Assessing the Impacts of Compost and Sulphur on Some Soil Quality Indicators and Yield of Maize Grown in Saline Soil

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ABSTRACT: A field experiment was carried out on maize at the Experimental Farm of Faculty of Agriculture (Saba-Bacha), Alexandria University, Egypt, during the summer season of 2017, to evaluate the effects of compost and sulphur amendments on soil quality and maize yield potentials in salt-affected soil. The experiment was run, using split plot design with three replicates. The treatment variables were comprised of 4 compost application rate, including 0, 5.25, 10.5 and 21 kg/plot (0, 2, 4 and 8 ton/fed) and 4 application rates of elemental sulfur, 0, 0.525, 1.05 and 2.10 kg/plot (0, 200, 400 and 800 kg/fed). The results revealed that the soil physical properties were markedly improved in terms of aggregation and infiltration rate, accompanied with a decrease in the soil bulk density. The results detected on the soil chemical properties characteristics showed remarkable reductions on the soil pH, EC and SAR. In the absence of sulphur application, the respective detected values were defined by 8.28, 5.34 dS/m, and 12.11, due to compost applications; the subsequent receded values were actually decreased to 7.60, 4.43 dS/m, and 6.12, when 8 ton/fed compost was combined with 800 kg/fed sulphur. Similarly, the available phosphorus and potassium were increased. The biological soil date revealed remarkable increases in organic matter and active carbon, content, being the highest for the combined treatment of 8 ton/fed compost and 800 kg/fed sulphur, providing 4.86%, 5.92 mg C/kg dry soil, respectively. The date also showed that the highest records of straw and grain yield potentials were defined by 13.68 and 18.7 ton/fed for the combined treatments of 8 ton/fed compost and 800 kg/fed sulphur, respectively, accompanied with marked increases in the harvest index criteria.

Keywords: soil quality, quality indicators, soil salinity, compost, sulphur, maize.

INTRODUCTION

Abiotic stress is the principal cause of crop loss worldwide, reducing yield of major crops by more than 50% (Boyer, 1982). Soil salinity is a major concern to agriculture because it affects almost all plant functions. Millions of hectares throughout the world are too saline to produce economic crops, and more land is becoming non-productive each year due to salinity build up. About 7% of the world’s land area, 20% of the world’s cultivated land and nearly half of the irrigated land are affected by soil salinity (FAO, 2008 and Mali *et al.*, 2015). Salt stress increases the accumulation of toxic ions such as Na and Cl ions in different plant parts, tissues, cells and cell organelles. Accumulation of excess Na and Cl ions causes ionic imbalances that may weaken the selectivity of root membranes and induce potassium deficiency (Gadallah, 1999). Soil amendment with organic materials is a common element of soil fertility managing for crop production, with the aim of providing plant nutrients and improving overall soil physical, chemical, and biological quality (Diacano and Montemurro, 2010). Inorganic amendments commonly used for saline-sodic soil remediation include elemental sulfur, which upon application, dissolve native calcium carbonate in calcareous soils and increase soil Ca ion levels (Vance *et al.*, 2008). Application of S in salt affected soils is a viable procedure to counteract uptake of unnecessary toxic elements (Na and Cl), which encourage selectivity of K/Na and ability of calcium ion to decrease the harmful impacts of sodium ions in plants (Zaman *et al*., 2002). Beneficial effects of sulfur on plant establishment under saline sodic environment had also been reported in maize (Manesh *et al*., 2013). Sulfur not only increase crop production and quality of the produce, but also improves soil conditions for healthy crop growth (El- Tarabily *et al*., 2006).While compost and sulphur have been widely evaluated for agricultural applications, evaluation of both as amendment materials is limited with regard to soil quality. Application of compost or sulphur may uniquely affect soil quality parameters. In this study, the supposed benefits of compost and sulphur amendments for crop growth and production were assessed in a sweet corn (*Zea mays* L.) field experiment, including analysis of soil physical, biological, and chemical properties. An integrated approach to soil quality includes physical, chemical, and biological soil characteristics as indicators of overall soil health and potential for crop production (Gugino *et al*., 2009). In many cases, a change in one soil property affects other soil quality parameters.

