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EFFECT OF AMELIORATION PROCESSES ON SALT AFFECTED SOIL PROPERTIES AND ITS PRODUCTIVITY OF WHEAT PLANT

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ABSTRACT: A field experiment were carried out saline soil at the region of Demro Village, Sidi salem City, Kafr El Shiekh Governorate, Egypt, during two successive growing winter seasons of 2018/2019 and 2019/2020. Therefore this study was carried out to evaluate the effect of leaching technique. i.e. uncontinuous process "ULP" and continuous process "CLP" under individual and combined gypsum application rates as a percent of soil gypsum requirements "GR".i.e. 0, 50 and 100 % (G1,G2 and G3, respectively) and tillage depth .i.e. without "T1", 20 cm "T2" and 50 cm "T3". These treatments were arranged with in the experimental plots in split-split plot at randomized complete block design in three replicates. The effect of the studied treatments on soil salinity, bulk density and hydraulic conductivity as well as productivity on wheat (*Triticum aestivum*, Masr3) plants were studied.

Increasing rate of added gypsum as well as increasing in tillage depth resulted in a significant decrease of both soil salinity and its bulk density while resulted in a significant increase of soil hydraulic conductivity. The high changes of the studied soil properties were observed with ULP technique. In addition straw and grains yields of wheat plants were increased significantly as a resulted of gypsum applications and increase of tillage depth, where the highest yields were found with the combined treatments of GR3 and T3 with ULP technique. The data of this study show the high efficiency of combined amelioration processes in improve properties of saline soil and its productivity of crops compared with the single process.

Key wards: Saline soil, Gypsum, Tillage, Leaching, soil properties and Wheat.

INTRODUCTION

Salt affected soils are characterized as those containing high levels of soluble salts, mainly sodium carbonates (Na_2CO_3) and sodium sulphate (Na_2SO_4) and is one of the world's most serious environmental problems. Estimates on global salinization in land and water resources have shown that, about 7% of the world's total land area is affected by salt (Munns et al., 2002). Accumulation of salts in such agricultural soils alters its physio-chemical properties, including pH, EC, SAR, ESP, K_s (saturated hydraulic conductivity and AWC "available water capacity" (Al-Busaidi and Cooksen, 2003). Consequently, mineral elements and water availability for plant growth and yield of most crops is affected (Tanji, 1990). It has been reported that excessive exchangeable sodium in soil, decrease the soil permeability and infiltration capacity through swelling and dispersion of clays as well as slaking of aggregates (Lauchli and Epstein, 1990). These modifications may further compromise the yield of salinized crops, thus, jeopardizing the income of most farmers.

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sustainable agriculture, which have damaging effects on soil properties and crop growth (Okur, 2002 and Devkota et al., 2015). Salt affected soils generally render hostile conditions for plant growth due to insufficient organic matter and excess of toxic soluble salts (Lodhi et al., 2009 and Bilandzija *et al.*, 2016). Physical and chemical properties of these soils are generally degraded due to presence of excessive soluble Na^+ and improvement in these soil's properties could be accomplished by different approaches, depending upon local conditions and available resources (Elsharawy et al., 2008). Compaction in salt affected soils a well-recognized problem, which pose a prompt threat to crop growth and economic yields, in addition to a long term hazard to future crop yields (Hamza and Anderson, 2005 and Singh et al., 2014). Gypsum is widely use as amendment for sodic-soil reclamation because its economic, ease of handling and quick reaction. Gypsum removes the Na^+ from the root zone and decreases the pH of salt affected soils (Lim et al., 2011) and improves the physical properties like, hydraulic conductivity, bulk density and macroporosity (Emami and Astaraei, 2012 and Singh *et al.*, 2014). Water permeability of salt affected soils is restricted, where excess of Na^+ results dispersion, translocation and deposition of clay particles in conducting pores (Mari et al., 2011).

