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EFFECT OF MINERAL POTASSIUM, COMPOST AND BIOFERTILIZERS ON SOIL PHYSIO-CHEMICAL PROPERTIES AND PRODUCTIVITY OF SESAME GROWN ON SALT AFFECTED SOILS

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ABSTRACT

A field experiment was conducted in salt affected soils during the summer season 2010 at El- Amel village, Sahl El-Tina, North Sinai Governorate, Egypt. This experiment aimed to evaluate the effect of potassium fertilizer applied at a rate of 25, 50 or 75 K_2O kg fed^{-1} as mineral fertilizer (K_2SO_4) individually or combined with compost at a rate of 5 Mg fed^{-1}or biofertilizer on sesame yield and yield components as well as some soil physical and chemical properties and available macronutrients (N, P and K) and micronutrients (Fe, Mn and Zn). The results showed that potassium sulfate combined with compost significantly increased growth parameters and sesame yield and its contents of macro and micronutrients. The seed inoculation with biofertilizer in the presence of potassium sulfate significantly affected the sesame yield and its contents of the studied nutritive elements.

The interaction between potassium sulfate combined with compost and biofertilizers exhibited significant effect on plant growth, nutrients status in the seeds of sesame. Also, it enhanced some physical and chemical soil properties, where it reduced both pH, EC, bulk density, HC and increased total porosity, field capacity, wilting point and available water as well as availability of some nutrients such as N, P and K. It could be concluded that the seed inoculation with biofertilizer combined with compost in the presence of potassium sulfate resulted in high productivity of sesame under new reclaimed salt affected soils. Overall, compost treatments improved soil physical and chemical properties compared to mineral potassium fertilizer and initial soils.

Keywords: compost, biofertilizer, sesame, salt affected soils, soil properties

INTRODUCTION

Soil salinity adversely affects physiological and metabolic processes and diminishes growth and yield (Ashraf and Harris, 2004). Excessive salts injure plants by disturbing the uptake of water into roots and interfering with the uptake of competitive nutrients (David , 2007). The inhibitory effect of salinity on plant growth and yield has been ascribed to osmotic effect on water availability, ion toxicity, nutritional imbalance, reduction in enzymatic and photosynthetic efficiency and other physiological disorders (Khan *et al.*, 1995).

Use of microbial preparations for enhancement of plant production is becoming a new practice in many countries (Higa, 1994 and Rodriguez and Fraga, 1999,). Inoculation with bacterial strain Bacillus edaphicus NBT was found to increase root and shoot growth of cotton and rape growing on soils treated with insoluble potassium and inoculated with strain NBT, the potassium content was increased by 30 and 26 %, respectively. Bacterial inoculation also resulted in higher N and P contents of above ground plant components (Sheng, 2005). Bio-fertilizers are of low-cost and at the same time, contain micro-organisms that enhance soil fertility, plant growth and yield crop (Hafeez and Hassan, 2012).

Organic fertilization is one of the oldest methods of soil cultivation. Every possible type of organic manuring has got vital importance for soil fertility preservation. The nutrient content of organic manures can vary widely depending on their source and moisture content. The organic materials contain the humus fraction which improves the soils physical condition. Addition of materials such as compost improves soil structure, texture and tilth (Biswas et al., 2001) which further provides better environment for root development and aeration. Also, compost play key roles in terms of maintaining or improving soil fertility, soil organic matter and plant nutrition through the direct and indirect effects on microbial activity and nutrient availability (Haynes et al., 1995 and Clark et al., 1998;). A large population of micro organisms is added to the soil through organic materials. This increases the nitrogen fixation and the phosphorus solubilization due to improved microbiological activity in organic matter - amended soils. However, when mineral fertilizers are added as a supplement, the effects on soil fertility and crop yields become tremendous.

