J. Agric. Sci. Mansoura Univ., 27(10): 7117 - 7126, 2002

EFFECT OF BENTONITE, COMPOST AND BIOFERTILIZER ADDITIONS ON SOME PHYSICAL PROPERTIES OF SANDY SOIL AND WHEAT AND PEANUT YIELDS.

El Sedfy, O.F.
Soil, Water & Environment Institute, Agri. Res. Center, Giza, Egypt

ABSTRACT

The present investigation aims at studying the individual effect of soil conditioning, i.e., bentonite, compost and biofertilizer on NPK availability, some sandy physical properties, wheat and peanut, growth and yield. Therefore, a field experiment was conducted out at Ismailia Agric. Res. St.

The used conditioners were bentonite, compost, commercial biofertilizer and their mixture. These conditioners were mixed and incorporated into the surface soil layer (0-20cm) at different rates before cultivation of wheat. The soil availability of macronutrients and NPK contents and the yield of wheat and peanut grains were determined after two successive growth seasons (winter 2000/2001 and summer 2001).

The obtained results indicated that the addition of compost (10 ton/fed.) alone or mixed with biofertilizer gave the high values of organic matter content, while applying bentonite (10 ton/fed.) followed by compost (10 ton/fed.) markedly decreased the soil hydraulic conductivity.

The maximum values of available N P were obtained by applying compost (10 ton/fed.) as well as applying compost (10 ton/fed.) mixed with biofertilizer. While, the highest value of available K was realized by applying either bentonite (10 ton/fed.) or mixture of bentonite (10 ton/fed.) and biofertilizer.

The best values of NPK concentrations and also the yield of wheat and peanut were obtained by applying compost (10 ton/fed.) mixed with biofertilizer.

Keywords: Sandy soil, hydraulic conductivity, available NPK, bentonite, compost, biofertilizer, wheat, peanut.

INTRODUCTION

The use of natural soil conditioners is an effective method for improving soil physical and hydrophysical properties and to find the optimum conditions for plant growth and giving clean yield production without any pollution. El-Hady, 1979, Fahim, 1986, Awad, 1989 and El-Komas and Selem, 1989 stated that the addition of bentonite, agrosok and poudrutte can be used for improving moisture retentivity and fertility of sandy soils. In this concern, the use of farmyard manure as soil conditioner improved the hydrological characters of the sandy soil as well as it furnished the plants with adequate nutrients (El-Badry and Asaad, 1983).

The addition of bentonite and /or organic manure to sandy soil increased the concentration of N, P and K in grains of wheat and soybean, consequently the yield increased (Lotfy and El-Hady, 1984; El-Sokkary and El-Keiry, 1989).

The biofertilizer is a cheap technique to produce plants proteins, mainly in developing countries. The symbiotic nitrogen fixing bacteria are

considered to be one of the most important organisms playing an important role in soil fertility (Neyra and Dobereiner, 1977).

Great efforts are now made to improve crop production of the none leguminous plants through inoculation with a syrnbiotic N–fixing bacteria, particularly Azotobacter and Azospirillum (Boddey *et al.*, 1991).

The present work was designed to study the effect of application of bentonite, compost and biofertilizer as soil conditioners on some sandy soil physical properties and growth and yields of wheat and peanut crops.

MATERIALS AND METHODS

A field experiment was conducted at Ismailia Station to study the effect of application of bentonite, compost and bio-fertilizer on some physical properties of sandy soil and growth and yields of wheat and peanut. Some physical and chemical characteristics of the soil surface under investigation as well as bentonite and compost analyses were determined according to Jackson, 1967 and shown in Tables (1-3).

Table (1): Mechanical and chemical analyses of the investigated soil.

Particle size distribution									
Coarse sand%	Fine sand%	Silt %	Clay %	$CaCO_3$ %	O.M %	Texture			
73.61	15.23	0.34	10.82	0.28	0.40	Sand			
pH 1:2.5	EC dS/m	SP %	Soluble ions meq/L						
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}$	HCO^{-}	Cl^{-}	$SO_4^{=}$
8.04	0.39	20	0.24	0.32	2.62	0.24	--	0.21	0.32	2.89

Table (2): a-Some physical and chemical properties of the used bentonite.

