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Effect of Irrigation with Diluted Seawater on Coriander Growth and Soil Properties of Sandy Soil Amended by Chicken Manure and Biochar

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ABSTRACT

Salt stress is abiotic stress that limits plant growth, crop productivity as well as the main factor contributing to land degradation. This study was conducted to evaluate the ameliorative effect of chicken manure and biochar applications used as soil amendments in alleviating the adverse effects of saline water irrigation on plant attributes and macro nutrients uptake by coriander (*Coriandrum sativum*) plant grown on a sandy textured soil. The ameliorative effect of soil amendments was also evaluated on the properties of the soil and nutrients availability for the plant. For this purpose, a pot experiment was conducted on coriander plant at The Experimental Farm of the Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt. A split plot design with three replications was used during the spring season of 2016. Treatments were the combination of two types of organic amendments (chicken manure and biochar) and three saline irrigation water treatments, .i.e. non-saline water (control) (S0 = 0.45 dS m^{-1}) and saline water (S1= 3.12 dS m^{-1}, 5% and S2 = 6.25 dS m^{-1}, 10%) irrigation. Obtained results showed that soil productivity, as indicated by the vegetative growth and physiological aspects (plant height, leaves fresh and dry weight, no. of leaves/plant and total chlorophyll) for coriander plant were adversely and significantly affected by saline water irrigation. Addition of chicken manure and biochar significant increased the vegetative growth and physiological parameters due to their ameliorative effect. It had been observed a significantly increased in plant N, P and K contents and uptake by plant due to the addition of chicken manure and biochar amendments under saline and non-saline water irrigation compared to unamended one. The contents and uptake of N, P and K in coriander leaves decreased significantly as salinity of irrigation water increased from (S0) to (S2). Soil pH and EC values increased significantly in saline water irrigation treatments (S1 and S2) compared to non-saline water (S0)**.** Soil pH and EC values decreased in soil amended with chicken manure and biochar application under three water types. The reduction in EC values in soil amended with biochar was higher than those in soil amended with chicken manure under all salinity levels. While, the reduction in soil pH values in soil amended with chicken manure was higher than those in soil amended with biochar. Soil available Na^{+}, K^{+}, Ca^{2+} and Mg^{2+} concentrations increased with increases in irrigation water salinity, while available P and Zn concentrations were decreased. Soluble Na^{+} significantly decreased but K^{+}, Ca^{2+} and Mg^{2+} increased as a result of amendments application under three water types used. Soil P and Zn availability increased after applying different soil amendments, the concentration of available P in chicken manure amended soil was higher than those in biochar amended soil. While, available Zn concentration in biochar amended soil was higher than unamended one. In conclusion, chicken manure and biochar added to soil as amendments have the potential to mitigate the negative effects of salt stress mainly related to their ability to improve soil physio-chemical properties, promote vegetative growth of coriander plant, increases soil content of organic matter and available nutrient uptake.

Keywords: Salinity, Chicken Manure, Biochar, Coriander, Nutrient Availability, Sandy Soil.

INTRODUCTION

Egypt relies heavily on natural resources exposed to climate change, where sea level rise is among the most dangerous threats to increase salinity of arable land in the northern Nile Delta to increase the salinity of the North Delta. Nicholls *et al.,* (1995) estimated sea level rise by about 0.37 meters at the Nile delta if the global average sea level rise is 1 meter by 2100 and approximately 12 to 15 % of current arable land in Egypt may be damaged by sea level rise of 1 m.

Salinity is one of the most serious environmental issues limiting the productivity of crop plants, especially in arid and semi-arid zones like Egypt, where wherever forty five million hectares of irrigated soil that account to 20-30 % of geographical area of the world been degradation by salt worldwide and drastically reduce the yields of a variety of plants worldwide, resulted in irrigation with saline water which is the main resources for agriculture, in Egypt (FAO, 2012). The physiological, morphological and metabolism processes changes of the plant occur as a result of exposure to salinity. All of those changes may be adversely affected by nutritional disorders due to reduce of availability of nutrients, nutrient competition and their transport within the plant (Nasim *et al.,* 2008).

Ion toxicities and nutrient deficiencies are likely to occur due to degraded physical, chemical and biological conditions in soil irrigated with saline water. Excessive soluble salts in soil could have an effect on acquisition and availability of essential nutrients either via, the raised osmotic pressure of the solution decline the mass flow of nutrients to the root or by competition between ions or by salt-influenced soils are generally low in nitrogen, phosphorous and potassium because several reasons, like as well as low input of organic matter from plant biomass. Salinity adversely effects the growth and activity of the soil microbic populations and so affects the transformation of nutrients and their availability to plants (Fageria *et al.,* 2011).

Coriander (*Coriandrum sativum*) belongs to the Umbelliferae (*Apiaceae*) family. it's a herb that possesses healthful and nutritional properties, each seeds and leaves of the plant are used for healthful purpose. Coriander contains many active principles primarily citronellol, borenol, camphor, geraniol, pinene, flavonoids, rich in vitamins A, B (riboflavin), C and dietary fiber and essential oils so, it is used in detox diet (Chithra and Leelamma, 1997). Coriander has been reported to own many pharmacological effects such as digestive stimulant, antioxidant and hypotensive. It helps to get rid of toxic mineral residue, like Hg and Pb and excretes them within the faces or urine, (Leena *et al.,* 2012). Coriander plants were found to resist salinity up to the concentration of 3000 ppm (Ewase *et al.,* 2013).

