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EFFECTS OF ON-FARM COMPOSTED TREATED WITH SOME SOIL CONDITIONERS ON SOIL FERTILITY AND PRODUCTIVITY

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ABSTRACT: *A field experiment was conducted on a clayey soil at Sids Agric. Res. Station, Egypt to study the effects of on-farm composted (rice straw, corn stover and mixture of them) on the changes in some soil properties and corn (Third hybrid 310) production and its components and nutrient contents of grain. Treatments comprised in combination with three heaps (rice straw 100%, corn stover 100% and mixture of them 50 % by 50 %, weight by weight) and five conditioner materials of applied were 0.0 (FYM) as control, rock phosphate (0.5 %), feldspar (0.5 %), gypsum (5.0 %) and sulfur (1.0). Total 15 treatments were laid out in randomized block design, replicated three times. Generally, it can be concluded that under the present study, the soil treated with compost and gypsum with 5.0 %, exhibited pronounced increase in the available content of N for the three heaps (rice straw, corn stover and mixture of them), being corn stover was the best. While, the soil treated with compost mixed with rock phosphate exhibited pronounced increase in the content of available P for the three heaps, being corn stover was the best. On the other hand, the soil treated with compost mixed with feldspar exhibited pronounced increase in the content of available K for the three heaps, being corn stover was the best. Moreover, application of on-farm composted and conditioners resulted in a significant increase in grains yield of corn plant and its components, i.e., N, P and K compared with control. The positive response of maize yield to gypsum as conditioner was associated with the different compost, being corn stover gave the best yield. In regard to the effect of applying compost plus rock phosphate or feldspar or sulfur as soil conditioners on the yield of corn grains, data revealed that the application of these materials resulted in a marked increase in the yield of corn grains over control. This true was observed for all composted, being corn stover was the best. Also, data of nutrient contents indicated that N, P and K contents of corn grains were favorably affected by the used of compost treated with conditioners. This was true under application of rice straw, corn stover and mixture of them as well as application of rock phosphate, feldspar, gypsum and sulfu. The highest contents of N, P and K were obtained upon treating the soil with gypsum (5 %) and corn stover.*

Key words: *On-farm composted (rice straw, corn stover and mixture of them), gypsum, rock phosphate, feldspar and sulfur , soil fertility and corn plant.*

INTRODUCTION

The worldwide production of rice husk, a by –product and agro waste that causes serious environmental problems, may reach 116 million t y^{-1} (Anda *et al.,* 2008). Thus, on-farm composting is an efficient, cost effective and environmentally safe biological process for recycling of residual agricultural biomasses into new cropping production cycles. Where, on-farm composting substantially contributes and concomitantly provides the farmer with a self-supply of quality compost for the improvement of agricultural productivity.

Loss of soil quality is related to soil organic matter depletion that is increased by continuous cropping without rotations, frequent soil tillage and large use of both inorganic chemical fertilizers and non-selective pesticides. Intensively exploited

soils need an external supply of stabilized organic matter, such as compost, in order to counteract progressive soil organic matter decline. A large part of our country' s (Egypt) soil is poor in organic matter. This condition has led to a significant deterioration of soil physical, chemical and biological properties in time. One of the most basic ways passing in front of this condition is to increase the content of the soil organic matter. For that reason, rice husk and corn stover originated many organic wastes and compost obtained from those is recommended for use in agricultural land.. The results of the study carried out by Nweke (2014) showed that quinea grass compost significantly increased soil parameters studied enhanced growth and yield of maize. This study suggests that quinea grass compost is capable of improving the fertility status of soil; enhance the growth and yield of maize.