Potassium is an abundant element, ranking seventh among all the elements in the earth crust, 2.59 percent of which is potassium in combined forms. Potassium is one of the most important macronutrients for the growth and reproduction of the plants (Budr, 2006). Potassium ions serve to activate certain enzymes especially those involved in photosynthesis, respiration and in starch and protein synthesis (Hopkins, 1995). Moreover, opening and closing of stomata guard cells or daily changes in the orientation of leaves are affected by potassium concentration. Potassium is founded in four forms in the soil which are K ions (K^+) in the soil solution, as an exchangeable cation, tightly held on the surfaces of clay minerals and organic matter, tightly held or fixed by weathered micaceous minerals, and present in the lattice of certain K-containing primary minerals (Ahmad, 2009). Inoculation with bacteria, which can improve P and K availability in soils by producing organic acids and other chemicals, stimulated growth and mineral uptake of plants (Girgis et al., 2008). Integration of organic and inorganic fertilizer materials has been found to be promising not only in maintaining higher productivity but also for providing stability in crop production.

Sesame *(Sesamum indicum* L.) is a crop highly value for production of high quality oil in the world. Its seeds have a high content of oil and protein. It is also grown in many parts of the world for its insecticidal and medicinal properties as well as for its cosmetic and ornamental values.

The objectives of this study are to evaluate the effect of the mineral potassium fertilizers applied merely or in combination with compost or inoculate of silicate dissolving bacteria on sesame yield grown on salt affected soils and its uptake of different minerals. Also, the effect of the used fertilization treatments on some soil properties was taken in consideration in this investigation.

MATERIALS AND METHODS

To evaluate the effects of potassium fertilizers alone or combined with compost and/or biofertilizer application on sesame grown on a salt affected soil. A field experiment in a factorial randomized complete block design with three replications was conducted during summer season of 2010. The investigated soil was salt affected soils located in El-Amal village of Sahle El-Tina North Sinai Governorate, Egypt (32° 35$^-$ to 32^0 _ 34$^-$ E and 31^0 _000 to 31^0 _ 25$^-$ N. Some physical and chemical properties of the soil are shown in Table 1. Where K_2O, compost, biofertilizer and compost + biofertilizer represents the main plot, while the rate of application K_2O, 25, 50 and 75 kg K/fed, were the sub plots.

Table 1. Some characteristics of the studied experimental soil at initial state.

Soil character	Value	Soil character	Value
Particle size distribution %:		pH (1: 2.5 ,soil suspension)	7.90
Sand	74.64	*Chemical analysis of soil paste extract:*	
Silt	7.90	ECe (dS m^{-1})	10.62
Clay	17.47	*Soluble cations (m molc $^{L-}$1):*	
Textural class	Sandy loam	Ca^{++}	11.28
$CaCO_3$ content %	10.40	Mg^{++}	14.13
Organic matter content %	0.60	Na^+	80.00
Available N (mg kg^{-1})	30.00	K^+	0.79
Available P (mg kg^{-1})	4.30	*Soluble anions (m molc $^{L-}$1):*	
Available K (mg kg^{-1})	186.00	CO_3^{--}	0.00
Available Fe (mg kg^{-1})	2.60	HCO_3^-	6.240
Available Mn (mg kg^{-1})	1.30	Cl^-	75.00
Available Zn (mg kg^{-1})	0.77	SO_4^{--}	24.96
Hydro physical properties			
Bulk density BD (g cm^{-3})	1.55		
Total porosity T.P. (%)	42.38		
Haydrluc conductivity HC. (cm h^{-1})	18.81		
Field capacity FC (%)	11.16		
Welting point Wp (%)	6.23		
Available water (%)	4.93		

The biofertilizer was provided by Soil Microbiology unit at Soils, Water and Environment Res. Inst., ARC. Sesame seeds were inoculated before sowing with biofertilizers by coating the seeds with the gum media carrying the bacteria strain on the same day of sowing. Sesame seeds (Shandaweel 3 cv.) were sown on 5th May in 2010 at rate of 3 kg fed^{-1}, a were harvested at 10 August. Compost was plowed 30 days before sesame planting at a rate of 5 Mg fed^{-1}. The compost analysis was done according to the standard methods described by Brunner and Wasmer (1978). Chemical composition of the used compost is shown in Table (2).

Table 2: Some chemical properties of the used compost.

