EFFECT OF LONG-TERM APPLICATIONS OF P FERTILIZERS AND CROP RESIDUES ON P ADSORPTION AND P BALANCE IN SOILS UNDER CORN-CLOVER CROPPING SYSTEM

Raghib, H.M.A., Hala H. Gomah*; M.F. Ghoneim and M.H. Raslan
Department of Soil and Water, Faculty of Agriculture, Assiut University.
Halagomaa71@hotmail.com

ABSTRACT

In the permanent experimental site, started in 1988, in the farm of Soils and Water Department, Assiut University, ground corn stover and ground clover straw (CR) were incorporated in the surface (0.00- 0.25 m) soil layer at an average rates of 5.45 ton fed^{-1} $year^{-1}$ and 3.71 ton fed^{-1} $year^{-1}$, respectively. Six rates of fertilizer P fertilization (0, 100, 200, 300, 400, and 500 kg superphosphate fed^{-1}) were also applied each season.

The results showed that the amount of Olsen's P_t required to give the maximum P uptake in grains was equal to 46.8 and 51.4 ppm P in P fertilization management without crop residues (-CR) and with crop residues (+CR), respectively. In both P fertilization managements (-CR and +CR), P application significantly ($p \leq 0.05$) and curvilinearly increased the dry matter accumulation and grain yield of corn plants.

The P apparent balances showed that in both P fertilization managements (with and without CR), P fertilization rate of 62 kg P_2O_5 fed^{-1} (400 kg SP fed^{-1} each growth season) and higher were more than the requirements of corn-clover cropping system, and resulted in accumulation of P in soil. Phosphorous adsorption in the surface layer of soil treated with all levels of mineral P fertilizer appeared to be decreased with incorporation of crop residues into soil

Keywords: P uptake, P balance, long term, crop residues, P adsorption.

INTRODUCTION

Several researchers have evaluated the effect of crop residues management practices on the crop yield of the following crop. Results are conflicting because of a number of factors involved, including residue quality, management, and edaphic factors. Some organic compounds, such as certain phenolic acids, have phytotoxic properties; others, such as auxins, enhance plant growth (Stevenson, 1982). Guenzi and McCalla (1966) demonstrated that crop residues contained water-soluble substances, which had a phytotoxic effect (depression of germination, and early root and shoot growth) on several crop species. Yakle and Cruse (1983) reported that corn residues reduced early corn growth and suggested that autotoxic compounds were involved.

In semiarid regions, application of different organic materials increased straw and grain yields of wheat (Aal *et al.,* 2003; Barzegar *et al.,* 2002). In a field experiment conducted in semiarid west Africa, Kouyate' *et al.* (2000) found that incorporation of sesbania and dolichos as a green manure at the end of the rainy season increased cereal grain and stover yields by 37

and 49%, respectively, on the loamy sand soil , and by 27 and 30%, respectively, on the loamy soil, compared to cereal monoculture without organic amendment, when averaged across tillage regimes and years.

Adsorption of phosphates varies with soil constituents and properties, and is affected by agricultural operations that alter soluble P levels and contents such as fertilization, liming, manuring, soil pH and organic matter content (Pierzenski *et al.,* 2000). Iyamuremy *et al.* (1996[a] and [b]) reported that the phosphorus sorption capacities of five high-phosphorus fixing capacity soils were reduced when amended with manure and alfalfa residues. This was attributed to the release of $PO4^{3-}$ from decomposing organic residues. Furthermore, organic amended soils released significant amounts of SO_4^{2-} and Fl^-, which are considered as complexing agents for Al, Fe, and Ca. Application of crop residues of tithonia significantly decreased the P adsorption capacity of the soil (Nziguheba *et al.,* 1998). Incubation of organic residues into soil for up to 30 days decreased orthophosphate sorption; however, it was increased when incubation period was raised up to 150 days (Sing and Jones, 1976).

The effects of organic materials on phosphate adsorption/ desorption behaviors could be attributed to (1) competition of organic compounds such as humic and fulvic acids with phosphates for the adsorption sites on the surfaces of Al and Fe hydrous oxides or other clay minerals, (2) the formation of metal complexes (Al and Fe with organic acids) which in turn readily react with orthophosphates and (3) effects of organic acids on surface charges and precipitation reactions (Iyamuremye and Dick 1996).

The goal of this study is to evaluate the effect of long- term applications of P fertilizers and crop residues on P adsorption on soils and on enhancing P uptake and crop yield. The other aim is to determine the best fertilization management to fulfill P requirement of corn crop.

MATERIALS AND METHODS

In 1988 a long term field experiment with corn-Egyptian clover cropping system was initiated at the Experimental Farm of Assiut University, Assiut, Egypt. The alluvial soil of the experimental site is clay loam (37% clay and 33% silt) with pH 7.79, ECe 2.96ds/m, OM 1% and 5.12 total Olsen P. Two treatments of crop residues (with and without CR) and six rates of phosphorus fertilizer (0, 100, 200, 300, 400, and 500 kg superphosphate fed^{-1}) were applied to both corn and Egyptian clover. The crop residues were incorporated into the surface (0.00-0.25 m) soil layer at the end of each growth season (5.45, 3.71 ton fed^{-1} corn stover and Egyptian clover straw, respectively). The treatments were arranged in a split-plot design with crop residues (CR) in the main plots and rates of superphosphate (SP) in the sub-plots. Each treatment was replicated four times in the same plot each year. The area of each replicate was 1\100 feddan.