One of the most economical and feasible approach to improve physical and chemical properties of salt affected soils is management by tillage practices (Mosaddeghi et al., 2009). Tilling is a fundamental practice that's manipulate the soil for good seed bed preparation and change the soil environment for root penetration and make it favorable for plant growth. Conventional tillage not only alter the bulk density of top soil but also considerably increased water permeability and introduce minimum resistance to root growth (Ji et al., 2013), but at some depth below the top soil a hard layer, commonly called plow sole develops and is characterized by high bulk density and low infiltration rate. This plow sole limits the water movement and gaseous exchange. According to Ahmed and Maurya (1988) and Deshesh (2021), under such circumstances, deep tillage by such as chiseling is beneficial for crop production and improve the soil physical and chemical properties.

Therefore, selection of a specific tillage package is a necessary that sustains and improves the soil properties required for successful crop growth (Jabro et al., 2009). Azhar et al. (2001) studied the effect of different tillage implements (subsoiler, chisel plough, disc plough and narrow tin cultivator) with two rates of gypsum (50 and 75% gypsum requirements"GR") in salt affected soils. They reported that wheat emergence was maximum in subsoil plot followed by chisel plough. Gypsum application at rate of 75% GR proved more superior over 50% GR in improving soil properties, soil EC, pH and ESP are decreased by 85, 8.27and 84.34%, respectively of their initial value with application of gypsum at 75% GR. Similarly, Singh et al. (2011) reported that deep tillage, combined with gypsum and green manuring, improved the grain and straw yield of wheat. Also, Ahmed et al. (2015) showed that gypsum and FYM with chiseling, improved pH, EC, SAR, organic matter, hydraulic conductivity, bulk density and increase fodder beet root and shoot biomass. Islam et al. (2015) concluded that deep tillage with gypsum and organic manure applications should be right choice for managing silty loam soils in Bangladesh. Costa et al. (2016) also reported that tillage with disc narrow and application of gypsum increased porosity, infiltration rate and bulk density. Numerous other researchers

stated that deep tillage by plowing or loosening with fertilizer combination (Jeyasree and Rao, 2005; Xiong et al., 2012 and Meng et al., 2016). Also, Zhao et al., 2014 showed positive results on remediation of saline-sodic soils and improvement in plants, grain yields of surface lower. Keeping the above facts in view a study was planned to develop the best reclamation strategy with tillage implements and different rates of gypsum for improving the physical and chemical properties of salt affected soils and obtaining maximum fodder yield of sorghum and clover crops. Garcia-Sanchez et al. (2003), Flagella et al. (2004) and Abou Hussien et al. (2020) reported that advantageous effects of leaching on soil improvement and crop yield.

The maximum improvement in hydraulic conductivity (Ks) was only possible with simulated sub-soiling and gypsum-saturated solution (Shahid, 1993). Although abundant literature on the effect of gypsum on sodic and saline sodic is available (Qadir et al., 2001; Sahin et al., 2003 and Makoi and Ndakidemi, 2007), only few studies have reported the effects of gypsum and placement methods on saline soils (Rains and Goyal, 2003). So, understanding the effect of gypsum and placement methods on these properties may be critical importance in order to optimize farm management strategies by farmers practicing agricultural activities in such soils.

On other hands, Setrag (2019), showed that intermittent ponding was the most effective water application method for salinity leaching in the loamy soil, and that the unsaturated water application was the most effective for salinity leaching in the clay soil by achieving 75% salt removal out of the columns using the least amount of water. The findings from this research will allow farmers to improve their water management practices and reduce groundwater contamination from excessive irrigation.

Therefore this study was carried to maximizing the improve level of salt affected soil profiles through applying some amelioration processes. i.e. leaching, tillage techniques and gypsum application as well as its effect on the soil productivity of wheat plant (Masr3).

