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Effect of Using Some Soil Conditioners on Salt Affected Soil Properties and Its Productivity at El-Tina Plain Area, North Sinai, Egypt

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TWO FIELD experiments were conducted in El-Tina Plain area, North Sinai, Egypt, to study the effect of biochar and humic acids as nontraditional soil conditioners on some properties of sandy soil as well as the productivity of wheat and corn plants grown on such soil. The two conditioners were applied individually with three rates. The application rates of biochar were 5, 10 and 20 ton/fed., while the respective rates of humic acids were 5, 10 and 20 kg/fed.

Results of the present study revealed that the application of all the studied treatments decreased soil bulk density, hydraulic conductivity, pH, EC, soluble Na, SAR and ESP values, while increased cation exchange capacity, organic matter content, total N as well as available amounts of P, K, Fe, Mn, Zn and Cu in soil.

Data also indicated that all the treatments significantly increased the grain yields of wheat and corn plants and the treatment (20 kg humic acids/fed.) was the best one. The rate of increment over the control due to such treatment reached 39.49 and 37.68 % for wheat and corn grain yields, respectively. Also, macro and micronutrient concentrations of such grains were significantly increased by increasing the application rates of the applied conditioners.

Based on results of the current study, it can be concluded that using biochar and humic acids as organic conditioners is helpful to improve soil properties, compensate the deficiency of nutrients in soil and have significant effects on the productivity of wheat and corn plants. These materials are easily producible, biodegradable, less expensive, cause no environmental hazards to human health and will be ecologically safe and culturally more acceptable among farmers. So, it can be recommended to use such materials as soil conditioners under salt affected soil conditions.

Keywords: Biochar, Humic acids, Salt affected soils, Corn yield, Wheat, Macro and micronutrients.

Introduction

Salt affected soils occur commonly in arid and semi-arid regions and characterized by excessively high levels of water- soluble salts. In most cases, sodium chloride is a major salt contaminant in such soils, it has a small molecule size and when oxidized by water, produces Na^+ and Cl^- ions, which are easily absorbed by the root cells of higher plants and transferred to the whole plant causing ionic and osmotic stresses at the cellular level of such plants, (Rodriguez-Navarro and Rubio, 2006).

Salt toxicity is one of the major factors limiting crop production and environmental quality in saline and/or sodic soils. Excessive amounts of salts adversely affect the physical and chemical properties of soil, microbiological processes and plant growth (Ramoliya and Pandey, 2003 and Pitman & Läuchli, 2004).

Biochar is the carbonaceous residue left in the pyrolysis process. Several studies have highlighted its benefit for mitigation of global climate change and as an effective strategy to manage soil quality and crop productivity (Renard *et al*., 2012). Amending soil with biochar has increasingly attracted widespread attention for its chemical stability, ideally suited for sequestrating C in soil, rapidly increases soil fertility and plant growth by supplying and retaining

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nutrients while simultaneously improving the physical and biological properties of the soil (Woolf *et al*., 2010 and Uzoma *et al*., 2011).

Humic acids is produced by the chemical and biological decomposition of organic material. It is an important constituent of soil organic matter which enhances the growth and yield of crops and improves soil physical and chemical characteristics, (Hafez, 2003; Abd El- Al *et al*., 2005 and Khan *et al*., 2012). It is particularly used to ameliorate or reduce the negative effects of salt stress. Humic acids contributes to plant growth through its effect not only on the physical and chemical but also on biological properties of the soil. It is mainly a nutritional function, as it serves as a source of N, P, and cations for plant growth (Arancon *et al*., 2006).

Several studies have reported the ability of humic acids to increase the growth of different plant species grown under adverse conditions. Some authors suggested that humic acids promote plant growth by improving the bioavailability of certain nutrients, mainly iron and zinc. Others proposed that humic acids can directly influence the plant metabolism by both activating the root plasma membrane ATPase activity and increasing the nitrate uptake rates in roots (Nardi *et al*., 2002; Chen *et al*., $2004_{a,b}$ and Mora *et al*., 2010).

The aim of this study is to evaluate the efficiency of using those nontraditional soil conditioners, *i. e*., biochar and humic acids for improving some properties of salt affected soil as well as raising its productivity of wheat and corn yields.

