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IMPACT OF SOME ORGANIC AND BIOFERTILIZERS SOIL AMENDMENTS ON THE FERTILITY STATUS, SOME SOIL PROPERTIES, AND PRODUCTIVITY OF SANDY SOILS

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ABSTRACT

A field experiment was conducted on sandy textured soil under sprinkler irrigation system during the two successive agricultural growing seasons of (2009/2010) and (2010) at Ismailia Agricultural Research Station, Agricultural Research Center. Ismailia governorate, Egypt, to evaluate the effect of applying some organic soil amendments i.e.,compost at rates of (2.5, 5, and 7.5 tonfed^{-1}), humic acid rate of (5l fed^{-1}) and biofertilizer (*Bacillus Polymxa)* individually or incorporated with biofertilizer on the fertility status, some soil physico -chemical properties, and productivity of wheat plants (*Triticumvulgare)* C.V. Giza 168 and peanut plants *(Arachishypogaeal.)* C.V. Giza 4. The experiment was designed statistically as a split plots with three replicates. The main plots were located for the biofetilization and the sub plots were devoted for the organic amendments types. At the end of the growing seasons (i.e. after 6 and 4 months from plantation of wheat and peanut respectively) some hydro physical and chemical properties of the soil were determined

The obtained results revealed that application of either organic amendments or bio fertilizer as individual or in combination improved fertility status of the soil as well as, the seed yields of wheat and peanut. These include, (a) Increasing available N, P, and K of the treated soil. (b) Increasing OM content in treated soil. Mixing soil conditioners together i.e. organic amendments and biofertilizer was more efficient in improving chemical properties of the soil than applying each of them alone. In this context, the maximum content of available NPK were (22.64, 13.23 and 68.41 mg kg^{-1} soil) and (24.14, 13.71 and 70.46 mg kg^{-1} soil) for N, P and K in the soil after wheat and peanut harvesting, respectively, resulted from the high rate of compost (7.5 ton fed^{-1}) combined with biofertilizers. (c) Increases in the concentration of (N, P, and K) in the seeds as well as yields of seed. It's also noticed that yields significantly increased by increasing rate of organic fertilizer, which amounted to 1.50 times for wheat seed vs 1.95 times for peanut seed over control treatment by treating the soil with compost at rate of (7.5 tonfed^{-1}), in sequence.

Applied conditioners significantly improved the hydro physical properties of the soil. These include, (a) decreasing soil bulk density as well as macro porosity (drainage pores) on the expense of micro ones. Therefore, water holding pores were increased, (b) increasing retained moisture in the soil at field capacity, wilting point and available water because the increase in water retained in the soil at field capacity is far beyond that at wilting percentage, available water was highly increased. (c) Decreasing soil hydraulic conductivity. Generally, mixing both types of soil conditioners together i.e. organic amendments and biofertilizer was more efficient in improving physico- chemical properties of the soil than applying each of them alone.

Keywords: Sandy soil; Bio-fertilizer; Composts; Humic acid; Soil properties; wheat; peanut crop.

INTRODUCTION

Most of newly reclaimed sandy lands in Egypt have to be put under cultivation to cope with the social and economic obligations. Such soils are poor with respect to their physico-bio-chemical properties as well as their nutritional status. Within this context, applying organic materials to soil not only generates a better nutritional state, but furthermore, positively influences the chemical and physical characteristics of the soil, which ultimately generate high production with minor environmental impact. Among organic soil amendments, which have been used in Egypt for reclamation of sandy soils are composts and humic acids. Compost (as organic fertilizer) is a very good alternative supplement for increasing the organic matter content in soil. Compost is a rich source of nutrients with high content of organic matter, which increases cation exchange capacity (CEC) and is responsible for adsorbing power of the soils up to 90 %. Cations such as Ca2+, Mg2+ and K+ are produced during decomposition. Compost also improves nutrient supply to plants and thus may reduce the input of mineral fertilizer *(Erhart et al., 2005 and Sarwar et al., 2008)*. Moreover, *EL Sedfy et al., (2008)* reported that the highest significant increase of available N, P, and K as well as the maximum value of soybean yield were realized by applying 5 ton bio- compost/fed. Also, Humic acid provides numerous benefits to soil properties and crop production. In this concern, *Pettit, (2004)* indicated that humic acids are important soil components, they can improve soil fertility and increases the availability of nutrient elements by holding them on mineral surfaces; increases cation exchange capacity, converting the mineral elements into forms available to plants. In this respect, *Badr et al., (2009)* reported in their studies that microbial inoculums Bacillus megaterium and Bacillus mucilaginous not only increased the plant growth, but also improved nutritional assimilation of plant (total N, P, and K). They also found that the differences among the four rates of used organic fertilizer (zero, 10, 20, 30 m^3 fed^{-1}) were significant. They added that, addition of (30 m^3 fed^{-1}), produced the highest values grain yields of wheat. *Salwa and, A.I. Eisa, (2011)* concluded that application of humic acid show a significant increments in weight of peanut pods and seeds (ton/ha).The highest yields for peanut and sesame seeds achieved upon treating by foliar spray with 6gm/L humic acid. They also show that increases in peanut seeds quality i.e. proteins%, P%, K% and oil % & proteins yield, P and K content were found due to foliar spray of humic acid. Many researchers have identified the influence of organic soil amendments on physical properties of soil. In this regard, *El-Sedfy et al., (2008)* found that compost increased total porosity and enhanced the soil structure, quality of the pore system and leads to enhancement of hydraulic properties. He found also highly significant increments of total porosity and available water content on sandy soils were achieved by applying 5 ton bio compost/fed Also, *Hussein and Hassan, (2011)* reported that compost significantly improved soil bulk density, soil moisture content. In addition, Humic acids can significantly reduce water evaporation and increase its use by plants in non-day, arid, and sandy soils. Furthermore, it enhances water retention and increases water holding capacity of soils.