In order to evaluate the efficacy of compost and sulphur amendments as a practice with application to saline soil, a field experiment was undertaken to compare the effects of compost amendment on the yield of sweet corn and soil quality in comparison to use of sulphur was conducted. The primary objectives of this study were to evaluate the combined effect of compost and sulphur on some soil quality indicators and the grain yield potenials of sweet corn grown under saline soil conditions.

MATERIALS AND METHODS

A field experiment was conducted during the growing season of 2017. The initial soil characteristics were carried according to (Jackson, 1973) and the data including physical, biological, and chemical properties were presented in Table (1). According to the EC , SAR and pH values , the soil was moderate saline. Corn crop yield was considered an indicator of soil quality with the assumption that a high soil quality would result in a higher crop yield. In this experiment, each plot consisted of 5 ridges, each 3.5 m in length and 60 cm in width, occupying an area of 10.5 m^2 (1/400 fed) with a distance of 30 cm between hills.

The soil was plowed and processed for agricultural operations and divided into 48 plots. The treatment variables were comprise of 4 compost application rates, including 0, 5.25, 10.5 and 21 kg/plot (0, 2, 4 and 8 ton/fed) and 4 application rat of elemental sulfur, 0, 0.525, 1.05 and 2.10 kg/plot (0, 200, 400 and 800 kg/fed). The compost was produced by the Egyptian Dutch Company in Egypt and analyzed for chemical properties, according to the methods described by (FCQAO, 1994) as shown in Table (2). The elemental sulfur was produced in fine powder with purity ratio of 98%, in Kafr El Zayat Company for pesticides and chemicals.

In 21th May maize kernels were seeded by hand in the soil ridges to a depth of 2.5 cm at a rate of ~2-4 seeds in each hole. The Gesaprim herbicide 80% was used to fight weeds. Nitrogen fertilizer at the rate of 47 kg N /fed was added as urea in three equal doses after 15, 30, and 45 days after sowing. Phosphorus fertilizer, as calcium superphosphate 15.5% P_2O_5, at the rate of 32 kg P_2O_5/fed and potassium sulphate 48% K_2O at the rate of 25 kg K_2O/fed were applied during seed ped preparation.

The normal agronomic practices of growing maize were practiced till harvest. Irrigation water was applied in adequate amounts, as needed and whenever necessary, depending on the moisture content of the soil and during the critical stages of crop growth. The experimental design was complete split plot design with three replicates. At the harvest (1/9/2017), grain, straw and Biological yields were recorded (Gain yield + straw yield) and the harvest index was calculated, using the following formula:

$$\text{Harvest index} = \frac{\text{Gain yield}}{\text{Biological yield}} \times 100$$

At the end, soil samples were collected from each plot for physical, chemical and biological analysis as follows:

- Particle-size distribution: The percentages of sand, silt and clay particles in the soil sample were determined mechanically using the hydrometer method (Gee and Bauder, 1986)

- Aggregation: The value of aggregation was determined according to the dry sieving method (Le Bissonnais and Le Souder, 1995).

- Bulk density: Bulk density was measured according to the weight of soil and the volume of packed column (Grossman and Reinsch, 2002).

