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EFFECT OF ORGANIC AND INORGANIC PHOSPHORUS APPLICATION ON SOME CHEMICAL PROPERTIES AND SOIL PHOSPHORUS FRACTIONS

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ABSTRACT

Two successive cultivation seasons (winter season 2006/2007 and summer season 2007) were conducted in field experiments on silty clay loam soil at El-Gemmeiza Agricultural Research Station, El-Gharbia Governorate. The experiment was designed using a randomized complete block design with three replicates to study the effect and residual effects of organic and inorganic phosphorus using farmyard manure (FYM) as a source of organic phosphorus, rock phosphate (RP) and supper phosphate (SP) as a source of inorganic phosphorus on some soil chemical properties and phosphorus fractions. Furthermore, economical analysis was done by calculating the net income.

The obtained results can be summarized as follows:-

1-The use of organic and inorganic phosphorus lead to a slightly decreases in soil reaction (pH) and progressive increases in soil salinity (EC), soluble ions (Ca, Mg, Na, HCO_3, Cl and SO_4), total soluble salts (TSS) and sodium adsorption ratio (SAR).

2-The mean values in the two seasons showed that the effect of organic phosphorus (FYM) on soil chemical properties was more pronounced than the effect of inorganic phosphorus additions (rock phosphate and supper phosphate).

3-The distribution values of inorganic P, i.e., easily soluble P (labile-P fraction), Al-P fraction, Fe-P fraction and Ca-P fraction were increased with increasing the addition of OP with RP and SP. Also, the labile-P fraction, Al-P fraction and Fe-P fraction as a percent of the total P were increased by increasing all added treatments, except the Ca-P fraction as a percent of total P which was decreased with increasing all added treatments.

4-The mean values of total P of soil were increased with increasing all added treatments. The highest values were recorded by addition of 30 m^3/fed OM with 200 Kg/fed RP and 150 Kg/fed SP which gave 12.63 and 14.93 µg/g soil, comparing with the control which recorded 4.54 and 4.66 µg/g soil in the first and second seasons, respectively.

5-Economical analysis indicate that the addition of 30 m^3/fed. OM with 200 Kg/fed RP and 150 Kg/fed SP was the most valuables compared with the other treatments. Also, it gave the highest net income (8263.96 LE/fed) as compared with the control which gave the lowest value (4798.86 LE/fed.).

6-Results reveal that it is useful to use the treatments of organic and inorganic phosphorus represented by (OM, RP and SP) to get a markedly improvement in soil chemical properties which reflect on higher yield incorporated with high net income under silty clay loam soils.

Keywords: Organic matter, inorganic phosphorus, rock phosphate (RP), super phosphate (SP), soil chemical properties, phosphorus fractions

INTRODUCTION

Phosphorus is one of the essential nutrients for plant and animal life. Phosphorus availability to plants in most soils is usually restricted.

Maximum availability to plants of both native and applied P is in the pH range of 6.0 to 7.5. At higher pH values, phosphate anions react with Ca and Mg to form phosphate compounds of limited solubility, Mortvedt *et al.*, (1999).

Phosphorus is found in both organic and inorganic forms in soils. Typically organic P can account for up to 80% of the total P in soils and is generally viewed as the more important form in supplying phosphorus to plants, Brown (1993).

In agricultural systems P inputs in form of mineral and / or organic fertilizers are necessary to increase the production and replace P removed in plant and / or animal products, Haygarth *et al.*, (1998). The presence of P in different forms or its association with different soil colloids influences availability of P.

Rock phosphate is the main source for producing phosphate fertilizers, and it is a good source of phosphorus if organic matter and powdered sulfur are added, where organic acids produced from organic matter help to dissolve the rock phosphate and increase the availability of phosphorus, Lotfollahi *et al.*, (2001). Therefore, the rock phosphate could be combined with organic matter and sulfur for use as phosphorus fertilizers, Awaad (2005). Also, the dissolution of rock phosphate increased as exchangeable Ca decreased and as P-sorption capacity of the soil increased, Mackey *et al.* (1986)

Johnston (2000) reported that soil organic matter can chelate Ca ions derived from rock phosphate dissolution and thus increase P release from it. Thus the composting of rock phosphate with organic matter follows the same mechanism.

Zebarth *et al.* (1999) suggested that the soil pH was increased or decreased depending on the initial pH of the amendment materials. The sensitivity of soil pH to the organic amendments was likely due in part to the low buffering capacity typical of the sandy soil. Abdel-Aziz *et al.* (1996) reported that applied soil conditioners namely FYM and Ch.M to soil resulted in decreasing soil pH and increasing sunflower yield and its components. Abou-Baker and Omar (1996) showed that the pH of soil treated with organic manure was slightly lower than that of the untreated one. Such trend is probably due to the produced organic acids by decomposition of organic substances in the soil.

El-Maddah (2005) found that organic soil amendments had a slightly decreases in soil reaction (pH) and progressive increases in soil salinity (EC), organic carbon (OC,%) and C/N ratio. Also, the application of organic amendments clearly enhanced the nutrients status of the investigated soil.

Abd El-Naim, *et al.* (1975) reported that the application of organic wastes such as sheep refuse to soil increased total soluble salts and soluble ions at six months of the experimental duration but decreased them after ten months.

Electrical conductivity has been shown to increase with increasing manure/compost application rates, Eghball (2002). Also, Rdresh *et al.* (2004) found that the application of compost tended to increase organic matter, available phosphorus and silicate, exchangeable cations in the soil.

Kifuko et *al.* (2007) in field experiment showed that the available P values increased significantly above the control in all the treatments where Minjingu phosphate rock (MPR) and organic materials were applied separately or combined.

Mokolobate and Haynes (2003) found that application of envisaged organic manure and indigenous rock phosphate (RP) can improve soil pH and nutrient status and subsequently increase crop production.

Hue (1992) reported that inorganic phosphorus fertilizers were utilized more efficiently by crops when applied with organic inputs due to reducing phosphorus sorption capacity and hence increasing phosphorus concentration in the equilibrium solution. Selvi et al (2003) reported that the application of rock phosphate with organic manure enhances the dissolution of rock phosphate in the soil and thus increases the availability of P to plant.

Saloid – P (NH_4Cl extractable –P): The saloid – bound phosphorus does not represent a certain solid state and was defined by Peterson and Corey (1966) as the easily soluble and loosely soil phosphorus. Thus it represents the immediately available – P fraction in the soil. Holah *et al.* (1985) found that saloid – P ranged from 3.2 ugg^{-1} in Maryout calcareous soil and 17.5 ugg^{-1} in Seds alluvial soil, representing from 0.7 to 2.1% of inorganic – P fractions. El-Ghozoli (1994) explained that the soil content of available phosphorus increased progressively as the C/N ratio of the added residues became closer and thus the C/N ratio of 10:1 yielded the highest inducing effect on soil content of available phosphorus. Mahmoud (1994) reported that organic acids resulting from the metabolic breakdown of organic materials form complexe with the inorganic phosphate. This formed phosphorus was more readily available to higher plants and the precipitation of phosphorus by calcium was inhibited.

Al – P (NH_4F extractable – P): Holah *et al.* (1985) indicated that Al–P was the second dominant phosphate fraction. The amounts varied widely from 39.2 to 270, 18.0 to 48.5, 9.5 to 19.3 ugg^{-1} in the alluvial, the desert sandy, and the calcareous soils, respectively. This fraction comprised 16.6, 10.0 and 3.6 % of sum of soil inorganic–P, respectively.

Fe–P (NaOH extrctable–P): The formation of Fe–P in soils is favored mainly under acidic conditions and in soils containing high amounts of free Fe_2O_3, Ahmed and Jones, (1967). Amer and Abou El-Roos (1975) indicated that values of Fe-P fraction ranged from 7 to 21 ugg^{-1} in some alluvial soils. Han and Jordan (1995) found that the amount of P in solution increased with increasing organic acid concentrations, while the amount of Fe- and Al-bound P decreased. Lee *et al.* (2004) found that compost application decreased the residual P and Fe–P fractions and then increased inorganic P fraction, in spite of continuous compost application. Increase in total, inorganic and extractable P with time may be closely related to the increase in the availability of accumulated P for rice growth. Park *et al.* (2004) found that the P fixation was higher with iron than with aluminum and calcium in the paddy soil. The highest Fe-P content occurred in the compost plus NPK fertilizer treatment. Excessive application of P to soil could increase P fixation, largely in form of Fe-P in paddy soil.

Ca–P (acid extractable–P): This fraction refers mainly to the insoluble Ca–p compounds such as octacalcium phosphate and apatites as well as the Ca–P compounds which coated with $CaCO_3$, (Chang and Jackson, 1957). Chang and Jackson, (1958) reported that, after the application of phosphate fertilizers, calcium and aluminum phosphate are more likely to be formed than iron phosphate. This was explained by the high activities of Ca and Al ions in the soil relative to Fe ions. Mohamed (1990) showed that the overall relation magnitude indicated inorganic P factions were Ca-P > Al-P> Fe-P > Saloid-P in sandy calcareous soil. Behiry *et al.* (2003) indicated that the relative abundance of inorganic-P fractions in most soils is in the order of Ca-P > Saloid-P ≈ Fe-P > Al-P. They added that Ca-P is the most dominant in the investigated soils. It ranged from 27.1 to 826.9 mg P/kg soil. Saliman *et al.* (2003) revealed that the native soil Ca-P comprised almost 93%, 94% and 93% from the inorganic-P for Abu-Hamad, El-Nubaria and El-Gabal El-Asfar soils respectively. They arranged the soil inorganic-P fractions of fallows: Ca-P > Al-P > Fe-P > Saloid -P.

The objective of the present work is to find out the effect and residual effects of applying organic and inorganic phosphorus using organic matter (farmyard manure), rock phosphate and mono super phosphate on some soil chemical properties as well as phosphorus fractions of soils. Also, the whole improvement of such soils are economically determined by calculating the net income for all experimental treatments.

