Impact of some Organic and Inorganic Amendments on some Soil Properties and Wheat Production under Saline-Sodic Soil

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ABSTRACT

Two field experiments were conducted at two sites in Sakha Agric. Res. Station Farm, North Delta, during two successive winter seasons, 2017/2018 and 2018/2019 to study the effect of individual and combined applications of gypsum, compost tea and biochar on some soil properties and wheat (*Triticum aestivum*, *L*) productivity under saline and saline-sodic soils. Gypsum requirements (G), 400 L compost tea (C), 1 Mg biochar (B₁) or 2 Mg biochar (B₂) were applied. Data revealed that application of G+ C+ B2 decreased soil ECe by 28.06 and 13.16 %, SAR by 17.23 and 8.92 %, ESP by 17.23 and 8.92 % for site 1 and site 2, respectively as compared to the control. While, the sodium removal efficiency (RSE %) with different treatments was increased in somewhat according to the following order: $G+C+B_2>G+C+B_1>G+C>G+B_2>G+B_1>G>C+B_2>C+B_1>C>B_1$ compared to that of the initial soil. Also, the application of different soil amendments decreased soil bulkdensity and increased soil porosity after the two growing seasons. The plant height, 1000-grain weight, grain yield and straw yields of wheat were significantly increased with different treatments. **Keywords:** Soil amendments, Soil properties, Wheat productivity and Salt affected soils.

INTRODUCTION

Wheat is one of the most important cereal crops in Egypt and covers 1.32 million ha with an annual production of 8.45 million ton. Egypt's wheat consumption in 2018/19 at 20.1 ton, up 1.5 percent from the 2017/18 estimate of 19.8 million tons. Egypt's wheat imports in 2018/19 at 12.5 ton, up 1.62 percent from the 2017/18 import figure of 12.3 million tons according to USDA (2018). So, the Egyptian government's, make efforts to increase the productivity of wheat per unit area by cultivating new soils and low water consumption (Mekkei and El Haggan, 2014).

Unfortunately, soil degradation resulting from soil salinity and/or sodicity, is a major problem of land resources under arid and semiarid climates (Qadir, *et al* 2007). Globally, about 95 million ha of soils are under primary salinization, while 77 million hectares are under secondary salinization (Metternicht and Zink, 2003; and Amini *et al.*, 2016). In Egypt, nine hundred thousand ha of irrigated lands were salt affected soils (Abou-Baker and El-Dardiry, 2016). So, the salt affected soils are one of the available natural resources to increase the cultivation area in Egypt.

Amelioration of saline-sodic soil is becoming an increasingly vital tool to improve crop production by organic and inorganic amendments. Several studies have been carried out concerning the effectiveness of various amendments in improving the physical and chemical properties of saline sodic. One of these amendments gypsum (CaSO₄, 2H₂O), is a naturally product that is mined for many purposes. Gypsum has a calcium content of 23%. The application of gypsum reduced ECe, SAR and ESP (Shah et al., ,2013, Daur and Tatar, 2013, Amer ,2015, Hamad ,2015, Zia-Ur-Rehman et al., 2016, Amer ,2017, Kima et al., 2017, Sagib et al., 2017, Wafaa Hafez et al., ,2017, Ravinder et al., 2017 and Amer and Hashem, 2018), while the removal sodium efficiency calculated (RSE %) significantly increased by 46.67, 57.89 and 71.83% in soil treated by gypsum, gypsum + sand, and gypsum + rice straw, respectively, compared to that of the initial soil (Amer, 2017).

Biochar (BC) is a C rich organic material which is produced by thermal decomposition of plant-derived biomass in partial or total absence of oxygen. The stability of BC in soil environment has been reported to be up to 1000 years (Sohi *et al.*, 2010). Also, BC has been used in arable soils for improving soil physical properties and plant growth (Downie *et al.*, 2009, Liu *et al.*, 2014 and Lu *et al.*, 2014). Biochar amendment decreased soil bulk density and increased soil

porosity (Laird *et al.*, 2010, Rachel *et al.*, 2012, Jein and Wang, 2013, Aslam *et al.*, 2014, Njoku *et al.*, 2015, Głąb *et al.*, 2016 and Sara *et al.*, 2018).