Microorganisms which can either fix atmospheric nitrogen, solubilize phosphate, synthesis of growth promoting substances or by enhancing the decomposition of plant residues to release vital nutrients and increase humic content of soils, will be environmentally begin approach for nutrient management*(Cakmakci et al., 2005). Metin et al., (2010)* reported that soil microorganisms are important components in the natural soil sub ecosystem because not only can they contribute to nutrient availability in the soil, but also bind soil particles into stable aggregates, which improve soil structure and reduce erosion potential .

The main target of the current study is to identify the beneficial effect of incorporating both of compost and humic acid as organic amendments and/or bio fertilizers individually or in combination at applied rates on soil fertility, soil physical properties for improving sandy soil productivity of peanut and wheat crops.

MATERIALS AND METHODS

A field experiment was conducted on a newly reclaimed sandy textured soil under sprinkler irrigation system at Ismailia Agricultural Research Station, Ismailia Governorate, Egypt, which located between Latitude 30° 35' 30" N, Longitude 32° 14' 50" E and elevation 3 meters from the sea level, and cultivated with Wheat plants as a winter crop and peanut plants as a summer crop during the agricultural growing seasons of (2009/2010) and (2010), respectively. Some physical and chemical characteristics of the studied soil before planting were presented in Table 1 which was determined according to *Page et al., (1982)*

The field experiment was laid in split plot design with three replicates. The plot area was 15.36 m^2 (3.2 m × 4.8 m). The experiment included ten treatments, two rates of biofertilizers and five additions of organic amendments. Biofertilizers were placed in the main plots. Meanwhile, organic fertilizers were devoted in the sub - plots.

The main plots were divided to:

- Without biofertilizers which denoted (BIO1)
- With Cerealien (nitrogen – fixing Cyanobacteria) which denoted (BIO2).

The biofertilizers were produced by Agricultural Microbiology department, Soil Water and Environmental Institute.

The sub – plots were assigned for:

- Control (without additions).
- Compost at rates of (2.5, 5 and 7.5 ton/fed).
- Humic acid that was applied as soil drenching with the rate of (5L/fed).

Table 1: Some characteristics of the experimental soil.

a. Soil physical properties			
Particle size distribution %:		Hydraulic conductivity (m day^{-1})	12.50
Coarse sand	86.20	Field capacity (% v/v)	5.52
Fine sand	4.23	Wilting point (% v/v)	1.06
Silt	3.76	Available water (% v/v)	4.46
Texture class	sandy	Total porosity %	37.54
		Bulk density (Mg m^{-3})	1.75
b. Soil chemical properties			
Soil pH (1:2.5)[1]	8.03	Organic matter content %	0.19
ECe (dSm^{-1})[2]	0.50	$CaCO_3$ content %	0.21
Cations (mmolc L^{-1}):		c. Available macro (mg kg^{-1}soil)	
Ca^{++}	0.81	N	10
Mg^{++}	0.70		
Na^{+}	1.76	P	8
K^{+}	0.30		
*Anions (mmolc L^{-1})**		K	47.50
HCO_3^{-}	3.59		
Cl^{-}	1.34		
SO_4^{--}	0.03		

***No soluble carbonates were detected [1]1:2.5 w/v soil: water suspension [2]Soil paste extract**

Wheat grains *(Triticumvulgare)* C.V. Giza 168 was sown on 15th November in 2009/2010 season and Peanut seeds *(Arachishypogaeal.)* C.V. Giza 4 was planted on 21thin May in 2010 season. Plants were fertilized by N, P, and K according to the general recommendations in the proper time. The normal agronomic practices of growing wheat and peanut were practiced till harvest as recommended.

At harvest time; 6 and 4 months after planting of wheat and peanut, respectively, plants of each plot were cut, air dried, grain yields (Kg/fed) were achieved. Oven dried plant samples were analyzed for N, P, and K as described by *Chapman and Pratt (1961).*

The undisturbed soil samples were used to determine some physical properties. Soil bulk density was determined using the core method technique according to *Black (1982).* The saturated hydraulic conductivity (Ks) was determined with constant head method at laboratory according to *Klute and Drieksen (1986).*Soil moisture characteristics were determined according to *Stakman (1966).* Pore size distribution was calculated from the soil moisture retention curve according to *De-Leenheer and De-Boot (1965).* The disturbed soil samples air-dried and ground to pass a 2mm screen and kept for chemical analysis. Particle size distribution was carried out by pipette method by *Gee Bander (1986).*Soil samples were analyzed for available NPK according to the method described by *Dewis and Freitas (1970).* Organic carbon was determined by modified Walkely – Black method (*Jackson, 1967).* Data were analyzed using the SAS statistical package for analysis of variance *(ANOVA, SAS institute, 1982)* according to *Snedecor and Cochroan (1976).*

RESULTS AND DISCUSSION

Effect of bio and organic soil amendments on soil fertility status

- **Soil fertility status as expressed by nutrients availability**

It is well known that availability of nutrients in sandy soils is low. Under the conditions of conducted experiment, available N, P and K were 10, 8 and 47.50(mg kg^{-1}soil) respectively, that refer to poor nutritional status of the studied soils, Table 1.

Data presented in Table 2 show the amounts of some available macronutrients i.e. N, P and K (mg kg^{-1}soil) in the studied soil under the effect of different treatments. Generally, data show that the available N, P, and K in soil were significantly enhanced by using organic amendments and/or bio-fertilizer after wheat and peanut.

