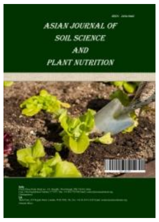

Asian Journal of Soil Science and Plant Nutrition

6(3): 47-60, 2020; Article no.AJSSPN.59946
ISSN: 2456-9682

Amelioration of Salt Affected Soils and Improvement of Rice and Wheat Yields by Adding Compost and Foliar Spray of Zinc, Potassium and Compost Tea

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI:10.9734/AJSSPN/2020/v6i330092
Editor(s):
(1) Dr. Paola Angelini, University of Perugia, Italy.
Reviewers:
(1) Ibrahim Iro Ibrahim, Nigeria.
(2) M. Jahiruddin, Bangladesh Agricultural University, Bangladesh.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59946

Original Research Article

Received 26 May 2020
Accepted 03 August 2020
Published 05 August 2020

ABSTRACT

Amelioration of salt-affected soils requires an integrated management approach, by eco-friendly environmental methods which help improve soil properties, increases crop yield and quality. Hence, a study was done to evaluate the performances of combined use of compost and foliar application of Zn, K and compost tea. In salt affected soil in the rice-wheat system. A field experiment at El Hamool district, Kafr El Sheikh governorate, Egypt was carried out during 2019 summer for rice and 2020 winter season for wheat. A split plot design with three replicates was performed. The main plots were occupied by levels of compost: C1 (2MgFed.$^{-1}$), C2 (4MgFed.$^{-1}$) and C3 (6MgFed.$^{-1}$), (Fed= 0.41ha). Whereas, sub-plots were foliar application: control (T_1), Zinc sulphate (T_2), Mono potassium phosphate (T_3), compost tea (T_4), Zinc + potassium (T_5), zinc + compost tea (T_6), potassium + CT (T_7) and Zn + PK + CT (T_8). EC_e and SAR) were significant decreased due to application of compost up to C3 (6MgFed^{-1}) while CEC and organic carbon were significantly increased by compost application, C3(6MgFed.$^{-1}$). The highest results were recorded due to use of Zn+PK+CT and compost. The grain and straw yields of both rice and wheat were markedly increased due to application of compost and foliar nutrients. The highest values were noted with the interaction of C3 am and T8.Nitrogen uptake, N use efficiency and N-recovery for both rice and wheat were considerably increased due to application of compost and foliar treatments, the highest performance being observed in C3 coupled with T8.

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Keywords: Saline soil; N uptake; N use efficiency; rice; wheat.

1. INTRODUCTION

Bread wheat *(Triticum aestivum L.)* is one of the most important cereal crops in Egypt and local production is not sufficient to face the annual requirements [1]. Rice (*Oryza aestivum L.*) So, the Egyptian government's, make efforts to increase the soil productivity for wheat and rice. The increasing pressure on soil resources lead to different types of degradation including salinization, which is the process of increasing salt in soil profile. Hence, soil degradation resulting from salinity; it is a major impediment to optimal utilization of soil resources [2]. Thus, in order to reach the food security, the sustained productivity from these limited soil resources is further threatened by the multiplicity of resource degradation problems. Improving salt affected soils could be considered as an important issue in the agricultural security program [3]. Several studies have been carried out concerning the effectiveness of various amendments in improving the physical and chemical properties of saline soil. One of these organic amendments (farmyard manure, compost, green manure and municipal solid waste). Under saline soils, reduction in crop yield is associated with osmotic [4]. Compost application combined with N-fertilizer are considered as an important part of environment friendly sustainable soil fertility [5]. The application of compost has a positive effect on soil salinity due to its improving soil physical properties; hence it led to remove Na^+ from root zone [6,7]. 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 [8]. Enormous publications over more than five decades reported that humic substances have positive effects on plant growth and productivity [9,10]. and substantial interest in their potential for improving nutrient-use efficiency and contributing to carbon sequestration in the soil [10,11].The stimulatory effects of humic substances were attributed to hormone-like activity and its action similar to auxins, cytokinins and absisic acid [12]. And enhancing the uptake of macronutrients, such as N, P, S [13] and micronutrients, i.e. Fe, Zn, Cu and Mn [14]. In addition, humic substances enhance the uptake of minerals through the stimulation of microbiological activity [12]. amending of soil by organic fertilizers helps to achieve the long-term stable yields and maintain optimal soil properties [15,16,17] reported an acceleration of Na^+ leaching, decrease the exchangeable sodium percentage (ESP) and the electrical conductivity (EC). These authors reported that less oxidized, higher molecular weight humic matter is more important in the process of aggregate stabilization than more oxidized humic substances of lower molecular weight. Thereby resulting an enhancement the chelation ability of Ca^{2+} and Mg^{2+}in soil solution to effectively replace Na^+ from the cation exchange complex particularly at alkaline pH values as well as and reducing the sodium adsorption ratio (SAR) of the saline soil, [18]. Potassium plays an imperative role in the photosynthesis process and the subsequent carbohydrate translocation and metabolism, which eventually increase the crop yield and improve the grain quality [19,20]. K helps to increase the N uptake as well as N use efficiency that help in increasing the yield of rice, [21,22]. Potassium is also essential for the function and performance of many plant enzymes; at least 60 enzymes require K as a cofactor for activation [23]. These enzymes regulate the vital metabolic mechanisms in arable plants [24,25]. Potassium contributes for tolerance against salinity as it has competing nature to sodium for binding and maintaining plant water status .Therefore, under these previous conditions, potassium (K) can play an important role in mitigating the adverse effects of high salt concentrations in soil [26,27,28] and the stress tolerance of crops [29]. The addition of Zn helped in reducing the unfavorable effects of increased salinity tolerance of wheat to salinity [30]. Application of zinc reduces the negative effect of salinity on crop growth and yield of wheat [31].

Integrated nutrient management is a judicious use of organic and inorganic sources of nutrient to crop fields for sustaining and maintaining both of soil fertility and productivity [32]. Improvement of the chemical and physical properties soil and nitrogen use efficiency as well as yield of rice and wheat interaction experiments, which carry out in salt affected soils can be considered as an important issue in soil sciences. A more systematic research is required to observe the responses of crops to this interaction at the field level where extreme variability in salinity, soil texture and soil nutritional status is a norm. Therefore, the present study the effectiveness of compost as valuable soil conditioner and foliar of some nutrients and compost tea to alleviate the increasingly soil degradation due to salinization and improvement yield of rice and wheat.

