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Evaluation of some Soil Conditioners on some Properties of Salt Affected Soil and Wheat Productivity and Quality

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ABSTRACT

Two field experiments were conducted during winter seasons of 2018/2019 and 2019/2020 at Sahl El-Hussainia Agric. Rcs. Station, El-Shakia governorate, to study the effect of addition of soil conditioners (compost, gypsum and bio-fertilizer alone or combination on some soil chemical and physical properties of saline soil and yield, yield components and chemical composition of wheat plant (*Triticum astivum* L.). The results showed that all used amendments either solely or combined application led to decrease EC (dSm^{-1}), pH, SAR and ESP compared with control. The Bulk density, porosity and infiltration rate were positively affected by soil amendments. The combined application of compost and gypsum or between compost and bio-fertilizer were more affective than single one the soil chemical and physical properties. All treatments were significantly increase wheat yield and yield components. The highest significant effect on wheat yield and yield component were obtained by application compost+ gypsum, and also N, P, K, Zn, Fe, Mn in grain and straw.

Keywords: salt affected soil, compost, gypsum, bio-fertilizer, wheat productivity.

INTRODUCTION

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. About 900 000 ha suffer from salinization problems in irrigated areas, 6 % of Northern Delta region are salt-affected, 20 % of the Southern Delta and Middle Egyptian region and 25 % of the Upper Egypt region (FAO, 2003). Salinity problem accrued to accumulation of soluble salts in root zoon. These excess salts can reduce plant growth by effect in water uptake and casing specific toxics problem (Saad El-Deen and Glala. 2017). Increasing soil salinity advert physical properties, lower permeability, decreased structural stability and bulk density (Amer and Hashem .2018).

Compost addition increased soil productivity and sustainability due to their (Adugna. 2016). Addition of organic substances to soil play very important role on its physical, chemical and biological characteristics (Brawn and Cotton. 2011). Ahmed *et al*., (2014) pointed out that addition of organic matter to salt affected soil had significantly effect on physical and chemical properties and yield growth. The release of organic acid from decaying of organic matter, which dissolution and liberate more calcium for sodium exchange (Ghafoor *et al*. 2008). Many researchers pointed out that addition of compost to salt affected soil and sodic soil decreased EC, pH, SAR and increase soil aggregation and permeability (Amer *et al*. 2018). In another study, El-Maaz *et al*. (2014) found that the great importance of the appropriate role of compost and bio-fertilizer improving soil characters and enhancing its productivity of wheat as well as promotes the concentration of N, P, K, Fe, Mn and Zn by grains of wheat plants under the conditions of saline soil.

Gypsum ($CaSO_4.H_2O$) is most economically as soil amendment under saline –sodic soil of poor aggregation or soil structure (Fisher. 2011). Application of gypsum increases soluble Ca^{+2} in soil solution to substitute the adsorbed sodium hence overcome the dispersion of Na^+ and improve soil structure (Abd el-Fatah .2012). Shaaban *et al* (2013) found that most efficient and economic method for reclamation of salt soil is addition of gypsum as source of Ca^+, which change ionic composition of soil solution and replace the Na^+ from exchange site which is leached down of soil depth (Ghafoor *et al* 2008).

Bio-fertilizer is very affective in salt affected soil for improving the crop productivity and soil properties (Kumar *et al*., 2014). Sahay *et al*., (2018) stated that addition of bio-fertilizer on sodic saline soil increased growth and yield of rice and also increased organic carbon, available N, P and K. Shaaban *et al*., (2013) reported that application of bio-fertilizer improved soil physical properties and yield in saline soil. Mohamed *et al* (2011) found that inoculation by *Bacillus blymcya* increased soil total aggregated size disruption porosity.

Application of organic matter combined with gypsum has been successfully used to improve the physical and chemical properties of salt affected soil (Wange *et al*. 2009). Abdel-Fattah (2012) stated that addition of gypsum combined with compost decreased soil salinity and sodicity. Sarwar *et al* (2011) concluded that addition of gypsum requirement (3.5-ton ha^{-1}) and compost (24-ton ha^{-1}) to saline sodic soil improved its chemical properties such as electrical conductivity, soil reaction and sodium adsorption ratio to low level. Also, soil fertility, organic matter, available N, P and K were increased. In a study by Amer *et al* (2018) it was found that soil chemical properties of salts affected soil significantly affected by addition gypsum combined with 4 $Mgfed^{-1}$ compost. Soil bulk density decreased porosity and infiltration rate were increased. Another study was conducted by Zaka *et al* (2018) to study the effect of gypsum combined with

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compost addition on salt affected soil on wheat plant and soil properties result showed effect on significant wheat yield, while decreased the soil pH, SAR, bulk density, porosity and hydraulic conductivity. Ograla and Naglaa (2019) showed that compost and gypsum application were significantly affected on soil moisture, field capacity, available water and available N, P and K in saline sodic soil.

