the same trend. Similar trend was found throughout the three seasons. This could be attributed to the production of high amount of soluble calcium and organic matter from previous mixtures which enhanced the soil aggregates, consequently improving physical soil properties and the dynamic soil water movement (EL-Sharawy *et.al*. 2008 and Mansour 2012). Further more surface applied water would pass through the surface applied amendment and infiltrate the top layers allowing exchange process between Ca^{2+} and Na^{+} (El-Sharawy *et al*., 2008).

b). **Penetration Resistance (P.R.):**

Penetration resistance was measured with a cone number (1) and cross-sectional area of 1 cm^2.Mean values of the penetration resistance in the surface and subsurface layers throughout three periods are presented in tables (8 and 9).The data showed that the P.R. decrease with repeatedly leaching cycles and application of different soil amendments either surface or subsurface layers. The data reveal that the most effective treatments were T_8, T_9 and T_7 for section width of 8.m and 16 m. The P.R. values can be arranged accordingly as follow:

$T_8 < T_9 < T_7 < T_{12} < T_{13} < T_{11} < T_4 < T_5 < T_3 < T_6 < T_{10} < T_2 < T_1$. The same trend was observed in subsurface layers either section width of 8 m. or 16 m. respectively. Similar trend was found throughout the three seasons. This could be attributed to the decomposition of amendments and increasing both soluble and exchangeable calcium which enhanced the soil aggregates which increase both of total porosity and drainable pores. These results were similar to that reported by (Mansour 2012 and Abd El-Hamid *et al.* 2011).

c) Soil bulk density:

Soil bulk density is the main soil character that must be taken into consideration when improving soil physical properties, especially in such clayey soil. Data in Tables (8 and 9) showed that the impact of open drains installation and the secondary treatments of soil amendments (alternatives gypsum) on soil bulk density were more pronounced. The data indicated that the process of leaching was effective in presence as well as in absence of amendments. Where, it is noticed that the values of soil bulk density were reduced with time, increasing leaching cycles and applied alternatives gypsum compare with initial soil.

The obtained data showed that there was a reduction in soil bulk density after three seasons of adding alternatives gypsum as an amendment from 1.49 at the initial state to 1.11, 1.13 and 1.15 g cm^3 at the applied mixtures of T_8, T_9 and T_7, respectively, for section width 8.0m., while, the mean values reach to 1.15, 1.19 and 1.20 for section width 16m, at the same applied mixtures T_7, T_8 and T_6. The bulk density improved as a result of amended soil with all the treatments. Application of different soil amendments decreased the soil bulk density compared with the (T_1) leaching only and they could be arranged descending as follows: **$T_1 > T_2 > T_{10} > T_6 > T_3 > T_5 > T_4 > T_{11} > T_{13} > T_{12} > T_7 > T_9 > T_8$.** Similar trend was found throughout the three seasons and both for section width 8.0 and 16 m. either in surface and subsurface. These results may be attributed to the decomposition amendments and increasing exchangeable calcium which enhance aggregation process and consequently increase apparent soil bulk density volume and decrease soil bulk density which increased the efficiency of leaching processes (Abd El-Hamid *et al.,* 2011).

d) Water table depth (WTD):

Water table depth fluctuations during leaching cycles are illustrated in Figs. (2 and 3).The data showed that water table depth increased with decreasing spacing between drainage, and increasing the leaching cycles as well as develops more rapidly in the presence of the applied amendment treatments than the control, particularly T_8 of application. WTD fluctuated between 80 to 110 cm and 70 to 100 cm for both drain spacing of 8 .m and 16 m., respectively at the end of experimental time (four periods) for application previous different amendments.These results may be attributed to the increasing exchangeable Ca^{+2} which encourage flocculation of soil particles leading to the formation of large soil aggregates with void volume which increased the efficiency of leaching processes. (Mansour *et al*.,2014)