Particle size distribution								
Coarse sand%	Fine sand%	Silt %	Clay %	$CaCO_3$ %	O.M %	Texture		
22.9	2.20	30.0	44.9	30.9	0.18	clay		
pH 1:2.5	EC dS/m	Soluble ions meq/L(soil extract 1:5)						
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO^{=}$	HCO^{-}	Cl^{-}	$SO_4^{=}$
7.78	3.85	2.47	19.40	16.5	0.34	--	0.75	4.77	33.19

b- Bentonite analysis

Analysis	Measurement
Density (g/cm^3)	0.83
Organic carbon %	0.10
Total N %	0.54
Total P %	0.03
Total K %	1.21
C/N ratio	0.19

Table (3): Compost manure analysis.

Analysis	Measurement
Moisture contents %	20.53
pH	7.97
EC mmhos/cm at 25 °C (soil extract 1:5)	2.60
Density (g/cm^3)	0.45
Organic matter %	37.62
Organic carbon %	21.15
Total N %	1.12
Total P %	0.27
Total K %	0.36
C/N ratio	18:1

A complete block randomized design in three replications was used in this experiment. Each plot was 3x3.5m^2
The treatments were as follows:

1. Bentonite (10 ton/fed.)
2. Compost (10 ton/fed.)
3. Bentonite (5 ton/fed) + Compost (5 ton/fed.)
4. Bentonite (10 ton/fed.) + Bio-fertilizer*
5. Compost (10ton/fed.) + Bio-fertilizer
6. Bentonite (5 ton/fed) + Compost (5 ton/fed.) + Bio-fertilizer
7. Control (without additions of any fertilizer)

**Commercial biofertilizers "Microbin" for peanut and "Cerealine" for wheat were added by inoculcating the seeds before sowing. These biofertilizers supplied from Ministry of Agriculture.*

The previous treatments were mixed with the surface soil layer by hatchet. Then, the area was planted by wheat (*Triticum vulgare*) c.v. Sakha 169 and peanut (*Arachis hypogaea* L.) c.v. Giza 4 for two successive growth seasons (2000-2001) under sprinkler irrigation system. The recommended dose of macro and micro nutrients were added for both crops.

At harvest time; 6 and 4 months after sowing wheat and peanut respectively, plants of each plot were cut, air dried and yield (seed and grains) (kg/f) and 100 grain and seed weight were achieved. Oven dried plant samples were analyzed for N, P and K as described by Chapman & Pratt (1961). Soil samples were analyzed for available N, P and K according to the method described by Dewis and Freitas, (1970). Organic carbon was determined by modified Walkely –Black method (Jackson, 1967). Soil hydraulic conductivity was determined using undisturbed samples from the cores (Black, 1965).

Analysis of variance was statistically Analysed according to Snedecor and Cochran (1976) using SAS program (SAS Institute, 1982).

RESULTS AND DISCUSSION

1- Effect of different treatment on some soil physical properties:

1. a- Organic matter:

Data in Table (4) show that all treatments increased the organic matter concentration of the studied sandy soil. The results indicated that addition of 10 ton compost /fed increased the O.M concentration from 0.44% (control treatment) to 0.59%; this increase is due to the high concentration of O.M in the applied compost, (37.62%). It was noticed that the application of compost and bio-fertilizer as a mixture to sandy soil as well as mixture of bentonite, compost and bio-fertilizer raised the organic matter concentration of sandy soil up to 0.64% and 0.55%, Table(4). This increase could attributed to the activity of the organisms of the bio-fertilizer which enhanced the hydrolysis of applied compost and consequently the soil organic matter concentration increased. The lowest value of soil organic matter was observed with the application of bentonite (10 ton/fed.), Table (4).

1.b- Hydraulic conductivity:

The high value of clay concentration in the applied bentonite as well as the high values of organic matter resulted in the application of compost alone or mixed with biofertilizer reflected on soil hydraulic conductivity.

Table (4): Effect of different treatments on soil hydraulic conductivity (K) and organic matter under wheat and peanut crops.

Treatment No.	Winter season(wheat)		Summer season(peanut)	
	K m/day	O.M %	K m/day	O.M %
1	1.95	0.47	2.31	0.45
2	2.09	0.59	2.34	0.58
3	2.77	0.49	3.25	0.48
4	2.44	0.50	2.52	0.48
5	2.24	0.64	2.46	0.59
6	3.00	0.55	3.08	0.55
7	3.76	0.44	4.00	0.43

Where the treatments were:

1. Bentonite (10 ton/fed.)
2. Compost (10 ton/fed.)
3. Bentonite (5 ton/fed.) * Compost (5 ton/ fed.)
4. Bentonite (10 ton /fed.) * biofertilizer
5. Compost (10 ton/fed.) * biofertilizer
6. Bentonite (5 ton/fed.) * Compost (5 ton/fed.)* biofertilizer
7. Control

