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Nitrogen, P and K in Soils Amended with Organic Wastes and their Uptake by Corn and Wheat Plants

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Abstract:

Pot experiments were carried out in a completely randomized design in the screenhouse of Faculty of Agriculture, South Valley University, Egypt, to evaluate the application effects of different organic wastes (sewage sludge, filter mud cake, compost, filter mud cake-compost mixture and sewage sludge-compost mixture) at different levels (5, 15 and 30 ton/fed. on the release and availability of N, P and K in three different soils (clay, calcareous sandy, and sandy soils). Corn plants followed by wheat plants were grown during two successive seasons of summer 2011 and winter of 2011/2012.

Total Nitrogen (N), available phosphorus (P) and available potassium (K) in soils as well as plant dry matter and the uptake of these nutrients by plants were determined to evaluate the N, P and K released in the soil and their uptake by these plants.

The application of these organic wastes at different levels showed significant increases in N, P and K that were released in the studied soils as well as plant dry matter yield and the uptake of these nutrients by corn and wheat plants. In general, use of these investigated organic wastes at the level of 30 ton/fed. in these studied soils gave the best results.

Keywords: Organic wastes; N, P, and K release and uptake; corn and wheat plants; dry matter.

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Introduction:

Soils of arid and semiarid regions are low in their organic matter. Organic amendments should be added to these soils to improve their physical, chemical and biological properties as well as fertility. In addition, the application of organic wastes to soils that are used for crop production is of great importance due to their nutritional input and low cost (Mantovi *et al.* 2005; Sigua *et al.*, 2005b) productivity of these soils (O'Connor *et al.*, 1980; Baran *et al.,* 2001; Cogger *et al.,* 2004).

The addition of organic wastes to the soil is a current environmental and agricultural practice for maintaining soil quality. It has a great effect on organic matter and nutrient contents. It also improves the structure, water and air balance as well as microbiological activity of the soi (Candemir and Gulser, 2007; Chaturvedi *et al.,* 2008).

The most widely used organic amendments are sewage sludge and compost which have high organic matter, nitrogen and phosphorous contents that make them suitable for agricultural purposes. Sewage sludge serves as a good source of plant nutrients and organic constituents the provide beneficial soil conditioning properties (Singh and Agrawal, 2008). Since sewage sludge usually contains high organic matter and macro and micronutrients, its application to soils improves soil properties and productivity (Wilden *et al.,* 2001; Lavado, 2006). Applications of organic wastes such as sewage sludge and compost to soils result in a significant increase in the dry matter yield of the crops that are grown on these soils (Al-shallash, 2008; Taha, 2000).

As soil organic matter increases, N and P availability in the soil increases (Ewulo *et al.*, 2008). Chattopad Hyay *et al.* (1992) showed that the application of compost increased the total N and the available forms of P and K in the soil. Morsy and El-Dawwey, (1999) also indicated that the total N, available P and exchangeable K in the soil increased after filter mud cake application. Hassan (1999) also found that a significant increase in N, P and K uptake by wheat plants grown on sandy and sandy calcareous soils treated with composted sugar beet residues. In addition, Taha (2000) reported that the application of different composted organic residues significantly increased the uptake of N, P and K by corn plants over the control and the increase was proportional to the increase in the composted organic residues level.

The current study aims to evaluate the application effects five organic wastes to clay, calcareous sandy and sandy soils at different levels to N, P and K release from these wastes and their availability in these amended soils. It also investigates the effect of these organic wastes on the dry matter yield of corn and wheat plants grown in these organic waste amended soils as well as the uptake of N, P and K by these plants.

Materials and Methods:

Pot experiments were conducted to study the application effect of different organic wastes (sewage sludge, filter mud cake, compost, filter mud cake-compost mixture and sewage sludge-compost mixture) at different levels (0, 5, 15 and 30 ton/fed.) on the release of N, P and K from these waste and their accumulation in three different soils (clay, calcareous sandy and sandy soils). Two pot experiments were conducted in the screen house, Faculty of Agriculture, South Valley University, Qena, Egypt, in the summer season of 2011 and the winter season of 2011/2012.

In the first experiment, corn plants were grown to study the direct effect of the tested organic wastes on the dry matter yield as well as N, P and K contents of these plants. However, in the second one, wheat plants were sown to evaluate the residual effect of these organic wastes on these plant parameters in the studied soils.

Soil Sampling:

Samples of the studied soils were collected from different locations (the sandy soil from Salheyia, Qena governorate, the calcareous sandy soil from the experimental farm at Faculty of Agriculture, South Valley University, at Qena and the clay soil from Dandara village, Qena governorate), air dried, sieved to ≤ 2 mm, thoroughly mixed and kept for physical and chemical analysis as well as pot experiments. Some physical and chemical properties of these soils are present in Table 1.

Used Organic Wastes:

Five organic wastes were used in these experiments as follow:

a- Sewage sludge (SS): It was an air-dried sewage sludge produced from Qena sewage station at Salheyia. It was applied to the soils after crushing.

b- Filter mud cake (FM): It was produced from the organic wastes of Quos sugarcane factory.

c- Compost (C): It was produced from the experiment farm of Faculty of Agriculture at Qena, South Valley University.

d- Sewage sludge-compost mixture (SSC): It was prepared by mixing sewage sludge and compost at 1:1 ratio (w).

e- Filter mud cake-compost mixture (FMC): It was prepared by mixing filter mud cake and compost at1:1 ratio (w).

