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EFFECT OF COMPOST ON PROPERTIES AND SELECTIVITY COEFFICIENT OF SALT AFFECTED SOILS I. ON pH, EC AND SOLUBLE CATIONS AND ANIONS

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ABSTRACT: ***This study was carried out in Soil. Sci. Dept. Faculty of Agriculture, Menoufia University, Egypt during years of 2016 and 2017 on two salt affected soils of El-Hamoul area, Kafr El-Sheikh Governorate, North Nile, Delta, Egypt. This was to study the effect of added compost with different rates and incubation period on the chemical properties of these soils. The applied compost rates were 0, 1, 2 and 3%. The incubation periods were 0, 3 and 6 months at the room temperature. The studied soil properties were pH, EC, the content of soluble cations (Na^+, Ca^{2+}, Mg^{2+} and K^+), soluble anions (Cl^-, CO_3^{2-}, HCO_3^- and SO_4^{2-}).***

The results indicated that, the increasing rates of added compost as well as incubation periods resulted in a decrease in soil pH, soluble Na^+ and Cl^-. Whereas, these led to an increase in EC. In general, compost application improved the chemical properties of the studied salt affected soil.

Key words: ***Salt affected soils, Compost, Incubation, Soil properties.***

INTRODUCTION

Salt-affected soils are soils with high concentrations of dissolved mineral salts in their profiles. Such these dissolved salts adversely affect crop production (Rengasamy, 2006 and Wong *et al.,* 2010). According to FAO (2016), Egypt's climate is characterized by a hot dry summer and mild winter, high evaporation rates between 1500 to 2400 mm per year and very low rainfall between 5 to 200mm per year (Negm, 2017). The beneficial effects of composts on salt affected soil properties depend on soil texture and moisture conditions, as well as on the origin of organic matter. In saline soil, Na^+ constitutes a highly dispersive agent resulting directly in the breakup of aggregates.

The application of organic matter in salt affected soil promotes flocculation of clay minerals, which is an essential condition for the aggregation of soil particles and play an important role in control of erosion. It is well known that, the increase of salinity in soil limits its fertility. In fact, most salt-affected soils are deficient in nitrogen (N), phosphorus (P), and potassium (K).

The objective of the present study was to study the effect of compost as a soil conditioner and incubation periods on some chemical properties for two salt affected soils in Egypt.

MATERIALS AND METHODS

1. Materials

a- Soil sampling

Two salt affected soil samples were collected from two different locations of EL-Hamoul area Kafr El-Sheikh governorate, north Nile Delta, Egypt. These soils varied in their physical and chemical properties especially the content of total soluble salts (electrical conductivity) "EC" and exchangeable sodium percentage "ESP". The first soil was located at 31 18 12.6 N and 31 03 28. 5 E and cultivated with clover.

The second one was located at 31 18 59.1 N and 31 03 28.8 E, and uncultivated but having grass like blink, shrew and throat. Irrigation water source having Ec_w value of 0.8dS/m was from El-Zawya canal Samples were collected from the surface (0 - 20 cm) of each soil, air – dried ground and sieved through a 2 mm sieve. Then the fine fraction (<2 mm) was analyzed for some physical and chemical properties according to Cottenie *et al.* (1982). The obtained data are recorded in Table (1).

b- Compost

The used compost was produced from the mixture of maize stalks and farmyard manure at ratio of 65:35. Compost was, air dried ground and analyzed for some physical and chemical properties according to the methods described by Page *et al.* (1982). The obtained data is recorded in Table (2).

Table1: Main properties of the used two soils

Properties and units	Soil number	
	SAS1	SAS2
Particles size distribution (%)		
Coarse sand	8	4
Fine sand	12	4
Silt	40	12
Clay	40	80
Texture grade	Clay loam	Clay
pH (1:2.5) soil water suspension	8.52	8.53
EC (dSm^{-1}) Soil paste extraction	3.28	22.93
Soluble Cations (meq/l) Soil paste ext.		
Na^+	9.80	136.8
K^+	0.68	6.52
Ca^{2+}	6.48	40.9
Mg^{2+}	8.50	45.8
Soluble anions (meq/l) Soil paste ext.		
Co_3^{2-}	0	0
HCo_3^-	8.63	31.85
Cl^-	10.52	145.1
SO_4^{2-}	5.44	53.18
Organic matter "O.M" (%)	1.36	0.35
CEC (c.mole/kg)	35.53	46.5
Exchangeable cations (c.mole/kg)		
Na	9.58	15.5
K	3.26	2.95
Ca	8.88	11.88
Mg	11.63	13.40
ESP (%)	26.92	33.48

Table (2): Some physical and chemical properties of the compost and its content of nutrients.