MATERIALS AND METHODS

This study was carried out as a field experiments during two successive winter growing seasons of 2018/2019 and 2019/2020 at private farm, Demro Village, Sidi Salem City, Kafr El Shiekh Governorate, Egypt, (30^0 $47^\backslash$ $58.50^{\backslash\backslash}$ E 31^0 $21^\backslash$ $31.02^{\backslash\backslash}$ N). This study was conducted to found the effect of tillage depth and gypsum applications individually and in together under two techniques of leaching (uncontinuous procedures "ULP" and continuous procedures "CLP") on some physical and chemical properties of salt affected soil and its productivity of wheat (*Triticum aestivum*) plant.

Soil sampling

Before planting of the first growing season (2018/2019) undisturbed and disturbed soil samples were taken from the study soil at depths of 0 – 10, 10 - 20, 20 – 30, 30 – 40, 40 – 50 and 50 – 100 cm. The soil samples of each depth were prepared for the studied physical and chemical determinations according to Klute (1986), Cottenie et al. (1982) and Page et al. (1982). At the same time mean gypsum requirement "GR" (ton fed^{-1}) was determined for the soil depth of 0 – 10 and 10 – 20 according to Schoonover's methods (Page et al., 1982). The data of initial physical and chemical determinations as well as GR were recorded in Tables (1 and 2). Leaching requirements "LR" (m^3 fed^{-1}) of the studied soil was 950 $m^3 fed^{-1}$. by Kavoda et al. (1967).

Table (1): Some physical properties of the studied salt affected soil.

Soil depth	Bulk density	Particles density	Total porosity	Hydraulic conductivity	Particles size distribution (%)				Texture class	A.W	Gypsum	O.M
(cm)	gm/cm3	gm/cm3	%	cm/hour	C.S %	F.S %	Silt %	Clay %		%	%	%
0 -10	1.26	2.67	52.81	3.20	7.50	13.90	37.10	41.50	Clay	32.80	0.14	0.60
10 - 20	1.27	2.67	52.43	3.14	7.20	13.70	37.30	41.80	Clay	32.81	0.12	0.55
20 - 30	1.29	2.67	51.69	2.29	7.00	13.65	37.35	42.00	Clay	33.01	0.13	0.50
30 - 40	1.30	2.67	51.31	2.28	4.50	13.75	34.35	47.40	Clay	33.10	0.11	0.48
40 - 50	1.31	2.67	50.94	2.27	4.20	13.50	34.60	47.70	Clay	33.00	0.12	0.45
50 - 100	1.33	2.67	50.19	2.25	4.80	11.70	35.40	48.10	Clay	32.80	0.15	0..35

A.W=Available water

Table (2): Some chemicals properties of the studied salt affected soil.

Soil depth	pH (1:2.5) (soil :water) suspension	EC	Soluble anions (meq/l)				Soluble cations(meq/l)				ESP	CEC	$CaCO_3$	G.R
(cm)		dSm^{-1}	CO_3^{--}	HCO_3^-	Cl^-	$SO4^{-2}$	Ca^{++}	Mg^{++}	Na^+	K^+	%	meq/100g	%	ton/ fed/20cm
0 -10	7.89	12.40	0.00	0.74	136.40	40.80	42.78	19.84	113.83	1.36	17.9	37.5	5.70	8.5
10 - 20	7.92	12.65	0.00	0.76	139.15	41.62	43.64	20.24	116.13	1.39	18.1	37.7	5.71	
20 - 30	7.97	12.91	0.00	0.77	142.01	42.47	44.54	20.66	118.51	1.42	18.3	38.2	5.86	
30 - 40	8.10	13.50	0.00	0.81	148.50	44.42	46.58	21.60	123.93	1.49	18.45	38.6	5.90	
40 - 50	8.15	14.22	0.00	0.85	156.42	46.78	49.06	22.75	130.54	1.56	18.6	38.9	5.98	
50 - 100	8.22	14.55	0.00	0.87	160.05	47.87	50.20	23.28	133.57	1.60	18.70	39.01	6.11	

G.R= Gypsum requirement

Treatments and experiment design

This study includes 18 treatments which arranged in split-split plot at randomized complete block design with three replicates (experimental plots were 54). The leaching procedures (ULP and CLP) represents the main factor, the depth of tillage treatments (T1, T2 and T3) non, 20 and 50 cm, respectively were arranged as sub factor, while the treatments of gypsum applications 0, 50, 100 % (G1, G2, and G3, respectively) were represented by sub sub-factor. The area of each experimental plot was 25m^2 (5×5 m). At one month before leaching in the two seasons, treatments of gypsum application, were carried out and good mixed with the soil depth of 20 cm.