2. MATERIALS AND METHODS

2.1 Experimental Site and Treatments

Field trials were carried out at El Hamool district, Kafr El Sheikh governorate. The experiment was conducted during two successive summer seasons, 2019 and winter season, 2020) to study the effect of the interaction between application of compost and both of zinc, potassium and compost tea application on rice and wheat (*Triticum aestivum L.)* using a split plot design with three replicates.Plot area was 21 m^2 (7 m length x 3 m width). The main plots were devoted to ameliorators: Application of compost occupied leveles of compost application C1: 2MgFed.$^{-1}$, C2: 4MgFed.$^{-1}$ and C3:6MgFed.$^{-1}$ The sub-main plots are (T1) control: without application, (T2) Zn as sulphate zinc (Zn), (T3) Mono potassium phosphat (PK), (T4) Compost tea (CT), (T5) Zn+ PK, (T6) Zn+CT, (T7) PK+CT and (T8) Zn+PK+CT.

Zinc, P and K were added at 3.0 g L^{-1} twice after 20 (before transplanting) and 25 days *after transplantigvia* a foliar application for rice and after 20 , 45day from sowing of wheat , while compost application *via* a soil application. The compost tea, which produced from the Agricultural Research Center (ARC, Giza, Egypt) The chemical composition of compost tea: pH, EC(dSm^{-1}), NO^{-3}, NH_4, P, K, Ca, Mg, Na, Fe, Mn, Zn were 8.11, 5.81, 67.0, 0.73, 21.0, 1.544,463, 240, 58.0, 22.8, 1.18 and 0.93 mgl^{-1} respectively. And its contains N_2-fixing free living bacterial cultures (*Azotobacter chroococcum* and Azospirillium *lipoferum*) and phosphate dissolving bacterial culture (*Bacillus megaterium*) was added at 2LFed.$^{-1}$ after 20 and 50 days from sowing *via* foliar application.Oriza seeds cv.Sakha108 were planted on 25th April 2019 and harvested in 30th Septmber whereas, wheat cv.Giza 171 was sowing in 25November, 2019, and harvested in 30 April 2020.The recommended cultural practices of rice and wheat were performed, according to Egyption Ministry of Agriculture.

2.2 Data Recorded at Harvest

Aftert harvest of each treatment was determine the following parameter: 1000-seed weight (g), seed yield (Mg fed.$^{-1}$).

2.3 Recovery of Nutrient (%)

The recovery of N (%)was calculated for each treatment according to [33] as follow:

Recovery of nutrient (%) = [(Total nutrients uptaked from treatment - Total nutrient uptaked from control) / applied nutrients with treatment] X 100 %

N use efficiency (NUE) was calculated as follows:

NUE (kg/kg N-applied) = grain yield (kg fed^{-1}) from fertilizer- grain yield from control / total N applied (kg fed^{-1})

2.4 Chemical Analysis of Soil and Plant Samples

Before the cultivation, soil samples were taken from each treatment in both growing seasons at two depths (0 - 20 20 - 40 and 40-60 cm depth). Soil samples were prepared for physical and chemical analysis according to the standard methods. These soil samples were dried, sieved through a 2 mm mesh and analyzed for texture, soluble cations and anions, soil pH, EC, and available NPK as well asorganic matter content was determined using the Walkley and Black method according to [34]. Particle size distribution of soil was measured using pipette method according to [35]. Soil bulk density and total porosity were determined for each treatment according to [36]. Field capacity and permanent wilting point were calculated from soil moisture tension curve [37] as shown in Table 1. Three samples of rice and wheat were randomly collected from each treatment,dried at 70°C in a hot air oven and analyzed for oil content using Soxhlet apparatus and petroleum ether as a solvent. Seed nitrogen content was measured by an automated colorimetric method following Kjeldahl digestion [34]. The protein content was calculated using the factor of 6.25 (on a dry weight basis).

2.5 Statistical Analysis

The obtained results were subjected to analysis of variance according to the procedure outlined by [39], and significant differences were weighted by LSD test at 0.05 and 0.01 level of probability.

Table 1. Some physical properties of the experimental field

Soil depth(cm)	soil physical properties								
	Soil moisture characteristics					Particle size distribution (g/kg)			
	F.C. (%)	W.P. (%)	A.W. (%)	BD (kg m^{-3})	Total porosity (%)	Sand	Silt	Clay	Soil texture
0-20	43.00	21.61	21.39	1.35	49.06	181.0	242.4	571.6	clay
20-40	39.8	20.81	18.99	1.38	47.92	187.4	249.3	563.3	clay
40-60	36.51	18.40	18.11	1.45	45.28	192.6	239.9	567.5	clay
mean	40.36	20.59	19.77	1.39	47.42	187.0	243.9	567.5	clay

soil chemical properties

Soil depth (cm)	pH -	EC (dSm^{-1})	ESP (%)	CEC (cmole kg^{-1})	OC (g kg^{-1})	$CaCO_3$ (gkg^{-1})	N ($mgkg^{-1}$)	P	K
0-20	8.30	6.61	12.51	39.15	1.18	2.50	35.65	8.50	270
20-40	8.40	7.97	14.21	39.1	1.14	2.37	27.44	8.91	261
40-60	8.45	8.25	15.55	37.63	1.10	2.26	21.33	7.45	214
mean	-	7.61	14.09	38.63	1.14	2.38	28.14	8.29	248.3

chemical properties of compost

EC dsm^{-1}	pH -	C (gkg^{-1})	OM	C/N ratio	N (gkg^{-1})	P	K	Fe	Zn	Mn	Moisture %
3.04	7.70	30.05	54.00	17.57	1.71	0.90	1.27	162	72	118	27.8

F.C.: Field Capacity; W.P.: Wilting Point; A.W.: Available Water; BD: Bulk Density; PH: was determined in soil water suspension (1:2.5); EC: was determined in saturated soil paste extract; ESP: Exchangeable Sodium Percentage; CEC: Cation Exchange Capacity; OM: Organic Carbon. According to Natural Resources Conservation Service (NRCS), Oregon State University, USA, the soil of experiment can be classified as saline soil [38]

3. RESULTS AND DISCUSSION

3.1 Soil Chemical Properties

Treatments had a positive significant effect on decreasing soil salinity (EC_e and SAR) after harvesting of rice and wheat (Table 2 and Fig. 1a,b). Data show that EC_e and SAR values (for both two seasons) were significant decreased by increasing application of compost up to C3 (6MgFed^{-1}). This results may be due to due to application of compost on improving soil physical properties, enhancement the chelation ability of $Ca^{2+}$and Mg^{2+}in soil solution to effectively replace Na+ from the cation exchange complex particularly at alkaline pH values as well as and reducing the sodium adsorption ratio (SAR) of the saline soil; hence it led to remove Na^+ from root zone [6,7,18].

