Zagazig Journal of Agricultural Research
www.zu.edu.eg/agr/journals

EFFECT OF SOME PHOSPHATIC FERTILIZERS AND SOIL AMENDMENTS ON THE AVAILABILITY OF PHOSPHORUS IN SOIL

Abd El-Rahman M.A. Merwad*, E.A.M. Awad, I.R. Mohamed and S.M.M. Dahdouh

Soils Science Dept., Fac. Agric., Zagazig Univ., Egypt

ABSTRACT

An incubation experiment was conducted under laboratory condition to study the effect of some phosphatic fertilizers *i.e* ordinary super phosphate (OSP) and rock phosphate (RP) at a rate of 100 kg P_2O_5 fad^{-1}., either singly or combined with organic soil amendments *i.e* orange residues (OR) and chicken manure (Ch.M) at a rate of 20 tons fad^{-1}.,mineral soil amendments *i.e* perlite (Per) and vermiculite (Ver) at a rate of 2 tons fad^{-1} and elemental sulphur (S) at a rate of 500 kg fad^{-1} .,on available phosphorus content through different incubation periods *i.e* 7, 15 , 30 , 60 , 90 ,120 and 150 days in two different soil samples. The first sample was non calcareous sandy soil, collected from the Farm of the Faculty of Agriculture, at El-Khattara County, Zagazig University, El-Sharkia Governorate. The second one was a sandy loam calcareous soil, collected from El-Noubaria Research Station beside El-Noubaria County, northern part of Tahreer Province. The obtained results can be summarized as follows: In absence of organic and mineral soil amendments, the available phosphorus was greater with ordinary super phosphate treatment than with rock phosphate in the tested soils. In absence of mineral soil amendments and in presence of any phosphatic fertilizers, 2% chicken manure gave the greatest value of available phosphorus if compared to 2% OR and its other rates combined with chicken manure in the two studied soils. In absence of organic soil amendments, (OSP +Per) treatment gave the greatest average value of available phosphorus in a sandy soil, while (OSP+Ver) treatment gave the greatest one in a calcareous soil if compared to the other treatments. The treatment of (OSP plus 2% Ch.M plus Ver) in a sandy soil and the treatment of (OSP plus 2% Ch.M plus S) in a calcareous soil showed beneficial effects on the available phosphorus if compared to the other treatments. The most treatments of OSP or RP singly or combined with organic and mineral soil amendments gave the greatest values of available phosphorus after 15,60 and 150 days, while the lowest ones were obtained after 7, 30, 90 and 120 days incubation. The average values of available phosphorus were greater in a sandy soil than in a calcareous one, when treated with OSP or RP fertilizers mixed with organic and mineral soil amendments, while the average values were the least in a sandy soil if compared to a calcareous one, when treated with OSP or RP fertilizers in presence or absence of mineral soil amendments.

Key words: Phosphatic fertilizers, organic soil amendments, mineral soil amendments, sandy and calcareous soils.

INTRODUCTION

Phosphorus is the second most commonly soil limiting nutrient element after nitrogen. Phosphorus is a very important element to plant growth and plays a key role in metabolic processes such as the conversion of sugar into starch and cellulose (Mengel and Kirkby, 1987). The phenomena of P fixation and precipitation in the form of insoluble calcium phosphate compounds in soils (pH above 7) led to reduce in soil available P. Most of the newly reclaimed soils are sandy and calcareous, which are poor in their content of organic matter and available phosphorus (Sharpley, 1985). Perlite is a glassy volcanic rock with a rhyolitic compostion. During the thermal treatments, a structural transition from amorphous to crystalline occurs,

* **Corresponding author: Tel.** : +201009512873
E-mail address: abdo.soil@yahoo.com

accompanied by increasing cation exchange capacity (CEC) from 20-30 to 35-50 cmol kg^{-1} as a result of multiplication of broken edges, and increased specific surface area from 1.2 to2.3 m^2g^{-1} (Dogan and Alkan, 2004). Vermiculite is an excellent regulator of the soil moisture and positively influences the development of roots with its favourable properties of aeration and air capacity. When added to soil, it supports optimal conditions of soil moisture, air capacity and heat balance, creating favourable conditions for plant nutrition (Marinova *et al.*, 2012). Metwally and Abdel-Bary (1999) reported that maximum available phosphorus was increased by the treatment of 0.5 ton fad^{-1}., of rock phosphate. Basyouny *et al.*, (2003) found that the availability of N, P and K in a calcareous soil was increased with different organic manures alone or combined with sulphur. Also, results indicated the superiority of FYM+ sulphur for increasing the available N, P and K as compared to the chicken manure+ sulphur. Sulphur plays several important roles in soils, physically, biologically and chemically (Hilal *et al.*, 1990). From the first moment of its application to soil, sulphur fine particles increase significantly the water holding capacity of the soil, decrease soil bulk density, pH and EC which results in increasing availability of most nutrients and so the plant growth and yield increase.

The present work aimed to study the change in available phosphorus as affected by different phosphatic sources (Ordinary super phosphate and rock phosphate) added singly or combined with organic and mineral soil amendments (orange residues, chicken manure, perlite, vermiculite and elemental sulphur) to sandy and calcareous soils.

MATERIALS AND METHODS

An incubation experiment was conducted to study the change in soil content of available phosphorus after each incubation period (7, 15, 60, 90, 120 and 150 days) as affected by different phosphatic sources added either singly or combined with different organic and mineral soil amendments to the used soil samples (non calcareous sandy soil and a sandy loam calcareous soil).The first sample was collected from the Farm of Faculty of Agriculture, at El-Khattara County, Zagazig University. The second sample was collected from El-Noubaria Research Station near El-Noubaria County at Northern part of Tahreer Province, Egypt. Table 1 shows physical and chemical characteristics of the investigated soils.

