Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 102 (2018) 173-179 EISSN 2392-2192

SHORT COMMUNICATION

Phosphorous transformation as influenced by different levels of phosphorous alone and in combination with humic acid

Aftab Jamal*, Iqrar Hussain, Muhammad Sarirullah Sarir and **Muhammad Fawad**

Department of Soil and Environmental Sciences University of Agriculture Peshawar, Pakistan

*E-mail address: aftabses98@gmail.com

ABSTARCT

An incubation experiment was carried out in completely randomized design (CRD) at the laboratory of soil and environmental sciences, the university of Agriculture Peshawar, Pakistan to investigate changes in AB-DTPA extractable soil Phosphorous (P) with the addition of Humic acid (HA) and added P levels as single super phosphate (SSP). Two levels of HA including control (H0: control and H1: 500 g ha^{-1}) and four levels of P as single super phosphate (SSP) including control (P0: control, P1: 60 kg ha^{-1}, P2: 90 kg ha^{-1}, and P3: 150 kg hectare) were utilized. Soil treated with different levels of SSP alone or reinforced with HA showed an initial decline in AB-DTPA extractable P in first 14 days and then rapid mineralization up to 56 days of incubation in the laboratory. HA increased mean available P by 44.93, 16.08 and 7.25 % at 0, 60 and 90 kg P_20_5 ha^{-1}. Weekly turnover of P ranged from 0.19 to 0.43 mg P kg^{-1} soils for soils treated with different levels of SSP alone or reinforced with HA. HA increased weekly turnover by 40 and 8.82 % at 60 and 90 kg P_20_5 ha^{-1} as SSP respectively. HA applied alone or reinforced with 60 and 90 kg P_20_5 ha^{-1} increased mean available P, weekly turnover of P as well as mineralization potential.

***Keywords*:** Incubation, SSP, Humic acid, phosphorous transformation

(Received 08 May 2018; Accepted 18 June 2018; Date of Publication 25 June 2018)

1. INTRODUCTION

One of the key threats to crop growth is the deficiency of elements called plant nutrients. Among them phosphorous (P) is one of the most important one recognized by various investigators (Ahmad et al 2013 and Naseer et al 2014). P possess complicated behavior both in acidic and in alkaline soil environment faced by scientists (Quan et al. 2008). Most of Pakistani soils were found deficient in available P (80-90%) and needs proper supplementations to boost up maximum crop yield (Memon 1996).

Even though P is widely distributed in nature, yet in most of the soils P availability in soluble form is very limited, only 0.1% is available to plants (Xiao et al. 2011). In the form of phosphate fertilizers, phosphorous are added to the soil, a significant part of the phosphatic fertilizer is lost through different mechanisms, of which both chemical and biological transformations into insoluble and unavailable forms play an important role. In order to maximize the fertilizer P use efficiency and to know the mechanism of P solubility and insolubility, P transformation study is must. Organic matter content through its microbial decomposed products influences the availability of P content in soil (Sarir et al. 2006). So far very little work has been done on P transformation under conditions inducing the mineralization of organic P or the immobilization condition inducing of soil inorganic P. Keeping in mind the importance of P transformation in soil the present study was carried out to measure changes in AB-DTPA extractable P resulting from the addition of HA and different levels of inorganic P fertilizer. Incubations effects on P transformation were also studied from 0 to 84 days period.

2. MATERIALS AND METHODS

An incubation experiment was carried out to investigate changes in AB-DTPA extractable soil Phosphorous (P) with the addition of Humic acid (HA) and added P as single super phosphate (SSP).

2. 1. Location and collection of Soil Sample

The experiment was performed at Department of Soil and Environmental Sciences, University of Agriculture Peshawar, Pakistan. A composite soil sample was collected from Research Farm of Agriculture University Peshawar, Pakistan at 0-20 cm depth. Sample was weighed into plastic bottles in fresh condition and was mixed with different levels of SSP alone and in combination with HA.

2. 2. Treatments and Experimental design

Two levels of humic acid including control (H0: control and H1: 500 g ha^{-1}) and four levels of P as single super phosphate (SSP) including control (P0: control, P1: 60 kg ha^{-1}, P2: 90 kg ha^{-1}, and P3: 150 kg hectare) were utilized. There were total eight treatments (given below) replicated three times. One replicate of each treatment was placed in each of three chambers of incubator in completely randomized design (CRD) at 25 °C. Soil was incubated for 12 weeks using incubation techniques of Jenkinson and Powlson (1976) with some modification.

