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Addition Effects of Certain Organic Materials on Some Chemical Properties and Available Calcium and Phosphorus of Calcareous Soils

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Abstract: Four soil samples were collected from the surface layer of some cultivated and uncultivated calcareous soils located in the areas of Wadi El-Assiut and its interference zone with the Nile valley at Assiut to evaluate the application effects of certain organic materials on some chemical properties and the available Ca and P of these soils. The organic materials included 1) humic acid (HA) 2) vinasse (V) 3) clover straw (CS) and 4) ethyllyene diamine tetra acetic acid (EDTA). They were applied to the soil samples at levels of 2.5 and 5.0%. Soil samples treated with organic materials as well as the controls were moistened to the field capacity and then incubated at 24±2ºC for different time periods (30, 60 and 120 days).

The EC of studied soils significantly increased with the addition of the studied organic materials and with increasing the addition level. It also increased with the time of incubation until 60 days but then decreased after 120 days of incubation. The soil pH increased with adding both humic acid and EDTA compared to the control. However, the application of vinasse and clover straw to all studied soils at both application levels showed a reduction in the soil pH. The $CaCO_3$ content of the organic material treated soils decreased with increasing both the application level of each organic material and the incubation time. Most organic material treated soils showed decreases in $CaCO_3$ in the order of CS > HA ≈ EDTA ≈ Vinasse.

The available Ca of the studied soils increased with adding the investigated organic materials as well as their application level, except using CS. EDTA as a synthetic chelating agent gave the highest amounts of the available calcium in all studied soils. The increases in the soil available Ca induced by addition of the investigated organic materials showed the order of Vinasse> HA> EDTA> CS in all soils.

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All organic materials resulted in significant increases in the available P of all studied soils compared to the control treatment. In most cases, the available P of the studied soils treated with the investigated organic materials increased with increasing the incubation time up to 30 days and then, decreased in the last two incubation periods (60 and 120 days). Highest levels of available P were observed in the treated A and B (cultivated) soils. However, relatively low available P levels were found in the treated C and D (uncultivated) soils. The increases in the soil available P induced by addition of the investigated organic materials, generally, decreased in the order of the Vinasse > HA > CS > EDTA.

Introduction

Most of the newly reclaimed soils of Egypt are mainly sand and sandy calcareous which are very poor in organic matter and plant nutrients, especially N and P. Thus, the addition of different organic materials is essential to these soils not only to provide the required nutrients but also to improve the physical and chemical properties of these soils. Organic materials may have advantage effects on P status when they are added to calcareous soils. During the mineralization of these materials, P and organic acids become free in these soils. So, more available P levels may be added and/or transformations among soil P forms may occur in these soils. Organic acids, CO_2 and other products resulting from the microbial decomposition of organic matter may solubilize the insoluble phosphate forms by chelating cations, lowering soil pH and / or the partial occupation of organic anions on the surface of $CaCO_3$ and clay minerals (Halford and Mattingly, 1975; El-Desoky and Ragheb, 1993). Moreover the organic matter can block the calcium carbonate ($CaCO_3$) surfaces and hinder the nucleation of Ca-P crystals (Inskeep and Silvertooth, 1988).

Several studies showed that soil chemical properties e.g., soil pH, total soluble salts and calcium carbonate were reported to be influenced by the addition of organic materials to soils (Ahmed and Ali, 2005; John and Stella, 2005; Ohno et al, 2005; Abdel-Kaway,2006;Wandruszka, 2006; Awad,2007; Hamed,2008).

The organic matter was reported to block $CaCO_3$ surfaces and hinder the nucleation of Ca-P crystals (Inskeep and Silvertooth, 1988). The manured soils were found to have more organic C, exchangeable Ca and total P than the unmanured ones (Andrew et al, 2004). Soil Phosphorus was also reported to increase with organic matter application (El-Desoky and Ragheb, 1993; Elgala et al, 1988; Bautista et al, 2000; Sarir et al, 2006).

The objective of this study is to evaluate the addition effects of some organic materials (humic acid, vinasse, clover straw and EDTA) to some calcareous soils on their chemical properties as well as their available phosphorus and calcium contents.

Materials and Methods

Four soil samples were collected from the surface layer (0-20 cm) of cultivated and uncultivated calcareous soils of Wadi El-Assiuti and its interference zone with the Nile Valley to study the application effects of certain organic materials on some chemical properties as well as available calcium and phosphorus of these soils. These soils had different contents of calcium carbonate and available Ca and P. Soil samples A and B represented the cultivated calcareous soils and are located in the interference zone between the Nile Valley and Wadi El-Assiuti, while, samples C and D represented the uncultivated ones that are located in Wadi El- Assiuti and its fringe (El-Ghorieb), respectively. Some physical and chemical properties of these soil samples (A, B, C and D) are present in Table (1).

Property	Soil sample			
	A	B	C	D
Partical-siz distribution				
Sand (%)	77.43	78.11	90.50	92.17
Silt (%)	9.07	7.80	5.20	4.03
Clay (%)	13.50	14.09	4.30	3.80
Texture	Loamy Sand	Loamy Sand	Sand	Sand
Saturation capacity (%)	27.00	28.00	21.00	23.00
pH (1:2.5)	8.55	8.50	8.59	8.65
EC (1:2.5, dS/m)	0.30	0.27	0.79	0.43
Organic matter (%)	1.52	2.26	0.53	0.51
$CaCO_3$ (%)	16.50	19.00	25.00	35.00
Soluble cations and anions (mmol/kg)				
Na^+	4.55	2.55	7.57	5.10
K^+	0.55	0.43	1.55	0.89
Ca^{+2}	3.13	3.12	10.56	6.86
Mg^{+2}	1.19	0.63	1.13	1.56
HCO_3^-	0.58	0.83	0.71	0.42
Cl^-	1.04	1.05	2.90	1.25
SO_4^{-2}	60.00	57.50	103.00	75.00
NaAOC-extractable Ca (g/kg)	1.51	1.49	1.10	1.06
$NaHCO_3$-extractable P (mg/kg)	12.89	30.00	2.97	2.40

An incubation experiment was conducted in the laboratory containing the four soil types (A, B, C and D), four organic materials and two addition levels of these organic materials. The experiment was designed as a randomized complete block with three replications.