Addition of bio-fertilizer with compost is considered as an important way to improve soil chemical and physical characteristics and fertility of soil, which reflected on planting yield (Ananaia. 2002). Paras *et al* (2008) concluded that maize grain and straw yield grown in saline soil were significantly increased by addition of organic and bio-fertilizer. Helmy *et al* (2013) pointed out that addition of compost combined with bio-fertilizer (PGPR) *Rhizobateria* was decreased electrical conductivity (EC dSm^{-1}) and soil pH values and increased soil structure and barley grain yield as well as N, P, K, Fe, Mn and Zn content in straw and grain. El-El-Eter *et al* (2016) studied the effect of bio-fertilizer (symbiotic N fixing bacteria leguminosarum combined with compost and humic acid on salt affected soil of Sahl El-Hussinia , Egypt was the soil pH and EC values decreased. Soil porosity and stable aggregate significantly affected by this treatment. In study by Said *et al* (2017), they found that addition of gypsum, farmyard manure and bio-fertilizer to salt affected soil of North Delta, Egypt significantly affected on wheat yield, soil bulk density and porosity.

This work aims assessing the effects of organic fertilizer (compost), gypsum and bio-fertilizer on some soil chemical properties, availability of some macro and micro nutrients in the soil and wheat productivity and its quality under newly reclaimed saline soil conditions.

MATERIALS AND METHODS

A field experiment was conducted for the two successive winter seasons 2017/2018 and 2018/2019 at Sahl El-Hussinia agric. Res. Station, El-Sharkia Governorate, location lies between 32° / 00 to 32° / 15, N latitude and 30° / 50 to 31° / 15 E longitude. This study aimed to determine the effect of compost, gypsum and bio-fertilizer addition on soil fertility and wheat yield grown in salt affected soil. the experimental design was split plot with three replicates, compost was allocated in the main plots, and gypsum and bio-fertilizer allocated in the sub plots. The area of each plot was 7m long and 5m wid. Compost was added at rate of 10 Mg ha^{-1} and gypsum was added at rate 5 Mg ha^{-1} before 20 days from sowing and homogenously mixed top soil (0 – 30 cm). Bio-fertilizer (*Bacillus subtilis serrara marcescens)* were obtained from the Microbiology Dep, Soil, Water and Environment Res. Inst. (SWER). Inoculations were grown separately in flask (250 ml) containing nutrient liquid media for 3- 4 days was added at 21, 45 and 65 days at a rate 5 liter bacteria mixed with 200-liter water and sprayed at soil and plant.

The main physical and chemical properties of the used soil before planting were determined according to the methods described by Kulte (1986). The obtained data is recorded in Table (1 and 2).

The compost was analyzed according to the standard methods described by Page *et al*;(1982) and the obtained results are presented in Table (3).

Table 1. Soil physical and chemical properties of the soil before treatments for first seasons.

Depth	Soil pH	EC	SAR	ESP	Soluble cations meq/l				Soluble anions meq/l			CEC	O. M	$CaCO_3$
(cm)	(1:2.5)	(dSm^{-1})		(%)	Na	K	Ca	Mg	CHO_3	Cl	SO_4^{-2}	mole/kg	(%)	
0 - 20	8.4	9.84	15.90	21	65.1	1.10	14.10	18.10	5.20	42.10	51.00	32.10	1.10	10.75
20 - 40	8.30	10.96	17.10	23	71.10	1.30	17.10	20.10	5.90	48.10	55.60	30.20	0.80	9.36
40 -60	8.40	12.78	18.20	26	82.10	1.40	20.20	24.10	6.20	59.10	62.50	31.50	0.80	6.33

Depth	K.	IR	FC	W. P	A.W.	B.D.	Particle size distribution (%)			
(cm)	(m/d)	(cm/h)	(%)	(%)	(%)	mg/cm_3	Fine Sand	Silt	Clay	Texture
0 - 20			36.20	17.90	17.90	1.39	29.30	26.60	44.10	Clay
20 - 40	0.16	0.26	37.30	17.50	17.50	1.42	28.30	26.20	45.50	Clay
40 -60			38.50	19.40	19.40	1.41	29.10	24.10	46.80	Clay

IR: infiltration rate **SAR: sodium absorption ratio** **EC: electric conductivity** **ESP: exchangeable sodium percent**
CEC: cation exchangeable capacity **OM: organic matter** **CaCO3: calcium carbonate** **K: hydraulic conductivity**
FC: field capacity **WP: wilting point** **AW: available water** **BD: bulk density**

Table 2. Soil physical andchemical properties of the soil before treatments for second season.

Depth	Soil pH	EC	SAR	ESP	Soluble cations meq/l				Soluble anions meq/l			CEC	O. M	$CaCO_3$
(cm)	(1:2.5)	(dSm^{-1})		(%)	Na	K	Ca	Mg	HCO_3	Cl	SO_4^{-2}	mole/kg	(%)	(%)
0 - 20	8.30	10.45	16.19	22.10	68.10	1.20	15.11	20.10	6.10	47.20	33..20	32.20	1.10	9.86
20 - 40	8.40	11.77	16.70	23.50	75.20	1.40	18.60	22.50	6.50	54.10	31.11	31.20	0.90	7.50
40 -60	8.45	13.77	18.30	26.00	88.80	1.60	21.10	26.20	5.70	68.10	31.20	31.10	0.80	6.22

Depth	K.	IR	FC	W. P	A.W.	B.D.	Particle size distribution (%)			
(cm)	(m/d)	(cm/h)	(%)	(%)	(%)	mg/cm_3	Fined Sand	Silt	Clay	Texture
0 - 20			35.10	17.10	18.00	1.40	32.70	25.10	42.10	Clay
20 - 40	0.80	0.30	36.20	18.20	18.40	1.43	32.610	24.20	43.20	Clay
40 -60			37.10	18.50	18.60	1.44	31.40	24.30	44.30	Clay

Table 3. Some chemical characteristics of compost.