Pane *et al.* (2015) demonstrated that compost characteristics affected plant development and productivity through increased nutrient uptake. Badar *et al.* (2015) said that composted organic materials enhanced more growth as compared to uncomposted materials. Organic soil amendments can improve soil fertility and plants growth. Demir and Gulser (2015) reported that the soil organic matter contents significantly increased by the application of rice husk compost, while pH significantly reduced. Bulk density values were reduced, while permanent point and available water capacity generally increased according to the control. Rice husk composted application to the soil in greenhouse generally improved soil quality and tomato yield. Reynolds *et al.* (2015) showed that compost addition increased bulk density relative to virgin soil by 46 %, while organic carbon content, air capacity and plant available water capacity had decreased relative to virgin soil by 60, 56 and 43 %, respectively. Analysis of soil carried out by Teshome *et al.* (2014) indicated that except for pH value, all the salient soil properties including Ec_e, organic carbon, total nitrogen, available P and available K were slightly increased due to compost application. Arthur *et al.* (2012) reported that vegetable, fruit and yard waste compost, garden waste compost and spent mushroom compost significantly increased soil total carbon, total nitrogen, pH, electrical conductivity and significantly decreased bulk density with no effect on plant available water compared to the control. Fresh and dry fruit weights of tomato were significantly increased after compost addition.

The objectives of this study were (i) to determine the chemical changes of rice straw and corn stover and its structural chemistry during composting (ii) to determine the effect of the prepared on - farm composted on clay soil content of N , P and K and corn grains yield and its content of N , P and K .

MATERIALS AND METHODS

A field experiment was conducted on clayey soil at Sids Agric. Res. Station, Egypt through summer season 2014 with maize plant to study the effect of on-farm composted in combination of some conditioners on some characteristic of soil and plant productivity. On-farm composted was made through winter season 2013/2014 where rice straw and corn stover were collected from the farms and ground to be preparation. One hundred kg from rice straw, corn stover and mixture of them (50 % rice + 50 % corn) were taken to make the heaps. FYM was applied to each the heap at the rate of 10 kg. Each heap was replicated four times to apply the materials of conditioners used . The conditioner , and their application rates were 0.0 as control , rock phosphate (0.5 %), feldspar (0.5 %), gypsum (5.0 %) and sulfur (1.0). Three treatments from residual plants × 5

conditioner materials were used and the heaps were left up to the summer season 2013 (five months). Some characteristics of on-farm composted are shown in Tables (2 and 3). The treatments were comprised 3 plant residues i.e., rice straw (100 %) and corn stover (100 %), and mixture of rice straw and corn stover by 50 % + 50 % weight by weight and 5 conditioners i.e. control , rock phosphate (0.5 %) , feldspar (0.5%) , Gypsum (5%) and sulfur (1%). Total 15 treatments were laid out in randomized block design, replicated three times. Application treatments were thoroughly mixed with the surface soil (0 – 15 cm) during the soil preparation. Recommended field practices were undertaken (N, P and K as recommended fertilizers). Corn grains (Third hybrid 310) were sown and planted in summer season 2013. At maturity, all the area of each plot was harvested and the grain yield of maize was recorded. Nutrients content of grains were analyzed according to Chapman and Pratt (1961). Some physical and chemical characteristics of the studied soil were determined according to Piper (1950) and Jackson (1967) and shown in Table (1).

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

Soil characteristics	Value
Particle size distribution (%):	
Coarse sand	4.20
Fine sand	10.00
Silt	34.60
Clay	51.20
Textural class	Clayey
ESP	16.50
Field capacity (%)	38.42
Wilting point (%)	17.06
Available water (%)	21.36
pH (1:2.5 soil - water suspension)	8.10
Calcium carbonate (%)	1.70
Organic matter (%)	1.25
ECe (dS / m, soil paste extract)	2.50
Cation exchange capacity (mq/100 g)	36.60
Total nitrogen (%)	0.17
Available N (mg/kg soil)	17.90
Available P (mg/kg soil)	8.65
Available K (mg/kg soil)	275.33