The organic materials used in this study were 1) humic acid (HA) solution as a natural liquid organic material, 2) vinasse (V) solution as a by-product liquid organic material of sugar cane industry, 3) clover straw (CS) as a natural solid organic material, and 4) ethyllyene diamin tetra acetic acid (EDTA) as a synthetic organic material Some chemical characteristics of these organic materials are found in Table (2). Each organic material was added to 200g of each soil in a plastic pot at two levels (2.5 and 5%). All soil samples in the pots were moistened to its field capacity and incubated at 24±2ºC for 30, 60 and 120 days. Each of humic acid and vinasse was added to each plastic pot as a solution to reach its saturation capacity; the additions were repeated until finishing the required amount. Moreover, the required amount of EDTA was dissolved in 100ml distilled water, added to each soil in each pot, and completed to the saturation capacity by distilled water. However, the required amount of clover straw was mixed with each soil in each pot and then, the distilled water was added to the saturation capacity (Table 3).

Table (2). Some chemical characteristics of the studied organic materials.

Character	Organic material		
	Humic acid	Vinasse	Clover straw
pH (1:2.5)	11.66	4.36	7.16
EC (1:2.5,dS/m)	16.45	15.00	6.42
Organic matter (%)	2.99	5.01	94.00
Total Ca (%)	0.49	0.60	0.41
Total P (%)	0.015	0.02	0.06

Table (3). Amounts of P (mg/kg) that were added to the soil through the applied organic materials during the incubation experiment.

Organic Material	Level(%)	Amount added to 200 g soil.	P (mg/kg)
Humic acid	2.50	166.7 mL	127.50
Humic acid	5.00	333.4 mL	255.00
Vinasse	2.50	100 mL	108.00
Vinasse	5.00	200 mL	216.00
Clover straw	2.50	5 g	13.75
Clover straw	5.00	10 g	27.50

The incubated soil samples were daily adjusted to their field capacity by the addition of distilled water during the incubation period. Soil samples were taken from each treatment at the end of each incubation period. They were analyzed for some soil chemical properties and the available content of both P and Ca.

Particles-size distribution and the electrical conductivity in the soil samples were performed using the method of Jackson (1973). Soil calcium carbonate was determined by the calcimeter method, according to Nelson (1982). Soil pH was determined using the method of Mclean (1982). Available P in the soil samples was extracted using the method of Olsen et al (1954) and measured using the spectrophotometer at wavelength of 660 um. Soil available calcium was extracted with 1N NaAOC buffered at pH 8.2 (Jackson,1973) and determined using the versinate titration method.

The data were statistically analyzed according to the methods described by Sendecor and Cochran (1980).

Results and Discussion

1. Soil Chemical Properties.

The addition effects of the investigated organic materials i.e, humic acid, vinasse, clover straw and EDTA on some soil chemical properties (electrical conductivity, soil pH, soil organic matter, calcium carbonate content) of the studied soils will be discussed as follow:

1.1 Electrical conductivity (EC)

The results in Tables 4 and 5 indicated that the examined organic materials varied in their effects on the soil salinity (EC) depending upon the soil type, the organic material, and its addition level as well as the time period of incubation.

Generally, the application of the investigated organic materials resulted in increases in the EC of the studied soils compared to their controls. The EC of the soil increased with increasing the application level of each organic material It also increased with increasing the incubation period up to 60 days but it decreased in the last period (120 days).. These results agree with those obtained by Abdel-Moez et al (1995) Elgala et al (1998), Kutuk et al (2002) and Awad (2007).

Both humic acid and vinasse had a similar effect on the EC of each soil and its increase trend (Tables 4 and 5). Each of these materials had a higher salt content than the other two organic materials (16.45 and 15.00 dS/m, respectively) as it is shown in Table 2. So, the soil incubated with each of these materials gave higher EC values (Engracia et al, 2001; Chouliaras and Gemtos, 2002; Subash et al, 2002). However, the soils treated with clover straw showed the lowest EC values. As it is shown in Table 2, the natural organic material (clover straw) had the lowest salt content. The increases in the EC of the organic material treated soils induced by the incubation time period is probably related to releasing soluble salts from the degradation of this organic material The decreases in the EC after 120 days of incubation may be attributed to the formation of insoluble salts due to the release of the polyvalence cations and anions from the organic material degradation that react with soluble salts in the soil.