MATERIALS AND METHODS

field experiments were carried out on silty clay loam soil at El-Gemmeiza Agricultural Research Station in El-Gharbia Governorate during two successive seasons, winter season 2006/2007 using wheat plants (Triticum aestivum) and summer season 2007 using maize plants (Zea maize) to study the effect and residual effects of organic and inorganic phosphorus on some soil chemical properties and phosphorus fractions. Some soil properties of the experimental soil are presented in Table (1a) and some characters of the used organic matter are shown in Table (1b).

Mono-super phosphate is made by treating rock phosphate with sulfuric acid, which contains about 12 % sulfur as calcium sulfate (Liekam *et al.*, 1991). It also contains about 15.5% P_2O_5 and its water solubility was above 90%, while rock phosphate contains about 32% P_2O_5 and its water solubility was less than 1% (Minor *et al.*, 1993). Chemical composition of rock phosphate are shown in Table (1c).

The area of the experiment was divided into 81 plots using a randomized complete block design with three replicates. The area of each plot was 6 m^2 (2 m in width and 3 m in length). The main plots were conducted for farmyard manure (FYM) by the rates of 0, 20 and 30 m^3/fed. as a source of organic phosphorus, and as a source of organic acids which help in dissolution of rock phosphate. While rock phosphate and super phosphate used as a source of inorganic phosphorus. Rock phosphate rates were considered as sub-plots including addition of 0, 100 and 200Kg/fed. Supper phosphate rates were considered as sub-sub-plots including the rates of 0, 100 and 150 Kg/fed. All treatments were added to the soil surface during seed bed preparation on the first season before sowing.

Table (1-a) : Some physical and chemical properties of the used soil.

Soil depth, cm	0-30	30-60	Soil depth, cm	0-30	30-60
physical properties					
Particle size distribution			Texture class	* Si.C.L.	* Si.C.L.
Sand, %	16.35	17.12	Bulk density (Db, g cm^{-3})	1.32	1.34
Silt, %	48.03	44.75	Total porosity (E, %)	50.19	49.43
Clay, %	35.62	38.13	Hydraulic conductivity (Kh, cm hr^{-1})	0.39	0.35
chemical properties					
pH 1 : 2.5 (Suspension)	7.89	7.96	EC, dSm^{-1}	1.39	1.5
Soluble cations, meq l^{-1}			Soluble anions, meq l^{-1}		
Ca^{2+}	4.28	4.73	CO_3^{2-}	0.00	0.00
Mg^{2+}	4.46	4.87	HCO_3^-	3.98	4.2
Na^+	4.62	4.91	Cl^-	6.95	7.25
K^+	0.54	0.49	SO_4^{2-}	2.97	3.55
$CaCO_3$, %	3.42	3.28	C/N ratio	10.48	9.52
Organic matter (O.M., %)	2.26	1.71	Available N, mg Kg^{-1}	29.17	27.1
Organic carbon (O.C., %)	1.31	0.99	Available P, mg Kg^{-1}	9.78	7.35
Total nitrogen (T.N., %)	0.125	0.104	Available K, mg Kg^{-1}	358	346

* Si. C. L. : Silty clay loam.

Table(1b): Some characteristics of the used organic matter.

Properties	Farmyard manure
pH (1:10 organic manure : Water susp.)	7.39
EC dSm^{-1} (1:10 organic manure : Water extract)	1.34
$CaCO_3$, %	1.27
*O.M., %	29.45
*O.C. , %	17.08
Total N, %	0.82
C / N ratio	20.83
Available P, %	0.041
Available K, %	0.514
Soluble cations meq/l (1:10 water extract)	
Ca^{2+}	6.40
Mg^{2+}	2.70
Na^+	2.40
K^+	1.90
Soluble anions meq/l (1:10 water extract)	
CO_3^{2-}	0.00
HCO_3^-	8.20
Cl^-	2.80
SO_4^{2-}	2.40

*** Organic matter (O.M.) = Organic carbon (O.C.) X 1.724 (Waksman, 1952)**

Table (1-c) : Chemical composition of rock phosphate

Element	pH (1:20) susp.	EC, dSm^{-1} (1:20)	Total $CaCO_3$, %	Fe, %	K, %	Ca, %	Mg, %	P_2O_5, %
Composition	8.1	1.95	14.27	0.52	0.18	39.95	4.56	32.00

In winter season 2006/2007 Wheat grains (Sakha 69 variety)were planted at the rate of 60 Kg/fed. during the third week of November 2006, while in summer season 2007 maize grains (Zea maize, three-way cross-321) were planted at the rate of 15 kg/fed. during the first week of June 2007.

During the two seasons, the basel doses of N and K were applied according to the recommendations for each crop in the form of ammonium nitrate (33.5% N) and potassium sulphate (48 % K_2O). The other usual agricultural practices were carried out as usual for each crop according to the recommendations of El-Gemmeiza Research Station.

Soil samples (0-30cm) were collected from each field treatment plot in each season after crop harvesting. The collected soil samples were air-dried, ground and passed through 2 mm sieve and stored for chemical analysis.

Soil pH in soil water suspension (1: 2.5) and soil electrical conductivity (EC) in soil paste extract were measured. Soluble cations and anions were determined in soil paste extract using the methods described by Page *et al.* (1982).

Sodium Adsorption Ratio (SAR) was calculated as:

$$SAR = \frac{Na\ meq/l}{\sqrt{\frac{Ca + Mg\ meq/l}{2}}}$$

Total soluble salts, % were calculated according to the following equation:

$$T.S.S.,\% = \frac{EC\ dSm^{-1} \times 0.064 \times SP}{100}$$

where: SP = Saturation percentage

Fractionation of soil inorganic-P:

Duplicate 1.0 gm of soil samples were used to determine the various fractions of inorganic P.

- Easily-soluble P: A 50 ml solution of 0.5 M NH_4Cl was added and shaken for 30 min. (Chang and Jackson, 1957).
- NH_4F-P (aluminum-bond P): A 50 ml solution of 0.5 m NH_4F adjusted at pH 8.2, shaken for 24 hours was used as an extractant for P fraction. (Khin and Leeper, 1960).
- NaOH-P (iron-bond P): This fraction was extracted using 50 ml solution of 0.1 N NaOH + 1 M NaCl shaken for 17 hours.(Williams *et al.*, 1967)
- H_2SO_4-P (Ca-P): extraction was run by shaking in 50 ml solution of 0.5 N H_2SO_4 for 1 hour (Chang and Jackson, 1957).

At harvesting time of each crop, total yield of both wheat grains and straw as well as maize grains separately harvested, weighed, and related to Ton/fed. The collected data were statistically analyzed according to procedure outlined by Snedecor and Cochran (1981). The main values were compared at 0.05 level using L.S.D.

Economic evaluation was done to compare between different treatments to state which one is more available. The test was executed according to the price of the yield (1200 LE/Ton grain of wheat and 800 LE/Ton straw of wheat in the first season and 1100 LE/Ton maize in the second one, as well as the cost of different treatments including the price of the addition treatments and the price of labor, which was calculated considering conventional method of estimating both fixed and variable costs.

RESULTS AND DISCUSSION

I- Effect of different treatments on some soil chemical properties.

1- Soil reaction (pH).

Results in Tables (2 and3) and Fig. (1) show that all application treatments lead to a favorable decrease in soil reaction (pH) of the two seasons compared with the control (untreated soil). The decrease in soil pH was ranged between 0.25 and 3.54 % and between 0.25 and 3.55 % under the control treatment for the first and second seasons, respectively.

It is clear from Tables (2 and 3) and Fig. (1) that by increasing organic matter rates, the soil pH significantly decreased, where the 30 m^3/fed of farmyard manure decreased it more than the rates of 20 and zero m^3/fed. where the decrease reached to 3.04 and 318 % in the first and second seasons, respectively. This may be due to the produced organic acids by decomposition of organic substances in the soil. The results are in harmony with those obtained by Abou-Baker and Omar (1996) and Abdel-Aziz *et al.* (1996) and El-Maddah (2005).

Concerning the effect of inorganic phosphorus on soil pH, it was observed that all inorganic phosphorus treatments were slightly decreased soil pH comparing with the control. The decreases were ranged between 1.65 and 2.16 % and 1.65 and 2.29 % for rock phosphate in both first and second seasons respectively with increasing rock phosphate rates. While, by increasing supper phosphate rates, the decreases of soil pH were ranged between 1.65 and 2.16 % in both the first and second seasons, respectively. Similar results were obtained by Kifuko *et al.* (2007).

Concerning the combined effect of different treatments, it could be observed that the lowest values was obtained with the application of 30 m^3/fed farmyard manure with 200 Kg/fed RP at 150 Kg/fed SP, in which pH values were 7.61 and 7.56 comparing with the control (7.89 and 7.86) in the first and second seasons, respectively. Similar results were obtained by Mokolobate and Haynes (2003).

Table (2): Some soil chemical properties after wheat in the first season (winter 2006/2007) as affected by different treatments.