After harvesting of each crop and before mixing the crop residues into soil, soil of each plot was sampled. In each plot, 3-5 soil cores were taken from the surface 0.00-0.25 m soil layer at random, mixed together to form a

composite sample. Soil samples of each growth season were prepared following the standard procedure and stored for analysis later on. Soil samples taken after corn growth season of 1992, 1996, 1999 and 2003 were subjected to phosphorus adsorption analysis.

Total soluble salts were determined in the saturated soil-paste extract by measuring the electrical conductivity (Jackson, 1973). Organic matter content was determined using Walkely-Black method, following Baruah and Barthakur (1997). Soil pH was measured in 1:1 (soil: water) suspensions using a glass electrode (Jackson, 1973). Mechanical analysis was carried out using the pipette method (Piper, 1950). Olsen P extraction (Olsen *et al.,* 1954) with 0.5 M NaHCO$_3$ (pH 8.5, 1: 20 soil: extract ratio, 30 min shaking) was prepared and a portion was digested with potassium persulphate as described by Bowman (1989) and analyzed for total Olsen's extracted P (P$_{Ot}$).

Soil samples collected in the years 1992, 1996, 1999 and 2003 after corn harvesting were used to measure phosphorus adsorption isotherm following the method described by Nwoke *et al.* (2004). Duplicate soil samples of 3 gm each were placed in 50 ml centrifuge tubes and shaken for 2 hours with 30 ml of 0.01 M KCl having a concentration of KH$_2$PO$_4$ that ranged from 10 to 100 μg P ml^{-1}. The clear extracts were obtained by centrifugation and the concentration of phosphate in the supernatant were measured using phosphomolibdic-sulfuric acid system and stannous chloride as a reducing agent as described by Jackson (1973). The difference between P added to the soil and that remaining in the filtrate was regarded as P sorbed by soil.

Representative plant samples of corn were collected from each plot during the growth season of 2003 at tow stages of corn growth {at 30 and 60 days after planting}. Corn plants were harvested at physiological maturity (105-110 days after planting) and were separated to ears and stover and then air-dried and the yield of each plot was recorded. Grain and stover samples were collected for chemical analyses. All plant samples were cleaned and then dried at 70°C and prepared for P analysis.

The collected plant samples were subjected to analysis using the wet digestion in H$_2$SO$_4$-H$_2$O$_2$ mixture as described by Parkinson and Allen, (1975). Phosphorous concentration in the digest was determined calorimetrically using the stannous chloride phosphomolibdic-sulfuric acid system as described by Jackson (1973).

RESULTS AND DISSECTIONS

Dry matter accumulation, yield and Phosphorus uptake:
During the early growth season of corn plants, P fertilization management that contained CR enhanced the relation between Olsen's extractable P and P uptake (Fig. 1). The amount of P uptake was significantly ($p \leq 0.05$) increased with incorporation of CR into the soil (Table 1). However, in the middle of the growth season the effect of CR on the amount of P taken up was not that much, though it was significant. It is well known that corn plants take up most of its P requirements during the early growth period. Therefore, the effect of CR on P uptake during the early growth period could

be more pronounced compared with that of the middle growth period. By the end of the growth season, P uptake in stover and corn grains significantly and curve linearly increased with increasing the quantity of Olsen's extractable P (Fig. 1). The relations between Olsen's extractable P and P uptake in corn stover and grains were best fitted to quadratic polynomial equation and gave the significant ($p \leq 0.05$) R^2 values.

To calculate the size of Olsen's extractable P (P_{ava}) at which the maximum P uptake (P_{up}); the first order differentiations (dP_{up}/dP_{ava}) were calculated and equated to zero. The results showed that in the P fertilization management that did not contain CR (-CR), the amount of Olsen's P_t that was required to give the maximum P uptake in grains was equal to 46.8 ppm P. Meanwhile, in the P fertilization management that contained CR (+CR) the maximum P uptake in grains occurred when Olsen's P_t was equal to 51.4 ppm.

Continuous application of P various fertilization managements, for a relatively long time, as expected, exerts pronounced effects on the growth and productivity of crop plants. Moreover, including crop residues in the phosphorus fertilization management systems remarkably increased the dry matter accumulation and productivity of corn plants (Table 1).

Table 1. Effects of crop residues and P fertilization rates on dry matter production, grain and stover yield and phosphorus uptake of corn crop.