Materials and Methods

Two field experiments were conducted in El-Tina Plain, North Sinai, Egypt, to evaluate the efficiency of using biochar and humic acids for improving some properties of salt affected soil as well as raising its productivity of wheat and corn yields. Composite samples representing soil, in which the experiment was carried out, were taken and prepared to determine some properties of such soil (Table 1).

The experimental design was randomized complete block design with three replicates and the experimental treatments were as follows:

TABLE 1. Some physical and chemical properties of the soil under investigation

pH in soil paste extract	**Particle size distribution (%)**			**Texture class**	**Avail. soil water (%)**	**Bulk density (g/cm3)**	**H.C. (m/day)**	**CEC (me/100g soil)**
	Sand	**Silt**	**Clay**					
7.95	79.53	7.10	13.37	SL	8.67	1.45	3.25	10.40
EC (dS/m) in soil paste extract	Soluble cations (me/l)			Soluble anions (me/l)			SAR	ESP
	Ca^{2+}+ Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{2-}		
4.43	20.64	21.67	2.00	10.86	28.18	5.27	6.28	7.32
CaCO3 (%)	OM (%)	Total N (%)	Available micronutrients (μg/g)					
			P	K	Fe	Mn	Zn	Cu
1.80	0.38	0.09	9.80	82	11.82	15.24	0.95	1.11

The two conditioners were applied individually. Table 2 depicts some chemical properties of the applied materials.

TABLE 2. Some properties of the applied soil conditioners

Parameters	**pH**	**EC (dS/m)**	**OC (%)**	**Total macronutients (%)**			**Total micronutients (ug/g)**				**C/N ratio**
				N	P	K	Fe	Mn	Zn	Cu	
Biochar	7.4	1.5	36	1.8	4.3	2.9	365	190	120	9	20
Humic acids	6.88	1.94	34.4	2.15	2.5	3.5	418	260	219	21.96	16

1- Control treatment (without any soil conditioner application).
2- Biochar at the rate of 5 ton/fed.
3- Biochar at the rate of 10 ton/fed.
4- Biochar at the rate of 20 ton/fed.
5- Humic acids at the rate of 5 kg/fed.
6- Humic acids at the rate of 10 kg /fed.
7- Humic acids at the rate of 20 kg /fed.

Seeds of wheat (L.) cv. Sakha 8 at the rates of 70 kg seeds/fed.were sown on 32015/10/ after the application of soil conditioners to experimental plots (recent application). After wheat harvesting, corn (*Zea maize* L.) cv. Pioneer 30 K8 at the rates of 12 kg seeds/fed.were sown on the same plots on 152016/3/ without soil conditioners application (residual effect).

All plots received N, P and K fertilizers as follows:-
- Superphosphate (15.5% P_2O_5) at the rates of 150 and 200 kg P/fed., added before cultivation of both wheat and corn respectively.
- Ammonium nitrate (33.5% N) at the rates of 150 kg N/fed., added at two equal doses, one and two months, after cultivation of both wheat and corn, respectively.
- Potassium sulphate (48% K_2O) at the rate of 50 kg K/fed., for the two cultivated crops added in two equal doses at the same time of N fertilizer application.

TABLE 3. Chemical composition of the applied irrigation water

pH	EC (dS/m)	soluble cations(me/l)				soluble anions(me/l)				SAR
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	
7.45	2.41	4.39	8.78	10.79	0.14	-	3.90	10.74	9.46	1.16

The necessary management operations for the two cultivated crops were conducted at the appropriate times. Irrigation water from El-Salam Canal was applied every week and the irrigation was stopped 30 days before harvesting of the two crops. Table 3 presents the chemical composition of such water.

Plants were harvested at maturity, after 150 and 120 days from planting for both wheat and corn respectively, then grain yields were recorded.

Soil samples representing all the treatments were taken after harvesting then air dried, sieved through a 2 mm and stored for analysis. Also, grain samples represented all the treatments were taken, dried at 70 °C, ground and stored for analysis. Analysis of soil, plant, water and the applied conditioners were determined by the standard methods of (Black, 1982; Cottenie *et al*., 1982 and A.O.A.C., 1995). The statistical analysis was carried out according to Snedecor and Cochran (1982).