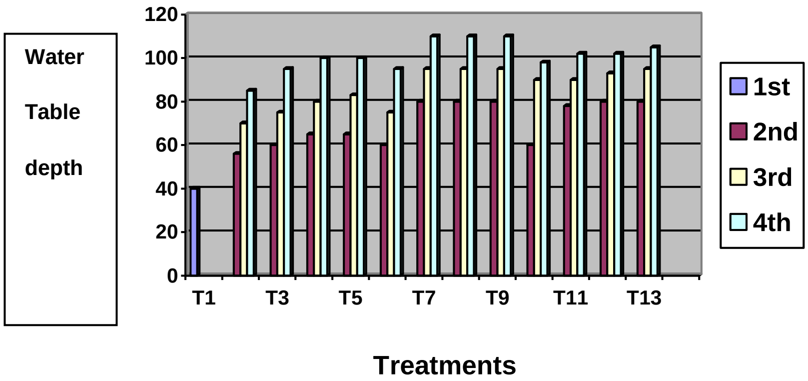

Fig. (2): Water table depth after application of different soil amendments and leaching process at drain spacing of 8 m.

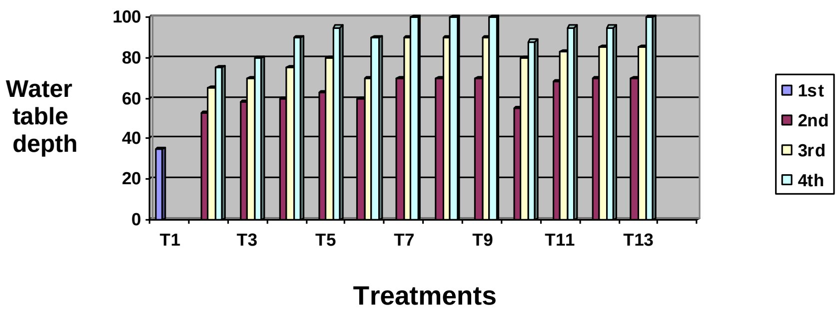

Fig. (3): Water table depth after application different of soil amendments and leaching process at drain spacing of 16 m.

CONCLUSION

From the mentioned above discussion,it could be concluded that using any amendments (.Sugar lime, vinasse, by-pass, pyrite (FeS_2) and aluminum sulfate (Al_2 $(SO_4)_3 18H_2O$) either individual or interaction among them tested in this study were effective in saline-sodic soil reclamation with intermittent leaching cycles .The application of any previous mixtures 2-9 with recommended dose, were superior to the gypsum of 6.0 Mg fed^{-1}. Generally**,** it could be concluded that the application any amendment precedent under intermittent leaching cycles, improved the physical properties of the soil (Ks, B.D, P.R and WTD) and chemical properties, (EC, pH and ESP).

Thus, the use of any amendment precedent may be useful for the saline-sodic soils. Therefore, the choice of any chemical amendment at any location depends on its cost, availability handling and application difficulties, relative effectiveness as judged from the improvement in soil properties and crop growth and time needed to effectively replace the adsorbed Na^+. On the other hand, Previous mixtures and used as an external source of Ca^{2+}, low price and easy application equal gypsum.

REFERENCES

Abd- El-Hamid, A., R.; S.F Mansour; T.A EL-Maghraby and M.A.A. Barky (2011). Competency of some soil amendments used for improvement of extreme salinity of Sahl El-Tina, soil J. Soil Sci. and Agric. Eng. Mansoura Univ., 2 (6): 649-667.

Abdalla, M.A.M.; S.F. Mansour; and M. M.K. Abdel Razek (2010). Effect of applying gypsum on some physio-chemical and hydrological properties of saline sodic soil provided with tile drainage system. Fayaum J. Agric. Res. and development, 24(2):89-103.

Ahmed, M., B.H. Niazi, Rahmatullah and G.R. Sandhu (1986). Reclamation of calcareous saline sodic soils by gypsum and HCl under rice cultivation. Trop. Agric. (Trinidad) 63: 271-272.

Al-Sibai, M.; M.A Adey. and D.A Rose, (1997). Movement of solute through porous medium under intermittent leaching. European J.of soil Sci., 48:711-725.

Curtin D. and R. Naidu (1998). Fertility constraints to plant production. In 'Sodic soils: distribution, properties, management and environmental consequences'. (Eds ME Sumner, R Naidu) pp. 107–123. (Oxford University Press: Oxford, UK).