Therefore, several ways and approaches have been attempted to mitigate the well-known negative effects of salinity and improving plant adaptation to salinity stress. Of these ways, application of organic materials like, chicken manure is one of the effective strategies in reducing the damage of water salinity irrigation and increased plant tolerance. The addition of organic materials to soil irrigated with water salinity could be a positive approach for improving surface soil fertility, soil structure, and permeability, thus, enhancing salt leaching, reducing surface evaporation, inhibiting salt accumulation in surface soils. Furthermore, the application of chicken manure increases the quantity and quality of total organic carbon, N, P and other nutrients compared to other manures (Jones *et al.,* 2012). Application of chicken manure might be effective in enhancing plant growth through their useful effects on physical, chemical, biological and nutritional properties of saline soils. In soil irrigated with salinity water, organic amendments provide essential nutrients, alleviate negative effects of salinity by: (1) enhancing the porosity of the soil, plus raising the water movement within the soil, are effective ways that of enhancing crop production wherever salinity water is limiting factor (Jalali and Ranjbar, 2009), (2) organic matter within the soil stimulates the activity of the microorganisms to convert nutrients in an organic form and soil particles into an acceptable form for plants uptake, and (3) enhancing root growth and vigor that successively creates water channels to extend water movement within the soils and improves the soil structure (Tejada *et al.,* 2006; Wang *et al.,* 2014).

Soil amendments can improve the dissolution of ($CaCO_3$) minerals *via* the generated acid compounds within the soil profile. Such dissolution would release Ca^{2+} in soil solution to facilitate the removal of sodium (Na^+) from the ion exchange sites (Yaduvanshi, 2017). Organic amendments like chicken manure may be a right away supply of calcium and magnesium to improve removal of sodium from the soil exchange complex. Organic amendments reinforce, the binding of the small particles to create large water-stable aggregates thus, formation of channels in poorly structured saline soils that leach sodium (Na^+) from the profile as a result of improved soil permeability (Muyen and Wrigley, 2016).

Soil addition of organic amendments will increase surface charge density (CEC) to attract calcium (Ca) over sodium from soil solution, resulting in decline soil exchangeable sodium percentage (ESP). Nevertheless, it is worth mentioning that organic amendments have to be compelled to be applied at high rates and at regular intervals particularly under semi-arid regions, during which high temperature will increase decomposition rate and under stresses like salinity stress to possess alleviate adversely impact.

Biochar is pyrolysis organic material and regarded as an activated carbon soil conditioner, an organic fertilizer intended for use as a soil amendment where has more advantage than direct land application (Lehmann and Joseph, 2015; Amini *et al.,* 2016). The addition of biochar to sandy soil changes soil characteristics like its structure and porosity. Due to its physical properties, biochar helps in improving soil function, with avoiding any negative effects. Biochar has many positive effects on soil properties like, increment content of soil organic carbon and nutrients, particularly cationic ones K^+, Mg^{2+}, Ca^{2+} and Zn^{2+}, increases surface area and cation exchange cabacity (CEC); therefore, will increase adsorption properties allowing retention of water and nutrients within the soil solution aids plant growth and regulation of phytohormones and stomata conductance. Biochar improves water holding cabacity, modification in soil bulk density (ρb), increase the activity of biological factor in soil. On the other hand, biochar reduces nutrient leaching, the phytotoxicity of heavy metals and decrease of Na uptake while, it is increasing uptake of elements and improved photosynthesis. Moreover, biochar can hasten salt leach and therefore reduce the time required for reducing salt concentration to level appropriate for growing plants (Usman *et al.,* 2016 and Ali *et al.,* 2017).

Therefore, the main objective of this research was to evaluate the effects of irrigation with diluted seawater on coriander growth and soil properties of sandy soil amended by chicken manure and biochar.

MATERIALS AND METHODS

A pot experiment was conducted on coriander (*Coriandrum sativum*) plant during the spring season of 2016 at The Experimental Farm of the Faculty of Agriculture, Mansoura University, Dakahlia Governorate, Egypt. The objectives of the present study were to investigate 1) effects of chicken manure and biochar as soil amendments under irrigation with diluted sea water on some soil properties as well as growth parameters and chemical composition of coriander, and 2) the safeguard effect of chicken manure and biochar against the adverse effects of salt stress.

To achieve the aim of the study, experimental treatments were arranged in a split plot design with three replicates. Main treatments were assigned to water salinity with three irrigation levels: S0 (0.45 dS m^{-1}), S1 (3.12 dS m^{-1}) and S2 (6.25 dS m^{-1}). The intended level of salinity was obtained by diluting seawater in tap water (10 L seawater per 200 L tap water for S1 and 20 L seawater per 200 L tap water for S2). Organic soil amendments were presented in sub plots: control (without adding organic amendments), chicken manure at a rate of 20 Mg fed^{-1}, i.e. 400 g pot^{-1}), biochar at a rate of 5 Mg fed^{-1}, i.e. 100 g pot^{-1}). The used experimental soil as well as organic amendments was obtained from the farm of kalabsho, Belqas center, Dakahlia Government. Sandy soil were mixed thoroughly with organic amendments and filled into plastic pots (20 kg) to achieve the objective of the study. Twenty seeds of coriander plant were sown in each pot.

Irrigation water analysis:

Water samples were analyzed according to the standard methods of APHA, (1995) for conventional parameters presented in Table (1).

Soil and organic amendments analysis:

Representative subsample of the experimental soil was obtained according to the certified quartering method for certified physicochemical analysis in Table (2 and 3). Particle size distribution was determined according to Piper, (1950) using the standard pipette method. Soil pH was measured in a 1:2.5 soil suspension as well as in a 1:5 for organic amendments, and EC (dS m^{-1}) was determined in a 1:5 soil water extract as well as in a 1:10 for organic amendments using digital pH meter and EC meters Jenco (model 3173), respectively as described by Rowell, (1994). Organic matter (OM, g kg^{-1}) was determined using Walkely's & Black method by Jackson, (1967). Soluble cations and anions were determined in 1:5 soil-water extract by standard titration methods USSL, (1954). The measurements and calculations of available N, P, K, Na, Ca and Mg were conducted using the techniques described by Page *et al.,* (1982). DTPA extractable Zn, Fe and Mn were determined using an atomic absorption spectrophotometry (Berkin Elmer Model 5100) as described by Lindsay and Norvell, (1978). Analysis was performed C/N ratio in accordance with International Standards for Total carbon and Total nitrogen, using N.C. Soil Analyzer - Flash 2000.

Table 1. Chemical composition of water used for irrigation.