Using compost alone as a soil amendment raised its nutrients availability by 39.34%, 76.90% and102.54% for N, 22.35%, 33.76% and 48.23% for P and 10.01%, 21% and 33.09% for K after wheat crop. While, nutrients availability raised by 18.8%, 50.48% and 84% for N, 25.24%,38.68% and 53.89% for P and 10%, 21% and 33.08% for K after peanut harvesting due to application of compost at a rate of 2.5, 5 and 7.5 (ton fed^{-1}),respectively than that of untreated soil. It is evident that, the availability of studied nutrients is much higher by applying the combination of different used rates of compost and bio-fertilizer together than that due to addition of each of them alone. Data in Table 2 show that applying compost with association of biofertilizer raised the availability of studied nutrients to be 1.46, 1.85, and 2.13 folds for N, 1.28, 1.44 and 1.56 for P and 1.15, 1.27 and 1.39 folds for K after wheat harvesting. While, it increased by 1.26, 1.61 and 1.97 folds for N,1.31, 1.45 and1.62 folds for P and 1.15, 1.27 and 1.40 folds for K after peanut harvesting over untreated soil. On the other hand, the available of N, P, and K in the experimental soil increased with increasing the applied rates of compost and/or biofertilizers. The highest value of the availability of nutrients was obtained by using compost at rate of 7.5 (ton fed^{-1}) and inoculation with *(Bacillus Polymxa*) under wheat and peanut crops. In this context, the maximum values for available NPK were (22.64, 13.23 and 68.41 mg kg^{-1} soil) and (24.14, 13.71 and 70.46 mg kg^{-1} soil) for N, P and K in the soil after wheat and peanut harvesting, respectively, resulted from the high rate of compost 7.5(ton fed^{-1}) combined with biofertilizers. Data reveal that humic acid when added as individual treatment enhances the availability of essential plant nutrients (NPK) to be 1.56, 1.27, and 1.15 folds and 1.41, 1.33, and 1.15 folds for NPK after wheat and peanut harvesting, respectively. The highest consequent increase in the availability of the studied nutrients was occurred with application humic acid in combination with biofertlizers that amounted for N, P, and K consequently to be 64.69%, 33.29% and 20.71% after wheat harvest while, the corresponding increases in the nutrients availability were 47.84%, 39.50%, and 20.65% for N, P and K in sequence after peanut harvest over untreated soil.

Table 2: Effect of applied bio and organic amendments on the availability of some macronutrient contents in soils after peanut and wheat

Treatments / Crops			Wheat Available macronutrients (mg Kg^{-1}soil)			peanut Available macronutrients (mg Kg^{-1}soil)		
Bio fertilizers	Organic fertilizers		N	P	K	N	P	K
BIO1	Control (Untreated soil)		10.65	8.50	48.95	12.25	8.48	50.42
	Compost (ton/fed)	2.5	14.84	10.40	53.85	14.85	10.62	55.46
		5	18.81	11.67	59.23	18.81	11.76	61.01
		7.5	21.57	12.60	65.15	23.00	13.05	67.10
	Humic acid (L/fed)	5	16.65	10.79	56.27	17.25	11.26	57.96
BIO2	Control		11.18	8.92	51.40	12.86	8.91	52.94
	Compost (ton/fed)	2.5	15.55	10.92	56.54	15.48	11.14	58.23
		5	19.75	12.25	62.19	19.68	12.36	64.06
		7.5	22.64	13.23	68.41	24.14	13.71	70.46
	Humic acid (L/fed)	5	17.54	11.33	59.09	18.11	11.83	60.83
LSD at 5%								
Organic			0.551**	0.372**	0.088**	0.852**	0.115**	0.088**
BIO			0.349**	0.235**	0.055**	0.539**	0.073**	0.550**
Organic*BIO			N.S	N.S	0.124**	N.S.	N.S.	0.124**

This is true, since humic acid partially capable to retain nutrients for growing plants, where it would act as complex agents *(Mackowiak et al., 2001)*.The statistical analyses show that soil N, P, and K significantly affected by both organic amendments and biofertilizers after wheat and peanut. These results are agreed with *Rifat et al. (2010)* reported that a bio-fertilizer helps in fixing N2, solubilizing mineral phosphates and other nutrients. Increasing the soil content of NPK due to the application of organic fertilizers might be a result of its decomposition and producing organic acids, which increases the nutrients availability in the soil. It might also, be due to the additions of these nutrients after the decomposition of the organic fertilizers and preventing fixation of P and probably other nutrients. This is in agreement with *(Ahmed and Ali, 2005)*.

- **Soil organic matter content**

Concerning the effect of organic amendments and biofertilizer on soil organic matter content (%), data in Table 3 show significant differences between treatments. Addition of compost alone and/or in combination with biofertilizer enhanced organic matter status of soil significantly after wheat and peanut. So, Compost when added alone to soil raises the content of soil organic matter being higher with the higher rate of compost. On the other word, using compost alone at a rate of 2.5, 5 and 7.5 (ton fed^{-1}) increased organic matter content of the soil to be 1.74, 1.79 and 2.11 and 1.82, 2.14 and 2.32 times after wheat and peanut respectively, as compared to untreated soil. Similarly, by adding of biofertilizers alone to the soil, the increase in its organic matter contents over that of the untreated soil reached about of 1.37 and 1.79 times after wheat and peanut, in consequence.

By adding mixtures of compost and biofertilizer to the soil, the increase in organic matter contents over that of the untreated soil were 1.84, 2.42 and 2.79 times with applying 2.5, 5, and 7.5 (ton fed $^{-1}$) compost after wheat harvesting. Similar trend of organic matter enhancement was noticed after peanut harvesting with further improvement of organic matter status of soil. The increase rates were 1.89, 2.21 and 2.43 times with 2.5, 5, and 7.5 (ton fed^{-1}), respectively over that of the untreated soil. It was observed that high rates of compost resulted in pronounced increase of soil organic matter status. A combination of compost and bio fertilizer proved further helpful in increasing the organic matter level of the soil. Similar results were also obtained by *Sarwar et al., (2008).*

Table 3: Effect of applied bio and organic amendments on soil organic matter content after wheat and peanut