Treatments		Phosphorus uptake (kg fed⁻¹)				Dry matter, stover and grain yield (kg fed⁻¹)			
		30 day	60 day	Stover	Grain	30 day	60 day	Stover	Grain
Without crop residues	P_0	0.695	5.10	9.02	5.92	274.5	2709	4100	2143
	P_1	0.915	6.85	10.58	8.19	287.9	3238	4600	2446
	P_2	0.935	9.82	11.28	10.04	289.3	3886	4700	2498
	P_3	0.983	10.96	12.00	10.38	291.4	4035	4800	2514
	P_4	1.123	11.69	12.48	11.63	301.5	4100	4800	2633
	P_5	1.299	12.12	13.77	12.70	328.7	4121	5100	2788
Mean		**0.992**	**9.42**	11.52	**9.81**	**295.5**	**7732**	**4683**	**2504**
With crop residues	P_0	0.962	6.71	11.04	8.94	334.7	3070	4600	2603
	P_1	1.298	8.34	15.25	14.26	385.9	3701	6100	3389
	P_2	1.639	10.57	16.99	15.37	452.1	3958	6533	3447
	P_3	1.797	12.06	17.96	16.00	467.6	4092	6650	3492
	P_4	2.258	13.91	18.76	16.64	544.6	4247	6700	3584
	P_5	2.582	17.72	19.43	20.26	580.6	4638	6700	3740
Mean		**1.706**	**11.55**	16.57	**15.24**	**461**	**3951**	**6214**	3376
LSD 0.05	CR	0.130	1.22	1.03	0.52	33.4	250	408.6	151
	P	0.097	1.21	0.78	1.06	26.5	402	300.4	181
	CR× P	0.162	1.85	0.87	1.51	43.30	NS	505.2	264

P_0= 0.00, P_1= 100, P_2= 200, P_3=300, P_4= 400, P_5=500 kg SP fed⁻¹ for each growth season. CR= Crop residues, P= Phosphorus NS= Non-significant.
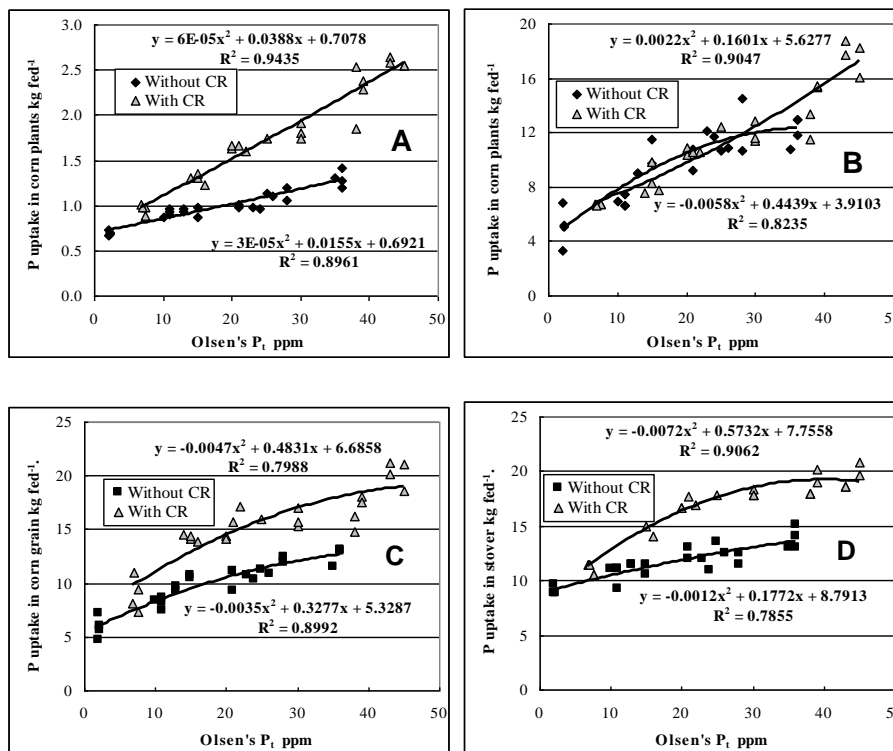
A=30 days, B=60 days, C=grain, and D=stover.

Fig. 1: Relationships between Olsen's extractable Pt and P uptake in corn plants.