Portions of the used soil sample, each weighing hundred-grams were placed in small plastic containers. The various phosphatic fertilizers *i.e.* ordinary super phosphate 15.5% P_2O_5 (OSP) and rock phosphate 34.5% P_2O_5 (RP) were added at a rate of 100 kg P_2O_5 fad^{-1}., either individually or combined with organic soil amendments *i.e.* orange residues(OR) and chicken manure (Ch.M) at a rate of 2% (20 tons fad^{-1}.) and mineral soil amendments as perlite (Per) and vermiculite (Ver) at a rate of 0.2% (2 tons fad^{-1}.) and a rate of 0.05% S (500 kg fad^{-1}.) *i.e.* elemental sulphur 99.8% S to soil samples. Some characteristics of organic and mineral soil amendments are shown in Tables 2 and 3. The analyses of two soil samples and organic and mineral soil amendments were carried out according to Jackson (1958).

The experimental treatments were as follow:

- OSP or RP were applied either alone or mixed with Per or Ver or S in absence of organic soil amendments.
- OSP or RP plus 2% (20 tons fad^{-1}.) OR were applied either without or with Per or Ver or S.
- OSP or RP plus2% (20 tons fad^{-1}.) Ch.M were applied either without or with Per or Ver or S.
- OSP or RP plus 0.5% (5 tons fad^{-1}.) Ch.M+1.5 % (15 tons fad^{-1}.) OR were applied without or with Per or Ver or S.
- OSP or RP plus 1% (10 tons fad^{-1}.) Ch.M+1% (10 tons fad^{-1}.) OR were applied without or with Per or Ver or S.
- OSP or RP plus 1.5% (15 tons fad^{-1}.) Ch.M + 0.5% (5 tons fad^{-1}.) OR were applied without or with Per or Ver or S.

Treatments were replicated two times and the containers were kept under laboratory condition. The soil moisture content was adjusted at the field capacity through the experiment period. The plastic containers were covered maentavning astate of good auzation through the experimental time and incubated at room temperature (±29°C approximately). Soil samples were taken at intervals of 7, 15, 30, 60, 90, 120 and 150 days, where available phosphorus was determined.

Table 1. Physical and chemical properties of the investigated soils

Soil characteristics	Soil location	
	El-Khattara	El-Noubaria
Soil particles distribution		
Sand ,%	91.87	65.08
Silt,%	6.03	18.49
Clay,%	2.10	16.43
Textural class	Sandy	Sandy loam
Field capacity (FC),%	9.14	22.28
$CaCO_3$, ,(gkg^{-1})	5.0	231
Organic matter,(gkg^{-1})	4.8	7.8
pH*	8.02	7.81
EC dSm^{-1}**	0.51	3.42
Soluble cations and anions, (mmolc/L) **		
Ca^{++}	1.52	19.0
Mg^{++}	0.38	3.80
Na^{+}	2.67	10.33
K^{+}	0.69	1.38
$CO_3^{=}$	-	-
HCO_3^{-}	1.60	3.2
Cl^{-}	2.80	11.4
$SO_4^{=}$	0.86	19.91
Total P,(gkg^{-1})	0.12	0.35
Available P (mg kg^{-1}soil)	17.36	54.60

* Soil-water suspension 1: 2.5 ** Soil water extract 1: 1

Table 2. Some characteristics of organic soil amendments

Organic soil amendments	characteristics							
	EC**, dSm^{-1}	pH*	Organic matter, (gkg^{-1})	Total nutrients (gkg^{-1})			C/N ratio	WHC % ***
				N	P	K		
Orange residues	2.75	3.49	651	19.8	1.2	14.3	19.07	291
Chicken manure	7.44	6.91	397	25.8	6.3	13.4	8.93	390

*Soil-water suspension 1: 5 **Soil water extract 1: 5 ***Water holding capacity

Table 3. Some characteristics of mineral soil amendments

Characteristic	Perlite	Vermiculite
SiO_2, (g kg^{-1})	720	-
Al_2O_3, (g kg^{-1})	110	-
K_2O, (g kg^{-1})	40	-
Na_2O, (g kg^{-1})[1]	29	-
Ca O, (g kg^{-1})	25	-
Fe_2O_3, (g kg^{-1})	15	-
MgO, (g kg^{-1})	5	-
TiO_2, (g kg^{-1})	2	-
H_2O, (g kg^{-1})	40	-
pH (soil paste)	6.7	7.23
EC, dSm^{-1}	2.50	2.50
Available nutrients, ($mgkg^{-1}$)		
P	-	3.65
K	-	267
Na	-	238
Fe	-	12.03
Mn	-	4.52
Zn	-	2.85
Water holding capacity (WHC), %	601	101
Hygroscopic moisture, (%)	0.50	2.93
Bluk density, kg m^{-3}	90	1120
CEC, $cmol_c$ kg^{-1}	210	160

RESULTS AND DISCUSSION

Data in Tables 4 and 5 demonstrate the effect of applied various phosphatic fertilizers and organic and mineral soil amendments on phosphorus availability in sandy and calcareous soils during incubation for successive intervals.

Phosphorus Sources

Data revealed that values of available phosphorus in the treated sandy soil with OSP in absence of organic and mineral soil amendments, over the different periods of incubation,ranged from 14.5 to 25.5 with an average of 21.2 mg P kg^{-1}.The corresponding range in a calcareous soil was 13.6 to 34.5 with an average of 22.9 mg P kg^{-1}.The corresponding range in the treated sandy soil with only RP was 12.4 to 20.9 with a general average of 17.1 mg P kg^{-1}. The corresponding range in a calcareous soil was10.3 to 27.5 with an average of 19.5 mg Pkg^{-1} .Such results show that the available phosphorus level was greater in the calcareous soil than in a sandy one. This result could be due to the great native content of available phosphorus in a calcareous soil (Table 1).

With respect to the effect of the source of applied phosphorus, it is evident that, the two tested phosphorus sources generally induced phosphorus availability in the soil. The general solubility of applied phosphorus sources as stated by El-Fahham (1997) and Nassar *et al.* (2000). The ordinary super phosphate was more efficient than rock phosphate. Therefore, ordinary super phosphate could be recommended as a good source of phosphorus in these soils to attain higher available phosphorus content.