Table (4): Effect of adding some organic materials and the incubation time on the electrical conductivity (dS/m) of soil (A) and soil (B).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	A soil				
Control	0.29	0.30	0.32	0.31	0.30
Humic acid 2.5%	3.46	3.58	3.71	3.61	3.59
Humic acid 5%	7.63	7.73	7.82	7.73	7.73
Vinasse 2.5%	3.82	4.84	4.96	4.65	4.57
Vinasse 5%	7.32	7.43	7.62	7.62	7.50
Clover straw 2.5%	0.70	0.71	0.98	0.67	0.77
Clover straw 5%	1.01	1.11	1.19	1.03	1.09
EDTA 2.5%	2.12	2.34	2.42	2.33	2.30
EDTA 5%	5.25	5.35	5.46	5.28	5.34
Mean	3.51	3.71	3.83	3.69	3.69
$L.S.D_{0.05}$					
Incubation time (IT)	0.04				
Organic material (OM)	0.06				
IT x OM	0.12				
	B soil				
Control	0.27	0.29	0.31	0.29	0.29
Humic acid 2.5%	3.58	3.69	4.03	3.71	3.75
Humic acid 5%	6.65	7.88	7.99	7.88	7.60
Vinasse 2.5%	4.03	4.19	4.36	3.76	4.09
Vinasse 5%	7.17	7.40	7.57	7.11	7.31
Clover straw 2.5%	0.58	0.62	0.67	0.64	0.63
Clover straw 5%	0.91	0.98	1.06	1.02	0.99
EDTA 2.5%	2.64	2.67	2.67	2.34	2.58
EDTA 5%	5.17	5.42	5.68	5.52	5.45
Mean	3.44	6.87	3.82	3.59	4.43
$L.S.D_{0.05}$					
Incubation time (IT)	0.04				
Organic material (OM)	0.07				
IT x OM	0.13				

Table (5): Effect of adding some organic materials and incubation time on the electric conductivity (dS/m) of soil (C) and soil (D)

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	C Soil				
Control	0.73	0.75	0.76	0.74	0.75
Humic acid 2.5%	4.55	4.66	4.78	4.55	4.64
Humic acid 5%	8.84	8.89	9.05	8.66	8.86
Vinasse 2.5%	4.58	4.76	4.56	4.52	4.61
Vinasse 5%	8.82	8.82	8.95	8.50	8.77
Clover straw 2.5%	1.11	1.24	1.28	1.20	1.21
Clover straw 5%	1.55	1.57	1.63	1.49	1.56
EDTA 2.5%	3.47	3.67	3.65	3.39	3.55
EDTA 5%	5.52	5.63	5.72	5.49	5.59
Mean	9.79	10.00	10.10	9.64	4.39
$L.S.D_{0.05}$					
Incubation time (IT)	0.04				
Organic material (OM)	0.06				
IT x OM	0.13				
	D soil				
Control	0.43	0.44	0.47	0.45	0.45
Humic acid 2.5%	3.95	4.03	4.22	3.69	3.97
Humic acid 5%	8.77	8.92	8.95	8.69	8.83
Vinasse 2.5%	4.37	4.61	4.65	4.53	4.54
Vinasse 5%	8.74	8.86	8.93	8.59	8.78
Clover straw 2.5%	0.72	0.76	0.84	0.82	0.79
Clover straw 5%	1.02	1.10	1.18	1.04	1.09
EDTA 2.5%	3.24	3.30	3.42	2.89	3.21
EDTA 5%	5.19	5.50	5.63	5.34	5.42
Mean	4.05	4.17	4.25	4.00	4.12
$L.S.D_{0.05}$					
Incubation time (IT)	0.03				
Organic material (OM)	0.05				
IT x OM	0.10				

1.2 Soil pH.

The examined organic materials and the time of incubation showed significant effects on the pH of treated soils (Tables 6 and 7). The soil pH increased with adding both humic acid (HA) and EDTA compared to the control. However, the application of vinasse and clover straw to all studied soils at both application levels showed a reduction in the soil pH. These results agree with those of Awad (2007) who reported that leaching the soils with some organic materials caused decreases in the soil pH. The pH of the organic material treated soils decreased with increasing the time period of incubation. These decreases varied from one soil to another, depending upon the type and the level of organic material In most cases the highest mean values of the soil pH were observed for the soils treated with humic acid. Humic acid had a high pH value (11.66) as it is shown in Table 2. On the other hand, the lowest mean values of the soil pH were found for the soils treated with vinasse. Pure vinasse has a native low pH value of 4.36 (Table 2). Moreover, the organic materials contained in vinasse decompose producing CO_2 and organic acids that lower its pH value (Arafat et al, 2000).

Table (6): Effect of adding some organic materials and incubation time on the soil pH of soil (A) and soil (B).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	A soil				
Control	8.54	8.44	8.39	8.38	8.44
Humic acid 2.5%	8.82	8.56	8.34	8.23	8.49
Humic acid 5%	9.34	9.08	8.94	8.93	9.07
Vinasse 2.5%	8.46	8.31	7.93	7.88	8.15
Vinasse 5%	8.32	8.11	8.04	8.01	8.12
Clover straw 2.5%	8.54	8.43	8.39	8.31	8.42
Clover straw 5%	8.42	8.36	8.28	8.26	8.33
EDTA 2.5%	8.67	8.62	8.46	8.18	8.48
EDTA 5%	8.92	8.85	8.84	8.66	8.82
Mean	8.67	8.53	8.40	8.32	8.48
$L.S.D._{0.05}$					
Incubation time (IT)	0.05				
Organic material (OM)	0.07				
IT x OM	0.14				
	B soil				
Control	8.50	8.48	8.41	8.38	8.44
Humic acid 2.5%	9.30	9.12	9.00	8.93	9.09
Humic acid 5%	9.57	9.42	9.26	9.07	9.33
Vinasse 2.5%	8.37	8.13	8.11	8.05	8.17
Vinasse 5%	8.29	8.11	8.04	7.92	8.07
Clover straw 2.5%	8.43	8.38	8.31	8.27	8.35
Clover straw 5%	8.36	8.32	8.28	8.25	8.30
EDTA 2.5%	8.71	8.61	8.53	8.44	8.57
EDTA 5%	8.91	8.82	8.71	8.65	8.77
Mean	8.72	8.59	8.52	8.44	8.57
$L.S.D._{0.05}$					
Incubation time (IT)	0.02				
Organic material (OM)	0.03				
IT x OM	0.07				