In both P fertilization managements, P application significantly ($p \le 0.05$) and curvilinearly increased the dry matter accumulation and grain yield of corn plants. The grain yield increased from 2143 kg fed^{-1} to 2788 kg fed^{-1} with increasing the P fertilization rates from zero to 77.5 kg P$_2$O$_5$ fed^{-1} (Table 1 and Fig. 2). Compared to mineral P fertilization management, corn plants in the +CR P fertilization management accumulate significantly ($p \le 0.05$) higher amount of dry matter during the early growth season (30 days after planting). At this early growth stage, corn grown on plots that received the +CR P fertilization management accumulated 35.9% more dry matter compared to the −CR P fertilization management. However, in the middle growth season (60 days after planting) the increases in dry matter accumulation due to incorporation of CR was less pronounced and reached only 6.8%. At maturity, the +CR P fertilization management increased the dry matter accumulated in stover and corn grain yield by 24.6 and 25.6%, respectively).
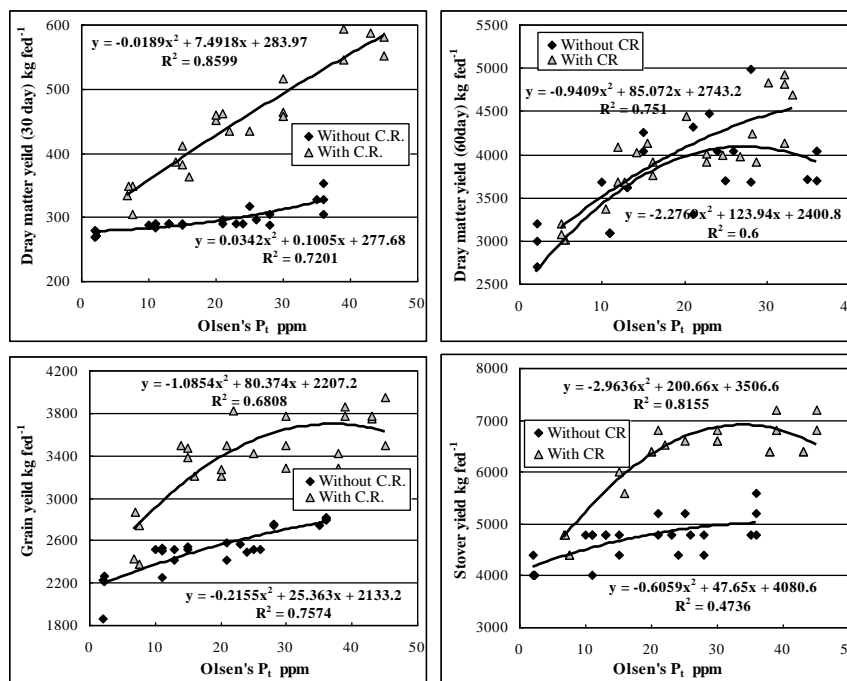
Fig. 2: Relationships between Olsen's extractable P_t and dry matter accumulation and grain yield of corn plants

These results coincide with those obtained by Mubarak *et al.* (2003) whose results showed that during five crops cycle of continuous application of crop residues with inorganic fertilizers, 43% of the observed maximum yield of the maize was sustained compared to 21% in plots where crop residues were removed. Tsuji *et al.* (2006) found that long-term addition of crop residues and phosphorus fertilizer increased yield of summer (maize, soybean, upland rice, sweet corn and groundnut) and winter (barley, wheat, leaf mustard and rape) crops.

Obviously, the higher increases in the amount of available P are not the only reason behind the great response of crops to +CR P fertilization management. Many other physical and chemical soil properties, as well as nutrient status have been favorably affected by increasing the amount of soil organic matter (SOM) associated with continuous incorporation of CR for a long time (16 years). The level of SOM became as high as 2.4% due to continuous application of CR for 16 years. Besides increasing the size of available P, this increase in SOM may significantly contribute to improving other soil properties such as CEC, porosity, water holding capacity, bulk density, aeration, aggregate size and stability. Increasing microbial biomass could also be another reasonable explanation. Hafner *et al.* (1993) attributed the increases in P taken up by millet plants associated with the incorporation of crop residues in the topsoil (0- 0.30 m) to increasing the root length density. Their results showed that higher P uptake was related to a greater total root length in 0.0- 0.30 m surface soil layer and to a higher P uptake rate

3222

per unit root length (P influx). Ragheb (1993) reported that wheat cultivars that have higher root length takes up more P under P deficiency stress conditions.

The relationship between Olsen's extractable P and dry matter accumulation during growth period of corn was used to calculate the size of available P required for maximum production in corn. The polynomial quadratic model was found to best fit the data and gave the highest R^2 values. Therefore, data were fitted to the quadratic polynomial equation; the obtained equations are presented in Fig. 2.

The polynomial quadratic model can be written as follows:

$$Y = a + b_1 P_{av} + b_2 P_{av}^2$$

Where: Y = estimated amount of dry matter or grain yield (kg fed^{-1}), a = intercept, b_1 = linear coefficient, b_2 = quadratic coefficient, and P_{av} = the size of available P pool (kg fed^{-1}). The size of P available pool (P_{av}^0), at which the maximum yield occurred was calculated by differentiating dY/dP_{av} and equating with zero ($dP_{upt}/dP_{av} = 0$) as shown by (Colwell, 1994).

The results showed that in the +CR P fertilization management, the total Olsen's extractable P (Po_t) that was required to produce the maximum grain yield was 37.09ppm. In the case of using the mineral P fertilizer only, the size of available P required for maximum grain yield would be as high as 58.85mg kg^{-1}.

This data reflects the fact that in corn-clover cropping system, with continuous incorporation of CR into the surface soil layer (0.25 m), the amount of mineral P fertilizer required for maximum growth and productivity of corn and clover plants could be reduced down to not more than 250 kg fed^{-1} for each growth season.

P balance and sustainability in soil:

The apparent P balance in soil was computed as the difference between P added through P fertilizer, irrigation water and CR and P removed by corn and clover plants.