Treatments \ Crops			Wheat	peanut
Biofertilizers	Organic fertilizers		OM (%)	OM (%)
BIO1	Control (Untreated soil)		0.19	0.28
	Compost (ton/fed)	2.5	0.33	0.51
		5	0.34	0.60
		7.5	0.40	0.65
	Humic acid (L/fed)	5	0.34	0.56
BIO2	Control		0.26	0.50
	Compost (ton/fed)	2.5	0.35	0.53
		5	0.46	0.62
		7.5	0.53	0.68
	Humic acid (L/fed)	5	0.52	0.58
LSD at 5%				
Organic			*0.050***	0.0055**
BIO			*0.030***	0.0036**
Organic*BIO			*0.07**	N.S

It is worthy to mention that humic acid is touted as an organic soil additive which has positive effect on soil organic matter content. Data presented in Table 3 show that conditioning the soil with humic acid alone increased the values of soil organic matter by 1.78 and 2 times after wheat and peanut harvesting, respectively versus untreated treatment. Where the values of organic matter content were much higher by adding mixtures of humic acids and biofertilizers to the soil, the increase in its organic matter over that of untreated soil were 2.74 and 2.1 times after wheat and peanut harvesting, respectively.

The statistical analyses show that soil organic matter contents after peanut significantly affected by application each of organic amendments and biofertilizers alone or in combination. Humic acid improves physical, chemical, and biological properties of the soil and influences plant growth. In this concern, these results are in harmony with those obtained by *Hussein* *and Hassan (2011)* and *(Mantripukhri, 2006)* who indicated that humic acids can improve nutrient availability and have impact on other important chemical, biological, and physical properties of soils. Also, Foliar application of humic acids increased the uptake of P and K. Bio-fertilizers, especially those containing N- fixing bacteria, were suggested to reduce the used mineral fertilizer quantities and produce clean and healthy crops.

- **Effect of bio and organic soil amendments on nutritional status of wheat and peanut seeds**

Obtained results recorded in Table 4 reveal that application of organic and/or bio sources significantly enhanced nitrogen, phosphorus, and potassium concentrations in wheat and peanut seeds. In this regard, data reveal that the N, P, and K concentration in seeds of wheat and peanut increased with all treatments compared to untreated soil. Whereas, incorporating compost alone at different rates in the sandy soil led to consequent increases in the concentration of studied nutrients. The highest increases associated with compost application alone at rate of 7.5(ton fed^{-1}). Consequently, N concentration increased over the untreated soil in wheat and peanut seeds with 1.54, 1.88 times respectively. When, the corresponding values of P were 1.52 and 1.44 and were 1.72, 1.58 times for K, respectively.

Table 4: Effect of applied bio and organic amendments on some macronutrient contents (%) of wheat and peanut seed

Treatments / Crops			Wheat Macronutrients contents (%)			peanut Macronutrients contents (%)		
Bio fertilizers	Organic fertilizers		N	P	K	N	P	K
BIO1	Control (Untreated soil)		1.63	0.165	1.09	1.98	0.18	1.22
	Compost (ton/fed)	2.5	2.27	0.215	1.24	2.83	0.23	1.27
		5	2.33	0.240	1.53	3.18	0.25	1.56
		7.5	2.51	0.250	1.88	3.73	0.26	1.93
	Humic acid (L/fed)	5	2.27	0.230	1.34	2.86	0.24	1.37
BIO2	Control		1.71	0.175	1.14	2.04	0.19	1.16
	Compost (ton/fed)	2.5	2.39	0.225	1.30	2.96	0.24	1.33
		5	2.45	0.250	1.60	3.35	0.26	1.64
		7.5	2.63	0.260	1.97	3.92	0.27	2.02
	Humic acid (L/fed)	5	2.38	0.240	1.41	3.01	0.25	1.45
LSD at 5%								
Organic			0.074**	0.0075**	0.0051**	0.038**	0.0075**	0.072**
BIO			0.047**	0.0048**	0.0032**	0.025**	0.0048**	0. 0458*
Organic*BIO			N. S	N.S	0.007**	0.055**	N.S	N.S

Data in Table 4 indicate the effect of using biofertilizers individually and pointed out that the concentration of nitrogen, phosphorus and potassium in the studied crops seeds significantly increased by inoculation of seeds with biofertilizers (*Bacillus Polymxa)* when compared with untreated soil (without inoculation) to amounted of 1.71 and 2.04% for N %, 0.175 and 0.19% for P %, 1.14 and 1.16 for K % for wheat and peanut seeds respectively, compared with untreated soil (without inoculation). Glance on Table 4, it is clear that compost application jointly with biofertilizers in the sandy soil led to consequent increases in the concentration of studied nutrients in plant seeds after harvest than untreated soil and those obtained when applying each of them solely. Hence, the concentrations of N, P, and K in the seeds were increasing with increasing the applied rates of compost and /or biofertilizer. It is worth to mention that, more increase in nutrients concentration was obtained by doubling the rate of compost to be 5 (ton fed^{-1}) and mixing with biofertilizers, to be 1.50 and 1.69 times for N; 1.52 and 1.4 times for P ; 1.47 and 1.34 times for K that of the untreated soil for seeds of wheat and peanut respectively. It is evident that, using compost at rate of 7.5 (ton fed^{-1}) with biofertilizer in the sandy soil led to the highest consequent increase in the concentration of studied nutrients in the seeds that amounted to 61.35% and 97.98% for N, 57.57% and 50% for P and 80.73% and 65.57% for K compared to the untreated soil at harvesting of wheat and peanut, respectively

Generally the obtained increases in macronutrient concentration in seeds may be due to the increase the nutrients availability in the soil. These beneficial effects are more attributed to the improvements status of soil-water regime of studied sandy soil, consequently increasing nutrients availability for plants. It is well known that, during the decomposition of organic matter, macro and micronutrients are incorporated into the soil matrix, allowing the soil to act as a reservoir of these nutrients. These nutrients will be released, to become available for uptake by plants. Otherwise, humus which is the final component of organic matter decomposition, accumulate in the environmental systems to increase moisture retention and nutrient supply potentials of soils. *(Suganya and Sivasamy, 2006)*

