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EFFECT OF SOME COMBINATION OF ORGANIC WASTES AND BIOFERTILIZER ON PHOSPHORUS AVAILABILITY IN CERTAIN SOILS OF NORTH SINAI

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ABSTRACT: The effect of some combined organic wastes viz., sewage sludge - olive pomace (SS-OP) and sewage sludge -tomato residues (SS-TR) and phosphate dissolving bacteria (PDB) as biofertilizer on soil pH, soil organic carbon, total nitrogen and P availability of sandy and calcareous soils, were investigated in a pot incubation experiment. The combined organic wastes were mixed with the tested soils at a rate of 0.5%. Inorganic P was also added as ordinary superphosphate (OSP) at a rate of 30 kg P_2O_5 fed^{-1}, Phosphate dissolving bacteria (PDB) inoculation was applied at a rate of 1 ml broth pot^{-1} ($1x10^7$ cells).

pH values of the investigated soils were generally decreased by the different treatments particularly with the treatment. (SS-TR +PDB+OSP), which resulted in a considerable increase in available P content. The combined organic wastes increased the soil organic carbon at the beginning of the incubation period. Afterwards, it was decreasing till the end of incubation course. The rate of decomposition was higher for (SS-TR) than (SS-OP). Total nitrogen content in the tested soils was increased by applying the combined organic wastes. Minerlization rate of organic carbon in the soils was increasing during the incubation course with the treatments of (SS-OP) and (SS-TR), particularly with the (SS-TR) treatment. The C/N ratio in soils generally decreased by addition of the combined manures. This decrease was more pronounced with (SS-TR) treatment.

INTRODUCTION

Most of the newly reclaimed soils in North Sinai are sandy and calcareous, which are poor in their content of organic matter and available phosphorus. The pool of available P in soil can be replenished from both organic and fertilizer P pools (Sharply, 1985). On the other hand, organic wastes such as sewage sludge, olive pomace and tomato residues are becoming more an environmental problem in North Sinai. Organic manures were repeatedly used as soil amendments in order to decrease soil pH and increase availability of phosphorus and some micronutrients (Abdel Fattah et al,1996, 1997; Abdel Moez et al, 1995, 1997). Soil organic matter is also known to be important as an energy source for soil microorganisms and for soil structure and stability, water relations, soil erosion control, ion exchange, chelation and buffering providing with growth regulators, promoting crop growth, and controlling the incidence of soil-born diseases and weeds (Abdel Fattah and Saleh 1999; Fauci et al, 1999; Flores et al, 1999).

Some soil microorganisms, especially phosphate dissolving bacteria (PDB) can play a basic role in converting the insoluble P to a soluble form (Forster and Freter, 1988).

Data on the effect of sewage sludge, olive pomace and tomato residues on North Sinai soil characteristics and fertility are scarce. The objective of this work was to identify the effect of combinations of these wastes when applied either with or without phosphate dissolving bacteria (PDB) as a biofertilizer on soil reaction, P availability and N transformations, under sandy and calcareous soil conditions of El-Arish area.

MATERIALS AND METHODS

Two surface soil samples (0-30 cm) differing in their $CaCO_3$ content, were collected from the Experimental Farm of the Faculty of Environmental Agricultural Sciences, Suez Canal University, El-Arish, North Sinai, Egypt. Some initial soil physical and chemical properties are given in Table 1.

Three organic wastes viz, sewage sludge (SS), tomato residues (TR) and olive pomace

Table (1): Physical and chemical properties of the tested soils

Parameters	*Calcareous soil*	*Sandy soil*
ECe (dSm^{-1})*	20.0	2.25
Soluble ions (me l^{-1})*		
Ca^{2+}	29.2	6.00
Mg^{2+}	35.2	10.0
Na^{+}	130	4.00
K^{+}	2.6	1.50
HCO_3^{-}	15.6	3.10
Cl^{-}	170	8.00
SO_4^{2-}	11.4	10.4
CEC (cmol kg^{-1})	10.4	5.22
pH**	8.46	8.35
$CaCO_3$ (g kg^{-1})	403	47.0
Available P (g kg^{-1})	5.02	3.00
Organic C (g kg^{-1})	0.082	0.080
Total N (g kg^{-1})	0.009	0.008
C/N ratio	9.11	10.0
Particle size distribution (%)		
Without $CaCO_3$		
Clay	0.04	0.16
Silt	4.74	0.33
Fine Sand	44.12	76.1
Coarse sand	10.8	18.71
With $CaCO_3$		
Clay	0.72	3.30
Silt	33.88	0.57
Fine Sand	53.2	76.31
Coarse sand	12.2	19.82
Textural class	Sandy loam	Sand