Some characteristics of these tested organic wastes are found in Table 2 .

Experiments:

The pot experiments were arranged in a completely randomized design using plastic pots of 30 cm in diameter and 35 cm in height which were filled with the prepared different three soil samples. Each pot contained 5 kg soil sample. The five different organic wastes were added at the four different levels and thoroughly mixed into the soil samples in the pots. Sixteen different treatments were applied to each soil. Each treatment was replicated three times for each soil.

In the first season (summer 2011), the soil samples in the pots which were amended with different organic wastes at different levels were cultivated using corn plants on June 10, 2011. Five seeds of corn (Giza 2 variety) were sown in each pot and thinned to two plants after germination. Nitrogen was applied to each pot as ammonium nitrate (33.5% N) at a level of 300 kg /fed in two equal doses (after two and five weeks from planting). Phosphorus was added to each pot as superphsphate (15.5% P_2O_5) at a level of 100 kg/fed. Potassium was applied to each pot as potassium sulfate (48% K_2O) at a level of 100 kg/fed. Both superphsphate and potassium sulfate fertilizer were applied before planting during the soil preparation.

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

property	Clay soil	Calcareous sandy soil	Sandy soil
Particle-size Distribution:			
Clay (%)	47	10	6
Silt (%)	33	15	4
Sand (%)	20	75	90
Texture	Clay	Sandy loam	Sand
pH (1:1)	7.76	8.33	7.92
EC_e (dSm^{-1})	1.11	2.65	1.35
Calcium carbonate %)	1.74	16.21	3.01
Organic matter (%)	1.38	0.44	0.23
Total nitrogen (%)	0.04	0.02	0.01
Available P (mg kg^{-1})	8.21	5.01	3.25
Available K (mg kg^{-1})	230.06	176.65	151.08

The plants were harvested after 45 days from planting. They were washed using deionized water, and oven-dried at 70^o C, The plant dry weight was recorded for each pot. Then, a plant sample of each pot was mill-ground and prepared for chemical analysis. Nitrogen, P, and K contents in corn plant samples were determined. Soil samples were collected after harvest from each pot, air-dried, passed through a 2 mm sieve and kept for analysis. Total N and available P
and K were estimated in the soil samples.

In the second season (winter 2011/2012), ten seeds of wheat (Giza 168 variety) were planted in each pot of the pots that were used in the first experiment on November 21, 2012. and thinned to 5 plants per pot after 20 days from sowing. All agricultural practices that were applied at the first season were carried out for wheat plants without adding the tested treatments. The plants were harvest after 50 days from sowing, washed with deionized water, over-dried at 70 C^0 and the plant dry weight per pot was recorded. Plant samples were mill ground and kept for chemical analysis of N, P and K. Soil samples were also collected from each pot, air-dried, passed through a 2 mm sieve and kept for the determination of total N and available P and K.

Table (2): Some chemical characteristics of the tested organic wastes

Property	Sewage sludge (SS)	Filter mud cake (FMC)	Compost (C)	Sewage sludge-Compost mixture (SS-C)	Filter mud cake-compost mixture (FMC-C)
pH (1:10)	6.8	6.7	7.6	7.1	7.3
EC (1:10) (dS/m)	2.08	5.6	3.1	2.55	4.12
OM (%)	37.08	65.4	25.3	32.41	42.65
Organic carbon (%)	21.51	37.94	14.67	18.79	24.74
Total nitrogen (%)	3.65	2.31	0.70	1.32	1.15
C/N ratio	5.89	16.40	20.96	7.37	10.66
Total P (P_2O_5%)	2.24	2.51	1.23	1.70	1.88
Total K (K_2O %)	0.27	0.21	0.56	0.44	0.42

Methods of Soil, Plant and Organic Wastes Analysis

The particle-size distribution of the soil samples was carried out using the pipette method according to Jackson (1973). The organic carbon in the soil and organic waste samples was determined using the Walkley-Black wet combustion method (Jackson, 1973). and then, the soil organic matter was calculated. The calcium carbonate content in the soil samples was determined using a collins volumetric calcimeter (Jakson, 1973). The electrical conductivity of the soil samples was measured in the saturated soil paste extract (EC_e). The soil pH of the soil samples was measured in the water suspension of 1:1 soil to water ratio using a glass electrode (Jackson, 1973). The pH and the EC of organic wastes were measured in water suspensions and extracts of 1:10 ratio. (Schlichting *et al.,* 1995). Available P in the soil samples was extracted using the $NaHCO_3$ method buffered at pH 8.5 according to Olsen *et al.* (1954) and measured using the chlorostannus-phosphomolybdic acid method by spectrophotometer (Jackson, 1973). Available potassium in the soil samples was extracted with 1 N ammonium acetate at pH 7.0 and determined using the flame photometer (Jackson, 1973). The total N in the soil samples was determined using the microkjeldahl method described by Jackson, (1973).