Moisture	pH	EC	O.M	O.C	N (%)	C/N ratio	P	K	Micronutrients (mg/kg)			
(%)	(1:2.5)	(dSm^{-1})	(%)	(%)		(%)	(%)	(%)	Fe	Zn	Mn	B.D.
20.00	7.90	5.80	36.10	20.70	1.25	16.60	0.35	0.91	10.10	3.90	9.20	0.51

Wheat grain (*Tretcum Assetivum* L.) cultivar Masr 1. Seeds were planted (broadcasting) at a rate of 160.kg ha^{-1} during the winter season (November 15, 2017 and November 20, 2018). All plots received the recommended 250 Kg N / ha as ammonium sulphat, 400 kg /ha calcium super phosphate and 120 kg/ha potassium sulphat. Calcium super phosphate was added before planting during the soil tillage and the N and K fertilizers were added in two equal doses after 31 and 50 days from planting.

After wheat maturity, plant was harvested and samples were taken to determine plant height, spike length (cm), number of spiklete /spike and 1000 grains (g). The weight of biological yield estimated in the net plot and separated into grain and straw. Sample from grain and straw were taken, dried on oven at 70C° for chemical analysis. Soil samples of experimental sites were taken at the depth (0- 20 cm, 20- 40 and 40- 60 cm) before sowing and after harvest. The chemical and physical are presented in Table (1 and 2). Soil bulk density (BD) was estimated in the undisturbed soil sample using steel ring 100 cm^3, Soil pH was determined in 1:2.5 soil. water suspension using pH meter and soil EC meter according to (Page *et al*. 1982). Organic carbon content was determined in the soil sample by the modified Walkley and Black method as outlined by Sparks *et al* (1996). Available nutrients were determined in the soil samples according to the procedures described Page *et al* (1982) as follow: 1- available N was extracted by K_2SO_4 (1 %) and then determined using macro kjeldahel. 2- Available P extracted by $NaHCO_3$ (0.5 N pH 8.5). 3- Available K was extracted by ammonium acetate (1 N, pH 7) and then determined by phlame photometer. 4- Available Fe, Mn and Zn were determined by ammonium acetate DTPA according to Soltan pour and Schwab (1977) and then determined with atomic adsorption photometer (Perkin –Elmer 372).

Plant samples were oven dried at 70 C° for 72 hr and ground. Plant portions equivalent to 0.29 were digested using mixture of concentrated sulphuric acid and perchloric acid ratio 2:1 as outlined by Mohamed *et al* (2019), after wards, the digest was dilute to volume of 100 ml by deionized water. Total N in plant determined was by micro-Kjeldahl apparatus. Phosphorus was determined spectrophotometrcally using ammonium molybdate/ stannous chloride. Potassium was determined by a flame photometer, according to Page *et al.* (1982). Fe, Mn, and Zn were determined by using Atomic Absorption (model GBC 932).

Statistical analysis.

All measurements were carried out in triplicate. The statistical significance of the treatment effects was calculated with LSD procedure at p = 0.05 by using SPSS software programs.

RESULTS AND DISCUSSION

Effect of treatments on soil properties.

Soil electrical conductivity (EC dSm^{-1}).

Soil EC is very important parameter, and it was indicated that the over all soluble salts. Data in Table (4) show that the addition of compost, gypsum and bio-fertilizer alone or combination to soil were significant decreased soil EC from 9.84 to 6.50 dSm^{-1} at the first season and from 10.45 to 7.2 dSm^{-1} at the second season in upper layer (0 – 20 cm). the significant effect of compost addition on soil EC might attributed to the improvement of physical and chemical properties of soil such as ESP, porosity, aggregation and infiltration rates which led to increased salt leaching through soil profile (Zaka *et al*. 2005 and 2018). Addition of gypsum decreased soil EC of upper layer from 9.84 to 7.20 dSm^{-1} and from 10.45 to 7.50 dSm^{-1} at first and second seasons respectively after wheat harvesting. The beneficial that of gypsum addition on decreased soil salinity may be due to that release Ca^{+2} from gypsum change ionic composition of soil solution and replace the Na^{+} from exchange site which leached down of soil profile. Also, addition of gypsum imports soil structure (Fisher, 2011 and Zaka *et al*., 2018) which led to increase leaching of salt down soil profile.

Table 4. Effect of treatments on some chemical properties of soil after wheat harvest.