O.M. m^3/fed	Rock Phosphate Kg/fed	Supper Phosphate Kg/fed	Soil pH 1:2.5 susp.	EC dSm^{-1}	Soluble cations, meq/l				Soluble anions, meq/l				TSS, %	SAR
					Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4		
0	0	Control	7.89	1.36	3.75	4.00	4.35	0.02	0.00	4.06	3.57	4.49	0.08	2.21
		100	7.87	1.39	3.75	4.00	4.36	0.02	0.00	4.26	4.00	3.87	0.08	2.21
		150	7.86	1.41	3.75	3.00	5.69	0.02	0.00	5.06	3.40	4.00	0.08	3.10
	100	0	7.87	1.39	4.50	3.50	4.69	0.02	0.00	4.46	4.62	3.63	0.08	2.35
		100	7.85	1.45	4.75	3.50	4.86	0.02	0.00	5.05	4.02	3.56	0.09	2.39
		150	7.84	1.47	4.00	3.50	5.36	0.02	0.00	5.14	4.62	3.12	0.09	2.77
	200	0	7.85	1.44	3.50	4.40	5.03	0.02	0.00	4.64	4.25	4.06	0.09	2.53
		100	7.83	1.49	3.50	4.00	5.70	0.02	0.00	5.23	4.87	3.12	0.09	2.94
		150	7.81	1.53	3.50	4.25	5.72	0.02	0.00	5.31	4.87	3.31	0.09	2.91
20	0	0	7.76	2.05	6.25	5.75	6.03	0.02	0.00	5.40	5.87	6.78	0.13	2.46
		100	7.74	2.13	6.25	5.50	6.70	0.03	0.00	6.40	5.87	6.21	0.13	2.76
		150	7.73	2.16	6.25	5.50	6.70	0.03	0.00	6.50	6.12	5.86	0.13	2.76
	100	0	7.74	2.12	6.25	5.50	6.70	0.03	0.00	5.40	6.37	6.71	0.13	2.76
		100	7.72	2.19	6.25	6.25	6.71	0.03	0.00	5.79	6.67	6.78	0.14	2.68
		150	7.70	2.23	6.95	6.15	6.77	0.03	0.00	5.89	7.07	6.94	0.14	2.65
	200	0	7.73	2.17	6.75	5.70	7.37	0.03	0.00	5.99	7.62	6.24	0.14	2.95
		100	7.70	2.24	6.75	5.50	8.71	0.03	0.00	6.58	7.42	6.99	0.14	3.52
		150	7.69	2.28	6.95	5.75	8.74	0.03	0.00	6.88	6.62	7.97	0.14	3.47
30	0	0	7.68	2.40	7.50	6.25	7.05	0.03	0.00	6.58	6.87	7.38	0.15	2.69
		100	7.66	2.49	7.75	6.25	7.72	0.03	0.00	6.17	7.87	7.71	0.16	2.92
		150	7.65	2.52	7.50	6.75	7.39	0.03	0.00	6.27	7.50	7.90	0.16	2.77
	100	0	7.67	2.46	7.50	6.25	7.06	0.03	0.00	6.17	6.50	8.17	0.16	2.69
		100	7.64	2.54	7.50	6.00	8.73	0.04	0.00	6.37	6.80	9.10	0.16	3.36
		150	7.63	2.57	7.50	6.75	8.40	0.04	0.00	6.55	6.17	9.97	0.17	3.15
	200	0	7.65	2.52	8.75	6.00	8.74	0.05	0.00	5.25	6.37	11.92	0.16	3.22
		100	7.62	2.59	8.75	6.75	9.08	0.09	0.00	5.65	6.65	12.37	0.18	3.26
		150	7.61	2.63	8.95	6.35	9.13	0.13	0.00	5.65	7.95	10.96	0.19	3.30
(A) O.M. m^3/fed		0	7.85	1.44	3.89	3.79	5.08	0.02	0.00	4.80	4.25	3.68	0.09	2.60
		20	7.72	2.17	6.52	5.73	7.16	0.03	0.00	6.09	6.63	6.72	0.14	2.89
		30	7.65	2.52	7.97	6.37	8.14	0.05	0.00	6.07	6.96	9.50	0.17	3.04
		F	162.59*	25543.61*									84.44*	193.99*
		LSD 5%	0.03	0.01									0.02	0.06
(B) Rock Phosphate Kg/fed		0	7.76	1.99	5.86	5.22	6.22	0.03	0.00	5.63	5.67	6.02	0.12	2.65
		100	7.74	2.05	6.13	5.27	6.59	0.03	0.00	5.65	5.87	6.44	0.13	2.76
		200	7.72	2.10	6.38	5.41	7.58	0.05	0.00	5.69	6.29	7.44	0.14	3.12
		F	5.66*	35.56*									2.28NS	254.84*
		LSD 5%	0.02	0.03									0.01	0.05
(C) Supper Phosphate Kg/fed		0	7.76	1.99	6.08	5.26	6.34	0.03	0.00	5.33	5.78	6.60	0.12	2.65
		100	7.74	2.06	6.14	5.31	6.95	0.03	0.00	5.72	6.02	6.63	0.13	2.90
		150	7.72	2.09	6.15	5.33	7.10	0.04	0.00	5.92	6.04	6.67	0.13	2.99
		F	3.62*	40.08*									0.59NS	255.61*
		LSD 5%	0.03	0.02									0.01	0.03

These results reveal that there is no wide variation between the different treatments on soil pH values. Similar results were obtained by Zebarth *et al.* (1999), who suggested that the variation on soil pH was depending on the initial pH of the added materials.

Table (3): Some soil chemical properties after maize in the second season (sumn

O.M m³/fed	Rock Phosphate Kg/fed	Supper Phosphate Kg/fed	Soil pH 1:2.5 susp.	EC dSm⁻¹	Cations, meq/l				Anions, meq/l				TSS. %	SAR
					Ca	Mg	Na	K	CO3	HCO3	Cl	SO_4		
0	0	Control	7.86	1.39	4.75	3.25	4.04	0.02	0.00	3.63	4.37	4.06	0.08	2.02
		100	7.84	1.41	4.75	3.75	4.71	0.02	0.00	3.63	4.55	5.05	0.08	2.29
		150	7.83	1.43	4.75	3.75	5.71	0.02	0.00	3.75	5.00	5.49	0.09	2.77
	100	0	7.85	1.41	4.75	4.25	5.05	0.02	0.00	4.75	4.00	5.32	0.09	2.38
		100	7.82	1.48	4.75	4.00	5.72	0.03	0.00	4.75	4.22	5.52	0.09	2.73
		150	7.81	1.49	4.75	4.00	5.72	0.03	0.00	5.17	4.62	4.71	0.09	2.73
	200	0	7.83	1.47	5.75	3.00	5.38	0.03	0.00	5.17	4.87	4.13	0.09	2.57
		100	7.80	1.52	5.75	4.25	5.05	0.03	0.00	5.37	5.32	4.39	0.10	2.26
		150	7.78	1.55	5.75	4.05	5.72	0.03	0.00	5.07	5.43	5.05	0.10	2.58
20	0	0	7.73	2.11	6.50	5.50	6.06	0.03	0.00	6.08	5.62	6.39	0.14	2.47
		100	7.70	2.17	7.50	5.00	6.39	0.03	0.00	6.30	5.83	6.79	0.14	2.56
		150	7.69	2.19	7.50	5.00	6.73	0.03	0.00	6.50	5.95	6.81	0.14	2.69
	100	0	7.70	2.15	7.50	5.25	6.73	0.03	0.00	6.99	6.37	6.15	0.14	2.66
		100	7.68	2.22	7.50	4.75	6.73	0.04	0.00	6.50	6.38	6.13	0.14	2.72
		150	7.67	2.25	6.75	5.75	6.73	0.04	0.00	6.51	6.48	6.28	0.15	2.69
	200	0	7.68	2.20	6.75	6.25	7.07	0.04	0.00	6.61	7.37	6.13	0.14	2.77
		100	7.65	2.27	6.50	6.25	7.74	0.04	0.00	6.62	7.00	6.91	0.15	3.07
		150	7.64	2.30	6.50	6.00	7.75	0.05	0.00	6.71	7.62	5.96	0.15	3.10
30	0	0	7.65	2.42	7.50	6.75	9.43	0.05	0.00	8.23	7.62	7.88	0.16	3.53
		100	7.63	2.53	8.50	7.00	9.43	0.05	0.00	8.54	8.50	7.94	0.17	3.39
		150	7.62	2.56	8.50	7.75	9.11	0.05	0.00	8.64	8.50	8.27	0.17	3.20
	100	0	7.63	2.50	8.50	7.00	9.11	0.05	0.00	7.64	8.12	8.90	0.17	3.27
		100	7.61	2.59	8.50	7.00	9.78	0.06	0.00	7.64	8.62	9.08	0.18	3.51
		150	7.60	2.64	8.50	7.00	10.46	0.06	0.00	7.66	8.75	9.61	0.18	3.76
	200	0	7.60	2.56	8.50	6.75	9.46	0.07	0.00	8.26	7.35	9.16	0.18	3.42
		100	7.58	2.64	8.75	7.00	9.79	0.08	0.00	8.57	7.65	9.40	0.18	3.49
		150	7.56	2.79	9.75	7.25	10.13	0.12	0.00	8.59	8.25	10.41	0.20	3.47
(A) O.M, m³/fed		0	7.82	1.46	5.08	3.81	5.23	0.03	0.00	4.59	4.71	4.86	0.09	2.48
		20	7.68	2.21	7.00	5.53	6.88	0.04	0.00	6.54	6.51	6.39	0.14	2.75
		30	7.61	2.58	8.56	7.06	9.63	0.07	0.00	8.20	8.15	8.96	0.18	3.45
		F	255.02*	8021.42*									1071.69	5569.69*
		LSD 5%	0.03	0.02									0.01	0.02
(B) Rock Phosphate Kg/fed		0	7.73	2.02	6.69	5.31	6.85	0.03	0.00	6.14	6.22	6.52	0.13	2.77
		100	7.71	2.08	6.83	5.44	7.33	0.04	0.00	6.40	6.40	6.86	0.14	2.94
		200	7.68	2.14	7.11	5.64	7.57	0.05	0.00	6.77	6.76	6.84	0.14	2.97
		F	28.41*	170.38*									2.86NS	81.42*
		LSD 5%	0.01	0.01									0.01	0.04
(C) Supper Phosphate Kg/fed		0	7.73	2.02	6.72	5.33	6.93	0.04	0.00	6.37	6.19	6.46	0.13	2.79
		100	7.70	2.09	6.94	5.44	7.26	0.04	0.00	6.44	6.45	6.80	0.14	2.89
		150	7.69	2.13	6.97	5.62	7.56	0.05	0.00	6.51	6.73	6.95	0.14	3.00
		F	6.92*	64.99*									0.67NS	133.45*
		LSD 5%	0.02	0.02									0.02	0.03

2- Soil salinity (EC) and soluble ions.