A ground dried plant material or organic waste of 0.2 g was digested using 10 ml of a mixture of 7:3 ratio sulfuric to perchloric acids and then analyzed for K using the flame photometry method Jackson (1973). Phosphorous in the plant and organic waste digests was determined using the chlorostannous-phosphomolybdic acid (Jackson, 1973). The total N in the soil, plant and organic waste samples was determined using the microkjeldahl method as described by (Jackson, 1973).

All data were subjected to the proper statistical analysis of variance according to the procedures outlined by Gomez and Gomez (1984). The differences between means of the different treatments were compared using the least significant difference (LSD) test at 5 and 1% probability.

Results and Discussion:

A. Release of N, P and K from organic wastes in Soils

1. NPK release after corn harvest:

Total Nitrogen

Data in Table (3) reveal that, generally, increases were occurred in the total of N in all studied soils as a result of applying different types and levels of the organic wastes.

The application of 5, 15 and 30 ton/fed. of the investigated organic wastes caused increases in the nitrogen released from the wastes in clay soil. The highest level of each organic waste resulted in the highest concentrations of total N in this soil. Moreover, the addition of 30 ton/fed. of sewage sludge-compost mixture recorded the highest value of total N (0.757%) in the clay soil. The significant increase in the total N occurred with 30 ton/fed. of sewage sludge-compost mixture accounted for 255% of the control treatment. Non significant differences were recorded when this treatment was compared with the same level for other organic wastes, except for sewage sludge treatment. Moreover, there are no significant differences in the total nitrogen between 15 and 30 ton/fed. levels of all organic wastes in this soil. Organic wastes additions at 5 ton/ fed. caused non significant increases in the total N of the clay soil except of the filter mud cake (FMC) treatment which recorded a significant increase. The results also showed that both levels of 15 and 30 ton/fed. of all organic wastes recorded highly significant increases in the total N in this soil.

Table (3): Effect of different sources and levels of some organic wastes on total (N %), available P mgkg^{-1}) and available K (mgkg^{-1}) in different soils after corn harvest.

Treatment	Application level (ton/ fed.)	Clay soil			Calcareous sandy soil			Sandy soil		
		N	P	K	N	P	K	N	P	K
Control		0.213	9.74	173.35	٠,١٠٦	8.60	١٦٧,٢٨	0.090	8.30	١٤٨,٦٢
Sewage sludge (SS)	5	٠,٣٥٣	23.26	١٧٩,٥٠	٠,١٨٣	22.29	٢٦٧,٠٤	٠,١٧٦	16.64	٢٣٠,١٦
	15	٠,٤٧٦	35.94	٢٨٧,٠٠	٠,٣٥٠	24.63	٣١٨,٦٠	0.486	28.98	257.78
	30	٠,٥٦٧	50.22	٣٩٧,١٠	٠,٥٧٧	39.25	٤٠٦,٦٨	٠,٦٠٩	43.60	٣٣٤,٨٥
Filter Mud Cake (FMC)	5	٠,٣٨٥	38.00	٢٣٠,٣٠	٠,١٩٤	27.03	٣٠١,٤٤	٠,٢١١	31.38	٢٤٢,٧٦
	15	٠,٥٧١	53.50	٣٨٨,٩٥	٠,٥٦٩	42.47	٣١١,٣٦	٠,٥٣٤	46.82	٢٤٨,٩٢
	30	٠,٧٠٣	62.50	٤٤٣,٣٩	٠,٥٧٤	51.53	٤٢٨,٣٥	٠,٦٣٢	55.88	٣٥١,١٢
Compost (C)	5	٠,٢٩٠	36.00	١٤٧,٤٥	0.126	25.03	260.60	٠,١١٨	29.38	٢٠٧,٠٣
	15	٠,٥٣٢	37.92	١٩٩,١٠	0.338	29.70	276.08	٠,٣٧٩	34.05	٢٢٠,٥٧
	30	٠,٦٣٧	44.19	٢٦٢,٧٥	0.549	33.22	300.80	٠,٦٤٧	37.57	٢٤٢,٢٠
Filter mud cake Compost (FMC-C)	5	٠,٣٣٩	37.03	٢٥٩,٧٥	٠,٢٠٢	26.06	٢٩٨,٤٠	٠,٢٣٣	30.41	٢٤٠,١٠
	15	٠,٦٢٥	47.88	٣٤٨,٥٠	٠,٥٥٤	36.91	٣١٠,٢٨	٠,٤٨٠	41.26	٢٥٠,٥٠
	30	٠,٧٣٨	59.01	٤٣٠,٧	٠,٧٦٥	44.46	٣٨٦,٩	٠,٧٥٨	48.81	٣١٧,٥

