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Impact of Mole Drains and Soil Amendments Application on Management of Salt Affected Soils

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ABSTRACT

Ameliorating the saline-sodic soil process represents an important target in the agricultural security program of Egypt. In this concern, two field experiment were conducted at El-Serw Agricultural Research Station, Damietta Governorate, Agricultural Research Centre Egypt during two successive growing seasons from (2014 \ 2015).and (2015)Cultivated crops comprised wheat and sunflower in a consecutive sequence, to study effect of applied alternative gypsum, (it is fabricating from some of sugar industry waste in Egypt, which cause environmental pollution problems by mixing some materials or other wastes in order to maximize the benefit and use it as an alternative gypsum) with mole depth and mole spacing on a possible amelioration for some properties of salt affected soils and its productivity of crops. The experimental design was laid out in split-split plots with three replications was followed. The main plots were three levels of irrigation treatments [field capacity (I_1), field capacity +10% (I_2) and field capacity +20% (I_3)]. The sub plots were five mole drains treatments [without mole(M_0),2m mole space with 30 cm depth (M_1), 2m mole space with 50 cm depth (M_2), 4m mole space with 30 cm depth (M_3) and 4m mole space with 50 cm depth (M_4)]. The sub sub plots were three alternative gypsum treatments [Gypsum (control), alternative gypsum one(AG1) and alternative gypsum two(AG2)] at a rate of 5,71 Mg fed^{-1} for ^{each} of them. The applied alternative gypsum treatments were uniformly spread on soil surface and thoroughly mixed in the top 15 cm. before sowing. Leaching requirements estimated and then amount of irrigation water applied. The most important findings can be summarized as follows: The effect of the depth, distance of the moles with the addition of alternative gypsum treatments and levels of irrigation treatments [field capacity +20% (I_3)]. Reduce salinity, acidity, bulk density, penetration resistances , total porosity,. On the contrary, increase the values of hydraulic conductivity, organic matter, Grain yield (Mg fed. $^{-1}$), Water productivity (kg/m^3) and Water consumptive use efficiency (m^{3}fed^{-1}).The highest values of field crops and water use efficiency occurred when the integration and overlap between increasing the depth of mole to 50 cm, decreasing of the mole to 2 meters and field capacity +20% (I_3) with the use of alternative gypsum one (GA1) followed alternative gypsum two (GA2) and gypsum. The achieved amelioration in physio-chemical and hydrological properties of the studied soil positively reflected on the increases of grain yields of crops (wheat and sunflower). Finally, the obtained results suggest that this work is considered as scientific and logic fundamental base for a successful agricultural development of such salt affected area as well as possible to increase unite area income

Keywords: alternative Gypsum, levels of irrigation treatments, Mole depth, Mole spacing, Salt-affected clay soil, Soil properties, Water productivity, Water consumptive use efficiency, Wheat and Sunflower productivity.

INTRODUCTION

Total salt affected area in the world about 955 Mega ha out of which 0.9 Mega ha in Egypt. 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. However, fifty five percent of the cultivated lands of northern Delta region are salt-affected, twenty percent of the southern Delta and middle Egypt region and twenty five percent of the Upper Egypt region are salt-affected soils (Elsharawy *et al*., 2008). On the other hand,Mostafa (2000) reported that salt affected soils include saline non-sodic, saline-sodic, and non-saline sodic soils. Soil salinity and sodicity are the major problems in the arid and semi-arid regions. In these areas there are increased potentials of low productivity of crops.

Ghafoor *et al*., (2001) concluded that 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. Beside gypsum, followed by leaching with canal water can reclaim saline-sodic soils.

The use of sugar lime and vinasse, which are final the by-product of sugar industry, is of great interest because of their low cost and large quantities that are being produced. Sugar Lime is waste product of the sugar refinery (resulting from sugar beet factories). It is an aggregated powder of light brown colour. Furthermore, in Egypt as many other countries, there are tremendous amount of industrial by-products from sugar beet factories reaches about 3.6×10^6 ton year^{-1} for sugar lime, which are increasing annually without utilization. Such by-products are rich in calcium carbonate and polysaccharides, so they could have an economical value as a natural soil conditioner. In addition, application of lime to saline sodic soil reduced soil sodicity in surface layer and found that the effect of lime applied is 72% from the comparative efficiency of gypsum. (Mostafa, 2000 and Mohamedin *et al*., 2005)

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. Opposed trend, soil bulk density and fine capillary pores were decreased by increasing application rate. Abd El-Hamid *et al*., (2011) concluded that the usage of any amendments such as gypsum and sugar lime, could be positively effect on about reclamation of saline clay soil in Shall El-Tina district. On the other hand, Reda, (2006) found that the best treatment in reference to improve certain soil structure of saline sodic soil, microbiological properties, as well as increasing wheat grains and straw yields and their nutrient contents was the combined treatment of (4.6-ton fed^{-1} sugar lime +1.0-ton fed^{-1} elemental sulphur) accompanied by inoculation with a mixture of N2-fixers, particularly in the presence of 50% of recommended dose of inorganic N-fertilizer.

Vinasse is a by-product of the sugar industries either sugar cane or sugar beet. Vinasse comes from sugar cane is called cane-vinasse or from sugar beet is called beet vinasse. Vinasse produced after the removal of the fermentation products from molasses. Vinasse is brown liquid colour and viscosity. Its chemical composition is variable depending among other factors, on water availability sugar-cane, characteristics and the fermentation and distillation processes employed (Mariano *et al*, 2009). In general, vinasse presents high turbidity and low pH, and it can be characterised by high organic carbon (350-830 g O.C kg^1), high calcium 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 (Gomez and Rodriguez,2000).

Addition of such by-product as amendment to soil lead 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. While, Arafat and Yassen (2002) concluded that application of vinasse increased crop because it is a good source of many of nutrients which plants needed to grow. Also, they found that the residual available N, P and K and organic matter in soil after wheat harvesting, increased with increasing the rates of vinasse applied. Adel and Mohsen (2008) found that application of vinasse to a newly reclaimed loamy sand soil caused a significant decrease in soil PH. Awaad *et al*, (2010) found that the application of vinasse to the soil increased soil microbial biomass mineralized organic matter, and consequently increased N-NO_3 content. Monika (2010) found that the application of beet vinasse to the light soils had a positive effect on CEC, exchangeable-cations and available P and K content.