Table 4. Effect of different phosphatic fertilizers and soil amendments on available phosphorus (mg kg^{-1}) in a sandy soil during incubation periods

Phosphatic fertilizers	Organic soil amendments	Mineral soil amendments	Incubation periods , days							Average
			7	15	30	60	90	120	150	
OSP	Control	Without	22.9	20.6	19.0	25.5	22.5	23.6	14.5	21.2
		Per	22.7	22.2	14.0	31.4	15.7	26.3	13.9	20.9
		Ver	22.2	21.5	20.6	53.1	15.3	29.5	13.7	25.1
		S	16.5	24.0	15.7	31.6	16.6	26.7	14.6	20.8
	2 % OR	Without	16.8	22.9	15.8	17.3	24.8	27.9	22.2	21.1
		Per	15.6	23.1	17.5	37.1	22.4	20.2	21.2	22.4
		Ver	17.0	20.6	14.6	47.2	24.7	22.3	21.0	23.9
		S	18.5	20.1	15.4	30.4	21.5	24.2	19.4	21.4
	2 % Ch.M	Without	26.0	35.9	22.5	52.8	38.7	33.8	24.5	33.5
		Per	24.6	35.9	28.5	53.8	32.8	27.0	24.6	32.5
		Ver	23.4	37.5	25.7	67.3	35.3	28.4	29.6	35.3
		S	22.8	34.6	26.6	47.9	41.3	29.2	29.5	33.1
	0.5 % Ch.M + 1.5 % OR	Without	16.7	27.8	18.4	37.4	27.6	23.2	22.9	24.9
		Per	17.5	22.9	16.0	42.1	23.5	28.1	20.3	24.3
		Ver	18.7	24.2	21.2	36.0	28.7	23.1	21.3	24.7
		S	17.9	21.4	24.4	56.5	31.1	30.2	13.5	27.8
	1 % Ch.M + 1 % OR	Without	18.6	20.3	23.3	54.4	33.6	29.3	21.0	28.6
		Per	19.0	30.8	24.4	72.8	30.1	37.2	24.6	34.1
		Ver	21.3	30.1	24.0	72.5	32.6	32.2	22.6	33.6
		S	19.0	36.1	27.1	42.5	33.4	31.8	23.2	30.4
	1.5 % Ch.M + 0.5 % OR	Without	19.9	33.8	26.3	53.3	31.4	32.2	23.7	31.5
		Per	21.1	33.8	24.3	41.7	34.2	36.9	23.3	30.8
		Ver	20.6	34.2	23.2	42.9	35.2	31.1	24.0	30.2
		S	22.3	32.2	23.6	53.0	55.9	31.1	17.1	33.6
RP	Control	Without	20.2	19.1	15.3	17.1	12.4	20.9	14.8	17.1
		Per	18.8	13.9	11.7	13.4	16.4	23.6	15.6	16.2
		Ver	22.4	18.8	13.0	14.6	15.5	30.6	17.5	18.9
		S	20.4	20.3	15.8	27.3	14.2	24.7	13.7	19.5
	2 % OR	Without	23.5	18.8	18.1	28.8	23.9	23.6	16.0	21.8
		Per	23.5	19.0	16.4	24.6	23.4	20.5	14.9	20.3
		Ver	22.3	13.1	15.2	31.8	21.3	26.6	15.6	20.9
		S	23.5	18.0	13.9	33.7	18.8	26.2	18.8	21.9
	2 % Ch.M	Without	21.5	29.3	25.8	68.7	34.1	27.6	27.6	33.5
		Per	20.0	33.4	24.3	49.2	30.3	34.2	21.8	30.5
		Ver	21.5	38.1	27.5	50.7	31.9	39.6	23.7	33.3
		S	23.1	32.5	30.9	55.2	35.4	33.5	25.7	33.8
	0.5 % Ch.M + 1.5 % OR	Without	17.5	21.5	16.0	36.0	25.3	24.8	18.5	22.8
		Per	19.2	26.1	16.1	33.0	25.1	23.0	19.1	23.1
		Ver	21.2	21.4	15.8	33.0	23.7	25.1	20.5	22.9
		S	20.6	23.5	14.2	25.0	22.7	24.4	17.0	21.1
	1 % Ch.M + 1 % OR	Without	19.2	31.6	23.5	42.9	28.6	31.1	21.8	28.4
		Per	20.3	29.8	25.9	43.8	29.7	29.2	20.5	28.5
		Ver	20.0	34.2	25.2	46.5	35.1	31.8	19.6	30.3
		S	17.6	25.5	23.6	44.1	30.6	35.1	23.4	28.6
	1.5 % Ch.M + 0.5 % OR	Without	18.3	31.7	28.5	52.8	32.0	37.9	21.0	31.7
		Per	21.5	37.5	25.8	56.5	22.6	29.1	21.1	30.6
		Ver	23.9	41.3	22.6	71.9	39.2	29.1	20.2	35.2
		S	25.8	33.9	28.4	46.5	32.6	31.2	22.5	31.6

OSP: Ordinary super phosphate, RP: Rock phosphate, Ch.M: Chicken manure, OR: Orange residues,Per: Perlite, Ver: Vermiculite and S: Sulphur

Table 5. Available phosphorus (mg kg^{-1}) in a calcareous soil as influenced by phosphorus sources and soil amendments during incubation periods