				٠			٦			٩
Sewage sludge Compost (SS-C)	5	٠,٣٢٢	38.94	٢٥٠,٣ ٠	٠,١٦٢	27.97	٢٩٠,٨ ٤	٠,١٩٧	32.32	٢٣٣,٤ ٩
	15	٠,٦٠٦	49.53	٢٨١,٢ ٥	٠,٣٥١	38.56	٣١٥,٦ ٠	٠,٤٣٢	42.91	٢٥٥,١ ٥
	30	٠,٧٥٧	56.15	٣٥٥,٤ ٥	٠,٤٠١	45.18	٣٧٤,٩ ٦	٠,٦٩٩	49.53	٣٠٧,٠ ٩
$LSD_{0.05}$		0.166	1.07	12.10	0.21	1.12	12.60	0.05	0.12	11.20
$LSD_{0.01}$		0.224	1.44	16.30	0.28	1.51	16.96	0.07	0.15	15.09

The addition of 5 ton/fed. of all organic wastes to the calcareous sandy soil did not record any significant increases in the total N of this soil. However, the application of 15 ton/fed. of compost and sewage sludge-compost mixture resulted in significant increases in soil N. Moreover, highly significant total N increases were obtained using the same applied level of sewage sludge, filter mud cake, and filter mud cake-compost mixture treatments. The result showed that addition of 30 ton/fed. of all organic wastes caused highly significant increases in the total N of the calcareous sandy soil. On the other hand, are no significant differences in the soil total nitrogen between 15 and 30 ton/fed levels of filter mud cake and sewage sludge-compost mixture. Significant increases were recorded in the soil N when comparing these two levels of sewage sludge, compost and filter mud cake-compost mixture. The highest total N (0.765%) in this soil was recorded for the 30 ton/fed level of the filter mud cake-compost mixture.

The total N release of the sandy soil showed the same trends of those obtained for the calcareous sandy soil regarding levels and types of organic wastes. The highest total N in this soil was recorded with filter mud cake-compost at the same level of 30 ton/ fed.

Available Phosphorus

Available phosphorus in all studied soils increased with increasing levels (Table 3). Highly significant increases in the available phosphorus of the clay soil were obtained due to increasing levels of organic wastes from 15 to 30 ton/ fed. as compared with control. Filter mud cake was the superior in the release of phosphorous in the clay soil at all applied levels compared with other organic wastes. The investigated organic wastes had the order to release P in the clay of FMC> FMC-C > SS-C> SS> C. The addition of filter mud cake at the high level (30 ton/fed) resulted in the highest value (62.5 $mgkg^{-1}$) of the available phosphorus in the clay soil. It was a highly significant increase in the available P that accounted for 541% of the control treatment.

In the calcareous sandy soil, the application of organic wastes at all levels caused highly increases in the released phosphorus compared to the control treatment (Table 3). Filter mud cake at all applied levels was also found to be the superior in releasing phosphorous in the calcareous sandy soil.

Phosphorus tended to be released in the calcareous sandy soil from the studied organic wastes in the order of FMC> SS-C >FMC-C > SS> C. In this soil, the use of filter mud cake at 30 ton/fed. gave the highest values of available P (51.53 $mgkg^{-1}$ that accounted an increase of 499% of the control treatment. The results of the available P in the sandy soil also showed the same trend as those of clay and calcareous sandy soils with regards of applying the investigated organic wastes. Moreover, filter mud cake treatment at the level of 30 ton/fed. recorded the highest level of highly significant the available P (55.88 $mgkg^{-1}$) in this soil that accounted an increase of 573% of the control treatment.

On the other hand, the available P had lowest values in the calcareous sandy soil compared to both clay and sandy soils in spite of the applied levels of the investigated organic wastes. It may be attributed to the high relation and fixation of the released P in the calcareous sandy soil that cause lower values of available P. The soil chemical properties play a major role for phosphate fixation in the calcareous soil (Chand and Tomar, 1993). Phosphorus ions coming in contact with calcium carbonate tend to are precipitate on the surface of these carbonate particles (Westerman, (1992).

Available Potassium

Highly significant increases were found in the available potassium release as a result of applying different levels of all investigated organic wastes to the studied soils (Table 3).

The results showed that the highest available potassium values were obtained in the case of applying filter mud cake at the level of 30 ton/fed. which reached to 443.35, 425.25 and 351.12 mgkg^{-1} in the clay, calcareous sandy and sandy soils, respectively, and accounted increases of 156, 154 and 136 %, respectively, compared to the control treatment. Abdel-Gawad *et al.,* (1992) found that the value of available K in the soil increased as the level of sewage sludge application increased. El-Ghamry *et al.* (2005) found that the application of compost to the soil significantly increased the available K compared to the control.

2. NPK release after wheat harvest:

Total Nitrogen

Table (4) shows that the residual N in the studied soils after wheat harvest in the second season was affected by the levels and types of organic wastes.

The highest levels of the total were 0.782, 0.688 and 0.632 % fin the clay, calcareous sandy and sandy soils, respectively, as result of amending these soils with 30 ton/fed. of FMC-C, FMC-C and FMC, respectively, which they gave significant increases of 262, 673 and 829%, respectively, of their control treatment.

Available Phosphorus

The residual of available P in the studied soils after wheat harvest significantly increased with increasing levels of the investigated organic wastes (Table 4). Filter mud cake at the level of 30 ton/fed was the superior treatment which caused increases in the residual available P of 541, 404 and 469% of the control treatment in the clay, calcareous sandy and sandy soils, respectively.