Components and units	Values
Organic matter (%)	33.00
pH (1: 5)	7.88
EC(dS/m) (1:5)	4.94
Total N (%)	1.89
Total P (%)	0.90
Total K (%)	1.88
Available Fe(mg kg^{-1})	41.80
Available Mn (mg kg^{-1})	60.40
Available Zn (mg kg^{-1})	33.00
Bulk density (gcm^{-3})	1.55
Total porosity (%)	42.38
Hydraulic conductivity (cmh^{-1})	18.21
Field capacity (%)	11.16
Wilting point (%)	6.23
Available water (%)	4.93

Area of each plot was 12 m^2 (4 m width and 3 m length) and consists of six rows. Plots were fertilized with 100 kg N fed^{-1} as urea applied at three equal doses 15, 21 and 60 days from planting. 15 kg P_2O_5 fed^{-1} was applied as superphosphate before sowing. Potassium sulfate fertilizer was added at rates of 25, 50 and 75 K2O kg fed-1. at two equal doses 15 and 21 days from planting.

At harvest time, sesame plants were collected from each plot and the following characters were determined: plant height (cm), capsules per plant, weight of seed/plant (g), seed and biological yields and harvest index (HI%). Total nitrogen content in seeds was determined using Kjeldahl method as described by Page *et al* (1982). Phosphorus was determined Spectrophotometrically using ammonium molybdate/ stannus chloride method according to Chapman and Pratt (1978) Potassium was determined using Flame Photometer according to the method described by Page *et al* (1982). Fe, Zn and Mn were determined using Atomic Absorption Spectrophotometer. Undisturbed and disturbed surface (0-30 cm) of soil samples were collected to determine some physical and chemical characteristics of the investigated soil, according to the methods described by Page *et al.* (1982) and Klute (1986).

RESULTS AND DISCUSSION

Data presented in Table 3 show the effect of application of mineral potassium fertilizer, compost and biofertilizer as well as their interaction on sesame yield and yield component characters. The results revealed that the application of compost and/ or biofertilizer in combination with mineral potassium at different rates significantly increased growth parameters of sesame plants, plant height (cm) number of capsules /plant, seeds weight /plant and weight of 1000 seed (g) and consequent seed yield (kg fed^{-1}) as compared with potassium sulfate alone. Also, the results indicated that all the aforementioned parameters were more pronounced by increasing rate of applied potassium. The lowest values of growth parameters were recorded when mineral potassium was applied solely. On the other hand, the highest values of growth parameters and seeds yield were obtained by application of mineral potassium at its highest rate combined with compost and biofertilizers. The data also indicate that treated seeds before sowing with biofertilizer increased efficiency of mineral fertilizer used as compared with untreated seeds. Such an increase was reflected the effect of biofertilization on increasing the mobility of fixed potassium in organic or inorganic fertilizers. These increases might be related to the positive effect of compost and microorganisms on increasing the root surface area per unit of soil volume, water-use efficiency and photosynthetic activity, which directly affects the physiological processes and utilization of carbohydrates. Similar results were obtained by Zaied *et al.* (2003). Abdelaziz *et al.* (2007) reported that application of compost and microorganisms could replace conventional NPK fertilizers in the cultivation of rosemary (*Rosmarinus officinalis*), and consequently minimize environmental pollution by these compounds.

Table 3. Effect of potassium sulfate, compost and biofertilizer on yield and some Parameters of sesame grown on salt affected soils.

Treatments	Rate of applied Kg K/fed	Plant height (cm)	capsules /plant (g)	Seeds /plant (g)	1000 seeds (g)	Seed yield kg fed-1	Oil (%)
Mineral K_2O	25	120.00	13.00	7.53	3.48	450	43.00
	50	128.00	16.00	7.66	3.69	489	47.00
	75	136.00	18.00	7.68	3.88	506	49.00
Mean		128.00	31.33	7.62	3.68	481.66	46.33
Compost	25	128.00	16.00	7.89	3.95	495	48.00
	50	134.00	18.00	7.90	4.02	508	51.00
	75	139.00	22.00	7.95	4.06	522	55.00
Mean		133.66	18.66	7.91	4.01	508.33	51.33
Bio-fertilizer	25	130.00	17.00	8.04	3.97	502	50.00
	50	137.00	19.00	8.07	4.05	509	53.00
	75	142.00	26.00	8.09	4.09	528	57.00
Mean		136.33	20.66	8.06	4.03	513.00	53.33
Compost + bio-fertilizer	25	132.00	18.00	8.14	4.02	513	53.00
	50	139.00	26.00	8.19	4.09	524	55.00
	75	144.00	29.00	8.23	4.13	536	58.00
Mean		138.33	24.33	8.18	4.08	524.33	55.33
L.S.D., at 0.05							
Treatment		0.09	0.07	0.002	0.36	0.003	0.07
Rate of K_2O		0.06	0.04	0.001	0.16	0.002	0.03
Interaction		0.11	0.07	0.003	0.31	0.005	0.05