Water used for irrigation	EC_w dS m^{-1}	pH	Soluble ions, ($mmol_C$/L)						
			Ca^{2+} + Mg^{2+}	Na^+	K^+	*CO_3^{2-}	HCO_3^-	CL^-	**SO_4^{2-}
S0= (Control)	0.45	7.90	3.45	2.35	0.17	N.D.	1.33	1.82	2.82
S1= (5% seawater)	3.12	7.97	11.16	10.56	0.53	N.D.	3.51	9.52	9.22
S2= (10% seawater)	6.25	8.23	25.03	28.43	2.46	N.D.	5.36	24.83	25.73

*** N.D. means not detected, **sulfate (SO_4^{2-}) ions were calculated as the difference between sum of cation and anions.**

Table 2. Physical and chemical properties of the sandy soil used for pot experiment

Soil properties							
A: Physical analysis							
Particle size distribution:							
B: Chemical analysis							
Sand (%)	Silt (%)	Clay (%)	Textural class	*pH	**$E.C_e$ (dS m^{-1})	(organic matter) O.M. (g kg^{-1})	
95.35	3.35	1.30	Sandy	8.56	3.02	4.1	
C: Soluble cations and anions, ($mmol_C$/L)							
Ca^{2+}	Mg^{2+}	Na^+	K^+	***Co_3^{2-}	HCO_3^-	CL^-	****SO_4^{2-}
2.12	1.70	1.55	0.17	N.D.	0.26	4.08	1.20
D: Available macronutrient (mg kg^{-1} soil)							
N						22.04	
P						4.62	
K						86.57	
E: DTPA extractable (mg kg^{-1} soil)							
Zn						0.10	
Fe						0.24	
Mn						0.02	

***pH : In (1:2.5) soil suspension. **EC_e: In (1:5) soil water extract. ***N.D. means not detected.**
******sulfate ($SO4^{2-}$) ions were calculate as the difference between sum of cations and anions.**

Table 3. Basic chemical properties and some mineral element composition of chicken manure and biochar

Organic amendments	Properties and Elements									
	*pH	**EC dSm^{-1}	Total carbon (%)	Total nitrogen (%)	C / N ratio	Available nutrients (mg kg^{-1}) P	Available nutrients (mg kg^{-1}) K	DTPA-extractable (mg kg^{-1}) Zn	DTPA-extractable (mg kg^{-1}) Fe	DTPA-extractable (mg kg^{-1}) Mn
Biochar	8.88	0.66	27.72	1.11	24.97	9.82	455.60	84.00	3800	103
Chicken manure	7.37	14.50	22.76	2.43	9.36	427.06	1426.32	480.00	1060	260

***pH : In (1:5) suspension. **EC : In (1:10) extract.**

Plant measurements

Randomized plant samples were taken from three pots at 90 days after sowing to measure vegetative plant characters: Plant height (cm), number of leaves per plant as well as fresh and dry weight of above ground biomass (g/pot). Chlorophyll reading was measured by portable Chlorophyll Meter (model SPAD-502, Soil and Plant Analysis Development) of Minolta Co. Ltd., Osaka, Japan (1989).

For plant mineral analysis, leaf samples were oven dried at 70 ^{0}C till constant weight. The dried plant samples were weighted and digested with concentrated mixture of $H_2SO_4/HCLO_4$ for chemical analysis (Chapman and Pratt, 1961). Total N and K were determined using the microKjeldahl and falamphotometer methods according to Chapman and Pratt, (1961). P concentration of coriander leaves was determined by a colorimetric method Olsen *et al.,* (1954).

Statistical Analysis

Data were statistically analyzed with the aid of Co-STATE Computer Software program using (ANOVA) technique as described by Gomez and Gomez, (1984), and the difference between the treatments means were tested at 5 % LSD.

RESULTS AND DISCUSSION

Plant growth parameters

The harmful effect of salinity on plant growth parameters was significant ($p < 0.05$) as cleared in Table 4. The highest reduction of plant growth parameters was recorded with S2. The plant height showed 23.62% reduction with S2 compared to the control treatment. Chicken manure and biochar showed a significant ameliorative effect against salinity hazard with noticeable superiority to chicken manure (14.95% vs. 5.50%). Under the stress condition, chicken manure showed 23.86% and 13.39% increases in plant height with S1 and S2, respectively. However, biochar showed only 10.10% and 10.30% increments in plant height at S1 and S2, respectively (Table 4).

Under stress condition, plants showed a significant decrease ($p < 0.05$), in number of leaves/plant at all salinity levels. The number of leaves per plant reduced by about 23.07% and 35.92% with S1 and S2, respectively without application of chicken manure or biochar. Under non saline treatment, chicken manure and biochar showed increments in number of leave per plant by about 79.46% and 21.30%, respectively. In stress-exposed plants, application of chicken manure and biochar proved their effectiveness. Chicken manure resulted in 93.30% and 87.99% increase, whereas biochar showed 17.80% and 15.96% increase in number of leaves per plant with S1 and S2, respectively (Table 4).

Fresh and dry weight of above ground biomass decreased significantly ($p < 0.05$) with all salinity levels. Plants exposed to salinity stress showed reduction in fresh weight by about 54.75% and 56.30% with S1 and S2, respectively. While, plants exposed to the stress with S1 showed 16.19% reduction, and with S2 salinity level showed 48.21% reduction in dry weight. Chicken manure and biochar application caused a significant increase in fresh and dry weight of plants grown under the normal and salinity stress condition (Table 4). Under the control condition, chicken manure caused 22.47% and 30.53% increments in the fresh and dry weight, respectively. Under the stress condition, chicken manure caused 85.15% and 19.41% increase in fresh weight with S1 and S2, respectively. While, 31.29% and 25.25% increase in dry weight after chicken manure application with S1 and S2, respectively (Table 4). On the other hand, under the control condition, biochar caused 4.41% and 26.52% increases in the fresh and dry weight, respectively. Under salinity stress, biochar caused 66.50% and 15.37% increase in fresh weight with S1 and S2, respectively. However, this enhancement in dry weight was accounted by 28.54% and 12.62% after biochar application to S1 and S2 treatments, respectively (Table 4).