	Soil amendments	Soil depth (cm)	2018 - 2019				2019 - 2020			
			pH (1:2.5)	EC (dSm^{-1})	SAR	ESP (%)	pH (1:2.5)	EC (dSm^{-1})	SAR	ESP (%)
0	0	0-20	8.20	9.50	15.90	21.00	8.30	9.50	16.19	20.20
		20-40	8.40	10.30	17.10	23.00	8.40	10.40	16.70	22.50
		40-60	8.40	11.90	18.20	26.00	8.40	12.10	18.30	23.50
	Mean		8.33	10.56	17.60	23.30	8.37	10.66	17.10	21.90
	Gypsum	0-20	7.90	7.20	10.10	15.10	8.10	7.50	11.10	14.50
		20-40	8.10	8.10	13.20	18.20	8.20	8.00	12.90	16.10
		40-60	8.30	9.20	15.10	19.50	8.30	9.30	15.20	19.20
	Mean		8.10	8.10	12.80	17.60	8.20	8.20	13.10	16.46
	Bio-fertilizer	0-20	8.10	7.80	12.10	17.20	8.00	8.10	13.20	16.20
		20-40	8.20	8.50	14.20	19.10	8.20	9.20	14.9	17.30
		40-60	8.20	8.70	15.6	20.10	8.20	9.30	15.10	18.50
	Mean		8.10	8.30	13.97	18.80	8.13	8.80	14.13	17.30
LSD. 0.05			0.75	1.10	1.80	2.10	0.09	1.10	1.40	2.10
Compost	0	0-20	7.40	6.50	11.20	13.10	7.85	7.20	12.10	13.20
		20-40	8.10	7.80	13.10	17.30	7.91	8.50	12.90	14.10
		40-60	8.10	8.30	15.20	19.10	8.10	9.00	14.10	14.50
	Mean		8.00	7.53	13.20	17.50	7.95	8.20	12.40	13.70
	Gypsum	0-20	7.70	5.50	9.20	19.90	7.80	6.10	9.10	11.10
		20-40	7.90	6.90	11.30	15.10	7.85	7.10	11.20	13.20
		40-60	8.00	8.80	13.10	17.20	8.10	8.50	12.10	13.30
	Mean		7.87	7.06	11.20	15.16	7.90	7.26	10.80	12.53
	Bio-fertilizer	0-20	7.75	6.10	10.30	14.10	7.90	6.50	9.90	12.20
		20-40	8.00	7.20	12.10	16.20	8.10	7.90	12.10	13.10
		40-60	8.10	9.10	14.20	18.10	8.20	8.90	13.20	13.30
	Mean		7.95	7.47	12.20	16.13	8.10	7.70	11.73	12.80
LSD. 0.05			0.16	1.30	1.90	2.20	0.10	0.095	1.60	1.10

Addition of bio-fertilizer significant effect on soil EC in Table (4) showed that the soil salinity decreased from 9.45 to 7.80 dSm^{-1} at the first season and from 10.45 to 8.10 at the second season. The benefit effect of bio-fertilizer on soil salinity may be due to improve physical soil properties such as increase total aggregates and soil porosity through produce expoly saccharidss (Mohamed *et al*.,2011, Shaaban *et al*., 2013 and Nisha , 2017). The highest decreases on EC were obtained by addition of compost combined by gypsum and bio-fertilizer. Soil C decreased from 9.84 to 5.50 dSm^{-1} in the first season and from 10.45 to 5.50 in second seasons for soil the addition of compost + gypsum. Addition of compost + bio-fertilizer decreased soil EC from 9.85 to 6.10 dSm^{-1} in the first season and from 10.45 to 6.5 dSm^{-1} in the second season. These data compared with the obtained by Shaaban *et al* (2013), Wange *et al* (2009) and Amer *et al* (2018).

Soil pH.

Soil pH reflects soil chemical properties. Data in Table (4) show that the soil pH slight decreased due to the solely application of compost, gypsum, bio-fertilizer and its combination. The highest reduction of soil pH was obtained by addition of compost combined with gypsum and bio-fertilizer. Main advantage of compost and gypsum on soil pH is that gypsum supplies Ca^{+2} to substitute the adsorbed Na^{+} and decomposition of organic matter, releasing organic acid which effected significantly on decreasing soil pH. These results are in agreements by Abdel-Fattah (2012), Helmy *et al* (2013) and Zaka *et al* (2018). The slight decreased of pH due to addition of bio-fertilizer reflected the activity of microorganisms in decomposition of organic matter and releasing organic acid and due to dehydrogenase activity in the rizopher of root (Shaaban and Omar, 2006) and (El-Maaze *et al* 2016).

Sodium Adsorption Ratio (SAR) and Exchangeable sodium percentage (ECP).

