Zagazig J.Agric. Res., Vol .30 No.(5) 2003 *1901-1917*

STUDIES ON SOILS OF TOSHKA REGION 2- FORMS OF INORGANIC PHOSPHATE IN SOILS OF TOSHKA REGION

Behiry, E.M.K.; A.E. Hassanein; M.H. Khider and E.A. Abdel Latif

Soil, Water and Environment Res. Inst., A.R.C.

Received 7 / 6 / 2003 ***Accepted 2 / 8 / 2003***

ABSTRACT: **Fifteen soil profiles were dug, during the 2001 year, at Toshka region and forty five soil samples were collected from layers 0-30, 30-60, and 60-90 cm.**

The inorganic P-fractions decreased with soil depth increases down the profile, and varied greatly along with the soil depth.

The relative abundance of P-fractions in most soils is in the order: Ca-P> saliod-P ≈ Fe-P > Al-P. The Ca-P was the most dominant fraction in these soil.

Fine textured soils contained more total – and saloid with the coarse ones. High positives correlations were obtained between the clay content and either total or available phosphorus.

INTRODUCTION

Toshka region is bounded by longitudes 30° 30′ and 32° 00′ east., and latitudes 22° 22′ north (Said, 1962). In this region work is under way, to extend the Nile water into the heart of the western desert to the Dakhela and Kharga oases. This bold project would create in effect a new agricultural land and was described as the national project for the twenty first century, (Egyptian Ministry of Economy, Dec. 1998).

Generally, desertlands are sandy in texture, poor in both organic matter and available nutrients content (Mitkees *et al.,* 1966 a,b,c; Abdel Latif *et al.,* 1987; Khatab *et al.,* 1999, Rahmou *et al.,* 2001and Hassanein *et al.,* 2002).

Phosphorus in soils can be classed, generally as organic and inorganic, depending on the nature of the compounds in which its occurs. The organic fraction is found in humus and other organic materials, (Black, 1968). The inorganic fraction occurs in numerous combinations with iron, aluminum, calcium, fluorine and other elements. These compounds, are usually only very slightly soluble in water as reported by (Chang and Jackson, 1957; Behiry, 1991 and Diab *et al.* 1994). Phosphorus, also reacts with clay to form generally insoluble clay-phosphate complexes (Tahoun *et al.*, 1975).

According to (Cooke, 1970), total soil phosphorus is often a useful parameter of soil-phosphate capacity. Soil poor in total phosphorus, usually has little capacity to supply the element to growing plants. Amer and Abou El-Roos, (1975); Ibrahim *et al.* (1980) and Diab *et al.* (1994) reported that total phosphorus in the Egyptian soils varies considerably, the low values are associated with sandy and calcareous soils and the high values are associated with heavy-textured alluvial soils.

The aim of this work is to study the individual fractions of phosphorus content in the virgin soils of Toshka region.

MATERIALS AND METHODS

Fifteen soil profiles were dug, during the year 2001, at Toshka region and soil samples were collected from tree layers: surface (0-30 cm), sub surface (30-60 cm) and deep (60-90 cm) layers. The location of the selected area are given in Fig. (1).

Samples were air dried, ground by wooden pestle., and sieved through a 2 mm nylon sieve. Particle size distribution was determined using the pipette method (Kilmer and Alexander, 1949), using sodium hexameta-phosphate as a dispersing agent. Soil pH, in soil paste extract was measured by a glass electrode pH-meter (Richards, 1954). Soil salinity in terms of electric conductivity (Ec) was determined, in the saturation extract. The organic matter content was determined according to Walkely and Black method, as given by Jackson (1958). Calcium carbonate was determined volumetrically suing the calcimeter as described by Piper (1950). Gypsum content was, also determined by precipitation with acetone (Richards, 1954). Available phosphorus was determined by the method of Olsen *et al.* (1954). Fractionation of soil phosphorus was performed according to the modified method of Chang and Jackson (1957) as follows:

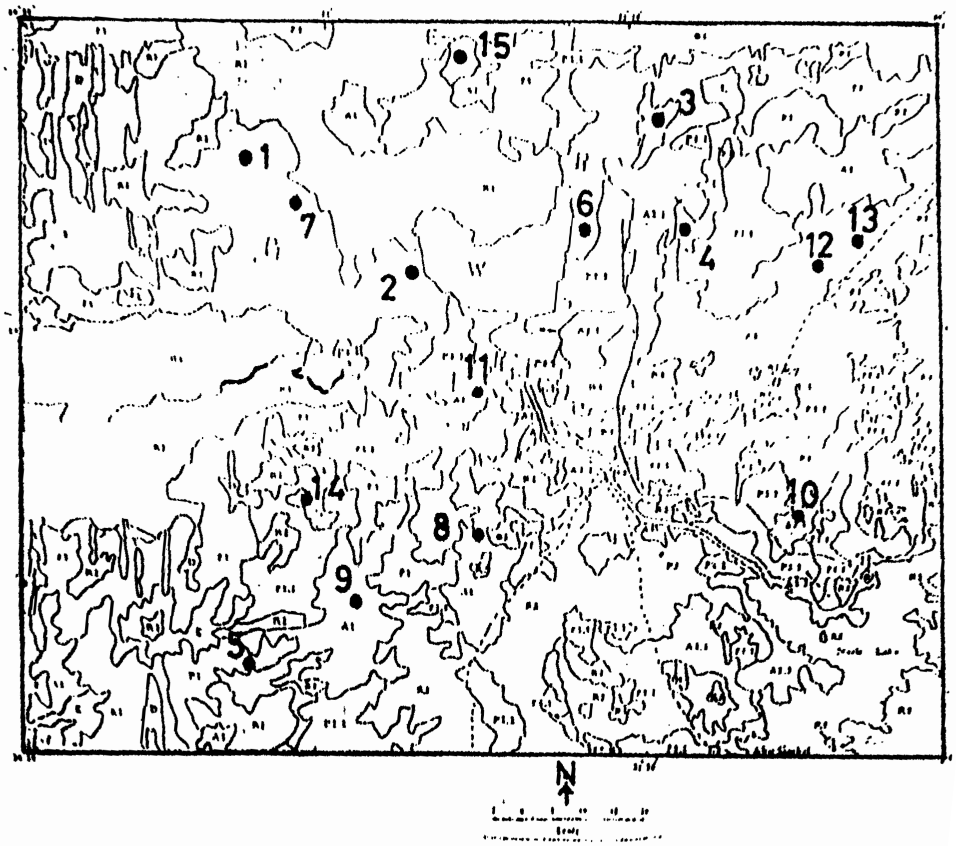

Fig. (1): Locations of the studied soil samples.

- **Physiographic soil legend:**
  - P_1 → Pediplain of soft rock (shale)
  - A_1 → Alluvial deposits over soft rock suprolite
  - A_2 → Alluvial deposits over hard rock (sandstone) suprolite
  - L → Playa
  - E → Aeolian plain
- **Miscellaneous land types and cover:**
  - R_1 → Dissected questa.
  - R_2 → Rock land.
  - D → Barchan sand dunes
  - W → Seeped water body with changeable beach line.

1- Saloid phosphorus was extracted by 1N NH_4Cl using a soil solution ratio of 1:50.

2- Al-phosphorus was extracted using 0.5 N NH_4F at pH 8.5 suing a soil solution ratio of 1:100.

3- Fe-phosphorus was extracted using 1.0 N NaOH + NaCl using a soil solution ratio 1:50.

4- Ca-phosphorus was extracted by 0.5 N H_2SO_4 using a soil solution ratio of 1:50.

In all phosphorus fractions, the ascorbic acid blue method as given by John (1970) was utilized, to measure P in solution.

RESULTS AND DISCUSSION

Soil properties: Properties of the studied soils are listed in Tables 1 and 2. The mechanical analysis showed that these soils are in general, characterized by medium in texture with a various range of both coarse sand + Fine sand % ranged from (15.2-88.25%), (20.5-88.09%) and (26.72 – 87.37%) for the surface subsurface and deep soil samples, respectively. The same pattern was found for both silt + clay % which ranged from (11.75 – 84.8%), (11.91 –79.50%) and (12.63 – 73.28 %) in the aforesaid soil samples, in a respective order. In general, the pH values were alkaline in the soil samples under study. Data also, showed that these soils are very poor in organic matter content are mainly due to the dryness and hot climate (Moustafa, *et al.*, 1988).

Concerning calcium carbonate, the obtained data reveal that its values widely varied within the studied soil profiles. The highest values of $CaCO_3$ % were found in soil profiles No: 3, 4, 5, 6, 8, 10 and 11. It could be stated that these seven sites have to be considered as calcareous soils, according to the definition of Anter *et al.* (1973).

Gypsum content was low, except for two soil sites which had a moderate content i.e., profiles No. 3 and 6. The values of electric conductivity (Ec) were in the range of 1.0 to 48.0 dSm^{-1} in the surface soil samples, and from 1.0 to 86.6 dSm^{-1}, in the subsurface soil samples, while the deep ones ranged from 2.92 to 35.0 dSm^{-1}, indicating that soil salinity of the studied profiles flucetated between non-saline to extremely saline. In general, the soluble cations were found to be in the order of $Na^+ > Ca^{++} > Mg^{++} > K^+$ in the

Table (1): Particle size distribution, organic matter (O.M.), $CaCO_3$ and gypsum content in the studied soil profiles.