Phosphatic fertilizers	Organic soil amendments	Mineral soil amendments	Incubation periods, days							Average
			7	15	30	60	90	120	150	
OSP	Control	Without	18.8	34.5	21.8	29.0	21.7	13.6	20.8	22.9
		Per	20.2	31.0	21.1	25.3	23.9	15.9	26.5	23.4
		Ver	21.7	30.3	20.5	23.3	22.4	14.1	20.1	21.8
		S	20.8	31.4	21.1	23.3	21.9	15.4	19.7	21.9
	2 % OR	Without	18.1	27.9	23.7	27.7	26.9	16.2	23.5	23.4
		Per	17.7	23.7	13.9	23.2	23.7	14.7	24.1	20.2
		Ver	17.4	29.2	14.9	22.6	24.2	15.3	21.1	20.7
		S	19.4	27.9	21.9	23.5	24.3	15.3	21.2	21.9
	2 % Ch.M	Without	28.4	42.5	32.7	38.2	37.4	16.4	32.2	32.5
		Per	22.5	42.9	27.9	38.2	38.2	19.8	28.1	31.1
		Ver	19.2	45.9	34.0	38.2	36.0	15.9	31.2	31.5
		S	19.3	44.2	26.4	38.6	37.4	25.3	28.1	33.3
	0.5 % Ch.M + 1.5 % OR	Without	19.7	27.7	21.6	28.1	27.3	18.8	22.3	23.6
		Per	21.5	31.6	22.0	29.0	21.1	16.2	24.0	23.6
		Ver	17.9	27.3	21.8	27.3	23.5	8.7	22.2	21.2
		S	20.3	27.2	22.4	27.3	25.0	14.9	21.5	22.7
	1 % Ch.M + 1 % OR	Without	22.9	36.8	25.2	32.8	28.3	14.7	28.3	27.0
		Per	18.8	35.6	22.0	35.2	32.6	23.6	29.1	28.1
		Ver	20.5	37.4	27.2	35.4	31.3	14.6	25.5	27.4
		S	22.0	38.2	25.6	36.0	31.9	14.7	23.9	27.5
	1.5 % Ch.M + 0.5 % OR	Without	22.0	36.1	26.2	35.5	29.4	17.1	27.6	27.7
		Per	23.5	38.6	22.9	34.7	32.5	16.2	24.6	27.6
		Ver	26.2	33.7	23.9	34.4	34.5	17.7	26.3	28.1
		S	26.4	32.7	25.2	35.5	36.0	16.0	33.3	29.3
RP	Control	Without	23.1	27.5	15.4	19.6	20.5	10.3	19.9	19.5
		Per	22.0	30.1	21.1	22.1	20.2	14.1	18.0	21.1
		Ver	17.1	27.7	14.1	23.7	20.2	12.0	19.1	19.1
		S	17.1	23.7	21.7	20.1	18.6	12.7	20.3	19.2
	2 % OR	Without	18.5	20.2	20.8	21.2	18.3	14.9	20.1	19.1
		Per	22.8	20.9	14.2	21.1	19.3	13.7	19.6	18.8
		Ver	16.7	18.0	16.1	19.9	17.9	14.5	23.4	18.1
		S	11.5	21.3	15.4	22.1	19.8	26.6	22.4	19.9
	2 % Ch.M	Without	20.1	40.5	29.4	37.1	32.1	29.1	29.9	31.2
		Per	25.0	41.6	24.0	36.2	35.6	27.3	30.4	31.4
		Ver	24.5	45.4	30.1	38.6	32.3	24.3	25.3	31.5
		S	25.9	39.7	25.2	35.8	34.5	25.8	26.6	30.5
	0.5 % Ch.M + 1.5 % OR	Without	17.7	25.8	20.8	24.5	23.6	22.5	16.9	21.7
		Per	17.1	22.9	16.8	25.5	28.8	27.6	22.0	22.9
		Ver	17.5	26.5	16.8	26.4	21.5	26.5	20.7	22.3
		S	17.0	30.4	17.9	22.3	32.9	24.1	18.3	23.3
	1 % Ch.M + 1 % OR	Without	17.8	34.3	20.4	31.0	37.4	25.8	25.3	27.4
		Per	19.5	34.3	23.5	29.3	30.5	26.1	28.7	27.4
		Ver	23.5	33.4	24.7	26.4	29.7	28.4	23.5	27.1
		S	17.0	33.8	21.8	22.3	30.0	26.2	26.2	25.3
	1.5 % Ch.M + 0.5 % OR	Without	32.2	37.2	24.7	32.3	33.3	25.8	25.6	30.2
		Per	29.8	35.6	28.3	31.0	31.7	23.1	31.4	30.1
		Ver	30.8	39.7	26.5	31.4	30.9	28.3	25.5	30.5
		S	21.4	38.6	24.5	36.4	30.1	27.9	24.4	29.0

OSP: Ordinary super phosphate, RP: Rock phosphate, Ch.M: Chicken manure, OR: Orange residues, Per: Perlite, Ver: Vermiculite and S: Sulphur

Organic Amendments

In absence of mineral soil amendments ,the general average of available phosphorus in the treated sandy soil with (2% OR), (2% Ch.M), (0.5% Ch.M +1.5% OR), (1% Ch.M + 1% OR) and (1.5% Ch.M +0.5% OR) under the application of ordinary super phosphate ,over the different incubation periods ranged from (15.8 to 27.9), (22.5 to 52.8), (16.7 to 37.4), (18.6 to 54.4) and (19.9 to 53.3) with an average of 21.1, 33.5, 24.9, 28.6 and 31.5 $mgPkg^{-1}$, respectively.The corresponding ranges in a calcareous soil were (16.2 to 27.9),(16.4 to 42.5), (18.8 to 28.1), (14.7 to 36.8) and (17.1 to 36.1) with an average 23.4, 32.5, 23.6, 27.0 and 27.7 $mgPkg^{-1}$, respectively. The corresponding ranges of the same treatments under the application of rock phosphate to a sandy soil were (16 to 28.8), (21.5 to 68.7), (16 to 36), (19.2 to 42.9) and (18.3 to 52.8) with an average of 21.8, 33.5, 22.8, 28.6 and 31.7 mg P kg^{-1}, respectively.The corresponding ranges in a calcareous soil were (14.9 to 21.2), (20.1 to 40.5), (16.9 to 25.8), (17.8 to 37.4) and (24.7 to 37.2) with an average 19.1, 31.2, 21.7, 27.4 and 30.2 $mgPkg^{-1}$, respectively. The beneficial effect of different organic soil amendments mixed with either OSP or RP in absence of mineral soil amendments on the level of available phosphorus in the tested soils followed the order (2% Ch.M) > (1.5% Ch.M+ 0.5% OR) > (1% Ch.M + 1% OR) > (0.5% Ch.M +1.5% OR) > (2% OR) .