Addition of compost alone decreased SAR and ESP significantly after harvest (Table 4). SAR decreased from 21 to 13.10 % and from 20.20 to 12.10 % an upper layer (0 – 20 cm) for first and second season respectively. The effect of compost on decreasing SAR and ESP may be due to release of organic acid with dissolution and liberateCa^{+2}, which decreased exchangeable sodium, (Ghafoor, 2008; Zaka, 2005 and Amer and Hashem (2018). Application of gypsum decreased SAR from 15.90 to 10.10 % and from 16.90 to 11.1a in upper layer (0 – 20 cm) for first and second seasons respectively. These results are confirmed by those obtained by Amer and Hashem (2018), Zaka *et al* (2018) as the significant effect of gypsum addition to soil salinity for SAR and ESP may be due to release calcium from gypsum increase concentrate Ca^{+2} in soil solution, which replace exchangeable sodium and ameliorate of soil chemical and physical characteristics. Addition of bio-fertilizer decreased SAR from 15.90 to 12.10 and from 16.90 to 13.20 in the first and second seasons respectively for upper layer (0- 20 cm). ESP decreased from 21.00 to 17.20 % and from 22.10 to 19.90 % in the first and second seasons respectively. The beneficial effect bio-fertilizer on SAR and ESP may be due to addition of bio-fertilizer amelioration soil physically and chemical properties. Mohamed (2011), Kumar *et al* (2014) and Nisha *et al* (2017).

The interaction between compost + gypsum and compost + bio-fertilizer on soil SAR and ESP were significant compared with control and solely addition of compost, gypsum and bio-fertilizer. Addition of compost + gypsum decreased SAR from 15.90 to 9.20 and from 16.90 to 9.10 in first and second seasons respectively as well as, the decreased of ESP from 21.00 to 10.90 % and from 16.19 to 10.30 % for the first and second seasons, respectively. Addition of compost + bio-fertilizer decreased SAR from 15.90 to 10.30 and from 16.19 to 9.90 and decreased ESP from 21.00 to 14.10 and from 22.1 to 12.20 % in the first and second seasons respectively in upper layer (0- 20 cm). These data confirmed with obtained by Ananaia (2002), Helmy *et al* (2013) and Said *et al* (2017).

Soil bulk density (BD) and porosity.

The effect of solely addition of compost, gypsum and bio-fertilizer and their combination on the soil BD and porosity are found in Table (5). Data indicated that the values of soil BD and Porosity of different treatments affected compared to control. The effect of compost on decreasing soil BD may due to the organic fraction in much liter in weight than mineral fraction in soil. As the result, increases in the organic fraction decrease the total weight and bulk density of the soil (Brawn and Cotton, 2011). In another side the compost addition influence on soil aggregation and porosity due inter action between organic and mineral fraction (Amlinger *et al*., 2007).

The effect of gypsum addition on soil bulk density and porosity may be to effect of gypsum on decreasing salinity and decreasing exchangeable Na^{+} which led to decrease soil dispersion and increase soil porosity and resultant net reduction in BD (Zaka *et al* 2018). The effect of bio-fertilizer on decaying of organic matter which affect on soil aggregation and porosity (Mohamed *et al*. 2011 and Sied *et al* 2017).

Table 5. Effect of treatments on some physical of soil after wheat harvest.

	Soil amendments	Soil depth (cm)	2018 - 2019 IR cm/ha	2018 - 2019 B.D. mg/m³	2018 - 2019 Porosity (%)	2019 - 2020 IR cm/hr	2019 - 2020 B.D. mg/m³	2019 - 2020 Porosity (%)
0	0	0-20	0.26	1.42	46.10	0.30	1.43	46.50
		20-40		1.43	45.60		1.44	45.10
		40-60		1.45	45.80		1.46	45.10
	Mean			1.43	45.80		1.44	45.60
	Gypsum	0-20	0.35	1.46	48.10	0.39	1.40	47.80
		20-40		1.42	46.20		1.41	46.90
		40-60		1.44	46.40		1.45	46.90
	Mean			1.41	46.90		1.41	47.20
	Bio-fertilizer	0-20	0.29	1.41	46.80	0.35	1.40	46.10
		20-40		1.42	45.60		1.42	45.60
		40-60		1.42	45.70		1.45	45.80
	Mean			1.42	45.80		1.42	45.80
Compost	0	0-20	0.40	1.38	47.20	0.43	1.38	48.30
		20-40		1.40	46.90		1.40	47.90
		40-60		1.41	46.00		1.42	47.80
	Mean			1.35	46.70		1.40	48.00
	Gypsum	0-20	0.55	1.36	49.80	0.58	1.37	47.90
		20-40		1.38	48.80		1.38	49.10
		40-60		1.36	48.20		1.38	48.80
	Mean			1.35	48.90		1.37	49.30
	Bio-fertilizer	0-20	0.45	1.37	47.90	0.46	1.38	48.90
		20-40		1.38	47.20		1.39	48.20
		40-60		1.38	47.10		1.40	47.90
	Mean			1.38	47.40		1.39	48.30

Effect of treatments on soil available N, P and K.