Dahlya,I.S.; R.S. Malik and M. Singh (1981).Field studies on leaching behavior of a highly salin-sodic soil under two modes of water application in the presence of corps. J. of Agric. Sci.Cambridge,97:383-389.

El-Sharawy, M.A.O. M.M. El-Bordiny and S.A. Abdel-Wahed (2008). Improvement of salt affected soils on Bahr El-Bakar area using certain industrial by-products: 1. Effect on physical and chemical characteristics. J. of Appl. Sci. Res., 4(7):839-854

Food and Agriculture organization of United Nations (FAO). (1988) *Salt-affected soils and their management*, Soil bulletin 39, Rome, Italy.

Gee, G.W. and J.W. Bauder (1986). "Particle size analysis". In: Methods of Soils Analysis, Part I. Klute, A. edit., Agronomy No.9.

Ghafoor, A.; M.A. Gill; A. Hassan; G. Murtaza and M. Qadir (2001). Gypsum: An economical amendment for amelioration of saline-sodic waters and soils for improving crop yields. Int. J. Agri. Biol., 3: 266-275.

Ghazy, M.A. (1994). Effect of water regime, gypsum and sewage sludge increments on the improvement and productivity of saline-sodic soils. Ph. D. thesis, Fac. Of Agric. Tanta Univ. Egypt.

Grattan, S.R. and J.D. Oster (2003). Use and reuse of saline-sodic water for irrigation of crops. In: S.S. Goyal, S.K. Shara and D.W. Rains (Eds), crop production in saline environments: Global and integrative perspectives. Haworth Press, New York, 131-162.

Gulsen,T.:A.I.Arol and G.Cayci (2014). Evaluation of pyritic tailings from a copper concentration plant for calcareous sodic soil reclamation. *hysicochem. Probl. Miner. Process. 50(2), 693−704*

Habib, F. M.; A.H Abd El-Hammed.; M.S. Awaad and T.H.M.A Deshesh. (2009). Effect of some organic conditioners on some chemical and physical properties of newly reclaimed soils in Egypt. J. Soil Sci. and Agric. Eng. Mansoura Univ., 34 (12): 11537-11547.

Hooghoudt, S. B. (1940). Bijdragen tot de kennis van enige natuurkundige grootheden van de ground. *No. 7 Versl. Landbouwk. Onderz.* 46: 515-707.

Hussain,N.; B.H.Niazi; M. Salim; A. Ali and G. Hassan (2000). Effect of split application of gypsum on wheat yield and properties of saline sodic soil irrigated with brackish water. Int. J. Agri. Biol., 3:2346.

Keren, R. (1990). Reclamation of saline, sodic and boron affected soils. Drainage for salinity control, agriculture salinity assessment and management, ASCE Manuals and Reports on Engineering Practice No.71, Scientific Publishers, Jodhpur, India pp410-431.

Kosmatka, S.H.; B. Kerkhoff; W.I. Panarese; N.F. Macleod and R.J. McGrath (2002). Design and control of concrete mixtures. 1st Edition Ottawa, Ontario; Cement Association of Canada.

Luthin, J.N.(1966). "Drainage engineering". John Wiley & Sons Inc., New York

Mace, J.E.; C. Amrhein and J.D. Oster (1999). *Comparison of gypsum and sulfuric acid for sodic soil reclamation*, Arid Soil Research and Rehabilitation, Vol. 13, 171–188.

Mahdy, A.M. (2011). Comparative Effects of Different Soil Amendments on Amelioration of Saline-Sodic Soils. *Soil & Water Res., 6, 2011 (4): 205–216*

Mansour, S.F. (2002). Improvement of soil structure in some soils of Egypt. Ph.D. Thesis Fac. of Agric. Cairo Univ., Egypt.

Mansour, S.F. (2012). Comparative effect of some industrial wastes as soil conditioners on some physiochemical hydro physical soil properties and maize productivity.Minufiya J.Agric.Res.2:387-396.