With respect to the effect of foliar application of some nutrients on soil EC_e and SAR after harvesting of rice and wheat , data pointed out that EC_e and SAR values were decreased with different treatments as compared with the control in both seasons as shown in Table 2 and Fig. 1a,b. Furthermore, the combined application of foliar Zn+PK+CT and compost was the best application method.

With respect to CEC, there is a positive significant effect due different treatments was observed during both seasons, Table 2. Data in Table 2 show that the mean CEC values of both seasons were increased by increasing of compost application. The highest values of the CEC can be achieved using C3(6MgFed.$^{-1}$). The same data showed that ECe, SAR recorded lowest values due to the interaction between C3*T8. Organic carbon was significant increased by application of compost up to C3(6MgFed.$^{-1}$)

On the other hand CEC and organic carbon were recorded highest values due to the same previous treatment.foliar application of zinc (Zn), mono potassium phosphate (PK), compost tea (CT), Zn+PK, Zn+CT, PK+CT and Zn+PK+CT had significant effect on increasing OC, the most efficient treatment (T8) and application of compost (C3), as shown in Table 2 and Fig. 1c,d.

Concerning the impact of the treatments on soil chemical properties, the impacts were in the following order: $T_8 > T_7 > T_6 > T_5 > T_4 > T_3 > T_2 > T_1$ in both growing seasons. This results may be due to the compost and organic amendments application can potentially affect the soil organic carbon and improvement of the soil properties as well as on the plants growth and yields [40,41].

3.2 Yield of Rice and Wheat

It is well known that the combined application of organic amendments and foliar application of organic and inorganic may play a significant role in improvement of yield of rice and wheat and 1000 grain weight. Yield of rice and wheat were significant increased with increasing of compost addition up to C3 (6Mgfed.$^{-1}$) as shown in Table (3). The highest values (3.78 and 3.5MgFed.$^{-1}$) for straw and grain yield of rice. With regarded to effect of compost application, the straw, grain and biological yield of wheat were significant increased (2.87, 2.68 and 5.55MgFed.$^{-1}$) up to the same previous levels of compost application (C3). In addition, compost are slow release nutrients all over the growth season, moreover, compost is rich in its nitrogen and micro-nutrients content. These favorable conditions creates better nutrients absorption and favors the growth and development of root system which in true reflects better vegetative growth, photosynthetic activity and dry matter accumulation under saline condition.Consequently higher total yield of rice and wheat would be obtained by compost application as compared without treatment.The obtained results are in good accordance with those which were reported by [9,10].

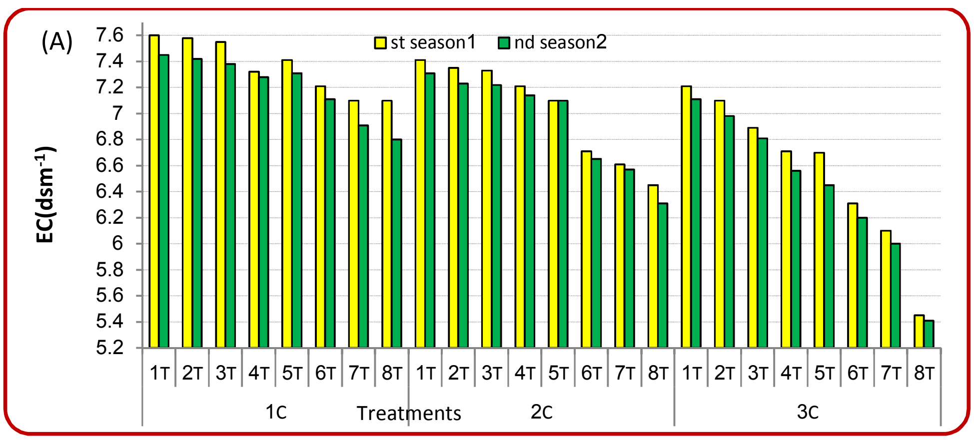
Data presented in Table 3 show significant differences among different treatment of spraying. Also the same data cleared that the straw, grain and biological yield of rice and wheat were significant increased with foliar application of zinc (Zn), mono potassium phosphate (PK), compost tea (CT), Zn+PK, Zn+CT, PK+CT and Zn+PK+CT.Where the highest values was obtained due to combination between Zn+PK+CT treatments.

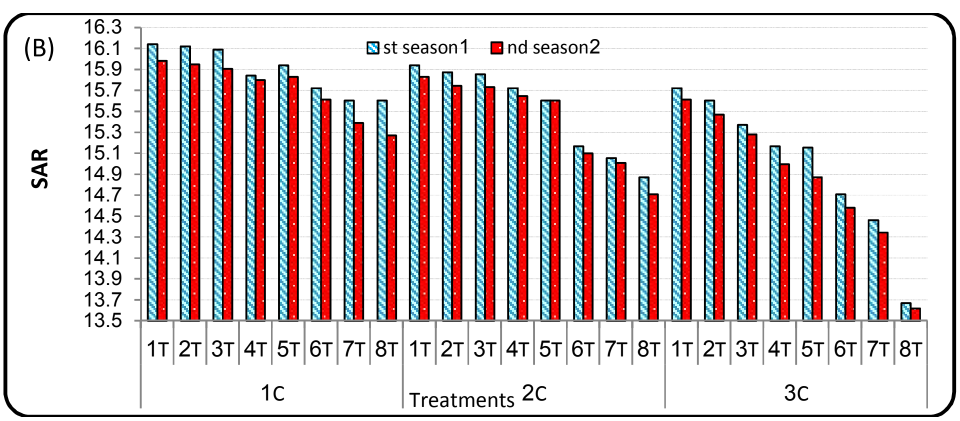
Table 3 showed that 1000 grain weight were significant increased by application of compost and recorded highest values (22.54 and 42.02g) for rice and wheat.Also1000 grain weight was significant increased with foliar application of zinc (Zn), mono potassium phosphate(PK), compost tea (CT), Zn+PK, Zn+CT, PK+CT and Zn+PK+CT. Where the highest values was obtained due to combination between Zn+PK+ CT treatments.