Table (7): Effect of adding some organic materials and incubation time on the soil pH of soil (C) and soil (D)

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	C soil				
Control	8.50	8.44	8.41	8.38	8.43
Humic acid 2.5%	9.35	9.21	9.12	8.98	9.17
Humic acid 5%	9.80	9.67	9.61	9.48	9.64
Vinasse 2.5%	8.37	8.13	8.11	8.05	8.17
Vinasse 5%	8.29	8.01	8.00	7.96	8.07
Clover straw 2.5%	8.43	8.38	8.26	8.14	8.30
Clover straw 5%	8.36	8.33	8.32	8.25	8.32
EDTA 2.5%	8.95	8.84	8.79	8.70	8.82
EDTA 5%	9.04	8.99	8.95	8.85	8.96
Mean	8.79	8.67	8.62	8.53	8.65
$L.S.D._{0.05}$					
Incubation time (IT)	0.03				
Organic material (OM)	0.04				
IT x OM	0.08				
	D soil				
Control	8.65	8.56	8.45	8.44	8.53
Humic acid 2.5%	9.34	9.21	9.15	8.66	9.09
Humic acid 5%	9.78	9.57	9.49	9.43	9.57
Vinasse 2.5%	8.46	8.41	8.28	8.11	8.32
Vinasse 5%	8.32	8.23	8.08	7.91	8.14
Clover straw 2.5%	8.54	8.32	8.29	8.21	8.34
Clover straw 5%	8.42	8.38	8.33	8.26	8.36
EDTA 2.5%	8.76	8.64	8.63	8.61	8.66
EDTA 5%	8.83	8.81	8.79	8.76	8.80
Mean	8.79	8.69	8.61	8.49	8.64
$L.S.D._{0.05}$					
Incubation time (IT)	0.04				
Organic material (OM)	0.05				
IT x OM	0.10				

It is shown that vinasse had the same effects at both application levels on the soil pH of both C and D soils (Table 7). Similar effects were also found with the application of clover straw at both levels on the pH of both C and D soils. These results are in a full agreement with those obtained by Arafat et al (2000), Yassen et al (2002) and Abed El-Kawy (2006). The application effect of the organic materials on the soil pH decreased in the order of HA > EDTA > CS > vinasse.

1.3 Calcium carbonate content.

The effects of these investigated organic materials and the incubation time period on the calcium carbonate content of the studied soils are shown in Tables 10 and 11. It was clear that the impact of applied organic materials on the calcium carbonate content of the studied soils was limited.

Table (8): Effect of adding some organic materials and incubation time on the calcium carbonate (%) of soil (A) and soil (B).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	A soil				
Control	16.43	16.36	16.33	16.29	16.35
Humic acid 2.5%	16.39	16.18	16.11	16.07	16.19
Humic acid 5%	16.01	15.76	15.61	15.53	15.73
Vinasse 2.5%	16.34	15.99	15.93	15.92	16.05
Vinasse 5%	15.93	15.69	15.39	15.38	15.60
Clover straw 2.5%	16.38	16.32	16.02	15.96	16.17
Clover straw 5%	16.01	15.84	15.85	15.78	15.87
EDTA 2.5%	16.32	16.26	16.00	15.99	16.14
EDTA 5%	16.04	15.79	15.74	15.62	15.80
Mean	16.21	16.02	15.89	15.84	15.99
L.S.D.$_{0.05}$					
Incubation time (IT)	0.07				
Organic material (OM)	0.10				
IT x OM	0.02				
	B soil				
Control	18.87	18.84	18.80	18.80	18.83
Humic acid 2.5%	18.71	18.48	18.47	18.39	18.51
Humic acid 5%	18.44	18.11	18.00	18.06	18.15
Vinasse 2.5%	18.73	18.51	18.43	18.36	18.51
Vinasse 5%	18.50	18.11	18.01	17.98	18.15
Clover straw 2.5%	18.72	18.48	18.47	18.42	18.52
Clover straw 5%	18.10	18.08	18.00	18.03	18.05
EDTA 2.5%	18.67	18.47	18.53	18.32	18.50
EDTA 5%	18.45	18.12	18.05	18.04	18.17
Mean	18.58	18.36	18.31	18.27	18.38
L.S.D.$_{0.05}$					
Incubation time (IT)	0.06				
Organic material (OM)	0.10				
IT x OM	0.19				

Table (9): Effect of adding some organic materials and incubation time on the calcium carbonate (%) of soil (C) and soil (D).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	C soil				
Control	24.80	24.89	24.75	24.71	24.79
Humic acid 2.5%	24.68	24.46	24.43	24.54	24.53
Humic acid 5%	24.29	23.99	23.94	23.93	24.04
Vinasse 2.5%	24.72	24.59	24.43	24.33	24.52
Vinasse 5%	24.31	24.07	23.93	23.87	24.05
Clover straw 2.5%	24.39	24.53	24.44	24.14	24.38
Clover straw 5%	24.36	23.97	23.92	23.73	24.00
EDTA 2.5%	24.75	24.57	24.38	24.42	24.53
EDTA 5%	24.25	23.99	23.87	23.84	23.99
Mean	24.51	24.34	24.23	24.17	24.31
L.S.D.$_{0.05}$					
Incubation time (IT)	0.11				
Organic material (OM)	0.17				
IT x OM	0.33				
	D Soil				
Control	34.86	34.76	34.78	34.82	34.81
Humic acid 2.5%	34.70	34.29	34.20	34.42	34.40
Humic acid 5%	34.19	33.99	33.94	34.00	34.03
Vinasse 2.5%	34.77	34.39	34.31	34.51	34.50
Vinasse 5%	34.37	34.07	33.84	33.65	33.98
Clover straw 2.5%	34.83	34.32	34.26	34.30	34.43
Clover straw 5%	34.45	34.00	33.73	33.35	33.88
EDTA 2.5%	34.89	34.34	34.25	34.26	34.44
EDTA 5%	34.46	34.03	33.66	33.74	33.97
Mean	34.61	34.24	34.11	34.12	34.27
L.S.D.$_{0.05}$					
Incubation time (IT)	0.08				
Organic material (OM)	0.13				
IT x OM	0.25				