Data in Tables (2 and 3) and Fig. (2) indicate that soil EC values were significantly increased with increasing all added treatments in the two seasons. The highest EC values were obtained by the addition of 30 m^3/fed farmyard manure with 200 Kg/fed RP at 150 Kg/fed SP, where the values were 2.63 and 2.79 dSm^{-1} is compared to control values of 1.36 and 1.39 dSm^{-1} in the first and second seasons, respectively. This means that the EC values of this treatment were increased by 93.38 and 100.72 % over the control in the first and second seasons, respectively.

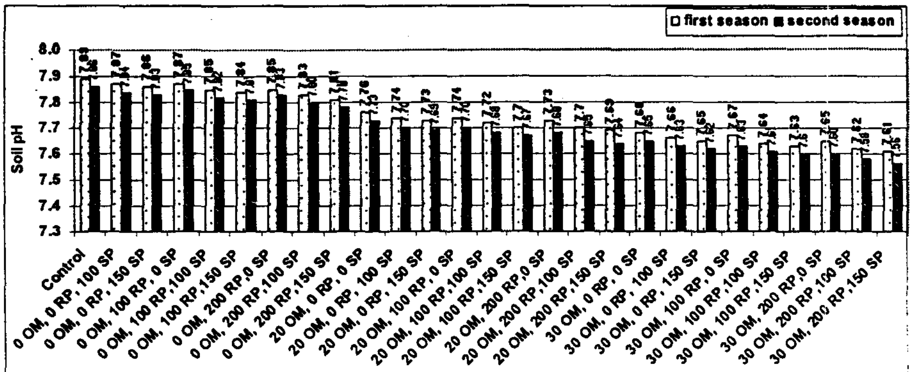

Fig.(1): Effect of different treatments on soil reaction (pH) in the first and second seasons

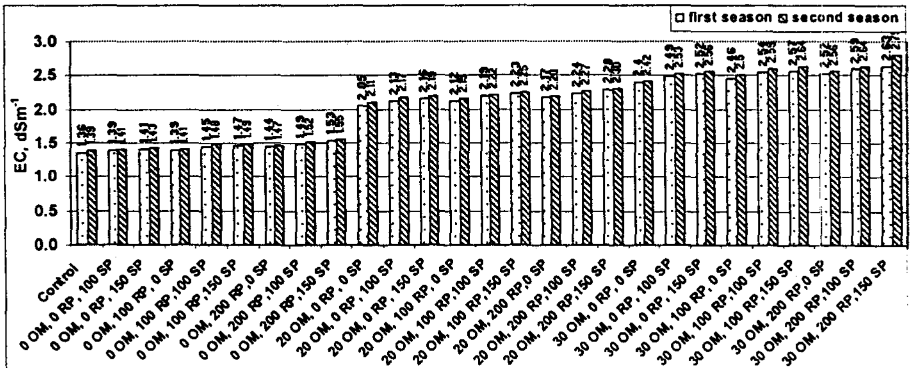

Fig.(2): Effect of different treatments on soil electrical conductivity (EC, dSm^{-1}) in the first and second seasons

Concerning the effect of organic P on soil salinity (EC), the results reveal that the EC values were significantly increased with increasing OP rates, where the increases of EC were between 5.88 and 85.29 % after wheat in the first season, while it was from 5.04 to 85.61 % after maize in the second one. These results reveal that by increasing OM rates, soil EC values were increased especially with the addition of 30 m^3/fed farmyard manure as compared the addition of 20 or zero m^3/fed. These results are agreement with that of El-Maddah (2005), who found that organic amendments had progressive increment in soil salinity (EC).

Regarding to the effect of inorganic phosphorus application on soil salinity, data in Tables (2 and 3) and Fig. (2) show that all kinds of phosphorus addition significantly increased the EC values. In case of rock phosphate application, the increases of EC were from 46.32 to 54.41 % after wheat in the first season and from 45.32 to 53.96 % after maize in the second one. The increment in EC values were noticed by increasing rock phosphate addition rate. Also, in case of the application of supper phosphate, it can be noticed that the increases of EC by increasing supper phosphate rates were ranged from 46.32 to 53.68 % and from 45.32 to 53.2 % over the control for the first and second seasons, respectively.

Soluble cations and anions in Tables (2 and 3) generally indicate that the soluble calcium, magnesium, sodium and soluble bicarbonate, chloride, sulfate slightly increased with increasing all added treatments.

It was obvious from Tables (2 and 3) that increasing organic P rates, the soil soluble Ca, Mg, Na, HCO_3, Cl and SO_4 were increased, where the 30 m^3/fed organic matter had the highest effect as compared to the rates of 20 and zero m^3/fed. The highest mean values of these ions were 7.97, 6.37, 8.14, 6.07, 6.96 and 9.50 meq/l, respectively in the first season and were 8.56, 7.06, 9.63, 8.20, 8.15 and 8.99 meq/l, respectively in the second one. Similar results were obtained by Abd El-Naim *et al.* (1975) and Gaskell *et al.* (2007), they reported that the application of organic wastes to soil increased total soluble salts and soluble ions at six months of the experimental duration.

On the other hand, the same trend was obtained by inorganic phosphorus additions, in which with increasing rock phosphate rates and / or supper phosphate rates, the soil soluble cations and anions were increased. The highest mean values were 6.38, 5.41, 7.58, 5.69, 6.29 and 7.44 meq/l in the first season, respectively and 7.11, 5.64, 7.57, 6.77, 6.76 and 6.87 meq/l in the second one, respectively recorded at 200 Kg/fed RP addition. Also, the highest mean values were 6.15, 5.33, 7.10, 5.92, 6.04 and 6.67 meq/l in the first season, respectively and 6.97, 5.62, 7.56, 6.51, 6.73 and 6.99 meq/l in the second one, respectively recorded at 150 Kg/fed SP addition. Similar results were obtained by Mackey *et al.* (1986). It can be noticed from these results that the effect of organic P application on soil soluble cations and anions was more pronounced than inorganic phosphorus application, which could be attributed to the effect of active groups of the organic matter molecules.

3- Total soluble salts (TSS) and sodium adsorption ratio (SAR).

The effect of different treatments in this study differed quietly in their effects on total soluble salts of soil paste extract (TSS, %) and sodium adsorption ratio (SAR) of the soil after wheat and maize in the first and second seasons. Data in Tables (2 and 3) and Fig. (3) indicate that all added treatments led to an increase in TSS and SAR values in the two seasons compared with the control (untreated soil). Increases in TSS were ranged from 12.50 to 137.50 % and from 12.50 to 150.00 % in the first and second seasons, respectively over the control. Also, the increases in SAR were ranged from 6.33 to 57.01 % and from 13.37 to 86.14 % in the first and second seasons, respectively.

Concerning the single effect of organic P addition, results indicate that the increases of organic matter (FYM) addition alone caused an increase in TSS and SAR values, where the increment of TSS were from 12.50 to 112.50 % and 12.50 to 125.00 % over the control in the first and second seasons, respectively. Also, the increment of SAR were from 17.65 to 37.56 % and from 22.77 to 70.79 % over the control in the first and second seasons, respectively.

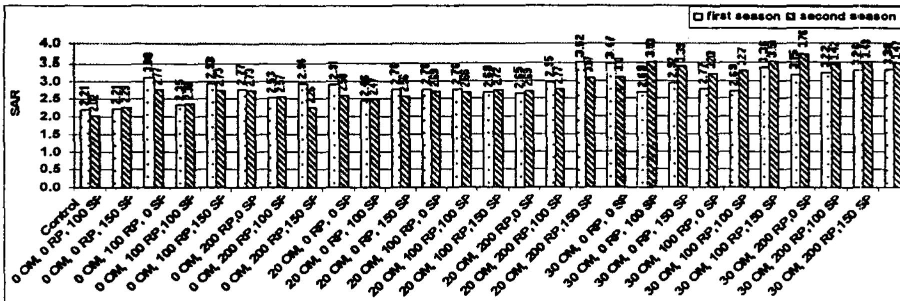

Fig.(3): Effect of different treatments on sodium adsorption ratio (SAR) in the first and second seasons

On the other hand, increases of inorganic phosphorus rates caused a slightly increases in TSS and significantly increases in SAR in the two seasons comparing with the control. The increases of TSS and SAR were 75.00 % and 41.18 % in the first season and were 75.00 % and 47.03 %, respectively over the control in the second one at 200 Kg/fed rock phosphate addition. While, at 150 Kg/fed supper phosphate addition, the increases of TSS and SAR were 62.50 % and 35.29 % over the control, respectively in the first season and were 75.00 % and 48.51 %, respectively in the second one.

II- Effect of different treatments on the main fractions of inorganic phosphorus of the soil.

Because identification and quantification of P compounds in the soil is very complicated, classes of soil P compounds are often defined functionally by the extractants that remove them from soil material in a sequential fractionation scheme. Sequential fractionation procedures are based on the assumption that chemical extractants selectively dissolve discrete groups of P compounds, and such operationally defined soil P fractions are subject to broad interpretations. Nevertheless, the information's obtained from P fractionation schemes has been useful for interpretations of soil development. This procedure aims to quantifying plant-available P (NH_4Cl-P) (Change and Jackson 1957), NH_4F-P (aluminium-bound P) (Khin and Leeper, 1960). Fe-oxide associated inorganic P (NaOH- P extractable) (Williams *et al.*, 1967) and Ca-associated P (H_2SO_4-P extractable) (Change and Jackson ,1957).