Table 2

Table 3

RESULTS AND DISCUSSION

1. Effects of on-farm composted and conditioners on soil fertility:

The obtained results showed that the contents of available N, P and K in the studied clayey soil were affected by the applied treatments of on-farm composted (three heaps) and soil conditioners as shown in Table (4). Data showed that there was an increase in available N when applied different materials for the three heaps. While, these materials varied in their effects on available N, being application of gypsum to the three heaps was the best treatment. The values of N obtained were 35.67, 44.00 and 36.67, mg/ kg soil for rice straw, corn stover and mixture of them, respectively. On the other hand, the best material effect on available P was rock phosphate when applied for the three heaps. The obtained content of available P were 16.73, 18.67 and 17.19 mg/ kg soil for rice straw, corn stover and mixture of them, respectively. While, application of feldspar as material to the three heaps was the best effect on available K. The obtained content of available K were 530.00, 459.00 and 502.00, mg/ kg soil for rice straw, corn stover and mixture of them, respectively.

Concerning the variation in the content of available N, P and K when applied different materials, data showed that the soil treated with compost and 5.0 % gypsum, exhibited pronounced increase in the available content of N for the three heaps (rice straw, corn stover and mixture of them), where the relative increase percentages of these nutrient reached 12.63, 13.78 and 13.42 % over that of control, respectively, being corn stover was the best. This may be due to the beneficial effect of gypsum on ameliorating some physical properties of soil. Also, due to the appreciable amount of N in the added compost of corn stover (see Table, 3). In this concern, Yadav and Chhipa (2007) stated that gypsum application at rate of 50 % GR recorded significant increases in available N content of soil. Wang *et al.* (2006) and Wenhui *et al.* (2010) found that the application of organic matter greatly increased available N content. Taha *et al* (2010) reported that the relative high soil contents of available N, P and K were achieved upon treating the soil with gypsum combined with FYM.

On the other hand, the soil treated with compost and rock phosphate exhibited pronounced increase in the available content of P for the three heaps (rice straw, corn stover and mixture of them), where the relative increase percentages of this nutrient reached 14.04, 17.20 and 13.61 % over that of control, respectively, being corn stover was the best. This may be due to organic matter is regarded as a very important parameter of soil productivity. It has a number of important roles to play in soils, both in their physical structure and as a medium for biological activity (Sarwari *et al.,* 2008). Also, due to the appreciable amount of P in the added compost of corn stover (see Table, 3). Also, organic manure has a good role in solubilizing the rock phosphate by producing organic acids (Hosseini *et al.,* 2010). Phosphate solubilizing bacteria and organic manure were effective in solubilizing rock phosphate by decreasing soil pH and increasing the organic matter into soil. Thus, phosphate solubilizing bacteria significantly increased soil availability of P in soil amended with rock phosphate and organic manure (Alzoubi and Gaibore, 2012).

Moreover, the soil treated with compost and feldspar exhibited pronounced increase in the available content of K for the three heaps (rice straw, corn stover and mixture of them), where the relative increase percentages of this nutrient reached 20.72, 27.50 and 17.01% over that of control, respectively, being corn stover was the best. This mainly attributed due to the appreciable

Table 4

amount of K in the added compost of corn stover and consequently increased the soil capacity for the available K (see Table, 3).

Concerning the effect of applied S and compost together, data revealed that their combination caused slight increase in the values of available N, P, K, where the relative increase percentages of these nutrients reached 4.19, 11.19 and 9.27 % for N over that of control, for rice straw, corn stover and mixture of them, respectively. For P the relative increases reached 8.58, 7.15 and 7.53 % for the three heaps in the same order. While, the relative increases in case of K reached 6.37, 14.16 and 10.02 % for rice straw, corn stover and mixture of them, respectively. These results were due to the appreciable amounts of N, P, K in the added compost, as well as, improving the soil properties as a result of S application i.e. decreasing soil pH (see Table, 3). These results are in accordance with those obtained by Hoda (2010) who found that the application of organic matter combined with S greatly increased available NPK content.

