Minufiya J. Agric. Res. Vol.40 No. 3(2): 817 – 825 (2015) **"http://www.mujar.net"**

AMELIORATIVE EFFECT OF DIFFERENT ORGANIC CONDITIONERS APPLICATION ON SOIL PHYSICAL PROPERTIES OF NORTH DELTA SOIL IN EGYPT

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(Received: Feb. 16, 2015)

ABSTRACT: *In order to appraise the role of organic manures in improving soil properties, a field experiment was conducted at the Experimental Farm of Sakha Agriculture Research Station, Kafr El- Shikh, Egypt to study the effect of compost as (4 or 8 ton fed^{-1}) along with Potassium- Humate (K-H) and fulvic acid (F A) as (20 L fed^{-1}) on some physical properties of the studied soil . The treatments comprised of 1) control (soil treated with 100 % NPK of recommended doses 2, 3) soil treated with either K –H or F A as 20 L fed^{-1} 4, 5) soil treated with compost at the rate either 4 or 8 ton fed^{-1} 6, 7) compost combination (4 and 8 ton fed^{-1}) by K-H as (20 L fed^{-1}) respectively 8, 9) compost combination (either 4 or 8 ton fed^{-1}) by fulvic acid as(20 L fed^{-1}). The wheat crop (Triticum aestivum L., var Sakha 93) was selected as concerned crop.*

The obtained results indicated an improvement in soil physical properties as affected by soil conditioners wherever those application slightly decreased soil bulk density and total porosity values compared to control (100% NPK) , improved soil aggregation as dry and wet stable aggregates along with structure parameters i.e., aggregate state (A. S), aggregate degree (A.D) , aggregate index (A.I) and ∆ M.W.D. As well as soil hydraulic conductivity (HC) and moisture content at both field capacity and available water were increased compared to the control (100 % NPK) c) . The combined treatments of compost with K-H or FA had superior effect compared to other treatments in improving physical properties of the studied soil.

Key words: *Compost, K- humate, fulvic acid, soil physical properties*

INTRODUCTION

The application of organic wastes with high organic matter content, such as fresh and composted urban wastes, shredded and composted plant materials derived from municipal landscape (Walker, 2003). Physical and chemical properties have been used to evaluate the effects of the application of different sources of organic matter on soil during long-term experiments (Tejada and Gonzalez, 2004). Noufal *et al.* (2005) summarized that organic materials decreased soil bulk density and increased total porosity. Soil water content at FC, WP and AW content were increased due to addition of organic materials to the soil. Ahmed, Marwa (2007) found that, the organic matter in soil plays an important role through building up soil aggregates and enhancing proper soil physical and chemical properties. The application of organic matter to examined sand soil improved its physical as well as chemical and fertility properties. Also, El-Maghraby *et al.* (2011) showed that, characteristic the positive effect of compost application in increasing available water reflected the high capacity of organic amendments in increasing soil porosity in general. Tejada *et al* (2006c) previously found that organic matter acts as a cementing factor, necessary for flocculated soil particles to give stable aggregation.

On the other hand, Humic acid (HA) is one of the most important components of bio- liquid complex. Because of its molecular structure, it provides numerous benefits to crop production. It helps breaking up clay compacted soils, enhances water retention, increases seed germination rates, improves water, air ratio and roots penetration. Humic is not a fertilizer, but considered as a compliment to fertilizer (Mackowiak *et al.,* 2001). Moreover, Robert (2011) reported that humic substances are key components of a friable (loose) soil structure. Various carbon containing humic substances are key components of soil crumbs (aggregates). Complex carbohydrates synthesized by bacteria and humic substances function together with clay and silt to form soil aggregates. The author (Robert, 2011) added that Fulvic acids (FAs) are a mixture of weak aliphatic and aromatic organic acids which are soluble in water at all pH conditions (acidic, neutral and alkaline). The objective of the current study aims to evaluate the role of compost, potassium-humate (K-Humate) and fulvic acid (FA) on the improving physical properties of a clay loam soil cultivated with wheat.