Mansour, S.F; A.M. Mohamedin and M.M. Mahmoud (2011). Evaluation of some soil amendments and their applied methods on the reclamation of saline-Sodic Soils .J.Biolo. Chemistry Environ.Sci.6:167-181

Mansour, S.F; M.M.A. Reda, M.M.H. Hamad, and E.G. Abo-Elala (2014). A Comparative study of some soil amendments and their Applied methods on the amelioration of saline-Sodic Soils. Minufiy, J. Agric. Res, Vol,39No.2(2):765-774

Naidu R. and P. Rengasamy (1993). Ion interactions and constraints to plant nutrition in Australian sodic soils. Australian Journal of Soil Research, 31: 801–819

Oster, J.D. and H. Frenkel (1980).The chemistry of the reclamation of sodic soils with gypsum and lime. Soil Sci. Soc. Am. J., 44:41-45.

Page A.L.; R.H. Miller and. D.R Jkeeney (1982). “Methods of Soil Analyses Part 2. Chemical and Microbiological Properties.” Second Edition. Agronomy Monograph, No. 9, Madison, Wisconsin

Parnaudea V.; N. Condom; R.Oliver; P. Cazevieille and S. Recous (2008). Vinasse organic matter quality and mineralization potential, as influenced by raw material, fermentation and concentration processes. Bioresearches Technology, 99: 1553-1562.

Reda, M.M.A; F.M. Mouhamed; S.F. Mansour and M. Y. Abou-Zaid (2006). Interaction between sugar lime, sulphur and applied Bio-Inorganic N. fertilization on saline Sodic soil properties and wheat production. Egypt. J. of Apply. Sci. 21(6): 150-162

Shainberg I. and J. Letey (1984): Response of soils to sodic and saline conditions. Hilgardia, 52: 1–57.

Tejada M.; Moreno J.L.; Hernandez M.T. and C. Garcia (2007). Application of two beet vinasse forms in soil restoration: effects on soil properties in an arid environment in southern Spain, Agriculture Ecosystems and Environment, 119: 289-298.

Van Beers, W.F.J. (1958).The Auger-Hole method, Bulletin 1, Int. Inst. for land recl. and impor, Wageningen, The Netherland.

Vomocil, J.A. (1965). Methods of Soil Analysis. Part 1 Edited by Klute, As Monograph No. 9, Madison, Wisconsin

Wallace, A. and G. A. Wallace (1992).Factors influencing oxidation of iron pyrite in soil. J .of plant Nutrition.15(10),1579-1587.

كفاءة استخدام مخلفات المصانع المختلفة كمصلحات للأراضى الملحية الصودية

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أقيمت تجربة حقلية بمحطة بحوث جنوب سهل الحسينية بمحافظة بورسعيد خلال عامين متتاليين 2012/2011 و2013/2012 بهدف تعظيم الاستفادة من بعض المخلفات الصناعية وتحويلها إلى محسنات تربة كبدائل للجبس لذا تم تقييم تأثير إحدى عشر مركباً تم تحضيرها من المخلفات الآتية: (الفيناس- جير السكر-الباى باس) بالإضافة إلى الشبه (كبريتات الالومنيوم) و البيريت (كبريتيد الحديد) ومقارنة تأثير كلا منهم بالجبس و ذلك على سرعة استصلاح الأراضي الملحية الصودية مع إتباع الغسيل المتقطع بمياه ترعة السلام.

وقد أشارت النتائج المتحصل عليها على:أن هناك تحسن واضح نتيجة إضافة كل المحسنات السابقة على الخواص الكيميائية للتربة (ملوحة التربة –قلوية التربة - نسبة الصوديوم المتبادل) والخواص الطبيعية (الكثافة الظاهرية – اندماج التربة – منسوب الماء الأرضي) حيث تفوقت المعاملات أرقام 8و 9 و7.على الترتيب عن باقي المعاملات سواء في الطبقة السطحية أو التحت السطحية ويمكن ترتيب تأثير هذه المعاملات كالاتى:

$$T_1 < T_2 < T_{10} < T_6 < T_3 < T_5 < T_4 < T_{11} < T_{13} < T_{12} < T_7 < T_9 < T_8$$

والهدف النهائي للبحث هو التوصل إلى أفضل محسن يمكن تحضيره من مخلفات المصانع المختلفة كبديل للجبس الزراعي ويؤدى إلى سرعة استصلاح الأراضي الملحية الصودية.

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