Lin *et al.* (2002) recorded increase in biomass by 125 % and increasing K and P uptake in tomato plant due to inoculation by silicate dissolving bacteria (*B. mucilaginosus*) than the non-inoculation. Thus there is a potential in applying RCBC13 for improving K and P nutrition. The effect of plant growth promoting rhizobacteria (PGPR) including phosphate and potassium soluiblizing bacteria (PSB and KSB). Applied the suitability of these biofertilizers as a sustainable solution to improve plant nutrient availability and consequently its production (Vessey, 2003). Sabannavar and Lakshman (2009) revealed that biofertilization increased plant growth, number of capsules/plant and seed yield of sesame. Shehu *et al.* (2010) observed that number of capsules/plant and seed weight/plant were increased by adding potassium fertilization (22.5 and 45 kg K_2O/ha). Hassan *et al.* (2012) reported that bio-fertilizer treatments, enhanced plant height, branch number/plant, plant dry weight, pods number/plant, pods dry weight, seed index ,seed number/plant and seed yield / plant & / feddan, nitrogen, phosphorus, potassium, protein percentage and alkaloids percentage and alkaloids content/plant(g). Mayak *et al.* (2004) observed that biomass of tomato plants inoculated with biofertilizers increased under 120 and 207 mM NaCl. These results indicated that inoculation with the selected bacterium could decrease the injurious effects caused by salinity. Danial *et al.* (2012) indicated that bacteria could ameliorate saline stress of maize plants caused by high levels of NaCl in soil. Hence, use of selected PGPB may be important to decrease the deleterious effects of soil salinity on plant growth.

Seed oil percentage

As for the seed oil percentage, data presented in Table 3 showed that fertilization with mineral potassium applied solely or combined with compost and/ or biofertilizer significantly increased oil percentage in seeds of sesame. The highest effect was obtained by application of compost along with mineral fertilizer at its high rate in the presence of seed inoculated with biofertilizer. The positive effect of potassium on seed oil content (%) might be due to important role of K in enhancing enzymes activity and metabolism of lipids. (Marschner, 1986). Ali (2002) mentioned that application of 48 kg K_2O/fed increased seed and oil yields/fed, seed oil content (%) and yield attributes. Badran and Safwat (2004) on fennel showed that the growth characters, yield components and oil yield were positively influenced by organic manure and inoculation with bio-fertilizers.

Macronutrient concentrations in seed of sesame plant:

Data presented in Table 4 revealed that N, P and K concentration in seeds of sesame increased with all treatments. The highest values of N, P and K in seeds were 2.69, 0.58 and 3.07 % due to the application of the high rate of mineral potassium combined with compost and biofertilizer. Inoculation with biofertilizer strains enhanced solubility of the added rock P and K to be more available for uptake by plant roots (Han and Lee, 2005). Higher N, P and K uptake subsequently promoted the plant growth. Therefore, KSB (Potassium Solubilizing Bacteria) are function to increase potassium availability in soils and hence increases and its contents in plants. This study suggests, that the plant growth promotion is related to both increasing K solubilization due to the effect of the solubility K strains as well as increasing the uptake of N and P. These results are in agreement with those of Archana (2007) who indicated that the inoculated bacteria increased the plant growth, nutrient uptake and yield components of maize plants over absolute control.

Table 4. Effect of potassium sulfate, compost and biofertilizer on Macro and micronutrients concentration (%) in seeds of sesame grown on salt affected soils.