* In soil saturation extract, no CO_3^{2-} was detected

** In soil water suspenstion (1 : 2.5)

(OP) were investigated in the present work. Sewage sludge was taken from El-Arish Wastewater Treatment Plant, North Sinai, Egypt. Tomato residues were used because tomato is one of the main vegetable crops in North Sinai. Olive pomace was collected from the Olive Oil Extractor of the Faculty of Environmental Agricultural Sciences.

The three organic wastes were air dried and crushed to pass through a 2 mm sieve. Some chemical characteristics of the organic wastes are presented in Table 2.

Experimental work

Two hundred gram portions of the two studied soils were placed in plastic pots (7.0 cm. height & 9.0 cm width). Each soil portion was thoroughly mixed with either of organic compost mixtures at a rate of 0.5% (w/w): Superphosphate (15.5% P_2O_5) was applied at a rate equivalent to 30 kg P_2O_5 fed^{-1}. Phosphate dissolving bacteria (PDB) inoculation was added at a rate of 1 ml broth pot^{-1} (1×10^{7} cells). PDB, strain No. 4, was isolated and pretested by Abd El-Azeem (1997).

The experimental treatments were as follows:

1-Control (soil without treatment).
2-Soil treated with PDB (PDB).
3-Soil treated with ordinary superphosphate (OSP)
4-Soil treated with PDB + ordinary superphosphate, (PDB + OSP).
5-Soil treated with sewage sludge and olive pomace mixture, (1:1) (SS-OP).
6-Soil treated with sewage sludge and olive pomace mixture,(1:1) + PDB, (SS-OP+OSP).
7-Soil treated with sewage sludge and olive pomace mixture, (1:1) + ordinary superphosphate (SS-OP+OSP).
8-Soil treated with sewage sludge and olive pomace mixture, (1:1) + PDB + ordinary superphosphate, (SS-OP+PDB+OSP).
9-Soil treated with sewage sludge and tomato residues mixture (2:1) (SS-TR).
10-Soil treated with sewage sludge and tomato residues mixture (2:1)+ PDB, (SS-TR+PDB).
11-Soil treated with sewage sludge and tomato residues mixture (2:1)+ ordinary superphosphate, (SS-TR+OSP).

Table (2): Some chemical properties of the organic wastes

Characteristics	*Sewage sludge*	*Olive pomace*	*Tomato Residues*
ECe (dSm^{-1})*	14.2	11.9	6.1
Soluble ions (me^{-1})*			
Ca^{2+}	30.6	29.7	22.8
Mg^{2+}	77.1	19.4	9.37
Na^{+}	37.4	64.0	26.3
K^{+}	6.9	3.30	1.05
HCO^{-}_{3}	25.8	3.50	7.92
Cl^{-}	36.4	33.8	31.2
SO_4^{2-}	89.8	79.1	20.4
pH*	6.8	6.4	7.5
Total N ($g\ kg^{-1}$)	23.7	16.4	10.2
Organic C ($g\ kg^{-1}$)	388	363	600
Total P ($g\ kg^{-1}$)	117	780	47.0
C/N ratio	16.4	27.1	58.8

* In organic residues water suspension (1:10)

12-Soil treated with sewage sludge and tomato residues mixture (2:1) + PDB + ordinary superphosphate, (SS-TR + PDB + OSP).

All pots were maintained at a moisture content equal to field capacity for 60 days. Each treatment was replicated three times. Samples from each treatment were taken after 0, 7, 15, 30, 45 and 60 days of incubation period, oven dried and subjected to chemical analyses (pH, OC, available P, total N), according to the standard methods.

Statistical analysis of the obtained results was carried out according to MSTAT-C (1988).

RESULTS AND DISCUSSION

Table 3 reveals that all manuring treatments resulted in a general decrease in calcareous soil pH as compared with the control, and the longer the incubation period the lower were the values of soil pH. By the end of incubation period, the treatments (SS-TR) and (SS-TR + PDB + OSP) proved to be the most effective in reducing pH values. Nevertheless, the obtained changes in soil pH were generally little. This seems to be due to the buffering phenomenon in calcareous soils. Similar trends were obtained by Awad (1991); Soltan et al. (1996) and Farh et al. (1997).