Data in Tables (4 and 5) show the distribution of the inorganic-P, i.e., easily soluble-P (NH_4Cl-P), NH_4F-P (Al-P), NaOH-P (Fe-P), H_2SO_4-P (Ca-P) and total-P as affected by the organic and inorganic phosphorus applications.

A) Labile-P (NH_4Cl-P Fraction):

The results in Tables (4 and 5) and Fig. (4) show the effect of organic and inorganic phosphorus application rates on the concentration of available phosphorus (labile-P fraction). It can be noticed that all added treatments led to increases the concentration of labile-P fraction in the first and second seasons as compared with the control (untreated soil). The highest values of labile-P fraction were recorded at the addition of 30 m^3/fed farmyard manure with 200 Kg/fed RP at 150 Kg/fed SP, where were 4.04 and 6.60 µg/g soil, as compared with the control which were 1.05 and 1.09 µg/g soil, in the first and second seasons respectively. The increases were 284.76 and 505.50 % over the control.

It can be noticed also, that the labile-P fraction values as a percent of total P were increased by increasing the addition of organic and inorganic P where the increment were ranged from 9.42 to 38.31 % and from 2.35 to 89.01 % in the first and second seasons, respectively over the control.

Organic P application in (Tables 4, 5 and Fig. 4) indicate that labile-P (NH_4Cl-P fraction) significantly increased with increasing the OM rates, where the increases of labile-P fraction were ranged from 41.90 to 177.14 % and from 46.79 to 220.18 % in the two seasons, respectively over the control. Similar results were obtained by Rdresh *et al.* (2004). Also, the labile-P fraction values as a percent of total P increased by increasing organic matter rates where the values were ranged from 26.44 to 29.46 % and 26.39 to 33.23 % in the first and second seasons, respectively. Similar results were obtained by Awaad (2005).

Inorganic P (data in Tables 4, 5 and Fig. 4) indicate that the labile-P fraction increased with increasing the rate of inorganic P either with RP or SP, where the increment of the labile-P fraction were ranged from 74.29 to 138.10 % and from 71.56 to 187.16 % in the first and second seasons, respectively by increasing the rate of RP from zero to 200 Kg/fed. While, with increasing SP rates from zero to 150 Kg/fed, mean values of labile-P fraction were increased from 95.24 to 111.43 and from 101.83 to 141.28 % in the first and second seasons, respectively over the control. Similar results were obtained by Selvi *et al.* (2003) and Kifuko *et al.* (2007).

On the other hand, the labile-P fraction values as a percent of total P increased by increasing RP and SP rates (Fig. 5), where the values were increased from 26.86 to 28.35 and from 27.01 to 32.25 %, also from 27.79 to 27.81 and from 28.78 to 30.14 % in the first and second seasons for RP and SP application, respectively. These results are in agreement with Mahmoud (1994) and Kifuko *et al.* (2007).

B) Al-P Fraction:

Data presented in Tables (4 and 5) point out that the values of P in the Al-P fraction also significantly increased with increasing all added treatments. The highest concentrations of P in the Al-P fraction were 0.22 and 0.20 µg/g soil in the first and second seasons, while the Al-P fraction as a percent of total P were 1.74 and 1.34 %, respectively in the two seasons. This occurred by 30 m^3/fed farmyard manure with 200 Kg/fed RP at 150 Kg/fed SP treatment.

Data in Tables (4 and 5) reveal that the mean values of Al-P fraction were significantly increased from 0.03 to 0.12 and from 0.05 to 0.09 and from 0.06 to 0.08 µg/g soil in the first season and from 0.03 to 0.11 and from 0.04 to 0.09 and from 0.06 to 0.07 µg/g soil in the second one. This occurred by increasing the application rates of OM, RP and SP, respectively. Also, the values of the Al-P fraction as a percent of total P were increased from 0.48 to 1.20 and from 0.69 to 1.00 and from 0.76 to 0.94 % in the first season and from 0.41 to 1.09 and from 0.60 to 0.87 and from 0.70 to 0.81 % in the second one. Also, this occurred with increasing the application rates of OM, RP and SP, respectively. Similar results were obtained by Chang and Jackson (1958) and Holah *et al.* (1985).

C) Fe-P fraction:

The results in Tables (4 and 5) show that the mean values of Fe-P fraction were significantly high with all treatments. The highest mean values of Fe-P fraction were 3.53 and 3.35 µg/g soil, while the Fe-P fraction values as a percent of total P were 27.95 and 22.44 % in the first and second seasons, respectively. These values were obtained by the addition of 30 m^3/fed OM with 200 Kg/fed RP at 150 Kg/fed SP treatment.

Table (4): The main fractions of inorganic P of the soil in the first season (winter 2006/2007) as affected by different treatments.

O.M m^3/fed	Rock Phosphate Kg/fed	Supper Phosphate Kg/fed	NH_4Cl-P, (µg.g-1)	Al-P, (µg.g-1)	Fe-P, (µg.g-1)	Ca-P, (µg.g-1)	Total P, (µg.g-1)	% of total P			
								NH4Cl-P	Al-P	Fe-P	Ca-P
0	0	Control	1.05	0.01	0.89	2.59	4.54	23.13	0.22	19.60	57.05
		100	1.24	0.02	0.94	2.70	4.90	25.31	0.41	19.18	55.10
		150	1.38	0.02	1.04	2.72	5.16	26.74	0.39	20.16	52.71
	100	0	1.54	0.02	1.05	2.76	5.37	28.68	0.37	19.55	51.40
		100	1.57	0.03	1.24	2.79	5.63	27.89	0.53	22.02	49.56
		150	1.58	0.03	1.46	2.81	5.88	26.87	0.51	24.83	47.79
	200	0	1.65	0.04	1.64	2.81	6.14	26.87	0.65	26.71	45.77
		100	1.70	0.04	1.84	2.84	6.42	26.48	0.62	28.66	44.24
		150	1.71	0.04	1.95	2.88	6.58	25.99	0.61	29.64	43.77
20	0	0	1.79	0.04	1.96	2.88	6.67	26.84	0.60	29.39	43.18
		100	1.88	0.06	1.98	2.90	6.82	27.57	0.88	29.03	42.52
		150	1.93	0.06	2.01	3.02	7.02	27.49	0.85	28.63	43.02
	100	0	1.97	0.06	2.04	3.06	7.13	27.63	0.84	28.61	42.92
		100	1.98	0.07	2.05	3.08	7.18	27.58	0.97	28.55	42.90
		150	2.07	0.07	2.12	3.14	7.40	27.97	0.95	28.65	42.43
	200	0	2.07	0.07	2.24	3.16	7.54	27.45	0.93	29.71	41.91
		100	2.08	0.07	2.45	3.17	7.77	26.77	0.90	31.53	40.80
		150	2.17	0.08	2.45	3.36	8.06	26.92	0.99	30.40	41.69
30	0	0	2.35	0.08	2.52	3.39	8.34	28.18	0.96	30.22	40.65
		100	2.39	0.08	2.54	3.47	8.48	28.18	0.94	29.95	40.92
		150	2.42	0.08	2.57	3.47	8.54	28.34	0.94	30.09	40.63
	100	0	2.60	0.09	2.63	3.57	8.89	29.25	1.01	29.58	40.16
		100	2.63	0.11	2.81	3.63	9.18	28.65	1.20	30.61	39.54
		150	2.72	0.14	3.23	3.64	9.73	27.95	1.44	33.20	37.41
	200	0	3.46	0.14	3.23	3.96	10.79	32.07	1.30	29.94	36.70
		100	3.61	0.15	3.49	4.56	11.81	30.57	1.27	29.55	38.61
		150	4.04	0.22	3.53	4.84	12.63	31.99	1.74	27.95	38.32
(A) O.M. m^3/fed		0	1.49	0.03	1.34	2.77	5.62	26.44	0.48	23.37	49.71
		20	1.99	0.06	2.14	3.09	7.29	27.36	0.88	29.39	42.37
		30	2.91	0.12	2.95	3.84	9.82	29.46	1.20	30.12	39.22
		F	8865.88*	80.49*	79506.63	2753.52*	44752.87	220.94*	49.00*	9111.76*	3787.93*
		LSD 5%	0.03	0.02	0.01	0.04	0.04	0.41	0.20	0.15	0.34
(B) Rock Phosphate Kg/fed		0	1.83	0.05	1.83	3.02	6.72	26.86	0.69	26.25	46.20
		100	2.07	0.07	2.07	3.16	7.38	28.05	0.87	27.29	43.79
		200	2.50	0.09	2.54	3.51	8.64	28.35	1.00	29.34	41.31
		F	905.01*	61.34*	1864.19*	1442.9	6072.55*	31.77*	34.77*	259.43*	321.63*
		LSD 5%	0.03	0.01	0.03	0.02	0.04	0.43	0.08	0.30	0.42
(C) Supper Phosphate Kg/fed		0	2.05	0.06	2.02	3.13	7.27	27.79	0.76	27.03	44.41
		100	2.12	0.07	2.15	3.24	7.58	27.66	0.86	27.68	43.80
		150	2.22	0.08	2.26	3.32	7.89	27.81	0.94	28.17	43.09
		F	87.54*	42.03*	186.15*	126.10*	612.97*	0.26NS	24.11*	18.96*	25.70*
		LSD 5%	0.03	0.01	0.03	0.02	0.04	0.43	0.05	0.38	0.38

Table (5): The main fractions of inorganic P of the soil in the second season (summer 2007) as affected by different treatments..