Results and Discussion

Effect of the applied conditioners on some soil physical and chemical properties:

Data in Table 4 show the effect of the applied treatments on some physical and chemical properties of the investigated soil. Concerning the effect of the applied treatments on soil bulk density and hydraulic conductivity values, data in Table 4 show that their values decreased by increasing the application rates of all the applied conditioners. The highest decreases of such values were associated with the treatment (20 kg humic acids/fed.) as the rate of decreases below the control under recent application reached 24.83 and 42.42% respectively, while the respective values under residual application reached 12.08 and 50.00%. Such decreases in soil bulk density can be attributed to the low specific gravity of organic materials and the role of organic products in enhancing soil aggregation which increases the apparent soil volume and consequently decrease bulk density. These results are in agreement with Tejada and Gonzalez (2006). Also, the improvement or the pronounced decrease in hydraulic conductivity of the studied sandy loam soil may be attributed to the creation of micro pores, and the dominance of meso and micropores on the exposed pore sizes. These results are in agreement with those of El-Fayoumy and Ramadan (2002).

It is also, clear that soil pH values decreased as a result of all treatment applications. The rate of decrement in soil pH values below the control treatment reached 2.53 and 2.02 % due to recent and residual applications of 20 ton. biochar/ fed., respectively. The respective values under 20 kg humic acids/fed. were 5.06 and 5.17 %. The positive effect of biochar on reducing soil pH values may be due to the acidic materials produced from the oxidation and decomposition of such material in soil (Senesi and Plaza, 2007;

TABLE 4. Effect of the applied conditioners on some physical and chemical properties of the investigated soil.

Treatments	Control	Biochar (ton./fed.)			Humic acids (Kg/fed.)		
Bulk density (g/cm3)							
Recent application	1.49	1.25	1.22	1.18	1.17	1.15	1.12
Residual effect	1.49	1.41	1.35	1.35	1.33	1.33	1.31
Hydraulic conductivity (cm/min^{-1})							
Recent application	0.33	0.27	0.23	0.28	0.24	0.21	0.19
Residual effect	0.36	0.29	0.24	0.24	0.24	0.23	0.18
pH							
Recent application	7.90	7.85	7.79	7.70	7.74	7.55	7.50
Residual effect	7.93	7.88	7.86	7.77	7.75	7.56	7.52
CEC (me/100g soil)							
Recent application	10.8	11.4	12.7	15.3	11.2	12.2	13.6
Residual effect	10.6	11.1	11.9	13.8	11.1	11.7	12.5
EC (dS/m)							
Recent application	4.27	3.33	2.92	2.79	3.19	2.65	2.29
Residual effect	4.31	3.70	3.31	3.15	3.61	3.05	2.63
Soluble Ca^{2+}+Mg^{2+} (me/l)							
Recent application	19.96	14.65	15.18	15.22	16.15	13.63	11.3
Residual effect	20.13	16.29	17.2	17.16	18.28	16.74	12.99
Soluble Na^{+} (me/l)							
Recent application	20.19	16.09	12.38	11.42	13.58	12.34	11.18
Residual effect	20.36	17.91	14.03	12.87	15.38	13.17	12.85
SAR							
Recent application	6.39	5.95	4.49	4.14	4.78	4.73	4.70
Residual effect	6.42	6.27	4.78	4.39	5.09	4.55	5.04
ESP							
Recent application	7.53	6.97	5.08	4.61	5.46	5.39	5.36
Residual effect	7.57	7.38	5.46	4.95	5.86	5.16	5.81

Dias *et al*., 2010). Biochar is not at all inert in soil and can be oxidized, especially at the surface, through chemical and microbial activity (Cheng *et al*., 2006, 2008). The slow oxidization of biochar in soils can produce carboxylic functional groups (Brodowski *et al*., 2005 and Cheng *et al*., 2006). The formation of the acidic functional groups can neutralize alkalinity and eventually decrease soil pH. These results are in agreement with those found by (Dhanushkodi and Subrahmaniyan, 2012). With respect to soil CEC, data in the same table indicated that soil CEC values increased by increasing the application rate of both conditioners, and biochar treatments were more effective than that of humic acids in this concern. The rate of increment under recent applications of 20 ton biochar/fed. reached 41.67%, while reached 30.19% for residual effect of such treatment. These increases might be due to the presence of ash in biochar, which helps for the immediate release of the occluded mineral nutrients like Ca, K and N for crop use, Scheuner *et al*. (2004).