Data in Table (4) indicated that the hydraulic conductivity of treated soils decreased after harvesting wheat crop and /or peanut crop. The data reveal that the highest decrease of soil hydraulic conductivity (K) for treated soil obtained by application of 10 ton bentonite/ feddan followed by 10 ton compost / fed. where these values decreased from 3.76 (control) to 1.95 and

2.05 m/day for treatment No. 1 and 2 respectively. Such decrease is attributed to the high concentrations of clay and organic matter from bentonite and compost, respectively. Thus, the application of such material improve the hydro physical properties of the studied sandy soil, which is in agreement with Abdel-Sabour et al., (1997) and Hamouda et al., (1999).

The low values of K for studied soil were obtained by the different mixtures (treatments No.,3, 4, 5 and 6) where the lowest value was observed by adding 5 ton bentonite with 5 ton compost / fed. with biofertilizer, treat. (No.60

The decrease of hydraulic conductivity for treated sandy soil could be attributed to the creation of soil aggregates which led to increase micro pores among sand particles. This explanation is in agreement with Moussa et al., (2000).

2-Effect of different treatments on the available NPK

2.a- Available Nitrogen (ppm):

Data in Table (5) show that all treatments increased the available N of sandy soil after harvesting of wheat crop. The highest value was obtained by applying compost alone or mixed with biofertilizer as the available N increased from 15.4 ppm to 38.5 ppm for either compost or compost and biofertilizer. These increases may be ascribed to the high nitrogen concentration in the applied compost, which increased the availability of N in the soil, Table (3). In addition the biofertilizer include symbiotic nitrogen fixing bacteria, particularly Azotobacter and Azospirillum that are considered from the most important organisms playing important role in soil fertility (Boddey *et al.*, 1991) Concerning the effect of different treatments on available N after peanut harvesting, data in Table (5) reveal that the treatments gave the same trend which mentioned above. These results are in agreement with El-Sokkary and El-Keiy, 1989 and Soliman *et al.*, 1995.

Table (5): Effect of different treatments on the available NPK in the soil.

Treatment No.	Winter season(wheat)			Summer season(peanut)		
	N (ppm)	P (ppm)	K(ppm)	N (ppm)	P (ppm)	K(ppm)
1	23.1	6.00	109.2	23.1	6.00	101.2
2	38.5	12.00	93.6	38.5	11.00	85.8
3	30.8	11.00	101.2	30.8	10.00	91.1
4	30.8	8.00	110.0	34.7	7.00	99.0
5	38.5	12.00	98.3	38.5	10.00	88.5
6	30.8	11.00	104.2	30.8	10.00	93.8
7	15.4	5.00	58.5	15.4	5.00	58.5

Table (6): Effect of different treatments on wheat yield (kg/fed.), 100grains weight (g) and NPK concentration % in wheat grains.

Treatment No.	The yield (kg/fed.)	Weight of 100grains (g)	N Conc. %	P Conc. %	K Conc. %
1	1984.9 b	5.488 cb	1.63 e	0.63 f	1.25 d
2	2501.8 a	6.296 a	2.22 b	0.83 c	1.35 c
3	1833.9 b	5.653 b	2.13 c	0.74 e	1.31 c
4	1418.08 c	5.174 c d	2.02 d	0.80 d	1.25 d
5	2526.3 a	6.426 a	2.53 a	0.91 a	1.87 a
6	1990.2 b	5.466 c b	2.22 b	0.85 b	1.52 b
7	1052.9 d	4.814 d	1.54 f	0.58 g	1.08 e
L.S.D (0.05)	188.5	0.455	0.0532	0.0168	0.0425

Conc. = concentration

Table (7): Effect of different treatments on peanut yield (kg/fed.), 100grains weight (g) and NPK concentration % in peanut grains.