Total chlorophyll content showeda significant reduction ($p < 0.05$) under saline conditions compared to normal conditions. Plants grown under salinity water showed 39.69% and 43.27% decreased in total chlorophyll content compared to the control. On the other hand, chlorophyll content enhanced with application of chicken manure and biochar under salinity stress. Under non-saline water irrigation, 52.95% increment in total chlorophyll content was observed by chicken manure application, while 35.81% increment by biochar application. At 10%, application of chicken manure showed increment of 14.84%, whereas biochar application showed increment of 13.65% (Table 4).

Table 4. Growth parameters and total chlorophyll of coriander plant under irrigation with diluted seawater with or without chicken manure and biochar application under sandy soil conditions.

Treatments		plant height, (cm)	Leaves fresh weight, (g)	Leaves dry weight, (g)	No. of leaves /plant	Total chlorophyll
S0	Untreated	42.33	66.83	13.46	13.00	10.33
	Chicken manure	48.66	81.85	17.57	23.33	15.80
	Biochar	44.66	69.78	17.03	15.77	14.03
S1	Untreated	36.33	30.24	11.28	10.00	6.23
	Chicken manure	45.00	55.99	14.81	19.33	10.26
	Biochar	40.00	50.35	14.50	11.78	7.16
S2	Untreated	32.33	29.20	6.97	8.33	5.86
	Chicken manure	36.66	34.87	8.73	15.66	6.73
	Biochar	35.66	33.69	7.85	9.66	6.66
LSD@5%		1.82	8.04	3.40	1.79	0.67

Current observations showed a serious decrease in plant's morphological growth of the coriander plant under non saline water. Salinity of irrigation water was restrictive effects and severely mediated the vegetative growth characteristics, physiological activity and metabolic disturbances in plants. Growth inhibition is closely related to a reduce in cell elongation, photosynthesis and stomatal system which reduce the CO_2/O_2 ratio in leaves and inhabited CO_2 fixation under salt stress as suggested by (Shabani *et al.,* 2013). The reduction of vegetative growth characters of coriander under salinity stress is related to two important reasons: first, by the increase in osmotic pressure that inhibits the ability of plant to absorb water for its growth processes, disturbed metabolic processes resulting in reduced meristematic activity or cell enlargement from the soil solution and this causes fast reduction within the rate of growth. The second reason is due to the secondary specific-ions effects of Na^+ because the excess of exchangeable Na will cause soil swelling, aeration and root penetration problems (Jouyban, 2012; Alaa El-din *et al.,* 2013).

The best means of maintaining soil fertility, productivity and salt tolerance may well be through addition of organic manures like chicken manures. It's clear from the data that application of chicken manures as organic amendments may be used for the improvement of salt-influenced soil and enhancement the vegetative growth of coriander plant. The improvement of growth parameters of coriander plant following fertilization with chicken manure under using diluted saline water for irrigation may be attributed to the development of each soil wet retention, improve physical, chemical and biological properties of soils under saline conditions and potentials of nutrient supply (with macro and micronutrients and reduce the toxic effects of salinity in numerous plant species). These results are in agreement with those obtained by El-Missery, (2003) who revealed that the utilization of saline water for irrigation (4200 ppm) reduced vegetative growth of spinach plant, when chicken manure was applied, significant increases were obtained in plant height, leaf number and plant fresh weight. Other investigators reported that organic fertilization enhanced salt tolerance of some vegetable crops under saline conditions. In this regard, Oustani *et al.,* (2015) revealed a significant and proportional increasing of all studied yield parameters of potato with the increase of poultry manure rates compared to the control under saline conditions. Chicken manure mineralized faster than alternative animal manure; hence it releases its nutrients for plant uptake and utilization rapidly. So, application of chicken manure ameliorated the adverse impact of saline water for irrigation in dry weight of shoot and root, fruit weight and total chlorophyll because chlorophyll is related to the amount of nutrients absorbed by the plant from the soil. Moreover, chicken manure contains essential nutrient elements related to high chemical action "photosynthetic" activities and therefore promoted roots and vegetative growths.

However, addition of biochar mitigated the detrimental impact of salinity because of its Na^+ absorbing potential and improved all measured vegetative features under salt stress. This finding indicated that biochar may be used to make a scavenging effect against hazards of salinity on leaf transpiration rates, particularly at sufficiently biochar application. These results are in agreement with those of (Amini *et al.,* 2016; Ali *et al.,* 2017). Results also showed decreased in chlorophyll content within the saline stressed-plants compared to the respective control plants. Under salt stress, increment chlorophyllase enzyme performance and reduced N uptake can be a possible reason for lowered total chlorophyll content. Data of our study showed that biochar application led to increase chlorophyll content. According to Lyu *et al.,* (2016) the application of biochar elevated photosynthesis rate, accumulated activity of photosystem and facilitates electron transport, which boost the total photosynthetic performance index and increased level of N in leaves that is an indication of enhanced chlorophyll content.

Nutrients concentration and uptake by coriander plant

The effect of applying chicken manure and biochar on nutrients contents of coriander plant moreover as their uptake was shown in Figs. (1 and 2). The statistical analysis showed that there were significant ($p < 0.05$) increments in N, P and K contents following the application of chicken manure and biochar under fresh water irrigation. Additionally, N, P and K uptake by coriander plant significantly ($p < 0.05$) increased with the application of chicken manure and biochar compared to unamended control. Under saline water irrigation, the application of chicken manure and biochar also increased significantly ($p < 0.05$) for plant contents and uptake of nutrients compared to the control without addition of chicken manure and biochar. This increment in nutrient uptake by coriander plant with chicken manure and biochar application will reflect on the noticeable increase of nutrients concentrations in plant tissues. The lower plant N, P and K contents and their uptake by coriander plant were found within the treatments receiving saline water than non-saline water irrigation Figs. (1 and 2). Irrigation with saline water decreased significantly the contents and uptake of N, P and K. Additionally, uses of saline water for irrigation decreased significantly the K content in plants. The lower plant K content and their uptake by coriander plant was found within the treatment receiving saline water at S2 and with increasing salt concentrations, K uptake by coriander plant was reduced compared with unamended control at S0 (non-saline water) without addition of chicken manure and biochar. The results of this study demonstrated also that the significant decline of nitrogen, phosphorous and potassium contents of the plant within the treatments receiving saline water irrigation corresponded with their soil availability. Indeed, increment soil salinity will act antagonistically to the nutrient uptake by plants, limiting vegetable yield through salinity or diffusion soil solution (Grattan and Grieve, 1999).