Data in Table 4 also indicate that the soil salinity (EC), soluble Ca + Mg and soluble Na were favorably affected by all the applied treatments. The application of the treatment (20 kg humic acids/fed.) showed the highest decrease in such values as compared with the other treatments. Where their decreases under the recent applications reached 46.37, 43.39 and 44.63% for EC, soluble Ca + Mg and soluble Na values, respectively. The respective values under residual applications reached 38.98, 35.47 and 36.89% as compared with the control treatment. The positive effect of humic acids on reducing soil pH values may be due to its function group that may give it high ability to separate Na Cl salt, thus reduces the deleterious effects of salt stress on plants.

Also, microorganisms used humic acids as carbon source, thus may stimulate microorganisms to produce phytohormones, which play an important role in decline soil salinity (Khalil *et al*., 2013).

Data in the same table also revealed that SAR and ESP values decreased by the application of all amendments and the biochar treatment (20 ton /fed.) was more effective than all the other treatments in this concern. The rate of decrement under recent applications of such treatment reached 35.21 and 38.78% for SAR and ESP values, respectively, while the respective values under residual applications were 31.62 and 34.61% as compared with the control treatment. This was expected since biochar treatments had more soluble Na than that of humic ones.

Effect of the applied conditioners on soil fertility status

Soil organic carbon is one of the key indicators of soil quality, data in Table 5 show that soil organic matter content was increased due to all the applied treatments. It is also clear that the soil organic matter content were higher with the application of humic acids to soil than that of biochar ones. This is due to the higher OM content of humic acids relative to the other amendment, (Table 2). The increases in soil organic matter content were more obvious with the higher application rates of both the two conditioners and the best treatment in this concern was the application of (20 kg humic acids /fed.) as the rate of increment over the control reached 97.90 and 69.39 % under recent and residual applications, respectively.

With respect to soil total N, data in the same table indicated that all the applied treatments, especially those of humic acids, increased soil total N. The rate of increment over the control reached 48.21and 59.18% due to humic acids application at the rate of 20 kg /fed. under recent and residual applications, respectively. The respective values for biochar (20 ton/fed.) were 25.89 and 30.61%. This may be due to larger amounts of total C and N in the applied conditioners that could provide a larger source of N for mineralization. These results are in agreement with those obtained by Ebhin Masto, (2013). In this regard, Angelova *et al*. (2013) stated that there was a strong positive correlation between the total organic carbon content and the total nitrogen content in soil and the application of organic materials might have produced more residual N in soil as compared with the control.

Data in Table 5 also indicate that the availability of P, K, Fe, Mn, Zn and Cu in soil was greatly enhanced by the application of all the applied treatments. The best treatment in this concern was that of (20 kg humic acids / fed.) where the rate of increment over the control reached 126.83, 78.8, 172.74, 190.3, 162.56 and 86.6 % for available P, K, Fe, Mn, Zn and Cu respectively under recent applications, while the respective increases under residual applications reached 98.38, 72.73, 153.68, 128.52, 78.65 and 77.53 %. The positive effects of the applied materials on such increases may be attributed to one or more of the following: a) higher initial content of such nutrients in the applied materials, (Table 2, b) reduction of soil pH values resulting from amendment application as found in this study (Table 4, c) slow mineralization process of organic matter, hence release of the nutrients and, d) converting unavailable soil phosphate into available forms due to humic acids application, (Bhattacharjee *et al*., 2001 and Angelova *et al*., 2013). The obtained results are in agreement with those reported by Shankar *et al*. (2012).