Soils in the bottles were kept at field capacity level by the addition of distilled water and were maintained aerobic. AB-DTPA extractable P was measured by spectrophotometer at 0, 7, 14, 28, 56, and 84 days of incubation interval (Soltanpur and Schwab, 1985).

Treatment 1	P0H0
Treatment 2	P0H1
Treatment 3	P1H0
Treatment 4	P1H1
Treatment 5	P2H0
Treatment 6	P2H1
Treatment 7	P3H0
Treatment 8	P3H1

2. 3. Calculations

Mean available P was determined by adding soil P at 0, 7, 14, 28, 56, and 84 days of incubation and then divided by total number of observations. The change in P content (weekly turnover) was calculated by subtracting the initial P extracted by AB-DTPA at time zero from the final P extracted after 12 weeks of incubation and divided by total number of weeks. Mineralization potential in kg ha^{-1} $week^{-1}$ was calculated by multiplying weekly turnover in mg P kg^{-1} $week^{-1}$ with 2,000,000 and divided by 1,000,000 because weight of one- hectare soil is approximately 2,000,000 kg and 1,000,000 mg is equal to one kg.

$$\text{Kg P ha}^{-1}\ \text{week}^{-1} \times 4 \text{ is} \rightarrow \text{kg P ha}^{-1}\ \text{month}^{-1} \times 6^{*} \rightarrow \text{kg P ha}^{-1}\ \text{season}^{-1}$$

*wheat growing season = 6 months

3. RESULTS AND DISCUSSION

Phosphorous determined in control soil showed both immobilization and mineralization at different stages of incubation. In case of soil treated with 500 g HA ha^{-1} (P0H1) alone, a slow and gradual increase in AB-DTPA extractable P was recorded from 0 up to 84 days of incubation. Extractable P content was found more in soil treated with 500 g HA ha^{-1} (P0H1) alone with mean value of 9.16 mg P kg^{-1} soil as compared with untreated soil (P0H0) where mean extractable P was 6.32 mg P kg^{-1} soil (Table 1). AB-DTPA extractable P in soils treated with 60 kg P_2O_5 ha^{-1} alone (P1H0) decreased in first 14 days and then rapid mineralization was recorded up to 56 days of incubation. Rise in extractable P was slow from 56 to 84 days of incubation. While 60 kg P_2O_5 in combination with HA (P1H1) showed rapid initial decline up to 7 days, followed by rapid release up to 56 days and then slow rise. Similar results were obtained from the treatments P2H0 and P2H1. Mean available P was increased at 0, 60 and 90 kg P_2O_5 ha^{-1} alone or reinforced with HA but at 150 kg P_2O_5 ha^{-1}, HA caused decline in mean available P. Highest mean available P was recorded in the treatment P3H0 (Table 1). Percent increase in mean available P due to HA against 0, 60 and 90 kg P_2O_5 ha^{-1} were 44.93, 16.08 and 7.25 %. It means that effect of HA is more pronounced at low level of SSP.

Table 1. Effect of different levels of SSP alone and in combination with HA on P transformation during incubation

Treatments	Incubation Period in days						Mean Available P (mg kg^{-1} soil)
	0	7	14	28	56	84	
	AB-DTPA extractable P (mg P kg^{-1} soil)						
P0H0	6.12	6.53	6.36	5.93	6.45	6.53	6.32
P0H1	7.82	8.42	9.00	9.68	9.96	10.10	9.16
P1H0	10.00	9.70	8.35	10.65	11.58	12.40	10.45
P1H1	11.07	9.28	10.55	13.37	14.09	14.42	12.13
P2H0	13.10	12.00	10.83	14.15	16.30	17.20	13.93
P2H1	13.84	12.35	13.55	15.86	17.75	18.31	14.94
P3H0	16.30	12.45	11.10	16.00	19.95	21.50	16.22
P3H1	14.10	10.94	12.48	14.73	17.55	18.43	14.70

The rate of changes of extractable P (weekly turnover) ranged from 0.19 to 0.43 mg P kg^{-1} soil for soils treated with different levels of SSP alone and in combination with HA, while it is 0.03 mg P kg^{-1} soil for control (Table 2 and Fig. 1). Percent increases in weekly turnover due to HA against 60 to 90 kg P_2O_5 ha^{-1} were 40.00 and 8.82 %. Weekly turnover increased at 0, 60 and 90 kg P_2O_5 ha^{-1} alone or reinforced with HA but at 150 kg P_2O_5 ha^{-1}, HA caused a decline in weekly turnover. Highest weekly turnover (0.43 mg P kg^{-1} soil) was recorded in the treatment P3H0. HA increased mineralization potential at 0, 60 and 90 kg P_2O_5 ha^{-1}. Highest mineralization potential of 20.64 kg P ha^{-1} $season^{-1}$ was recorded in the treatment P3H0 followed by 17.76 kg P ha^{-1} $season^{-1}$ in the treatment P2H1 (Table 2).