Table (1). Initial soil physical, chemical and biological properties

Parameters	Values
Particle size distribution	
Sand%	32.96
Silt %	20.40
Clay%	46.64
Textural grade	Clay
Aggregation, MWD* mm	0.62
Infiltration rate, mm/h	14.13
bulk density, g/cm^3	1.28
pH(1: 2 soil: water ratio	8.29
(EC_e) (dS/m) Saturated paste	5.94
Sodium Adsorption Ratio (SAR)	12.03
$CaCO_3$, %	8.47
Soluble cations, meq/l	
Ca^{+2}	8.53
Mg^{+2}	9.86
Na^+	36.47
K^+	0.45
Soluble Anions, meq/l	
HCO_3^-	8.30
Cl^-	37.43
SO_4^{-2}	9.43
Available K, mg/kg soil	236.00
Available P, mg/kg soil	8.09
NO_3^- concentration, mg/kg soil	16.52
Organic matter,%	1.05
Active carbon, mg C/kg dry soil	3.60

*MWD= The mean weight diameter

Table (2). The main chemical properties of compost

Properties	Values
pH (1:10)	7.57
EC (1:10, water extract), dS/m	2.84
Soluble cations (1:10), meq/l	
Ca^{+2}	4.1
Mg^{+2}	2.5
Na^+	5.3
K^+	8.2
Soluble anions (1:10), meq/l	
HCO_3^-	3.8
Cl^-	6.4
SO_4^{-2}	9.6
Total nitrogen, %	1.23
Total phosphorus, %	0.53
Organic matter, %	53.0
Organic carbon, %	30.74
C/N	25:1
Available micronutrients, mg/kg	
Copper	27.24
Manganese	243.5
Iron	487.71
Zinc	77.78
Nickel	0.60

- Infiltration rate: It was estimated by the single ring Infiltrometer Method as described in the Soil Quality Test Kit Guid (Lowery *et al*., 1996).

- Soil pH: Soil reaction was determined in (1:2) soil: water suspension using a glass electrode (AD 8000 pH/ mV/ EC/ TDS & Temperature Meter) as mentioned by (Jackson, 1967).

- Electrical conductivity (EC): The (E.C.) was measured in (1:2) soil: water by using an electrical conductivity meter according to (Jackson, 1967).

-Available phosphorus: Available phosphorus was extracted with 0.5 M $NaHCO_3$ solution adjusted to pH 8.5 according to (Olsen *et al*., 1954). Five ml of clear filtrate was taken in 100 ml volumetric flask and then added 5 ml color developing regent ascorbic acid molybdenum blue method and reading was recorded on spectrometer (model SpectrAA-200) using 880 nm wave length (Jackson, 1967).

- Available potassium: The extraction was done by ammonium acetate (1 N of pH 7.0) and potassium was determined according to (Jackson, 1967) by Jenway PFP-7 flame photometer.

- Sodium adsorption ratio (SAR): The formula for calculating the sodium adsorption ratio (SAR) was according to (Richards, 1954) as follows:

$$SAR = \frac{Na^{+}}{\sqrt{1/2(Ca^{+2} + Mg^{+2})}}$$

where sodium, calcium, and magnesium concentrations are expressed in meq/l.

- Organic matter content: It was determined according to Walkely and Black method as described by Allison (1965).

- Active carbon content: Active C represents the fraction of soil C oxidizable by $KMnO_4$ was determined according to (Gugino *et al*., 2009).

The data were statistically analyzed as a split-plot design, using CoStat program, according to (Snedecor and Cochran, 1990).Considering the compost rates as the main plots and sulfur rates as the sub-plots. The data were subjected to the analysis of variance (ANOVA) and the least significant differences LSD at 0.05 was used to compare the treatment means.

RESULTS AND DISCUSSION

Effect on soil physical indicators

The results in Tables (3 and 4) present the main effects of compost and sulphur and their interaction respectively for the aggregate stability, infiltration rate and bulk density. The data in Table (3) showed a significant increase in soil aggregation from 0.66 mm to a maximum of 1.16 mm with increasing rate of compost from zero (control) to 1.16 mm at 8 ton/fed. The same trend was observed for sulphur where as the aggregation values were increased from 0.84 mm at zero level of sulphur to 0.93 mm at 800 kg/fed. In general, the compost is more effective than sulphur at the three higher levels. Regarding the interaction effect between compost and sulphur (Table 4), the treatment of compost (8 ton/fed) and sulphur (800 kg/fed) was more superiors and gave the higher value (1.21 mm) than the corresponding values of the main effect of compost at (8 ton/fed) or sulphur at (800 kg/fed). The stability value exerted marked change from unstable to medium stability (Table 5).