The $CaCO_3$ content of the organic material treated soils decreased with increasing both the application level of each organic material and the incubation time. The increased organic acids and CO_2 evolution during the decomposition of the organic materials with increasing the level of application and with increasing the incubation time may cause few $CaCO_3$ in these soils to dissolve (Halford and Mattingly, 1975; El-Desoky and Ragheb, 1993).

The effect of each organic material type and its application level in reducing the $CaCO_3$ content of the studied soils differed from one soil to another. This effect in reducing $CaCO_3$ content of A soil, regardless the applied level effect, had the order of Vinasse > HA > EDTA > CS. However, the effect of the organic material in reducing the $CaCO_3$ content of B, C and D soils showed the order of CS > HA ≈ EDTA ≈ Vinasse.

The mean reductions in the $CaCO_3$ content of A soil treated with vinasse, humic acid, EDTA and clover straw at the applied level of 5.0% were 4.59, 3.80, 3.36 and 2.94%, respectively. Meanwhile, the mean reductions in the $CaCO_3$ content due to the application of clover straw, humic acid, EDTA and vinasse at the applied level of 5.0% were 4.14, 3.61, 3.50 and 3.61%, respectively, for B soil, 3.19, 3.03, 3.23 and 2.99%, respectively, for C soil, and 2.67, 2.24, 2.41 and 2.38%, respectively, for D soil. These results coincide with those obtained by Abdel-Naim (1975) who showed that the addition of the sewage water to calcareous and sandy soils caused their calcium carbonate contents to drop.

The $CaCO_3$ content of the organic material treated soils decreased with increasing the incubation time (Tables 10 and 11). As averages, $CaCO_3$ content decreased from 16.21 to 15.84% in A soil, from 18.58 to 18.27% in B soil, from 24.51 to 24.17% in C soil, and from 34.61 to 34.12% in D soil after 120 days of incubation.

2. Soil Available Calcium and Phosphorus.

2.1 Soil available calcium.

The impact of organic materials and the incubation time on the available calcium of the studied soils is present in Tables 12 and 13. The results showed variations in the available Ca in the treated soils depending upon the organic material type, its application level and the time of incubation.

Generally, as an average value, the available Ca of the studied soils increased with adding all organic materials, but with using clover straw at the 2.5% level in all soils and at the 5.0% level in D soil, it decreased compared to the control. Moreover, the high application level (5.0%) of each organic material resulted in a higher available Ca level in all studied soils compared with the low level (2.5%).

Vinasse induced the highest amounts of the available calcium in all studied soils. It may be attributed to its acidity that dissolves calcium carbonate as well as having some soluble organics that are able to chelate and complex calcium. Humic acid came after vinasse in its ability to increase the available calcium of the studied soils. It caused substantial increases in the available Ca of the soils under study due to its high ability to chelate soil calcium because of its high alkalinity (pH11.66) whereas calcium chelates are stable. Meanwhile, EDTA induced few increases in the available calcium of the studied soils. As a synthetic chelator, it has an ability to chelate soil calcium under high soil pH conditions. However, the Ca-EDTA chelate is effective and stable under soil pH equal or greater than 12. On the other hand, applying clover straw to these soils resulted in a decrease in the available Ca because of the precipitation of Ca^{+2} as $CaCO_3$ by CO_2 evolved from clover straw decomposition. Soil available Ca may be also immobilized inside soil microorganisms. The available Ca increases generally decreased in the order of Vinasse > Humic acid > EDTA > Clover straw.

Table (10): Effect of added organic materials and the incubation time on the available calcium (g/kg) of soil (A) and soil (B).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	A soil				
Control	1.503	1.667	1.625	1.792	1.647
Humic acid 2.5%	2.642	2.560	1.900	1.067	2.042
Humic acid 5%	2.982	2.887	2.340	1.500	2.427
Vinasse 2.5%	3.542	3.033	2.627	2.533	2.934
Vinasse 5%	3.900	3.533	3.071	2.765	3.317
Clover straw 2.5%	1.618	1.544	1.459	1.325	1.487
Clover straw 5%	1.753	1.735	1.611	1.473	1.643
EDTA 2.5%	2.01	1.703	1.595	1.495	1.701
EDTA 5%	2.148	1.941	1.742	1.699	1.883
Mean	2.455	2.289	1.997	1.739	2.120
$L.S.D._{0.05}$					
Incubation time (IT)	0.030				
Organic material (OM)	0.044				
IT x OM	0.089				
	B soil				
Control	1.497	1.604	1.767	1.876	1.686
Humic acid 2.5%	2.907	2.467	1.940	1.378	2.173
Humic acid 5%	3.127	2.913	2.456	1.775	2.568
Vinasse 2.5%	3.853	3.261	3.067	2.967	3.287
Vinasse 5%	4.173	3.910	3.487	3.266	3.709
Clover straw 2.5%	1.507	1.454	1.437	1.373	1.443
Clover straw 5%	1.627	1.587	1.531	1.555	1.575
EDTA 2.5%	2.133	1.933	1.73	1.646	1.861
EDTA 5%	2.28	2.032	1.984	1.831	2.032
Mean	2.567	2.351	2.155	1.963	2.259
$L.S.D._{0.05}$					
Incubation time (IT)	0.025				
Organic material (OM)	0.038				
IT x OM	0.075				