Table 2. Some chemical characteristics EC(dsm^{-1}), SAR and CEC($cmolc\ kg^{-1}$) of the soil as affected by compost and foliar application of some nutrients for both seasons

Treatments	1st Season				2st Season			
	EC	SAR	CEC	OC	EC	SAR	CEC	OC
Main treat. (A)								
C1	7.36a	15.88a	38.76a	11.56a	7.21a	15.72a	41.97a	11.64a
C2	7.02b	15.51b	39.24b	11.83b	6.94b	15.42b	43.49b	11.91b
C3	6.56c	14.98c	41.60c	12.05c	6.44c	14.85c	46.00c	12.13c
F_{test}	*	*	*		*	*	*	*
Sub-main treat. (B)								
Control (T_1)	7.41a	15.93a	38.92a	11.74d	7.29a	15.81a	42.70a	11.82d
Zn (T_2)	7.34a	15.87a	39.08b	11.79c	7.21a	15.72b	42.85b	11.87c
PK (T_3)	7.26a	15.77b	39.63c	11.79c	7.14a	15.64c	43.30c	11.87c
CT (T_4)	7.08b	15.58b	39.90d	11.79c	6.99ab	15.48d	44.04d	11.87c
Zn+ K (T_5)	7.07b	15.57b	39.88e	11.79c	6.95b	15.43e	43.87e	11.87c
Zn+CT.(T_6)	6.74c	15.20c	40.12f	11.83b	6.65c	15.10f	44.28f	11.91b
K+CT. (T_7)	6.60c	15.04d	40.55g	11.83b	6.49c	14.91g	44.33g	11.91b
Zn+K+CT (T_8)	6.33cd	14.71e	40.85h	11.92a	6.17d	14.53h	45.19h	12.00a
F_{test}	*	*	*	*	*	*	*	*
Interaction								
A*B	**	**	**		**	**	**	**

**, ** and NS indicate P< 0.05, P< 0.01 and not significant, respectively. In each factor, means designated by the same letter are not significantly different at 5 % level according to Duncan's Multiple Range Test*





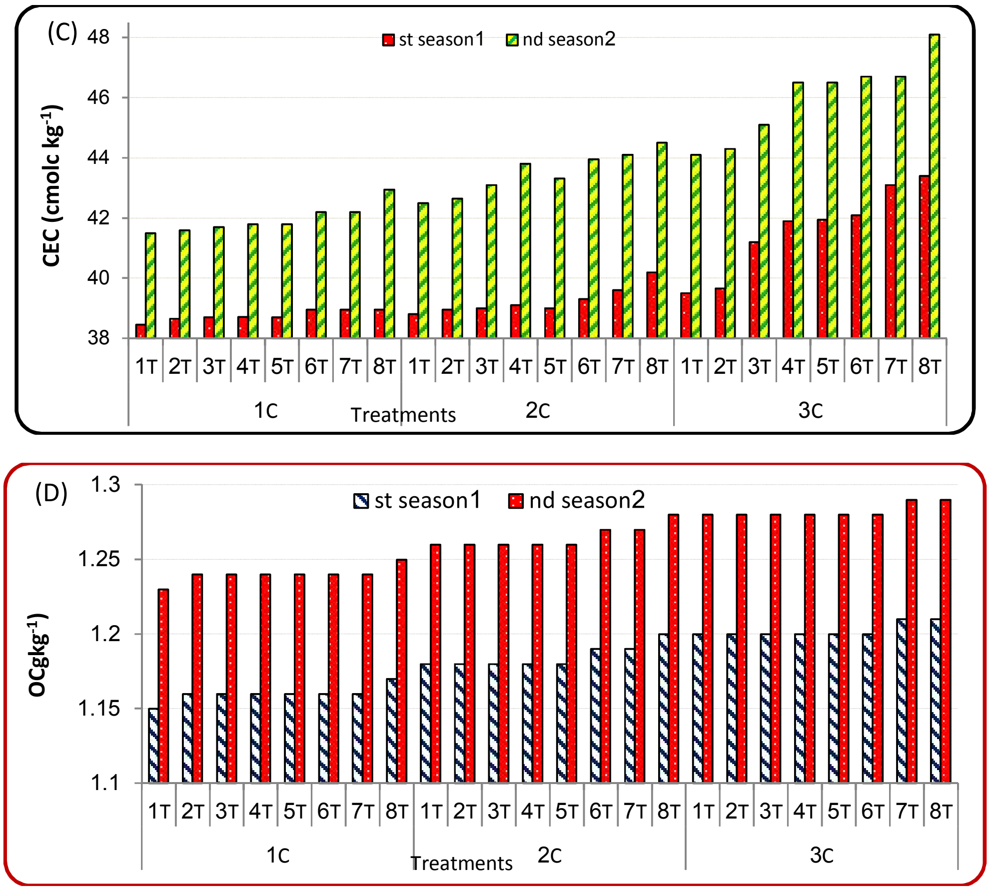


Fig. 1. ECe, dsm^{-1} (A) SAR (B), CEC, cmolc kg^{-1} (C) and organic carbon,gkg^{-1}(D) of the soil for both two seasons

Notce: C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT

Grain, straw yield and 1000 Grain weight were significant increased due to application of compost and foliar of some nutrients and recorded highest values due to interaction between application of compost and foliar of some nutrients (C3*T8).

3.2.1 Nitrogen uptake (kg Fed.$^{-1}$)

Data in Table (4) showed that nitrogen uptake were significant increased with compost application and recorded highest values up to C3, (6MgFed.$^{-1}$) (46.81 and 55.05 kg Fed.$^{-1}$) for both of rice and wheat. This results are supported by (13). Also the same data cleared that the nitrogen uptakeof rice and wheat were significant increased with foliar application of zinc (Zn), mono potassium phosphate (PK), compost tea (CT), Zn+PK, Zn+CT, PK+CT and Zn+PK+CT. Where the highest values (47.09 and 31.54kg Fed.$^{-1}$) for rice and wheat, was obtained due to combination between Zn+PK+CT treatments. With regared to the interaction effect of compost application and foliar some nutrients application, nitrogen uptake of rice and wheat were signficant increased due to the interaction between the treatments.where the highest values of N-uptake (54.54 and 58.94 kg Fed.$^{-1}$) Was obtained due to C3*T8 as shown in (Fig. 2).

This results are supported by [42] observed that foliar spraying of micronutrients may somewhat counteract the negative effect of NaCl on nutrient uptake by improving root growth and preventing disorders and as a result, caused an increase in the uptake of nutrients by the roots.