Mariano *et al.* (2009) stated that the addition of acid or acidic forming materials such as sulphur and Vinasse often reduced soil reaction (pH) and enhance microbial densities and activities. Amezketa, *et al.* (2005) found that the higher efficiency of the sulfuric acid over the three gypsum materials (mined-gypsum, coal-gypsum and lacto gypsum) is reflected in the fastest reductions of the ECe, Na , and SAR values in the leachates of the acid-amended soil.

Hussein *et al* (2003) found that sulfuric acid is more effective in decreased ECe, bulk density and sodium adsorption ratio (SAR) and increased total porosity and hydraulic conductivity of saline sodic soils. Also, Sadiq, *et al.* (2003) found that the application of sulfuric acid at a rate of 20% from gypsum requirement (G.R.)for amelioration of moderately saline-sodic and medium textured soil proved effective and ensured significantly higher yields. Mansour (2011) found that the addition of diluted sulfuric acid reduced soil reaction, soil bulk density penetration resistance, total $CaCO_3$ and active $CaCO_3$. While, total porosity, quickly drainable pores, available water and hydraulic conductivity were increased.

Generally, saline non-sodic and saline sodic soils need leaching processes in their reclamation heavy clayey salt affected soils with low permeability in the Nile Delta. Therefore, an efficient Aiad, (2012) reported that drainage system is an important factor to improve these soils to be suitable for crop production in the short time with low cost. Moleing is the best suited to clay soils with a minimum clay content of about 30%. Mole drain in clay soil with proper spacing can reduce waterlogging problems. Mole drain is widely used in heavy clay soils to improve the productivity (Moukhtar *et al*., 2012 and Antar, *et al*., 2008 and 2012). Moleing or subsoiling will enhance downward movement of irrigation water carrying off excess salts from surface layers. Adverse physical properties, low water permeability, osmotic effect, ionic imbalance and specific ion toxicity are the main harmful salinity and sodicity effects which inhibit plant growth and development (Chen *et al*., 2010).

Moukhtar *et al*., (2003) and Antar *et al*., (2008) found that, mole drains perpendicular to open drains accelerated downward water movement to the depth of mole low. Mole drains are generally considered to be the result of the physical shattering of the hardpan, which allows increasing water penetration into the subsoil. This may also accelerate the leaching of sodium from the subsoil thereby further reducing the possibility of reformation of the hardpan. Mole drain is considered as an intermediate system between surface drainage and subsurface drainage. Many researches have reported positive effects of applying mole drain system especially at heavy clay salt affected soils (El-Sabry *et al*., (1992) and Walter & Bishay, 1992). The mole drains network were the best combination treatments to obtain favorable physical and chemical properties since they improved the infiltration characteristics of soil and led to the lowest values of salinity and sodicity in all sites at ELHamol District, Kafr El Sheikh Governorate. However, application of gypsum and sub soiling under tile drainage of 25 m spacing reduced the soil salinity value of soil surface with the percentage of 20 and 55.36% of the initial state during two successive seasons, respectively (El-Shanawany *et al*., 2000).

The main target of this work was maximizing the utilization of some by-products which produced by the sugar industries in Egypt, i.e., sugar lime and vinasse which cause problems of the environmental pollution, by using as an alternative gypsum (conditioner) to ameliorate the salt affected soil, under mole drains system and irrigation levels, Also evaluating its effects on physio-chemical and hydrological properties, as well as subsequently improve the unite of both soil and water productivity.

MATERIALS AND METHODS

Two field experiment were conducted on saline sodic soil, at El-Serw Agricultural Research Station, Damietta Governorate, Agricultural Research Center Egypt, during two successive growing seasons (2014 \ 2015) (winter season) and 2015 (summer season) to study how to be maximizing the benefit of some by-products of sugar can or beet industries in Egypt , i.e., sugar lime and vinasse ,which cause environmental pollution problems, by mixing them or with other materials to using them as an alternative gypsum (conditioner) ,under mole drain system and different farrow irrigation levels. The experimental design was laid out in split-split plots with three replicates. The main plots were three levels of irrigation treatments [field capacity (I_1), field capacity +10% (I_2) and field capacity +20% (I_3)]. The sub plots were five mole drains treatments [without mole(M_0),2m mole space with 30 cm depth (M_1), 2m mole space with 50 cm depth (M_2), 4m mole space with 30 cm depth (M_3) and 4m mole space with 50 cm depth (M_4)]. The sub sub plots were three alternative gypsum treatments [Gypsum (control), alternative gypsum one(AG1) and alternative gypsum two (AG2)] at a rate of 5,71 Mg fed^{-1} for each of them. Wheat (*Triticum aestivum*) Sakha 93 variety) was planted at November 2014 followed by sunflower (Helianthus annuls.) Giza 1) which cultivated at May 2015 The different alternative gypsum treatments were prepared, applied and mixed with soil surface (0-15 cm layer) before planting (20 days). All plots were ploughed and mole drain treatments were done. Mineral fertilizer for N, P and K were applied at a recommended dose by the Ministry of Agriculture.