Treatments	Rate of applied Kg K/fed	Macronutrients (%)			Micronutrients (mg kg^{-1})		
		N	P	K	Fe	Mn	Zn
Mineral K_2O	25	2.47	0.31	2.83	73.64	51.96	12.77
	50	2.53	0.36	2.88	74.25	52.37	13.52
	75	2.55	0.41	2.90	74.44	52.51	13.63
Mean		2.52	0.36	2.87	74.11	52.28	13.30
Compost	25	2.53	0.42	2.95	75.60	53.66	13.55
	50	2.55	0.46	2.97	77.25	58.14	14.39
	75	2.61	0.52	2.98	79.35	58.30	14.52
		2.56	0.46	2.81	77.48	56.70	14.15
Bio-fertilizer	25	2.54	0.47	2.98	74.39	50.94	14.02
	50	2.56	0.49	3.02	76.58	51.48	14.22
	75	2.63	0.53	3.06	78.68	52.68	14.30
Mean		2.57	0.49	3.02	76.55	51.7	14.18
Compost + bio-fertilizer	25	2.60	0.51	3.01	77.01	55.69	16.53
	50	2.66	0.56	3.06	77.29	58.94	16.57
	75	2.69	0.58	3.07	77.32	59.71	16.60
Mean		2.65	0.55	3.05	77.21	58.11	16.56
L.S.D., at 0.05							
Treatment		0.003	0.008	0.001	0.003	0.003	0.03
Rate of K_2O		0.002	0.003	0.001	0.001	0.02	0.003
Interaction		0.005	0.007	0.001	0.003	0.03	0.005

Shata *et al.* (2007) and Basu *et al.* (2008) reported that interaction of chemical and Bio-fertilizers as inoculums prepared from microorganisms increased nutrient absorption by entering large population of active microorganisms at root activity zone. Sheng and Huang (2002) reported that potassium release from minerals was affected by pH, dissolved oxygen and strains used. Also, application of potassium solubilizing bacteria (KSB) increased K availability in soils and increased mineral uptake by plant. (Sheng *et al.* 2003). Ahmed *et al.* (2013) found that application of biofertilizer combined with nitrogen fertilizer led to increasing the N, P and K content in guar plants. Quesni at al. (2010) concluded that biofertilizers solely or combined with compost application decreased the hazard effect of salinity; also they exerted a favorable effect on growth and N, P and K concentration in *Schefflera arboricola* L. seedlings irrigated with saline water.

Fe, Mn and Zn concentrations in seeds of sesame plants:

Results showed that the all treatments increased Fe, Mn and Zn content in seeds of sesame plants Table (4). This increase in Fe, Mn and Zn content was generally observed in the combined treatment i.e., potassium fertilizer in the mineral form with compost or with inoculation with biofertilizer. However, the highest values of Fe, Mn and Zn in seeds of sesame plants were (77.32, 59.71 and 16.6 mg kg^{-1}), respectively due to application of the high rate of mineral potassium combined with compost and biofertilizer. This may be due to the release of more available micronutrients to be absorbed by plant roots caused by the organic acids which produced by microorganisms leading to a decrease in the pH of the soil (Subb-Rao, 1981). Likewise, microorganisms' activities occur in the rhizosphere and via their activities can construct good and healthy rhizosphere by having constant and sustainable production of nutrients to be supplied into the plants' root. Moreover, microorganisms that are supplied by biofertilizer can prevent nutrients leaching while adding nutrients to the soil via their activities. Mahfouze and Sharaf-Eldin, (2007) found that biofertilization of Egyptian soils decreased the pH, and increased availability of trace elements that enhanced plant growth.

Soil pH

Data in Table (5) revealed that the pH values tended to decrease slightly as a result of different treatments, the lowest soil pH was recorded due to application of mineral fertilizer combined with compost and biofertilizer. Also, data indicated that the pH tended to decrease slightly with increasing mineral potassium fertilizer rate combined with compost and biofertilizer. These results may be due to release of the organic acids due to its decomposition from compost.

Table 5. Effect of potassium sulfate, compost and biofertilizer on pH, EC and Macro- micronutrients availability in the investigated soil.