Compost tea is an infusion of compost in water for a period of time, the compost is removed, and the remaining solution is the compost tea, which is then applied to plant to provide beneficial microorganisms and essential plant nutrients (Scheuerell and Mahaffee 2004). Nasef *et al.*, (2009) found that physical properties, ie. hydraulic conductivity, bulk density and total porosity of salt affected soil are greatly improved due application compost, compost tea and bio-fertilizer. Enshrah El-Maaz *et al.*, (2016) found that soil EC and bulk density were decreased, while total porosity was increased due to application of compost tea. Amer (2016) concluded that soil EC, SAR and ESP and bulk density were decreased, while the soil porosity was increased with application of 400 L compost tea/fed.

This work aimed to study the improvement of some chemical and physical properties of salt affected clay soils to raise their productivity using some organic (compost tea and biochar) as well as inorganic (gypsum) amendments.

MATERIALS AND METHODS

Experimental location and design:

Two field experiments were conducted at two sites in Sakha Agric. Res. Station Farm, North Delta, during two successive winter seasons of 2017/18 and 2018/19 to study the effect of gypsum(G), compost tea (C) and biochar (B) on some soil properties and wheat productivity under salt affected soils. The site1 is located at 31°05'26.4" N latitude and 30°55'30.7" E longitude, where the site 2 is located at 31°05'19.8"N latitude and 30°56'13.2"E longitude with an elevation of about 6 meters above the sea level.

The experiments were designed as complete randomized blocks design with three replicates. The treatments were: control, G (gypsum requirements) with a rate of 4.36 and 8.88 Mg/fed in sites 1 and 2 respectively (Mg = metric tons; 1 fed = 0.42 ha), C (400 L fed ^1), B_1 (1.0 Mg fed ^1) and B_2 (2.0 Mg fed ^1) and their combinations; G+C, G+B_1, G+B_2, C+B_1, C+B_2, G+C+B_1 and G+C+B_2. Gypsum and biochar were thoroughly mixed with the surface soil layer (0-30 cm) before cultivation, where the application of compost tea was blended with water of the $1^{\rm st}$ and $2^{\rm nd}$ irrigations.

Cultural practices:

The experimental sites were prepared and divided into plots (2.5 m x 2 m). Gypsum requirements and biochar were ploughed with soil in the first season only. Gypsum

requirements were determined according to (FAO and IIASA, 2000). These amounts are sufficient to reduce the initial ESP to 10% for the soil matrix in the surface layer according the following equation:

$$Gr = (ESP_i - ESP_F)/100 \times CEC \times 1.72$$

Where Gr: gypsum requirement (Mg fed⁻¹), ESP_i: initial soil ESP, ESP_i: The required soil ESP (10) and CEC: cation exchange capacity (cmolc kg⁻¹).

To prepare the compost tea, 20 Kg of maturing compost was soaked in 200 liters tap water. Then, the mixture was turned daily and filtrated after 10 days. The compost tea was enriched by Azospirillium spp with a rate of 2L/400 L of compost tea. Biochar is a fine-grained and porous substance and can be produced through the slow pyrolysis of feedstock at low-medium temperatures (i.e. 450-650°C) in presence of limited oxygen source. The chemical composition of biochar and compost are listed in Table (1).

Table 1. Some chemical properties of the biochar and compost tea.

	pН	EC	%		(mg kg ⁻¹)				
Materials		(dS m ¹)	N	C	P	K	Ca	Mg	Na
Biochar (B)	7.9	2.05	1.22	66.7	22	984	52.4	22.4	0.3
Compost tea (C)	7.4	3.14	3.4	19.6	0.71	0.75	463	240	58

Wheat (*Triticum aestivum*, *L*. Sakha 93) grains was sown at the rate of 60 kg/fed in the 1st season on November 28th, 2017 and harvested after full maturity (April, 20th, 2017). While in the 2nd season it was sown on Nov., 19th, 2018 and harvested on April, 11th, 2018. Nitrogen fertilizer as urea (46%N) was applied at the rate of 75 kg N fed⁻¹in two doses, the first was following life watering irrigation and the second dose was done with second irrigation. Phosphorus was applied as a super mono phosphate with a rate of 31 kg P₂O₅ fed⁻¹, also100 kg potassium sulphate fed⁻¹ (48% K₂O) was applied with life watering. Other agricultural practices were performed according to the Ministry of Agriculture recommendation for wheat plants in North Delta area.