The initial of some physio-chemical properties of the experimental soil are presented in Table (1). In addition, Chemical characteristics of the studied water irrigation in Table (2) and the chemical composition of sugar lime, and vinasse used as aby-product in Table (3). The composition and chemical properties of the two mixtures of amendments used are presented in Table (4)

Table 1. The initial of some physio-chemical properties of the experimental soil

physical properties	Value	Chemical properties	Value
Particle size distribution		Organic matter %	0.53
Coarse sand %	1.53	pH (1:2.5soil-water suspension)	8.69
Fine sand %	11.33	EC (dSm^{-1})	10.50
Silt%	21,17	SAR %	19,7
Clay%	65,98	ESP %	21,8
Soil texture	Clay	CEC ($cmol_c\ kg^{-1}$)	42
Bulk density ($Mg\ m^{-3}$)	1.32	Gypsum requirements (GR) ($Mg\ fed^{-1}$)	5,71
Hydraulic conductivity ($cm\ h^{-1}$)	0.025	Field capacity (FC) %	40
Total porosity %	45.6		
Penetration resistance ($kg\ cm^{-2}$)	54.7		

Table 2. Chemical characteristics of the studied water irrigation

EC dSm^{-1}	pH	Solubleions ($meqL^{-1}$)								SAR
		Na^+	K^+	Ca^{++}	Mg^{++}	$CO3^=$	HCO^{3-}	Cl^-	$SO^{4=}$	
1.78	7,55	112	0.4	2.7	3.5	--	1.5	8.4	7.9	6.36

Table 3. Chemical composition of sugar lime and vinasse used as aby-product

Characteristics	Sugar lime	Vinasse
Bulck density ($Mg\ m^{-3}$)	0.74	1.14
pH (1:2.5)	8.30	4.50
$CaCO_3$ (%)	51.3	0.12
OM%	3.42	38.3
Total Nitrogen (%)	0.94	0.20
Total Potassium (%)	0.06	0.71
Total Calcium (%)	28.5	0.65
Total Phosphorus (%)	0.28	0.21
Total Manganese (%)	3.42	0.60
Total Iron (%)	0.007	0.0006
Total Copper (%)	0.21	0.0073
Total Zinc (%)	0.003	0.0024

Table 4. Composition and chemical properties gypsum and of Alternative gypsum used as soil amendments

Alternative gypsum (A.G.)	Composition			Chemical properties		
	Vinasse % (V)	Sugar lime % (S.L)	Sulfuric acid % (S.A)	pH	EC (dSm^{-1})	Degree of solubility ($g\ L^{-1}$)
Gypsum	-	-	-	7.7	3.84	1.9
(A.G. 1)	1	3	2	5.7	6.3	3.61
(A.G.2)	2	6	2	6.2	8.1	2.79

The studied parameters:

1- Yield and physio-chemical soil analysis

At harvesting stage grain yield of wheat plants and seed yield of sunflower were recorded. Disturbed and undisturbed soil samples (0-30 cm. depth) for each treatment were taken and prepared, to determine physical and chemical properties according to the standard methods described by the different publishers as follow

2-Some water relations:

1 - Amount of irrigation water applied:

It was measured by using a set of cut-throat flumes (30 x 90 cm) according to Early (1975)

Property	Publishers
▪ Particle size distribution (%).	Gee and Bauder (1986)
▪ Bulk density (Mgm^{-3}).	Campbell
▪ Total porosity %	(1994).
▪ Saturated hydraulic conductivity.	Klute and Dirksen (1986)
▪ Penetration resistance	Davidson (1965)
▪ Soil reaction (pH)and EC ($ds\ m^{-1}$)	
▪ Organic matter content ($g.kg^{-1}$).	Page *et al.*,
▪ Soluble cations and anions ($meqL^{-1}$)	(1982)
▪ Gypsum requirements	Schoonover (1952).

2 Determination of soil moisture percentage:

Soil moisture content (%) was determined by drying the soil samples at 105°C to constant weight and the moisture content was calculated according to Singh *et al.*, (1980).

3- Water consumptive use efficiency:

Water consumptive use by growing plants was calculated based on soil moisture depletion (SMD) according to the following equation (Hansen *et al.*, 1979).

$$Cu = SMD = \sum_{i=1}^{i=4} \frac{\theta_2 - \theta_1}{100} \times Dbi \times \frac{Di}{100} \times 4200$$

Where:

Cu=Water consumptive use (m2/fed.) in the effective root zone.

θ_2 =Gravimetric soil moisture percentage after irrigation

θ_1 =Gravimetric soil moisture percentage before next irrigation.

Dbi=Soil bulk density (kg/m3)

Di=Soil layer depth, m

i=Number of soil layers (1-4)

4- Irrigation application efficiency (Ea):

Irrigation application efficiency was calculated according to the following equation described by Downy (1970).

$$Ea = (ws/wa) \times 100$$

Where:

Ws and Wa are the volumetric water stored in effective root zone and water applied, respectively.

5- Water productivity (WP):

Water productivity is generally defined as crop yield per cubic meter of water consumption. Water production can be also defined as crop production per unit amount of water used. Concept of water productivity in agricultural production system is focused on producing more food with the same water resources, or producing the same amount of food with less water resources. It was calculated according to Ali *et al.*, (2007).

$$WP = Y \backslash ET$$

Where:

WP = Water productivity (kg/m^3)

Y = Yield ($kg\ fed^{-1}$.)

ET = Total water consumption of the growing season m3 fed-1. = Water consumptive use, m3 fed-1.

6 -Productivity of irrigation water (PIW):

Productivity of irrigation water (PIW) was calculated according to Ali *et al*, (2007):

$$PIW = Y \backslash IW$$

Where:

PIW = Productivity of irrigation water (kg/m^3) Y = Yield ($kg\ fed^{-1}$.)

IW = Irrigation water applied, $m^3\ fed^{-1}$.

Statistical analysis: Data obtained are subjected to statistical analysis according to Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

1- Chemical properties:

Soil pH, ECe, ESP and organic matter

1- Soil pH

When the different mixtures of alternative gypsum treatments were applied to the tested soil the pH values were highly affected after sunflower season than wheat season (Table 5). The alternative gypsum one (AG1) treatment was being more effective in decreasing soil pH, particularly under 2m mole space with 50 cm depth (M_2) and field capacity +20% (I_3) as compared with other treatments and control (Applied Gypsum without mole under field capacity treatment), mainly attained to the acidic effect of this material rather than the other materials and the soil buffering capacity (Mansour *et al*., 2014).

2- Electrical conductivity (ECe)

Concerning the effect of different treatments on ECe after wheat and sunflower harvesting, it could be notes that mole system and irrigation levels treatments at different alternative gypsum treatments hade ECe values lower than of control, particularly 2m mole space with 50 cm depth (M_2) and field capacity +20% (I_3) under alternative gypsum one (AG1). Moukhtar *et al*, (2003) and Zamil (2012) reported that, moling enhance downward movement of irrigation water carrying off excess salts from surface layers.(Abd El-Hamid*et al*,.2011) revelled that leaching is the only effective way to decrease the excessive salts from the root zone.