Effect of the applied conditioners on grain yield of the investigated plants:

Data in Table 6 indicate that grain yield of wheat and corn plants significantly increased by the application of all the experimental treatments. It is also clear that such increases were more pronounced in humic acids treatments than that in biochar ones. Also, the higher the application rate of conditioners, the higher the grain yield of both wheat and corn plants. It is worth to notice that such increases were coincided with EC and Na reduction, (Table 4) as well as the increase of organic matter, total N and available nutrients, (Table 5).

TABLE 5. Effect of the applied conditioners on some soil nutrient concentrations

Treatments	Control	Biochar (ton./fed.)			Humic acids (Kg/fed.)		
		5	10	20	5	10	20
O.M (%)							
Recent application	0.49	0.60	0.61	0.63	0.65	0.71	0.97
Residual effect	0.49	0.53	0.55	0.59	0.56	0.67	0.83
Total N (%)							
Recent application	0.11	0.13	0.13	0.14	0.15	0.16	0.17
Residual effect	0.10	0.12	0.12	0.13	0.14	0.15	0.16
Available P (ug/g)							
Recent application	10.25	11.12	13.23	15.18	17.35	20.14	23.25
Residual effect	9.91	10.11	12.20	14.62	14.82	16.54	19.66
Available K (ug/g)							
Recent application	85	96	118	132	123	145	152
Residual effect	77	82	95	110	98	123	133
Fe (ug/g)							
Recent application	30.30	41.90	57.18	63.25	61.50	72.61	82.64
Residual effect	27.72	33.18	42.40	50.23	48.97	58.35	70.32
Mn (ug/g)							
Recent application	15.62	19.90	25.40	32.61	30.42	36.50	45.35
Residual effect	13.22	16.36	19.51	24.33	23.90	26.31	30.21
Zn (ug/g)							
Recent application	1.95	2.18	3.25	4.65	3.11	4.32	5.12
Residual effect	1.78	1.82	1.98	2.12	1.95	2.27	3.18
Cu (ug/g)							
Recent application	0.97	1.12	1.55	1.64	1.53	1.69	1.81
Residual effect	0.89	0.92	1.08	1.50	0.95	1.20	1.58

TABLE 6. Yield and nutrients content of wheat and corn grains as affected by the applied conditioners

Treatments	**Control**	**Biochar (ton./fed.)**			**Humic acids (Kg/fed.)**			**LSD at 5%**
		5	**10**	**20**	**5**	**10**	**20**	
Grain yield (ton./fed.)								
Wheat	1.95	2.12	2.42	2.58	2.27	2.58	2.72	0.031
Corn	3.45	3.66	4.21	4.52	3.65	4.23	4.75	0.271
N (%)								
Wheat	0.69	0.96	1.04	1.24	0.92	1.22	1.34	0.035
Corn	0.62	0.87	0.95	1.12	0.92	1.10	1.25	0.032
P (%)								
Wheat	0.27	0.31	0.35	0.42	0.35	0.45	0.57	0.023
Corn	0.36	0.42	0.44	0.47	0.45	0.48	0.56	0.034
K (%)								
Wheat	0.51	0.58	0.61	0.56	0.58	0.63	0.68	0.040
Corn	0.48	0.51	0.53	0.55	0.51	0.55	0.62	0.026
Fe (ug/g)								
Wheat	75	105	124	137	121	142	155	4.340
Corn	66	73	82	112	95	110	125	3.243
Mn (ug/g)								
Wheat	27	35	39	44	36	42	46	13.435
Corn	25	32	35	39	32	37	41	2.885
Zn (ug/g)								
Wheat	46	51	55	62	50	60	73	2.885
Corn	40	45	48	48	45	53	65	2.386
Cu (ug/g)								
Wheat	14	15	19	21	20	22	26	2.093
Corn	18	19	20	22	21	25	28	3.439

The best treatment in this concern was the application of humic acids at the rate of 20 kg/ fed., where the rate of increment in wheat and corn grain yields over the control reached 39.48 and 37.68%, respectively. This positive effect may be attributed to the improvement action of the applied materials on soil physical properties as well as on the nutrients status in the soil which enhances plant growth, El Sanat (2003). Also, it may be due to the presence of essential nutrients in such materials which increased the metabolic activity of plant, Gupta (2005) as well as the direct effect of humic acids on solubilization and transport of nutrients which ultimately affect the plant productivity, Zaghloul *et al*., (2009). Morever, it may attributed to the increase in soil nutrient content and uptake of nutrients by plants as well as higher organic matter in the ash, Awodun *et al*., (2007). These results are in agreement with those reported by (Norman *et al*., 2004 and Steiner *et al*., 2007).