Table 3. 1000-Seed weight, straw andgrain yield ($MgFed.^{-1}$) of rice as affected by different treatments

Treatments	1000-grain weight (g)	Straw yield	Grain yield	Biological yield
		($MgFed.^{-1}$)		
Rice				
Main treatments (A)				
C1	19.52c	2.88c	2.74c	5.62c
C2	21.21b	3.27b	3.20b	6.53b
C3	22.54a	3.78a	3.50a	7.28a
Ftest	*	**	**	**
Sub-main treatments (B)				
Control (T_1)	19.77h	2.86f	2.75e	5.67f
Zn (T_2)	20.67g	3.08e	2.93d	6.11e
K (T_3)	20.82f	3.31d	3.18d	6.50d
CT (T_4)	21.25e	3.34d	3.19d	6.54d
Zn+ K (T_5)	21.30d	3.36d	3.19d	6.58d
Zn +CT.(T_6)	21.38c	3.41c	3.21c	6.64c
K+CT. (T_7)	21.55b	3.49b	3.34b	6.88b
Zn+K+CT (T_8)	21.98a	3.64a	3.44a	7.08a
Ftest	*	**	**	**
Interaction				
A*B	**	**	**	**
Wheat				
Main treatments (A)				
C1	41.24c	2.53c	2.33c	4.86c
C2	41.49b	2.75b	2.62b	5.37b
C3	42.02a	2.87a	2.68a	5.55a
F_{test}	**	**	**	**
Sub-main treatments (B)				
Control (T_1)	40.07g	2.57d	2.27d	4.84f
Zn (T_2)	41.44f	2.69c	2.55c	5.24e
K (T_3)	41.67e	2.72b	2.56bc	5.28d
CT (T_4)	41.68e	2.74a	2.56bc	5.30c
Zn+ K (T_5)	41.72d	2.75a	2.57bc	5.32c
Zn +CT.(T_6)	41.77c	2.75a	2.58b	5.34b
K+CT. (T_7)	41.96b	2.76a	2.59b	5.35b
Zn+K+CT (T_8)	42.35a	2.76a	2.67a	5.42a
F_{test}	**	**	**	**
Interaction				
A*B	**	**	**	**

**, ** and NS indicated P< 0.05, P< 0.01 and not significant, respectively. In each factor, means designated by the same letter are not significantly different at 5 % level according to Duncan's Multiple Range Test. C_1, C_2 and C_3 represent 2, 4 and 6$MgFed^{-1}$ from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT*

3.2.2 Nitrogen recovery (%)

Table 4 pointed out that nitrogen recovery (%) were significant increased (66.87and 73.4%) for both of rice and wheat with treatment of compost application C3, (6$MgFed.^{-1}$). Also the same data cleared that the nitrogen recovery (%) of rice and wheat were significant increased with foliar application of zinc (Zn), mono potassium phosphate (PK), compost tea (CT), Zn+PK, Zn+CT, PK+CT and Zn+PK+CT.Where the highest values (67.27 and 73.7%) for rice and wheat, was obtained due to combination between Zn+PK+CT treatments. N-recovery of rice and wheat were signficant increased due to the interaction between compost and foliar some nutrients application.where the highest values of N-recovery (77.92 and 78.59%) was obtained due to C3*T8 as shown in (Fig. 3). This results may be due to effect of compost on increasing the CEC and balance of the nutrients release in soil solution hence increses the N-recovery and decrease the nitogen loseses in ground water and environmemt conservation

3.2.3 Nitrogen use efficiency, NUE (kg grain/kgN)

Data in Table 4 and Fig. 4 Cleared that NUE was significant increased (53.27 and 31.79 kg grain/kgN) for rice and wheat by application of compost C3.This results are supported by [10,11].

The same data showed that NUE was significant increased with foliar application of Zn, PK, CT, Zn+PK, Zn+CT, PK+CT and Zn+PK+CT.

Where the highest values (52.33and 55.28%) for rice and wheat, was obtained due to combination between Zn+PK+CT treatments. N-recovery of rice and wheat were signficant increased due to the interaction between compost and foliar some nutrients application.where the highest values of N-recovery (58.5 and 33.8 kg grain/kgN) was obtained due to C3*T8 as shown in (Fig. 4).

3.2.4 Protein content (%)

Protein (%) in grains was significantly affected by application of compost and recorded highest values (7.66and 11.78%) with C3 for rice and wheat (Table 4). Foliar application of Zn, PK, CT, Zn+PK, Zn+CT, PK+CT and Zn+PK+CTwas significant effect on increasing of protein (%),the highest values (7.79 and 11.79%) for grains of rice and wheat were obtained with Zn+K+CT (T8).

The same data showed that protein (%) for grains of rice and wheat were significant increased due to the interaction between treatment of compost and foliar application .Where recorded highest values (8.19 and 12%) for rice and wheat by C3(6MgFed.$^{-1}$) (T8) Zn+K+CTAs shown in (Fig. 5). This results are supported by [21,22].

Table 4. Nitrogen uptake (kg Fed.$^{-1}$), N-recovery (%), NUE(kg grain/kgN) and protein content (%) of rice and wheat

Treatments	Rice				Wheat			
	N-uptake	N-R (%)	NUE*	Protein (%)	N-uptake	N-R (%)	NUE	Protein (%)
Main treatments (A)								
C1	34.40c	49.14c	40.09c	7.10c	47.24c	62.98c	27.02c	11.76b
C2	42.84b	61.21b	48.26b	7.60b	53.22b	70.96b	30.94b	11.76b
C3	46.81a	66.87a	53.27a	7.66a	55.05a	73.40a	31.79a	11.78a
F_{test}	**	**	**	*	**	**	**	*
Sub-main treatments (B)								
Control (T1)	33.86h	48.37h	39.29h	6.94f	26.28h	58.08h	43.56h	11.13e
Zn (T2)	38.16g	54.52g	43.89g	7.35e	30.00g	68.97g	51.73g	11.77d
Potassium (T3)	41.36f	59.08f	47.94f	7.40d	30.07f	69.68f	52.26f	11.81c
Compost tea (T4)	41.79e	59.70e	48.22d	7.44d	30.18e	69.95e	52.46e	11.81c
Zn+ K (T5)	42.39d	60.55d	48.17e	7.56c	30.28d	70.16d	52.62d	11.81c
Zn + CT.(T6)	42.72c	61.03c	48.56c	7.56c	30.43c	71.00c	53.25c	11.90b
K+CT. (T7)	44.84b	64.06b	50.67b	7.65b	30.54b	71.38b	53.53b	11.94b
Zn+K+CT (T8)	47.09a	67.27a	52.33a	7.79a	31.54a	73.70a	55.28a	11.96a
F_{test}	**	**	**	*	*	**	**	*
Interaction A*B	**	**	**	**	**	**	**	*