The increase in the aggregation of soil with compost addition could be ascribed to the role of organic matter in the formation of soluble substances when dissolved by microbiological activity and the release of organic acids, acted well to increase the aggregates stability (Assefa *et al*., 2004). In addition, the increased biological activity and their release of soil agglutinants such as exo-polysaccharides, was promotive contributed to the increase of soil aggregation(Roberson *et al*., 1995). Increased aggregation has been also demonstrated by (Tejada and Gonzales, 2008; Adamtey *et al*., 2010) upon addition of plant residue compost as well as chicken manure to soils in arid regions.

The data in Table (3) showed a significant increase in soil infiltration rate from 14.68 mm/h at control to 21.87 mm/h at 8 ton/Fed. The same trend was observed for sulphur where as the infiltration rate values were increased from 17.17 at control to 18.99 at 800 kg/Fed. Also, compost was more primitive than sulphur at the higher levels. Regarding the interaction effect between compost and sulphur (Table 4), the treatment of compost (8 ton/fed) and sulphur (800 kg/fed.) gave the higher value (22.82 mm/h) than the corresponding values of the main effect of compost at (8 ton/fed) or sulphur at (800 kg/fed). The results given in Table (3) indicated a moderately slow infiltration rate (14.13 mm/h) based on the Table (6) adapted from soil quality kit test guide (USDA-ARS, 1998). This finding supports the views of other scientists, who reported beneficial effects of organic matter in improving the soil physical properties and crop yield on sustainable basis (Mbah *et al*., 2004; Mbah and Mbagwu, 2006).

On the other hand the results in Table (3) showed a decrease in the bulk density from 1.26 g/cm^3 at control to 1.11 g/cm^3 at 8 ton/Fed. for compost and from 1.20 g/cm^3 at control and 1.16 g/cm^3 at 800 kg/fed. for sulphur in comparison to the initial soil status (Table 1). Regarding the interaction effect between compost and sulphur (Table 4), the treatment of compost (8 ton/fed) and sulphur (800 kg/fed.) gave the lower value (1.09 g/cm^3) which is ideal for plant growth (Table 7) than the single application of compost at (8 ton/fed) or sulphur at (800 kg/fed). The reduced bulk density might be inferred to the increased soil pores and soil aeration, higher soil organic carbon content, and better soil aggregation which improved soil porosity and water holding capacity as well (Gangwar *et al*., 2006). These results are in agreement with those obtained by (Wang *et al*., 2014).

Table (3). The main effect of compost and sulphur rates on aggregate stability, infiltration rate and bulk density of soil

Treatments	Aggregation, MWD (mm)	Infiltration rate (mm/h)	Bulk density (g/cm$^{3)}$
Compost rates (ton/fed)			
0	0.66	14.68	1.257
2	0.80	16.63	1.206
4	0.93	19.14	1.157
8	1.16	21.87	1.110
LSD$_{0.05}$	0.02	0.032	0.004
Sulphur rates (kg/fed)			
0	0.84	17.17	1.202
200	0.87	17.71	1.160
400	0.91	18.46	1.176
800	0.93	18.99	1.162
LSD$_{0.05}$	0.01	0.016	0.003

Table (4). Interaction effect between compost and sulphur rates on aggregate stability, infiltration rate and bulk density of soil