Treatments	Kg K_2O/fed	pH (1:2.5)	EC dSm^{-1}	Macronutrients ($mgkg^{-1}$)			Micronutrients ($mgkg^{-1}$)		
				N	P	K	Fe	Mn	Zn
Mineral K_2O	25	8.04	7.52	47.63	4.89	196.00	2.58	1.37	0.88
	50	8.03	6.94	52.79	4.93	203.00	2.63	1.42	0.93
	75	8.00	6.43	56.88	5.03	209.00	2.66	1.48	0.94
Mean		8.00	6.96	52.43	4.95	202.66	2.62	1.42	0.91
Compost	25	8.02	6.13	50.63	4.99	200.00	2.63	1.44	0.93
	50	8.00	5.52	55.94	5.08	209.00	2.69	1.58	0.95
	75	7.98	5.38	60.74	5.12	214.00	2.71	1.63	0.97
Mean		8.00	5.67	55.77	5.06	144.33	2.67	1.55	0.95
Bio-fertilizer	25	8.03	6.08	49.86	5.00	208.00	2.67	1.47	0.89
	50	7.99	6.03	53.77	5.04	213.00	2.69	1.56	0.93
	75	7.96	5.94	58.93	5.07	216.00	2.72	1.59	0.95
Mean		7.99	6.01	54.18	5.03	212.33	2.67	1.54	0.92
Compost + bio-fertilizer	25	7.94	5.97	57.63	5.04	212	2.71	1.55	0.95
	50	7.90	5.34	62.14	5.09	215	2.73	1.59	0.98
	75	7.89	5.22	64.33	5.13	219	2.75	1.63	0.99
Mean		7.91	5.51	61.45	5.08	215.33	2.73	1.25	0.82
L.S.D., at 0.05									
Treatments		0.001	0.014	0.08	0.001	0.11	NS	0.008	NS
Rate of K_2O		0.001	0.005	0.04	0.02	0.05	0.01	0.004	NS
Interaction		0.001	0.01	0.08	0.001	0.10	NS	0.007	NS

Rodriguez and Fraga (1999) reported that the production of organic acids led to drop in pH. Moustafa (2005) found that application of farmyard manure and gypsum reduced pH values in the alkali (sodic) soil with maximum decrease in the upper layer (0–20 cm). These results could be attributed to the reduced amounts of soluble and exchangeable sodium and increased forms of both soluble and exchangeable calcium due to amendments' applications. Also, the positive effect of organic substances on improving soil chemical properties could be due to release of CO_2 during the degradation process which decreased the precipitation of Ca^{2+} and CO_3^{2-} ions in the $CaCO_3$ form.

Soil EC

Data in Table 5 showed that the EC of soil, significantly decreased with all treatments and the decrease was more pronounced due to application of potassium fertilizer in combination with compost and biofertilizer. The decrease in EC value relative to initial value of soil were 34.46 %, 46.61% and 48.11%, for potassium sulfate, potassium sulfate combined with compost and potassium sulfate combined with compost and biofertilizer, respectively. Application of compost with biofertilizer decreased salinity probably due to improving soil structure, increasing aggregate stability and consequently improving leaching process. Wong *et al.* (2009) studied the effect of farmyard manure, gypsum and mix two of them on some characteristics of soil irrigated with drainage water and found that both EC and ESP values significantly decreased with different treatments, especially with application of farmyard manure mixed with gypsum. Beheiry *et al.* (2005) reported that addition of organic manures decreased soil salinity and they attributed that improving physical properties of the soil which in turn facilitated the leaching of salts outside the root zone.

Available nutrients in soil:

Table 5 shows that the available contents of N, P and K in soil were enhanced due to the studied all treatments i.e., mineral potassium at different rates either alone or combinations with compost and biofertilizer. The highest values of N, P and K concentrations in the soil were 64.33, 5.13 and 219 mg kg^{-1}, respectively. These results are in harmony with those obtained by Jen (2006) who found that soil micro-organisms play a significant role in regulating the dynamics of organic matter decomposition and the availability of plant nutrients such as N, P and K.