Concerning the effect of addition of humic acid, the same Table shows that, when applying humic acid alone at rate of 5 (L fed^{-1}) to the soil positively increased nutrients concentration in seeds of wheat and peanut. The increase in nutrients concentration over that of the non-conditioned soil were 39.26% and 44.44% for N, 39.39% and 33.33% for P and 22.93% and 12.30% for K in wheat and peanut seeds, respectively. The highest consequent increase in the nutrients concentration was occurred with application humic acid combind with biofertlizers that amounted for N, P, and K consequently to 46.01%, 45.45% and 29.36% after wheat harvest while, the corresponding increases in the nutrients concentration in seeds of peanut were 52.02%, 38.88%, and 18.85% for N, P and K in sequence. These results are in agreement with *Antoun et al., (2010)*. Generally the obtained increases in macronutrient concentrations in seeds may be due to the availability of them in the soil. Moreover, the role of humic substances application is mainly related to the enrichment of nutrients content where these humic substances increases soil's cation exchange capacity (ability to hold and release cations such as K^+ , Ca^{+2} , or NH_4^+), and can also form aqueous complexes with micronutrients. These effects were associated with increasing nutrients concentration in wheat and peanut seeds.

- **Effect of bio and organic soil amendments on yield of wheat and peanut**

Data presented in Table 5 show the effect of conditioning sandy soil with compost and/ or biofertilizer individually or their mixtures on the productivity of the soil. It is evident that such effects depend on the rate of applied organic amendment and the nature of the used biofertilizer. Data reveal that the yield of seeds was significantly increased due to application of compost individually by 24.87%, 39.08% and 42.93% and by 37.35% ,65.11% and 85.48% for wheat and peanut seeds at rate of 2.5, 5 and 7.5 (ton fed^{-1}), respectively over that of the untreated soil. It is noticed that the yield of seeds increased as the rate of compost application increased than that of untreated. Similar results were obtained by *Badr et al., (2009)*. Regarding, the interaction effect of organic fertilizer and biofertilizer on yield, the same Table show that association of organic and biofertilizer led to increase seeds yield (kg fed^{-1}). The highest values of seeds yield were obtained by using7.5 (ton fed^{-1}) compost and inoculation with *(Bacillus Polymxa)* for both wheat and peanut crops. Under these conditions, the corresponding increases were 1.50 times for wheat seeds vs 1.95 times for peanut seeds over untreated soil, in sequence. It can be concluded that biofertilizers in combination with organic fertilizers may increase the availability of nutrients for wheat plants. These results were in the same line with those obtained by *Shoman et al., (2006)* who showed that yield was significantly affected by interaction between organic fertilizer and biofertilizer. With respect to response of seeds yield to biofertilizer, data show that biofertilization with *(Bacillus Polymxa)* individually had a significant increase on seeds yield. This increment is about 1.04 and1.05 times for wheat and peanut seeds respectively.

Table 5: Effect of applied bio and organic amendments on yield (kg fed^{-1}) of wheat and peanut

peanut	Wheat	Treatments / Crops		
Yield (kg fed^{-1})	Yield (kg fed^{-1})	Organic fertilizers		Bio fertilizers
669.8	1630.10	Control (Untreated soil)		BIO1
920	2035.60	2.5	Compost (ton/fed)	
1105.9	2267.10	5		
1242.4	2329.90	7.5		
970.30	2135.70	5	Humic acid (L/fed)	
703.30	1711.60	Control		BIO2
966	2134.60	2.5	Compost (ton/fed)	
1161.20	2380.50	5		
1304.6	2446.20	7.5		
1018.80	2242.50	5	Humic acid (L/fed)	
LSD at 5%				
54.83**	21.64**	Organic		
34.67**	13.68**	BIO		
N.S	N.S.	Organic*BIO		

Obtained results might be due to the stimulation effect between organic amendments and bio-fertilizer inoculation on improving the physical properties of the soil as well as and increasing the availability of many nutrients element to plant uptake, which in turn on improving the yield and its components of wheat plants. The increment of seeds yield may be due to the positive effect of biofertilization which play important role in assimilation processes of wheat plants which reflected on enhancing these characters *(Mahdi et al., 2010)*. Moreover, the relative positive effect of bio-fertilizer treatment on yield criteria may be attributed to their N2-fixing activity and the production of plant growth promoting substances such as Indol Acetic Acid (IAA), gibberellins, and cytokinine-like substances *(Wu et al., 2005)*.

It is evident that the application of humic acid as an individual treatment show superior increases in the seeds yield of wheat and peanut crop cultivated in sandy soil. The corresponding increases were 1.31 times for wheat seeds vs 1.45 times for peanut seeds over untreated soil. It is worthy to mention that application of humic acid as organic materials in combination with biofertilizers enhanced seeds yield to be 1.37 and 1.52 for wheat and peanut, consequently. These results were in agreement by *Zaki et al. (2007)* indicated that bio-fertilizer inoculation with Azospirillum produced significant increment in all growth characters of wheat.

Effect of Applied Bio and Organic Soil Amendment on some physical properties of sandy soils:

The conditioning effect organic amendments in the form of compost and humic acid and/ or biofertilizer on some physical properties of sandy soil under consideration were estimated at the end of the growing season of peanut.

Soil Bulk Density:

Generally speaking data in Table 6 show that the measured values of soil bulk density for the studied soil. Data indicate greater decrease in bulk density values which reflect the radical effect of treatments. However, the solely organic amendments treatments show positive and significant effects for decreasing the values of soil bulk density. The greater decrease of soil bulk density values are contributed to application both of compost and humic acid solely. It is noticed also that increasing the application rate of compost is accompanied by a significance decrease in soil bulk density values. Therefore, the lowest bulk density values are attained for application compost at rate of 7.5 (ton fed^{-1}) and humic acid at rate of 5 (L fed^{-1}) individually. The relative mean of decrease are 8.48% and 3.64% as compared to untreated soil resulted from applying compost at rate of 7.5 (ton fed^{-1}) and humic acid at rate of 5 (L fed^{-1}), respectively. While, the relative mean of decrease is 3.64% in the case of using biofertilizer alone as soil conditioner than that of untreated soil.