Treatments		Aggregation, MWD (mm)	Infiltration rate (mm/h)	Bulk density (g/cm$^{3)}$
Compost rates (ton/fed)	Sulphur rates (kg/fed)			
0	0	0.62	14.21	1.279
	200	0.64	14.41	1.266
	400	0.67	14.94	1.245
	800	0.70	15.33	1.236
2	0	0.75	15.84	1.226
	200	0.78	16.46	1.215
	400	0.83	16.94	1.199
	800	0.85	17.50	1.184
4	0	0.89	17.86	1.175
	200	0.92	18.56	1.164
	400	0.94	19.93	1.154
	800	0.96	20.41	1.134
8	0	1.10	20.94	1.126
	200	1.14	21.64	1.115
	400	1.18	22.29	1.105
	800	1.21	22.82	1.094
Statistical LSD 0.05				
Compost x sulphur		4.88	0.55	1.172

Table (5). The classes of stability and crust ability according to MWD values (Le Bissonnais and Le Souder, 1995)

Class	Value(mm)	Stability	Crust ability
1	<0.4	Very unstable	Systematic crust formation
2	0.4-0.8	Unstable	Crusting frequent
3	0.8-1.3	Medium stable	Crusting moderate
4	1.3-2.0	Stable	Crusting rare
5	>2.0	Very stable	No crusting

Table (6). The infiltration rate in mm per hour and inches per hour and the associated infiltration class (USDA-ARS, 1998)

Infiltration rate (mm per hour)	Infiltration rate (inches per hour)	Infiltration class
>508	> 20	Very rapid
152 to 508	6 to 20	Rapid
51 to 152	2 to 6	Moderately rapid
15 to 51	0.6 to 2	Moderate
5.1 to 15	0.2 to 0.6	Moderately slow
1.5 to 5.1	0.06 to 0.2	Slow
0.04 to 1.5	0.0015 to 0.06	Very slow
<0.04	< 0.0015	Impermeable

Table (7). General relationship of soil bulk density to root growth based on soil (Arshad *et al.*, 1996)

Soil Texture	Ideal bulk densities for plant growth (g/cm^3)	Bulk densities that restrict root growth (g/cm^3)
Sandy	< 1.60	> 1.80
Silty	< 1.40	> 1.65
Clayey	< 1.10	> 1.47

Effect on soil chemical indicators

The post-harvest soil results, Tables (8 and 9) indicated significant ($P<0.05$) differences on pH, EC and SAR, due to the compost and sulphur rates and also to their interactions. The data demonstrated that the lowest mean values of pH, EC, SAR in soil was noted in the treatment of combined rates compost (8 ton/fed) and sulphur (800 kg/fed). The results showed a gradual decrease in pH values from (8.30) at control to (7.60) at the treatment of compost (8 ton/fed) and sulphur (800 kg/fed), due to oxidation of sulphur to sulphuric acid, as well as the decomposition of organic matter and the release of organic acids that reduce the pH too. The results showed also, a decrease in the electrical conductivity (EC) from (5.3 dS/m) at control to (4.4dS/m). The same trend was observed for SAR values, being 12.11 at control to 6.12 at the treatment of compost (8 ton/fed) and sulphur (800 kg/fed). The decrease in soil SAR could be interpreted to decrement of Na^+ concentration in soil solution relative to the Ca^{+2} and Mg^{+2} concentrations. The pre planting soil values were 8.29 for pH, 5.94 for EC, and 12.03 for SAR (Table1).

These results are concurred with those reported by (Shaaban *et al*. 2013) and (Tazeh *et al*., 2013), who also confirmed significant reductions in SAR after leaching soils amended with gypsum and organic amendments. Soil EC_e values tends to decrease probably due to the occurrence of the charged sites (COO–), accounts for the ability of humate to chelate, and retains cation in non-active forms (Semida *et al*., 2014; Ouni *et al*., 2014).