Table (4): The residual effect of different sources and levels of some organic wastes on the total N (%), available P ($mgkg^{-1}$) and available K ($mgkg^{-1}$) in different soils after wheat harvest.

Treatment	Application level (ton/ fed.)	Clay soil			Calcareous sandy soil			Sandy soil		
		N	P	K	N	P	K	N	P	K
Control	0	0.216	11.89	169.67	٠,٠٨٩	10.83	١٣٨,٥٠	0.068	10.26	١٢٢,٥٧
Sewage sludge (SS)	5	٠,٤٥٨	24.11	٣٢٥,٢٦	٠,١٤٣	13.03	٣٠٢,٧٩	٠,١٦٣	18.45	٢٥٢,٢١
	15	٠,٥٠١	35.36	٤٠١,٤٢	٠,٤٤٥	25.73	٣١٣,٥٧	0.460	٣١,١٨	316.79
	30	٠,٦٣٨	51.36	٤١١,٩٩	٠,٥٥١	42.21	٣٢٥,٣٩	٠,٥٧٣	45.55	٣٨٦,٥٨
Filter Mud Cake (FMC)	5	٠,٤١٣	41.02	٢٨٩,٣٥	٠,١٥١	30.25	٢٧٨,١١	٠,١٢٠	33.41	٢٦٩,٥٧
	15	٠,٥١٩	56.81	٤٧٢,٠١	٠,٤٨٤	45.49	٤١٨,٣٢	٠,٣٤٥	49.20	٢٩٤,١١
	30	٠,٧٦٢	65.52	٥١٨,٦٣	٠,٦٠٠	54.61	٤٣٢,٦٧	٠,٦٣٢	58.37	٣٤٨,٢٩
Compost (C)	5	٠,٣١٣	38.67	٢٢٥,٤٤	0.122	28.25	236.53	٠,١٠٨	31.39	٢١٢,٥٩
	15	٠,٥٦٠	41.94	٢٧٩,٦٩	0.313	32.96	253.12	٠,٣٥٨	36.04	٢٣٨,٠٤
	30	٠,٦٦٤	47.41	٣٢٥,٥٤	0.516	36.24	٣١٠,٧٧	٠,٥٩٧	39.83	٢٩٥,٨٦
Filter mud cake Compost (FMC-C)	5	٠,٣٥٥	39.85	٣٢٢,٣٩	٠,١٣٤	29.18	٢٨٤,٢٤	٠,١٣٦	32.32	٢٥٩,٥٦
	15	٠,٦٤٧	43.25	٣٩١,٠٦	٠,٤٢٨	32.78	٣٣٩,٢٢	٠,٤٢٥	37.20	٢٩٠,٢٦
	30	٠,٧٨٢	62.15	٤٩٤,٦٧	٠,٦٨٨	48.48	٤١٤,٥٤	٠,٥٨١	51.56	٣٩٩,٦٧
Sewage sludge Compost (SS-C)	5	٠,٣٥٨	41.93	٣١٢,٤٥	٠,١٠٦	31.03	٢٦٦,٣٢	٠,١٥٨	33.09	٢٦٧,١٧
	15	٠,٦١٠	52.55	٣٤٨,٤٦	٠,٣٦٦	41.41	٢٩٨,٨٣	٠,٤١١	44.76	٢٧٧,٨٣
	30	٠,٧٧٠	59.18	٣٨٧,٨٤	٠,٤٨٤	47.48	٣٧٤,٨٩	٠,٦٣٦	50.83	٣٤٢,٧٤
$LSD_{0.05}$		٠,٠٧٤	1.29	١٣,١٦	٠,٠٢٩	1.09	٧,٨١	٠,٠٥٣	1.23	١٢,٣٦
$LSD_{0.01}$		٠,١٠٠	1.73	١٦,٦٨	٠,٠٣٩	1.48	١٠,٤٧	٠,٠٧١	1.65	١٦,٦٣

Soil Science Society of America (1997) defined the available form of a nutrient as the amount of soil nutrient in chemical forms that is accessible to plant roots or compounds likely to be convertible to such forms during the growing season. As the soil organic matter increases the availability of N and P in the soil also increases (Ewulo *et al.,* 2008).

Available Potassium

The residual available potassium in the studied soils after the second season (wheat harvest) is shown in Table (4). All types of organic wastes at different levels gave highly significant increases in residual available potassium that was released from the decomposition of these organic wastes in all studied soils..

The highest values of the residual available potassium occurred with filter mud cake at the level of 30 ton/fed. in both clay and calcareous sandy soils. The respective values in both soils were 518.63 and 432.67

mgkg^{-1} and increases of 206 and 217% of the control treatment. In the sandy soil, the filter mud cake-compost mixture treatment at the level of 30 ton/fed. recorded the highest available K (399.67 mgkg^{-1}), resulting in a significant increase of 226% of the control treatment.

The results in Table 4 also revealed that all organic wastes at all applied levels are continusely decomposing even after the second season. Levels of total N, available P and available K in all studied soil after the second season are higher than those after first season under the use of these types and levels of the investigated organic amendment.