Table 6: Effect of Bio and Organic amendments on some physical properties in sandy soils soil

Treatments			Bulk density (Mg m^{-3})	Total Porosity %	Pore size distribution		
					Macro-pores	Micro-pores (<28.8µ)	
Bio fertilizers	Organic fertilizers				Drainable pores (>28.8µ)	Water Holding pores (28.8-0.19 µ)	Fine capillary pores (<0.19µ)
BIO1	Control (Untreated soil)		1.65	39.02	28.74	8.61	1.67
	Compost (ton/fed)	2.5	1.62	41.69	28.19	11.06	2.44
		5	1.61	43.09	27.84	12.68	2.57
		7.5	1.51	41.93	23.82	14.77	3.34
	Humic acid (L/fed)	5	1.59	42.23	26.30	13.42	2.51
BIO2	Control		1.59	41.60	24.42	14.45	2.73
	Compost (ton/fed)	2.5	1.57	41.35	24.04	14.44	2.87
		5	1.51	41.47	22.78	15.35	3.34
		7.5	1.47	44.91	20.68	18.56	5.67
	Humic acid (L/fed)	5	1.55	43.86	23.11	16.22	4.53
LSD at 5%							
Organic			0.014**	0.69**	0.65**	0.78**	0.24**
BIO			0.0089**	0.44**	0.41**	0.49**	0.24**
Organic*BIO			0.020*	0.98**	0.92**	1.11*	0.34**

Data show that application of bio fertilizer combined with organic amendments is more effective than applying each of them alone. The significant changes in bulk density values from the sole treatments give indication of good interactions among the applied of microbiological strain with the organic amendments. The decrease in bulk density of the soil relative to that of the untreated soil were 4.85%, 8.48%, 10.90% and 6.06% due to the application of bio fertilizer combined with compost at rate of 2.5, 5 and 7.5 (ton fed^{-1}) and humic acid 5 (L fed^{-1}), sequentially. This probably due to the favorable effect of organic matter and bio-fertilizer content on soil structure, which was reflected on the soil bulk density. Soil bulk density significantly decreased with addition of organic amendments and effective microorganisms hence, this can be attributed to the low specific gravity of organic materials and the role of organic products in enhancing soil aggregation which increase the apparent soil volume and consequently decrease bulk density these results in agreement with (*Tejada and Gonzalez 2006a).*

Total Porosity, Macro, and Micro Porosity:

From data in Table 6, Values of soil porosity and macro and micro-porosity are positively influenced as a result of applied organic soil conditioners individually however, soil organic conditioning imposed significantly decreased on the macro-porosity (drainable pores having the diameter of > 28.8 µ) relative to those of untreated soil. This decrease was calculated to be 1.91%, 3.13%, 17.12%, 8, 49% for the macro porosity due to the individual application of compost at rates of 2.5,5 and 7.5(ton fed^{-1}) and humic acid at rate of 5 (L fed^{-1}), respectively. When culture of *(Bacillus polymyxa)* is used as bio-fertilizers, individually the relevant decrease was 15.03% for the macro pores. It is of interest to mention that the macro porosity was taken as the air filled porosity when the soil water system was in equilibrium with 100 cm suction *(Loveday, 1974)*. These results are in agreement with, *El-Hady and Abo-Sedera (2006)*

In regard to the effect of added bio fertilizer or organic conditioners individually on total porosity and micro porosity specially those, which hold available moisture to plants i.e. water holding pores (WHP) having the diameters of (28.8 - 0.19 µ) and fine capillary pores (FCP) having diameter of (< 0.19µ), the data took an opposite trend to that of bulk density and macro porosity. In this connection, total porosity increased with the additions of organic amendments in all the treatments. The highest increase was calculated to be 10.43% was associated with the application of compost 5 (ton fed^{-1}), whereas the lowest one was about 6.84% which detected with added compost at rate of 2.5 (ton fed^{-1}) treatments. Also, data reveal that the increase in total porosity due to individual application of humic acid 5(Lfed^{-1}) and biofertilizer are about 8.25% and, 6.64% than that untreated soil.

Concerning, micro porosity (WHP and FCP); data reveal a marked changes of WHP as well as FCP as compared to that untreated soil. These changes are pointed on increasing of WHP and FCP as the application rate of compost increase. The more pronounced increase in WHP was found when soil treated with compost at rate of 7.5 (ton fed^{-1}) and humic acid 5(L/fed^{-1}) individually, Therefore, WHP and FCP are found to occupy a considerable volume. Hence, it forms about of 35.23%, 7.96% and 31.78%, 5.94% of total porosity, respectively.

Similarly, data of the combined effect of both organic materials and biofertilizer when added together to the soil on the aforementioned parameter showed that the decrease in the percentages of macro pores due to the application of the biofertilizer and organic amendments together were calculated to be 16.35%, 20.74% 28.04% and 19.59% for the combination mentioned above, in sequence. On the other hand, total porosity and water holding porosity showed higher values by application of biofertilizer in combination with organic amendments in the studied sandy soil and being higher with increasing the applied rates of the tested organic conditioners. On other words, the corresponding increase reached 5.97%, 6.28%, 15.09 % and 12.40% for total porosity and 67.7%, 78.28%, 115.56% and 88.38% for water holding pores when the studied soil conditioned with compost at rate of 2.5, 5 and 7.5 (ton fed^{-1}) and humic acid 5 (L fed^{-1}) in combination of biofertilizer, in consequence. These results are in agreement with, *El-Hady and Abo-Sedera (2006)*.