Table (8).The main effect of compost and sulphur rates on pH, EC, sodium adsorption ratio (SAR), available K and available P of soil

Treatments	pH (1: 2)	EC (1: 2) (dS/m)	SAR	Available K (mg/kg)	Available P (mg/kg)
Compost rates (ton/fed)					
0	8.25	5.26	11.84	262.96	11.04
2	8.13	5.00	10.47	324.58	16.63
4	7.90	4.75	8.77	392.08	23.68
8	7.70	4.50	6.74	456.75	32.15
$LSD_{0.05}$	0.03	0.04	0.05	5.57	0.26
Sulphur rates (kg/fed)					
0	8.04	4.96	9.97	339.08	18.37
200	8.01	4.91	9.64	349.09	19.84
400	7.98	4.85	9.21	366.13	21.83
800	7.94	4.79	8.99	382.08	23.46
$LSD_{0.05}$	0.01	0.01	0.04	2.59	0.05

Table (9). Interaction effect between compost and sulphur rates on pH, EC, Sodium adsorption ratio (SAR), available K and available P of soil

Treatments						
Compost rates (ton/fed)	Sulphur rates (kg/fed)	pH(1: 2)	EC (1: 2) (dS/m)	SAR	Available K (mg/kg)	Available P (mg/kg)
0	0	8.28	5.34	12.11	250.83	9.43
	200	8.26	5.30	11.89	255.5	10.37
	400	8.24	5.23	11.75	268.0	11.65
	800	8.22	5.17	11.61	277.5	12.7
2	0	8.17	5.09	11.06	303.17	14.67
	200	8.14	5.05	10.77	314.83	15.82
	400	8.12	4.96	10.13	331.0	17.21
	800	8.08	4.89	9.91	349.33	18.82
4	0	7.94	4.83	9.23	371.33	20.75
	200	7.92	4.78	8.97	381.83	22.45
	400	7.89	4.72	8.51	401.83	24.78
	800	7.86	4.65	8.35	413.33	26.72
8	0	7.76	4.58	7.49	431.0	28.62
	200	7.73	4.52	6.91	444.17	30.72
	400	7.69	4.48	6.46	463.67	33.65
	800	7.60	4.43	6.12	488.17	35.62
Statistical LSD 0.05						
Compost x sulphur		3.50	2.08	0.09	5.18	1.79

The data in Tables (8 and 9) showed that the available phosphorus and potassium was significantly affected by the various treatments. The maximum available P and K were noted in the treatment of compost (8 ton/fed) and sulphur (800 kg/fed) (488.17, 52.28 mg/kg) respectively. The minimum available of P and K were registered at the control treatment (Table 1). These observations are agreed quite with previous studies (Sommer *et al*., 2011; Ding *et al*., 2016). The obtained results in Table 1 or in Tables 8 and 9 could be evaluated according to the given categories in Table (10) for P and Table (11) for K.

Table (10). Phosphorus (P) soil test categories (Marx *et al*., 1996)

P, ppm	Classification
<5	Deficient
5-10	Low
10-25	Moderate
25-50	Sufficient
>50	Excessive

Table (11). Extractable potassium (K) soil test categories (Marx *et al*., 1996)

K, ppm*	Classification
<150	Low
150-250	Moderate
250-800	Sufficient
>800	Excessive

* Detected by ammonium acetate or sodium bicarbonate extraction method.

The biological properties

With regard the effects of compost and sulphur rates on organic matter and active carbon content in soil, the results in Tables (12, 13) showed that, relative to the initial soil status (Table 1), significant increase in organic matter and active carbon contents, due the increases of compost and sulphur applications. The highest values were detected when 8 ton/fed was combined with 800 kg/fed sulphur, yielding 4.86%, 5.92 mg C/kg dry soil, respectively. On the other hand the lowest values were recorded with the control treatment (without fertilization).

A repeatable, easy-to-use method for estimating active carbon will be helpful in assessing soil quality only to the extent that the C fraction measured is sensitive to changes in soil quality and allows the investigator to detect these changes consistently. Furthermore, to be meaningful as an estimate of the size of the active C pool, the results of the proposed method should exhibit significant relationships with soil microbial processes and other soil-quality indicators. Here we present data to show that the proposed method is both more sensitive to management-induced soil changes and more closely related to biologically mediated soil properties than are other measures of soil C, including total soil organic C and C oxidizable by the 0.333 M $KMnO_4$ method of (Blair *et al*., 1995).