Addition of the different manuring treatments caused the pH of the sandy soil to be reduced particularly at the last three stages of the incubation period. At the end of incubation period, the decrease in soil pH became more pronounced relative to the control. In this respect, the treatments (SS-TR+PDB) and (SS-TR + PDB + OSP) observed to be the most effective ones which produced the lowest soil pH values.

In this concern, Mehana and Matloub (1997) found that the pH reduction reached a maximum of about 0.43 pH unit in a sandy soil treated with 3% sewage sludge. Abou Seeda et al (1992), Farh (1996) and Soltan et al (1996) found that incubation of the soil with organic manures resulted in a general slight increase or decrease in soil pH as compared with those recorded initially.

With respect to the effect of inoculation with PDB on soil pH, table 3 shows that the reduction

Table (3): pH of the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation course

*Treatment**	*Incubation period (days)*											
	0	7	15	30	45	60	0	7	15	30	45	60
	Calcareous soil						*Sandy soil*					
Control	8.46	8.45	8.44	8.42	8.41	8.41	8.35	8.35	8.32	8.34	8.32	8.33
PDB	8.45	8.44	8.41	8.41	8.40	8.33	8.35	8.34	8.29	8.27	8.22	8.22
OSP	8.44	8.44	8.40	8.38	8.38	8.35	8.35	8.35	8.34	8.30	8.29	8.27
PDB + OSP	8.45	8.45	8.43	8.40	8.40	8.32	8.34	8.34	8.34	8.27	8.29	8.29
SS - OP	8.45	8.45	8.41	8.42	8.38	8.31	8.33	8.34	8.33	8.28	8.27	8.21
SS - OP - PDB	8.45	8.44	8.41	8.41	8.38	8.31	8.33	8.34	8.28	8.26	8.20	8.19
SS - OP - OSP	8.46	8.46	8.44	8.41	8.39	8.35	8.35	8.35	8.31	8.31	8.29	8.25
SS - OP - PDB - OSP	8.44	8.44	8.41	8.39	8.33	8.32	8.34	8.33	8.30	8.29	8.24	8.24
SS - TR	8.45	8.45	8.42	8.43	8.33	8.21	8.35	8.35	8.29	8.30	8.23	8.20
SS - TR - PDB	8.45	8.44	8.44	8.41	8.35	8.37	8.34	8.34	8.30	8.30	8.23	8.16
SS - TR - OSP	8.44	8.44	8.44	8.37	8.31	8.30	8.35	8.34	8.33	8.27	8.26	8.25
SS - TR - PDB - OSP	8.43	8.44	8.44	8.37	8.29	8.21	8.33	8.34	8.29	8.24	8.22	8.18

* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

was small, for both calcareous and sandy soil by the end of the incubation period. Louw and Webley (1959) stated that organic acids produced by phosphate dissolving microorganisms lowered the pH of the soil. At the end of incubation course, the combination of PDB with organic manures proved to have a synergistic effect in lowering the pH of calcareous soil. The difference in response of the two soils seems to be attributed to the high buffering capacity of calcareous soils. The promotive effect of organic manuring on PDB activity can be due to its chemohetrotrophic nature, and to the addition of organic manures which enhances its activity in the soil especially with phosphate source (Dey et al, 1976).

Available P

Table 4 manifests that soil content of available P, significantly increased as a result of soil incubation with the organic residues (SS-OP) or (SS-TR), either in presence or absence inoculation with PDB, as compared with the control. This was generally true for both investigated soils throughout the incubation course, particularly at the last three stages, i.e, after 30, 45 and 60 days.

(SS-TR) mixture proved to be more effective in enriching both soils with available P than the (SS-OP) one. However the effect was more emphasized in the calcareous soil. The excess amounts of P extracted from the sandy soil by the end of incubation period were 5.70 and 6.13 mg kg^{-1} with (SS-OP) and (SS-TR), respectively, over the control. The corresponding excess amounts with the calcareous soil were 7.43 and 8.83 mg kg^{-1}. In this regard, Hussien (1995) concluded that application of organic manure with or without phosphorus fertilizer increased available phosphorus in soil during different periods of incubation.