Properties and units		Values
EC (dSm^{-1}) (1:10) compost:water		10.5
pH (1:10) compost water extract		8.6
C/N ratio		12.9
OC(%)		35
OM %		60.3
BD gcm-3		0.35
Moisture %		11.8
Ash %		42
WHC %		160
Total macronutrient	N%	2.7
	P%	1.88
	K ($mg\ kg^{-1}$)	950.5
Total micronutrient ($mg\ kg^{-1}$)	Fe	320
	Mn	65
	Zn	50
Soluble cations (meq/l) Soil paste ext.		
	Na^+	28.3
	K^+	6.64
	Ca^{2+}	23.9
	Mg^{2+}	30.5
Soluble anions (meq/l) Soil paste ext.		
	Co_3^{2-}	0
	HCo_3^-	26.6
	Cl^-	54.4
	SO_4^{2-}	8. 34

Notes: WHC %= water holding capacity; BD gcm-3=bulk density , OC= organic carbon

2. Incubation Experiment

A pot experiment was conducted at the green house of Soil Science Department, Faculty of Agriculture, Menoufia University Shibin El-Kom, Egypt during the two years of 2016 and 2017. In this experiment 72 plastic pots with 15 cm in both the depth and inter diameter were used. These pots were divided into two main groups each group (36 pots) was used for each of the two salt affected soils. Each pot was filled with one Kg of the soil sample. The pots of each main group were divided into four sub groups (9 pots/sub group) representing the application rates of compost. i.e. 0, 1, 2 and 3 %. Added compost was mixed with the soil sample

in each pot. The pots of each sub group divided into three sub groups (3pots/sub group) representing three incubation periods namely 0, 3 and 6 months. The applied treatments for each soil were arranged in the experimental units in completely randomized block design with three replicates. All experimental units were incubated at room temperature (25± 2 ˚C) for the three above mentioned incubation periods. All pots were moisted every three days by tap water at field capacity. At the end of each incubation time, the soil of the three replicates of each treatment was taken separately, air dried, ground, sieved through a 2 mm sieve and analyzed for their chemical properties. These properties were pH, EC_e and soluble cations and anions.

3. Statistical Analysis.

The obtained data were statistically analyzed using 3 way completely randomized design with three replicates using the Costat statistical software (Costat 6.311, Copyright (C) 1998-2005).

RESULTS AND DISCUSSION

Effect of added compost rates and incubation periods on pH and EC of salt affected soils.

Data in Table (3) showed that, the average values of pH were decreased significantly in the two studied soils with increasing the compost rates. The mean pH values of the two soils were 8.64, 8.56, 8.47 and 8.42 at 0, 1, 2, 3% compost rates respectively. Also, at the same compost rate, the increasing of incubation period resulted in a significant decrease of soil pH. The mean pH values at 0, 3 and 6 months incubation periods with the compost rates were 8.71, 8.53 and 8.33 respectively. In addition, the average values of EC were increased significantly in the studied soils with the increasing rate of added compost. The mean EC values of the two soils were 9.35, 9.97, 10.36 and 10.65 dSm^{-1} at 0, 1, 2, 3% compost rates respectively. Similar trend was observed with the increase in the incubation period, where the mean value of EC were 9.88, 10.07 and 10.30 dSm^{-1} at the 0, 3 and 6 months incubation periods respectively.

Mekail, *et al*. (2000) found that, the pH values of soils treated with different rates of composted plant residues were decreased compared to the control. This decrease was significant before cultivation and after the two successive crops. There was also, a decreasing trend in pH value with land use time passing even in the control. In field experiments Wang and Yang (2003) and Rehan, *et al.* (2004) indicated that, the application of organic materials prevented soil pH from decreasing. They added that, increasing application rate of composted plant residues to sandy soil led to slight decrease in the soil pH as compared to either control or mineral fertilizers. One efficient way to increase SOM level is compost application, produced especially from biomass wastes. However, the essential influencing factors for SOM-enrichment are quantity, type and degree of humification of compost, the soil properties (soil type; clay content) and managements. Mature composts increase SOM much better than fresh and immature composts due to their higher level of stable C (Bouajila and Sanaa, 2011 and Daniel and Bruno, 2012). In addition, the high amount of OM in compost increased OC in both soil and OC amount in uncultivated soil. This was higher than that in cultivated soil because of plant cultivation effect and increased the OM degradation in cultivated soil (Soheil *et al.* 2012). In this respect, Mahmoud (2017) and Rabie (2019) found similar significant increase effect of incubation period on EC of different soils treated with different sources of organic materials.