**, ** and NS indicated P< 0.05, P< 0.01 and not significant, respectively.*
In each factor, means designated by the same letter are not significantly different at 5 % level according to Duncan's Multiple Range Test. C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.
T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT

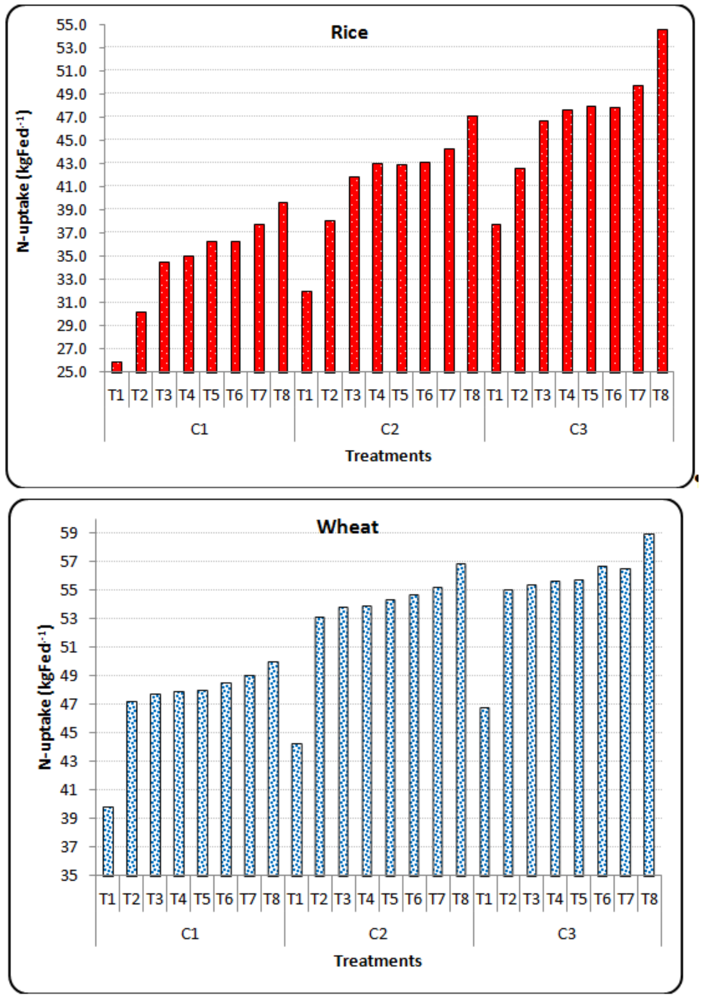
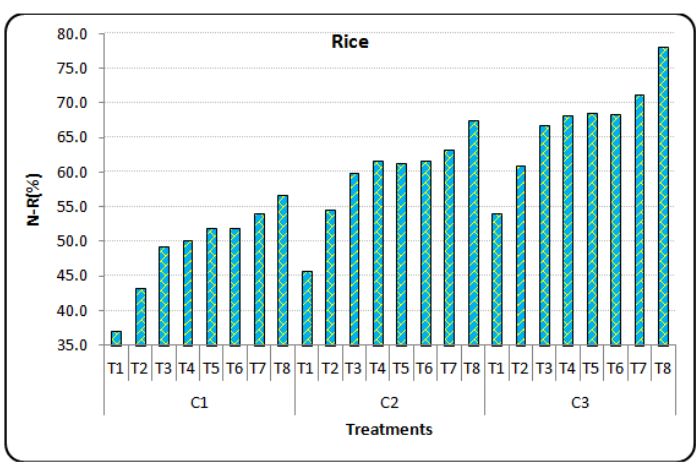