Results show that under the application of OSP and RP, the average values of available phosphorus increased with the increasing application rates of chicken manure mixed with the decreasing application rates of orange residues in absence of any mineral soil amendments.These results could be attributed to the higher content of total phosphorus in chicken manure than in orange residues (Table 2).

Also, results show that the average values of available phosphorus increased with the application of different organic manures combined with OSP or RP if compared to OSP or RP. Such response is dependent on the source of organic manure and its rate of application, 2% chicken manure plus OSP being generally superior and 2% orange residues plus RP being inferior. Increasing phosphorus availability in the studied soils with organic manures application may be due to mineralization of organic phosphorus and solving ability of some mineral and organic acids, produced during manure decay as well as displacement of phosphate by organic anions formed from break down of these indicated organic acids. This finding agreed with those obtained by Gill and Meelu (1983) Mohamed (1990) and Merwad (2009).

Moreover, phosphate fertilizers could be increased markedly if they were applied along with organic acids or with organic wastes due to their influences in lowering soil pH values along with chelating Ca and Mg ions and consequently increase the availability of phosphate (Savini *et al.*, 2006).

In general, the values of available phosphorus in the studied soils were higher with chicken manure treatments than with orange residues ones under the application of ordinary super phosphate or rock phosphate and in absence of mineral amendments These results may be due to one or all the three of the following possibilities:

1. The release of amino acids and other organic acids as a result of the decomposition of chicken manure lead to reduce the Ca^{+2} activity in the soil solution. This finding is in agreement with that obtained by Hassan *et al.* (2002).
2. The total phosphorus content in chicken manure was greater than in orange residues (Table 2). This result is in agreement with that obtained by El-Kohly *et al.* (2000) and Basyouny (2001).
3. The accumulated carbon dioxide values from chicken manure than the other organic ones as reported by Salem *et al.*, (2004) as well as the solubilizing action of certain organic acids produce during manure decomposition. This finding agreed with that obtained by Mohamed *et al.* (1991) and Merwad (2009).

In general, data presented in Tables 4 and 5 show that the average values of available phosphorus in a sandy soil were slightly greater than in a calcareous soil when treated with the most solely treatments of chicken manure and orange residues and their combination

treatments at different rates. This result may be due to the high release rate of phosphorus by mineralization process of the organic phosphorus and/or the low fixation rate of available phosphorus in form of insoluble phosphate compounds in a sandy soil if compared to a calcareous one.

Mineral Amendments

In absence of organic soil amendments, the available phosphorus values for each of the Per, Ver and S treatments under application of ordinary super phosphate, over the different incubation periods ranged from (13.9 to 31.4),(13.7 to 53.1) and (14.6 to 31.6) with an average of 20.9, 25.1 and 20.8 mg P kg^{-1}, respectively.The corresponding ranges in a calcareous soil were (15.9 to 31), (14.1 to 30.3) and (15.4 to 31.4) with an average of 23.4, 21.8 and 21.9 mg P kg^{-1}, respectively. The corresponding ranges of the same treatments under application of rock phosphate were (11.7 to 23.6),(13.to 30.6) and (13.7 to 27.3) with an average of 16.2, 18.9 and 19.5 mg P kg^{1}, respectively. The corresponding ranges in a calcareous soil were (14.1 to 30.1),(12 to 27.7) and (12.7 to 23.7) with an average of 21.1, 19.1 and 19.2 mg P Kg^{-1},respectively .Such results may suggest that in absence of soil organic amendments, (OSP+Ver) treatment had slightly better effect upon the average value of soil available phosphorus in a sandy soil if compared to (alone OSP or RP), (OSP or RP plus Per) and (OSP or RP plus S) ones, whereas the result of available phosphorus in a calcareous soil may suggest that in absence of organic soil amendments, (OSP +Per) treatment had slightly better effects upon the average value of available phosphorus if compared to (alone OSP or RP),(OSP or RP plus Ver) and (OSP or RP plus S) ones.

The favourabe effect of perlite and vermiculite materials on soil available–P level may be due to the positive effect of these materials on increasing the available moisture content and hence increasing the availability of phosphorus in the soil solution.

When 2% orange residues was added, the average values of available phosphorus in the treated sandy soil with Per, Ver and S materials under application of OSP ,over the different incubation periods were 22.4 ,23.9 and 21.4 mg P kg^{-1},while in a calcareous soil were 20.2, 20.7 and 21.9 mg P kg^{-1}, respectively. The corresponding average values of the same treatments under application of RP were 20.3, 20.9 and 21.9 mg P kg^{-1} in a sandy soil, while in a calcareous one were 18.8, 18.1 and 19.9 mg P kg^{-1}, respectively.

In presence of 2% chicken manure, the average values of available phosphorus in the treated sandy soil with Per, Ver and S materials under application of ordinary super phosphate, over the different incubation periods were 32.5, 35.3 and 33.1 mg P kg^{-1}, while in a calcareous soil were 31.1 , 31.5 and 33.3 mg P kg^{-1}, respectively. The corresponding average values of the same materials combined with rock phosphate were 30.5, 33.3 and 33.8 mg P kg^{-1} in a sandy soil, while in a calcareous one were 31.4,31.5 and30.5 mg P kg^{-1}, respectively. Such results may suggest that under the application of OSP or RP , the treatments of Per or Ver or S mixed with 2% OR or 2%Ch.M in a sandy soil and mixed with 2%Ch.M in a calcareous soil showed positive effects on the average values of available phosphorus if compared to the treatment of Per or Ver or S individually ,while treatment of Ver mixed with (2% OR plus OSP) in a sandy soil and the treatment of S mixed with (2% OR plus OSP or RP) in a calcareous soil could not materially affect these average values if compared to the alone treatments of Ver and S, respectively, but the treatments of Per or Ver mixed with (2% OR plus OSP or RP) in a calcareous soil showed a negative effect on the average values of available phosphorus if compared to the singly treatments of Per or Ver.