The results confirmed that more increase in application rate of compost to be 7.5 (ton fed^{-1}) greatly improved pore size distributions of treated soils towards high moisture retention and lower loss of water from the soil by leaching or deep percolation. In general, the improvement of soil porosity may be related to the increase of storage pores in the studied sandy soil and physical improvement of soil, which can be regarded as an index of an improved soil structure. Moreover, a thin coat of humate as organic material partially covered the walls interconnected vughs, which are usually the most common pores in this soil. (*Amjad et al., 2010),*

Moisture Constants:

Table 7 show the retained moisture in the soil as influenced by application of soil amendments. Data refer an increase in the percentage of retained moisture due to application of organic and/or bio sources being higher with increasing the applied rate. At saturation, (i.e. at pF=0) the total water holding capacity (WHC) of the soil was increased by 4.79 %, 5.57%, 11.91% and 8.53 % by application of compost at a rate of 2.5, 5, 7.5 (ton fed^{-1}) and humic acid (5 l fed^{-1}), respectively.

Table 7: Water holding capacity %, Field capacity (FC), Wilting point (WP), Available water (AW) and Hydraulic conductivity

Treatments			Water holding capacity (WHC) %	Filed capacity (FC) %	Wilting Percentage (WP) %	Available Moisture (AW) %	Hydraulic Conductivity (Ks) ($m.day^{-1}$)
Biofertilizers	Organic fertilizers						
BIO1	Control (Untreated soil)		21 .91	6.24	1.01	5.23	11.60
	Compost (ton/fed)	2.5	22.96	8.32	1.50	6.82	10.97
		5	23.13	9.50	1.60	7.90	10.55
		7.5	24.52	11.79	2.21	9.76	8.14
	Humic acid (L/fed)	5	23.78	10.05	1.58	8.47	10.05
BIO2	Control		23.76	10.82	1.71	9.11	10.06
	Compost (ton/fed)	2.5	24.33	11.03	1.83	9.20	9.61
		5	26.26	12.36	2.21	10.15	8.15
		7.5	27.65	16.48	3.85	12.63	5.48
	Humic acid (L/fed)	5	25.08	13.40	2.92	10.48	7.34
LSD at 5%							
Organic			0.498^{**}	0.5207^{**}	0.1500^{**}	0.5338^{**}	0.406^{**}
BIO			0.315^{**}	03293^{**}	0.0945^{**}	0.3376^{**}	0.257^{**}
Organic*BIO			0.704^{**}	0.736^{*}	0.2122^{**}	0.7550^{*}	0.575^{*}

The values of retained moisture at field capacity (FC), wilting percentage (WP), and the available water show different increases of as relative to that of the untreated soil by applying the same conditioners and same rates of the compost and/or inoculation with biofertilizer. The amounts of moisture retained into the soil at its FC increased than that of the untreated soil to be 1.33, 1.52, 1.92 and 1.61 times at its FC, 1.48, 1.58, 2.19 and 1.56 times for W.P and the corresponding increase reached 1.30, 1.51, 1.87 and 1.62 times for available water, consequently due to conditioning the soil with compost at a rate of 2.5, 5, 7.5 (ton fed^{-1}) and humic acid 5(L fed^{-1}), respectively. Likewise, the values of retained moisture at FC, W.P and available water showed increase of 1.73, 1.67, and 1.74 times as relative to that of the untreated soil as mentioned above.

Conditioning the soil with combination of organic amendment and bio fertilizer possess relatively high values of moisture retained into the soil at its FC, W.P, and available moisture. Data indicated that, the treatments of bio fertilizers which combined with compost at rate of 7.5 (ton fed^{-1}) represented the higher increase of FC and WP compared to untreated soil, and the increments were 2.64 and 3.81 times, respectively. Where, AW increased by 2.41 of the untreated soil. This due to the fact that organic substances attain a pronounced high content of active organic compounds that enhancing the water molecules to be chelated. *(Moustafa et al., 2005)*

Obtained results could be explained on the basis of increasing the smaller pores that having the diameter of 28.8 - 0.19 μ on the expense of the large ones, i.e., drainable pores having the diameter of > 28.8 μ. Moreover, the higher applied rate of the conditioners, the lower in the macro-pores in the soil. As previously mentioned, the increase of water storage pores is vital to ensure water reservation in sandy soil under dry farming conditions. It is well known that increasing available moisture for plant elongates irrigation frequencies and in turn decreases the quantities of irrigation water needed and costs of irrigation process *(El-Hady and Abo-Sedera, 2006)*.

Hydraulic Conductivity:

It is worth mentioning that the downward movement of the water by gravitational forces in natural soil is principally through the pore spaces, and depends mainly on their relative amount in the bulk volume, their diameters, and the continuity of pore paths. The hydraulic conductivity values of the soil under investigation are presented in Table 7 data show that hydraulic conductivity (Ks) values show general decrease due to conditioning soil by organic amendment and /or Bio fertilizer inoculation. In this regard the decrease in the values of (Ks) for the soil under study due to the addition of compost only with different rates 2.5 ,5, and 7.5 (ton fed^{-1}) and humic acid 5 (L fed^{-1}) reached 5.43%, 9.05% , 29.83% and 13.36%, respectively that of untreated soil. Hence, (Ks) values show general decrease by increasing the application rate of compost. It's worthy to mention that using biofertilizer only was also able to reduce the values of (Ks) and the decrease amounted to13.27% that of un-treated soil.

The combined effect of the application of both techniques combination for conditioning sandy soil, i.e. compost with biofertilization is more effective than using each of them alone. By adding compost with inoculation by bio fertilizer reduced the (Ks) values of the soil under study. The decrease in its (Ks) values over that of the untreated soil treatment was 17.15% with Bio fertilizer +compost at rate of 2.5 (ton fed^{-1}). Then, the values of Ks decrease gradually by increasing the application rates of compost in the presence of inoculation of bio fertilizer. Moreover, the combined effect of incorporating both Humic acid biofertilizer together into studied soil was clear, where the value of (Ks) was much lower. Where, the decrease reached 36.72% that of un-treated.