Prof. No.	Depth. Cm,	Particle size distribution (%)				Silt + Clay %	O.M. %	$CaCO_3$ %	Gypsum %	Texture class
		C. Sand	F. Sand	Silt	Clay					
1	0-30	8.0	25.5	27.8	38.8	66.6	0.1	9.8	0.6	CL.
	30-60	1.5	29.6	32.2	36.8	69.0	0.3	6.6	0.3	CL.
	60-90	2.9	25.9	30.8	40.5	71.3	0.2	7.5	0.2	C.
2	0-30	4.2	34.8	16.0	45.1	61.0	0.2	6.5	2.4	C.
	30-60	3.1	30.9	25.2	40.9	66.0	0.2	4.1	1.2	C.
	60-90	2.8	37.3	17.8	42.2	60.0	0.2	2.6	1.2	C.
3	0-30	25.7	34.3	17.2	22.9	40.0	0.1	15.2	4.0	SCL.
	30-60	5.1	35.9	28.2	30.9	59.0	0.5	23.5	9.7	CL.
	60-90	4.1	32.2	30.5	33.3	63.8	0.4	28.2	3.7	CL.
4	0-30	2.9	12.4	34.2	50.6	84.8	0.1	13.1	1.7	C.
	30-60	4.6	15.9	35.5	44.0	79.5	0.2	13.7	1.5	C.
	60-90	7.1	19.6	27.2	46.1	73.3	0.2	13.9	1.5	C.
5	0-30	15.7	30.0	22.6	31.7	54.2	0.2	14.6	3.0	SCL.
	30-60	21.2	28.9	22.3	27.6	49.9	0.3	15.3	2.0	SCL.
	60-90	28.0	27.8	19.1	25.2	44.3	0.3	19.3	1.7	SCL.
6	0-30	52.9	31.0	7.4	8.7	16.1	0.1	13.7	9.4	SCL.
	30-60	50.9	27.8	8.1	13.3	21.4	0.2	12.5	4.2	SL.
	60-90	14.5	24.6	24.3	36.6	60.9	0.1	10.1	2.7	CL.
7	0-30	29.1	28.3	18.1	24.6	42.6	0.1	8.1	1.5	SCL.
	30-60	16.3	25.6	25.1	33.2	58.2	0.2	4.4	0.9	CL.
	60-90	18.2	27.3	19.3	35.3	54.6	0.2	5.0	0.5	SC.
8	0-30	41.0	28.8	12.9	17.3	30.2	0.1	21.2	0.4	SL.
	30-60	54.3	22.1	10.6	13.1	23.7	0.3	10.8	0.3	SL.
	60-90	50.6	28.7	11.2	9.6	20.8	0.1	10.8	0.2	SL.

Table (1): Cont.

Prof. No.	Depth. Cm,	Particle size distribution (%)				Silt + Clay %	O.M. %	$CaCO_3$ %	Gypsum %	Texture class
		C. Sand	F. Sand	Silt	Clay					
9	0-30	46.7	27.9	10.7	14.8	25.5	0.1	1.2	0.3	SL.
	30-60	50.3	26.2	9.9	13.6	23.5	0.1	1.5	0.2	SL.
	60-90	46.7	30.3	10.3	12.7	23.0	0.1	2.8	0.3	SL.
10	0-30	45.3	23.4	12.7	18.9	31.3	0.1	20.0	0.4	SL.
	30-60	49.7	22.1	11.7	16.5	28.2	0.1	22.0	1.3	SL.
	60-90	45.5	25.8	12.0	16.7	28.7	0.1	24.6	4.2	SL.
11	0-30	66.1	22.2	5.1	6.7	11.8	0.0	14.9	0.3	S.
	30-60	61.2	25.0	6.1	7.7	13.8	0.0	10.7	0.3	S.
	60-90	43.6	28.9	12.3	15.2	27.5	0.0	12.3	0.3	SL.
12	0-30	59.6	27.2	5.9	7.4	13.3	0.0	10.8	0.3	LS.
	30-60	56.2	31.2	5.5	7.1	12.7	0.0	5.9	0.2	S.
	60-90	51.9	24.4	9.5	14.3	23.8	0.1	3.6	0.2	SL.
13	0-30	62.8	25.4	4.8	6.9	11.8	0.0	9.1	0.3	S.
	30-60	54.6	32.1	5.8	7.9	13.6	0.0	6.2	0.3	LS.
	60-90	50.1	33.0	6.8	10.1	16.9	0.1	9.4	0.3	LS.
14	0-30	65.0	20.4	7.2	7.4	14.6	0.1	12.1	0.4	LS.
	30-60	67.8	17.4	6.7	8.1	14.8	0.1	10.2	0.3	LS.
	60-90	62.2	20.9	7.1	8.7	15.8	0.1	10.6	0.3	LS.
15	0-30	55.3	31.9	5.6	7.2	12.8	0.0	3.7	0.4	S.
	30-60	59.6	28.5	5.1	6.8	11.9	0.1	1.3	0.6	S.
	60-90	56.6	30.8	5.4	7.2	12.6	0.1	0.4	0.4	S.

C : Clay; **S:** Sand ; **CL:** Clay loam ; **SL:** Sandy loam
LS: Loam sand; **SCL:** Sandy clay loam

Table (2): Chemical composition of the soil saturation extract of the studied soil profiles.