For adding (0.5% Ch.M + 1.5% OR), the average values of available phosphorus in the treated sandy soil with Per, Ver and S materials under application of ordinary super phosphate for all studied incubation periods were 24.3, 24.7 and 27.8 mgPkg^{-1},while in a calcareous soil were 23.6,21.2 and 22.7 mgPkg^{-1}, respectively. The corresponding average values of the same materials combined with rock phosphate were 23.1, 22.9 and 21.1 mg P kg^{-1} in a sandy soil, while in a calcareous soil were 22.9,22.3 and 23.3 mg P kg^{-1}, respectively.

These results reveal that in presence of (0.5% Ch.M + 1.5% OR), the materials of Per or Ver or S mixed with OSP in a calcareous soil and the material of Ver mixed with OSP in sandy soil could not materially affect the average values of available phosphorus, but the materials of Per and S mixed with OSP in a calcareous soil and the materials of Per or Ver or S mixed with RP showed the positive effect on these average values if compared to the alone materials of Per or Ver or S.

With respect to (1% Ch.M + 1% OR) application, the average values of available phosphorus in the treated sandy soil with Per or Ver or S materials under application of ordinary super phosphate for all incubation time intervals were 34.1,33.6 and 30.4 mg P kg^{-1}, while in calcareous soil were 28.1, 27.4 and 27.5 mg P kg^{-1}, respectively. The corresponding average values of the same materials mixed with rock phosphate in a sandy soil were 28.5, 30.3 and 28.6 mg P kg^{-1}, while in a calcareous soil were 27.4,27.1 and 25.3 mgPkg^{-1}respectively.

Regarding the application of (1.5% Ch.M+ 0.5% OR), the average values of available phosphorus in the treated sandy soil with the materials of Per, Ver and S under application of ordinary super phosphate for prolonging incubation periods up to 150 days were 30.8 , 30.2 and 33.6mgPkg^{-1}, while in a calcareous soil were 27.6, 28.1 and 29.3 mg P kg^{-1},respectively. The corresponding average values of the same treatments under application rock phosphate in a sandy soil were 30.6 , 35.2 and 31.6 mg P kg^{-1}, while in a calcareous soil were 30.1, 30.5 and 29.0 mg Pkg^{-1},respectively. Such results may suggest that the materials of Per or Ver or S combined with (1% Ch.M + 1% OR) and (1.5% Ch.M+ 0.5% OR) in presence of OSP or RP showed the positive effect on the average of available phosphorus if compared to the alone treatments of Per or Ver or S in the two studied soils.

Such results may suggest that the treatments of (OSP plus 2% Ch.M plus Ver) and (RP plus 1.5% Ch.M plus 0.5 % OR plus Ver) in a sandy soil and the treatment of (OSP plus 2% Ch.M +S) in a calcareous soil had the beneficial effects upon average values of soil available phosphorus if compared to the other treatments.

Generally, the average available phosphorus values for most treatments of the phosphatic fertilizers (OSP or RP) combined with organic plus mineral soil amendments were greater in a sandy soil than in a calcareous one, while application of OSP or RP fertilizers either alone or mixed with mineral soil amendments gave the lowest ones in sandy soil if compared to calcareous one.

Incubation Periods

After 7 days, the greatest values of available phosphorus (26.0 mg P kg^{-1}) was found with the treatment of (OSP + 2% Ch.M) and (RP + 1.5% Ch.M + 0.5% OR) without mineral soil amendments in sandy and calcareous soils, respectively, while the lowest ones (15.6 and 11.5mg Pkg^{-1}) were observed with the treatments of (OSP + 2% OR + Per) and (RP + 2% OR + S) in sandy and calcareous soils, respectively.

After15 days the treatments of (RP + 1.5% Ch.M + 0.5% OR +Ver) and (OSP +2% Ch.M+ Ver) gave the greatest values of available phosphorus (41.3 and 45.9mg P kg^{-1}), while the lowest ones (13.1 and 18.4mg P kg^{-1}) were found with the treatments of (RP +2 %OR +Ver) and (RP +2%OR +Ver) in sandy and calcareous soils, respectively.

After 30 days the treatments of (RP + 2% Ch.M + S) and (OSP+2% Ch.M +V) gave the greatest values of available phosphorus (30.9 and 34.0 mg P kg^{-1}), while the lowest ones (11.7 and13.4mg P kg^{-1}) were found with the treatment of (RP + Per) in absence of organic amendments and (OSP +2% OR +Per) in sandy and calcareous soils, respectively. This finding agreed with those obtained by Al-Oud (2011).

After 60 days, the greatest value of available phosphorus (72.8 and 38.6mg P kg^{-1}) were obtained with the treatment of (OSP + 1% Ch.M+ 1%OR + Per) in a sandy soil and the treatments of (OSP + 2% Ch.M+S) and (RP +2% Ch.M +Ver) in a calcareous soil , while the lowest one (13.4 and 19.6) mg P kg^{-1})were observed with (RP +Per) without organic soil amendments and with only RP in sandy and calcareous soils, respectively.

After 90 days, the treatments of (OSP + 1.5% Ch.M+ 0.5% OR + S) and(OSP+2% Ch.M + Per) gave the highest values of available phosphorus (55.9 and 38.2 mg P kg^{-1}), while the lowest ones (12.4 and 17.9 mg P kg^{-1}) were found with RP without organic and mineral soil amendments and with (RP+ 2% OR + Ver) in sandy and calcareous soils, respectively.similar results were obtained by Al-Oud (2011).

After 120 days, the greatest values of available phosphorus (39.6 and29.1 mg P kg^{-1}) were found with the treatment of (RP +2% Ch.M +Ver) and (RP+2% Ch.M) without mineral soil amendments, while the lowest ones (20.2 and 8.7mg P kg^{-1}) were observed with (OSP + 2% OR+P) and (OSP+0.5% Ch.M + 1.5% OR+Ver) treatments in sandy and calcareous soils, respectively.

After 150 days, the treatments of (OSP+ 2% Ch.M + Ver or S) and (OSP+1.5% Ch.M+0.5% OR+S) gave the greatest values of available phosphorus(29.6 and 33.3mg P kg^{-1}), while the lowest ones (13.5 and 18mg P kg^{-1}) were found with the treatments of (OSP+0.5% Ch.M+ 1.5% OR + S) and (RP +Per) without organic soil amendments in sandy and calcareous soils, respectively.