Directly after gypsum applications leaching process were carried out. Grains of wheat plant (*Triticum aestivum*) "Masr3" were planted at 15th November 2018 and 2019 at rate of 75 Kg grains fed^{-1}. Also before planting ordinary calcium super phosphate (15.5 % P_2O_5) was added at rate of 150 kg fed^{-1} and mixed with the soil surface layer (0 – 10 cm). Other agricultural practices for wheat plants were carried out according the recommendations of Agriculture and Soil Reclamation Ministry of Egypt. Nitrogen fertilizer was added as ammonium sulphate "$(NH_4)_2SO_4$" (20.5 % N) at application rate of 100 kg fed^{-1} in two equal doses. Also, potassium sulphate "K_2SO_4" (48% K_2O) was applied at a rate of 100 kg fed^{-1} as K source, where its added on two equal doses. The two doses of both N and K fertilizer were applied after 20 and 40 days of planting.

At harvest stage .i.e. 15th and 25th April of 2019 and 2020, wheat plants were harvested separately from each experimental plot. The harvested plants from each plot were divided into straw and grains and weighted to found the yields of straw and grains as kg fed^{-1}.

After plant harvesting, undisturbed and disturbed soil samples were taken from each experimented plot at soil depths of 0 – 10, 10 – 20, 20 – 30, 30 – 40, 40 – 50 and 50 – 100 cm and determined for their physical and chemical properties (Klute, 1986, Cottenie et al. (1982) and page et al., 1982).

Statistical analysis

The obtained data for both plant and soil analysis were statistically analyses according to Costata program.

RESULTS AND DISCUSSION

I Effect of the studied treatments on soil properties

a. Soil salinity

The presented data in Table (3) show both individual and combined treatments of the three studied factories i.e. technique of leaching process (ULP and CLP), tillage depth and gypsum application rates on soil content of total soluble salts measured as EC (dSm^{-1}). Soil salinity was decreased as a result of different treatments under study. With the same treatment of tillage and gypsum application, uncontinuous leaching techniques reduced soil EC more than that recorded with continuous leaching technique. This trend was found in all studied soil depths. These findings reveals to high efficiency of ULP on removal salts from soil compared with that recorded with CLP. Also, these findings means that water movement through soil pores under ULP was faster than under CLP. The decrease of soil EC varied significantly from leaching technique to other. These results are in similar with these obtained by Setrag (2019) and Singh et al. (2014). Under each techniques of leaching process the high decrease of soil EC was found in the surface layer and decrease with the increase of soil depth which resulted from the high movement of leaching

water in the surface layer characterized by high porosity. With the same leaching technique and tillage depth increasing rate of added gypsum resulted in a decrease of soil EC at different soil depths, where the high decrease was observed in the surface layers (0 – 10 and 10 -20 cm) (Table, 3). The efficiency of gypsum applications on reducing values of EC was increased with the increase of soil depth. Also, the decrease of EC as a result of gypsum applications was significant. These findings were found with ULP and CLP techniques under all tillage depths. The decrease of EC as a result of gypsum applications attributed to high solubilized effect of gypsum as well as its effect on soil aggregation and soil bulk density and total porosity. The obtained data in this study are in similar with these obtained by Ahmed et al. (2015) and Costa et al. (2016).

Data in Table (3) show a significant decrease of soil EC with tillage, where this decrease was increased with the increase of tillage depth from 0 – 20 to 20 – 50 cm. These findings were observed with both ULP and CLP and gypsum applications treatments. With the two-tillage depth, the found decrease of soil EC was decrease with the increase of soil depth. Such decrease resulted from increased effect of tillage on soil total porosity and hydraulic conductivity as mentioned before that by Jabro et al. (2009); Ji et al. (2013); Meng et al. (2016) and Abou Hussien et al. (2020).