Prof. No.	Depth. Cm,	pH	EC dSm^{-1}	Soluble ions in saturation extract (meq/L)							Available Phosphorus mg Pkg^{-1} soil
				Cations				Anions			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	$SO_4^=$	
1	0-30	7.4	31.8	131.1	44.7	250.0	2.8	1.8	264.0	162.7	17.1
	30-60	7.7	13.3	31.6	23.2	122.5	2.1	2.2	89.0	88.2	15.4
	60-90	7.3	35.0	121.1	60.0	280.0	3.3	2.0	299.0	163.3	12.0
2	0-30	7.6	8.2	32.0	5.9	66.2	0.8	2.0	47.6	55.2	18.9
	30-60	7.6	6.5	46.1	13.9	24.6	0.8	2.1	32.9	50.3	17.2
	60-90	7.5	10.0	41.3	7.0	88.0	1.0	2.0	58.7	76.5	17.7
3	0-30	7.6	8.5	27.4	5.0	72.5	2.1	2.4	19.0	85.5	13.6
	30-60	8.0	22.1	35.3	10.0	242.5	3.4	1.6	107.0	182.5	13.0
	60-90	7.8	17.2	41.1	16.1	172.5	2.2	1.6	100.0	130.2	10.0
4	0-30	7.9	7.4	25.3	2.8	67.5	1.1	1.8	7.0	87.9	21.2
	30-60	7.8	19.4	32.6	9.8	185.0	1.5	1.6	135.0	92.2	19.5
	60-90	7.7	15.4	36.8	7.0	137.5	1.4	1.6	111.0	70.1	18.4
5	0-30	7.5	10.6	36.3	11.3	88.8	1.7	2.2	44.0	91.8	13.3
	30-60	7.5	8.9	30.0	8.6	70.0	1.3	2.0	35.0	72.9	11.6
	60-90	7.5	7.8	30.0	7.1	63.8	1.4	2.2	25.0	75.1	10.6
6	0-30	7.2	48.0	233.7	25.4	390.0	2.6	2.0	400.0	249.7	3.7
	30-60	7.2	86.6	276.2	43.3	845.0	1.1	2.0	1098.0	95.6	5.6
	60-90	7.6	26.1	41.8	20.8	292.5	1.7	1.3	205.0	150.5	5.4
7	0-30	7.6	10.0	35.3	17.6	67.5	1.9	1.6	49.0	71.6	14.3
	30-60	7.6	17.2	31.6	27.5	147.5	1.4	1.8	106.0	100.1	13.9
	60-90	7.4	17.0	47.4	32.6	125.0	1.3	1.4	128.0	76.9	10.8
8	0-30	7.8	3.2	16.3	4.6	20.0	1.7	1.6	7.0	34.1	7.3
	30-60	8.0	5.6	9.0	2.0	53.8	1.4	1.6	19.0	45.5	5.5
	60-90	7.6	14.8	40.5	11.9	135.0	1.8	1.4	93.0	94.7	4.0

Table (2): Cont.

Prof. No.	Depth. Cm,	pH	EC dSm^{-1}	Soluble ions in saturation extract (meq/L)							Available Phosphorus mg Pkg^{-1} soil
				Cations				Anions			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	$SO_4^=$	
9	0-30	7.7	5.1	29.0	2.3	34.0	0.9	1.7	14.5	49.9	6.2
	30-60	7.4	5.1	36.8	1.3	25.0	0.9	1.2	22.0	40.8	5.7
	60-90	7.4	5.2	37.9	5.4	19.3	0.8	1.2	26.0	36.2	5.4
10	0-30	7.7	15.7	41.1	9.9	130.0	3.6	1.6	89.0	93.9	7.8
	30-60	7.5	20.3	74.2	3.4	150.0	3.5	1.8	112.0	117.3	6.9
	60-90	7.6	22.8	59.6	10.0	195.0	2.7	1.8	130.0	134.5	7.0
11	0-30	8.3	1.0	3.7	0.9	4.8	0.8	2.6	1.7	5.9	6.7
	30-60	7.3	2.5	6.3	1.5	17.1	1.1	2.0	10.5	13.5	3.2
	60-90	7.4	5.8	32.5	9.9	16.6	1.1	2.4	30.8	26.9	2.4
12	0-30	8.1	1.4	4.7	1.0	9.2	0.8	2.3	3.5	9.9	5.1
	30-60	8.3	1.0	3.2	1.1	9.2	0.4	2.0	2.6	9.3	3.0
	60-90	7.4	6.1	30.5	6.6	32.0	1.2	1.4	28.0	41.0	4.0
13	0-30	8.1	1.2	7.7	1.1	5.2	0.7	2.0	2.2	10.4	4.9
	30-60	7.5	6.5	36.8	3.6	30.0	1.5	1.4	26.0	44.6	3.3
	60-90	7.6	2.9	15.3	1.4	14.1	0.6	1.4	13.5	16.5	3.1
14	0-30	7.9	6.8	26.3	9.9	53.8	1.9	1.8	35.0	55.1	4.0
	30-60	7.5	12.9	50.0	11.9	86.3	1.8	1.6	72.0	76.3	3.4
	60-90	7.8	8.3	40.0	7.4	54.0	1.4	1.4	40.0	61.1	3.7
15	0-30	7.8	4.7	31.6	4.6	14.0	3.2	1.4	3.0	49.0	3.0
	30-60	7.6	11.1	43.7	10.1	112.5	3.0	1.6	61.0	106.7	2.9
	60-90	7.3	15.8	95.5	29.5	56.0	1.7	1.2	123.0	58.5	2.0

investigated soil samples. In addition, the soluble anions showed a general distribution pattern of Cl- > SO_4= > HCO_3^-, while $CO_3^=$ was absent in the soil samples. Similar results were found in the 1st, part of the current study about Toskha region (Hassanein, *et al.*, 2002).

Inorganic phosphorus fractions: The obtained results of the inorganic phosphorus fractions in the investigated soils are given in Table (3). These data indicate that all phosphorus fractions in all soils gradually decreased as the soil depth increased down in the profile. These results agree with those obtained by Piccolo and Huluka (1986); Fuleky, (1997) and Abdel Hamed (1998). This effect is attributed to the low mobility of soluble phosphorus in most soils. Sorensen and Wiese (1982) and Behiry (1991) reported that the upper layers of soils usually contain more organic and inorganic phosphorus than the lower layers.

These data indicate that the amount of individual phosphorus fractions varies greatly along with the soil depth. The relative abundance of these fractions in most soils is the order: Ca-P > Saloid-P ≈ Fe-P > Al-P.