Table (11): Effect of added organic materials and the incubation time on the available calcium (g/kg) of soil (C) and soil (D).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	C soil				
Control	1.007	1.042	0.792	0.959	0.950
Humic acid 2.5%	2.413	2.267	1.867	1.513	2.015
Humic acid 5%	2.896	2.640	2.300	1.787	2.406
Vinasse 2.5%	2.480	2.533	2.067	2.040	2.280
Vinasse 5%	3.007	3.733	2.953	2.587	3.070
Clover straw 2.5%	0.888	0.849	0.857	0.771	0.841
Clover straw 5%	1.060	0.987	0.965	0.919	0.983
EDTA 2.5%	1.361	1.185	1.168	0.98	1.174
EDTA 5%	1.546	1.247	1.201	1.064	1.265
Mean	1.851	1.831	1.574	1.402	1.665
$L.S.D._{0.05}$					
Incubation time (IT)	0.030				
Organic material (OM)	0.046				
IT x OM	0.091				
	D soil				
Control	1.249	1.151	1.042	1.139	1.145
Humic acid 2.5%	2.508	2.167	1.453	1.500	1.907
Humic acid 5%	3.020	2.600	1.980	1.720	2.330
Vinasse 2.5%	3.020	2.640	1.700	1.659	2.255
Vinasse 5%	3.507	2.973	2.533	2.460	2.868
Clover straw 2.5%	0.875	0.837	0.813	0.753	0.820
Clover straw 5%	1.013	0.963	0.978	0.970	0.981
EDTA 2.5%	1.392	1.157	1.083	0.997	1.157
EDTA 5%	1.535	1.239	1.149	1.024	1.237
Mean	2.013	1.747	1.415	1.358	1.633
$L.S.D._{0.05}$					
Incubation time (IT)	0.026				
Organic material (OM)	0.039				
IT x OM	0.078				

The organic material treated A and B soils had the higher values of available Ca with average values of 2.120 and 2.259 g/kg, respectively. On the other hand, the treated C and D soils contained lower levels of available Ca with average levels of 1.665 and 1.633 g/kg, respectively. The average levels of available calcium in the incubated untreated A, B, C and D soils were 1.647, 1.686, 0.966 and 1.145 g/kg, respectively. Moreover, the average increase in the available Ca of the organic material treated A, B, C and D soils were 32.3, 38.3, 84.7 and 48.0 %, respectively. Therefore, the treated soils with the investigated organic materials could be ordered according to the average content of available calcium as B soil > A soil > C soil > D soil and according to the average increase in the available Ca as C soil > D soil > B soil > A soil.

2. 2 Soil available phosphorus

The effect of the investigated organic material on the available P of the studied soil is shown in Tables 14 and 15. The results indicated that all organic materials resulted in significant increases in the available P of all studied soils compared to the control treatment. These increases depended upon the type of the organic material, its application level and the time of incubation. Moreover, the available P levels of the treated soils differed due to the studied soil type. Singh and Jones (1976) found that the organic amendments can increase or decrease the P adsorption of soil depending upon the type of organic material, its P concentration and the amount added.

The available P of A soil increased with increasing the application level of each organic material In most cases, the available P of the studied soils treated with the investigated organic materials increased with increasing the incubation time up to 30 days and then it decreased in the last two incubation time periods (60 and 120 days). So, the available P of the treated soils reached the maximum level at 30 days of incubation. Wandruszka (2006) reported that P added to the soil in manure and other sources, however, tended to become less available to plants with the passing time.

As mean values, the available P reached maximum values of 30.16, 52.10, 21.26 and 18.97 mg/kg in A, B, C and D treated soils, respectively, at 30 days of incubation. These results are in an agreement with those obtained by Abdel-Rahem (2006) and Elgala et al (1998). Das et al (1995) showed that the soil available P increased in the incubation period that the decomposition of the applied organic materials occurred (30 days in this case) but a substantial portion of the available P was immobilized after 60 days of incubation by microorganisms. Stevenson (1982) reported that the increases in the available P by applied organic materials may be attributed that organic acids, CO_2, and other products resulting from the microbial decomposition of these organic materials may solubilize the insoluble phosphate forms by chelating cations and lowering soil pH (Halford and Mattingly, 1975; El-Desoky and Ragheb, 1993). Also, Rahate et al, (1979) reported that the increase in the soil available P could be attributed mostly to the role of FYM in converting a portion of native P and not the applied P which transforms into compounds which are not easily extractable resulting in the build up of total P in soil. On the other hand, Gupta (1975) showed a decrease in the available P with adding organic matter to calcareous soils. This may be due to increasing the activity of calcium resulting from the solubility of calcium carbonate. Also, Barrow (1974) showed that some of the phosphate may vacate the adsorption sites and slowly form discrete crystals or may remain on these sites and become more tightly held. In addition, Hopkins and Ellsworth, (2005) found that the reduced P availability in alkaline soil was driven by the reaction of P with calcium, with the lowest solubility of these calcium phosphate minerals at about pH 8. The lime in calcareous soil reacts with soil solution P to from a strong calcium phosphate bond at the surface of the lime. Sarir et al (2006) also found that the decreases in the extractable P after 7 days of incubation may be due to the formation of insoluble P compounds in the soil.