Table (3): Effect of tillage depth "T"(cm) and gypsum application "G" rate (ton/ fed) on soil salinity (dS/m) in different soil layers under uncontinuous or continuous leaching process (mean values of the two growth seasons seasons).

Soil depth (cm)	Tillage depth (cm)								
	Non (T1)			0 - 20 (T2)			20 - 50 (T3)		
	Gypsium application (ton fed-1)								
	G1	G2	G3	G1	G2	G3	G1	G2	G3
	Uncontinuous leaching (ULP)								
0 -10	10.3	9.2	8.7	9.8	8.3	8	9	7.5	7.3
10 - 20	10.5	9.8	9.2	9.9	8.7	8.2	9	7.8	7.7
20 - 30	11.3	10.5	9.9	10.7	10.5	9.3	9.3	7.9	7.8
30 - 40	11.8	11.5	10.9	11.5	10.3	10	8.7	10.2	9.5
40 - 50	12.2	12.5	12	11.2	12	11.2	10.2	11	8.3
50 - 100	13.3	12.9	12.8	11.5	13.3	11.4	11.3	13.3	10.4
Mean	11.57	11.07	10.58	10.77	10.52	9.68	9.58	9.62	8.50
	Continuous leaching (CLP)								
0 -10	11.2	10.5	10	10.5	9.9	9.2	10.2	9.25	8.5
10 - 20	11.6	10.1	10.3	10.8	10.2	9.5	10	9.5	8.7
20 - 30	12.2	11.3	10.9	11.7	10.7	9.9	10.4	9.5	9
30 - 40	12.8	11.8	11.2	12.2	11.9	10.5	10.9	10.6	9.3
40 - 50	13	12	11.8	12.9	12.4	11.8	11.6	11.2	10.3
50 - 100	13.3	13.3	13.2	13.3	13.3	13	13.6	13.3	13.3
Mean	12.35	11.50	11.23	11.90	11.40	10.65	11.12	10.56	9.85
Mean	T1	11.38	G1	11.21	ULP	10.21			
	T2	10.82	G2	10.78	CLP	11.17			
	T3	9.87	G3	10.08					
LSD 0.05	T= 0.38, G = 0.38 and L.P = 0.57								
G1, G2, and G3 0, 4.25 and 8.5 (ton fed-1) respectively									

In addition, the data in Table (3) show significant decreases of soil Ec were observed with double and treble treatments of leaching technique, gypsum applications and the depth of tillage. Therefore the highest decreases of soil EC were found in the layers of 0 – 10, 10 – 20 and 20 – 30 cm under ULP in the soil treated by 100% GR with tillage depth of 20 -50 cm. These results are in similar with the results mentioned before that by Elsanat (2003) and Costa et al. (2016).

b. Soil bulk density

Data in Table (4) show a wide variation within the found values of soil bulk density as affected by the studied three factors. i.e. leaching process technique, tillage depth and gypsum application rates plus the soil depth. Generally, soil bulk density was increased with increase of soil depth under all the studied treatments. At the same soil depth soil bulk density under ULP was lower than the found with CLP technique. This result is in harmony with the decrease EC value. Also, increasing of tillage depths resulted in a more decrease of soil bulk density with the two leaching techniques as well as with all gypsum applications. These results are in similar with these found by Jabro et al. (2009) and Mari et al. (2011). Under the two leaching techniques and the same tillage depth as well as the same soil depth, gypsum applications resulted in a significant decreased of soil bulk density which resulted from removing of salts particular the sodium with leaching water away from rhizosphere and the aggregation effect of gypsum as mentioned before that by El-sanat (2003) and Ahmed et al. (2015). The highest decrease of soil bulk density was found the experimental plots received the combined treatments of gypsum at application rate of 100% GR, tillage at depth of 20 – 50 cm and ULP, where this decrease was significant. These finding are in confirmed with the results reported before that by Azhar et al. (2001) and Costa et al. (2016), they showed a high significant decrease of soil bulk density in salt affected soil under the combined treatment of gypsum applications and deep tillage.