Table (3): Effect of compost application and incubation period "P" (months) on ECdSm^{-1}, pH values in two salt affected Soils.

Salt affected soils	Compost application	EC				pH			
	Compost rates%	P0	P3	P6	Mean	P0	P3	P6	Mean
SAS1	0	2.86	2.83	2.80	2.83	8.68	8.56	8.44	8.56
	1	2.90	3.04	3.26	3.07	8.62	8.46	8.39	8.49
	2	3.08	3.14	3.46	3.23	8.52	8.41	8.30	8.41
	3	3.19	3.23	3.61	3.34	8.47	8.39	8.26	8.37
Mean		3.01	3.06	3.28	3.12	8.57	8.46	8.35	8.46
SAS2	0	21.07	21.21	21.03	21.10	8.88	8.76	8.56	8.73
	1	21.99	22.65	23.00	22.55	8.79	8.65	8.44	8.63
	2	22.95	23.33	23.75	23.34	8.69	8.56	8.33	8.53
	3	23.09	23.68	23.94	23.57	8.65	8.48	8.27	8.47
Mean		22.28	22.72	22.93	22.64	8.75	8.61	8.40	8.59
G Means		9.88	10.07	10.30	23.03	8.71	8.53	8.33	8.52
LSD $_{0.05}$									
Soils					0.0269				0.03
Compost					0.0240				0.02
Incubation					0.0208				0.02

Effect of compost rates and incubation periods on the content of soluble cations of studied soils.

Date in Table (4) showed that, the average content of Na^+ were decreased significantly with increasing rate of added compost in the studied soils. The mean contents of Na^+ in these soils was 56.60, 56.09, 55.57 and 55.06 meq/l at 0, 1, 2 and 3% of compost rates with the different incubation periods respectively. Regarding to the influence of the incubation periods on the content of soluble Na^+ in the studied soils, data showed that the mean content of Na^+ were 55.95, 55.89 and 55.65 meq/l respectively at the incubation periods of 0, 3 and 6 months. Also, data in Table (4)

showed that, the average content of K^+, Ca $^{2+}$ and Mg $^{2+}$ were increased

Table (4): Effect of compost rates (%) and incubation periods (months) on of soluble Na^+, K^+, Ca^{2+}, and Mg^{2+} (meq/L) in the studied soils

Salt affected soils	Compost rates	Na^+					K^+					Ca^{2+}					Mg^{2+}				
	Compost %	P0	P3	P6	Mean		P0	P3	P6	Mean		P0	P3	P6	Mean		P0	P3	P6	Mean	
SAS1	0	10.47	10.40	10.40	10.42		0.54	0.51	0.56	0.54		4.33	4.67	4.33	4.44		6.00	5.67	6.00	5.89	
	1	10.14	9.93	9.87	9.98		0.62	0.68	0.67	0.66		5.00	5.67	6.00	5.56		6.67	7.33	7.67	7.22	
	2	9.40	9.33	9.23	9.32		0.68	0.74	0.75	0.72		6.67	7.33	8.00	7.33		7.67	8.33	9.00	8.33	
	3	9.11	9.07	9.03	9.07		0.74	0.78	0.79	0.77		7.67	8.67	9.33	8.56		9.00	6.67	10.00	8.56	
Mean		9.78	9.68	9.63	9.70		0.64	0.68	0.69	0.67		5.92	6.58	6.92	6.47		7.33	7.00	8.17	7.50	
SAS2	0	137.63	137.80	137.70	137.71		5.63	5.70	5.73	5.69		36.33	37.00	36.67	36.67		42.67	42.33	42.33	42.44	
	1	137.20	137.23	137.07	137.17		6.10	6.47	6.70	6.42		38.00	39.00	39.00	38.67		44.33	45.00	45.67	45.00	
	2	136.80	136.87	136.17	136.61		6.50	6.47	7.37	6.78		41.00	42.00	44.00	42.33		46.33	47.00	47.67	47.00	
	3	136.37	135.67	135.63	135.89		6.80	6.93	7.80	7.18		44.33	46.00	47.67	46.00		48.33	49.00	50.00	49.11	
Mean		137.00	136.89	136.64	136.84		6.26	6.39	6.90	6.52		39.92	41.00	41.83	40.92		45.42	45.83	46.42	45.89	
G Mean		55.95	55.89	55.65	73.27		3.05	3.17	3.36	3.59		22.40	23.21	27.60	23.69		26.10	26.52	27.47	26.69	
$LSD_{0.05}$																					
Soils					0.06					0.03					0.3					0.2	
Compost					0.05					0.03					0.2					0.2	
Incubation					0.04					0.02					0.2					0.19	