O.M m^3/fed	Rock Phosphate Kg/fed	Supper Phosphate Kg/fed	NH_4Cl-P, (µg.g-1)	Al-P, (µg.g-1)	Fe-P, (µg.g-1)	Ca-P, (µg.g-1)	Total P, (µg.g-1)	% of total P			
								NH4Cl-P	Al-P	Fe-P	Ca-P
0	0	Control	1.09	0.01	0.79	2.77	4.66	23.39	0.21	16.95	59.44
		100	1.24	0.01	1.06	2.87	5.18	23.94	0.19	20.46	55.41
		150	1.35	0.02	1.30	2.91	5.58	24.19	0.36	23.30	52.15
	100	0	1.57	0.02	1.42	2.95	5.96	26.34	0.34	23.83	49.50
		100	1.69	0.03	1.50	2.98	6.20	27.26	0.48	24.19	48.06
		150	1.78	0.03	1.53	3.01	6.35	28.03	0.47	24.09	47.40
	200	0	1.83	0.03	1.58	3.03	6.47	28.28	0.46	24.42	46.83
		100	1.91	0.04	1.77	3.03	6.75	28.30	0.59	26.22	44.89
		150	1.92	0.04	1.93	3.03	6.92	27.75	0.58	27.89	43.79
20	0	0	1.93	0.05	1.95	3.05	6.98	27.65	0.72	27.94	43.70
		100	1.96	0.05	1.95	3.05	7.01	27.96	0.71	27.82	43.51
		150	2.00	0.05	1.96	3.17	7.18	27.86	0.70	27.30	44.15
	100	0	2.01	0.05	1.96	3.20	7.22	27.84	0.69	27.15	44.32
		100	2.22	0.06	2.00	3.20	7.48	29.68	0.80	26.74	42.78
		150	2.24	0.06	2.01	3.23	7.54	29.71	0.80	26.66	42.84
	200	0	2.24	0.06	2.04	3.30	7.64	29.32	0.79	26.70	43.19
		100	2.31	0.06	2.21	3.35	7.93	29.13	0.76	27.87	42.24
		150	2.35	0.07	2.23	3.36	8.01	29.34	0.87	27.84	41.95
30	0	0	2.39	0.07	2.24	3.39	8.09	29.54	0.87	27.69	41.90
		100	2.41	0.07	2.28	3.45	8.21	29.35	0.85	27.77	42.02
		150	2.49	0.07	2.44	3.53	8.53	29.19	0.82	28.60	41.38
	100	0	2.69	0.09	2.48	3.56	8.82	30.50	1.02	28.12	40.36
		100	2.85	0.10	2.50	3.64	9.09	31.35	1.10	27.50	40.04
		150	2.98	0.13	2.68	3.82	9.61	31.01	1.35	27.89	39.75
	200	0	4.04	0.13	2.92	4.09	11.18	36.14	1.16	26.12	36.58
		100	5.00	0.17	3.34	4.73	13.24	37.76	1.28	25.23	35.73
		150	6.60	0.20	3.35	4.78	14.93	44.21	1.34	22.44	32.02
(A) O.M, m^3/fed		0	1.60	0.03	1.43	2.95	6.01	26.39	0.41	23.48	49.72
		20	2.14	0.06	2.03	3.21	7.44	28.72	0.76	27.34	43.19
		30	3.49	0.11	2.69	3.89	10.19	33.23	1.09	26.82	38.87
		F	5856.00*	1122.32*	4784.44*	6799.74*	61616.67*	384.99*	451.75*	229.04*	1805.95*
		LSD 5%	0.05	0.01	0.04	0.02	0.03	0.70	0.06	0.54	0.50
(B) Rock Phosphate Kg/fed		0	1.87	0.04	1.77	3.13	6.82	27.01	0.60	25.31	47.07
		100	2.23	0.06	2.01	3.29	7.59	29.08	0.78	26.24	43.90
		200	3.13	0.09	2.37	3.63	9.23	32.25	0.87	26.08	40.80
		F	6668.61*	325.26*	1073.97*	600.34*	24167.18*	675.12*	128.11*	17.51*	308.81*
		LSD 5%	0.02	0.00	0.03	0.03	0.02	0.31	0.04	0.36	0.55
(C) Supper Phosphate Kg/fed		0	2.20	0.06	1.93	3.26	7.45	28.78	0.70	25.43	45.09
		100	2.40	0.07	2.07	3.37	7.90	29.41	0.75	25.98	43.85
		150	2.63	0.07	2.16	3.43	8.29	30.14	0.81	26.22	42.82
		F	1190.76*	11.87*	151.82*	102.92*	1485.65*	45.55*	4.99*	8.47*	67.74*
		LSD 5%	0.02	0.01	0.03	0.02	0.03	0.29	0.07	0.40	0.40

With respect to the application rates of OM, RP and SP, the results reveal that the mean values of Fe-P fraction were significantly increased from 1.34 to 2.95, 1.83 to 2.54 and 2.02 to 2.26 µg/g soil in the first season and from 1.43 to 2.69, 1.77 to 2.37 and 1.93 to 2.16 µg/g soil in the second one. On the other hand, the Fe-P fraction values as a percent of total P were significantly increased from 23.37 to 30.12, 26.25 to 29.34 and 27.03 to 28.17 % in the first season and from 23.48 to 26.82, 25.31 to 26.08 and 25.43 to 26.22 % in the second one with the increasing rates of OM, RP and SP, respectively. Similar results were obtained by Park *et al.* (2004), they reported that excessive application of P to soil could increase P fixation largely in form of Fe-P in soil.

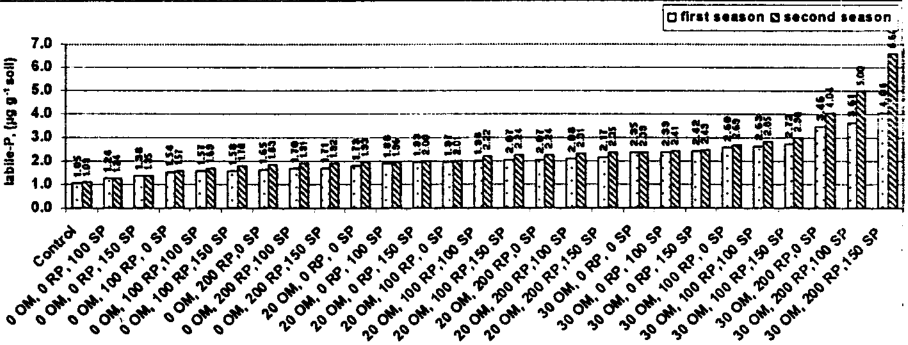

Fig.(4): Labile-P (NH4Cl-P fraction)(µg.g^{-1} soil) in the first and second seasons as affected by different treatments.

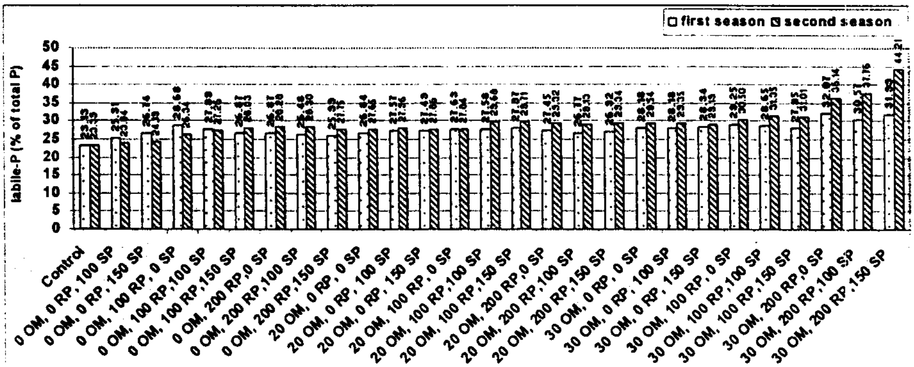

Fig.(5): Labile-P (NH4Cl-P fraction) as a percent of total P in the first and second seasons as affected by different treatments.

D) Ca-P fraction:

Data in Tables (4 and 5) and Fig. (6) indicate that the mean values of P in Ca-P fraction were significantly increased with increasing all added treatments, where the highest mean values were recorded with the addition of 30 m^3/fed OM at 200 Kg/fed RP and 150 Kg/fed SP which were 4.84 and 4.78 µg/g soil in the first and second seasons, respectively.

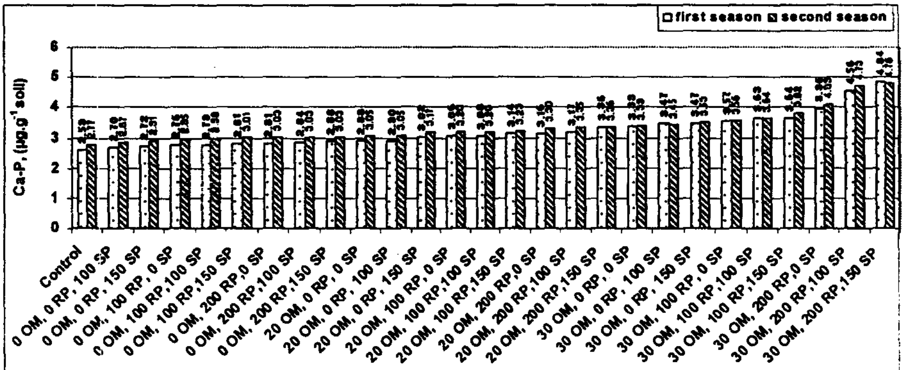

Fig.(6): Ca-P fraction (µg.g^{-1} soil) in the first and second seasons as affected by different treatments.