MATERIALS AND METHODS

A field experiments were conducted on clay loam soil at the Experimental Farm of Sakha Agriculture Research Station, Kafr El Shikh, Egypt during two successive seasons (2010/2011 and 2011/ 2012) cultivated with wheat crop (*Triticum aestivum* L., var Sakha 93). The experimental design was a randomized complete block design with three replicates, the plot area was 10.5m^2 (3 m width and 3.5 length), the recommended doses of NPK (100% NPK) alone as a control treatment were also included. Superphosphate (15.5 % P_2O_5) at the rate 200 kg fed $^{-1}$ added basically before planting during soil preparation. Nitrogen added at the rate 400kg fed $^{-1}$ in three equal doses after 15, 30 and 60 days from planting in the form of ammonium sulfate (20 % N) while, potassium added at the form potassium sulfate (48 % K_2O) at the rate 50 kg fed $^{-1}$ in two equal doses at sowing and 30 days from planting .

Organic matter was used as compost at the rate of either 4 or 8 ton fed^{-1}, Potassium humate (K- Humate) and fulvic acid (FA) at the rate 20 L fed^{-1} (3 % v\v). The used compost was thoroughly incorporated into the top soil (25cm depth), two weeks before cultivation. K- Humate and fulvic acid treatments were added as soil application at three times after 20, 40, and 60 days from planting.

The treatments involved 1) control (soil treated with 100 % NPK of recommended doses 2,3) soil treated with either K –H or F A 4, 5) soil treated with compost at the rate of either 4 or 8 ton fed^{-1} 6, 7) soil treated with mixture of K-H and either C4 or C8 (K-H+C4 and K- H +C8) 8, 9) soil treated with mixture of FA and either C4 or C8 (FA+ C4 and FA +C8) .

Before planting surface soil sample (0-30 cm) was taken from experimental field, air-dried, ground, sieved through a 2 mm sieve and analyzed. Some soil physical and chemical characteristics of the studied soil, evaluated according to Klute (1986) and Page *et al.* (1982) are presented in Table (1). Some characteristics of compost, K-Humate and fulvic acid application in Table (2 a, b). Undisturbed and disturbed soil samples were collected from the surface layers (0-30 cm) for all plots after harvest for two seasons. The soil samples were air-dried and analyzed for some physical characteristics, including soil particle size distribution carried out by the pipit method descripted by Gee and Bauder (1986) using sodium hexameta phosphate as a dispersing agent. Soil bulk density was determined using the undisturbed soil column according to Richards (1954).

Stability of water stable aggregates was determined using the wet sieving technique described by Yoder (1936) and modified by Ibrahim (1964). Mean weight diameter was estimated using the values of both dry and water stable aggregates and calculated according to Yonker and McGuiness (1956), Δ M.W.D then was estimated by the difference between mean weight diameters of dry and wet sieving. Aggregate state, aggregate degree and aggregation index were calculated according to Richards (1954). Total soil porosity was calculated as percentage from the obtained values of soil real and bulk densities (Richards, 1954). Hydraulic conductivity was determined using the undisturbed soil samples according to the method of Richard (1954). Wilting point was determined according to Stakman and Vanedrhast (1962), field capacity being determined as described by Richards (1954).

Table (1): Some physical and chemical properties of the studied soil

characteristic	value
Particle size distribution (%)	
Coarse Sand	22
Find sand	18
Silt	28
Clay	32
Texture class	Clay loam
Chemical analysis	
pH(1:2.5 soil suspension)	7.97
Total carbonate (%)	3.17
Organic matter (%)	1.46
EC, dS/m soil paste	1.52
Soluble cations (meq/L)	
Ca^{++}	7.0
Mg^{++}	5.0
Na^{+}	2.9
K^{+}	0.3
Soluble anions (meq/L)	
CO_3^{--}	-
HCO_3^{-}	4.2
Cl^{-}	5.6
SO_4	5.4

Table (2 a): Some characteristics of compost application

analysis	values
Moisture %	13.0
pH (1:10)	8.18
EC dS\m	3.25
OM %	25.7
C : N	26.62
Total N %	0.56
Total P %	0.39
Total K %	0.65

Table (2 b): Some characteristics of K-Humate and FA application

Determination	K- Humate	Fulvic acid
EC dS\m	58.0	56.0
pH	5.08	2.50
Total N %	1.29	1.11
Total P %	0.15	0.12
Total K %	0.98	0.98

RESULTS AND DISCUSSION

Bulk density, porosity, and moisture parameters.