Table 3 also shows that the total inorganic phosphorus, (including Saloid-P, Al-P, Fe-P and Ca-P,) varied greatly in the soils with profile means ranging from 41.5 mg Pkg^{-1} soil, in the sandy soil (profile 15) to 844.2 mg Pkg^{-1} in the clay soil (Profile, 3) Phosphorus was highest in the clayey soils than the sandy ones, while the loamy soils were in between. Pierzynski *et al.* (1990) reported that the total phosphorus concentration is, generally, higher in the clay fraction of the soils compared with the silt or the sand fractions. Abdel Hamed (1998) found that means of total inorganic phosphorus in profiles ranged from 321.0 to 661.4 mg/kg soil in Dakhlia alluvial soils. The obtained values of inorganic phosphorus are in well agreement with those obtained by several Egyptian workers such as Mashady and Ramy (1981), Diab *et al.* (1994) and Abdel Hamed (1998).

As regards the individual forms of phosphorus in the soil, the aforementioned table, shows that Ca-P content is far greater than any other fraction, and this may be due to; a) the alkaline pH reaction; b) the high content of calcium carbonate in these soils (specially soils of profiles: 3, 4, 5, 6, 8, 10, 11 and 14); and c) the calcium ions are often high in the soil solution of such soils. Chang and Jackson (1957),

Table (3): Inorganic phosphorus fractions (mg Pkg^{-1} soil) in Toshka soil samples.

Prof. No.	Depth. Cm,	Saloid-P	Al-P	Fe-P	Ca-P	Total
		(mg Pkg^{-1})				
1	0-30	7.1	4.7	2.2	558.8	572.8
	30-60	6.7	0.6	1.6	552.5	561.4
	60-90	5.0	0.3	0.9	537.5	543.7
	Mean	6.3	1.9	1.6	549.6	559.4
2	0-30	6.9	4.9	17.1	920.0	948.9
	30-60	6.1	0.7	13.7	750.0	770.9
	60-90	4.8	0.5	11.3	575.0	770.5
	Mean	5.9	2.0	14.0	748.3	770.2
3	0-30	6.3	4.1	4.1	777.5	792.0
	30-60	5.3	0.6	1.3	597.5	604.7
	60-90	4.1	0.3	0.9	507.5	512.8
	Mean	5.2	1.7	2.1	627.5	636.5
4	0-30	7.9	2.2	12.5	925.7	948.3
	30-60	6.7	1.9	9.8	735.0	753.4
	60-90	3.0	0.7	7.1	820.2	831.0
	Mean	5.9	1.6	9.8	826.9	844.2
5	0-30	4.8	2.7	13.9	623.8	645.0
	30-60	4.5	0.9	5.2	615.0	625.6
	60-90	4.0	0.2	4.2	475.0	483.4
	Mean	4.3	1.3	7.8	571.3	584.7
6	0-30	8.3	3.2	3.1	580.0	594.6
	30-60	7.6	0.5	1.8	475.0	484.9
	60-90	4.8	0.5	1.8	167.8	174.9
	Mean	6.9	1.5	2.0	407.6	418.0
7	0-30	10.4	0.8	11.5	623.8	646.5
	30-60	9.6	0.7	3.8	560.3	574
	60-90	0.1	0.5	3.5	115.8	119.9
	Mean	6.7	0.7	6.2	435.3	452.9
8	0-30	7.9	0.5	5.3	435.0	448.7
	30-60	6.0	0.3	3.8	95.0	105.1
	60-90	3.1	0.2	1.6	91.4	96.3
	Mean	5.6	0.4	3.6	207.3	216.9

Table (3): Cont.

Prof. No.	Depth. Cm,	Saloid-P	Al-P	Fe-P	Ca-P	Total
		(mg Pkg^{-1})				
9	0-30	7.3	2.2	4.5	565.0	579.0
	30-60	5.9	0.9	3.5	559.5	569.8
	60-90	5.1	0.7	2.0	544.6	552.4
	Mean	6.1	1.3	3.3	556.4	567.1
10	0-30	6.0	3.5	1.5	615.0	626.0
	30-60	5.1	0.3	0.8	560.0	566.2
	60-90	4.3	0.3	0.8	552.5	557.9
	Mean	5.1	1.4	1.0	575.8	583.3
11	0-30	9.3	3.0	15.3	200.6	228.2
	30-60	8.2	2.0	11.2	79.0	100.4
	60-90	7.9	0.3	9.9	66.0	84.1
	Mean	8.5	1.8	13.1	115.4	138.8
12	0-30	7.7	2.3	14.5	244.4	268.9
	30-60	6.5	0.6	11.1	107.5	125.7
	60-90	3.6	0.5	9.8	60.3	74.2
	Mean	5.9	1.1	11.8	137.4	156.2
13	0-30	8.4	3.5	12.0	177.3	201.2
	30-60	7.0	1.3	10.5	151.1	169.9
	60-90	7.9	0.2	9.1	129.8	147.0
	Mean	7.8	1.7	10.5	152.7	172.7
14	0-30	8.9	2.2	16.1	260.1	287.3
	30-60	6.3	1.6	7.0	180.2	195.1
	60-90	6.2	0.8	2.5	100.0	109.5
	Mean	7.1	1.5	8.5	180.1	196.3
15	0-30	6.8	2.1	10.0	28.0	46.9
	30-60	5.5	0.9	8.2	27.0	41.6
	60-90	3.6	0.7	5.5	25.3	41.4
	Mean	5.3	1.2	7.9	27.3	41.5
Grand mean		6.17	6.2	1.4	6.9	366.5