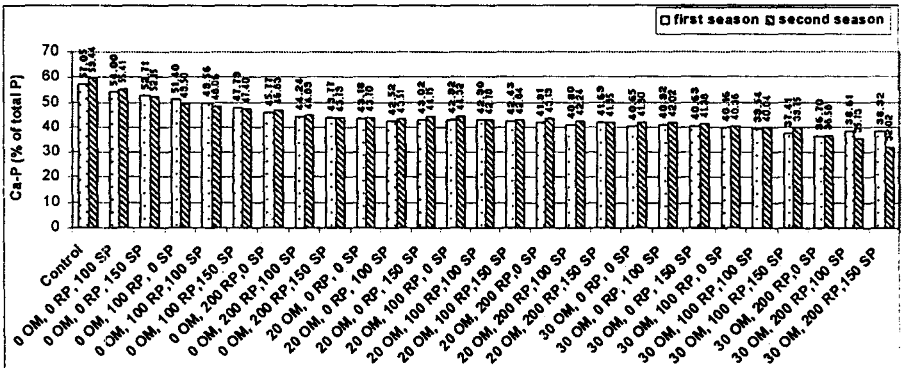

Fig.(7): Ca-P fraction as a percent of total P in the first and second seasons as affected by different treatments.

Combined effect of OM, RP and SP, results reveal that the Ca-P fraction values were differed between 2.70 and 4.84, 2.87 and 4.78 µg/g soil in the first and second seasons, respectively comparing with the control which were 2.59 and 2.77 µg/g soil. The relatively increment values were ranged from 4.25 to 86.87 and 3.61 to 72.56 % over the control. On the other hand, the mean values of Ca-P fraction as a percent of total P were significantly decreased by increasing the rates of OM, RP and SP, where the decrease percentage were ranged from 3.42 to 32.83 and 6.78 to 46.13 % in the first and second seasons, respectively under the control.

Organic P, results show that the mean values of Ca-P fraction increased from 2.77 to 3.84 and from 2.95 to 3.89 µg/g soil in the first and second seasons, respectively with increasing OM rates, as compared with the control (untreated soil) which were 2.59 and 2.77 µg/g soil, respectively. This compressed increment from 6.95 to 48.26 and 6.50 to 40.43 % over the control in the first and second seasons respectively. On the other hand, the mean values of Ca-P fraction as a percent of total P were significantly decreased from 49.71 to 39.22 and 49.72 to 38.87 % in the first and second seasons, respectively (Fig. 7).

Results of application of inorganic phosphorus rates reveal that the mean values of Ca-P fraction increased with increasing RP and / or SP rates, where the mean values were ranged from 3.02 to 3.51 and 3.13 to 3.63 µg/g soil in the first and second seasons, respectively by increasing RP rates. Also, by increasing SP rates, the mean values of Ca-P fraction were ranged from 3.13 to 3.32 and 3.26 to 3.43 µg/g soil in the first and second seasons, respectively. Similar results were obtained by Chang and Jackson (1958), they reported that calcium and aluminum phosphate are more likely to be formed than iron phosphate because the high activities of Ca and Al ions in the soil relative to Fe ions. On the other hand, the mean values of Ca-P fraction as a percent of total P were significantly decreased from 46.20 to 41.31 % and 47.07 to 40.80 % in the first and second seasons, respectively by increasing RP rates. Ca-P fraction decreased also from 44.41 to 43.09 and 45.09 to 42.82 % in the first and second seasons, respectively by increasing SP rates (Fig. 7).

III- Effect of different treatments on total phosphorus of the soil.

Organic and inorganic phosphorus additions on total P of the soil, (Tables 4, 5 and Fig. 8) indicate that the mean values of total P were significantly increased with increasing all added treatments. Increases percentage were differed between 7.93 and 178.19 % and between 11.16 and 220.39 % in the first and second seasons, respectively. The highest values were recorded by the addition of 30 m^3/fed OM with 200 Kg/fed RP at 150 Kg/fed SP which gave 12.63 and 14.93 µg/g soil, comparing with the control which recorded 4.54 and 4.66 µg/g soil, respectively in the first and second seasons.

Regarding to the addition of organic P, data show that the mean values of total P in the soil increased from 5.64 to 9.82 and 6.01 to 10.19 µg/g soil in the first and second seasons, respectively.

Inorganic phosphorus, data reveal that the mean values of total P in the soil increased from 6.72 to 8.64 and from 6.82 to 9.23 µg/g soil and increased from 7.27 to 7.89 and from 7.45 to 8.29 µg/g soil in the first and second seasons by increasing RP and SP additions, respectively.

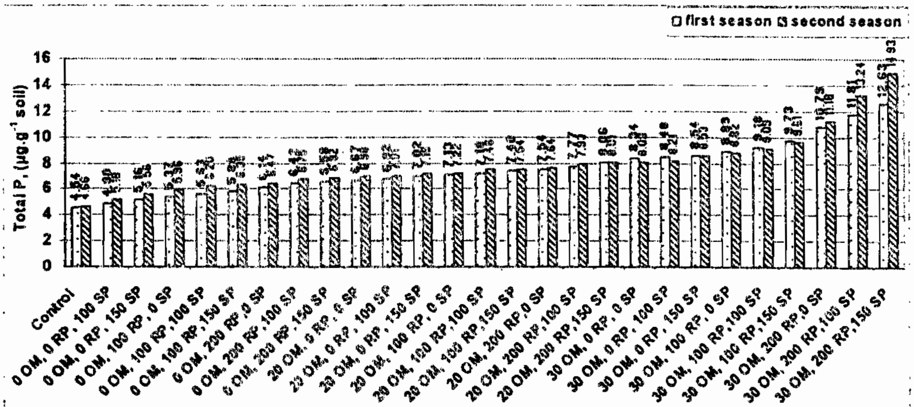

Fig.(8): Total P (µg.g⁻¹ soil) in the first and second seasons as affected by different treatments.

In conclusion, the obtained results reveal that the total inorganic P and its distribution, i.e., easily soluble P (labile-P fraction), Al-P fraction, Fe-P fraction and Ca-P fraction were increased with increasing the addition of OP (represented by O.M as a source of it), with RP and SP. Also, the labile-P fraction, Al-P fraction and Fe-P fraction as a percent of the total P were increased by increasing all added treatments, except the Ca-P fraction as a percent of the total P which was decreased by increasing all added treatments. These results means that the addition of OM with RP and SP encourage the availability of phosphorus in soil to plant and increase its solubility from insoluble phases. These results are in agreement with Selvi *et al.* (2003), Rdresh *et al.* (2004), Kifuko *et al.* (2007), they reported that application of O.M or compost with rock phosphate enhances the dissolution in soil and thus increases the available P to plants.

IV- Economical analysis.

Data presented in Tables (6 and 7) and Fig. (9) show the total inputs costs, outputs, net income and the investment ratio for the tested treatments besides the control. The obtained results indicate that the highest net income value (8263.96 LE/fed.) was incorporated with the mixing of 30 m^3/fed OM, 200 Kg/fed RP and 150 Kg/fed SP, while the control treatment (without any addition) gave always the lowest value (4798.86 LE/fed.)

Table (6) : Input production items and output of the experiments through the two growing seasons under study (winter season 2006/2007 and summer season 2007).

Items	Treatment	Unit	Unit price (LE)
Inputs			
Farmyard manure	0, 20 and 30 m^3/fed	m3	15.00
Rock phosphate	0, 100 and 200 Kg/fed	Kg	1.00
Supper phosphate	0, 100 and 150 Kg/fed	Kg P_2O_5	4.54
Ammonium nitrate	Recommended dose	Kg N	2.10
Potassium sulphate	Recommended dose	Kg K_2O	4.17
Seeds of wheat	60 Kg/fed	Kg	2.10
Seeds of maize	15 Kg/fed	Kg	7.50
Land preparation		per fed.	200.00
Labor		per fed.	500.00
Pesticides		per fed.	450.00
*Other costs		per fed.	150.00
Outputs			
Wheat grain		Ton	1200.00
Wheat straw		Ton	800.00
Maize grain		Ton	1100.00

* Depreciation rate of pumping machine, transportation of seeds, fertilizer…etc.

This best treatment should be recommended due to a relative high net income comparing with the other treatments. This may be due to this treatment was recorded the highest values of yield in the first and second seasons consequently high net income and high investment ratio.

On the other hand, most of the investment ratio values were incorporated with the highest net income which were resulted from mixing different sources of organic and inorganic phosphorus.

The results in Table (7) and Fig. (10) indicate that the net income values of OM treatments (which represent O.P) were in general higher than those of the other treatments. Thus, the added treatments can be arranged according to their high net income as follows: OM > RP > SP. These results clear that it is better economically to increase the rate of OM application to 30 m^3/fed to increase the net income.

Table (7) : Input production items and output of the experiments through the two growing seasons under study (winter season 2006/2007 and summer season 2007).