Under both calcareous and sandy soils, the mixture (SS-TR) proved to be superior, although of its initial wider C/N ratio and lower P content, (Table 2), compared to (SS-OP) may be due to its relatively easily decomposability. In this matter Badawy (1987) and Montasser (1987) reported that organic manures with high organic carbon and available nitrogen were more

Table (4): $NaHCO_3$- extractable P (mg kg^{-1}) of the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation

Treatment*	Incubation period (days)													
	0	7	15	30	45	60	Avre.	0	7	15	30	45	60	Avre.
	Calcareous soil							Sandy soil						
Control	5.00	4.80	3.33	3.87	4.70	4.87	4.43	3.00	3.00	2.87	3.07	3.10	3.17	3.04
PDB	5.20	6.70	7.17	8.20	10.4	11.5	8.20	4.70	5.07	5.87	7.20	7.97	9.00	6.64
OSP	5.50	5.40	3.97	5.50	5.97	7.33	5.61	4.10	4.17	4.80	5.10	5.77	6.33	5.05
PDB + OSP	5.60	7.60	8.33	9.80	11.3	14.7	9.56	4.90	5.67	7.40	8.27	10.7	12.5	8.24
SS - OP	6.70	5.57	4.47	6.37	8.8	12.3	7.37	4.00	4.33	4.43	4.63	8.60	8.87	5.81
SS - OP - PDB	7.50	7.77	9.27	11.3	12.3	15.3	10.9	4.90	5.50	6.03	8.47	10.3	11.9	7.85
SS - OP - OSP	6.00	8.33	10.4	11.1	12.7	13.9	10.4	4.20	4.53	5.27	6.47	7.80	8.13	6.07
SS - OP - PDB - OSP	6.80	7.53	9.33	12.3	13.0	15.1	10.7	4.90	5.77	6.70	8.87	11.9	13.6	8.63
SS - TR	5.60	4.23	3.20	5.80	8.13	13.7	6.78	4.00	5.37	6.90	7.47	8.20	9.30	6.87
SS - TR - PDB	5.50	5.30	8.60	12.5	13.1	14.3	9.88	4.70	5.13	7.80	8.67	9.80	13.7	8.30
SS - TR - OSP	5.90	6.37	8.20	11.1	14.4	15.4	10.2	4.10	4.6	6.70	8.30	9.50	10.7	7.32
SS - TR - PDB - OSP	6.50	8.47	9.20	10.3	12.2	15.7	10.4	4.90	6.73	8.60	10.1	12.4	15.3	9.67
LSD. 0.05	-	0.24	0.25	0.28	0.23	0.19	-	-	0.26	0.20	0.91	0.23	0.31	-

* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

effective in enriching soil with P than those relatively poor in these elements.

The excess in extractable P due to inoculation with PDB only was higher in the calcareous soil than in sandy one. The excess values of extractable P were 6.63 and 5.83 mg kg^{-1}at the end of incubation period, for the calcareous and sandy soils, respectively, over the control. This seems to be due to that calcareous soils usually have more total phosphorus content than sandy soils, and that PDB can utilize the native organic matter of the soil.

The increase in extractable P, due to the application of (SS-OP) manure and inoculation with PDB was higher in the calcareous soil than in sandy one. However, the opposite was found to be true with (SS-TR+PDB). Alexander (1977) reported that organic residues added to soil not only increase the P content of the soil, but also enhance growth and activate soil biota, which considerably increase solubility of P compounds in soil. Microorganisms are able to promote the solubilization of inorganic P by formation of carbonic acid and some organic acids, which may solubilize certain insoluble P compounds.

The increase in extractable P due to application of superphosphate was lower in the calcareous soil than in sandy one. The available phosphorus excess values were 2.46 and 3.16 mg kg^{-1}, respectively by the end of incubation course. This trend can be explained by the fact that calcareous soils have high ability to fix the phosphate ions released from the applied phosphorus fertilizer. Phosphate ions coming in contact with solid phase calcium carbonate are precipitated on the surface of these particles. This mechanism is responsible for decreasing the activity of phosphorus in soil (Tisdale *et al*, 1985).

Comparing the different treatments, the application of (SS-TR+PDB+OSP) proved to be the most promotive in increasing the available phosphorus particularly in the sandy soil. By the end of incubation course, the values were 10.8 and 12.1 mg P kg^{-1}, for the calcareous and sandy soils, respectively, over the control. This was followed by the treatment (SS-

OP+PDB+OSP), with which the corresponding values were 10.2 and 10.4 mg P kg^{-1}.