In general, the increases in the soil available P decreased in the order of the vinasse > HA > CS > EDTA treated soils. The investigated organic materials may contain chelating agents that complex Ca ions releasing P, that is fixed with Ca, to the soil solution. Moreover, vinasse has acidic effect that can dissolve $CaCO_3$ that may also fix the soil P. Humic acid as a natural organic material contains different chelating agents that may have high ability to complex Ca ions. Clover straw is slowly decomposed releasing few acidity due to CO_2 evolution and some unidendate ligands that complex lower amounts of Ca ions than both HA and vinasse. As average values, the available P of vinasse, HA, CS and EDTA treated soils at a level of 5.0% was 46.24, 37.07, 24.60 and 22.49 mg/kg, respectively, for A soil, 66.46, 57.89, 46.40 and 44.85 mg/kg, respectively, for B soil, 31.14, 26.84, 16.58 and 14.52 mg/kg, respectively, for C soil, and 28.41, 23.12, 14.36 and 12.89 mg/kg, respectively, for D soil. These results are in agreements with those obtained by Bach et al (1993).

On the other hand, the 2.5% level of vinasse, HA, CS and EDTA showed available P levels of 35.17, 26.60, 19.44 and 17.76 mg/kg, respectively, for A soil, 53.16, 48.64, 37.43 and 36.17 mg/kg, respectively, for B soil, 21.92, 17.27, 10.84 and 9.48 mg/kg, respectively, for C soil, and 19.16, 15.36, 8.85 and 7.56 mg/kg, respectively, for D soil. The mean available P levels of the untreated A, B, C and D soils (control soils) were 14.03, 32.31, 3.01 and 2.58 mg/kg, respectively.

High levels of available P were observed in the treated A and B soils. However, relatively low available P levels were found in C and D soils that were treated with the investigated organic materials. On the other hand, A and B soils contained a low $CaCO_3$ content (16.5 and 19 %, respectively), while both C and D soils showed a high content of $CaCO_3$ (25 and 35%, respectively). It is clear that the ability of the investigated organic material to release the fixed P increases as the $CaCO_3$ content of the soil decreases. Therefore, generally, the soil available P level has the order of B soil > A soil > C soil > D soil, while, $CaCO_3$ content shows the order of D soil > C soil > A soil > B soil after organic material treatments compared to the control of each soil.

Table (12): Effect of adding some organic materials and incubation time on the available P (mg/kg)) of soil (A) and soil (B).

Organic Material	Incubation time (day)				Mean
	0	30	60	120	
	A soil				
Control	14.40	14.80	13.67	13.24	14.03
Humic acid 2.5%	22.30	31.21	25.15	27.74	26.60
Humic acid 5%	33.88	44.10	34.70	35.59	37.07
Vinasse 2.5%	25.73	39.93	36.87	38.15	35.17
Vinasse 5%	41.50	49.75	44.92	48.78	46.24
Clover straw 2.5%	17.08	21.42	18.76	20.51	19.44
Clover straw 5%	20.91	27.81	24.01	25.65	24.60
EDTA 2.5%	15.31	18.98	17.66	19.09	17.76
EDTA 5%	19.37	23.43	23.35	23.79	22.49
Mean	23.39	30.16	26.57	28.06	27.04
L.S.D.$_{0.05}$					
Incubation time (IT)	0.64				
Organic material (OM)	0.95				
IT x OM	1.91				
	B soil				
Control	31.71	33.28	32.25	32.01	32.31
Humic acid 2.5%	45.67	53.77	46.51	48.61	48.64
Humic acid 5%	53.67	63.65	55.68	58.55	57.89
Vinasse 2.5%	49.32	59.04	49.83	54.46	53.16
Vinasse 5%	60.55	70.10	64.57	70.63	66.46
Clover straw 2.5%	34.76	42.41	36.86	35.69	37.43
Clover straw 5%	39.58	54.22	46.31	45.47	46.40
EDTA 2.5%	33.40	41.53	36.38	33.38	36.17
EDTA 5%	41.86	50.89	44.23	42.42	44.85
Mean	43.39	52.10	45.85	46.80	47.03
L.S.D.$_{0.05}$					
Incubation time (IT)	0.60				
Organic material (OM)	0.91				
IT x OM	1.81				

Table (13): Effect of adding some organic materials and incubation time on the available P (mg/kg) of soil (C) and soil (D)

. Organic Material	Incubation time (day) 0	30	60	120	Mean
	C soil				
Control	2.89	3.19	2.98	2.97	3.01
Humic acid 2.5%	11.22	24.28	16.22	17.34	17.27
Humic acid 5%	19.19	33.69	29.20	25.26	26.84
Vinasse 2.5%	13.99	27.45	22.55	23.69	21.92
Vinasse 5%	24.01	37.22	33.43	29.88	31.14
Clover straw 2.5%	6.52	13.54	12.70	10.59	10.84
Clover straw 5%	11.48	21.13	17.94	15.76	16.58
EDTA 2.5%	5.71	12.42	11.02	8.76	9.48
EDTA 5%	9.86	18.45	15.33	14.42	14.52
Mean	11.65	21.26	17.93	16.52	16.84
$L.S.D._{0.05}$					
Incubation time (IT)	0.44				
Organic material (OM)	0.66				
IT x OM	1.32				
	D soil				
Control	2.25	2.86	2.80	2.40	2.58
Humic acid 2.5%	9.52	20.93	14.61	16.44	15.38
Humic acid 5%	15.86	30.01	24.86	21.75	23.12
Vinasse 2.5%	11.61	25.53	20.02	19.46	19.16
Vinasse 5%	21.80	35.13	29.98	26.73	28.41
Clover straw 2.5%	5.80	11.14	9.38	9.08	8.85
Clover straw 5%	9.65	18.43	15.34	14.02	14.36
EDTA 2.5%	4.80	10.06	8.08	7.30	7.56
EDTA 5%	7.57	16.64	14.34	12.99	12.89
Mean	9.87	18.97	15.49	14.46	14.70
$L.S.D._{0.05}$					
Incubation time (IT)	0.4				
Organic material (OM)	0.6				
IT x OM	1.19				