Table 5. Soil pH, EC, ESP % and O.M% as affected by different treatments under cultivation of wheat and sunflower crops

Alternative gypsum Treatments (A. G.)	Mole drain system	First season											
		pH (1:2.5)			EC (dSm-1)			ESP (%)			O.M. (%)		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum	M0(Cont.)*	8.70	8.69	8.68	10.1	9.9	9.6	17.1	1682	16.43	0.52	0.48	0.46
	M1	8.67	8.65	8.64	8.70	8.54	8.24	15.61	1523	15.78	0.49	0.46	0.44
	M2	8.66	8.64	8.65	8.54	8.32	8.15	14.75	146	14.18	0.48	0.44	0.42
	M3	8.62	8.60	8.60	8.91	8.72	8.42	16.3	1600	15.61	0.52	0.47	0.45
	M4	8.63	8.62	8.61	8,81	8.66	8.29	15.7	154	15.06	0.51	0.45	0.43
(A. G. 1)	M0	8.56	8.55	8.54	8,9	8.8	8.65	15,5	15.27	15.05	0.88	0.85	0.82
	M1	8.53	8.50	8.48	7,20	7.11	6.67	13.5	13.1	12.75	0.80	0.76	0.73
	M2	8.45	8.42	8.40	6.94	6.80	6.31	12.7	12.3	12.1	0.78	0.73	0.70
	M3	8.59	8.57	8.56	7,51	7.32	7.12	14.4	14.1	13.62	0.85	0.82	0.77
	M4	8.58	8.56	8.55	7,31	7.23	7.88	13.9	13.7	13.25	0.83	0.80	0.75
(A. G. 2)	M0	8.58	8.57	8.56	9.37	9.01	8.81	16.8	16.5	16,18	0.83	0.81	0.80
	M1	8.55	8.53	8.51	8.58	8.4	8.17	14.1	13.22	13.01	0,75	0.72	0.70
	M2	8.48	8.45	8.43	7.74	7.5	7.3	13.4	12,7	12.56	0,72	0.68	0.65
	M3	8.61	8.59	8.58	7.71	7.62	7.37	14.8	14.5	13.87	0.80	0.78	0.74
	M4	8.61	8.58	8.56	7.61	7.50	7.28	14,4	13,9	13,46	0.78	0.75	0.73
Cont.* (Applied Gypsum 5.71Mg fed^{-1} without mole under field capacity treatment)													
L. S .D at 0.05													
A (G. alternative)		0.106	0.116	0.118	0.183	0.188	0.193	0.407	0.409	0.417	0.001	0.001	0.001
B (Mole depth)		0.149	0.159	0.160	0.159	0.162	0.169	0.234	0.236	0.238	0.001	0.001	0.001
C (Mole spacing)		0.312	0.318	0.320	0.012	0.018	0.020	0.001	0.009	0.011	0.001	0.001	0.001
A*B		0.191	0.198	0.200	0.169	0.173	0.179	0.191	0.198	0.200	0.001	0.001	0.001
A *C		0.150	0.154	0.157	0.133	0.138	0.141	0.150	0.154	0.157	0.001	0.001	0.001
B*C		0.150	0.156	0.160	0.133	0.135	0.137	0.150	0.153	0.156	0.001	0.001	0.001
A*B*C		0.260	0.266	0.269	0.230	0.237	0.241	0.260	0.262	0.264	0.001	0.001	0.001

Alternative gypsum Treatments (A. G.)	Mole drain system	Second season											
		pH (1:2.5)			EC (dSm-1)			ESP (%)			O.M. (%)		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum	M0(Cont.)*	8.65	8.64	8.63	9.6	8.98	8.72	16.8	16.52	16.13	0.46	0.44	0.40
	M1	8.62	8.60	8.59	8.61	8.34	8.04	11.31	10.93	10.48	0.44	0.41	0.39
	M2	8.61	8.59	8.60	8.50	8.22	8.03	10.45	10.3	9.88	0.43	0.40	0.38
	M3	8.57	8.55	8.55	8.74	8.52	8.22	12.3	11.70	11.31	0.45	0.42	0.40
	M4	8.58	8.57	8.56	8.73	8.46	8.09	11.4	11.1	10.76	0.45	0.41	0.39
(A. G. 1)	M0	8.51	8.50	8.49	8.4	8.3	8.15	16.2	15.97	15.75	0.82	0.81	0.80
	M1	8.48	8.45	8.43	7.00	6.91	6.47	10.2	9.71	9.45	0.79	0.77	0.73
	M2	8.40	8.27	8.15	6.74	6.6	6.1	9.4	9.0	8.8	0.77	0.73	0.70
	M3	8.54	8.52	8.51	7.31	7.12	6.92	11.1	10.8	10.32	0.81	0.79	0.77
	M4	8.53	8.51	8.50	7.11	7.03	6.68	10.6	10.4	9.95	0.80	0.78	0.75
(A. G. 2)	M0	8.53	8.52	8.51	8.77	8.65	8.51	16.3	16.2	15.88	0.78	0.75	0.72
	M1	8.50	8.48	8.46	7.68	7.42	7.37	10.8	9.92	9.71	0,72	0.70	0.68
	M2	8.43	8.40	8.36	7.54	7.3	6.97	10.1	9.4	8.96	0,68	0.65	0.62
	M3	8.56	8.54	8.53	7.91	7.52	7.27	11.5	11.2	10.57	0.76	0.73	0.70
	M4	8.56	8.53	8.51	7.61	7.47	7.15	11,1	10.8	10.26	0.74	0.70	0.68
Cont.* (Applied Gypsum 5.71Mg fed-1 without mole under field capacity treatment)													
L. S. D at 0.05													
A (G. alternative)		0.102	0.112	0.114	0.180	0.185	0.190	0.401	0.405	0.411	0.001	0.001	0.001
B (Mole depth)		0.143	0.151	0.156	0.154	0.157	0.160	0.230	0.233	0.230	0.001	0.001	0.001
C (Mole spacing)		0.310	0.316	0.320	0.010	0.012	0.020	0.001	0.004	0.011	0.001	0.001	0.001
A*B		0.188	0.193	0.200	0.160	0.163	0.169	0.188	0.190	0.194	0.001	0.001	0.001
A *C		0.144	0.150	0.153	0.130	0.134	0.137	0.147	0.150	0.154	0.001	0.001	0.001
B*C		0.146	0.151	0.155	0.131	0.133	0.134	0.142	0.150	0.153	0.001	0.001	0.001
A*B*C		0.253	0.260	0.262	0.228	0.233	0.240	0.250	0.252	0.254	0.001	0.001	0.001