Concerning the effect of the different treatments on availability of micronutrient (Fe, Mn and Zn) in soil (Table 5) data show that there is a positive effect due to application of potassium sulfate individually as well as potassium sulfate in the presence of compost and biofertilizer. However, the highest values of Fe, Mn and Zn were obtained due to application of potassium sulfate at the highest rate combined with compost and biofertilizer. This may be due to the beneficial role of organic substances on physic-chemical properties of soil such as inducing chelating agents during organic substances decomposition. The application of compost increased the availability of micronutrients due to its effect on reducing the soil pH beside of the formation of organic chelates of higher stability with organic legends, which have lower susceptibility to adsorption, fixation and/or precipitation in the soil. These results are in agreement with those of Senthil Kumar, (1998) who found that organic manure increased availability of cationic micronutrients, such as, Zn and Fe in soils and attributed that to firstly, lowering soil pH and consequently increase in solubility of cationic micronutrients, secondly liberation of micronutrients during decomposition of amendments and thirdly, chelating action of organic anion keeping micronutrients soluble and available. Negm *et al.* (2003) found that application of bio-compost in combination with sulfur or phosphorus improved physical and chemical properties of soil, such as decreasing soil pH and increasing both macro and micronutrients availability in the soil.

Table 6. Soil physical properties of the treated soil at harvesting stage of sesame plants

Treatments	Kg K_2O/fed	Bulk Density (gcm^{-3})	Total porosity (%)	H.C (cm/h)	Field capacity (%)	Wilting point (%)	Available water (%)
Mineral K_2O	25	1.48	46.91	18.19	10.20	3.51	6.69
	50	1.44	48.12	18.10	11.11	4.21	6.90
	75	1.42	48.35	18.70	12.66	6.15	6.51
Mean		1.45	47.79	18.33	11.32	4,62	6.70
Compost	25	1.36	51.35	13.19	14.28	6.27	8.01
	50	1.34	51.95	12.51	16.01	7.90	8.11
	75	1.33	52.09	15.20	18.88	10.45	8.43
		1.34	51.80	31.63	16.39	8.21	8.18
Bio-fertilizer	25	1.43	47.51	13.56	15.83	8.61	7.22
	50	1.40	48.43	16.19	15.10	7.21	7.89
	75	1.39	48.82	16.41	15.89	9.75	6.14
Mean		1.34	48.25	15.39	15.60	8.52	7.08
Compost + bio-fertilizer	25	1.35	53.17	12.40	15.88	7.22	8.66
	50	1.33	53.55	14.11	16.30	7.21	9.09
	75	1.32	53.96	13.60	17.90	8.39	9.51
Mean		1.33	53.65	13.37	16.60	7.61	9.09
L.S.D., at 0.05							
Treatment		N.S	0.011	0.025	0.031	0.03	0.013
Rate of K_2O		N.S	0.015	0.113	0.190	0.09	0.053
Interaction		N.S	0.022	0.049	0.063	0.06	0.026

Some soil physical properties

Data presented in Table 6 showed that the organic fertilizer (compost) individually or mixed with biofertilizer led to a significant and negative effect on soil bulk density, whereas, its values tended to decrease after harvesting compared to the initial value and K_2O addition alone. That was true, since the organic compost and the biofertilizer play an important role in the formation of soil aggregation and increasing macro porosity in the studied soil and consequently decreasing soil bulk density, moreover, the dilution effect of soil mass resulting from mixing added organic compost and biofertilizer mixture decreased soil mass fraction in the soil after harvesting, such result are in agreement with El-Hady *et al.* (2010) who found that the application of compost sand calcareous soils led to decreasing of soil bulk densitity as well as macro porosity. On the other hand, the applied organic compost fertilization mixed with K_2O mineral fertilizer significantly increased the total porosity, with a superiority for organic compost alone or mixed with biofertilizer under different K_2O fertilizer addition compared to the initial treatment.

Generally, it could be observed that the increasing pattern in soil total porosity as related to the applied treatments followed the following increasing, order of K_2O mineral fertilizer + compost + biofertiizer)> K_2O mineral + compost) > K_2O mineral + biofertilizer) > K_2O mineral. Stevenson (1994) who found that organic matter also acts as a cementing agent between soil particles, thereby improving aggregation and increasing porosity.