Soil analysis:

Surface soil samples (0-30 cm) were collected before and from each experimental unit at the end the experiment. Samples were air dried, crushed, sieved to pass through a 2.0 mm sieve and analyzed for their physical and chemical properties according to the standard methods outlined by Page *et al.* (1982) and Klute (1986). Sodium adsorption ratio (SAR) was calculated by the following equation according to (Richards, 1954): Where,

$SAR = Na \sqrt{(ca^{2+} + Mg^{2+})/2}$

While, Exchangeable sodium percentage (ESP) was calculated according to the equation of Rashidi and Seilsepour (2008):

ESP = 1.95 + 1.03 SAR

Removal sodium efficiency (RSE) in percentage from soils at end of the experiment was calculated as follows equation Amer (2017):

$RSE = (ESP_i - ESP_f) * 100/ESP_i$

Where, ESP_i is the initial ESP and ESP_f is the final ESP at the end of the experiment.

Soil bulk density and total porosity in all plots were measured as described by (Klute, 1986 and Campbell, 1994). Organic matter content was determined according to Walkally & Black method (Hesse, 1971). CaCO₃ was determined using calcimeter meter method as described by (Piper, 1950). Cation exchange capacity (CEC) was determined using ammonium acetate method as described by (Rengasamy and Churchman, 1999). Mechanical analysis was determined according to the international pipette method (Dewis and Fertias, 1970). The soil content of available N was determined using K₂SO₄ (1%) according to Jackson (1973), Also, available P and K were extracted by ammonium bicarbonate- DTPA and determined according to Soltan pour (1985). Data of physical and chemical characteristics of the tested soil before planting are presented in Table (2-3).

Table 2. Soil chemical characteristics of the experimental site before cultivation.

Sites	nЦ	_f EC	Soluble cations meq / L			Soluble anions meq / L			SAR	ESP -	AV	AP	AK		
sites pri		dS/m	Na^{+}	\mathbf{K}^{+}	Ca ⁼	$Mg^{=}$	$CO_3^{=}$	HCO ₃	Cl	$SO_4^=$	SAK	ESF		mg/kg	
Site 1	8.23	6.81	46.3	0.2	15.0	6.1	0.0	4.0	36.1	27.5	14.25	16.63	55	9.5	201
Site 2	8.52	14.8	100.6	0.3	32.6	13.3	0.0	2.5	78.5	65.8	21.01	23.59	50	8.2	185

Soil pH in (1:2.5 soil: water suspension), whereas soil salinity (EC) in soil paste extract, AN, AP, AK are available N, P and K respectively.

Table 3. Some soil physical characteristics of the experimental site before cultivation.

Sites	Soil mechanical analysis (%)			OM	Total	C.E.C.	Bulk density	Total porosity	
Sites	Sand	Silt	Clay	Texture	%	CaCO ₃ (%)	(cmolc kg ⁻¹)	(g cm ⁻³)	(%)
Site 1	19.04	33.15	47.81	Clay	1.25	2.42	38.20	1.44	47.04
Site 2	18.5	31.41	50.09	Clay	1.16	2.31	37.97	1.43	45.66

Plant sampling:

At maturity stage, plant height (cm) and 1000-grain weight (g), total yield, grain and straw yield (Mg fed⁻¹) were recorded for each plot.

Statistical analyses:

The obtained results were subjected to analyses of variance and LSD test at 0.05 and 0.01 levels of probability according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

I. Effect of different amendments on some soil chemical properties:

a. ECe:

The data in Figs (1 and 2) revealed that ECe values with different treatments were lower than that in the check

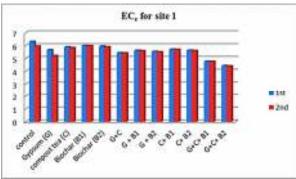
plots. The lowest ECe values of saline-sodic soil in site 1 and site 2 were (4.43 and 13.08 dS/m, respectively) were achieved due application of G+C+B₂, while the check plots in both sites recorded the lowest ECe values (6.15 and 15.04 dSm1, respectively). Consequently, the decrease in ECe % due to this combination treatment comparing to the control in both sites after the 2nd season were 28.06 % and 13.16 %, respectively (Table, 4). Also, there were obvious differences in ECe values with various treatments comparing to the control. Also, ECe is indirectly related to the total concentration of soluble salts in soil and is a direct measurement of salinity. These results may attribute to the improvement in soil porosity and hydraulic conductivity as a result of soil amendments, which enhance the leaching of salts, as observed by Shah *et al.*, (2013), Daur and Tatar