The application of filter mud cake to the soil caused increases in the exchangeable K (Morsy and El-Dawwey, 1999). Moreover, Khalifa (1993) found that the available K significantly increased in the surface and subsurface layers of the soil with increasing the applied of sewage sludge and farmyard manure. He added that the highest values of available K were obtained with the highest application levels of sewage sludge and farmyard manure (40 ton/fed).

B. Plant Dry Matter Yield

1. Corn dry matter yield

Applications of all organic wastes at all investigated levels caused significant increases in the dry weight of corn plants grown in the clay, calcareous sandy and sandy soils (Table 5).

There were highly significant increases in the dry matter yield of corn plants for all treatments compared to the control. Pronounced significant increases in the dry matter yield of corn plants occurred with increasing the application level of all organic wastes. Such increases were higher of the plants grown in both clay and sandy soils than those grown in calcareous sandy soil. This relative poor growth of the plants grown in calcareous soil may be attributed to the relatively unfavorable physical and chemical conditions of such soil. The mean values of the dry matter yield were higher in corn plants grown in the clay soil followed by the sandy soil and the calcareous sandy soil.

The best significant increases in corn dry weight were recorded with the application of all organic wastes at level of 30 ton/fed. in all studied soils. These increases may be due to the favorable effect of the added organic wastes on the physical, chemical and biological properties of the studied soils, particularly those concern with the availability of nutrients. These results are in a full agreement with those obtained by Abdel-Moez (2001a) and (2001b), Taha (2000) and Al-Shallash (2008). However, there was any significant increase in the dry matter yield of corn plants between the applied levels of 15 and 30 ton/fed. of filter mud cake in the sandy soil. These results are in an agreement with those reported by Kandil, Hala *et al.* (2012).

2. Wheat dry matter yield

The results of dry weight of wheat plants recorded the same trends at those obtained for corn plants (Table 6). A pronounced increase in the dry matter yield of wheat plants was obtained with increasing the application level of all organic wastes. Such increase was higher for the plants grown in the clay and calcareous sandy soils than those grown in the sandy soil.

The highest of wheat dry matter yield were occurred with the addition of all organic wastes at the highest level (30 ton/fad). Highly significant differences in wheat dry matter between 15 and 30 ton/fed levels of sewage sludge-compost mixture treatment in the clay, calcareous sandy and sandy soils. In addition significant differences in wheat dry matter yield between 15 and 30 ton/fed. levels of sewage sludge, filter mud cake, compost and filter mud cake-compost mixture in the clay soil.

These results are in accordance with those reported by Sakr *et al.* (1992) who found that the dry matter yield of wheat and maize plants showed a pronounced increase with adding organic manures; such increase was higher for the plants grown on the calcareous soil than on the alluvial one.

Table (5): Effect of different sources and levels of some organic wastes on the dry matter yield (g/pot) and the uptake of N, P and K (mg/pot) by corn plants grown in different soils.

Treatment	Application level (ton/ fed.)	Clay soil				Calcareous sandy soil				Sandy soil			
		dry matter	N uptake	P uptake	K uptake	dry matter	N uptake	P uptake	K uptake	dry matter	N uptake	P uptake	K uptake
Control	**0**	٢,٨٩	62.79	7.81	76.67	٢,٣٢	35.14	3.41	53.68	٢,٣١	٣٩,١٧	4.16	46.33
Sewage sludge (SS)	**5**	٤,٥١	105.76	21.94	126.61	٣,٤٤	58.19	7.12	85.31	٣,٤٩	٦٥,٤٤	8.25	76.68
	15	٤,٦٠	118.81	26.35	144.65	٤,١٠	78.31	12.85	115.36	٤,٦٥	٩٨,٠٥	16.11	115.28
	30	٥,٤٦	182.79	34.73	190.18	٤,٦٤	125.19	19.47	146.19	٥,١٦	١٤٩,٧٤	23.75	145.6
Filter Mud Cake (FMC)	**5**	٤,٥٣	114.08	22.93	132.77	٣,٥٧	65.04	10.37	92.90	٣,٥٩	٧٢,٤٢	11.85	82.65
	15	٥,١٠	156.47	33.98	166.65	٤,٢٨	92.09	16.43	113.94	٤,٨٦	١٢٤,٩٨	22.02	126.99
	30	٥,٣٠	169.32	35.84	191.20	٤,٨٨	109.65	19.28	140.34	٥,٠٤	١٣٩,١١	24.70	148.35
Compost (C)	**5**	٣,٨٥	85.14	17.31	104.93	٣,٢٨	51.01	6.23	78.48	٣,٨١	٦٦,٩٩	8.77	79.09
	15	٤,٣٨	104.01	21.89	132.33	٣,٩٧	68.51	10.05	106.74	٤,١٤	٧٩,٧٠	12.14	98.61
	30	٤,٧٥	134.43	25.65	150.11	٤,١٧	92.29	11.82	117.62	٤,٨١	١١٦,١٧	15.57	119.71
Filter mud cake Compost (FMC-C)	**5**	٤,١٠	96.89	19.34	115.22	٣,٢٥	54.81	8.06	8.44	٣,٥٧	٦٧,٣٥	9.50	79.78
	15	٤,٨١	129.78	28.52	126.54	٤,١٥	85.01	15.57	95.53	٤,٢٢	٩٤,٨٩	18.06	104.13
	30	٥,٢٣	163.71	32.62	179.32	٤,٣١	105.44	17.23	133.25	٤,٨٣	١٢٨,٠٠	23.03	134.36
Sewage sludge Compost (SS-C)	**5**	٤,٣٢	100.51	19.08	113.09	٣,٥٨	58.12	7.10	81.79	٤,٤٩	٨١,٨٧	10.70	94.59
	15	٤,٨٢	120.84	25.57	141.72	٤,٠٦	73.89	11.51	105.87	٤,٨١	٩٧,٠٢	15.38	109.23
	30	٥,٤٧	168.12	33.37	172.98	٤,٥١	107.49	15.87	127.68	٥,١١	١٣١,٨٤	20.44	127.44
L.S.D $_{0.05}$		0.1391	4.34	1.53	19.62	0.247	2.58	0.686	16.00	0.28	4.09	1.29	5.88
L.S.D $_{0.01}$		0.1871	5.83	2.06	26.38	0.332	3.47	0.92	21.51	0.38	5.50	1.74	7.90