Data presented in Table (6) show the available (mg/kg) as affected by different treatment in soil after wheat harvest. The results revealed that application compost, gypsum and bio-fertilizer solely or on combination increased significant available N, P and K. The highest increases values of available N, P and K were found by compost + gypsum. The beneficial effect of compost on available N, P and K may be due to the compost contains N, P and K which released to soil in their available forms through organic matter decomposition (Agegnehu *et al*., 2014) and El-Shony (2020). There data confirmed with data obtained by Sarwar (2011) and Helmy *et al* (2013). Also, degradation of organic matter increased organic acid and humates which contributed to amelioration of soil chemical and physical characteristics of salt affected soil. The beneficial effect of gypsum on available N, P and K may be addition of gypsum amelioration soil chemical and physical characteristic of salt affected soil such as pH, EC and infiltration rate which led to increases biological activity in soil and decomposition of organic matter which release nutrient.The beneficial effect of bio-fertilizer on available N, P and K in soil may be due to bio-fertilizer increased soil organic matter and also its role in nitrogen fixation (Nisha *et al*., 2017). The increment percentage in soil available N, P and K in the first seasons was 38.15, 22.60 and 32.26 % for addition of compost, gypsum and bio-fertilizer respectively. The highest increasing in N, P and K were obtained for addition compost + gypsum, which reached 64.50, 77.40 and 15.50 % respectively.

Table 6. Effect of treatments on soil available macronutrients after wheat harvest.

Compost	Soil amendments	N		P		K	
		1st	2nd	1st	2nd	1st	2nd
0	0	31.00	33.00	5.10	5.30	260.00	270.00
	Gypsum	38.00	41.00	6.30	6.70	290.00	280.00
	Bio-fertilizer	41.00	45.00	6.80	7.50	301.00	295.00
LSD. 0.05		3.10	4.10	0.50	0.61	20.20	18.50
Compost	0	43.00	49.00	7.20	7.40	340.00	330.00
	Gypsum	49.00	56.00	8.10	8.30	390.00	355.00
	Bio-fertilizer	55.00	62.00	8.30	8.60	355.00	360.00
LSD. 0.05		5.10	4.90	1.20	0.90	25.10	26.20

Available micronutrients (Fe, Zn and Mn (mg/kg soil).

Addition of compost, gypsum and bio-fertilizer combined or alone were significantly increased available Fe Zn and Mn at the end of experiment for tow seasons Table (7). The effect of compost in available Fe, Zn and Mn may be due to compost contents of micronutrients, which release though its decomposition by microorganism (Agegnehu *et al* (2014). Also, through organic mater decomposition some organic acid and chelating compounds chalet micronutrients ageist fixation and make it more available for plant (Sarwar *et al*., 2011) and Helmy at al., 2013). The effect of gypsum on soil available micronutrients may be due to the favorite effect of gypsum on chemical and physical properties such as EC, pH, porosity and hydraulic conductivity which increased the supplying power of available nutrients to plant.

Also, bio-fertilizer significantly increased on available micronutrients through their effect on organic matter decomposition and amelioration physical and chemical properties of saline soil. These date confirmed with obtained by Shaaban *et al* (2013) and Nisha *et al* (2017). The increment percentage in soil available Fe, Zn and Mn in the first season was 90.10, 38.00 and 56.40 % for Fe, 87.5, 43.9 and 53.8 for Zn and 26.60, 40.00 and 60.00 %for Mn due to addition of compost, gypsum and bio-fertilizer respectively. The highest increase in available Fe, Zn and Mn was obtained by combined compost with gypsum which reaches to 117.80, 44.83 and 53.30 % for Fe, Zn and Mn.

Table 7. Effect of treatments on soil available micronutrients after wheat harvest.

Compost	Soil amendments	Fe		Zn		Mn	
		1st	2nd	1st	2nd	1st	2nd
0 control	control	3.26	3.60	0.91	0.95	1.50	2.20
	Gypsum	4.50	4.70	1.30	1.10	2.10	2.60
	Bio-fertilizer	5.10	5.50	1.40	1.30	2.30	2.70
LSD. 0.05		0.61	0.51	0.05	0.03	0.18	0.20
Compost 10Ton fed-1	control	6.20	6.60	1.71	1.10	2.70	2.90
	Gypsum	7.10	7.40	1.85	1.20	3.20	3.20
	Bio-fertilizer	7.80	8.10	1.80	1.40	3.10	3.10
LSD. 0.05		0.90	0.80	0.06	0.07	0.20	0.22

Yield and its component.

Data presented in Table (8 and 9) showed that plant height, spike length (cm) No. spikelets /spike, 100 grain (g), weight yield grain (Mg/ha) and straw yield (Mg/ha) were affected significant by adding solely of compost, gypsum and bio-fertilizer and their combination for two seasons. Compost addition significantly increased wheat grain yield and its complements. The relative increases over the control were 32.40 % and 15.20 % for grain and straw respectively. The positive effect of compost application on yield of wheat grown in this salt affected soil may be due to its favorable effect on soil physical and chemical properties such as decreased salinity, sodicity, infiltration rate and hydraulic conductivity. Also, compost content significant amounts of plant nutrient including, N, P, K, Fe, Zn and Mn, which stimulating plant growth and yield (Adugna. 2011). These data confirmed with data obtained by Sarwar *et al* (2011), Hellmy *et al* (2013), Amer *et al* (2018) and Ograla and Naglaa (2019).

Gypsum addition significant increased wheat straw and grain yield and its components. The relative increases over the control were 37.80 and 15.20 % for grain and straw. The favorite effect on wheat yield and its components grown on this salt affected soil may be due to that application of gypsum increased Ca^{+2} ,which substitute absorbed Na^{+} which amelioration soil chemical and physical characteristic which led to favorite effect on plant grown and yield, Ghafoor *et al* (2008) and Amer *et al* (2015).