The improvement impacts of organic amendments on nutrient availability and uptake by plants have been reported by different researchers (Antil and Singh, 2007; Wang *et al.,* 2014). The incorporation of biochar into soils like different amendments could have positive impacts on soil functions and act as a fertilizer by increasing the fertilizer use efficiency through enhancing the soil physico-chemical properties and increasing the dissolve and/or maintained amounts of nutrients due to the charge and surface area characteristics of biochar leading to increased plant nutrient contents and uptake. The high sorption capacity of biochar toward binding Na^+ ions might lead to reduce the hazardous effect of Na^+ ions. Furthermore, the biostimulating compounds existed in humic substance derived from biochar might reduce the adverse effects of salinity on plant physiological indices. On the other hand, nutrients released from biochar (K in particular) could have an ameliorative effect against salinity stress (Prendergast-Miller *et al.,* 2014 and El-Banna *et al.,* 2018).

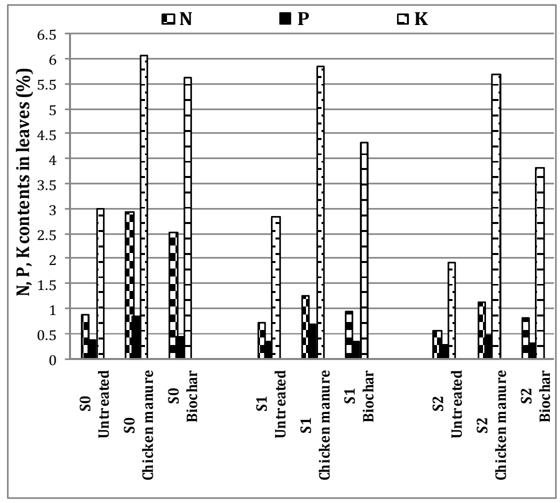

Fig. 1. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on N, P and K contents in leaves of coriander plant.

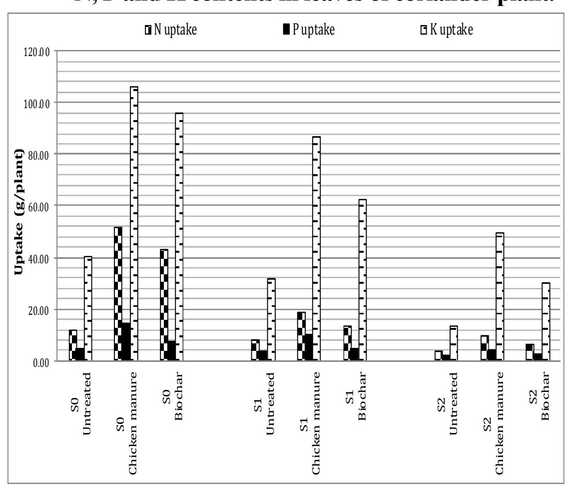

Fig. 2. Effect of interaction between irrigation with diluted seawater, chicken manure & biochar on N, P and K uptake by coriander leaves.

Effect of diluted seawater, chicken manure and biochar on soil chemical properties and nutrients availability.

As shown in Fig. (3), EC values increased significantly with raising irrigation water salinity level in comparison to fresh water. With non-saline water irrigation, the values of EC were (0.45, 0.81 and 1.42 dS m^{-1}) under untreated (S0), saline water irrigation with (S1 and S2) treatments, respectively. On the other hand, EC values in soil amended with chicken manure were (0.28, 0.71 and 0.57 dS m^{-1}) and with biochar application were (0.22, 0.54 and 0.41 dS m^{-1}) under S0, S1 and S2 treatments, respectively lower than those in soil unamended with chicken manure or biochar. These results indicated that soil amendments applications significantly reduced EC values under non saline and salinity stress treatments. Soil EC was significantly influenced by the type of material used. Such changes in EC may be explained by the mineralization of the organic materials. The addition of chicken manure to soil irrigated with saline water improve the distribution of soil pores, where enhancing salt leaching, reducing surface evaporation, inhibiting salt accumulation in surface soils. Organic material also play a role in the rapid washing of Na^+ ions and the reduction of ESP, thus reducing electrical conductivity so, these materials reduce the harmful effect of salts in soil solution. These results are in agreement with (Jones *et al.,* 2012). On the other hand, EC values decreased under non-saline and saline water irrigation combined with biochar application, if the biochar EC is lower than or equal to the soil EC. The reduction in EC values in soil amended with biochar was higher than those in soil amended with chicken manure under all salinity levels , because the biochar EC is lower than the chicken manure EC. The reduction in EC was attributed to the biochar-induced improvement in soil porosity and hydraulic conductivity that accelerated leaching of salt, the adsorption/retention of salts such as Na on the biochar surfaces, or physical entrapment of salts in fine pores of biochar, that decreased salt concentration in soil solution and biochar-induced reduction in the upward movement of salinewater (biochar cover reduced evaporation) resulting in decreased salt accumulation in surface soils (Hammer *et al.*, 2015). These results are agreement with Luo *et al.,* (2017) who demonstrated that biochar can improve leaching of soluble salts to decrease soil EC.