2. Effects of on-farm composted and conditioners on corn yield and its components:

The data presented in Table (5) revealed that application of on-farm composted and conditioners resulted in a significant increase in maize yield and its plant components, i.e., N, P and K compared with control. The positive response of maize yield to gypsum as conditioner was associated with the different compost, where their values were 3885.75, 4187.19 and 4091.42 kg/fed, for rice straw, corn stover and mixture of them, respectively, being corn stover gave the best yield. The corresponding relative increases were 3.04, 8.85 and 7.64 % over the control, respectively. The increase in the yield with gypsum application might be due to the improvement of physical and chemical properties of the studied soil and addition of compost. These results are in close conformity with the findings of Yadav and Chhipa (2007) who stated that higher grain and straw yields of wheat observed under combined application of (20 ton FYM /ha + gypsum at 50 % GR). Also, Ganeshamurthy and Reddy (2001) found that dry matter production of wheat was increased significantly by the application of both FYM and gypsum. Also, Taha *et al* (2010) found that the highest yields of grain and straw of wheat were achieved upon treating the soil with gypsum combined with FYM.

In regard to the effect of applying compost plus rock phosphate or feldspar or sulfur as soil conditioners on the yield of maize, data presented in Table (5) revealed that the application of these materials resulted in a marked increase in the yield of corn grains over control. This true was observed for all composted. The relative increases were 2.29, 3.02 and 2.43 % for rock phosphate when applied with rice husk, corn stover and mixture of them, respectively. For feldspar, these relative increases were 1.25, 3.51 and 3.13 % in the same. For sulphur, these relative increases were 0.50, 0.69 and 0.57% for rice straw, corn stover and mixture of them, respectively. These results are in accordance with the findings of Fathi *et al* (2015) who found that organic manure addition with RP had a significant increase on yield and its components. These increases were higher when organic manure applied together with rock phosphate as compared with control treatment. Hoda (2010) reported that addition of S in combination with FYM gave the highest increases in the grain and straw yields of maize as compared to each of the studied treatment alone. Also, Fathi *et al* (2015) concluded that the application of organic manure and elemental sulphur cause a significant increases in growth, yield of sesame and its components than the control treatment.

Table 5

Data of nutrient contents as affected by the prepared materials on-farm composted are given in Table (5). The obtained values indicated that N, P and K contents of maize were favorably affected by the used compost and conditioners. This was true under application of rice husk, corn stover and mixture of them as well as application of rock phosphate, feldspar, gypsum and sulfur. The highest contents of N, P and K were obtained upon treating the soil with gypsum (5 %) and corn stover, where, the corresponding relative increase percentage of the N content in grain of corn yield was 18.31 %. While the corresponding relative value of P was 56.66 %. Also, the corresponding relative value in case of K was 1.94 %.

On the other hand, the corresponding relative values in case of P were 43.33, 48.48 and 43.75 % with gypsum addition with rice straw, corn stover and mixture of them, respectively. In the same order, the relative increase percentages of K in grain of maize yield when the soil treated with gypsum plus compost were 2.58, 7.64 and 7.05 %, respectively. The superiority of gypsum for increasing N, P and K contents in maize is probably attributed to the ability of gypsum to improvement of some physical and chemical properties of soil i.e. reduce soil pH, and in turn increasing the available nutrients in the soil.

Table (5) also revealed that different materials addition (rock phosphate, feldspar and sulphur) exert a more beneficial effect on N, P and K contents as compared with no addition. In this respect, Fathi *et al* (2015) found that organic manure addition with RP had a significant increase on yield and its components. Also, Hoda (2010) indicated that addition of a mixture S with FYM to the studied clayey soil markedly increased the contents of N P K in maize grains, particularly at the highest rates of both elemental sulphur and organic manure.

Under the condition of this experiment, it was concluded that application of gypsum and on-farm composted especially corn stover as soil amendments to corn plants grown on a clayey soil increased the efficiency of either mineral or organic fertilizers used. Whereas, application of gypsum and compost improve some physical and chemical properties of a clayey soil through reduced soil pH and increased mobility of nutrients from bulk soil to the rhizosphere. Consequently, the efficiency of nutrients uptake by maize were increased and positively reflected on plant growth and crop productivity.