As a general result, the available phosphorus was remarked increase after 15 or 60 days of incubation for the calcareous and sandy soils, respectively.

Results reveal that after 15 days from the beginning incubation, the available phosphorus level increased in the tested soils for all studied treatments, except some treatments of RP in a sandy soil and the treatment of (RP +2% OR + Per) in a calcareous soil, then decreased after 30 days in the two soils under study except, the treatment of (RP + 2%OR) without mineral soil amendments in a calcareous soil, but increased again after 60days for all tested treatments in the two soils ,then again gradually decreased after 90 for most treatments in both soils ,except some treatments of phosphatic fertilizers applying either alone or mixed with certain soil amendments in a calcareous soil ,then again increased with most treatments under study in a sandy soil after 120 days,except some treatments of phosphatic fertilizers applyied either alone or mixed with certain soil amendments, while decreased in a calcareous soil with all treatments except with (RP + 2% OR + S) and (RP+ 0.5% Ch.M +1.5% OR+Ver), then after 150 days decreased for most tested treatments, except (OSP + 2% OR+Per) and (OSP + 2% Ch.M + Ver or S) in a sandy soil, but in a calcareous soil, available phosphorus increased in most treatments ,except some treatments of rock phosphate combined with certain soil amendments as shown in Tables 4 and 5.

The increase in available phosphorus level after 15 days in the tested soils may be due the microbial activity which have ability to affect soil reaction in the soil microenvironment leading to solubilizing mineral phosphorus. This Finding is in agreement with that obtained by Mohamed *et al.,* (1991). The decrease in available phosphorus level after 30 days in tested soils may be attributed to assimilation by microorganisms. Montasser (1987) and Merwad (2009) suggested a possibility for fixation of phosphorus released from applied manure. The increase in the available phosphorus level in the two soils under study after 60 days may be due to the mineralization of organic phosphorus and solubilizing action of certain organic acids produced during manure decomposition. Montasser (1987), Mohamed *et al.,* (1991) and Merwad (2009) suggested that the decomposition of organic residues changes the status of phosphorus sorption by soil. The reduction in available phosphorus level after 90 days in the two soils, after 120 days in a calcareous soil and after 150 days in a sandy soil is dependent on features of the type of organic and mineral soil amendments, rate of decomposition and/or immobilization of the organic manure source as well as role of mineral soil amendment in retention and/or release of soil available phosphorus. This finding is in agreement with that obtained by Mohamed *et al.,* (1991), El-Fahham (1997); Merwad (2009) and Silber *et al.,* (2010). The increase in level of available phosphorus after 150 days from the start of the incubation experiment in a calcareous soil may be due soil microflora decomposition leading to releasing the mineral phosphorus probably was induced by transformation of organic phosphorus.This result is in a good agreement with those obtained by Mohamed *et al.* ,(1991) and Merwad (2009).

Such results may suggest that the phosphorus release in available form is dependent on the chemical composition of applied organic manure and mineralization of its phosphorus as well as the positive effect of the organic manure decay products, microbial activities and applied mineral soil amendments in change of the status of phosphorus sorption by soil.

In general, it could be concluded that the treatment of 2% chicken manure combined with vermiculite under application of ordinary super phosphate may be more beneficial under the condition of a sandy soil and with the treatment of 2% chicken manure combined with elemental sulphur under application of ordinary super phosphate may be also beneficial under the condition of a calcareous soil.

REFERENCES

Al-Oud, S.S. (2011). Improving phosphorus availability from phosphate rock in calcareous soils by amending with organic acids, sulfur and /or organic manure. Ozean J. Appl. Sci., 4 (3): 227 - 235.

Basyouny, E.A. (2001). Plant response to fertilization in relation to micronutrietns status in plant and soil. Ph.D. Thesis, Fac. Agric. Ain Shams Univ., Egypt.

Basyouny, E.A., Sh. El-Borhamy and S.A. Eisa (2003). Response of corn plants grown on calcareous soil to organic fertilization and sulpher. Egypt. J. Appl. Sci., 18 (9): 360-372.

Dogan, M. and M. Alkan (2004). Some physicochemical properties of perlite an adsorbent. Fresenius Environmental Bulletin, 13 : 252-257.

El-Kohly, H.E.M., T.A. Abou El-Defan and M.M. El-Ghanam (2000). Influence of some natural soil conditioners on wheat grown on sandy soils. J. Agric. Sci., Mansoura. Univ., 25 (9): 5963-5971.

El-Fahham, M. (1997). Factors affecting transformation of some nutrients in soils. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Gill, H.S. and O.P. Meelu (1983). Studies on the utilization of phosphorus and causes for its different response in rice-wheat rotation. Plant and Soil, 74 : 211-222.

Hassan, M.A.M., R.K. Rabie and E.R. Marzouk (2002). Effect of some combinations of organic wastes and biofertilizer on phosphorus availability in certain soils in North Sinai. Zagazig J. Agric. Res., 29: 2051-2070.

Hilal, M.H., S.A. Korkor and A. Abd El-Fattah (1990). Effect of sulphur application on salt movement and accumulation in root zone and their imposed effects on crop yield. Middle east sulphur: symposium, Cairo, Egypt, 12-16.

Jackson, M.L. (1958). 'Soil Chemical Analysis'. Prentice Hall, Ic., Englewood Califfs, New Jersy.

Marinova, SV., R. Toncheva, E. Zlatareva and Hr. Pchelarova (2012). Characteristics of vermiculite and its influence on the yield of Lettuce in greenhouse experiments. Institute of Soil Sci., Sofia, Bulgaria., Ohrid,Balwois 2012-Republic of Macedonia-27 May, 2 June 2012.

Mengel, K. and E.A. Kirkby (1987). "Principle of Plant Nutrition" International potash Institute, Bern, Switzerland.

Merwad, A.M.A. (2009). Effect of some soil amendments on behaviour of some nutrients in different soils. M. Sc. Thesis, Fac. Agric., Zagazig Univ., Egypt.