With respect to soil hydraulic conductivity (HC), the data obtained in the Table 6 showed that the applied K_2O as mineral fertilizer combined with organic compost or biofertilizer led to a pronounced decrease in hydraulic conductivity (HC) as compared with K_2O soil fertilization addition alone. The data also reveled that, the superior reduce of HC values were recorded under mixture of compost + biofertilizer followed by compost addition alone. These results could be due to the pronounced increments of organic substances and which enhance soil aggregation and increase meso and micro-porosity and decreasing the pathways of water flow in the studied light textured soil. These results are in harmony with El-Kotb (2013) who found that applicatiom of compost or FYM enhanced the some physical properties such as hydraulic conductivity.

The moisture tension drying data is of a practical significant in determining the range of soil moisture available pattern. The upper is known as field capacity (FC) and the lower is known as wilting point (WP). Data in Table 6 showed that the value of soil moisture constants, i.e., field capacity (FC), wilting point (wp) and available water content (AW) were significant affected by the combination between K_2O mineral fertilizer + organic fertilizer + biofertilizer. These results mean that highest values of individual fertilization sources upon soil moisture contents were recorded for compost addition, while, the lowest ones was obtained with K_2O mineral fertilizer. These results were obtained by Celik *et al.* (2004) who reported that the available water content of soils increased by 58-86% in the compost amended soil as a result of increase in micro- and macro porosity.

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تـآثير البوتاسيوم المعدنى و الكمبوست و الاسمده الحيويـه علـى خصـائص التربـه الفزيائيه و الكيميائيه و انتاجيه السمسم فى التربه المتآثره بالاملاح

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أجريت تجربة حقلية في احدى الترب المتأثرة بالأملاح خلال موسم صيف 2010 في قرية الامل منطقه سهل الطينه، محافظة شمال سيناء، مصر. هذه التجربة تهدف إلى تقيم تآثير البوتاسيوم المعدنى و الكمبوست و الاسمده الحيويه على خصائص التربه الفزيائيه و الكيميائيه و انتاجيه السمسم فى التربه المتآثره بالاملاح حيث تم اضافتها بمعدل 25 أو 50 أو 75 كجم K_2O فى صوره ة (K_2SO_4) منفردة أو مجتمعة مع الكمبوست بمعدل 5 طن/فدان او التسميد الحيوي على محصول السمسم و مكونات المحصول وكذلك بعض خواص التربة (درجة الحموضة وEC) والمواد الغذائية الرئيسية المتاحة (N، P و K) والمغذيات الدقيقة (الحديد والمنجنيز والزنك). و ايضا بعض خواص التربه الهيدروفزيائيه . أظهرت النتائج أن اضافة كبريتات البوتاسيوم جنبا إلى جنب مع الكمبوست قد ادى الى زيادة كبيرة فى معدل النمو وإنتاجية محصول السمسم ومحتوياته من العناصر الكبرى و الصغرى ايضا. و قد ادي تلقيح البذور بالتسميد الحيوي في وجود كبريتات البوتاسيوم تأثيرا كبيرا على محصول السمسم ومحتوياته من العناصر الغذائية المدروسة.

أظهر التفاعل بين كبريتات البوتاسيوم والكمبوست جنبا إلى جنب مع الأسمدة الحيوية تأثير كبير على نمو النبات، ووضع العناصر الغذائية في بذور السمسم. وعززت ذلك بعض خواص التربة، حيث خفضت كل من درجة الحموضة، ، وزيادة توافر بعض المواد الغذائية مثل N، P و K، يمكن أن نخلص إلى أن التلقيح البذور مع التسميد الحيوي جنبا إلى جنب مع الكمبوست في وجود كبريتات البوتاسيوم أدى الى زياده فى إنتاجية مخصول السمسم تحت التربة المتأثرة بالأملاح المستصلحة ولذللك يوصى اضافة الكمبوست ايضا قد ادى الى تحسين فى خواص التربة الفيزيائية والكيميائية مقارنة مع السماد المعدنى البوتاسى المضاف.