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تأثيرات كمبوست المزرعة المعامل ببعض محسنات التربه على خصوبة التربه وانتاجيتها

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الملخص العربى

أجريت تجربة حقلية بمحطة البحوث الزراعية بسدس للاستفادة من مخلفات المزرعة (قش الارز وحطب الذرة) فى دراسة التاثيرات المختلفة لهذه المخلفات على خواص الارض الطينية وانتاجيتها لمحصول الذرة الشامية (هجين ثلاثى ٣١٠) وكذلك محتوياته من عناصر النيتروجين والفسفور والبوتاسيوم فتم عمل خمسة مكمورات لكل من قش الارز ١٠٠ % وحطب الذرة ١٠٠% وخليط بينهما بنسبة ٥٠ % قش الارز و٥٠% حطب الذرة ثم تم اضافة المحسنات التالية لهذه المخلفات سماد المزرعة (١٠٠ كجم) و صخر الفوسفات (٠.٥ %) و الفلدسبار (٠.٥ %) والجبس الزراعى (٥.٠ %) و الكبريت (١.٠ %) وذلك فى تصميم تام العشوائية (١٥ معاملة) لكل ثلاثة مكررات وتركت المكامير لمدة خمسة اشهر قبل ان تضاف الى الارض وذلك خلال عام ٢٠١٣-٢٠١٤ ثم اضيفت المعاملات بعد ذلك الى التربة.

عموما امكن ايضاح ان الارض المعاملة بالجبس الزراعى ٥ % مع الكمبوست اظهرت زيادة واضحة لعنصر النيتروجين الميسر فى الارض وكان ذلك مع الثلاث مكمورات وكان احسنهم هى مكمورة حطب الذرة ، بينما الارض المعاملة بالكمبوست مع الصخر الفوسفاتى اظهرت زيادة واضحة لعنصر الفسفور الميسر فى الارض وكان حطب الذرة احسن المكمورات، ومن ناحية اخرى اظهرت الارض المعاملة بالكمبوست مع الفلدسبار زيادة واضحة لعنصر البوتاسيوم الميسر فى الارض وكان ذلك واضحا مع حطب الذرة.

علاوة على ذلك فاضافة كمبوست المزرعة مع محسنات التربه اعطى زيادة معنوية فى محصول الذرة من الحبوب وكذلك مكوناته من عناصر النيتروجين والفسفور والبوتاسيوم بالمقارنة بالكنترول، وكانت الاستجابة الواضحة لمحصول الذرة من الحبوب عند اضافة الجبس الزراعى مع حطب الذرة.

اما فيما يتعلق باضافة الكمبوست مع الصخر الفوسفاتى او الفلدسبار او الكبريت فان محصول الذرة من الحبوب اعطى زيادة ملحوظة بالمقارنة بالكنترول وكانت هذه الزيادة مع حطب الذرة وقش الارز والخليط منهما الا ان حطب الذرة كان احسنهم.

وايضا محتوى عناصر النيتروجين والفسفور والبوتاسيوم فى الحبوب تاثر باضافة الكمبوست والمحسنات وكان اكثرهم وضوحا عند اضافة الجبس الزراعى ٥ % مع حطب الذرة.

Table (2): Content (%) of total N , P , and K of on-farm composted treated with some conditioner materials and incubated for five months.

Conditioners treatments	Composted plant residues														
	Rice straw (100 %)					Corn stover (100 %)					Mixture of rice straw and corn stover (50% + 50 %)				
	CO (%)	OM (%)	C/N (ratio)	pH (1:5)	EC (dS/m)	CO (%)	OM (%)	C/N (ratio)	pH (1:5)	EC (dS/m)	CO (%)	OM (%)	C/N (ratio)	pH (1:5)	EC (dS/m)
Control (FYM)	19.76	34.07	16.06	8.38	9.82	31.27	53.91	20.98	8.20	12.19	26.20	45.17	18.19	8.25	9.78
Rock phosphate (0.5%)	23.21	40.01	19.02	8.24	9.51	31.46	54.24	19.91	8.02	11.14	28.85	49.74	20.03	8.03	9.18
Feldspar (0.5%)	25.94	44.72	23.58	8.25	11.24	33.35	57.50	21.79	8.18	11.06	28.28	48.75	19.24	8.05	12.12
Gypsum (5 %)	25.74	44.38	17.28	8.06	7.81	32.37	55.81	20.85	7.90	11.32	29.71	51.22	20.07	7.88	11.95
Sulfur (1 %)	26.59	45.84	23.74	6.69	11.11	31.85	54.91	20.82	7.26	14.66	29.71	51.22	20.63	6.60	10.94

Table (3): Content (%) of total N,P,and K of on-farm composted treated with some conditioner materials and incubated for five months.