3- Exchangeable sodium percentage (ESP)

Data presented in Table (5) showed that the using of different forms of alternative gypsum treatments as soil amendments reduced the ESP values.(AG1) amendment was the most effective in reducing the ESP values than other amendments, particularly in the second season under field capacity +20% (I_3)] at a mole system M_2 treatment. This may be due to the release of organic acids and CO_2 ions during the decomposition process of organic materials *i.e.*, Vinasse and S.L. and thus decreased precipitation of Ca^{2+} and CO_3 ions which should lead to decrease ESP. 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*., 2003).

4 - Organic matter (OM)

Results of organic matter content after harvesting of either wheat or sunflower, as influenced by application of the different alternative gypsum amendments treatments to soil under mole system and irrigation levels are presented in Table (5). Generally, there are a positive relationship between alternative gypsum application, particularly alternative gypsum one (AG1) was more effective under M_2 treatment, compared with the control and other treatments. Soil organic matter content after sunflower harvesting was lower than that after wheat. This could be due to the rabid oxidation and decompaction of soil organic matter with time (El-Sharawy *et al.* 2003).

2-Physical Propertes

Bulk density (BD), penetration resistance (P.R), total porosity (T.P) and hydraulic conductivity (K)

1-Bulk density (BD)

When the different mixtures of alternative gypsum treatments were applied to the tested soil the Bulk density values were highly affected after sunflower season than wheat season (Table 6). The alternative gypsum one (AG1) treatment was being more effective in decreasing soil(BD) particularly under 2m mole space with 50 cm depth (M_2) and field capacity +20% (I_3) as compared with other treatments and control These results may be attributed to the effects of mole depth or distances on breaking soil clods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers (Amer, 1999, Abdel-Mawgoud *et al*., 2006 and Antar *et al*., 2008). which enhanced the formati on of large soil aggregates? This could be due to the dominance of soluble $Ca+^2$ on the exchange complex. Such results agree with Mansour (2011) who reported that the addition of diluted sulfuric acid led to reduce of soil bulk density and decrease of total porosity. Results of the statistical analysis indicated that there are significant differences among forms of the used gypsum alternative, mole depth and mole spacing.

2-Penetration resistance (PR)

Data presented in Table (6) showed that the using of different forms of alternative gypsum treatments as soil amendments reduced the penetration resistance values.(AG1) amendment was the most effective in reducing the (P.R)values than other amendments, particularly in the second season under field capacity +20% (I_3)] at a mole system M_2 treatment.

This could be attributed to the decomposition amendments and increasing both soluble and exchangeable calcium which enhanced the soil aggregates processes which increase both of total porosity and drainable pores, subsequently soil penetrability resistance decreases. These results were similar to that reported by Mansour (2012) and Abd El-Hamid (2011). Results of the statistical analysis indicated that there are significant differences among forms of the used alternative gypsum, mole depth and mole spacing.

3-Total porosity (TP)

Concerning the effect of different treatments on total porosity after wheat and sunflower harvesting, it could be notes that mole system and irrigation levels treatments at different alternative gypsum treatments hade total porosity values higher than of control, particularly 2m mole space with 50 cm depth (M2) and field capacity +20% (I3) under alternative gypsum one (AG1). These results may be attributed to the effects of mole depth or distances on breaking soil clods and bigger granular into smaller crumbs as well as breaking and cracking the compacted layers (Amer, 1999, Abdel-Mawgoud *et al*., 2006 and Antar *et al*., 2008). which enhanced the formati on of large soil aggregates.

4- Hydraulic Conductivity (K)

Results of Hydraulic Conductivity (HC) content after harvesting of either wheat or sunflower, as influenced by application of the different alternative gypsum amendments treatments to soil under mole system and irrigation levels are presented in Table (6). Generally, there are a positive relationship between alternative gypsum application, particularly alternative gypsum one (AG1) was more effective under M_2 treatment, compared with the control and other treatments. The efficiency of the studied amendments on increasing the values of hydraulic conductivity could be arranged in the following order: (AG1) **>** (AG2**)** > gypsum. This could be attributed to the effect of such treatments increased the macro pores and decreased the micro pores. Similar results were obtained by Reda *et al*., (2005) using biofertilization with diazotrophs and Mariano (2009) using vinasse. At the same time, a similar trend was observed with total porosity. Results of the statistical analysis indicated that there are significant differences among forms of the used gypsum alternative, mole depth and mole spacing.

3-Grain yield (Mg fed. $^{-1}$), Water productivity (kg/m^3) and Water consumptive use efficiency ($m^3 fed^{-1}$)

1- Grain yield (Mg fed. $^{-1}$)

The results in Table (7) reveal that, the grain yields (Mg fed^{-1}) of both wheat and sunflower. Data show that not only positively affected by mole drains installation but also to some extent by the application of alternative gypsum and levels of irrigation treatments

The same trend was observed in the first and second seasons either with Wheat or sunflower. However, positive effect of the amended soils is partly due to alternative gypsum treatments that improve soil chemical, physical and hydrological characteristics as mentioned above, besides the beneficial effect of mole drains to accelerate leaching processes and the disposal of excess water and salts from the root zone, and in turn improving soil structure, increasing soil aeration and biological conditions. Also, such findings may be attributed to the effect of mole depth and spacing on improving soil properties which caused water-air balance in the root zone, and increasing the amount of available nutrients for the plant. Similar results were obtained by Moukhtar *et al*., (2003 and 2012) Antar *et al*., (2008 and

2012) and Aiad *et al*., (2012) Results of the statistical analysis indicated that there are significant differences among types of the used alternative gypsum, mole depth and mole spacing. From the abovementioned discussions, it could be concluded that mole drainage, depth and mole spacing, installation is the most important tool to conserve or reclaim the harmful effects of salty clayey soils to a feasible one. This process must be undertaken with gypsum requirements.