Data presented in Table (2) and Fig. (3) show the apparent balance of P in corn-clover cropping system with different P fertilization managements over that period. Examination of these values of P shows that in both P fertilization managements (+CR and –CR), the apparent P balance increased progressively with increasing the rates of fertilizer P. In corn-clover cropping system, P fertilization management would be better designed to keep Olsen's P average at 18.5 kg fed^{-1} to sustain P apparent balance in the positive side. In the –CR P fertilization management, P fertilization rate up to 31 kg P_2O_5 fed^{-1} resulted in a negative P balance. This means that the P fertilization rate of 31 kg P_2O_5 fed^{-1} each growth season was not enough to meet the crop requirement, and the P fertilization rate should not be less than 46.5 kg P_2O_5 fed^{-1} each growth season (300 kg SP fed^{-1} each growth season). In the +CR P fertilization management, addition of 31 kg P_2O_5 fed^{-1} each growth season should be enough to fulfill the P requirement of corn-clover cropping system. Analyses of P apparent balances also shows that in both P fertilization managements, P fertilization rates of 62 kg P_2O_5 fed^{-1} (400 kg SP fed^{-1} each growth season) and higher were more than the requirements of corn-clover cropping system, and resulted in accumulation of P in soil.

Table 2: Apparent balance of P in corn-clover cropping system under different P fertilization practices over the period of 1988- 2003.

Treatment	P in SP (kg fed⁻¹)	P in CR (kg fed⁻¹)	P in irrigation water (kg fed⁻¹)	Crop uptake (kg fed⁻¹)		Available P (kg fed⁻¹)	Apparent balance (kg fed⁻¹)
				Corn	Clover		
Without CR							
P_0	0.00	0.00	17.136	238.98	119.76	2.12	-343.72
P_1	216.64	0.00	17.136	300.31	153.48	11.53	-231.54
P_2	440.00	0.00	17.136	341.03	182.52	14.00	-80.41
P_3	649.60	0.00	17.136	358.16	199.84	23.25	85.49
P_4	886.40	0.00	17.136	385.74	224.92	28.74	264.14
P_5	1082.56	0.00	17.136	423.42	245.60	35.75	394.92
With CR							
P_0	0.00	334.40	17.136	319.72	164.84	7.20	-140.22
P_1	216.64	334.40	17.136	472.07	202.72	15.13	-121.74
P_2	440.00	334.40	17.136	517.74	220.32	20.75	32.73
P_3	649.60	334.40	17.136	543.17	233.36	28.75	195.86
P_4	886.40	334.40	17.136	566.37	254.32	38.5	378.75
P_5	1082.56	334.40	17.136	635.02	278.88	44.00	476.20

P_0=, P_1= 100, P_2= 200, P_3= 300, P_4= 400, P_5= 500 kg SP fed⁻¹ for each growth season.
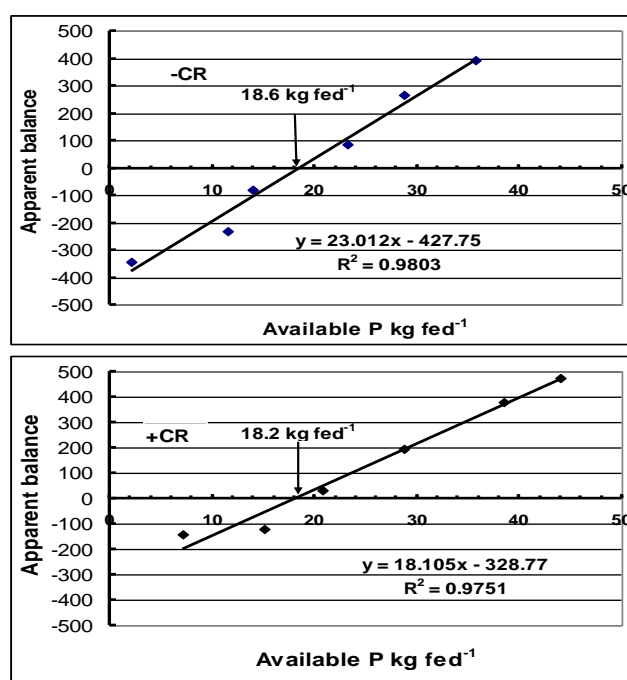CR= Crop residues, SP= Superphosphate.

Fig. 3. Apparent balance of P under different P fertilization practices over the period of 1988-2003.

Long term effects of P fertilization and/or crop residues on adsorption of P:

Continuous application of mineral P fertilizer and/or crop residues for a long time could potentially and remarkably affects the amount of adsorbed P and the parameters of Q/I relationship, as well. In this study, the parameters of phosphorous sorption isotherm were estimated using the simple Langmuir equation after Sui and Thompson (2000):

$$X = S_{max} k C/(1+kC)$$

Where X represents the amount of P adsorbed by soil (mg kg^{-1}), C is the P concentration in equilibrium solution (mg L^{-1}), S_{max} is the sorption maximum (mg kg^{-1}), and k is the binding energy measuring the P adsorption affinity (L mg^{-1}). To construct the Q/I relationship the linear form of the previous equation was derived as follow:

$$C/X = C/S_{max} + (1/kS_{max})$$

The S_{max} was calculated as the reciprocal of the slope, and k as the slope/intercept. For the sake of summarization the results of P adsorption and the Q/I isotherms for represented years i.e. 1992, 1996, 1999 and 2003 over the span of the experiment, and for some levels of P fertilization i.e. P_0, P_3 and P_5 were presented.