c. Soil hydraulic conductivity

The recorded data of hydraulic conductivity in Table (5) of salt affected soil treated by gypsum at three tillage depths under two techniques of leaching show that, gypsum applications resulted in a significant increase of soil hydraulic conductivity as a result of decrease in soil bulk density and aggregation index. Similar findings were found before that by Lim et al. (2011) and Ahmed et al. (2015). With the same treatment of gypsum application, increasing tillage depths resulted in significant increases of soil hydraulic conductivity. These increases resulted from tillage effect on pores size distribution and decrease soil bulk density. This increase effect of deep tillage on soil hydraulic conductivity was mentioned by Jabro et al. (2009) and Bilandzija et al. (2016). The increase effect of both individual treatments of tillage deep and gypsum applications was observed under the two leaching techniques, where with the same treatment of tillage and gypsum, recorded increase of hydraulic conductivity under ULP was higher than that found under CLP technique. These findings means that the treatments of both gypsum applications and deep tillage was increased the efficiency of leaching processes of salt affected soil values of soil hydraulic. Therefore, the high hydraulic conductivity was found with the combined treatment of gypsum applications (at 100 % GR) and deep tillage (20 – 50 cm) using ULP as leaching technique (El-sanat, 2003 and Costa et al., 2016).

Table (4): Effect of tillage depth "T"(cm) and gypsum application "G" rate (ton/ fed) on bulk density(g/cm^3) in different soil layers under uncontinuous or continuous leaching process (mean values of the two growth seasons).

Soil depth (cm)	Tillage depth (cm)								
	Non (T1)			0 - 20 (T2)			20 - 50 (T3)		
	Gypsium application (ton fed-1)								
	G1	G2	G3	G1	G2	G3	G1	G2	G3
	Uncontinuous leaching (ULP)								
0 -10	1.25	1.26	1.24	1.21	1.25	1.2	1.19	1.24	1.18
10 -20	1.27	1.27	1.26	1.21	1.25	1.21	1.21	1.24	1.19
20 - 30	1.27	1.27	1.27	1.23	1.25	1.42	1.21	1.25	1.21
30 - 40	1.29	1.27	1.29	1.27	1.27	1.27	1.23	1.25	1.21
40 - 50	1.29	1.28	1.29	1.29	1.28	1.29	1.25	1.27	1.22
50 - 100	1.33	1.33	1.33	1.33	1.33	1.34	1.33	1.33	1.23
Mean	1.28	1.28	1.28	1.26	1.27	1.29	1.24	1.26	1.21
	Continuous leaching (CLP)								
0 -10	1.28	1.26	1.26	1.23	1.25	1.24	1.26	1.21	1.22
10 - 20	1.28	1.26	1.26	1.28	1.25	1.24	1.26	1.21	1.22
20 - 30	1.29	1.27	1.28	1.29	1.27	1.25	1.27	1.23	1.23
30 - 40	1.29	1.27	1.25	1.29	1.28	1.28	1.28	1.23	1.25
40 - 50	1.31	1.29	1.25	1.3	1.24	1.3	1.28	1.53	1.26
50 - 100	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.3
Mean	1.30	1.28	1.27	1.29	1.27	1.27	1.28	1.29	1.25
Mean	T1	1.28	G1	1.28	ULP	1.27			
	T2	1.28	G2	1.28	CLP	1.28			
	T3	1.26	G3	1.26					
LSD 0.05	T= 2.89 , G = 0.7 and T.G = 0.5								
G1, G2, and G3 0, 8.5, and 17 (ton fed-1) respectively									

Table (5): Effect of tillage depth and gypsum application on hydraulic conductivity in different soil layers under uncontinuous or continuous leaching process (mean values of the two growth seasons).