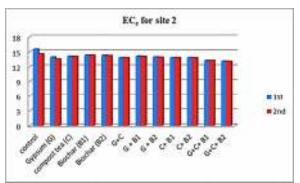
(2013), Amer (2015), Hamad (2015), Zia-Ur-Rehman *et al.*, (2016), Amer (2017), Kim *et al.*, (2017), Saqib *et al.*, (2017), Wafaa Hafez *et al.*, (2017), Ravinder *et al.*, (2017), Amer and Hashem (2018).

b. Soil alkalinity (SAR, ESP and RSE %):

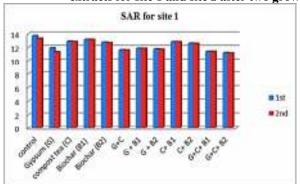
It was observed that the combined application of G+C+B₂ was superior to all other treatments and clearly alleviated soil alkalinity since it reduced the values of SAR and ESP of soil after harvesting in the two growing seasons

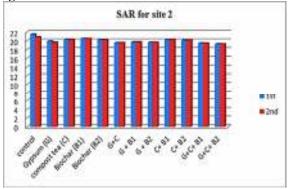
in both sites. This treatment exhibited the lowest values of SAR for site 1 and site 2 (11.19 and 19.29, respectively), while the highest values in both sites at the end of the experiment (13.52 and 21.18, respectively) were recorded in the control (Figs. 3 and 4). However, this combined treatment showed 17.23 % and 8.92 % decreases in SAR in both sites 1 and 2, respectively compared to the control at the end of the experiment (Table 4).





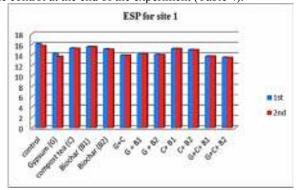
Figs. 1 and 2. Effect of organic and inorganic amendments on Electrical conductivity (ECe) of saturated soil extracts for site 1 and site 2 after two growing seasons.



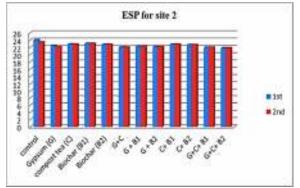


Figs. 3 and 4. Effect of organic and inorganic amendments on SAR of soil for site 1 and site 2 after two growing seasons.

Also, the combination treatment of G+C+B $_2$ achieved the lowest ESP values of soil in the 1 $^{\rm st}$ and 2 $^{\rm nd}$ sites (13.47 and 21.82, respectively) after the 2 $^{\rm nd}$ season, while the check plots recorded the highest ESP values in both sites (15.88 and 23.77, respectively) after the 2 $^{\rm nd}$ season (Figs.5 and 6). In addition, this combined treatment of added soil amendments showed 15.15 % and 8.18 % decreases in ESP in both sites, respectively compared to the control at the end of the experiment (Table 4).



The sodium adsorption ratio and exchangeable sodium percentage is reduced either due to increase of Ca on soil exchangeable complex as a result of the application of gypsum or due to the reactions of organic acids and compost tea with soil CaCO₃. These results are in agreement with Amer (2017) and Amer and Hashem (2018) who reported that gypsum application decreasing SAR. Also, Amer (2016) concluded that compost tea and biochar decreased SAR.



Figs. 5 and 6. Effect of organic and inorganic amendments on ESP of soil for site 1 and site 2 after two growing seasons.

The removal sodium efficiency (RSE %) clearly increased approximately according the following descending order: $G+C+B_2>G+C+B_1>G+C>G+B_2>G+B_1>G>C+B_2>B_2>C+B_1>C>B_1$ compared to that of

the initial soil (Table 4). These results are in agreement with Amer (2017) who found that the RSE increased by 46.67, 57.89 and 71.83% in soil treated by G, G + sand and G + rice straw, respectively compared to the untreated soil.