The effect of bio-fertilizer on wheat yield and its components presented in (Table 8) were significantly compared with control treatment (without inoculation). The relative increases over control were 17.14 and 13.80 % for grain and straw respectively. The favorite effect of bio-fertilizer on wheat yield may be due the ability of microorganisms to fixing atmospheric nitrogen N and Plant growth regulator substances i.e. indol acidic acid, gibberillic acid and cytokinines, which important role on plant growth and advert effect of soil salinity. These results are in agreement with those obtained by Zaki *et al* (2012), Shaban *et al* (2013), Helmy (2013), and Saied *et al* (2017). The interaction effect between compost and gypsum on yield and yield parameter had significant effect (Table 8). The relative increases over the control were 76.90 and 43.70 for grain and straw respectively. These results confirmed with data obtain by Sarwar *et al* (2011), Amer *et al* (2018) who found that

addition compost + gypsum for reclamation of salt affected soil more effective than solely application of compost or gypsum. Interaction effect between compost and bio-fertilizer Table (9) on of wheat yield and its component had significant effect as compared with control or solely addition of compost or bio-fertilizer. The relative increases were 60.00 and 29.30 % for grain and straw, respectively as compared to control (without any addition).

Table 8. Effect of treatments on wheat yield and yield components in 2018 -2019.

Compost	Soil amendments	Plant height (cm)	Spike length (cm)	No. of spikiest /spike	1000 seeds (g)	Grian yield (Mg/ha)	Straw yield (Mg/ha)	H. T.
	0	69.40	8.90	17.10	36.80	3.70	9.30	28.50
0	Gypsum	95.10	9.61	18.90	38.90	5.10	10.71	32.20
	Bio-fertilizer	92.20	9.50	17.90	39.10	4.30	10.50	29.10
LSD. 0.05		1.60	0.41	0.70	1.10	0.30	0.61	ns
	0	96.20	9.80	18.50	40.10	4.90	10.70	31.40
Compost	Gypsum	99.30	10.60	20.20	42.20	6.10	13.10	32.10
	Bio-fertilizer	101.10	10.80	19.50	44.50	5.50	11.56	32.40
LSD. 0.05		1.80	0.60	0.82	1.50	0.41	0.12	ns

Table 9. Effect of treatments on wheat yield and yield components in 2019 -2020.

Compost	Soil amendments	Plant height (cm)	Spike length (cm)	No. of spikiest /spike	1000 seeds (g)	Grian yield (Mg/ha)	Straw yield (Mg/ha)	H. T.
	0	87.30	8.70	16.60	35.10	3.90	8.70	39.00
0	Gypsum	90.50	9.50	18.20	38.30	5.30	10.760	33.12
	Bio-fertilizer	88.50	9.10	17.10	36.50	4.10	9.90	29.00
LSD. 0.05		1.50	0.43	0.80	1.20	0.25	0.52	ns
	0	91.20	9.20	18.10	39.10	5.10	10.41	31.80
Compost	Gypsum	93.30	10.30	20.20	41.20	6.21	12.50	33.50
	Bio-fertilizer	92.50	10.30	19.50	40.30	5.60	11.25	33.22
LSD. 0.05		1.90	0.55	0.91	1.55	0.35	0.62	ns

Nutrients concentration of N, P and K grain and straw.

The effect of different treatments on N, P and K concentration in wheat grain and straw was shown in Table (10). The N, P and K concentration increased significantly by solely addition of compost, gypsum and bio-fertilizer and their combination during two seasons. The effect of compost on N, P and K concentration may be to that compost contains significant amount of available plant nutrients, (Agegnhu *et al* 2014). Also, addition of compost significantly effects on soil properties such as EC, pH, porosity and infiltration rates which encourage plant to adsorb nutrients (Amlinger *et al* 2007). The effect of gypsum on plant N, P and K concentration may be due to gypsum amelioration chemical and physical characteristics of salt affected soil, which affect the availability of nutrients solubility and availability and their uptake and concentration in plant. The effect of bio-fertilizer on N, P and K concentration may be due to the role it's of nitrogen bacteria on increasing endogenous phytohormons (IAA, Gas), which play an important role in formation high activate root system, increasing nutrients uptake and photosynthesis rate and translocation and accumulation on different plant prates. This resulted in agreement with these obtained by Nisha *et al* (2018), Zaka *et al* (2012) and Helmy *et al* (2013). The increment percentage in N, P and K of grain for addition of solely compost, gypsum and bio-fertilizer in the first season were 51.70, 52.60 and 29. % for N and 52.30, 30.00 and 40.00% for P and 50.00, 21.80 and 25.70 % for K as affected with solely addition of compost, gypsum and bio-fertilizer, respectively. Similar trends were observed in the second season. The interaction between compost and gypsum and bio-fertilizer were significant.

Table 10. Effect of treatments on the N, P and K concentration (%) on wheat grain and straw.