Conditioners treatments	Composted plant residues								
	Rice straw (100 %)			Corn stover (100 %)			Mixture of rice straw and corn stover (50% + 50 %)		
	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
Control (FYM)	1.10	0.317	1.53	1.49	0.372	1.78	1.44	0.362	1.58
Rock phosphate (0.5 %)	1.22	0.391	1.79	1.58	0526	2.06	1.44	0.468	1.91
Feldspar (0.5 %)	1.12	0.333	2.15	1.53	0.402	2.28	1.47	0.423	2.17
Gypsum (5 %)	1.49	0.360	1.68	1.60	0.455	2.00	1.48	0.406	1.81
Sulfur (1 %)	1.23	0.344	1.66	1.53	0.452	1.85	1.44	0.379	1.80

Table (4): Effect of on-farm composted and conditioners applied to clayey soil on soil fertility

Conditioners treatments	Composted plant residues								
	Rice straw (100 %)			Corn stover (100 %)			Mixture of rice straw and corn stover (50% + 50 %)		
	N (mg/kg)	P (mg/kg)	K (mg/kg)	N (mg/kg)	P (mg/kg)	K (mg/kg)	N (mg/kg)	P (mg/kg)	K (mg/kg)
Control (FYM)	31.67	14.67	439.00	38.67	15.93	360.00	32.33	15.13	429.00
Rock phosphate (0.5 %)	33.67	16.73	492.00	42.33	18.67	435.00	35.00	17.19	464.00
Feldspar (0.5 %)	34.33	16.20	530.00	43.33	18.40	459.00	35.33	16.47	502.00
Gypsum (5 %)	35.67	16.60	487.00	44.00	18.26	383.00	36.67	16.47	486.00
Sulfur (1 %)	33.00	15.93	467.00	43.00	17.07	411.00	35.33	16.27	472.00
$LSD_{0.05}$ for Compost	0.42	0.21	9.50						
Conditioners	0.54	0.28	12.30						
Interaction	0.94	0.49	21.20						

Table (5): Effect of on-farm composted and conditioners applied to clayey soil on the yield of maize and its chemical composition.

Conditioners treatments	Composted plant residues											
	Rice straw (100 %)				Corn stover (100 %)				Mixture of rice straw and corn stover (50% + 50 %)			
	Yield (kg/fed)	N (%)	P (%)	K (%)	Yield (kg/fed)	N (%)	P (%)	K (%)	Yield (kg/fed)	N (%)	P (%)	K (%)
Control (FYM)	3771.14	1.36	0.30	1.55	3846.50	1.42	0.33	1.57	3800.97	1.40	0.32	1.56
Rock phosphate (0.5 %)	3857.49	1.48	0.41	1.61	3962.68	1.55	0.47	1.58	3893.60	1.50	0.42	1.59
Feldspar (0.5 %)	3818.24	1.50	0.34	1.65	3981.52	1.55	0.38	1.58	3920.29	1.52	0.35	1.58
Gypsum (5 %)	3885.75	1.56	0.43	1.59	4187.19	1.68	0.49	1.69	4091.42	1.64	0.46	1.67
Sulfur (1 %)	3789.98	1.50	0.38	1.60	3873.19	1.59	0.42	1.59	3822.95	1.54	0.35	1.54
$LSD_{0.05}$ for Compost	19.37	0.086	0.023	0.019								
Conditioners	25.01	NS	0.030	NS								
Interaction	43.32	NS	NS	0.043								