Table 4. Relative change (± %) in soil EC, SAR, ESP and RSE in surface layer as affected by different treatments of organic and inorganic amendments

		EC	CAD	ECD	RSE %			
Site	Amendments	EC	SAR	ESP	1 st	2 nd	14	
		(± %)	(± %)	(± %)	season	season	Mean	
	Control	6.13	13.52	15.88	-	-	-	
	Gypsum (G)	-11.26	-13.94	-12.22	11.44	13.02	12.23	
	Compost tea (C)	-4.40	-4.77	-4.16	5.16	3.13	4.14	
	Biochar (B ₁)	-2.12	-2.70	-2.36	3.54	1.15	2.35	
	Biochar (B ₂)	-3.34	-5.92	-5.17	6.09	4.21	5.15	
Site	G+C	-11.42	-14.02	-12.28	13.31	11.23	12.27	
1	$G + B_1$	-8.56	-12.35	-10.87	11.88	9.83	10.85	
	$G + B_2$	-9.95	-13.17	-11.53	12.50	10.53	11.51	
	$C+B_1$	-6.93	-5.21	-4.57	5.72	3.38	4.55	
	$C+B_2$	-8.40	-6.88	-6.02	7.09	4.91	6.00	
	$G+C+B_1$	-22.27	-15.61	-13.67	14.74	12.57	13.66	
	$G+C+B_2$	-27.81	-17.23	-15.15	16.11	14.17	15.14	
	Control	15.04	21.18	23.77	0.0	0.0	0.0	
	Gypsum (G)	-8.84	-6.63	-6.08	6.76	5.38	6.07	
	compost tea (C)	-6.62	-4.06	-3.72	5.02	2.39	3.70	
	Biochar (B ₁)	-4.95	-3.19	-2.92	4.27	1.54	2.90	
	Biochar (B ₂)	-5.39	-4.44	-4.06	5.31	2.78	4.04	
	G+C	-8.34	-7.79	-7.15	8.42	5.85	7.13	
	$G + B_1$	-6.52	-6.82	-6.23	7.51	4.91	6.21	
Site	$G + B_2$	-7.55	-7.37	-6.75	8.00	5.47	6.74	
2	$C+B_1$	-8.28	-4.23	-3.87	5.23	2.48	3.85	
	$C+B_2$	-8.24	-4.89	-4.50	5.81	3.16	4.48	
	$G+C+B_1$	-12.13	-8.05	-7.38	8.71	6.02	7.37	
	$G+C+B_2$	-13.07	-8.92	-8.18	9.46	6.87	8.17	

II. Effect of different amendments on soil bulk density and total porosity:

Results in Table (5) revealed that, the lowest values of soil bulk density (1.33 and 1.34 Mg/m³ respectively) and the highest values of porosity (48.65 and 47.12 %, respectively) were obtained by application of G+ C + B₂ in both sites, respectively as a mean of both growing seasons. These results may be attributed to the role of biochar application in increasing of soil porosity through (i) pore contribution due to high-porosity of biochar, and (ii) improved aggregate stability (Hardie *et al.*, 2014). Also, addition of gypsum led to a reduction in soil bulk density and a corresponding increase in soil porosity (Amer, 2015, Kim *et al.*, 2017, Ravinder *et al.*, 2017 and Amer and Hashem, 2018). In addition, compost tea caused reduction in soil bulk density and an increase in soil porosity (Scheuerell and Mahaffee, 2004, Nasef *et al.*, 2009, Enshrah *and Fatma*, 2016 and Amer .2016).

III. Effect of organic and inorganic amendments on plant height, yield and yield components:

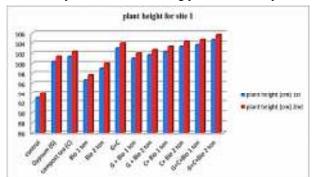
Figs 7, 8,9 and 10 argued that application of G, C or B individually or combined strongly affected the plant

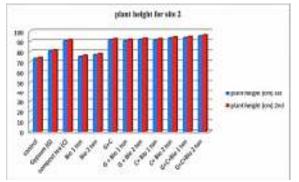
heights and 1000-grain weight of wheat. The plots amended by $G+C+B_2$ in both sites achieved the tallest plants and the heaviest grains, while the lowest values of both parameters were recorded with the untreated plants.

Table 5. Soil bulk density (BD) and porosity and their relative change (± %) as affected by organic and inorganic amendments.