Compost	Soil amendments	Grain						Straw					
		N		P		K		N		P		K	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
	0	1.51	1.60	0.19	0.21	0.32	0.35	0.60	0.60	0.24	0.26	0.85	0.93
0	Gypsum	1.85	1.80	0.25	0.25	0.39	0.41	0.68	0.70	0.30	0.36	0.91	1.20
	Bio-fertilizer	1.98	1.90	0.27	0.28	0.41	0.44	0.70	0.72	0.35	0.38	1.10	1.20
LSD. 0.05		0.10	0.09	0.01	0.02	0.03	0.04	0.03	0.04	0.02	0.05	0.04	0.06
	0	2.20	2.21	0.29	0.31	0.48	0.51	0.76	0.80	0.40	0.38	1.30	1.50
Compost	Gypsum	2.35	2.40	0.34	0.34	0.53	0.56	0.87	0.91	0.46	0.46	1.45	1.60
	Bio-fertilizer	2.40	2.51	0.31	0.35	0.51	0.58	0.89	0.95	0.48	0.47	1.50	1.55
LSD. 0.05		0.08	0.10	0.02	0.021	0.04	0.05	0.07	0.08	0.04	0.035	0.06	0.05

The increment increase over control in the first season for grain were 55.60, 78.90 and 65.60 % for N, P and K concentration due to addition of compost + gypsum. The addition compost + bio-fertilizer were 58.90, 63.200 and 59.40 % for N, P and K.

Micronutrients concentration in wheat grain and straw (Fe, Zn and Mn mg/kg).

The effect of different treatments on Fe, Zn and Mn concentration mg/kg are given in Table (11). The results revealed that the application of compost, gypsum and bio-fertilizer solely or on combination significantly affected on

Fe, Zn and Mn concentration of grain and straw of wheat plant at the two seasons. The increment percentage for grain in the first season attained 45.90, 22.95 and 31.10 % for Fe; 68.30, 34.10 and 46.30 % for Zn and 46.40, 25.00 and 42.80% for Mn for solely addition of compost, gypsum and bio-fertilizer respectively. The interaction between compost and gypsum and between compost and bio-fertilizer were significantly. The relative increase on Fe, Zn and Mn in wheat grain in the first season was 55.70, 75.60 and 60.70 % for Fe, Zn and Mn respectively for addition compost + gypsum. The relative increases of Fe, Zn and Mn were 45.90, 82.50 and 60.70 % respectively for addition compost + bio-fertilizer

Table 11. Effect of treatments on the Fe, Zn and Mn concentration (mg/kg) on wheat grain and straw.

Compost	Soil amendments	Grain						Straw					
		Fe		Zn		Mn		Fe		Zn		Mn	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0	0	61.00	65.00	41.00	45.00	28.00	30.00	85.00	75.00	22.00	25.00	32.00	29.00
	Gypsum	75.00	78.00	55.00	58.00	35.00	36.00	91.00	80.00	27.00	28.00	38.00	32.00
	Bio-fertilizer	80.00	85.00	59.00	63.00	40.00	38.00	99.00	95.00	29.00	31.00	41.00	36.00
LSD. 0.05		6.10	5.20	4.20	7.80	3.40	4.10	4.00	4.30	2.10	1.80	2.30	1.30
Compost	0	89.00	90.00	65.00	69.00	41.00	49.00	110.00	120.00	31.00	36.00	41.00	39.00
	Gypsum	95.00	98.00	76.00	76.00	45.00	51.00	125.00	130.00	33.00	38.00	45.00	42.00
	Bio-fertilizer	89.00	95.00	81.00	81.00	46.00	56.00	132.00	145.00	38.00	45.00	50.00	51.00
LSD. 0.05		4.20	5.10	3.80	4.10	2.10	3.20	6.10	8.10	3.20	4.10	3.10	ns

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تقييم بعض محسنات التربة علي بعض صفات الاراضي المتأثرة بالاملاح وجودة وانتاجية محصول القمح

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اقيمت تجربة حقلية خلال موسمي 2018-2019 , 20219-2020 في محطة البحوث الزراعية بسهل الحسنية - معهد بحوث الاراضي والمياة والبيئة لدراسة اثر الاضافات المنفردة للكمبوست بمعدل 10 طن/ هكتار والجبس بمعدل 5 طن/ هكتار واضافة السماد الحيوي() علي بعض خواص الاراضي المتأثرة بالاملاح ومحصول القمح (مصر1) ومكوناته ومحتوي الحبوب والقش من العناصر. اظهرت النتائج ان اضافة كل من الكمبوست + الجبس او الكمبوست + السماد الحيوي الي تحسين في صفات الاراضي الملحية الطبيعية والكيماوية مثل النفاذية والسامية و PH, EC, SAR, ESP كذلك ادت جميع المعاملات الي زيادة معنوية في محصول القمح ومكونات ومحتوي الحبوب والقش من العناصر الغذائية مثل النيتروجين والفوسفور والبوتاسيوم والحديد والمنجنيز والزنك وكانت اعلي تأثير علي الصفات الطبيعية والكيماوية للارض ومحصول القمح ومكوناته نتيجة لاضافة 10 طن كومبوست + 5 طن جبس.