The priority of the two treatments mentioned above, probably ascribed to that the hetrotrophes need a carbon source for their growth and activity particularly with supplement with phosphate source (Dey et al, 1976). In the meantime, significant correlation was found between the soil pH and available phosphorus at the 60 days from an incubation course under the two studied soil conditions.

Organic C, total N, mineralization rate and C/N ratio

Tables (5, 6) reveal that application of organic manures (SS-OP, SS-TR) increased the soil content of organic carbon at the beginning of the incubation period. Afterwards, the longer the incubation period the lower was the organic carbon content in the soil, and this was found to be true in both investigated soils. However, at the end of incubation experiment, the rate of decomposition was higher for (SS-TR) than (SS-OP) and this was correct with both soils used. In addition, the rate of manure decomposition proved to be much higher in the sandy soil than in calcareous one. At the end of incubation experiment, the percentage of manure decomposition in a calcareous soil was 44.1 and 51.4 for (SS-OP) and (SS-TR), respectively. The corresponding values for the sandy soil were 54.2 and 73.8%. Some of the factors affecting the rate of decomposition of an applied manure to a soil are the resistance of the material to microbial attack (a function of the amount of lignins, waxes and fats present), temperature and moisture levels in the soil (Tisdale et al, 1985).

Similar results were obtained by Abdel Malek et al (1977) and Ismail et al (1988) who found that the decomposition of organic matter is higher in a sandy soil than in a calcareous one. This may be attributed to the physico-chemical properties, which allow high oxygen tension to penetrate in a sandy soil, enhancing a rapid decomposition of the added organic materials.

At the last stage of incubation experiment, a stationary decrease in the organic carbon content was observed in a calcareous soil when treated with PDB. This seems to be ascribed to the tendency of

Table (5): Organic carbon (g kg^{-1}) of the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation course

*Treatment**	*Incubation period (days)*											
	0	7	15	30	45	60	0	7	15	30	45	60
	Calcareous soil						*Sandy soil*					
Control	1.80	1.80	1.80	1.70	1.50	1.40	0.80	0.70	0.70	0.70	0.60	0.60
PDB	2.00	1.60	1.60	1.50	1.50	1.50	0.80	0.80	0.70	0.70	0.70	0.60
OSP	1.80	1.80	1.80	1.50	1.50	1.50	0.80	0.80	0.70	0.60	0.60	0.60
PDB + OSP	1.90	1.80	1.70	1.50	1.50	1.40	0.80	0.80	0.70	0.70	0.70	0.60
SS - OP	3.40	2.80	2.40	2.30	2.10	1.90	2.40	2.30	2.10	1.90	1.50	0.73
SS - OP - PDB	3.10	2.80	2.60	2.30	2.10	1.70	2.50	2.10	1.60	1.60	1.30	1.10
SS - OP - OSP	3.30	3.00	2.80	2.50	2.20	1.90	2.50	1.90	1.50	1.40	1.30	1.00
SS - OP - PDB - OSP	3.50	2.60	2.30	2.30	1.90	1.70	2.70	2.30	2.10	1.60	1.40	1.20
SS - TR	3.70	3.20	2.60	2.30	2.10	1.80	2.60	1.80	1.70	1.40	1.20	0.680
SS - TR - PDB	3.90	3.10	2.40	2.00	1.70	1.40	3.50	2.60	1.70	1.30	1.00	0.70
SS - TR - OSP	4.00	2.60	2.20	1.80	1.80	1.50	2.90	2.40	1.30	1.10	0.80	0.80
SS - TR - PDB - OSP	3.80	2.90	2.50	2.10	1.80	1.50	2.80	1.80	1.10	1.10	1.00	.90
LSD. 0.05	-	0.02	0.03	0.02	0.03	0.03	-	0.02	0.03	0.03	0.02	0.02

* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

Table (6): Total nitrogen (g kg^{-1}) of the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation course