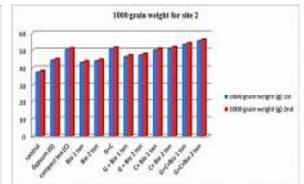
		Bd		To			
		$(Mg m^{-3})$		poros		>	
Site	Amendments	1st season 2nd season	Bd (± %)	1 st season	2 nd season	Porosit (± %)	
	Control	1.44 1.45	1.45	47.04	47.07	47.06	
	Gypsum (G)	1.41 1.42	-2.42	47.83	47.86	+1.65	
	compost tea (C)	1.37 1.38	-5.19	47.33	47.36	+0.58	
	Biochar (B ₁)	1.38 1.39	-4.50	47.35	47.38	+0.63	
	Biochar (B ₂)	1.35 1.36	-6.57	47.53	47.56	+1.01	
Site	G+C	1.39 1.40	-3.81	48.05	48.08	+2.11	
1	$G + B_1$	1.40 1.41	-3.11	48.11	48.14	+2.24	
	$G + B_2$	1.38 1.39	-4.50	48.26	48.29	+2.56	
	$C+B_1$	1.38 1.39	-4.50	47.60	47.63	+1.16	
	$C+B_2$	1.36 1.37	-5.88	47.68	47.71	+1.33	
	$G+C+B_1$	1.33 1.34	-7.96	48.26	48.29	+2.56	
	G+C+B ₂	1.32 1.33	-8.65	48.64	48.67	+3.37	
	Control	1.43 1.44	1.44	45.66	45.71	45.69	
	Gypsum (G)	1.41 1.42	-1.74	46.37	46.42	+1.50	
	compost tea (C)	1.36 1.37	-5.23	45.86	45.91	+0.38	
	Biochar (B ₁)	1.38 1.39	-3.83	45.97	46.02	+0.62	
	Biochar (B ₂)	1.34 1.35	-6.62	46.07	46.12	+0.84	
Site	G+C	1.39 1.40	-3.14	46.59	46.64	+1.98	
2	$G + B_1$	1.39 1.40	-3.14	46.56	46.61	+1.92	
	$G + B_2$	1.40 1.41	-2.44	46.75	46.80	+2.33	
	$C+B_1$	1.39 1.40	-3.14	46.04	46.09	+0.78	
	$C+B_2$	1.37 1.38	-4.53	46.25	46.30	+1.24	
	$G+C+B_1$	1.34 1.35	-6.62	46.80	46.85	+2.44	
	G+C+B ₂	1.33 1.34	-7.32	47.10	47.15	+ 3.10	

On the other side, the data in Table (6) revealed that the grain and straw yields were significantly increased by different amendments in both growing seasons. The plots amended by G+ C + B₂ in both sites seemed to produce the highest grain yields (3.017 and 2.282 ton/fed, respectively) with relative increase of 37.3 and 56.0 %, respectively and the highest straw yields (4.137 and 3.171 ton/fed, respectively), with increase of 22.4 and 31.3%, respectively compared to the control. However, this combined treatment in both sites showed 37.3 and 56.0 %, increases in grain yield respectively, while with the increases in straw yield were 22.4 and 31.3%, respectively comparing to the control which recorded the lowest yields of grain (2198 1.463 ton/fed, respectively) and straw (3381and 2.415 ton/fed, respectively).





Figs. 7 and 8. Effect of organic and inorganic amendments on plant height of wheat plant for a- site 1 and b- site 2 after two growing seasons.



Figs. 9 and 10. Effect of the amendments on 1000-grain weight for a- site 1 and b- site 2 after two growing seasons.

The ameliorative role of the previous amendments in salt affected soils may be attributed to the increase the tolerance of plants to salinity at physiological growth stages and improve some soil proprieties. Similar results were obtained by Shah et al., (2013), Zia-Ur-Rehman et al., (2016), Saqib et al., (2017) and Amer (2017) who found that application of G increased plant heights, 1000grain weight, grain yield and straw yield of wheat, and Amer (2016) who observed that application of B and C or significantly increased the yield of wheat and maize. Also, Iqbal (2017) reported that plant height, thousand grain weight, grain yield and straw yield of wheat were increased with addition of biochar.