Treatment No.	The yield (kg/fed.)	Weight of 100grains (g)	N Conc. %	P Conc. %	K Conc.%
1	956.53 bc	81.25 ba	1.79 e	0.25 f	0.72 c
2	1141.95 ba	84.03 a	2.38 b	0.37 b	0.76 b
3	908.68 c	79.73 b	2.27 c	0.28 e	0.70 d
4	859.46 c	75.00 c	2.19 d	0.30 d	0.73 c
5	1269.62 a	84.68 a	2.64 a	0.40 a	0.77 a
6	762.58 dc	72.87 dc	2.29 c	0.32 c	0.70 d
7	650.69 d	70.78 d	1.57 f	0.18 g	0.64 e
L.S.D (0.05)	194.56	4.044	0.074	0.0163	0.0088

2-b- Available Phosphorus:

Data in table (5) indicated that after harvesting of wheat and peanut, the application of compost (10 ton/fed.) alone or mixed with biofertilizer gave the highest value of soil available phosphorus as compared to control treatment. This increase may be ascribed to the phosphorus content of applied compost, Table (3). Although, the mixture of bentonite with biofertlizer obtained lower values of available phosphorus than its mixture with compost, Table (5). The lowest value of available phosphorus resulted in application of bentonite (10 ton/fed.).

2-c- Available potassium:

The influences of different treatments on available potassium of sandy soil are shown in Table (5). After harvesting of wheat and peanut, it was noticed that addition of bentonite (10 ton/fed.) as well as mixture of bentonite (10 ton/fed.) and biofertilizer gave the highest value of available potassium, Table (5). This may be attributed to the high content of potassium in the applied bentonite, Table (2). Also, the application of bentonite (5 ton/fed) mixed with compost (5 ton/fed) and/or mixed with compost and biofertilizer

obtained higher values of available potassium that addition of compost (10 ton/fed).this may be ascribed to the potassium content of compost was lower than it's content of bentonite, (Tables 2, 3). These results are in agreement with Lotfy and El-Hady, (1984) and El-Sokkary and El-Keiy, (1989).

3- Effect of different treatments on NPK concentrations in wheat and peanuts grains:

Regarding to the value of available NPK for different treatments in Table (5), it was observed that the highest value of available NP was realized by applying compost (10 ton/fed.) as well as applying Compost (10 ton/fed.) mixed with biofertilizer.

The statistical analysis of the values of NPK concentration for wheat grains are shown in Table (6). The maximum values of NPK concentration were obtained by applying compost (10 ton/fed.) mixed with biofertilizer. This high values may be ascribed to increase available NP resulted in using biofertilizer and consequently the concentrations of macro nutrients increased in wheat grains. These results are in agreement with (Rai and Gaur, 1989). Significant difference was observed between the values of NPK concentration in this treatment and another dealed with applying bentonite (5 ton/fed.), Compost (5ton/fed.) mixed biofertlizer. This significant difference may be due to increase the rate of applied compost in the presence of biofertilizer. The lowest value of NPK concentration were observed by applying bentonite (10 ton/fed.). These low values may be due to the low levels of available NP, Table (5).Similarly, the results in Table (7) indicated that the highest values of NPK concentration were realized by applying Compost (10ton/fed.) mixed with biofertilizer. Significant difference was obtained between these treatments and the other dealed with Compost (10 ton/fed.).this significant difference may be attributed to increase the concentration of macro nutrients in peanut grains resulted in using biofertilizer. While, the least value of K concentration in peanut grains was observed by applying bentonite (5T) mixed with Compost (5 ton/fed.).

The yield and weight of 100 grains:

The statistical analysis of wheat yields production was shown in Table (6). The maximum value of grain yield was obtained by applying Compost (10 ton/fed.) mixed with biofertilizer as well as Compost (10 ton/fed.) this high value of grain yield may be ascribed to increase organic matter concentration, available NPK and decrease hydraulic conductivity of the studied sandy soil. Also, the concentrations of N, P, and K increased I wheat grains resulted in the addition of these soil conditioners. Significant difference was observed between these treatments and treatments dealed with either applying bentonite (10 ton/fed.) or bentonite (5T), Compost (5 ton/fed.) mixed with biofertilizer. These results may be attributed to increase available N and the concentrations of N, P, and K in wheat grains, Tables (5, 6). On the other hand, the lowest value of grain yields was observed by applying bentonite (10 ton/fed.) mixed with biofertilizer, table (6).

Regarding, the effect of difference treatments on peanut seed yield, the results in Table(7) indicated that the highest value was obtained by

applying compost mixed with biofertilizer as well as Compost (10 ton/fed.). No significant was observed between treatments dealed with bentonite or compost at rate of 10 ton/fed. However, significant difference was obtained between the last treatment and other treated with applying either bentonite (5 ton/fed.) mixed with Compost (5ton/fed.) or bentonite (10ton/fed.) mixed with biofertilizer. This significantly may be due to increase the organic matter concentration, available NP and improving of studied sandy soil physical properties. In addition, the concentrations of N, P and K in peanut grains increased, too, Table (7). The lowest yield of peanut grains was observed by applying bentonite (5T), Compost (5Ton/fed.) mixed with biofertilizer, Table (7).