Effect of the applied conditioners on nutrients content of wheat and corn grains:

Nitrogen, phosphorus and potassium are of the integral components in plant metabolism. They are the key constituents of chlorophyll biosynthesis, protein, nucleic acids and other constituents. Data in Table 6 indicate that N, P and K concentrations in wheat and corn grains significantly increased by the application of all the experimental treatments. It is also clear that the values of such nutrients were higher under the humic acids applications than the biochar ones. The best treatment in increasing N, P and K was the application of humic acids at the rate of 20 kg/ fed., as the rate of increment over the control due to such treatment reached 94.20, 111.11 and 33.33 for N, P and K concentrations in wheat grains, respectively. The respective values for corn grains were 101.61, 55.55 and 29.17%. Data in Table 6 also indicate that Fe, Mn, Zn and Cu concentrations in wheat and corn grains significantly increased by the application of all experimental treatments. It is also clear that the values of such nutrients took the same trends previously mentioned for N, P and K concentrations in wheat and corn grains. The highest increases of Fe, Mn, Zn and Cu concentrations in wheat grains were found with the treatment (20 kg humic acids/ fed.), as the increases reached 106.67, 70.37, 58.70 and 85.71%, respectively. The respective increases in corn grains were 89.39, 64.00, 62.50 and 55.56%.

The positive effect of such materials on increasing macro- and micro-nutrients concentrations in wheat and corn grains may be attributed to that those materials act as valuable soil amendments that offer a balanced nutritional release pattern to plants, providing nutrients in readily available form that can be easily taken up by plants, Ferreras *et al*., (2006). Furthermore, humic acids have been reported to enhance mineral nutrient uptake by plants, because it affects the. permeability of root membranes (Türkmen *et al*., 2004). These results are in agreement with those obtained by Mesut *et al*. (2010).

Economical evaluation

Data in Table 7 (a,b,c) reveal assessment of the experimental inputs and output as will as the ratio between them for each treatment, introducing investment ratio (IR) under the condition of El-Tina Plain area . Investment ratio was calculated from output/input analysis of variance for the data, as mentioned by Snedecor and Cochran (1982).

The data indicated the progressive increment in IR by increasing recent application rate and residual effect rate. The application of humic acids led to highest IR for all the two seasons as compared with biochar application, where the IR values under humic acids reached 1.57, 0.74, 1.55 and 0.60 for wheat grains, wheat straw, corn grains and corn shoot respectively. The respective IR values under biochar application were 1.64, 0.66, 1.52 and 0.59.

Concerning the effect of recent application and residual effect, it is clear that IR value under recent application (4.8) was higher than that under residual effect (4.26).

Conclusion

Results of the current study indicated the beneficial application of biochar and humic acids recently suggested as a sustainable means to promote the revegetation and the restoration of degraded lands. Morever, the use of such organic materials as a partial substitution of the chemical fertilization, logically protect the environment from chemical pollution and its hazards on human and animal health. In the same time, produced higher yields and improved soil characteristics.

TABLE 7a. The prices of all agricultural management inputs under the condition of field experiment according to market price

Economic item	1st Season for wheat	2nd Season for corn
Biochar	5 X 100 = 500	-
	10 X 100 = 1000	-
Price to ton 100 (L.E)	20 X 100 = 2000	-
Humic acids	5 X 25 = 125	-
	10 X 25 = 250	-
Price to kg 25 (L.E)	20 X 25 =500	-
Agriculture rent	2000	2000
Irrigation water energy	500	500
Management operation	500	500
Man power	500	500
Seeds	490	840
Pesticides and herbicides	-	-
Mineral fertilizations	365	365
Total	8730	4705
	13435	

Biochar (price of ton = 100 pounds). Humic acids (price of kg = 25 pounds)