Data in Table (3) revealed that, the values of soil bulk density were decreased with different conditioning treatments; value of such parameter was lower than those of each conditioner or control treatment (100 % NPK). These decreases may be a resulted from soil aeration due to increases in soil porosity with the structural stability. On the other hand, data showed that, values of total porosity and hydraulic conductivity tended to increase with application of different conditioners compared to control (100 % NPK). Consequently, porosity as an index of the relative volume of soil pores should be improved due to the enhanced effect of organic conditioners in improving soil aggregates (Noufal *et al.,* 2005).

The obtained data also showed that, values of soil field capacity, wilting point and the calculated available water are considered to be the three main soil moisture constants were obviously responded to applied treatments. Data appeared that mixing compost at the rate 8 ton fed^{-1} with FA 20 L fed^{-1} was favorable for FC%, WP% and AW% by values of 14.57, 2.13 and 25.82 percent respectively over control; Increased capacity for water retention as a result of adding organic matter is a clear indication of its positive effect on modifying porosity and physical conditions of soil, similar results were obtained by Negm *et al.* (2004). Robert (2011) reported that, the most important function of humic substances within the soil is their ability to hold water.

Humic substances help to create a desirable soil structure that facilitates water infiltration and helps to hold water within the root zone. That may be ascribed to the large surface area and internal electrical charges, enhance the humic substances function as water sponges. Also, no doubt available water is the most important factor from fertile soil. Soil which contain high concentration of humic substances distinguish with holding water for crop use during period of drought. Similar results were obtained by EL- Maaz *et al.* (2010).

Table (3). Effect of compost, K- Humate and fulvic acid on bulk density (BD), total porosity (TP), hydraulic conductivity (HC) and moisture parameters (field capacity FC, wilting point WP and available water AW) of the studied soil.

treatment	BD g\Cm^3	TP %	HC Cm^3\h	Soil moisture parameters		
				FC %	WP %	AW %
Control (100%NPK)	1.39	47.54	6.31	27.59	13.11	14.48
K- Humat	1.36	48.67	8.04	29.08	12.08	17.00
FA	1.38	47.92	7.35	28.70	11.65	17.05
C4	1.35	49.05	9.78	29.96	13.07	16.89
C8	1.33	49.81	20.34	30.73	12.67	18.08
K-H+C4	1.28	51.69	15.29	30.80	14.36	16.44
K-H+C8	1.21	54.34	26.60	31.61	13.76	17.85
FA+C4	1.31	50.56	12.50	31.46	13.30	18.16
FA+C8	1.24	53.20	22.47	31.61	13.39	18.22

The aggregation stability:

Dry sieving aggregates (D.S.A %).

Data in Table (4) showed that, values of dry sieving aggregates % of the studied soil samples were affected by compost, K- Humat and fulvic acid additions. Dry stable aggregates having diameters of 10 - 2 mm were found to be the largest size present in the different treatments under study, followed by diameters 1- 0.5; percentage of other sizes especially the aggregates with diameters less than 0,063 mm which had. As usually the lowest values (Cox *et al.,* 2001). On the other hand, the percentages of aggregates having diameters < 0.063 mm were higher in all organic treatments compared to the control (100% NPK).

Wet sieving stable aggregates% (W. S. A %).