Lindsay and Moreno (1960) and Behiry (1991) reported that the Ca-P fractions are more likely to be formed during soil weathering, as well as by fixation and precipitation of applied soluble phosphate fertilizers. The obtained data clearly shows that the Ca-P fraction is the most dominant in the investigated soils. It ranged from 27.1 to 826.9 mg Pkg^{-1} soil. The Ca-P represent 65.3 to 97.9% of the total inorganic phosphorus. Diab *et al.* (1994), found that more 60% of phosphates exists in the form of Ca-P, while, Abdel Hamed (1998) found that 80% of the total inorganic phosphorus was in that form.

The former data, also reveal that of Fe-P which represent fine crystals of natural iron phosphate minerals, such as stregite and dufenite or precipitated phosphate on iron oxides surface (Chang and Jackson 1957), is very small compared with Ca-P fraction. The obtained mean values of Fe-P ranged between 1.0 and 14.0 mg Pkg^{-1} soil, with a grand mean of 1.4 mg Pkg^{-1} soil. This indicates that the formation of Fe-phosphate is unfavoured under alkaline soil conditions especially with presence of little amounts of free iron oxides as reported by Sing *et al.* (1966). Hola *et al.* (1985) reported that in soils of recent, origin calcium and aluminum phosphate are more likely to be found than iron phosphate. This is attributed to the relatively higher activities in the soil of Ca-and Al-ions than Fe-ions, which are controlled by the activities of the respective cations of $CaCO_3$, alumino-silicates, gibbsite and iron oxides.

Table (3) shows that the mean values of saloid-P in soil profiles ranged between 4.3 to 8.5 mg Pkg^{-1} soil, in the investigated soil samples. These results are similar to those found by El-Rashidy (1972), Amer and Abou Roos (1975) and Abdel Hamed (1998). This fraction does not represent a certain soluble state and was defined by Hesse (1971) as the soluble and loosely bound –P. which seems to represent the immediately available phosphorus fraction in soil.

Al-P which includes phosphorus derived from the Al-P crystals of certain minerals such as variscites, tarankite and wavellite or from aluminum phosphate precipitatior on alumino-silicates or gibbsite: (Chang and Jackson 1957), wa very small than other Phosphat fractions. Its mean content in th tested profiles ranged from 0.4 1 2.0 mg Pkg^{-1} soil.

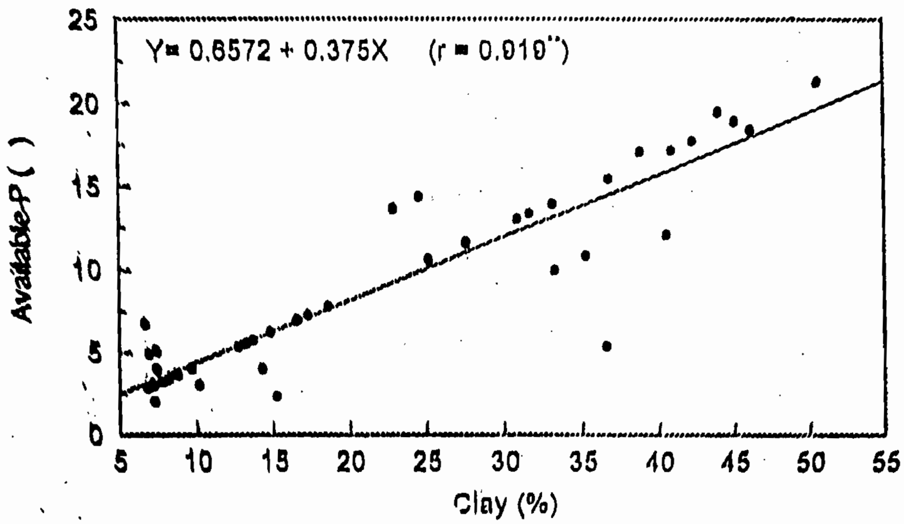

Fig. (2): The relation between clay content and Ca-phosphorus.

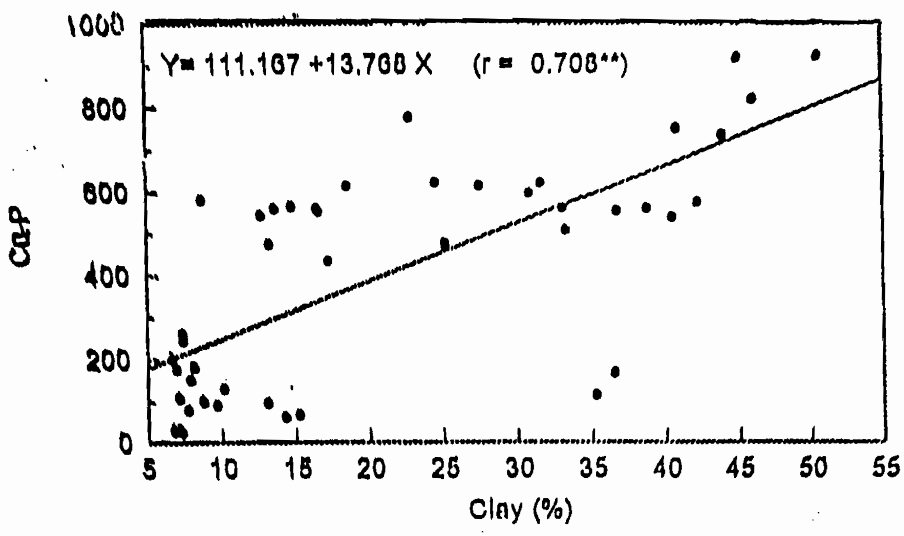

Fig. (3): The relation between clay content and Ca-phosphours.