Table(12).The main effect of compost and sulphur rates on organic matter and active carbon contents of soil

Treatments	Organic matter, (%)	Active carbon, (mg C/kg dry soil)
Compost rates (ton/fed)		
0	1.26	3.83
2	2.71	4.39
4	4.00	4.98
8	4.78	5.68
$LSD_{0.05}$	0.05	0.02
Sulphur rates (kg/fed)		
0	3.10	4.51
200	3.17	4.66
400	3.22	4.78
800	3.27	4.93
$LSD_{0.05}$	0.01	0.02

Table(13). Interaction effect between compost and sulphur rates on organic matter and active carbon contents of soil

Treatments		Organic matter, (%)	Active carbon, (mg C/kg dry soil)
Compost rates, (ton/fed)	Sulphur rates, (kg/fed)		
0	0	1.16	3.64
	200	1.25	3.77
	400	1.29	3.90
	800	1.35	4.02
2	0	2.62	4.25
	200	2.69	4.34
	400	2.74	4.43
	800	2.79	4.54
4	0	3.93	4.71
	200	3.98	4.87
	400	4.03	5.07
	800	4.08	5.26
8	0	4.71	5.44
	200	4.75	5.66
	400	4.81	5.72
	800	4.86	5.92
Statistical LSD 0.05			
Compost x sulphur		1.88	4.95

Effect on yield characteristics

The effect of compost and sulphur rates on yield and yield characters of hybrid maize are presented in Tables (14 and15). The results showed an increase in grain yield, straw yield, biological yield from (2.25, 7.35, 9.61) at control to (5.02, 13.68, 18.7) (ton/fed), respectively at the treatments of compost (8 ton/fed) and sulphur (800 kg/fed).

Table (14).The main effect of compost and sulphur rates on grain yield, straw yield, biological yield and harvest index of corn plant

Treatments	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index (%)
		Compost rates (ton/fed)		
0	2.39	7.67	10.06	23.78
2	2.85	8.68	11.53	24.72
4	3.45	9.98	13.44	25.68
8	4.57	12.64	17.21	26.54
$LSD_{0.05}$	0.08	0.19	0.26	.29
		Sulphur rates (kg/fed)		
0	3.08	9.21	12.29	24.85
200	3.23	9.57	12.80	25.01
400	3.38	9.87	13.24	25.29
800	3.58	10.33	13.91	25.51
$LSD_{0.05}$	0.06	0.19	0.25	0.10

Table(15).Interaction effect between compost and sulphur rates on grain yield, straw yield, biological yield and harvest index of maize

Treatments					
Compost rates (ton/fed)	Sulphur rates (kg/fed)	Grain yield (ton/fed)	Straw yield (ton/fed)	Biological yield (ton/fed)	Harvest index (%)
0	0	2.25	7.35	9.61	23.45
	200	2.36	7.58	9.94	23.75
	400	2.42	7.71	10.13	23.91
	800	2.54	8.04	10.58	24
2	0	2.66	8.29	10.96	24.28
	200	2.79	8.6	11.40	24.54
	400	2.89	8.72	11.61	24.88
	800	3.06	9.10	12.16	25.16
4	0	3.26	9.58	12.83	25.38
	200	3.36	9.8	13.17	25.54
	400	3.49	10.06	13.55	25.78
	800	3.7	10.51	14.21	26.03
8	0	4.14	11.61	15.75	26.27
	200	4.42	12.29	16.71	26.43
	400	4.70	12.96	17.66	26.61
	800	5.02	13.68	18.7	26.84
		Statistical LSD 0.05			
Compost*sulphur		0.13	0.37	0.50	0.20