Table 6. Bulk density (B.D), penetration resistance (P.R.), total porosity (T.P) and hydraulic conductivity (K), as affected by different treatments under cultivation of wheat and sunflower crops

Alternative gypsum Treatments (A. G.)	Mole drain system	First season											
		B.D. (Mg m^{-3})			P.R. (kg cm^{-2})			T.P. (%)			K.(cmh^{-1})		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum (cont.)	M0	1.36	1.32	1.31	50.3	49.9	48.7	47.1	48.7	50.2	0.022	0.025	0.026
	M1	1.29	1.26	1.23	43.1	42.6	41.5	54.2	54.8	55,2	0.33	0.35	0.37
	M2	1.25	1.22	1.20	42.2	41.5	40.2	59.5	59.7	59.9	0.35	0.37	0.38
	M3	1.33	1.30	1.29	44.9	43.3	42.3	57.7	57.8	57.9	0.23	0.26	0.27
	M4	1.30	1.27	1.25	43.5	42.9	41.9	55.5	56.7	57.5	0.26	0.30	0.31
(A. G. 1)	M0	1.27	1.26	1.23	48.6	47.8	46.8	48.1	49.5	52.5	0.026	0.029	0.031
	M1	1.23	1.18	1.16	41.2	40.2	38.1	59.0	59.2	60.4	0.36	0.38	0.39
	M2	1.21	1.16	1.14	39.4	38.7	37.5	61.6	61.6	62.4	0.41	0.40	0.42
	M3	1.27	1.25	1.21	42.2	41.4	40,1	58.2	58.7	59.3	0.29	0.33	0.35
	M4	1.25	1.22	1.19	٤1.7	41.9	39.7	58.3	58.6	59.8	0.33	0.35	0.36
(A. G. 2)	M0	1.29	1.28	1.25	49.4	48.3	47.3	47.7	48.1	51.5	0.024	0.028	0.029
	M1	1.27	1.24	1.20	41.9	40.6	39.4	58.1	58.4	59.2	0.34	0.36	0.38
	M2	1.24	1.20	1.18	40.2	39.3	38.3	60.3	60.7	60.9	0.38	0.39	0.40
	M3	1.30	1.28	1.24	43.5	41.8	40.6	57.3	57.4	58.3	0.27	0.31	0.32
	M4	1.28	1.25	1.22	42.7	41.4	39.9	57.9	58.5	58.7	0.30	0.33	0.34
L. S. D at 0.05													
A (G. alternative)		0.029	0.031	0.030	0.683	0.487	0.477	0.875	0.885	0.889	0.001	0.011	0.021
B (Mole depth)		0.023	0.024	0.024	0.559	0.294	0.324	0.831	0.841	0.853	0.001	0.011	0.021
C (Mole spacing)		0.025	0.027	0.026	0.212	0.321	0.341	0.051	0.071	0.081	0.001	0.015	0.018
A*B		0.040	0.042	0.041	0.269	0.591	0.601	0.241	0.261	0.273	0.001	0.017	0.019
A *C		0.031	0.033	0.031	0.433	0.650	0.660	0.190	0.198	0.200	0.001	0.016	0.020
B*C		0.031	0.033	0.032	0.533	0.750	0.650	0.195	0.200	0.230	0.001	0.012	0.015
A*B*C		0.054	0.055	0.056	0.730	0.360	0.370	0.328	0.348	0.368	0.001	0.019	0.023

Alternative gypsum Treatments (A. G.)	Mole drain system	Second season											
		B.D (Mg m^{-3})			P.R. (kg cm^{-2})			T.P. (%)			K.(cmh^{-1})		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum (cont.)	M0	1.34	1.30	1.29	49.3	48.9	47.7	48.1	49.7	51.2	0.025	0.028	0.03
	M1	1.27	1.24	1.21	42.1	41.6	40.5	55.2	55.8	56.2	0.36	0.38	0,40
	M2	1.23	1.20	1.19	41.2	40.5	39.2	59.9	60.3	60.9	0.38	0.40	0,41
	M3	1.31	1.28	1.27	43.9	42.3	41.3	58.7	58.8	58.9	0.26	0.29	0,31
	M4	1.29	1.25	1.22	42.5	41.9	40.9	57.5	57.7	57.9	0.29	0.33	0,34
(A. G. 1)	M0	1.26	1.24	1.21	47.6	46.8	45.8	50.1	50.9	52.5	0.029	0.032	0.034
	M1	1,21	1,16	1,14	40.2	39,2	37.1	60.0	60.2	60.8	0.39	0,41	0.42
	M2	1.19	1.14	1.12	38.4	37.7	36.5	62.6	62.8	62.9	0.44	0.43	0.45
	M3	1.25	1.23	1.18	41.2	40.4	39,1	59.2	59.7	60.3	0.32	0.36	0.38
	M4	1.23	1.20	1.16	40.7	40.9	38.7	58.6	58.9	60.8	0.36	0.38	0.39
(A. G. 2)	M0	1.28	1.26	1.23	48.4	47.3	46.3	50.4	50.7	51.5	0.027	0.031	0.032
	M1	1.25	1.22	1.18	40.9	39.6	38.4	59.1	59.4	59.8	0.37	0.39	0.41
	M2	1.22	1.18	1.16	39.2	38.3	37.3	61.3	61.7	61.9	0.41	0.42	0.43
	M3	1.28	1.26	1.22	42.5	40.8	39.6	58.3	58.4	58.8	0.30	0.34	0.35
	M4	1.26	1.23	1.20	41.7	40.4	38.9	58.4	58.5	58.7	0.33	0.36	0.37
L. S. D at 0.05													
A (G. alternative)		0.027	0.030	0.030	0.673	0.467	0.470	0.865	0.875	0.879	0.011	0.081	0.041
B (Mole depth)		0.020	0.022	0.024	0.545	0.274	0.334	0.821	0.831	0.823	0.011	0.071	0.031
C (Mole spacing)		0.024	0.026	0.027	0.202	0.311	0.340	0.041	0.051	0.061	0.041	0.019	0.028
A*B		0.038	0.040	0.041	0.249	0.581	0.611	0.231	0.241	0.253	0.061	0.047	0.039
A *C		0.030	0.030	0.031	0.423	0.640	0.650	0.186	0.188	0.190	0.081	0.066	0.030
B*C		0.029	0.031	0.031	0.523	0.730	0.640	0.185	0.190	0.210	0.021	0.022	0.035
A*B*C		0.051	0.052	0.054	0.630	0.350	0.360	0.318	0.328	0.338	0.031	0.029	0.043