These results were in agreement with the findings of Sarir et al. 2006 showed greater P recovery and mineralized P from humic acid application. Similarly Alvarez et al 2004 found that 9 months incubation caused labile P (resin plus bicarbonate P) to decrease by 11 mg P kg^{-1} soil (0.3 mg P kg^{-1} soil $week^{-1}$). The mean rate of change of AB-DTPA extractable P was found 0.45 mg P kg^{-1} $week^{-1}$ (Ali and Sarir 1992; Cimrin, 2001, 2005; Atiyeh, 2002; Bouyoucous, 1951; Lee, 1976; Lobartini, 1997; Wang, 1995).

Table 2. Effect of different levels of SSP alone and in combination with HA on weekly turnover and mineralization potential.

Treatments	Incubation Period (days)		Weekly turnover (mg P kg^{-1} soil)	Mineralization potential (kg P ha^{-1} $season^{-1}$)
	0	84		
P0H0	6.12	6.53	0.03	1.44
P0H1	7.82	10.10	0.19	9.12
P1H0	10.0	12.40	0.20	9.60
P1H1	10.50	13.42	0.24	11.52
P2H0	13.10	17.20	0.34	16.32
P2H1	13.84	18.31	0.37	17.76
P3H0	16.30	21.50	0.43	20.64
P3H1	14.10	18.43	0.36	17.28

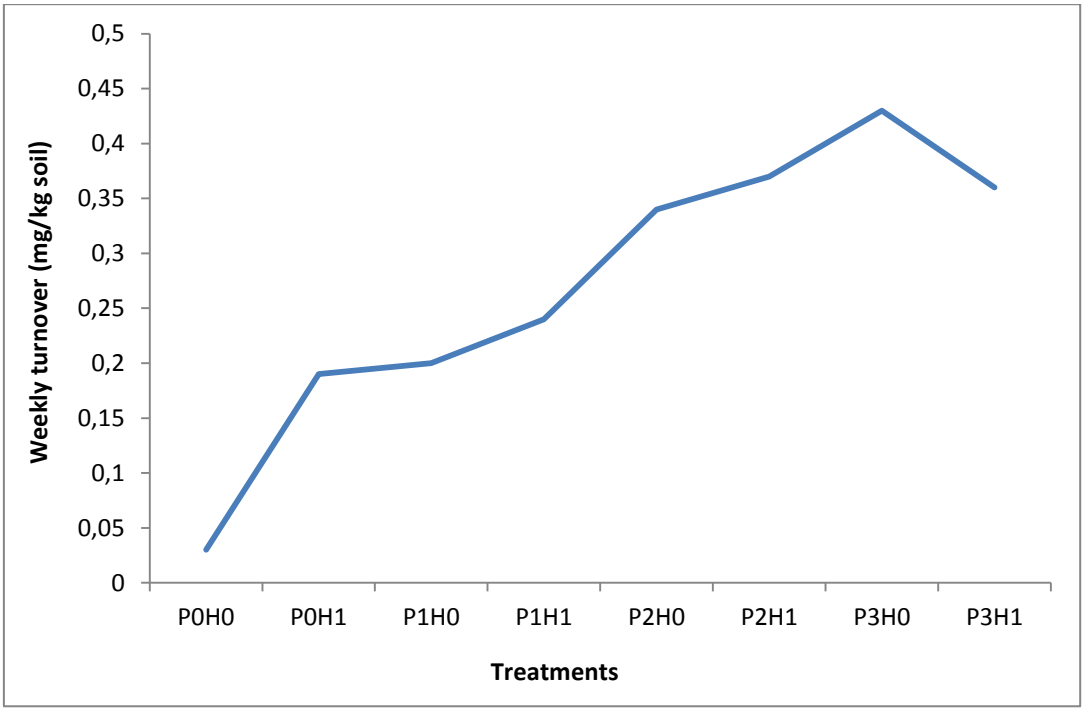

Fig. 1. Effect of different levels of SSP alone and in combination with HA on weekly turnover of soil P (mg P kg^{-1} $week^{-1}$) as influenced by incubation

It was noted that mineralization potential increased with increase in the level of P fertilizer applied alone (Table 2), while in case of soil treated with different levels of SSP reinforced with HA, highest mineralization potential was recorded in the treatment P2HI, however further increased beyond this level caused a decline in mineralization potential. It may be due to immobilization of P by HA (Table 2).