Available phosphorus. Data in Table (2) showed the available phosphorus content of the investigated soils as determined by the $NaHCO_3$ method (Olsen' *et al.*, 1954), ranged between 3.0 – 21.2, 2.9-19.5 and 2.5-18.9 mg Pkg^{-1} soil in the surface, subsurface and deep soil samples, respectively. Generally, fine textured soils contained more than coarse textured soils. Fig. (2) represents the relationship between available phosphorus and clay content. The calculation showed a highly positive correlation between available phosphorus and clay content. These results are similar to those reported by Dahdouh (1981), Pierzynski *et al.* (1990) and Behiry (1991).

It is interesting to note, that a highly positive correlation coefficient was found between the clay content and Ca-P (Fig. 3). No significant correlation was found between available phosphorus and either $CaCO_3$ % or organic matter %.

Data of Table 3 shows that the values of available phosphorus of these virgin soils, were low, excepted soils of profiles 1,2 and 4, which contained adequate amounts of available phosphorus according to the fertility interpreation by Soltanpour and Schwab (1977) and Zanati *et al.* (1982).

REFERENCES

Abdel Hamed, A.M. (1998). Phosphorus forms in Dakhalia Governorate soils. Ph.D. Thesis, Fac. of Agric. Mansoura Univ. Egypt.

Abdel Latif, E.A.; M.H. Rabie, A.M., El-Saadany and A.Y., El-Bashbishy (1987). Evaluation of some extractants to predict the availability of heavy metals in soils of Suez Governorate. Proceedings of the 1st, Conf. of fertilizers availability and needs. April 13-16, 1987. A.R.C. Cairo, Egypt.

Amer, S.A., and S.A. Abou El-Roos, (1975). Studies on soil phosphorus. 1- The forms of inorganic soil phosphate in some soils of Egypt. J. Soil Sci. A.R.E. 15: 11-18.

Anter, E., M.H. Hilal and A.H. El-Damaty (1973). A chemical and biological approach towards the definition of calcareous soils. Plant and Soil, 39: 479-486.

Behiry, E.M.K. (1991): Movement of water and fertilizers elements in soils. M.Sc. Thesis, Fac of Agric. Zagazig Univ. Egypt.

Black, C.A. (1968). Soil plant relationship, 2nd, edition. Wiley, New York. U.S.A.

Chang, S.C. and Jackson, M.L (1957). Fractionation of soi phosphorus. Soil Sci., 83:133-144

Cooke, G.W. (1970). The control of soil fertility. Eng. Lang. Book Society, London.

Dahdouh, S.M.M. (1981). Studies on phosphorus in the soils of Sharkia Governorate. M.Sc. Thesis, Fac. of Agric. Zagazig Univ. Egypt.

Diab, M., M.Sh. Khafagi, A.A. Mohamed and M.A. Negm (1994). Phosphorus fractions in alluvial soils cultivated with alfalfa as affected by phosphorus fertilization and quality of irrigation water. Zagazig, J. Agric. Res., 21 (6): 1839-1849.

Egyptian Ministry of Economy (1998). Egypt: Land of opportunity, 11 Dec. 1998, El-Ahram Comm-orcial Print shop. Qalyuab. Egypt.

El-Rashidy, M.A. (1972). Mobility of certain nutrients in highly calcareous soils of Egypt. Ph.D. Thesis Ain Shams Univ.

Fuleky, B. (1997). Soil phosphorus as plant nutrient and potential environmental pollutent. Zeszyty Problem owe Postepow Nauk Rolniczych, 400: 73-78.

Hassanein, A.E.; E.M.K. Behiry; H.E.A. Madkour and A.A. Rahmou (2002). Studies on soils of Toshka Region. 1- Status of some nutrients in virgin soils of Toshka region. Minufiya J. Agric. Res. 27 (6): 1425-1436.

Hesse, P.R. (1971). A textbook of soil chemical analysis. John Ltd. Murry Publishers. London.

Hola, Sh. Sh.; M.I. El-Kherbeny and M.A. Wahid (1985). Studies on the inorganic phosphorus fractions in some soils of Egypt and their relation to plant uptake. Bull. Fac. of Agric. Univ. of Cairo, 36 (1): 485-505.

Ibrahim, M.E.; S.A. Abou El-Roos; M. wasif, and A.A. El-Shall (1980). Evaluation of intensity quantity and capacity parameters of soil phosphorus as factors controlling the phosphorus availability to plant. Beitrag trop landwirtsch verterinarned, 18: 361-368.

Jackson, M.L. (1958). "Soil chemical analysis" Prentice Hall, England.

John, M.K. (1970). Colorimetric determination of phosphorus in soil and plant materials with ascorbic acid. Soil. Sci. 109: 219-220.