significantly with increasing compost rates. The mean contents of K^+ were 16.06, 19.78, 26.73 and 19.63 meq/l , Ca^{2+} were 20.88, 25.39, 34.22 and 32.76 meq/l and Mg^{2+} were 19.52, 22.88, 31.98 and 32.76 meq/l at 0, 1, 2 and 3% compost respectively. Similar increases of soluble K^+, Ca^{2+} and Mg^{2+} were observed with increasing incubation periods from 0, 3 to 6 months. The mean content of K^+ were 17.04, 17.89 and 20.49 meq/l, Ca^{2+} were 23.56, 24.49 and 27.81 meq/l and Mg^{2+} were 23.8, 24.59 and 26.86 meq/l at incubation period 0, 3 and 6 months, respectively. Soils having high concentrations of dissolved mineral salts could be had adversely affect on crop production (Rengasamy, 2006 and Wong *et al.,* 2010). These salts are primarily composed of carbonates, chlorides, sulfates, and bicarbonates of calcium (Ca^{2+}), magnesium (Mg^{2+}), and sodium (Na^+) (Qadir *et al.,* 2000 and Manchanda and Garg, 2008). The increase soluble K^+, Ca^{2+} and Mg^{2+} with the compost application could be attributed to the increase of chelating ability (i.e. the ability to form several bonds with a metal ion) of Ca^{2+} and Mg^{2+} in the soil. This enables them to replace Na^+ from the cation exchange complex. Also this could be decreasing the soil's ability to absorb Na^+ by reducing the sodium absorption rate (Lakhdar *et al.* 2009). The content of Na^+ in the soil is therefore reduced because it allows Na^+ to be disbursed and leached. The increasing of H+ ions in soil solution resulting from the decomposition of compost, led to the increase in leaching and changing of soluble K^+, Ca^{2+}, Mg^{2+} contents in the studied soils. These findings are generally agreement with the findings of Gell *et al.* (2011).

Effect of compost rates and incubation periods on soluble anions of the studied soils.

Data in Table (5) show that, the addition of compost at different rates to the studied soils led to decrease in the content of soluble Cl^- at the different incubation periods. The mean Cl^- content were 60.11, 59.47, 58.77 and 60.49 at 0, 1, 2 and 3% compost rates respectively. In addition, the compost application increased the average contents of HCO_3^- and SO_4^{2-} in the two studied soils. The mean contents of HCO_3^- were 18.27, 19.85, 20.86 and 21.73 meq/l and for SO_4^{2-} were 24.85, 28.29, 31.43 and 35.30 meq/l at 0, 1, 2 and 3% compost respectively. At incubation periods of 0, 3 and 6 months the mean contents of Cl^- were 58.86, 61.48 and 58.78 meq/l. At these periods HCO_3^- were 19.55, 19.95 and 21.03 meq/l and SO_4^{2-} were 29.10, 29.87 and 30.93 meq/l respectively. Compost could be considered as a critical source for the nutrients such as the soluble salts. Good quality compost has limited amounts of Cl^- . Therefore, it should not cause phytotoxic effects after long term application. Compost can also have a significant concentration of sulfate, which can either be readily absorbed by the plant, or transformed by enzymatic activity to readily available forms. The increase of Ca^{2+} and Mg^{2+} in the soil, could be enabled them to replace Na^+ from the cation exchange complex. This could be decreased the soil's ability to absorb Na^+ by reducing the sodium absorption rate. The Na^+ concentration in the soil is therefore reduced because it allows Na^+ to be disbursed and leached (Reddy and Crohn, 2012, Gransee and Führs, 2013 and Guangming *et al.,* 2017).