Metwally Sh.M. and E.A. Abdel-Bary (1999). Assesment of application of amendments to sandy soils using a computer model. Zagazig J. Agric. Res., 26 (2): 479-493.

Mohamed, I.R. (1990). Effect of some organic residues and phosphatic fertilizers on nutrients uptake by rye grass on alkali soil. Egypt. J. Appli. Sci., 5(8):259-267.

Mohamed, I.R., A.S. Metwally and S.M. Dahdouh (1991). Humic substances. some phosphorus forms and buffering capacity of a sandy calcareous soil amended with organic residues. Zagazig J. Agric. Res., 18(5) : 1689-1701.

Montasser, S.Y.B. (1987).Organic manuring and behaviour of certain elements in Egyptian soils with special reference to response of grown plants. Ph. D. Thesis, Fac. Agric. Ain Shams Univ., Egypt.

Nassar, K.E., M.Y. Gebrail and K.M. Khalil (2000). Efficiency of phosphate-dissolving bacteria with different forms and rates of P-fertilization on the quantity of faba been (*Vicia faba* L.). Minufiya J. Agric. Res., 25(3): 1335-1349.

Savini, I., P. Smithson and N. Karanja (2006). Effects of added biomass, soil pH and calcium on the solubility of Minjingu phosphate rock in a Kenyan Oxisol Archives of Agronomy and Soil Sci., 52 (1): 19-36.

Salem, F.S., M.Y. Gebrail, M.O. Easa and M. Abdel El-Warth (2004). Raising the efficiency of nitrogen fertilization for wheat plants under salt affected soil by applying some soil amendments. Minufiya J. Agric. Res., 29 (4):1059-1073.

Silber, A., B. Bar-Yosef, I. Levkovitch and S. Soryano (2010). pH-dependent surface properties of perlite : Effects of plant growth. J. Geoderma, 158:275-281

Sharpley, A.N. (1985). Phosphorus cycling in unfertilized and agricultural soils. Soil Sci. Soc. Am. J., 49: 905-911.

تأثيـــر بعض الأســـمدة الفـوســـفاتيـــة والمصلحـات الأرضيـــة علـى تيســـر الفـوسـفور فى التربة

عبد الرحمن محمد أمين مرواد - السيد عوض محمد عوض- إبراهيم رمضان محمد- صلاح محمود محمد دحدوح

قسم علوم الأراضي – كلية الزراعة – جامعة الزقازيق – مصر

أجريت تجربة تحضين تحت ظروف المعمل لدراسة تأثير إضافة بعض الأسمدة الفوسفاتية (سوبر فوسفات عادى وصخر الفوسفات) بمعدل ١٠٠كجم فو٢أ٥ / فدان منفردة أو مخلوطة مع المصلحات العضوية (مخلفات البرتقال - سماد الدواجن) بمعدل ٢٠ طن/ فدان ومصلحات معدنية (بيرليت – فيرمكيوليت) بمعدل٢ طن/ فدان والكبريت المعدنى بمعدل ٥٠٠ كجم / فدان وذلك على التغير فى محتوى الفوسفور الميسر خلال فترات زمنية مختلفة وهى (٧ - ١٥- ٣٠- ٦٠- ٩٠- ١٢٠- ١٥٠ يوم) على نوعين من التربة الأولى رملية غير جيرية جمعت من مزرعة الخطارة التابعة لكلية الزراعة جامعة الزقازيق والثانية أرض طمبية رملية جيرية جمعت من محطة بحوث النوبارية بالقطاع الشمالى بمديرية التحرير. وتتلخص النتائج المتحصل عليها فيما يلى: فى غياب المصلحات العضوية والمعدنية أعطى سماد سوبر فوسفات العادى أعلى قيم للفوسفور الميسر مقارنة بسماد صخر الفوسفات فى الأراضى تحت الدراسة. فى غياب المصلحات المعدنية زادت قيم الفوسفورالميسر فى الأراضى تحت الدراسة المعاملة بـ ٢% سماد دواجن مخلوطا بالأسمدة الفوسفاتية مقارنة بتلك المعاملة بـ٢% مخلفات برتقال ومعدلاتها الأخرى المخلوطة مع سماد الدواجن. فى غياب المصلحات العضوية أعطت معاملة البيرليت المخلوطة بسماد سوبر فوسفات العادى أعلى قيم للفوسفور الميسر فى الأرض الرملية بينما فى الأرض الجيرية أعطت معاملة الفيرمكيوليت المخلوطة بسماد سوبر فوسفات العادى أعلى قيم للفوسفور الميسر مقارنة بالمعاملات الأخرى. أعطت معاملة سوبر فوسفات العادى + ٢ % سماد دواجن + الفيرمكيوليت فى الأرض الرملية ومعاملة سوبر فوسفات العادى +٢% سماد الدواجن + الكبريت المعدنى فى الأرض الجيرية أفضل تأثير على متوسط قيم الفوسفور الميسر مقارنة بالمعاملات الأخرى. معظم معاملات سماد سوبر فوسفات العادى وصخر الفوسفات المنفردة أو المخلوطة مع المصلحات العضوية والمعدنية أعطت زيادة فى الفوسفور الميسر بعد مرور ١٥ ،٦٠، ١٥٠ يوم من التحضين بينما كانت أقل قيم بعد مرور ٧ ، ٣٠ ، ٩٠ ، ١٢٠ يوم من التحضين فى الأراضى تحت الدراسة. معظم المعاملات تحت الدراسة أعطت أعلى متوسط لقيم الفوسفور الميسر فى الأرض الرملية مقارنة بالأرض الجيرية بينما معاملات الأسمدة الفوسفاتية المضافة منفردة أو مخلوطة مع المصلحات الأرضية غير العضوية أعطت أقل متوسط لقيم الفوسفور الميسر فى الأرض الرملية مقارنة بالأرض الجيرية.

المحكمـــون :

١- أ.د. أحمد عفت أحمد الشربيني أستاذ الأراضى المتفرغ - كلية الزراعة - جامعة الزقازيق.

٢- أ.د. أحمد عبدالقادر على طة أستاذ ورئيس قسم الأراضى - كلية الزراعة - جامعة المنصورة.