Soil depth (cm)	Tillage depth (cm)								
	Non (T1)			0 - 20 (T2)			20 - 50 (T3)		
	Gypsium application (ton fed-1)								
	G1	G2	G3	G1	G2	G3	G1	G2	G3
	Uncontinuous leaching (ULP)								
0 -10	0.56	0.9	1.1	0.7	1.7	1.7	0.9	2.4	2.4
10 - 20	0.55	0.8	1.1	0.75	1.7	1.7	0.85	2.4	2.4
20 - 30	0.57	0.75	1	0.6	1.5	1.5	0.85	2.2	2.2
30 - 40	0.5	0.75	0.9	0.6	1.5	1.5	0.8	2	2
40 - 50	0.5	0.7	0.7	0.65	1	1	0.75	1.5	1.5
50 - 100	0.75	0.75	0.75	0.75	0.79	0.79	0.75	0.8	0.8
Mean	0.57	0.78	0.93	0.68	1.37	1.37	0.82	1.88	1.88
	Continuous leaching (CLP)								
0 -10	0.5	0.7	0.8	0.65	1	1.3	0.8	1.5	2
10 - 20	0.5	0.7	0.8	0.65	1	1.3	0.8	1.5	2
20 - 30	0.45	0.6	0.7	0.6	0.9	1	0.75	1.3	1.8
30 - 40	0.45	0.6	0.7	0.6	0.9	1	0.75	1.3	1.7
40 - 50	0.6	0.6	0.6	0.65	0.8	0.9	0.7	1	1.5
50 - 100	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.9	1.4
Mean	0.54	0.66	0.73	0.65	0.89	1.04	0.76	1.25	1.73
Mean	T1	0.67	G1	0.70	ULP	1.14			
	T2	1.14	G2	1.00	CLP	0.92			
	T3	1.28	G3	1.39					
LSD 0.05	T = 0.05 , G = 0.06 and L.P = 0.25								
G1, G2, and G3 0, 4.25, and 8.5 (ton fed-1) respectively									

II The Effect of the studied treatments on growth of what plants

a. yield of straw and grains

The presented data in Tables (5 and 6) show the individual and combined effects of both gypsum applications at rate of (without, 50 and 100% GR) and tillage depth (without, 0 – 20 and 20 – 50 cm) under two techniques of leaching (uncontentious and contentious) on the yields (Kg fed^{-1}) of straw and grains of wheat plants grown in salt affected soil. These tables show that, the yields of both straw and grains varied widely according to the experimental treatment, where its increased significantly as a result of tillage depth and gypsum application rate. The yields of straw and grains under ULP were higher than those found with CLP. This trend is in harmony with the greater improvement in physiochemical properties of the studied soil under ULP than that found with CLP .i.e. decrease of soil salinity and bulk density, increase of hydraulic conductivity… etc. The higher increase effect of ULP on the yields of grown plants than that with CLP was pointed by Setrag (2019).

Under two leaching techniques data in Tables (6 and 7) show that the highest yields of straw and grains were found with combines treatments of gypsum and tillage, where these yields were 1639.30 and 3487.67 kg fed^{-1} for grains and straw, respectively.

These increases attributed to improve the soil properties with gypsum applications and tillage especially with the deep tillage. These results are in similar with those obtained by Ahmed et al. (2015) on wheat plant and Jeyasree and Rao (2005) on rainfed and Meng et al. (2016) on maize plant.