Khatab, A.; K.M. Khalil; M.A. Ali and E.M. Abdel Latif (1999). Status of some macro and micronutrients in new cultivated soils in El-Qanain district, Suez Governorate, Egypt. J. Appli Sci. 14 (7): 640-651.

Kilmer, V.J. and L.T. Alexander (1949). Methods of making mechanical analysis of soils. Soil Sci. 68, 15.

Lindsay, W.L. and E.C. Moreno (1960). Phosphate phase equilibria in soils. Soil Sci. Soc. Am. Proc. 24: 177-182.

Mashady, A.S. and A. Ramy (1981). Extractable phosphorus in relation to inorganic forms of phosphate in calcareous soils. Egypt. J. Soi. 21 (3): 359-372.

Mitkees, A.; M. Hala and M.E. El-Hakim (1966$_a$). Physical and chemical characteristics of Maryut desert soils of U.A.R. Agric. Res. Rev. U.A.R, 44 (5): 141-146.

Mitkees, A.; H. Koussi; M. Abou Hussein; M. Shalabi and M. Hala (1966$_b$). Physical and chemical characteristics of North Eastern Sinai desert soils, of U.A.R. Agric. Res. Rev. U.A.R, 44 (2): 65-81.

Mitkees, A.; M. Shalabi; H. Koussi; M.El-Hakim and M. El-Banna (1966$_c$). Physical and chemical characteristics of Kharga desert soils of U.A.R. Agric. Res. Rev. U.A.R, 44 (2): 82-97.

Moustafa, A.T.A.; A.S. Ahmed and W.E. Ahmed (1988). Some soil studies on El-Ewinate area. 2-Soluble salts, calcium carbonate and fertility status. Agric. Res. Rev. U.A.R., 66 (4): 641-648.

Olsen, S.; E.V. Cole and F.S. Watanabe (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A. Circ No. 939.

Piccolo, A. and G. Huluka (1986). Phosphorus status of some Ethiopian soils. Tropical-Agri. 63 (2): 137-142.

Pierzynski, G.M., T.G. Logan; S.J. Traina AND J.M. Bigham (1990). Phosphorus chemistry and mineralogy in excessively fertilized soils. Quantative analysis of phosphorus rich particles. Soil Sci. Soc. Am. J. 54: 1576-1582.

Piper, C.S. (1950). "Soil and palnt analysis" Inter. Science Pupl. Inc. New York, U.S.A.

Rahmou, A.A.; K.E. Nassar; K.M. Khalil and E.A. Abdel Latif (2001). Status of some chemically available nutrients in sandy soils cultivated with wheat under marginal rainfed condition in North Sinai Governorate. Minufiya. J. agric. Res. 26 (6): 1749-1758.

Richards, L.A. (1954). Diagnosis and improvement of saline and alkaline soils. U.S.D.A. Hand-book No. 60 U.S. Gov., Printig office, Washington, D.C. U.S.A.

Said, R. (1962). The geology of Egypt. El-Sevicr Publ. Co. Amsterdam, the Netherlands.

Sing, R.N.; D.C. Martens and S.S. Obenshain (1966). Plant availability and form of residual phosphorus in devidson clay loam. Soil Sci. Soc. Am. Proc. 30: 617-620.

Soltanpour, P.N. and P. Schwab (1977). A new soiltest for simultaneous extraction of macro and micro nutrients in alkaline Soils. Comm. In Soil Sci. and Plant Anal., 8: 195-207.

Sorensen, G.R.; R.A. Wiese (1982). Distribution of phosphorus in columns of a very sandy soils after leaching with water or dommonium phosphate. Soil Sci. 134: 97-104.

Tahoun, S.; H. Hamdi, and N. Nassser (1975). The transformation of mono-calcium phosphate residue in soils. Egypt. J. Soil Sci. Spec. Issue: 161-166.

Zanati, M.; P.N. Soltanpour; A.T. Moustafa and A. Kelcy. (1982). Soil fertility survey of Kafr El-Sheikh El-Mansuriya and El-Minya Sites. EWUP Tech. Report 10, Waterr.

دراسات على أراضى إقليم توشكى

٢- صور الفوسفور المعدنى فى أراضى من منطقة توشكى

السيد محمد قطب بحيرى　　احمد السيد حسانين

مجـدى خضـر　　السيد احمد عبداللطيف

معهد بحوث الأراضى والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر

جمعت ٤٥ عينة تربه سطحية وتحت سطحية وعميقة مـن الأعمـاق ٠-٣٠، ٣٠-٦٠، ٦٠-٩٠ سم من خمسة عشر قطاع تربه فى منطقة توشكى. وقـد قـدرت الصـفات الطبيعيـة والكيمائية لهذه العينات وأشارت النتائج الى تناقص صور الفوسفور المعدنى تدريجياً مـع العمق، كما تنوعت كثيراً معه ولقد توزعت تلك الصور كآلاتى:

Ca-P > Saloid-P ≈ Fe-P > Al-P

وكان المحتوى السائد هو Ca-P ، كما أظهرت النتائج ان الأراضى الناعمة القوام ذات محتوى عال من الفوسفور الكلى والميسر بالمقارنة بالأراضى الخشنة لقوام ، ولقد ارتـبط محتوى الطين إحصائيا معنويا. مع كل من Ca-P، والفسفور الميسر.