2-Water productivity (kg /m^3)

The values of Water productivity (Water utilization efficiency) for both wheat and sunflower under different application of any alternative gypsum treatments (1, 2 and gypsum) are presented in Table (7). Data showed that all treatments led to increase in water productivity at the two seasons compared with the control. The values of Water productivity (Water utilization efficiency) as affected by mole spacing , mole depth and levels of irrigation treatments under application of any alternative gypsum treatments, these values indicated that Water productivity (Water utilization efficiency), increased in the presence of mole spacing at a distance of 2 meters greater than 4 meters, under any alternative gypsum alternative treatments, compared to control. The alternative gypsum one (AG1) treatment was being more effective in increasing water productivity at the two seasons, particularly under 2m mole space with 50 cm depth (M_2) and field capacity +20% (I_3) as compared with other treatments and control. The highest value of water productivity (Water utilization efficiency) was observed under alternative gypsum one (AG1), interaction between mole depth at 50cm, mole spacing at 2 m.and field capacity +20% (I_3) under cultivation of wheat and sunflower. while the least value was under gypsum (cont.) interaction between mole depth at 30cm, mole spacing at 4 m. and field capacity (I_1). This result may be due to improve the aggregation process consequently increase quickly drainable pores on the expense of fine capillary pores (Mansour, 2002). This finding could be explained on the basis of the effect of alternative gypsum on increasing the quickly drainable pores, it could be concluded that, using alternative gypsum one (AG 1) in the salty clayey soil.

Table 7. Grain and seed yield, Water productivity and water consumptive use efficiency as affected by different treatments under cultivation of wheat and sunflower crops .

Alternative gypsum Treatments(A. G.)	Mole drain system	Grain yield (Mg fed. $^{-1}$)			Water productivity (kg/m^3)			Water consumptive use efficiency (m^{3}fed^{-1})		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum (cont.)	M0	1.35	1,48	1,65	0,65	0,66	0,69	0,80	0,83	0,86
	M1	1.61	1.69	1.80	0.71	0.73	0.75	0.89	0.90	0.91
	M2	1,67	1.79	1.92	0.73	0.75	0.77	0.94	0.95	0.96
	M3	1.50	1.59	1.69	0.66	0.68	0.70	0.86	0.87	0.88
	M4	1,56	1.66	1.75	0.69	0.72	0.73	0.88	0.89	0.90
(A. G. 1)	M0	1.52	1.65	1.76	0.70	0.72	0.75	0.88	0.91	0.94
	M1	1.82	1.93	2.28	0.82	0.81	0.92	1.07	1.19	1.25
	M2	1.97	2,31	2.87	0,87	0,96	1,19	1,15	1,35	1.90
	M3	1,72	1.84	2.20	0.76	0.79	0.84	1.00	1.09	1.14
	M4	1,77	1.92	2.26	0.78	0.82	0.85	1.04	1.17	1.23
(A. G. 2)	M0	1,39	1.60	1.74	0.69	0.71	0.73	0.85	0.89	0.98
	M1	1.77	1.84	2.19	0.75	0.79	0.88	0.95	1.11	1.21
	M2	1,88	2.19	2.43	0.80	0.85	0.98	1.09	1.30	1.35
	M3	1.58	1.76	2.04	0.72	0.75	0.85	0.88	0.99	1.09
	M4	1.65	1.83	1.94	0.74	0.78	0.81	0.91	1.10	1.18

L. S. D at 0.05 A×B = 0.06 A ×C = 0.09 B×C = 0.07 A×B×C = 0.067
A (Alternative gypsum) = 0.022 B (mole drains treatments = 0.64 C (irrigation treatments =0.10

Alternative gypsum Treatments (A. G.)	Mole drain system	Second season								
		Seed yield (Mg fed. $^{-1}$)			Water productivity (kg/ m^3)			Water consumptive use efficiency (m^{3}fed^{-1})		
		Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3	Ir.1	Ir.2	Ir.3
Gypsum (cont.)	M0	0.76	0,89	0,97	0,35	0,36	0,38	0,63	0,66	0,68
	M1	0.96	1.05	1.12	0.39	0.41	0.43	0.69	0.71	0.73
	M2	1,00	1.15	1.19	0.41	0.44	0.46	0.70	0.74	0.77
	M3	0.91	0.96	1.03	0.35	0.38	0.39	0.64	0.68	0.69
	M4	0,95	1.00	1.10	0.37	0.39	0.42	0.68	0.69	0.72
(A. G. 1)	M0	0.85	0.96	1.07	0.39	0.41	0.42	0.65	0.69	0.73
	M1	1.12	1.20	1.26	0.46	0.47	0.49	0.73	0.75	0.79
	M2	1.17	1,24	1.30	0,47	0,49	0,51	0.75	0,79	0,82
	M3	1,02	1.09	1.17	0.42	0.43	0.45	0.67	0.71	0.75
	M4	1,06	1.12	1.19	0.44	0.46	0.48	0.72	0.74	0.77
(A. G. 2)	M0	0,81	0.93	1.03	0.37	0.39	0.41	0.63	0.68	0.70
	M1	1.05	1.14	1.22	0.42	0.44	0.46	0.71	0.73	0.76
	M2	1,07	1.18	1.23	0.45	0.47	0.49	0.73	0.76	0.79
	M3	0.97	0.99	1.12	0.39	0.41	0.42	0.65	0.69	0.72
	M4	1.00	1.09	1.15	0.41	0.43	0.45	0.70	0.72	0.74

L. S. D at 0.05 A×B =0.012 A ×C = 0.014 B×C = 0.016 A×B×C = 0.048
A (Alternative gypsum) =0.015 B (mole drains treatments = 0.023 C (irrigation treatments =0.045

3- Water consumptive use efficiency (m^{3}fed^{-1})

Data in Table (7) show that, the Water consumptive use efficiency (m^{3}fed^{-1}) for both crops (Wheat and sunflower).