O.M m^3/fed	Rock Phosphate Kg/fed	Supper Phosphate Kg/fed	Inputs (LE/fed)	Total yield Ton/fed.			Total yield price, LE/fed			Outputs (LE/fed)	Net income LE/fed	Investment ratio
				Wheat grain	Wheat straw	Maize grain	Wheat grain	Wheat straw	Maize grain			
0	0	Control	3448.16	2.1140	3.3150	2.7802	2536.80	2652.00	3058.22	8247.02	4798.86	2.39
		100	3518.53	2.2401	3.5750	2.9595	2688.12	2860.00	3255.45	8803.57	5285.04	2.50
		150	3553.71	2.3509	3.6820	3.0679	2821.08	2945.60	3374.69	9141.37	5587.66	2.57
	100	0	3548.16	2.2456	3.6050	2.9954	2694.72	2884.00	3294.94	8873.66	5325.50	2.50
		100	3618.53	2.4562	3.6830	3.1385	2947.44	2946.40	3452.35	9346.19	5727.66	2.58
		150	3653.71	2.4898	3.7490	3.3515	2987.76	2999.20	3686.65	9673.61	6019.90	2.65
	200	0	3648.16	2.4850	3.7310	3.1109	2982.00	2984.80	3421.99	9388.79	5740.63	2.57
		100	3718.53	2.5137	3.7620	3.4154	3016.44	3009.60	3756.94	9782.98	6064.45	2.63
		150	3753.71	2.5616	3.7940	3.5128	3073.92	3035.20	3864.08	9973.20	6219.49	2.66
20	0	0	3748.16	2.5145	3.8200	3.2775	3017.40	3056.00	3605.25	9678.65	5930.49	2.58
		100	3818.53	2.6621	3.8930	3.3229	3194.52	3114.40	3655.19	9964.11	6145.58	2.61
		150	3853.71	2.8681	3.9360	3.4115	3441.72	3148.80	3752.65	10343.17	6489.46	2.68
	100	0	3848.16	2.6621	3.9150	3.4516	3194.52	3132.00	3796.76	10123.28	6275.12	2.63
		100	3918.53	2.9255	3.9720	3.5536	3510.60	3177.60	3908.96	10597.16	6678.63	2.70
		150	3953.71	2.9352	4.0180	3.5814	3522.24	3214.40	3939.54	10676.18	6722.47	2.70
	200	0	3948.16	2.9303	3.9960	3.6239	3516.36	3196.80	3986.29	10699.45	6751.29	2.71
		100	4018.53	3.0164	4.0350	3.7232	3619.68	3228.00	4095.52	10943.20	6924.67	2.72
		150	4053.71	3.0404	4.1130	3.7649	3648.48	3290.40	4141.39	11080.27	7026.56	2.73
30	0	0	3898.16	2.9164	4.1210	3.5758	3499.68	3296.80	3933.38	10729.86	6831.70	2.75
		100	3968.53	3.1314	4.1850	3.6884	3757.68	3348.00	4057.24	11162.92	7194.39	2.81
		150	4003.71	3.2032	4.2110	3.7296	3843.84	3368.80	4102.56	11315.20	7311.49	2.83
	100	0	3998.16	3.1984	4.3000	3.7927	3838.08	3440.00	4171.97	11450.05	7451.89	2.86
		100	4068.53	3.2367	4.3900	3.8547	3884.04	3512.00	4240.17	11636.21	7567.68	2.86
		150	4103.71	3.4043	4.4810	3.8844	4085.16	3584.80	4272.84	11942.80	7839.09	2.91
	200	0	4098.16	3.2463	4.4650	3.9425	3895.56	3572.00	4336.75	11804.31	7706.15	2.88
		100	4168.53	3.5383	4.5300	3.9948	4245.96	3624.00	4394.28	12264.24	8095.71	2.94
		150	4203.71	3.6006	4.6170	4.0485	4320.72	3693.60	4453.35	12467.67	8263.96	2.97

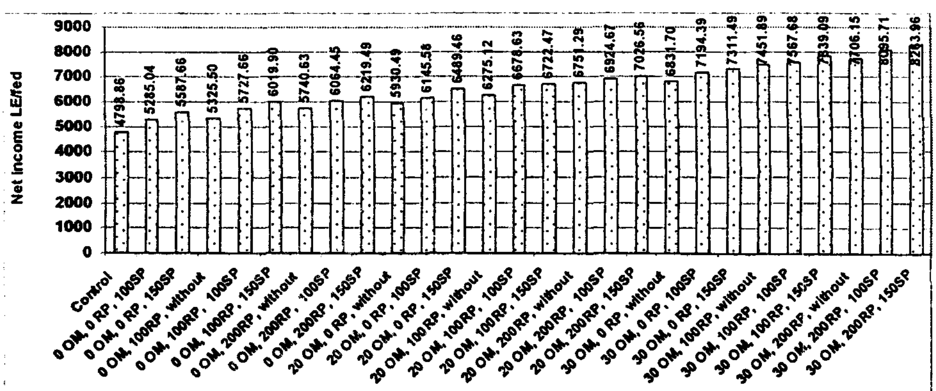

Fig. (9): The net income (LE/fed) due to different treatments through the two growing seasons under study.

Also, it can be noticed from Fig. (10) that the net income values were increased by increasing the addition rates of OM, RP and SP, either they were added single or mixed to the soil.

Finally, from the previous data it could be concluded that under silty clay loam soil conditions the effect of organic P was more pronounced than the inorganic phosphorus in improving some chemical properties as well as its better effect on increasing most of phosphorus fractions in the soil. This may be due to the effect of active groups of the organic matter molecules.

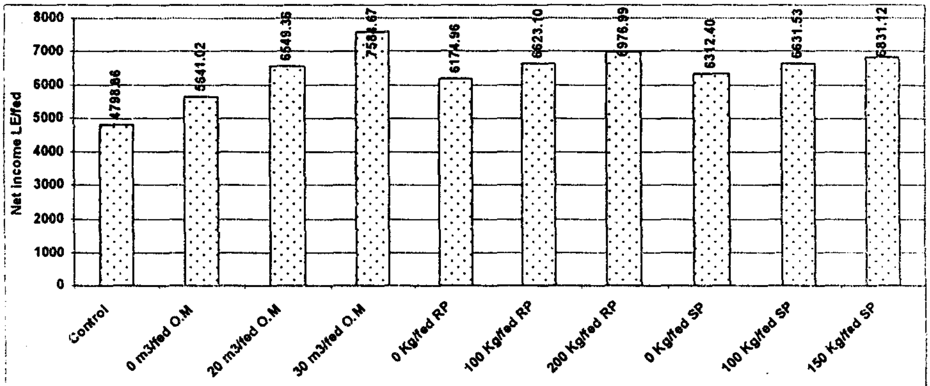

Fig. (10): net income (LE/fed) due to individual treatments through the two growing seasons under study

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تأثير الإضافات من الفوسفور العضوي والمعدني علي بعض الخصائص الكيميائية ومجموعات الفوسفور في التربه

منصور الدسوقي السوداني و الحسيني إبراهيم المداح
معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

في موسمين زراعيين متتالين (الموسم الشتوي ٢٠٠٦/٢٠٠٧ والموسم الصيفي ٢٠٠٧) نفذت تجربه حقليه علي ارض طمييه طينية سلتيه في محطة البحوث الزراعية بالجميزة , محافظة الغربية . استخدم في التجربة تصميم القطاعات الكاملة العشوائية في ثلاث مكررات لدراسة تأثير الفوسفور العضوي (المادة العضوية) والمعدني (صخر الفوسفات والسوبر فوسفات) علي بعض الخصائص الكيميائية للأرض ومجموعات الفوسفور مع دراسة الأثر المتبقي لهذه الإضافات علي نفس الخصائص السابقة , بالإضافة إلي إجراء الدراسة الاقتصادية بهدف تحديد أفضل معامله لتحقيق اعلي صافي دخل مزرعي . ويمكن تلخيص النتائج المتحصل عليها كالتالي :-

١- استخدام الفوسفور العضوي (المادة العضوية) والمعدني (صخر الفوسفات والسوبر فوسفات) أدى إلي انخفاض بسيط في رقم حموضة التربة بينما حدثت زيادة في درجة ملوحة التربة والايونات الذائبة مثل (الكالسيوم , الماغنسيوم , الصديوم , البيكربونات , الكلوريد والكبريتات) والأملاح الكلية الذائبة وكذلك النسبة الادمصاصيه للصديوم .

٢- متوسطات القيم للنتائج المتحصل عليها في موسمي التجربة بينت أن تأثير إضافة الفوسفور العضوي ممثلا في (المادة العضوية) علي خصائص الأرض الكيميائية كان أكثر من تأثير إضافة الفوسفور المعدني ممثلا في (صخر الفوسفات والسوبر فوسفات) عليها .

٣- القيم الناتجة عن مجموعات الفوسفور المعدني مثل جزء الفوسفور الذائب وجزء الفوسفور المرتبط بالالومنيوم وجزء الفوسفور المرتبط بالحديد وكذلك جزء الفوسفور المرتبط بالكالسيوم تزداد بزيادة الإضافات من الفوسفور العضوي وصخر الفوسفات والسوبر فوسفات . وكذلك فان جزء الفوسفور الذائب و جزء الفوسفور المرتبط بالالومنيوم و جزء الفوسفور المرتبط بالحديد محسوبا كنسبه مئوية من الفوسفور الكلي تزداد أيضا بزيادة كل المعاملات المضافة وذلك باستثناء جزء الفوسفور المرتبط بالكالسيوم محسوبا كنسبه مئوية من الفوسفور الكلي فقد حدث له انخفاض بزيادة كل المعاملات المضافة .

٤- متوسطات القيم للفوسفور الكلي في الأرض تزداد بزيادة كل المعاملات المضافة . فقد سجلت اعلي قيمه للفوسفور الكلي عند إضافة ٣٠ م٣/فدان مادة عضوية مع ٢٠٠ كجم/فدان صخر فوسفات و ١٥٠ كجم/فدان سوبر فوسفات حيث أعطت ١٢,٦٣ , ١٤,٩٣ ميكروجرام / جم تربه بالمقارنة مع معاملة الكنترول التي سجلت ٤,٥٤ , ٤,٦٦ ميكروجرام / جم تربه في الموسم الأول والثاني علي التوالي .

٥- أوضحت الدراسة الاقتصادية أن إضافة ٣٠ م٣/فدان مادة عضوية مع ٢٠٠ كجم/فدان صخر فوسفات و ١٥٠ كجم/فدان سوبر فوسفات حققت اعلي صافي دخل مزرعي بالمقارنة مع باقي المعاملات , فقد سجل اعلي صافي دخل مزرعي ٨٢٦٣,٩٦ جنيها للفدان بالمقارنة بمعاملة الكنترول التي سجلت اقل قيمه ٤٧٩٨,٨٦ جنيها للفدان .

٦- النتائج تؤكد انه من المفيد استخدام هذه المعاملات من الفوسفور العضوي و الفوسفور المعدني ممثلا في (المادة العضوية ، صخر الفوسفات والسوبر فوسفات) للحصول علي تحسن واضح في الخصائص الكيميائية للأرض والتي تنعكس علي زيادة المحصول وتحقيق اعلي صافي دخل مزرعي مع تحقيق اعلي مقابل نقدي في الأراضي الطمييه الطينية السلتيه .