The ANOVA results revealed that chicken manure, biochar and saline water irrigation significantly ($p < 0.05$) affected soil pH as shown in Fig. (4). Soil pH increased significantly in saline water irrigation treatments (S1 and S2) compared to S0, and decreased in soil amended with chicken manure and biochar Fig. (4). The reduction in soil pH values in soil amended with chicken manure was higher than those in soil amended with biochar. Under the control condition, chicken manure and biochar application, caused 8.22% and 5.61% decreases in soil pH, respectively. Treatment S1 resulted in 6.02% and 3.46% reduction in soil pH under the chicken manure and biochar application compared to the unamended treatment, respectively. Under stress condition, chicken manure and biochar caused 5.73% and 4.14% decrease in soil pH with increases in irrigation water salinity at S2. The reason for increasing pH values is primarily related to the high Na^+ content of saline water (Shaygan *et al.,* 2017). Soil pH decreased with chicken manure applications under three water types. Nitrification of mineralized residue might be the major cause of the reduction in soil pH. During the transformation of NH_4^+ to $N0_3^-$, hydrogen ions are generated, causing acidification. Another factor influencing the pH is soil electrical conductivity. The increase in EC values in soil is due to increase the ionic strength of the soil solution, which favors the dissociation of H^+ ions from the surface charges (Westerman, 1990). Several studies have reported the reduction of soil pH values by adding biochar to soils irrigated with saline water (Khalifa and Yousef, 2015; Liu *et al.,* 2017). Biochar enhances the negative effects of salinity by reducing Na^+ ions by adsorption, which leads to reduce ESP thus, the decrease in soil pH. Luo *et al.,* (2017) found a decline in the pH of soil influenced by salts, owing to hydrogen ion ($H^{+)}$ released from the ion exchange complex by calcium or magnesium brought by biochar. There is another reason for the pH reduction in amended soil with biochar application could be the increment cation exchange capacity of biochar that advanced enhance plant uptake of potassium, calcium and magnesium, because of the released hydrogen ion (H^+) from the roots to the equilibrium of the charges. In addition, reduce in soil pH following biochar application may be due to; (1) the proliferation of acids produced by soil microbes which in turn reduce soil pH. (2) the increment in acidic functional groups formed during oxidation of biochar. (3) further, decomposition of organic matter present in soil which contribute to decrease soil pH, and (4) even though biochar contains CO_3^- and soluble base cations, sparingly solvent CO_3^- may form in some soils, limiting the hydrolyzation of CO_3^- and decreasing the content of OH^- (Liu and Zhang, 2012).

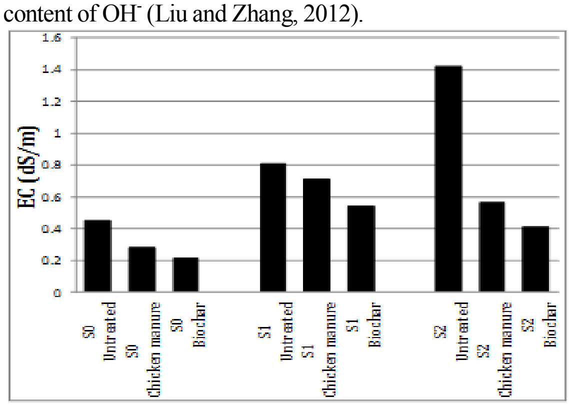

Fig. 3. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on EC values of sandy soil.

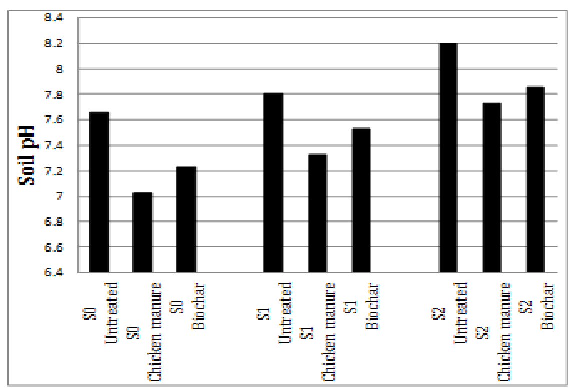

Fig. 4. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on soil pH of sandy soil.

Beheiry *et al.,* (2005) discovered that salinity of the soil decreased as a result of the addition of organic manures, which contribute to the improvement of soil physics, which in turn increasesd the depletion of salts outside the root area.

The effects of applied amendments on nutrients availability in soil irrigated with non-saline and saline water are shown in Figs. (5 & 6 & 7 and 8). Soil available

Na^{+}, K^{+}, Ca^{2+} and Mg^{2+} contents increased with increments in water salinity while, soil available P contents was (reverse direction) reduced with increments in water salinity. It is clear that the addition of amendments increased available K^{+}, Ca^{2+} and Mg^{2+} contents except soil available Na^{+} contents, under saline water system contrasted with non-saline water system.

Under used three water types, as a result of amendments application an increase in Ca^{2+}, Mg^{2+} and K^{+} and decrease in dissolvable Na^{+} were observed. Optimal K level ought to be kept up in salt-influenced soils in order to improve plant growth. Biochar addition can bring about improving K concentration in salt-influenced soils and is viewed as a standout amongst the most vital fundamental components for the biochar-induced increment in development of salt-stressed plants (Wakeel, 2013; Akhtar *et al.,* 2015b). The impacts of chicken manure and biochar applications on soil available phosphorus concentrations were showed in Fig. (9). The concentrations of available phosphorus in unamended control, chicken manure and biochar with water system of non-saline water were 72, 224 and 111.50 mg kg^{-1}, respectively. Under water system with saline water, the concentrations of available P reduced significantly to 27.50, 76.50 and 65.50 mg kg^{-1} at S1 treatment and 19.50, 70.50 and 28 mg kg^{-1} at S2, respectively. These clearly demonstrated that the lowest soil available P contents were found in the treatments receiving saline water irrigation. The increments in soil soluble calcium (Ca^{2+}) ions can be expected because of water system with saline water, due to Ca - P precipitation and decreased soil phosphorous availability. Additionally, salinity stress can decrease the activities of some key soil enzymes like phosphatase, which are related with the adverse effect on organic changes and the bioavailability of phosphorous and also, the decrease in soil available P observed be attributed to plant uptake and microorganism assimilation (Bano and Fatima, 2009). Also, observed in this regard, the contents of soil available P in chicken manure amended soil was higher than those in biochar amended soil. This increase is partially the result of the P present in the manure. Additionally, the pH decrease may have improved and increased Ca^{2+} dissolution in soil, thereby minimizing dissolved Na^{+} due to Ca^{2+} and Na^{+} completion. It was also observed that, in pots treated with saline water, an increase in available potassium was better than pots treated with non-saline water system, fundamentally because of its high concentrations in saline water. Biochar enhanced negative effects of salinity by discharging mineral supplements such as K, Ca, and Mg into the soil solution and diminshed osmotic stress by enhancing the soil available water content, (Akhtar *et al.,* 2015b). Novak (2012) expressed that biochar has strong absorptive characteristics binding allude to its high surface area and cation exchange capacity (CEC). By adsorbing harmful particles particularly Na^{+}, and additionally by releasing more important ions. Furthermore, organically amended soils under non-saline and saline stress can release sulfate and chloride, which are considered as complexing agents for calcium in soils.