The same trend was observed in the first and second seasons either with Wheat or sunflower.

Similar results were obtained by Moukhtar *et al*., (2012) Antar *et al*., (2008 and 2012) and Aiad *et al*., (2012)

CONCLUSION

Based on the aforementioned discussion, it could be concluded that the usage combination between mole depth at 50cm, mole spacing at 2 m , applied any alternative gypsum one or alternative gypsum two and levels of irrigation treatments especially at field capacity +20% (I_3) as compared with other treatments and control under cultivation of wheat and sunflower were the appropriate treatments to improve some soil chemical and physical properties, i.e., pH, Ece, ESP, bulk density, penetration resistances and total porosity and were decreased. On the contrary, hydraulic conductivity, organic matter, water productivity and total yield increased. Furthermore, the construction of mole drain combined with alternative gypsum and field capacity +20% (I_3) had a great effect on Grain yield (Mg fed. $^{-1}$), Water productivity(kg/m^3) and Water consumptive use efficiency (m^{3}fed^{-1}) under condition of salt affected soils Finally, it could be concluded that mole drainage gypsum (,AG1 and AG2) as well as irrigation level at filed capacity +20% (I_3) installation were the most important tool to conserve or reclaim the harmful effects of salt affected soils to a feasible one. This process must be undertaken with gypsum requirements. The results suggested that it will be possible to increase horizontally the cultivated area and to enhance unit area income.

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تاثير انفاق الصرف واضافه محسنات التربه على ادارة الاراضى المتاثره بالاملاح

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يمثل تحسين التربة الملحية - الصودية هدفا هاما في برنامج الأمن الزراعي في مصر لذلك أجريت تجربه حقليه بمحطة البحوث الزراعية بالسرو - محافظة دمياط ، مركز البحوث الزراعية بمصر ، خلال موسمين متعاقبين من (٢٠١٤\ ٢٠١٥) و٢٠١٥ لمحصولي القمح وعباد الشمس وذلك باستخدام بعض المخلفات الناتجة من صناعة السكر في مصر والمسببة تلوث للبيئه بغرض تعظيم الاستفادة منها واستخدامها كبديل للجبس كمحسنات للتربة مع تحسين الصرف بعمل انفاق المول على مسافات واعماق مختلفه تحت معاملات رى مختلفه (الرى عند السعه الحقليه – السعه الحقليه +١٠% - السعه الحقليه + ٢٠%) لتحسين بعض الخواص الطبيعيه والكميائيه والعلاقات المائيه للتربه وانتاجيتها من القمح وعباد الشمس و تم اضافة بدائل الجبس وكذا الجبس كمعاملة مقارنه نثرا وبشكل موحد على سطح التربة وتم خلطه تمامًا في أعلى ١٥ سم. قبل الزرعة كما تم إنشاء المول على ابعاد ٢ ، ٤ متر و ٥٠،٣٠ سم عمق. مع مراعاة معاملات الرى السابق ذكرها في التصميم التجريبي باستخدام تصميم القطع المنشقه مرتين فى ثلاث مكرارات حيث مثلت القطع الرئيسيه معاملات الرى المختلفه بينما وضعت ابعاد واعماق المول فى القطع المنشقه الاولى كما وضعت معاملات بدائل الجبس فى القطع المنشقه الثانيه. وقدرة الاحتياجات الجبسيه المقدرة للتربة ٥,٧ طن\فدان. وكذا كمية مياه الري المستخدمة و تم تنفيذ جميع الممارسات الزراعية على النحو الموصى به من قبل وزارة الزراعة. ومن ناحية أخرى ،احيطت كل قطعة بسور ترابي للحفاظ على المياه المتدفقة من مياه الغسيل الذى تم توفيره من قناة الهرنا. وقد اشارت النتائج المتحصل عليها على:انخفضت قيم ملوحة وحموضة وصودية التربه وكذا الكثافه الظاهريه ومقاومة التربه للاختراق والمسام الكليه وعلى النقيض من ذلك زيادة قيم الماده العضويه والتوصيل الهيدروليكى وكفاءة استخدام المياه وانتاجية المياه وانتاجية كلا من القمح ودوار الشمس . تفوق تاثير عمقي انفاق المول مع اى ابعاد لتلك الانفاق عند معاملة الرى (السعه الحقليه + ٢٠%)على معاملة الكنترول . لوحظ تفوق بدائل الجبس مع زيادة عمق الانفاق وقلة المسافه بينها فى كلا موسمى الزراعه. اعلى قيم للمحصول الحقلى وكفاءة استخدام المياه وانتاجيتها حدثت عند التداخل بين زيادة عمق الانفاق الى ٥٠سم وانخفاض ابعاد المول الى ٢ متر عند معاملة الرى (السعه الحقليه + ٢٠%) مع استخدام بديل الجبس رقم ١ يليه بديل الجبس رقم ٢ ثم الجبس . ان التحسن المتحقّق في الخصائص الفيزيائية والكيميائية والهيدرولوجية للتربة المدروسة ينعكس إيجابياً على الزيادات في كلا المحصولين (القمح - دوار الشمس)، عند اضافة بدائل الجبس و عمق المولي ٥٠ سم و مسافة المول ٢ م. وأخيرا ، تشير النتائج التي تم الحصول عليها إلى أن هذا العمل يعتبر أساسًا علميًا ومنطقيًا لنجاح التنمية الزراعية في هذه المنطقة المتأثرة بالملوحة.