4. CONCLUSIONS

It may be concluded from the study that SSP applied at the rate 90 kg ha^{-1} along with 500 g HA was more effective in making the soil environment conducive for soil P mineralization and for plant nutrients availibility. Morever soil treated with different levels of SSP alone and reinforced with HA showed an initial decline in AB-DTPA extractable P in first 7 and 14 days, then rapid mineralization up to 56 days of incubation and after 56 days, increase in extractable P slows down till 84 days of incubation. Further investigations are highly sugested to study the effect of different levels of P alone and in combination with HA on P transformation.

Refrences

[1] Ahmad, M., Khan, M. J., & Muhammad, D. (2013). Response of maize to different phosphorus levels under calcareous soil conditions. *Sarhad J. Agric*, 29(1), 43-48.

[2] Naseer, M., & Muhammad, D. (2014). Direct and residual effect of hazara rock phosphate (HRP) on wheat and succeeding maize in alkaline calcareous soils. *Pak. J. Bot*. 46(5), 1755-1761.

[3] Quan-Xian, H. U. A., Jian-Yun, L. I., Jian-Min, Z. H. O. U., Huo-Yan, W. A. N. G., Chang-Wen, D. U., & Xiao-Qin, C. H. E. N. (2008). Enhancement of Phosphorus Solubility by Humic Substances in Ferrosols. *Pedosphere*, 18(4), 533-538.

[4] Xiao CQ, Chi RA, Li XH, Xia M, Xia ZW (2011). Biosolubilization of rock phosphate by three stress-tolerant fungal strains. *Appl. Biochem. Biotechnol.* 165: 719-727.

[5] Memon, K.S. 1996. Soil and Fertilizer Phosphorous. In Soil Science. Bashir E. and R. Bentel (Ed).

[6] Sarir, M. S., Durrani, M. I., & Mian, I. A. (2006). Effect of the source and rate of humic acid on phosphorus transformations. *Journal of Agricultural and Biological Science*, 1(1), 29-31.

[7] Alvarez, R., Evans, L. A., Milham, P. J., & Wilson, M. A. (2004). Effects of humic material on the precipitation of calcium phosphate. *Geoderma*, 118(3-4), 245-260.

[8] Jenkinson, D.S, . and D.S Powlson (1976). The effect of biosidal treatments on metabolism in soil. *Soil. Biol. Biochem.* 8: 209-213

[9] Soltanpour, P.N. (1985). Use of AB-DTPA soil test to evaluate elemental variability and toxicity. *Commun. Soil Sci. Plant Anal*, 16: 323-338.

[10] Ali, M., and M.S. Sarir (1992). Transformation of P in soil series of Peshawar valley. M.Sc. Thesis Dept. Soil Sci. NWFP Agric. Univ. Peshawar-Pakistan.

[11] Zhen-Yu Du, Qing-Hua WANG, Fang-Chun Liu, Hai-Lin MA, Bing-Yao MA, S.S. Malhi. Movement of Phosphorus in a Calcareous Soil as Affected by Humic Acid. *Pedosphere* Volume 23, Issue 2, April 2013, Pages 229-235

[12] K. Mesut Cimrin, Ismail Yilmaz. Humic acid applications to lettuce do not improve yield but do improve phosphorus availability. *Acta Agriculturae Scandinavica, Section B — Soil & Plant Science* Volume 55, 2005 - Issue 1, Pages 58-63

[13] Atiyeh, RM, Lee, S, Edwards, CA, Arancon, NQ and Metzger, JD. (2002). The influence of humic acids derived from earthworm-processed organic wastes on plant growth. *Bioresource Technology*, 84: 7–14.

[14] Bouyoucous, GD. (1951). A recalibration of the hydrometer method for making mechanical analysis of soil. *Agron. J.* 43: 434–438

[15] Çimrin, KM, Karaca, S and Bozkurt, MA. (2001). The effect of NPK and humic acid applications on growth and nutrition of corn plant (Zea mays L.). *Ankara University Journal of Agricultural Sciences*, 7: 95–100

[16] Lee, YS and Bartlett, RJ. (1976). Stimulation of plant growth by humic substances. *Soil Sci. Soc. Amer. J.* 40: 876–879.

[17] Lobartini, JC, Orioli, GA and Tan, KH. (1997). Characteristics of soil humic acid fractions separated by ultrafiltration. *Commun. Soil Sci. Plant Anal.* 28: 787–796

[18] Wang, XJ, Wang, ZQ and Li, SG. (1995). The effect of humic acids on the availability of phosphorus fertilizers in alkaline soils. *Soil Use and Management*, 11: 99–102