Table (5): Effect of compost rates (%) and incubation periods (months) on salt affected soils content (meq/L) of Cl^-, HCO_3^- and SO_4^{2-}

Salt affected soils	Compost application	Cl^-				HCO_3^-				SO_4^{2-}			
	Compost rates %	P0	P3	P6	Mean	P0	P3	P6	Mean	P0	P3	P6	Mean
SAS1	0	11.56	11.57	11.47	11.53	6.46	6.40	6.37	6.41	3.31	3.28	3.46	3.35
	1	11.17	11.20	10.30	10.89	6.93	8.43	9.17	8.18	4.32	3.98	4.74	4.35
	2	10.57	10.43	9.83	10.28	8.03	8.93	11.34	9.43	5.81	6.37	5.81	6.00
	3	10.13	9.10	8.93	9.39	9.20	11.13	11.13	10.49	7.18	7.95	9.09	8.07
Mean		10.86	10.58	10.13	10.52	7.66	8.73	9.50	8.63	5.16	5.40	5.78	5.44
SAS2	0	146.83	146.50	146.67	146.67	30.50	31.33	30.60	30.81	44.93	45.00	45.17	45.03
	1	146.77	145.27	145.43	145.82	30.93	31.50	31.43	31.29	47.93	50.93	51.57	50.14
	2	145.47	144.83	143.90	144.73	31.60	32.00	32.37	31.99	53.57	55.50	58.93	56.00
	3	144.67	144.33	141.00	143.33	32.43	34.04	33.40	33.29	58.73	59.23	66.70	61.55
Mean		145.93	145.23	144.25	145.14	31.37	32.22	31.95	31.85	51.29	52.67	55.59	53.18
G Means		58.86	61.48	58.78	77.83	19.55	19.95	21.03	20.23	29.10	29.87	30.93	29.31
$LSD_{0.05}$													
Soils					1.9				0.30			1.4	0.30
Compost					1.06				0.30			1.3	0.30

CONCLUSION

This study was conducted on samples collected from two soils of El-Hamoul area, Kafr El-Sheikh governorate, north Nile, Delta, Egypt. These soils are salt affected soils. From the obtained results, it can be concluded that, the addition of organic amendments such as compost could be the best solution for the problems of these soils. These amendments could be improve the chemical properties of these soils such as decrease of their pH. In this study, the best rate of compost application was 3% and the best incubation period was 6 months. Therefore compost application must be added to soil before cultivation by sufficient times.

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تأثير الكومبست علي الخواص و معامل الأفضلية فى الأراضي المتأثرة بالأملاح .
1- على درجة حموضة التربة و درجة الاملاح الكلية والكاتيونات والأنيونات الذائبة

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الملخص العربي

أجريت هذه الدراسة بصوبة ومعامل قسم علوم الأراضي – كلية الزراعة – جامعة المنوفية – مصر خلال عامي 2016- 2017 م علي اثنان من العينات المجمعة من الأراضي المتأثرة بالأملاح فى منطقة الحامول – محافظة كفر الشيخ – شمال دلتا النيل- مصر لدراسة تأثر هذه الأراضي باضافة الكومبست كمحسن أرض عند مستويات صفر ، 1 ، 2، 3 % تحت ظروف التحضين (صفر، 3، 6 شهور) علي درجة حرارة الغرفة حيث تم دراسة تأثير معاملات الدراسة علي رقم حموضة التربة وقيمة التوصيل الكهربي بالاضافة الي محتوى الأرض من الكاتيونات الذائبة (صوديوم- بوتاسيوم- كالسيوم- ماغنسيوم) والأنيونات الذائبة (كلوريد – كربونات – بيكربونات – كبريتات) في تلك الأراضي محل الدراسة وتقييم علاقتها بعوامل الدراسة.

وقد أدت زيادة المضاف من الكومبست الى نقص فى حموضة الأرض وقيمة التوصيل الكهربي وكذلك حدث نقصا فى محتوى الأرض من كل الصوديوم والكلوريد الذائب وكذلك المحتوى من الذائب لكل من الكالسيوم والماغنسيوم. ومن ناحية أخرى فقد أدت زيادة فترة التحضين الى نقص فى رقم حموضة الأرض هذا بالاضافة الى المحتوى الذائب والمتبادل للصوديوم. فى ذات الوقت حدثت زيادة فى قيمة التوصيل الكهربي. وبصفة عامة أدت اضافة الكومبست الى تحسين الخواص الكيميائية .

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