The improvement or the pronounced decrease in hydraulic conductivity of the studied sandy soil may be attributed to the creation of micro pores, and the dominance of meso and micro pores on the expose other pore sizes. These results are in agreement with those of *(El-Fayoumy and Ramadan 2002).*

CONCLUSION

The integrated soil management and nutrient supply through judicious use of various sources of nutrients that will lead to improving the soil and high crop production. The beneficial effect of the organic amendments i.e compost and humic acid was more attributed with enhancing the biological activity in the soil which has ability to encourage the released nutrients in more mobile or available forms to uptake by plant roots. Consequently, these benefits are reflected positively on development of yield. Moreover, the above findings clearly indicated the usefulness and superiority of compost, humic acid, and bio fertilizer as soil conditioners in improving the physical properties of sandy soil. From all these information available it can be concluded that application compost the rate of 7.5 (ton fed $^{-1}$) or humic acid at 5 (L fed^{-1}) individually or in combination of bio fertilizer could bring out large scale improvement in soil bulk density, soil porosity and consequently increase their ability to retain water and render them less prone to drought, decrease hydraulic conductivity and greatly improve fertility status of sandy soils ensuring better yield of crops. Biofertilizers application in agriculture will have greater impact on organic agriculture and also on the control of environmental pollution, soil health improvement, and reduction in input use. So, we recommend using a mixture of selected effective microorganisms in combination with compost or humic acid in agriculture production.

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تأثير بعض المصلحات العضوية والحيوية على خصوبة و بعض خواص وإنتاجية الأراضى الرملية

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أجريت تجربة حقلية على أرض رملية القوام تحت نظام الرى بالرش خلال موسميين زراعيين متعاقبيين (٢٠٠٩-٢٠١٠) و(٢٠١٠) بمحطة البحوث الزراعية بالإسماعيلية بمركز البحوث الزراعية- محافظة الإسماعيلية- مصر. وذلك لتقييم أهمية إضافة بعض المحسنات العضوية مثل الكمبوست بمعدلات (٢,٥، ٥، ٧,٥) طن / فدان و حمض الهيوميك بمعدل ٥ لتر/فدان والسماد الحيوى *(Bacillus Polymxa)* سواء فى صورة مفردة أو مخلوطة على كل من خصوبة التربة و بعض الخواص الهيدرو فيزيقية وكذلك إنتاجية محصولى القمح *(Triticumvulgare)* C.V. Giza 168 و الفول السودانى *(Arachishypogaeal.)* C.V. Giza 4. وقد صممت التجربة بإستخدام القطع المنشقة مرة واحدة بثلاث مكررات وخصصت القطع الرئيسية الرئيسية للسماد الحيوى بينما خصصت القطع تحت الرئيسية للمحسنات العضوية (كمبوست،حامض هيوميك). قدرت بعض الخواص الكيميائية و الهيدرو فيزيقية فى نهاية موسم النمو (بعد ٦ و ٤ شهور من زراعة كل من القمح والفول السودانى على التوالى).

وقد أظهرت النتائج أن إضافة كلا من المحسنات العضوية والحيوية بصورة منفردة أو مخلوطة قد أدت إلى تحسين كل من خصوبة التربة و محصول الحبوب لكل من القمح والفول السودانى وهى كالأتى :

(أ)زيادة تيسر المغذيات (NPK)فى التربة ، (ب) زيادة محتوى المادة العضوية فى التربة.ووجد أن إضافة كلا المحسنات الأرضية سواء العضوية أو الحيوية معا بصورة مشتركة أدى إلى تحسين الخواص الكيميائية للأرض مقارنة بإضافة كل منها على حده.وفى هذا الصدد نجد أن أقصى محتوى للعناصر الغذائية الميسرة (NPK) كان (٢٢,٦٤، ١٣,٢٣، ٦٨,٤١ ملجم كجم$^{-1}$) ، (٢٤,١٤ ، ١٣,٧١ ، ٧٠,٤٦ ملجم كجم$^{-1}$) للنترجين والفوسفور والبوتاسيوم بعد حصاد القمح والفول على التوالى وعند إضافة الكمبوست بمعدل (٧,٥طن/ فدان) مخلوطا مع المصلح الحيوى.(ج) زيادة تركيز العناصر المغذية وهى النترجين والفوسفور والبوتاسيوم فى الحبوب مع زيادة محصول الحبوب ويلاحظ أيضا زيادة محصول الحبوب زيادة معنوية بزيادة معدل إضافة السماد العضوى فعند إضافة الكمبوست بمعدل(٧,٥طن/ فدان) مخلوطا مع المصلح الحيوى ليصل إلى (١,٥٠)،(١,٩٥) ضعف للقمح و الفول السودانى مقارنة بالكنترول على التوالى.

أدت إضافة المصلحات الأرضية إلى تحسين الخواص الهيدروفيزيقية للأراضى وتشمل الأتى :

(أ) نقص الكثافة الظاهرية وكذلك المسام الواسعة (مسام الصرف) على حساب المسام الضيقة ولذلك تزيدالمسام الحاملة للماء(WHP) ، (ب) زيادة قدرة الأرض وسعتها على الإحتفاظ بالرطوبة الأرضية عند السعة الحقلية ونقطة الذبول والماء الميسر . وزيادة نسبة الرطوبة عند السعة الحقلية عنها عند نقطة الذبول يزيد الماء الميسر زيادة كبيرة، (ج) انخفاض قيم معامل التوصيل الهيدروليكى. وبصفة عامة فإن إستخدام خليط من المصلحات الأرضية فى صورة مصلحات عضوية أو حيوية معا يكون أكثر كفاءة فى تحسين خواص الأرض الطبيعية و الكيميائية عن إستخدام كل منهما على حده.

قام بتحكيم البحث

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