*Treatment**	*Incubation period (days)*											
	0	7	15	30	45	60	0	7	15	30	45	60
	Calcareous soil						*Sandy soil*					
Control	182	181.2	181.4	180.4	180.3	180.2	100.0	99.87	99.37	99.63	99.57	98.17
PDB	185	182.9	177.9	180.4	180.3	180.2	100.0	99.90	99.43	99.70	99.67	98.23
OSP	184	182.9	182.4	181.0	180.4	180.3	100.0	99.90	99.57	98.50	98.50	98.13
PDB + OSP	191	189.7	190.4	185.9	182.7	181.7	100.0	99.87	99.30	105.3	100.2	99.80
SS - OP	254	247.9	233.5	229.1	202.5	200.4	181.0	181.5	177.7	171.4	168.9	168.9
SS - OP - PDB	225	251.2	240.9	227.8	205.9	190.2	182.0	180.6	182.0	173.2	158.5	146.2
SS - OP - OSP	261	242.3	231.9	228.5	216.4	201.6	181.0	178.0	170.2	163.9	169.5	143.0
SS - OP - PDB - OSP	267	232.4	231.9	237.7	209.3	198.8	191.0	182.8	172.9	164.5	160.4	153.6
SS - TR	221	201.1	198.2	195.5	195	195.9	173.0	163.1	152.3	140.6	130.5	119.3
SS - TR - PDB	222	200.4	200.2	198.3	195	180.4	175.0	152.8	151.7	143.8	124.3	120.1
SS - TR - OSP	222	200.6	200.5	198.1	198.3	196.5	175.0	154.2	148.9	145.2	122.8	115.5
SS - TR - PDB - OSP	224	200.5	200.2	200.4	199.3	199.	180.0	157.3	151.5	136.8	136.1	129.3
LSD. 0.05	-	5.190	6.13	1.98	4.76	1.51	-	3.59	3.47	4.02	3.22	0.68

* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

bacterial population to multiply rapidly resulting in an increase in the soil biomass in the presence of proper soil conditions.

Table 6 indicates that the total nitrogen content in the calcareous soil increased with application of the two manures (SS-OP, SS-TR) at the beginning of incubation course, the magnitude of increase was up to 39.5% relative to the control. The same was observed to be true with the sandy soil.

Data in Table 6 also depict that the total nitrogen content in the manured calcareous soil was decreasing during the process of incubation. The same was observed really with the manured sandy soil with different magnitudes. Such decrease in the total nitrogen content of the manured soils seem to be due to the gaseous losses of nitrogen particularly in the form of ammonia due to the alkaline soil pH (Tisdale et al, 1985; Ismail et al, 1988).

Table 7, shows that the mineralization rate of organic carbon was generally increasing during the incubation course, and this was particularly clear with the two manure mixtures (SS-OP) and (SS-TR) as well as their combinations for both investigated soils. The highest rates were obtained with (SS-TR) treatment and its combinations, especially with sandy soil by the end of incubation period. The above results confirm the fact that the rate of mineralization would be higher in the light textured soils than in the relatively heavy textured ones. Similar results were obtained by Ismail et al (1988).

The response of soil organic carbon and total nitrogen to the different treatments is reflected on the C/N ratio (Table 8). The results indicate that the C/N ratios in both studied soils were generally decreased by addition of the tested manures and their combinations. The decline in C/N ratio was more pronounced with (SS-TR) treatment and its combinations as compared with (SS-OP) treatment and its combinations, particularly in a sandy soi!.

Table (7): Rate of mineralization of organic-C (%)* in the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation

Treatment**	Incubation period (days)									
	7	15	30	45	60	7	15	30	45	60
	Calcareous soil					Sandy soil				
Control	0.00	0.00	5.56	16.7	22.2	12.5	12.5	12.5	25.0	25.0
PDB	20.0	20.0	25.0	25.0	25.0	0.00	12.5	12.5	12.5	25.0
OSP	0.00	0.00	16.7	16.7	16.7	0.00	12.5	25.0	25.0	25.0
PDB + OSP	5.31	10.5	21.1	21.1	26.3	0.00	12.5	12.5	12.5	25.0
SS - OP	17.6	29.4	32.4	38.2	44.1	4.17	12.5	20.8	37.5	54.2
SS - OP - PDB	9.68	16.1	25.8	32.3	45.2	16.0	36.0	36.0	48.0	56.0
SS - OP - OSP	9.09	15.2	24.2	33.3	42.4	24.0	40.0	44.0	48.0	60.0
SS - OP - PDB - OSP	25.7	34.3	34.3	45.7	51.4	14.8	22.2	40.7	48.1	55.6
SS - TR	13.5	25.7	37.8	43.2	51.4	30.8	34.6	46.2	53.8	73.8
SS - TR - PDB	20.5	38.5	48.7	56.4	64.1	25.7	51.4	62.9	71.4	80.0
SS - TR - OSP	35.0	45.0	55.0	55.0	62.5	17.2	55.2	62.1	72.4	72.4
SS - TR - PDB - OSP	23.7	34.2	44.7	52.6	60.5	35.7	60.7	60.7	64.3	67.9