Data presented in Table (5) elucidated values of wet sieving stable aggregates (W. S. A %) as well as distribution of aggregates size fractions; indicated ranged between 0.41 % and 14.68 %. For distribution of aggregate size fractions, the content of aggregates having diameters 10- 2 mm and 0.5-0.125 mm were generally higher than other aggregates fraction under study. This was true for all treatments including the control. 0n the other hand, the content of aggregates having diameters of 0.25-0.125 mm and 0.125-0,063 mm were lower than other aggregates fractions. the wet stable aggregate which having diameters of 10 - 2 mm were found to be the largest size presented in the different treatment aggregates for that application of K-H, FA, K-H +C8 and FA+C8 over that treatment with C4, C8 alone and control (100% NPK). Robert (2011) reported that, the Humic substances are key components of soil crumbs (aggregates). Complex carbohydrates synthesized by bacteria and humic substances function together with clay and silt to form soil aggregates. As the humic substances become intimately associated with the mineral fraction of the soil, colloidal complexes of humic – clay and humus silt aggregates are formed. Similar results were in agreement with that the obtained by Darwich *et al.* (2012).

Table (4). Dry stable aggregates (%), at various sizes of the studied soil as affected by compost, K-Humate and fulvic acid addition.

Treatment	Aggregate size						
	10- 2 mm	2-1 mm	1-0.5 mm	0.5-.025 mm	0.25-0.125 mm	0.125-0.063 mm	≤ 0.063 mm
Control (100%NPK)	50.52	14.62	17.68	8.37	4.48	4.14	0.14
K- H	68.25	9.23	12.23	6.16	2.36	1.33	0.44
FA	64.49	9.28	12.10	7.35	3.62	2.51	1.15
C4	48.92	10.90	18.10	12.16	5.98	2.54	1.40
C8	59.23	8.98	12.26	9.32	6.23	3.77	0.21
K-H+C4	50.47	11.30	17.44	11.45	6.22	2.28	0.84
K-H+C8	67.23	8.98	12.16	6.23	3.47	1.86	0.07
FA+C4	56.58	9.47	15.59	3.62	3.79	3.24	1.71
FA+C8	60.13	7.74	13.24	8.77	4.99	3.84	1.29

Table (5). Water stable aggregates (%), with various size of the studied soil as affected by compost, K-Humate and fulvic acid additions.

Treatment	Aggregate size						
	10- 2 mm	2-1 mm	1-0.5 mm	0.5-.025 mm	0.25-0.125 mm	0.125-0.063 mm	Total
Control (100%NPK)	12.74	3.24	8.03	12.75	3.08	1.18	41.02
K- H	13.15	5.66	11.22	11.25	4.90	0.41	46.59
FA	11.86	4.24	9.16	13.64	3.98	1.99	44.87
C4	6.36	4.60	8.09	7.40	4.21	3.93	34.59
C8	9.95	4.82	9.40	7.80	4.77	1.15	7.89
K-H+C4	5.50	3.37	6.65	8.48	4.04	5.38	33.42
K-H+C8	14.68	6.30	9.28	7.55	2.29	3.22	43.32
FA+C4	7.09	4.23	10.64	8.05	4.63	5.27	39.91
FA+C8	14.43	7.07	8.37	9.65	1.12	3.31	43.95

Structure parameters:-

Data of soil structure parameters, i.e., aggregate state (A.S), aggregate degree (A.D), aggregate index (A.I) and differences in mean weigh diameter (∆M.W.D) are shown in Table (6). Data indicated the same previously reported soil aggregation trend with different treatments under study. Values of A. S were highly affected by either K-H or FA addition. The greatest (A.D) values were observed in the K-H and combined FA +C8 treatments. These findings may be attributed to many benefit characteristics of fulvic acid and potassium humate rather than compost at the rate 4 and 8 ton fed $^{-1}$ for soil aggregation.The highest values were obvious with combination between compost with either K-H or FA; The higher values of (A.I) were for (FA-C8) treatment, the lowest ones being obtained with compost. The values of ∆ M. W. D for soil aggregates showed that the highest values were obtained with K- H treatment which seemed to have a favorable effect on the aggregation process; The lowest values were encountered with the control (100 % NPK).