Phosphorous adsorption in the surface layer of soil treated with all levels of mineral P fertilizer appeared to be decreased with incorporation of crop residues into soil (Table 3). At the very beginning of the experiment, the effects of both mineral P fertilization and CR on P adsorption was not clear. However, in year 2003 (16 years of continuous application of mineral P fertilizer and CR) the amount of sorbed P was remarkably reduced. When the initial solution P concentration was < 15 mg L^{-1} the reduction in adsorbed P associated with incorporation of CR in the surface layer was the least. That trend changed when the initial solution P concentration was > 15 mg L^{-1}, at which point the reduction in P adsorbed associated with incorporation of CR into the surface layer was maximum. Least amount of applied P sorbed by the soil reflects the relatively large amount of resin extractable P, as mentioned before, in soil continuously amended with CR, especially in year 2003 (continuous incorporation of CR for 16 years), and emphasized that labile P initially present in soil (untreated soil) can influence subsequent P sorption associated with increasing the OM in soil. Results obtained by Sui and Thompson (2000) were in agreement with these results. They reported that over the range of equilibrium P concentrations, the ability of the soil to sorb added P decreased due to biosolids amendment. Furthermore, earlier work of Smyth and Sanchez (1980) indicated that previous P applications can decrease P sorption so that inorganic P released from organic residues may complex with the sites of P sorption in surface reactions.

The calculated values of the P isotherm parameters S_{max} (maximum P adsorption), k (P binding energy), maximum P buffering capacity (MPBC) are shown in Table 3. The addition of crop residues with or without mineral P fertilizer (SP) significantly ($p \leq 0.05$) decrease the amount of adsorbed P, the P sorption maximum (S_{max}), P binding energy (k), and the maximum P buffering capacity (MPBC) of the soil. These results are in agreement with those obtained by Siddique and Robinson (2003), whose results emphasized that

all the P sources had a marked negative effect on P sorption and a positive effect on P availability in all soils.

Table 3. The maximum P adsorption (S_{max}), bonding energy constant (k) and maximum buffering capacity (MPBC) determined from the Langmuir equations for the various crop residues and inorganic P fertilizer treatment.

Year	Level	Without crop residues			With crop residues		
		S_{max} mg P kg^{-1}	k L kg^{-1}	MPBC L kg^{-1}	S_{max} mg P kg^{-1}	k L kg^{-1}	MPBC L kg^{-1}
1992	P$_0$	714.30	0.0820	58.97	725.15	0.0760	55.04
	P$_3$	676.50	0.0770	52.28	667.10	0.0780	51.83
	P$_5$	671.35	0.0670	45.10	675.55	0.0650	43.87
Mean		687.38	0.0753	52.11	689.27	0.0730	50.24
1996	P$_0$	692.80	0.0840	57.74	696.90	0.0760	52.69
	P$_3$	673.45	0.0700	47.56	666.30	0.0670	45.17
	P$_5$	663.25	0.0630	42.04	631.45	0.0620	39.14
Mean		676.50	0.0723	49.11	664.88	0.0683	45.66
1999	P$_0$	711.55	0.0790	55.76	698.25	0.0750	52.27
	P$_3$	623.55	0.0780	48.89	628.40	0.0700	44.02
	P$_5$	635.20	0.0640	40.44	620.95	0.0580	36.40
Mean		656.77	0.0737	48.36	649.20	0.0677	44.23
2003	P$_0$	707.40	0.0820	57.52	687.50	0.0750	51.43
	P$_3$	678.45	0.0640	43.32	583.25	0.0700	40.85
	P$_5$	641.70	0.0590	38.27	557.10	0.0590	33.28
	Mean	675.85	0.0683	46.37	609.28	0.0680	41.85
	Mean	674.13	0.0724	48.99	653.16	0.0692	45.50
LSD 0.05	CR	8.49	0.0020	1.00	8.49	0.0020	1.00
	P	11.17	0.0027	1.10	11.17	0.0027	1.10
	CR x Y	16.98	NS	NS	16.98	NS	NS
	Y	16.98	0.0024	1.41	16.98	0.0024	1.41
	P x CR	15.80	NS	1.56	15.80	NS	1.56
	P x Y	22.35	NS	2.20	22.35	NS	2.20

P$_0$= 0.00, P$_3$= 300, P$_5$= 500 kg SP fed^{-1} for each growth season.
CR= Crop residues, P= Phosphorus, Y= Year, NS= Non significant

In all studied years, increasing the rate of mineral P fertilization significantly ($p \le 0.05$) reduced the values of S_{max}, k, and MPBC. This negative effect of mineral P fertilization rate on P adsorption isotherm parameters became more noticeable by the year 2003. With continuous incorporation of CR into the surface layer of the soil, the P adsorption parameters were rather significantly ($p \le 0.05$) decreased with years (Table 3). At the very beginning of the experiment (year 1992), the negative effects of CR on S_{max}, k, and MPBC

were at least. Then after, the negative effects of incorporation of CR on the P isotherm parameters were aggravated by the year of 2003 and became significant ($p \leq 0.05$). The value of S_{max} of soil samples collected in 2003 was significantly ($p \leq 0.05$) reduced from 675.9 to 609.3 mg P kg^{-1} of soil as the result of CR incorporation. The same trend was recorded for MPBC, its value reduced from 46.4 to 41.9 mg P L^{-1}. Lowering the bonding energy constant and P buffering capacity meant that soil treated with higher rate of mineral P fertilizer and/or CR could potentially desorbed more P into the soil solution than those with high buffer capacity. Subramaniam and Singh (1997) reported that soils with lower buffer capacity and lower bonding energy constants desorbed more P to the soil solution than those with high buffer capacity.