*Rate of mineralization = 100- (unmineralized OC x 100/Initial OC)
* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

Table (8): C/N ratio of the two studied soils as affected by organic wastes, P fertilizer and inoculation with PDB during an incubation course

*Treatment**	*Incubation period (days)*											
	0	7	15	30	45	60	0	7	15	30	45	60
	Calcareous soil						*Sandy soil*					
Control	9.89	9.93	9.92	9.42	8.32	7.77	8.00	7.00	7.04	7.03	6.03	6.11
PDB	10.8	8.75	8.99	8.31	8.32	8.32	8.00	8.00	7.42	7.02	7.02	6.11
OSP	9.87	9.84	9.86	8.29	8.31	8.32	8.00	8.08	7.03	6.09	6.09	6.11
PDB + OSP	9.95	9.49	8.93	8.07	8.21	7.71	8.00	8.01	7.05	6.65	6.99	6.01
SS - OP	13.4	11.3	10.3	10.0	10.4	9.48	13.30	12.7	11.8	11.1	8.88	6.51
SS - OP - PDB	12.2	11.1	10.8	10.1	10.2	8.94	13.70	11.60	8.79	9.24	8.23	7.52
SS - OP - OSP	12.6	12.4	12.1	10.9	10.2	9.42	13.80	10.7	8.81	8.54	7.67	6.99
SS - OP - PDB - OSP	13.1	11.2	9.92	9.68	9.00	8.55	14.10	12.6	12.1	9.73	8.73	7.81
SS - TR	16.7	15.9	13.1	11.8	10.8	9.19	15.00	11.0	11.21	6.96	9.20	5.70
SS - TR - PDB	17.5	15.5	12.0	10.1	8.72	7.76	20.00	17.01	1.3	9.04	8.05	5.83
SS - TR - OSP	18.0	13.0	11.0	9.09	9.08	7.63	16.50	15.60	8.73	7.58	6.51	6.93
SS - TR - PDB - OSP	17.0	14.5	12.5	10.5	9.03	7.54	15.6	11.4	7.26	7.49	7.35	6.96

* PDB, phosphate dissolving bacteria ; OSP, ordenary superphosphate ; SS, sewage sludge ; OP, olive pomace and TR, tomato residues

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تأثير بعض مخاليط المخلفات العضوية والسماد الحيوى على صلاحية الفوسفور فى بعض أراضى شمال سيناء

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فى تجربة تحضين تم دراسة تأثير بعض مخاليط المخلفات العضوية مثل مخلفات المجارى الصلبة مع كل من تفل الزيتون وعرش الطماطم على رقم pH التربة ، والكربون العضوى ، النيتروجين الكلى والفوسفور الصالح فى تربتين أحدهما رملية والأخرى جيرية من شمال سيناء.

خلطت التربة مع أى من المخاليط السابقة بمعدل ٠.٥٪ وأضيف الفوسفور المعدنى على صورة سوبر فوسفات بمعدل ٣٠ كجم P_2O_2 / فدان ولقحت التربة بالبكتريا المذيبة للفوسفات. وكانت أهم النتائج ما يلى:

*انخفض رقم pH للتربة بوجه عام خاصة فى التربة الرملية مع المعاملة (مخلفات مجارى صلبة + عرش الطماطم + التلقيح بالبكتريا المذيبة للفوسفات + سوبر فوسفات) وقد أدى ذلك إلى زيادة فى الفوسفور الصالح فى التربة.

*أدت إضافة المخلفات العضوية إلى زيادة الكربون العضوى فى بداية فترة التحضين ثم انخفضت بعد ذلك حتى نهاية التجربة.

*كان معدل تحلل المادة العضوية عالياً بإضافة المخلفات السابقة خاصة مع المعاملة (مخلفات المجارى الصلبة + عرش الطماطم).

*زاد معدل معدنة الكربون العضوى فى التربة خلال التجربة مع كل من (مخلفات مجارى صلبة + تفل الزيتون) ، (مخلفات مجارى صلبة + عرش طماطم) وكانت الزيادة أعلى فى الحالة الثانية عنها فى الأولى.

*انخفضت النسبة C/N للتربة بوجه عام بإضافة الخليطين المدروسين وأن كان الإنخفاض أكبر فى حالة (مخلفات المجارى الصلبة + عرش الطماطم).