Regarding the effect of different soil conditioners treatment on ∆ M. W. D, data in Table (6) revealed a clear positive trend between soil conditioners and ∆ M. W. D values. it can be conducted that the application of compost were least efficient at aggregation process and on the values of aggregation state, degree and index. Application of K- H, FA and combined with compost more efficient at aggregation process and on the values of aggregation state, degree and index. These results are in consonance with the results of El-Maaz *et al.* (2010) .

Table (6). Structure parameter and difference mean weight diameter as affected by compost, K-Humate and fulvic acid additions for the tested soil.

Treatment	A.S	A.D	A.I	∆M.W.D
Control (100%NPK)	41.02	16.26	0.58	2.50
K- H	46.59	39.32	0.85	3.34
FA	44.17	29.75	0.79	3.23
C4	41.59	20.07	0.65	2.74
C8	37.89	15.65	0.67	3.05
K-H+C4	43.42	26.78	0.63	2.91
K-H+C8	43.32	31.16	0.86	3.21
FA+C4	39.91	26.48	0.73	3.09
FA+C8	43.95	33.51	0.88	2.79

Conclusion:-

The application of fulvic acid, K-H and compost at the rate of either 4 or 8 ton fed^{-1} alone or in combined were superior to improve soil bulk density, total porosity, hydraulic conductivity and soil moisture constants. Likewise the abovementioned treatments caused an improvement in aggregation stability and Structure parameters over treatments involving the application of compost alone or control (100 % NPK).

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تأثير المحسنات العضوية على الخواص الفيزيائية لأراضى شمال الدلتا

وفاء محمد طه العطر ، ناصر إبراهيم على طلحه ، ناهد أحمد محمد الصاوى عياد

معهد بحوث الأراضى والمياة والبيئة – مركز البحوث الزراعية

الملخص العربى

أجريت تجربة حقلية على تربة طينية طميية بمحطة البحوث الزراعية بسخا– محافظة كفر الشيخ حيث تم زراعة القمح (صنف سخا ٩٣) خلال موسمين زراعيين متتاليين (٢٠١٠-٢٠١١) و(٢٠١١-٢٠١٢) وذلك فى تصميم قطاعات تامة العشوائية وكانت المعاملات كالتالى:

١- معاملة الكنترول (١٠٠% من الموصى به من NPK التسميد المعدنى) ٢- إستخدام هيومات البوتاسيوم بمعدل ٢٠ لتر للفدان (٣ %) ٣ - إستخدام حمض الفالفيك بمعدل ٢٠ لتر للفدان (٣%)

٤- إستخدام الكمبوست بمعدل ٤ طن للفدان ٥- إستخدام الكمبوست بمعدل ٨ طن للفدان

٦و٧- خليط من الكمبوست بمعدل (٤ و٨ طن للفدان) +هيومات البوتاسيوم ٢٠ لتر للفدان على التوالى

٨ و ٩- خليط من الكمبوست بمعدل (٤ و٨ طن للفدان) + حمض الفالفيك ٢٠ لتر للفدان على التوالى وكانت أهم النتائج :

كان للمحسنات المضافة تأثيرا إيجابيا على الخواص الفيزيائية للتربة والتى تتمثل فى :-

خفض الكثافة الظاهرية للتربة مع كل المحسنات المضافة سواء منفردة او مختلطة مقارنة بالكنترول

٢ – زيادة كل من المسامية الكلية والتوصيل الهيدروليكى للتربة مقارنة بالكنترول

أما بالنسبة لثوابت الرطوبة والتى تتمثل فى السعة الحقلية ونقطة الذبول والمحتوى من الماء الميسر فإنها زادت جميعا فى قيمها مع إضافة المحسنات سواء منفردة أو مختلطة مقارنة بالكنترول

٣ – تفوق كل من هيومات البوتاسبوم وحمض الفالفيك منفردا أو مختلطا مع الكمبوست فى تحسين معايير البناء الأرضى ومدلولاته والتى تشمل التجمعات الثابتة فى الماء وحالة التجمع ودرجة التجمع مقارنة باستخدام الكمبوست منفردا