The harvest index is commonly used to relate the grain to biological yield, and this term gives an indication to the efficiency of yield potentials. The data recorded in Tables (14and15) showed that, relative to the control treatment, the maximum harvest index percentage of maize was recorded with 8 ton/fed compost plus 800 kg/fed sulphur, giving 26.84%. Sulphur encourages photosynthetic activity by increasing chlorophyll pigments, synthesis of essential amino acids and proteins, translocation and utilization of starch and nitrogen, acting for increasing grain yield potentials. Application of sulphur improves yield of crop (Tandon and Messick., 2002). The increment of the grain yield may be attributed to the increases in the phosphorus availability with adding organic matter to the soil that improves the biological, physical and chemical soil properties which enhance plant growth and soil productivity (Zhao *et al*., 2009). Baloach *et al*. (2014) stated that significantly higher grain yield accumulation in maize was observed using organic fertilization.

In general, it was found that the tested soil quality indicators were improved gradually by the combined application of compost and sulphur as compared to the control and the best results were obtained with compost (8 ton/fed) and sulfur (800 kg /fed). Accordingly, the application of compost and sulphur with the suitable rates to saline soil were operative to improve the physical, chemical and biological soil properties, and yield criteria.

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الملخص العربي

تقييم تأثيرات الكمبوست والكبريت على بعض مؤشرات جودة التربة ومحصول الذرة المنزرعة في تربة ملحية

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تم إجراء تجربة ميدانية على الذرة في المزرعة التجريبية بكلية الزراعة (سابا باشا)، جامعة الإسكندرية، مصر، خلال موسم الصيف ٢٠١٧، لتقييم آثار اضافة الكمبوست والكبريت على جودة التربة ومحصول الذرة في التربة المتأثرة بالأملاح. تم اجراء التجربة باستخدام تصميم القطع المنشقة بثلاثة مكررات. وكانت المحسنات المستخدمة مكونة من ٤ معاملات للكمبوست، وهي ٠ ، ٥.٢٥ ، ١٠.٥ و ٢١ كجم/شريحة (٠ ، ٢ ، ٤ و ٨ طن/ فدان) و ٤ معاملات للكبريت، ٠ ، ٠.٥٢٥ ، ١.٠٥ و ٢.١٠ كجم/شريحة (٠ ، ٢٠٠ ، ٤٠٠ و ٨٠٠ كجم/فدان).

أظهرت النتائج أن الخواص الفيزيائية للتربة قد تحسنت بشكل ملحوظ من حيث التحبب ومعدل الرشح، مع انخفاض في الكثافة الظاهرية للتربة. كما أظهرت النتائج انخفاض في قيم الخواص الكيميائية للتربة انخفاضًا ملحوظًا. فكانت قيم درجة حموضة التربة والتوصيل الكهربي (EC) وSAR، المتحصل عليها هي ٨.٢٨ و ٥.٣٤ ديسيسيمنز/متر و ١٢.١١ على التوالي عند الكنترول؛ وانخفضت القيم فعليًا إلى ٧.٦٠ و٤.٤٣ ديسيسيمنز/متر و ٦.١٢، عند معاملة الكمبوست ٨ طن/فدان و ٨٠٠ كجم/فدان كبريت, ويرجع سبب الانخفاض لإضافة الكمبوست. وبالمثل، زاد الفسفور والبوتاسيوم المتاح. وكشفت النتائج زيادة الخصائص البيولوجية بشكل ملحوظ من المادة العضوية ومحتوى الكربون النشط، وكانت أعلى القيم المتحصل عليها من الكمبوست ٨ طن/فدان و ٨٠٠ كجم/فدان كبريت ، هي ٤.٨٦٪، ٥.٩٢ مليجرام/ كجم من التربة الجافة، على التوالي. كما أظهرت النتائج أيضًا أن أعلى القيم لمحصول القش والحبوب هي ١٣.٦٨ و ١٨.٧ طن/فدان عند المعدلات من ٨ طن/فدان كمبوست و ٨٠٠ كجم/فدان كبريت، على التوالي، وأيضاً زيادة ملحوظة في مؤشر الحصاد.