Because of decomposition of CR a high amount of low molecular weight organic compounds were released. These molecules may potentially compete with phosphates for the same sites of adsorption and finely blocked the sorption sites, and/or chemically reacted with some mineral components of soil like Fe and Al sesquioxides and finely preventing the adsorption of phosphates anions on their surfaces. The results obtained by several workers support this explanation. Using laboratory kinetic studies Ohno and Erich (1997) demonstrated that dissolved organic carbon (DOC) isolated from field corn and wheat residues decreased the rate of P sorption in soil. Equilibrium sorption studies carried out by Ohno and Crannel (1996) showed that DOC from hairy vetch (*Viviane villosa* L.) and crimson clover (*Trifolium incarnates* L.) inhibited P sorption, findings that emphasized that DOC released from crop residues decrease P sorption, leading to greater soil P availability. Biosolid applications to soil not only increase available P, but also decrease P binding affinity by soils and increase P desorption capacity (Sui and Thompson, 2000).

Another explanation for the negative effects of organic compounds, continuously produced during the decomposition of crop residues, on P adsorption pertained on the chemical reactions of organic molecules with Fe and Al hydroxides. Iyamuremye and Dick (1996) reported that several organic anions including aromatic hydroxyl acids and aliphatic hydroxyl-organic acid were effective in preventing orthophosphate from combining chemically with Al or Fe and thus reducing the adsorption of phosphate. As reported by Violante *et al.* (1991) the pH of the soil has a major effect on competition between organic acid and P for adsorption sites. At high soil pH, like in our studied soil, the negative effect of organic acids on phosphates adsorption was more aggravated.

REFERENCES

Aal, S.I.A., M.A. Abdel-Hamid, S.A. Ismaiel, A. Abd-El-Fattah and A.S. Taalab. 2003. Effect of organic farming practice on nutrient availability and wheat yield grown on Torripsamments. *Egyptian. J. Soil. Sci. 43: 47-62*.

Baruah, T.C. and H.P. Barthakur. 1997. A textbook of soil analysis. Vikas Publishing House Pvt Ltd, New Delhi.

Barzegar, A.R, A. Yousefi and A. Daryashenas. 2002. The effect of addition of different amounts and types of organic materials on soil physical properties and yield of wheat. *Plant soil 247:295-301.*

Bowman, R.A. 1989. A sequential extraction procedure with concentrated sulfuric acid and dilute base for soil organic phosphorous. *Soil Sci. Soc. Am. J. 53:362-366.*

Colwell, J.D. 1994. Estimating fertilizer requirements: A quantitative approach. Chap. 3. pp 34-64. CAB International.

Guenzi, W.D. and T.M. McCalla. 1966. Phenolic acids in oats, wheat, sorghum and corn residues and their phytotoxicity. *Agron. J. 58: 303-304.*

Hafner, H., E. GeorGe, A. Bationo and H. Marschner. 1993. Effect of crop residues on root growth and phosphorus acquisition of pearl millet in an acid sandy soil in Niger. *Plant and soil 150: 117-127.*

Iyamuremye, F. and R.D. Dick. 1996. Organic amendments and phosphorus sorption by soils. *Adv. Agron. 56: 139-185.*

Iyamuremye, F., R. Dick, and J. Baham. 1996$_b$. Organic amendments and phosphorus dynamics: П. Distribution of soil phosphorus fractions. *Soil Sci. 436-443.*

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice-Hall, Inc. Englewood Cliffs, N.J. New Delhi.

Kouyate', Z., Franzluebbers, K., A.S.R. Juo and L.R. Hossner. 2000. Tillage, crop resides, legume rotation, and green manure effects on sorghum and millet yields in the semiarid Tropics of Mali. *Plant and soil. 225: 141-151.*

Mubarak, A. R., A. B. Rosenani, A. R. Anuar and D. Sitiauyah. 2003. Effect of incorporation of crop resides on a maize-groundnut sequence in the humid Tropics. I. yield and nutrient uptake. *J. Plant nutrition 26: 1841-1858.*

Nwoke O.C., B. Vanlauwe, J. Diels, Sanginga and O. Osonubi. 2004. The distribution of phosphorus fractions and desorption characteristics of some soils in the moist savanna zone of West Africa. *Nutrient Cycling in Agroecosystems 69: 127-141.*

Nziguheba, G., C.A. Palm, R.J. Buresh, and P.C. Smithson. 1998. Soil phosphorus fractions and adsorption as affected by organic and inorganic sources. *Plant and Soil. 198:159-168.*

Ohno, T. and B.S. Crannell. 1996. Green and animal manure-derived dissolved organic matter effects on phosphorus sorption. *J. Environ. Qual. 25: 1137-1143*

Ohno, T. and M.S. Erich. 1997. Inhibitory effects of crop residue-derived organic ligands on phosphate adsorption kinetic. *J. Environ. Qual. 26: 889-895.*

Olsen, S.R., C.V. Cole, F.S. Watanabe and L.A. Dean. 1954. Estimation of available phosphorus by extraction with sodium bicarbonate. USDA Circ. 939. U.S. Gov. Print. Office, Washington, DC.