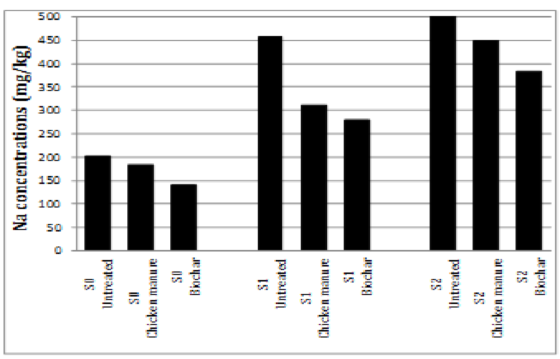

Fig. 5. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on Na concentrations in sandy soil.

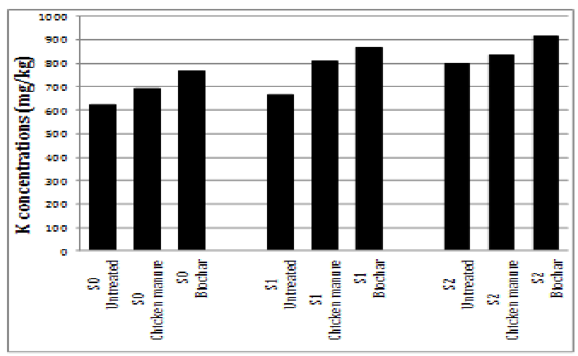

Fig. 6. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on K concentrations in sandy soil.

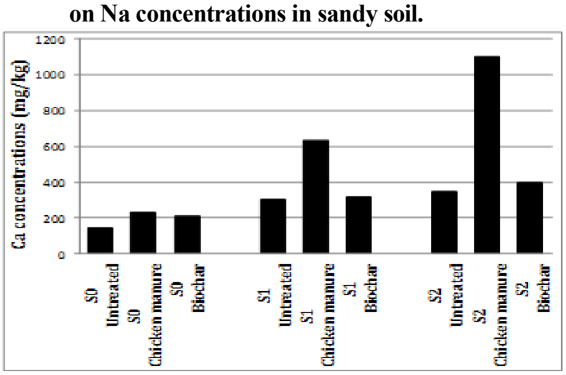

Fig. 7. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on Ca concentrations in sandy soil.

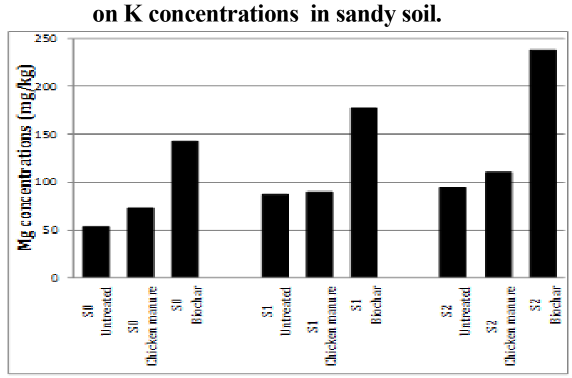

Fig. 8. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on Mg concentrations in sandy soil.

As shown in Fig. (10), available Zn in soil was significantly lower ($p < 0.05$) in the treatments receiving saline water than non-saline water system. Obtained results showed that increments in available Zn concentration following the utilization of biochar as organic amendments. These results are in agreement with Usman *et al.,* (2016) who found that the addition of biochar increased soil available Zn due to the stimulating effect of biochar on soil nutrient availability. Therefore, biochar might be successfully utilized for upgrading the efficiency of salt-influenced sandy soils under arid conditions.

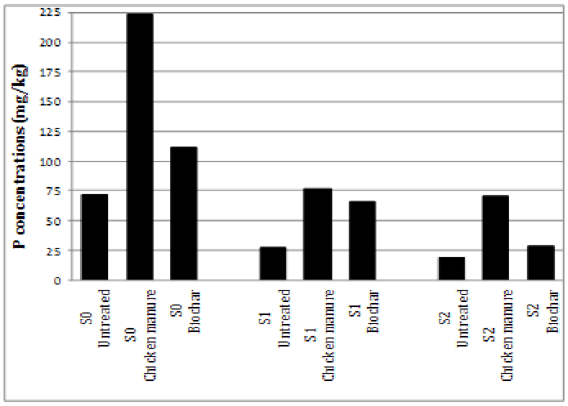

Fig. 9. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on P concentrations in sandy soil.

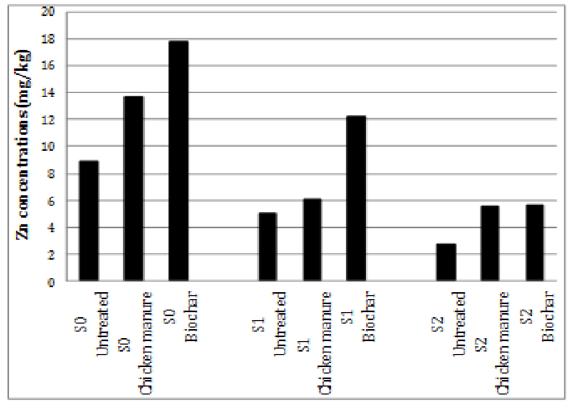

Fig. 10. Effect of interaction between irrigation with diluted seawater, chicken manure and biochar on Zn concentrations in sandy soil.