Fig. 2. Total Nitrogen uptake (kgFed.-1) for yield of rice and wheat

Notce: C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT



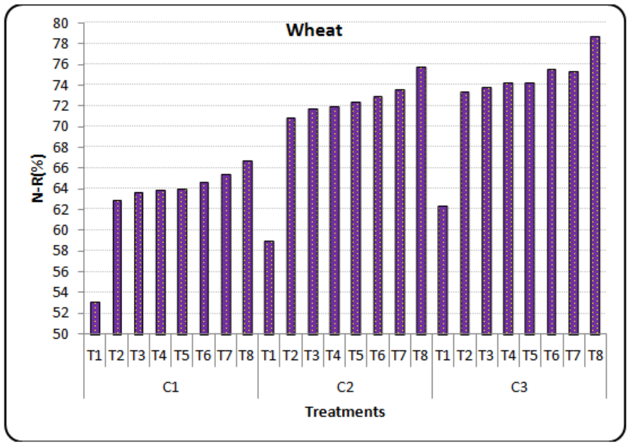


Fig. 3. Nitrogen recovery (%) by yield of rice and wheat

Notce: C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT

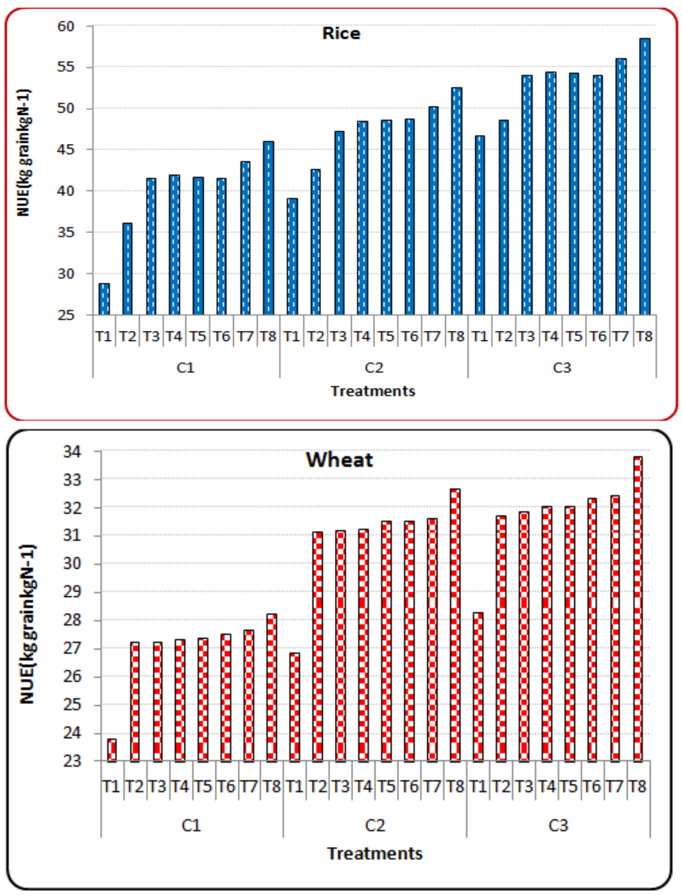
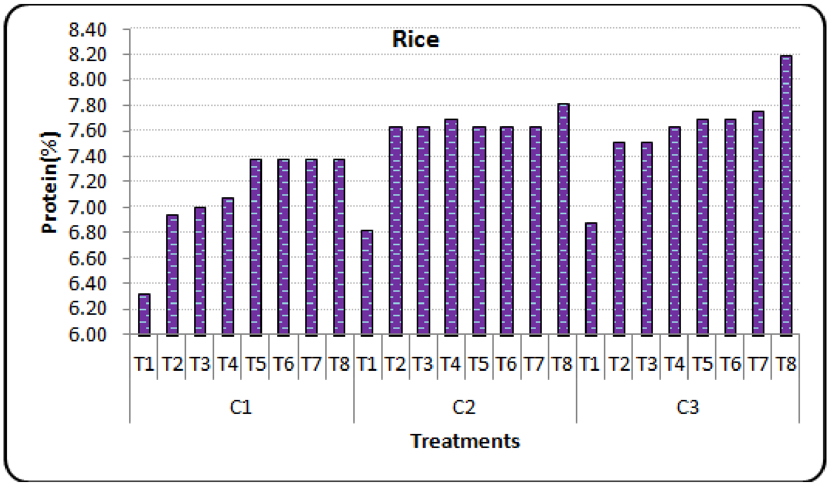


Fig. 4. Nitrogen use efficiency, NUE (kg grain/kgN) by yield of rice and wheat

Notce: C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT



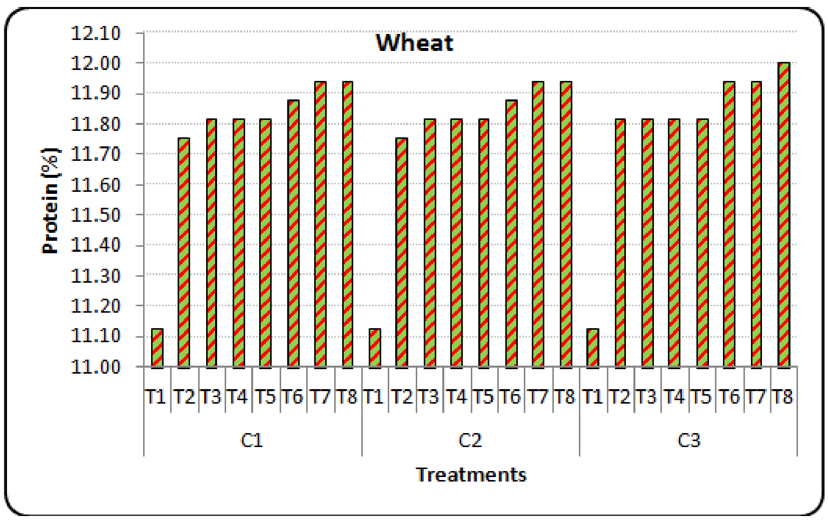


Fig. 5. Crude protein content (%) for grain yield of rice and wheat

Notce: C_1, C_2 and C_3 represent 2, 4 and 6MgFed^{-1} from compost.T_1: without application, T_2:foliar application of zinc, T3: foliar application of potassium, T4: foliar application of compost tea, T5: foliar application of Zn+K, T6: foliar application of Zn+CT, T7: foliar application of K+CT and T8: foliar application of Zn+K+CT

4. CONCLUSIONS

It could be concluded that application of 6MgFed^{-1} from compost and foliar application of zinc, potassium and compost tea was more effective treatment in improving some soil properties such as ECe, SAR, CEC, soil organic carbon and nitrogen uptake and it is use efficiency as well as yield of rice and wheat in salt affected soils.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Gharib H, Hafez E, EL Sabagh A. Optimized potential of utılızatıon efficiency and productivity in wheat by integrated chemical nitrogen fertilization and simulative compounds. Cercetari Agro.in Moldova. 2016;2(166):5-20.
2. Sahin U, Eroglub S, Sahin F. Microbial application with gypsum increases the saturated hydraulic conductivity of saline–sodic soils. Applied Soil Ecology. 2011; 48:247–250.
3. Abdel-Fattah MK. Role of gypsum and compost in reclaiming saline-sodic soils. J.