Parkinson, J.A., and S.E. Allen. 1975. A wet oxidation procedure for the determination of nitrogen and mineral nutrients in biological material. *Commun. Soil science and plant analysis 6: 1-11.*

Pierzynski, G.M., J.T. Sims and G.F. Vance. 2000. Soils and environmental quality. 2nd Ed. Chap. 5, pp 155-207. CRC. Press, Boca Raton, Florida.

Piper, C.J. 1950. Soils and Plant Analysis. Inter. Sci. Publishers, Inc. New York.

Ragheb, H.M.A. 1993. Screening of some wheat cultivars for tolerance to P stress. Assiut J. Agric. Sci. 24(3):31-49

Siddique, M.T. and J.S. Robinson. 2003. Phosphorus sorption and availability in soils amended with animal manures and sewage sludge. *J. Environ. Qual. 32: 1114-1121.*

Sing, B.B. and J. P. Jones. 1976. Phosphorus sorption and desorption characteristics of soils as affected by organic residues. *Soil Sci. Soc. Am. J. 40: 389-394.*

Smyth, T.J. and P.J. Sanchez. 1980. Effects of lime, silicates, and phosphorous applications to oxisols on phosphorus sorption and iron retention. *Soil Sci. Soc. Am. J. 44:500-505.*

Stevenson, F. J. 1982. Humus chemistry. Wiley. New York.

Subramaniam, V. and B.R. Singh. 1997. Phosphorus supplying capacity of heavily fertilized soils I. Phosphorus adsorption characteristics and phosphorus fractionation. *Nutrient Cycling in Agroecosystems. 47: 115-122.*

Sui, Y. and M.L. Thompson. 2000. Phosphorus sorption, desorption, and buffering capacity in a biosolids-amended Mollisol. *Soil Sci. Soc. Am. J. 64: 164-169.*

Tsuji, H., H. Yamamoto, K. Matsuo and K. Usuki. 2006. The effects of long-term conservation tillage, crop residues and P fertilizer on soil conditions and responses of summer and winter crops on an Andosol in Japan. *Soil Tillage Res. 89: 167-176.*

Violante, A., C. Colombo and A. Buondonno. 1991. Competitive adsorption of phosphate and oxalate aluminum oxides. *Soil Sci. Soc. Am.J.55:65-70.*

Yakle, G.A. and R.M. Cruse. 1983. Corn plant residue age and placement effects upon early corn growth. *Can. J. Plant Sci. 63: 871-877.*

تــأثير الاضـافات المسـتمره للسـماد الفوسـفاتى و بقايـا المحاصـيل علـى إدمصـاص الفوسفور و توازنه فى التربه تحت نظام دوره زراعيه للذره و البرسيم

حسين محمد على راغب ، هاله حسانين جمعه، محمد فتحى غنيم و محمود رسلان
قسم الاراضى و المياه - كلية الزراعه – جامعة اسيوط

تم إتباع دوره زراعيه للذره و البرسيم منذ 1988 و حتى الان و ذلك فى المزرعه البحثيه لقسم الاراضى و المياه بجامعة اسيوط0فى نهاية كل موسم، تم قلب بقايا كل محصول فى التربه (5.45 طن للفدان للسنه من بقايا الذره و 3.71 للفدان للسنه من بقايا البرسيم)0 كما اضيفت ستة معاملات من الفوسفور (صفر , 100, 200, 300, 400, 500 كجم سوبرفوسفات للفدان)0

و قد أوضحت النتائج أن كميـة الفوسفور الميسر التى يجب أن تتوفر فى التربـة لاعطـاء أعلى إمتصاص للفوسفور هى46.8 و 51.4 جزء فى المليون فى حالة عدم إضافة بقايا المحاصيل و فى حالة الضافه على التوالى0 كما حدثت زياده معنويه فى وزن الماده الجافه و محصول الحبوب فى كلا النظامين من التسميد0

أوضح تحليل الميزان الظاهرى للفوسفور فى كلا النظامين انه عند اضافة السماد الفوسفاتى بمعدل 400 كجم سوبرفوسفات للفدان كل موسم أو كميات اعلى من ذلك فانه يحدث تراكم للفوسفور فى التربه0

إنخفض ادمصـاص الفوسـفور فـى الطبقـات السـطحيه مـع كـل مسـتويات السـماد المعـدنى المستخدمه نتيجه لخلط بقايا المحاصيل بالطبقه السطحيه0