Concerning the effect of different treatments on 100 grain weight, data in Table (6) shows that the statistical analysis of weight of 100 wheat grains (9). It was noticed that the highest value of weight of 100 wheat grains was obtained by applying either compost (10Ton/fed.) mixed with biofertilizer or compost (10 ton/fed.). Significant difference was observed between these treatments and another dealed with applying bentonite (10 ton/fed.) as well as bentonite (5 ton/fed.) mixed with compost (5 ton/fed.). The lowest value of weight of 100 wheat grains was obtained by applying bentonite (10 ton/fed.) mixed with biofertilizer.

The statistical analysis of weight of 100 peanut grains was shown in Table (7). The results show that the maximum value of weight of 100 grains was observed by applying Compost (10 ton/fed.) mixed with biofertilizer and/or Compost (10 ton/fed.). No significant difference was obtained between these treatments and other dealed with bentonite (10 ton/fed.). Significant difference was observed between the treatment dealed with applying bentonite (5T) mixed with compost (5 ton/fed.) and another treated with applying bentonite (10 ton/fed.) mixed with biofertilizer. The lowest value of weight of 100 grains was obtained by applying bentonite (5 ton/fed.), compost (5 ton/fed.) mixed with biofertlizer.

From the obvious results, it could be recommended to addition 10 ton compost /fed alone or mixed with biofertilizer as soil conditioner. Hence, it was incorporated into the surface soil layer (0 – 20cm) of sandy soil.

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اثر اضافة الطفلة،الكمبوست والسماد الحيوى على تيسر العناصر الغذائية الكبرى ،بعض الخواص الطبيعية للاراضى الرملية وكذلك على محصولى القمحوالفول السودانى

اسامة محمد فتحى الصدفى
معهد بحوث الاراضى والمياه والبيئة-مركز البحوث الزراعية-الجيزة-مصر

الهدف من هذا البحث هو دراسة التأثير الفردى لاضافة محسنات التربة على تيسر عناصر النتروجين والفوسفور والبوتاسيوم، بعض الخواص الطبيعية فى الاراضى الرملية بالاسماعلية وكذلك على نمو ومحصول حبوب القمح والفول السودانى.

كانت المحسنات المستخدمة هى الطفلة، الكمبوست، السماد الحيوى التجارى وخليط منهم. وقد استخدمت هذه المحسنات بمعدلات مختلفة (٥،١٠ طن/فدان) وخلطت جيدا بالطبقة السطحية (صفر – ٢٠سم) قبل زراعة القمح وقد قدر كل من النتروجين والفوسفور والبوتاسيوم الميسر فى الارض كما قدرت نفس هذه العناصر فى النبات وكذلك قدر كل من محصول الحبوب للقمح والفول السودانى.

دلت أهم النتائج المتحصل عليها على أن:-

- أدت اضافة أى من خليط الكمبوست (١٠ طن/فدان) مع السماد الحيوى أو الكمبوست(١٠ طن/فدان) بمفرده الى ارتفاع قيم المادة العضوية للتربة بصورة ملحوظة.
- كما أدت اضافة البنتونيت (١٠ طن/فدان) بمفردة أو مخلوطا مع السماد الحيوى الى نقص واضح فى قيم التوصيل الهيدروليكى للتربة.
- أقصى قيم لكل من النتروجين والفوسفور الميسر أمكن الحصول عليها باضافة الكمبوست (١٠ طن /فدان) بمفردة أو مخلوطا مع السماد الحيوى فى حين أن أعلى قيمة للبوتاسيوم الميسر أمكن الحصول عليها باضافة البنتونيت (١٠ طن/فدان) بمفردة أو خليطا مع السماد الحيوى.
- أدت اضافة الكمبوست (١٠ طن/فدان) مخلوطا مع السماد الحيوى الى أعلى قيم للنتروجين والفوسفور والبوتاسيوم فى حبوب القمح والفول السودانى كما أعطت أيضا أعلى محصول للحبوب فى كل منهما.
- مما سبق نوصى باضافة الكمبوست بمعدل ١٠طن/فدان بمفردة أو مخلوطا بالسماد الحيوى كمحسن للتربة. وذلك بخلطة جيدا بالطبقة السطحية للتربة (صفر – ٢٠سم) فى الارض الرملية.