C. Uptake of N, P and K by plants:

Uptakes of N, P and K by corn and wheat plants were taken as an indication of the availability of these nutrients in the soils after resulting them during the decomposition of the applied organic wastes in these soils.

1. N, P and K uptake by corn plant:

The uptake values of N, P and K by corn plants grown in the clay, calcareous sandy and sandy soils significantly increased with adding the investigated organic wastes at levels of 5, 15 and 30 ton/fed. compared to control treatment (Table 5). The highest uptake values of N, P and K by corn plants were recorded with using each organic waste at the level of 30 ton/fed, while the lowest ones were showed with adding each organic waste at the lowest level (5 ton/ fed). The increase in the uptakes of N, P and K may be attributed to the decomposition of organic wastes resulting in releasing the nutrients in the soil in available forms (Butorac *et al.,* 1995). The uptake values of N, P and K by corn plants grown in the studied soils significantly increased with increasing the application level from all the used organic wastes up to 30 ton/fed.

In this study the uptake values of N, P and K by corn plants varied widely among the studied soils. The corn plants grown in the clay soil had a higher assimilative capacity for N, P and K uptakes than other soils. The a uptake values of N, P and K by corn plants showed increases in the studied soils in the order of the clay soil > the calcareous sandy soil> the sandy soils. It is obvious that the highest amounts of N taken up by corn plants in all studied soils were recorded for applying sewage sludge at the level of 30 ton/ fed (Table 5). On the other hand, use of filter mud cake at the level of 30 ton/ fed. to the studied soils gave the highest amounts of P and K that were taken up by corn plants.

These results also agree with those obtained by Abu-Sinna *et al.* (2000) who showed that the increase in the nutrient uptakes were due to the soil pH and increasing the availability of these nutrients during the decomposition of the organic wastes. Taha (2000) also reported that the application of different composted organic residues significantly increased the uptake of N, P and K by corn plants over the control and the increase was proportional to the increase in the composted organic residues level.

2. N, P and K uptake by wheat plants:

The uptake values of N, P and K by wheat plants grown in the clay, the calcareous sandy and the sandy soils significantly increased with increasing levels of the organic wastes from 5 to 30 ton/fed. compared to the control (Table 6). The highest mean amounts of N, P and K taken up by wheat plants were recorded with adding 30 ton/fed of all organic wastes, while the lowest ones were found for the lowest level (5 ton/fed) of these wastes. These results are in accordance with those obtained by Ali (1999).

Table (6): The residual effect of different sources and levels of some organic wastes on the dry matter yield (g/pot) and the uptake of N, P and K (mg/pot) by wheat plants grown in different soils.