TABLE 7b. Production of both wheat and corn with prices

Productions		Control	Biochar (ton/fed.)			Humic acids (ton/fed.)			Kg Price (L.E)
			5	10	20	5	10	20	
Wheat	Grain	1.95	2.12	2.42	2.58	2.27	2.58	2.72	3.10
	Straw	2.33	2.70	2.90	3.34	3.10	3.34	3.57	1.00
Corn	Grain	3.45	3.66	4.21	4.52	3.65	4.23	4.75	1.65
	Shoot	4.85	5.11	5.38	5.42	5.09	5.31	5.62	0.50

TABLE 7c. Economical evaluation of experimental treatments of El-Tina Plain aerie conditions

		Economic parameters	1st Season for wheat		2nd Season for corn	
			Grains	Straw	Grains	Shoot
Biochar	5	Output	6572	2700	6039	2555
	10	Output	7502	2900	6946	2690
	20	Output	7998	3340	7458	2710
		Total Input	13435	13435	13435	13435
		Total output	22072	8940	20443	7955
		IR	1.64	0.66	1.52	0.59
Humic acids	5	Output	7037	3100	6022	2545
	10	Output	7998	3340	6979	2650
	20	Output	8432	3570	7837	2810
		Total Input	13435	13435	13435	13435
		Total output	23467	10010	20838	8005
		IR	1.75	0.74	1.55	0.60
Investment Ratio		IR	3.39	1.41	3.07	1.19

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أثر استخدام بعض محسنات التربة على صفات و انتاجية الاراضى المتأثرة بالأملاح بمنطقة سهل الطينة , شمال سيناء ، مصر.

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أقيمت تجربة حقلية بمنطقة سهل الطينة - شمال سيناء لدراسة تأثير إضافة الفحم الحيوى ، احماض الهيوميك كمحسنات تربة غير تقليدية على صفات التربة الرملية و إنتاجيتها من محصولى القمح و الذرة الشامية.

- تم اضافة كلا المحسنين اضافة منفردة بثلاث معدلات اضافة مختلفة لكليهما. و كانت معدلات الإضافة للفحم الحيوى 5 ، 10 ، 20 طن / فدان و لأحماض الهيوميك 5 ، 10 ، 20كجم / فدان .

أوضحت النتائج المتحصل عليها ما يلي :

- انخفضت قيم الكثافة الظاهرية ،التوصيل الهيدروليكى ، pH ، EC ، Na الذائب فى التربة بينما ازدادت قيم السعة التبادلية الكاتيونية و المادة العضوية والنيتروجين الكلى والفوسفور والبوتاسيوم الميسر وبعض العناصر الصغرى الميسرة في التربة تحت الدراسة نتيجة لإضافة كل المعاملات.

- أدت إضافة جميع المعاملات إلى زيادة معنوية فى محصول الحبوب لنباتى القمح و الذرة الشامية و كانت المعاملة بأحماض الهيوميك (20كجم / فدان) هى الأفضل حيث أدت إلى حدوث زيادة فى محصول الحبوب لنباتى القمح والذرة مقدارها 49, 39 ، 68,37 % على الترتيب مقارنة بالكنترول .

- أدت إضافة جميع المعاملات إلى زيادة معنوية فى محتوى حبوب كلا النباتين من النيتروجين و الفوسفور و البوتاسيوم والعناصر الصغرى, و كانت معاملات الهيوميك هى الأفضل فى جميع الحالات .

. من كل ما سبق فانه يمكن القول بان إضافة الفحم الحيوى ، أحماض الهيوميك إلى التربة الرملية يساعد على تحسين خواص هذه التربة و علاج نقص العناصر الغذائية بها و زيادة إنتاجيتها . لذا فانه يمكن التوصية باستخدام هذه المحسنات خصوصا أنها سهلة الحصول عليها و سهلة التحلل و رخيصة التكلفة و لا تسبب أى أضرار للإنسان أو للبيئة التى يعيش فيها .

الكلمات الدالة: الفحم الحيوى – أحماض الهيوميك – الأراضى المتأثرة بالأملاح – محصول الذرة الشامية– محصول القمح - العناصر الكبرى و الصغرى.