At the same tillage treatment under the two leaching techniques and gypsum applications at rates of 50% (G2) and 100% (G3) resulted in a significant increases of wheat yields (straw and grains) as shown in Tables, 6 and 7. Therefore, all RC values of wheat yields in relation with gypsum application were positive and increased with the increase rate of added gypsum. For example, with the combined treatment of G1 and T1, the yields of straw and grains under ULP were increased from 2281 and775.5 kg fed^{-1} to 2876 and 917.5 kg fed^{-1} with the treatment of G3 and T1 recorded RC values of 26.09 and 30.24%, respectively. These results attributed to the improve effect of gypsum on soil properties and nutrients availability (El-sanat, 2003). These results are in similar with those obtained by Lim et al*.* (2011).

b. Harvest index (HI)

The presented data in Table (8) show the harvest index "HI" (%) of wheat plants grown in saline soil under two techniques of leaching (ULP and CLP) as well as affected by individual and combined treatments of gypsum applications (Non " G1", 50 % GR "G2" and 100 % GR "G3") and tillage depth. These results show that, there are a wide variations within HI values depending on the studied treatment. The HI show the greater importance of soil amelioration processes on soil properties and productivity of wheat plants. The values of HI increased as a result of increase depth of tillage and gypsum application rate. More increases of HI of wheat plants were found with the combined treatments of gypsum and tillage especially with ULP technique. Therefore all RC (%) values of HI were positive and become more positive with the combined treatments of G3 and T3.

Table (8): Harvest index "HI" of wheat plants affected by studied treatments and its relative
Change "RC" (%) (mean values of the two growth seasons)

Leaching Process	Gypsium application (ton fed-1)	Tillage depth (cm)					
		Non (T1)		0 - 20 (T2)		20 - 50 (T3)	
		HI %	RC %	HI %	RC %	HI %	RC %
ULP	G1	25.37		26.35		26.19	
	G2	25.70	1.30	29.68	12.64	30.42	16.15
	G3	26.00	2.48	32.40	22.96	31.97	22.07
	Mean	25.69	-	29.48	-	29.53	-
CLP	G1	24.97		26.60		27.27	
	G2	26.97	8.01	26.90	1.13	29.24	7.22
	G3	27.02	8.21	28.80	8.27	32.43	18.92
	Mean	26.32	-	27.43	-	29.65	-

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تأثير عمليات الإستصلاح على خواص الأرضي الملحية وانتاجيتها من القمح

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الملخص العربي

الدراسة الحالية تم تنفيذها كتجربة حقلية على الأراضي الملحية فى منطقة قرية دمرو، مدينة سيدي سالم، محافظة كفر الشيخ، مصر خلال موسمين نمو متتاين فى الشتاء ٢٠١٩/٢٠١٨ و ٢٠٢٠/٢٠١٩. لذلك أجريت هذه الدراسة لتقييم تأثير تقنية الغسيل المتقطع والمستمر تحت معاملات مجمعة أو فردية لمعدل إضافة الجبس كنسبة مئوية من الاحتياجات الجبسية الأرضية صفر و٥٠ و١٠٠٪ (G1 و G2 و G3 على الترتيب) وعمق الحرث (بدون حرث "T1"، و 0-20 سم "T2" و ٢٠-٥٠ سم "T3"). هذه المعاملات تم ترتيبها فى قطع تجريبية تم تصميمها فى بلوكات كاملة العشوائية فى ثلاث مكرارات. تمت دراسة تأثير المعاملات المدروسة على ملوحة التربة، الكثافة الظاهرية والتوصيل الهيدروليكي وكذلك إنتاجية نباتات القمح (Triticum aestivum، مصر٣).

أدت زيادة معدل إضافة الجبس وكذلك زيادة عمق الحرث إلى انخفاض معنوي في كل من ملوحة التربة وكثافتها الظاهرية بينما أدى إلى زيادة معنوية في التوصيل الهيدروليكي للتربة. وقد لوحظ أن التغيرات العالية في خصائص التربة المدروسة كانت مع استخدام تقنية الغسيل المتقطع ULP. بالإضافة إلى زيادة محصول القش والحبوب لنباتات القمح بشكل معنوي نتيجة اضافات الجبس وزيادة عمق الحرث، حيث تم العثور على أعلى محصول مع المعاملات المجمعة من GR3 و T3 وتقنية ULP. تظهر بيانات هذه الدراسة الكفاءة العالية للعمليات المجمعة في تحسين خصائص التربة المالحة وإنتاجيتها للمحاصيل مقارنة بالعملية المنفردة.

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