Treatment	Application level (ton/ fed.)	Clay soil				Calcareous sandy soil				Sandy soil			
		dry matter	N uptake	P uptake	K uptake	dry matter	N uptake	P uptake	K uptake	dry matter	N uptake	P uptake	K uptake
Control	**0**	2.05	25.62	5.19	34.17	1.50	17.10	3.50	24.25	1.27	7.22	2.81	18.13
Sewage sludge (SS)	**5**	3.30	47.13	16.50	58.08	2.76	36.71	13.52	47.47	2.52	16.36	11.23	38.02
	15	3.65	63.75	21.90	76.89	3.10	50.74	17.98	63.76	2.87	44.14	15.36	51.95
	30	4.73	97.44	29.96	105.01	3.88	75.79	23.80	84.20	3.95	72.00	22.38	75.39
Filter Mud Cake (FMC)	**5**	3.16	41.08	13.06	59.41	2.61	31.06	10.27	47.76	2.38	26.94	8.73	38.39
	15	3.51	61.54	20.59	76.52	2.96	48.64	16.77	63.05	2.73	42.15	14.31	51.16
	30	4.59	86.29	27.85	106.34	4.04	71.51	23.70	91.57	3.81	63.21	20.67	75.92
Compost (C)	**5**	2.77	36.10	12.56	49.03	2.23	26.61	9.66	38.36	2.00	22.70	8.06	30.35
	15	3.13	44.13	14.71	61.45	2.58	33.54	11.61	49.36	2.35	28.95	9.83	39.61
	30	4.21	69.89	20.91	89.11	3.66	56.73	17.45	75.64	3.43	50.05	15.18	62.39
Filter mud cake Compost (FMC-C)	**5**	2.97	41.97	15.98	52.27	2.42	31.54	12.54	41.38	2.19	27.04	10.51	33.04
	15	3.50	61.05	22.41	73.51	2.95	48.20	18.30	60.47	2.72	41.75	15.58	49.06
	30	4.54	92.99	30.80	105.63	3.59	69.59	23.64	81.75	3.76	67.90	22.94	75.27
Sewage sludge Compost (SS-C)	**5**	2.81	37.37	15.54	47.77	2.26	27.57	12.20	37.29	2.03	23.53	10.15	29.57
	15	3.34	58.47	21.61	68.92	2.79	45.77	17.49	56.16	2.56	39.45	14.82	45.36
	30	4.96	93.15	34.26	112.81	4.08	72.22	27.39	90.85	4.18	69.27	25.86	81.75
$LSD_{0.05}$		0.925	0.98	0.69	1.59	0.021	0.91	0.56	1.30	0.02	0.63	0.48	1.13
$L.S.D_{0.01}$		1.243	1.32	0.93	2.14	0.028	1.22	0.75	1.75	0.28	0.86	0.64	1.52

He found a significant increase in the uptake of N, P and K by wheat plants grown in the sandy and calcareous sandy soils treated with composted sugar beet residues.

On calcareous sandy and sandy soils treated with composted sugar beet residues**,** Hassan (1999) also showed a significant increase in the amounts of N, P and K taken up by wheat plants. The uptake values of N, P and K by wheat plants in this study varied widely among the studied soils. The wheat plants grown in the clay soil had a higher assimilative capacity for uptake of N, P and K than other soils.

The results also showed that the highest uptake values of N by wheat plants in all studied soils were obtained with adding sewage sludge at the level of 30 ton/ fed. (Table 6). However, applying the sewage sludge-compost mixture at the level of 30 ton/ fed. resulted in the highest uptake values of both P and K by wheat plants in all studied soils. This may be attributed to the high content of these nutrients in these organic wastes Mahmoud (2000). Such increase was higher in the plants grown in the clay and the sandy soils than in the calcareous sandy soil which has some special chemical properties that lower the available forms of these nutrients in this soil.

Conclusion:

The application of the investigated organic wastes (sewage sludge, filter mud cake, compost, filter mud cake-compost mixture and sewage sludge-compost mixture) increased the available N, P and K levels in the studied soils (clay, calcareous sandy and sandy soils). This was clearly indicated by the increase in the plant dry matter yield as well as N, P and K taken up by the tested plants. The highest values of the dry matter yield, release of N, P and K in the soils and uptake of these nutrients by corn and wheat plants were obtained with applying the organic wastes at the level of 30 ton/ fed. Effects of the investigated organic wastes on these estimated parameters varied among their types and applied levels. Therefore, more studies are needed to investigate the effect of these organic wastes on the plant growth and uptake of nutrients and metals by these crops under field conditions.

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النيتروجين والفوسفور والبوتاسيوم في أراضي معاملة بمخلفات عضوية والكمية الممتصة منها بنباتات الذرة والقمح

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الملخص:

أجريت تجارب أصص في تصميم كامل العشوائية في كلية الزراعة، جامعة جنوب الوادي بقنا، لتقييم تأثيرا لإضافات المختلفة من المخلفات العضوية (الحمأة ، وطينة المرشحات، والكمبوست ، خليط من طينة المرشحات- الكمبوست وخليط من الحمأه- كمبوست) بمستويات مختلفة ٥ ، ١٥ ، ٣٠ طن / فدان علي تحرر وصلاحية عناصر النيتروجين والفوسفور والبوتاسيوم في ثلاثة أنواع مختلفة من الاراضي (طينية ، رملية جيرية و رملية). تم زراعة نباتات الذرة يليه القمح خلال موسمين متتاليين في صيف ٢٠١١ وشتاء ٢٠١١/٢٠١٢. تم تقديرالنيتروجين الكلى (N) والفوسفور الميسر (P) والبوتاسيوم الميسر (K) وكذلك المادة الجافة للنبات وامتصاص هذه العناصر بواسطة النباتات في الاراضي المدروسة لتقييم تحررالنيتروجين والفوسفور والبوتاسيوم في الأراضي. أظهرت النتائج أن الاضافات من هذه المخلفات العضوية تحت مستويات مختلفة زيادة معنوية فى تحررالنيتروجين والفوسفور والبوتاسيوم في الاراضي تحت الدراسة وكذلك في المادة الجافة وامتصاص هذه العناص الغذائية بواسطة نباتات الذرة والقمح. وعموما فإن استخدام هذه المخلفات العضوية عند مستوى ٣٠ طن / فدان. في هذه الأراضي أعطى أفضل النتائج.