Table 6. Mean value of grain and straw yield of wheat as affected by organic and inorganic amendments										
Site	Amendments	Grain yie	ld Mg fed ⁻¹	Relative	d Mg fed ⁻¹	d ⁻¹ Relative				
Site	Amenuments	1 st season	2 nd season	G.Y. (± %)	1 st season	2 nd season	S.Y. $(\pm \%)$			
	Control	2072	2324	0.0	3318	3444	3381.00			
	Gypsum (G)	2478	2730	+ 18.47	3689	3815	+10.97			
	compost tea (C)	2583	2835	+23.25	3647	3773	+9.73			
	Biochar (B ₁)	2331	2583	+11.78	3411	3437	+1.27			
	Biochar (B ₂)	2436	2688	+16.56	3731	3857	+12.22			
	G+C	2772	3024	+31.85	3696	3822	+11.18			
	$G + B_1$	2569	2821	+22.61	3514	3640	+5.80			
	$G + B_2$	2667	2919	+27.07	3640	3766	+9.52			
	$C+B_1$	2590	2842	+23.57	3727	3853	+12.09			
Site 1	$C+B_2$	2653	2905	+26.43	3913	4039	+17.60			
	$G+C+B_1$	2835	3087	+34.71	3955	4081	+18.84			
	$G+C+B_2$	2891	3143	+37.26	4074	4200	+22.36			
	G F- test	**	**		ns	ns				
	C F- test	**	**		*	*				
	B F- test	**	**		**	**				
	G*C F- test	**	**		**	**				
	G*B F- test	**	**		**	**				
	C*B F- test	**	**		ns	ns				
	G*C*B F- test	**	**		**	**				
	Control	1337	1589	1463.00	2352	2478	2415.00			
	Gypsum (G)	1743	1995	+27.75	2723	2849	+ 15.36			
	compost tea (C)	1848	2100	+ 34.93	2681	2807	+13.62			
	Biochar (B ₁)	1596	1848	+17.70	2465	2491	+2.61			
	Biochar (B ₂)	1701	1953	+24.88	2765	2891	+17.10			
	G+C	2037	2289	+47.85	2730	2856	+ 15.65			
	$G + B_1$	1834	2086	+33.97	2548	2674	+8.12			
	$G + B_2$	1932	2184	+40.67	2674	2800	+ 13.33			
	$C+B_1$	1855	2107	+ 35.41	2761	2887	+ 16.93			
Site 2	$C+B_2$	1932	2184	+40.67	2933	3059	+ 24.06			
	$G+C+B_1$	2100	2352	+ 52.15	2989	3115	+26.38			
	$G+C+B_2$	2156	2408	+ 55.98	3108	3234	+31.30			
	G F- test	**	**		ns	ns				
	C F- test	**	**		*	*				
	B F- test	**	**		**	**				
	G*C F- test	**	**		**	**				
	G*B F- test	**	**		**	**				
	C*B F- test	**	**		ns	ns				
	G*C*B F- test	**	**		**	**				

CONCLUSION

The results showed that organic and inorganic amendments can improve saline-sodic soils properties and positively affected wheat growth and yield. Thus, it can be concluded that application of gypsum + compost tea + biochar can be used to combat salt effects on plant growth and improve wheat productivity and soil properties under saline-sodic soil conditions.

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تأثير بعض المحسنات العضوية والغير عضوية علي بعض خواص التربة وانتاجية القمح تحت ظروف التربة المتأثرة بالاملاح

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أجريت تجربتان حقليتان في موقعين بمزرعة محطة البحوث الزراعية بسخا ، شمال الدلتا ، خلال موسمين شتويين متعاقبين (2018/2017 و 2018/2018 و 10219/2018 للمبوست والبيوشار على بعض خواص التربة وإنتاجية القمح (سخا 93) تحت ظروف التربة المتأثرة بالأملاح. و2019/2018 للمبوست والبيوشار (B) أو 2 طن بيوشار (B) أو 2 طن بيوشار (C) ، الفدان (0.42) هكتار). أظهرت النتائج أن تم إضافة الأحتياجات الجبسية $G+C+B_2$ أحدثت أكبر انخفاض لقيم ECP للتربة بنسبة 28.06 و 13.16٪ ، وقيم SAR بنسبة $G+C+B_2$ ، وقيم ESP بنسبة ECP بنسبة $G+C+B_2$ مع المعاملات المختلفة وفق الترتيب 17.23 و 17.23٪ التوالي مقارنة بالكنترول. كما تمت زيادة كفاءة إزالة الصوديوم. (RSE) مع المعاملات المختلفة وفق الترتيب التالي إلى حد ما مقارنة مع التجربة $G+C+B_2 > C+B_1 > C > C+B_2 > C+B_1 > C > C+C+B_2 > C+C+B_1 > C > C+C+B_2 > C+C+B_1 > C > C+C+B_1 > C > C+C+B_2 > C+C+B_1 > C > C+C+B_1 > C > C+C+B_2 > C+C+B_1 > C > C+C+B_1 > C+C+B_1 > C+C+B_1 > C+C+B_1 > C > C+C+B_1 > C > C+C+B_1 > C+C+B_$