of Agric. and Veterinary Sci. 2012;1(3):30-38

4. Sharma DP, Rao KV. GK. Strategy for long term use of saline drainage water for irrigation in semi-arid regions. Soil Till. Res. 1998;48:287-295.
5. Amer M, Aiad M, Rashed S, El-Ramady H.Sustainable irrigation and fertilization management of successive cultivated sugar beet and cotton under salt-affected soil conditions. Env. Biodiv. Soil Security. 2019;3:227-239.
6. Mahdy AM. Comparative effects of different soil amendments on amelioration of saline-sodic soils. Soil & Water Res. 2011;6(4):205-216.
7. Day SI, Norton JB, Strom CF,Kelleners TJ, Aboukila EF. Gypsum, langbeinite, sulfur, and compost for reclamation of drastically disturbed calcareous saline–sodic soils. International Journal of Environmental Science and Technology, 2019;16:295–304. Available:https://doi.org/10.1007/s13762-018-1671-5
8. Scheuerell SJ, Mahaffee WF. Compost tea as a container medium drench for suppressing seedling damping-off caused by Pultimum. Phytopathol. 2004;94(11): 1156-1163.
9. Quilty JR, Cattle SR. Use and understanding of organic amendments in Australian agric.: A review. Soil Res. 2011; 49:1–26.
10. Billingham K. Humic products—potential or presumption for agriculture. NSW Department of Primary Industries, Orange, NSW, Australia; 2012.
11. Rose MT, Patti AF, Little KR, Brown AL, Jackson WR, Cavagnaro TR.A meta-analysis and review of plant-growth response to humic substances: practical implications for agric. Advances in Agronomy. 2014;124:38-89. Elsevier Inc.,
12. Mayhew L. Humic substances in biological agriculture. Reprinted from ACRES, A Voice for Eco-Agric. USA. 2004;34:1&2.
13. Chen Y, Aviad T. Effects of Humicsubstance on plant growth. In MacCarthy CE, Clapp RL, MalcolmPR. Bloom (eds.). Humicsubstances in soil and crop sciences: Selected readings. Soil Sci. Society of America, Madison, Wisconsin. 1990;161-186.
14. Chen Y, Clapp CE, Magen H, Cline VW. Stimulation of plant growth by humic substances: Effects on iron availability. In: Ghabbour EA, Davies G. (eds.), Understanding Humic Substances. Advanced Methods, Properties and Applications. Royal Society of Chemistry, Cambridge, UK. 1999;255-263.
15. Ladislav M, Hlisnikovský L, PospíšilováL, Kunzová E. The effect of application of organic manures and mineral fertilizers on the state of soil organic matter and nutrients in the long-term field experiment. J. of Soils and Sediments. 2018;18:2813–2822.
16. Qadir M, Ghafoor A, Murtaza G. Use of saline–sodic waters through phytore-mediation of calcareous saline–sodic soils. Agric. Water Manage. 2001;50:197–210.
17. Walker DJ, Bernal PM. The effects of olive mill waste compost and poultry manure on the availability and plant uptake of nutrients in a highly saline soil. Bioresour. Technol. 2008;99:396–403.
18. Gaffar MO, Ibrahim YM, Wahab DAA. Effect of farmyard manure and sand on the performance of sorghum and sodicity of soils. J. Ind. Soc. Soil Sci. 1992;40:540–543.
19. Pettigrew WT. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. Physiol. Plant. 2008;133:670–681.
20. Lu Z, Lu J, Pan Y, Lu P, Li X, Cong R, Ren T. Anatomical variation of mesophyll conductance under potassium deficiency has a vital role in determining leaf photosynthesis. Plant Cell Environ. 2016; 39:2428–2439.
21. Islam A, Muttaleb A. Effect of potassium fertilization on yield and potassium nutrition of Boro rice in a wetland ecosystem of Bangladesh. Arch. Agron. Soil Sci. 2016; 62:1530–1540.
22. Cheema MA, Wahid MA, Sattar A, Rasul F, Saleem MF. Influence of different levels of potassium on growth, yield and quality of canola (*Brassica napus* L.) cultivars. Pak. J. Agric. Sci. 2012;49:163–168.
23. Hawkesford M, Horst W, Kichey T, Lambers H, Schjoerring J,Skrumsager Moller I, White P. Function of macronutrients. In Marschner's Mineral Nutrition of Higher Plants; Marschner P., Ed.; Academic Press: London, UK. 2012; 135–189.
24. Marschner H, Marschner's. Mineral nutrition of higher plants, 3rd ed.; Academic Press: London, UK. 2012;178–189.

25. Mengel K. Potassium. In handbook of plant nutrition; Barker AV, Pilbeam DJ, Eds. CRC Press: Boca Raton, FL, USA. 2007; 91–120.
26. Garg BC,Gupta IC. Physiology of salt tolerance of arid-zone crops. IV. Rapeseed and Indian mustard, Central Arid Zone Research Institute, Jodhpure. India. Curr. Agric. 1998;22:1-2.
27. Kaya C, Higgs D, Burton A. Phosphorus acid phosphates enzyme activity in leaves of tomato cultivars in relation to Zn supply. Commun. Soil Sci. Plant Anal. 2002;31: 3239–3248.
28. Akram MS, Ashraf M, Shahbaz M, Akram NA. Role of foliar applied potassium from different sources on physio-biochemical attributes of sunflower (*Helianthus annuus* L.) under NaCl stress. J Plant Nutr Soil Sci. 2009;172:88493.
29. Roemheld V,Kirkby E. Research on potassium in agriculture: needs and prospects. Plant Soil. 2010;335:155–180.
30. Kamrani R, Ardalan M, Farahbakhsh M. The interaction Zn application and salinity on the yield and zinc concentration in grain wheat. Int. J. Agro. Plant Prod., 2013;4(8):2075–2080.
31. Sonia RI, Sharma MK, Kumar N, Neelam. Impact of salinity and zinc application on growth, physiological and yield traits in wheat. Current Science. 2009;116(8).
32. Wailare AT, Kesarwani A. Effect of integrated nutrient management on growth and yield parameters of maize (*Zea mays* L.) as well as soil physicochemical properties. Biomed J Sci& Tech Re. 2017; 1(2).
33. Crasswell ET, Godwin DC. The efficiency of nitrogen fertilizers applied to cereals in different climates. Adv. Plant Nutrition. 1984;1:1–55.
34. Page ALR, Miller H, Keeney DR. Methods of soil analysis. Part 2: Chemical and microbiological properties. 2nd Edition.Agronomy Monograph.1982;9. ASA, CSSA, and SSSA, Madison
35. Gee GW, Bauder JW. Particle-size Analysis. In A. L. Page(ed.). Methods of soil analysis, Part1, physical and mineralogical methods. 1986;383–411.
36. Klute A. Methods of soil analysis, Part 1, Physical and Mineralogical properties, Amer., Society, Agronomy, Monograph 9, 2nd ed. Madison, Wisc., USA; 1986.
37. Black CA. Methods of soil analysis. Amer. Soc.Agro. Inc., Madison, Wisconsin, U.S.A; 1965.
38. Horneck DA, Ellsworth JW, Hopkins BG, Sullivan DM, Stevens RG. Managing Salt-affected Soils for Crop Production. A Pacific Northwest Extension publication, Oregon State University; 2007.
39. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed., John Willey and Sons Pub. 1984;139-153.
40. Toumpeli A, Pavlatou-Ve AK, Kostopoulou, SK, Mamolos AP, Siomos AS, Kalburtji KL. Composting phragmitesaustralis cav. plant material and compost effects on soil and tomato (Lycopersiconesculentum Mill.) growth. J. Env. Manag. 2013;128:243–251.
41. Hachicha S, Sellami F, Cegarra J, Hachicha R, Drira N, Medhioub K, Ammar E. Biological activity during co-composting of sludge issued from the OMW evaporation ponds with poultry manure-Physico-chemical characterization of the processed organic matter. J. Hazard. Mater. 2009;162:402–409.
42. El-Fouly MM, Mobarak ZM, Salama ZA, Micro-nutrient foliar application control salination for horticultural prod-uctivity. Acta Hort. 2002;573:377–385.

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