Vinasse, HA, CS and EDTA treated soils at the level of 5.0% showed average available P increases of 3.30, 2.64, 1.75 and 1.60 times, respectively, for A soil, 2.06, 1.79, 1.44 and 1.39 times, respectively, for B soil, 10.3, 8.92, 5.51 and 4.82 times, respectively, for C soil, and 11.01, 8.96, 5.57 and 5.00 times, respectively, for D soil. In addition at 30 days of incubation, the mean available P increased 2.04 times for the treated A soil, 1.57 times for the treated B soil, 6.66 times for the treated C soil, and 6.63 times for the treated D soil compared to the control.

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تأثير إضافة بعض المواد العضوية على بعض الخواص الكيميائية و تيسر الكالسيوم و الفوسفور فى الأراضى الجيرية

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تم جمع أربع عينات تربة من بعض الأراضي الجيرية المنزرعة وغير المنزرعة فى منطقة الوادى الأسيوطى ومنطقة التداخل مع وادى النيل، بناءً على محتوى هذه العينات من كربونات الكالسيوم والفوسفور الميسر لدراسة تأثير إضافة بعض المواد العضوية (محلول حامض الهيوميك(HA) ، والفيناس(V) و قش البرسيم (CS) كمواد عضوية طبيعية و EDTA كمادة عضوية مخلقة) على بعض الخواص الكيميائية وكذلك تيسر الكالسيوم و الفوسفور فى هذه الترب.

تم تنفيذ تجربة تحضين فى أصص بلاستيك ، و تم إضافة كل مادة عضوية عند مستويين (2.5 ، 5.0%) فى صورة محاليل ماعدا معاملة قش البرسيم حيث تم خلطه مع التربة. وقد تم تنفيذ هذه التجربة عند أربع فترات تحضين وهى صفر، 30، 60 ، 120 يوماً. وقد إحتوت كل معاملة على ثلاث مكررات.

و أظهرت النتائج أن إضافة المواد العضوية المستعملة إلى الترب تحت الدراسة عند مستويات الإضافة المختلفة أدى إلى زيادة معنوية فى قيم الـ EC مقارنة بمعاملة الكنترول. و أدى زيادة مستويات الإضافة من المواد العضوية وكذلك زيادة فترة التحضين حتى 60 يوماً إلى زيادة قيم الـEC ثم إنخفضت بعد ذلك عند 120 يوماً من التحضين. و حامض الهيوميك عند أعلى مستوى للإضافة (5%) أدى إلى زيادة فى قيم الـ EC فى كل الترب عند زيادة فترة التحضين الى 60 يوماً.

إضافة كل من حامض الهيوميك و EDTA أدى إلى زيادة فى قيم الـ pH بينما إضافة كل من قش البرسيم و الفيناس أدى إلى إنخفاض بسيط فى قيم الـ pH مقارنة بمعاملة الكنترول ، و فى معظم الحالات فقد أظهر إضافة حامض الهيومبك أعلى متوسط فى قيم الـ pH فى كل الترب تحت الدراسة.

كما أن إضافة هذه المواد العضوية إلى الترب تحت الدراسة أدى إلى إنخفاض فى محتواها من كربونات الكالسيوم ، كما إزداد مستوى الإنخفاض بزيادة مستوى الإضافة وفترة التحضين مقارنة بالكنترول. و كان إنخفاض محتوى معظم الترب من كربونات الكالسيوم و المعاملة بهذه المواد العضوية تبعاً للترتيب : قش البرسيم > حامض الهيوميك ≈ EDTA ≈ الفيناس .

إضافة المواد العضوية المستعملة أدى إلى زيادة متوسط الكالسيوم الميسرفى الترب تحت الدراسة كما إزداد بزيادة مستوى الإضافة ماعدا معاملة قش البرسيم. كما أعطى إضافة EDTA كماده مخلبية مخلقة أعلى كمية للكالسيوم الميسر فى كل

الترب تحت الدراسة. وكان ترتيب تأثير المواد العضوية على زيادة الكالسيوم الميسر تبعاً للترتيب : الفيناس > حامض الهيوميك > EDTA > قش البرسيم .

كما أوضحت النتائج أن إضافة كل هذه المواد العضوية أدى إلى زيادة معنوية فى الفوسفور الميسر فى كل الترب تحت الدراسة مقارنة بالكنترول. وتوقفت الزيادة على نوع المادة العضوية ومستوى إضافتها وكذلك فترة التحضين ونوع التربة تحت الدراسة. و فى معظم الحالات، فقد إزداد الفوسفور الميسر فى الترب عند إضافة المواد العضوية بزيادة فترة التحضين حتى 30 يوماً ثم إنخفض بعد ذلك حتى 120 يوماً من التحضين. وسجلت أعلى قيم للفوسفور الميسرنتيجة إضافة المواد العضوية فى كل من التربتينB،A (أراضى زراعية) بينما كانت أقل القيم فى التربتينD،C (أراضى غير زراعية). وقد وجد أن قدرة المواد العضوية على تحرير الفوسفور المثبت فى التربة تزداد بإنخفاض مستوى كربونات الكالسيوم فى التربة. وعموما فإن الزيادة فى الفوسفور الميسر فى التربة نتيجة إضافة المواد العضوية تتناقص تبعا للترتيب: الفيناس>حامض الهيوميك>قش البرسيم> EDTA.