CONCLUSION

The widespread applications of saline water in irrigation have various deterioration on soil properties and in cultivated plants. Data of this study showed significant reduction in vegetative growth characters as well as plant biochemical attributes (chlorophyll and plant nutrients). Soil chemical properties affected significantly with saline water irrigation with a noticeable increase in soil pH and EC values in addition to a disturbance in nutrients availability in the root zone. Chicken manure and biochar showed a safeguard effect against the adverse effects of soil salinity with superiority to chicken manure given its high nutrients content and biostimulating compounds. In conclusion it is recommended to additive of chicken manure and biochar to sandy texture soil under irrigation with diluted sea water might be appropriate amendment for enhancing salt-influenced sandy soil quality, nutrient availability and thereafter improving plant growth, total chlorophyll and plant nutrient contents and uptake.

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تأثير التركيزات المختلفة لمياه البحر المخففة على نمو الكزبرة وخصائص التربة الرملية المحسنة بسماد الدواجن والفحم الحيوي

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قسم الأراضي ، كلية الزراعة ، جامعة المنصورة

يعتبر الإجهاد الملحي أحد أهم عوامل الاجهادات غير الحيوية المحددة لنمو النبات ، وإنتاجية المحاصيل ، فضلا عن أنه العامل الرئيسي الذي يسهم في تدهور الأراضي. وقد أجريت هذه الدراسة ، لتقييم أثراضافة سماد الدواجن و الفحم الحيوي المستخدم كمحسنات للتربة في التخفيف من الآثار السلبية للري بالمياه المالحة على خصائص النباتات ، وامتصاص العناصر الغذائية الكلية في نبات الكزبرة (*Coriandrum sativum*) المنزرع في التربة الرملية , كذلك تقييم تأثير محسنات التربة علي خصائص التربة وتيسير العناصر الغذائية للنبات. أجريت تجربة أصص على نبات الكزبرة بالمزرعة التجريبية بكلية الزراعة ، جامعة المنصورة ، محافظة الدقهلية ، مصر. نفذت هذه الدراسة التجريبية باستخدام تصميم قطع منشقة في ثلاث مكررات في فصل الربيع لعام ٢٠١٦. وكانت المعاملات مزيجًا من نوعين من محسنات التربة (سماد الدواجن والفحم الحيوي) وثلاث معاملات من مياه الري ؛ غير المالحة (الكنترول) (S0= ٠.٤٥ ديسيمنز متر$^{-١}$) والمياه المالحة (S1= ٣.١٢ ديسيمنز متر$^{-١}$, ٥% و S2=٦.٢٥ ديسيمنز متر$^{-١}$, ١٠%). أظهرت النتائج في هذه الدراسة أن إنتاجية التربة ، المشار اليها من خلال النمو الخضري والصفات الفسيولوجية (ارتفاع النبات ، الوزن الطازج والجاف للأوراق ، عدد الأوراق / النبات والمحتوي الكلي من الكلوروفيل) لنبات الكزبرة ، كانت عكسية حيث تتأثر بشكل كبير بمياه الري المالحة. أدت إضافة سماد الدواجن والفحم الحيوي الي زيادة كبيرة وتحسين في النمو الخضري والصفات الفسيولوجية في جميع مستويات الملوحة. كما لوحظ زيادة معنوية في محتوي النبات من النيتروجين والفوسفور والبوتاسيوم وامتصاص النبات لهم مع إضافة سماد الدواجن الفحم الحيوي تحت الري بالمياه المالحة وغير الملحية مقارنة بالتربة غير المحسنة. انخفض محتوي وامتصاص النيتروجين والفوسفور والبوتاسيوم في أوراق نبات الكزبرة بشكل ملحوظ مع زيادة ملوحة مياه الري من S0 الي S2 . ارتفعت معنويا قيم درجة حموضة التربة وقيم التوصيل الكهربي في معاملات الري بالمياه المالحة (S1 و S2) مقارنة بمعاملة المياه غير المالحة (S0). انخفضت قيم درجة حموضة التربة وقيم التوصيل الكهربي في التربة المضاف لها سماد الدواجن و الفحم الحيوي تحت الثلاثة أنواع من المياه. كان الانخفاض في قيم التوصيل الكهربي في التربة المضاف لها الفحم الحيوي أعلى من تلك القيم في التربة المضاف لها سماد الدواجن تحت جميع مستويات الملوحة. في حين أنه كان الانخفاض في قيم درجة حموضة التربة في التربة المضاف لها سماد الدواجن أعلى من تلك القيم في التربة المضاف لها الفحم الحيوي. ازدادت تركيزات الصوديوم , البوتاسيوم , الكالسيوم والماغنسيوم الميسرة في التربة فيما عدا انخفضت تركيزات الفوسفور والزنك الميسر في التربة مع زيادة ملوحة مياه الري. لوحظ انخفاض في تركيز للصوديوم الذائب ولكن زاد تركيز البوتاسيوم و الكالسيوم والماغنسيوم نتيجة لاضافة محسنات التربة تحت ثلاثة أنواع من المياه المستخدمة للري. فكان تركيز الفوسفور الميسر في التربة المضاف لها سماد الدواجن أعلى من التربة المضاف لها الفحم الحيوي. في حين أن تركيز الزنك الميسر في التربة المضاف لها الفحم النباتي كان أعلي من التربة غير المضاف لها محسنات .وفي الختام ، فإن سماد الدواجن و الفحم الحيوي المضاف الي التربة كمحسنات لديهم القدرة علي تخفيف الاثار السلبية الناتجة عن الاجهاد الملحي حيث ترتبط بشكل رئيسي بقدرتهم علي تحسين الخصائص الفيزيوكيميائية للتربة ، وتعزيز النمو الخضري لنبات الكزبرة ، والزيادات في محتوى التربة من المادة العضوية وتيسير المغذيات.