EFFECT OF THE SOURCE AND RATE OF HUMIC ACID ON PHOSPHORUS TRANSFORMATIONS

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ABSTRACT

An incubation experiment was carried out in vitro to monitor changes in bicarbonate extractable phosphate, resulting from the addition of applied-P (SSP) reinforced with both Farm Yard Manure (humic acid basis) and humic acid (lignitic coal). A calcareous soil was incubated with SSP (60 kg ha^{-1}) alone and in different combinations with Farm Yard Manure (FYM) and humic acid (200, 400, 800, 1600 and 2000gms ha^{-1}). Addition of FYM could not help in the mineralization of applied-P. The non significant effect of Farm Yard Manure on P-mineralization suggests that FYM recommendations on the basis of humic acid content do not fulfill the actual humic acid requirements. Therefore, further work is needed to incorporate additional parameters to fulfill the actual humic acid requirements. Humic acid (lignitic coal) applied @ 200g ha^{-1} showed least P-immobilization both from native and applied-P pool during 16 week of incubation. Percent P recovery and mineralized-P was also greater in humic acid @ 200g ha^{-1} soil.

Keywords: humic acid, FYM, Farm Yard Manure, phosphorus transformation, phosphate, lignitic coal.

INTRODUCTION

The most important constraint to crop growth is caused by shortage of the elements which are plant nutrients. Of these, phosphorus is one of the most important. It has attracted considerable attention of research workers. The main reason for this is the complicated behavior of P in both acidic and alkaline soil environment, faced by Soil Scientists.

Life in any form cannot exist without P. No soil can sustain high yields if it is deficient in P and this deficiency is not corrected. Most of our soils are deficient in P and need extraneous supplementation of P for sustained crop yields. However, it is possible that such increase in P addition for the purpose of enhancing plant growth can cause substantial P losses, due to chemical and biological immobilization. It is general belief, that organic matter influences the available phosphorus content through its microbially decomposed products. Very little work has been done on the influence of incubation on changes in extractable phosphate, resulting from the addition of organic matter. In the present study, changes in bicarbonate extractable phosphate resulting from the addition of both FYM (humic acid basis) and humic coal (lignitic coal) were investigated. The effects of incubations ranges from 0 to 16 weeks on P-transformation were also studied.

MATERIALS AND METHODS

Soil samples were collected from Peshawar soil series of NWFP. A visual assessment was made for selecting an area of uniform appearance over the series keeping in view the colour of the soil, topography, steepness of the slope, absence or presence of vegetation, density of vegetation and phosphorus treatment in the past.

A freshly collected soil samples were brought to the laboratory as soon as possible and spread out on clean plastic sheets. Any vegetation, roots, stone etc. were dried enough to permit sieving through a 2mm sieve with minimum of disturbance. Samples were dried at room temperature and away from chemicals containing phosphorus. The sieved samples were thoroughly mixed and stored in tied plastic bags at 4°C until they were to be used.

Soil Analysis

Soil samples were analyzed for texture (Moodi et. al, 1959), pH and ECe of 1:5 soil water suspension (Richard, 1954), $CaCO_3$ (Black, 1965), organic matter (Jackson, 1958) and moisture (Atikinson et. al. 1958).

Phosphorus Mineralization

To monitor changes in bicarbonate extractable phosphate (Watanab and Olsen, 1965), plastic bins with water soaked filter papers were used as an incubation chamber and stored in a growth room maintained at 30°C. Two experiments (RCB) each containing eighteen 100 g soil samples (6 treatments, 3 times replicated) in fresh condition were weighed into wide mouth 250 ml. plastic bottles. The amount of FYM (0, 1, 2, 4, 8, 10 g FYM, eq = 0, 0.1, 0.2, 0.4, 0.8 and 1.0mg humic acid kg^{-1} soil) was mixed with soil, water added to field capacity and incubated for 48 hours at 20°C. A known quantity of the stock solution of phosphorus was pipetted into each of the soil manure mixtures giving a final required phosphorus concentration. Humic acid was determined by the method of Page et. al. (1982). Phosphate extractable in sodium bicarbonate was measured in duplicate at 0, 1, 2, 4, 8, 12 and 16 weeks of incubation.

Calculations

The rate of change of extractable-P was calculated by subtracting the initial-P extracted at time zero, form the final-P extracted after 12 weeks of

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incubation. The change in P extracted per week was calculated by dividing the change in P by total weeks of incubation.

Percent P recovery was calculated according to the formula; Pa + Pq = Pe + Pr

Where

a = Added – P

q = Native – P

e = Extracted – P

r = Retained - P.

RESULTS AND DICUSSION

Farm Yard Manure

Changes in the extractable soil phosphate influenced by the amount of humic acid (FYM) and incubation time of both treated and untreated soils indicate that untreated soil showed a constant level of extractable-P irrespective of incubation time. Similarly, all the five levels of humic acid (FYM) behaved similar after initial immobilization. However, the magnitude of extractable-P increased with the increase of humic acid. The increase in extractable P over control due to humic acid has been depicted in Table-1. It is evident from the data that there was a tendency for the extractable P to decrease after 7 days of incubation. This may be due to the formation of insoluble P compounds in the soil. Humic acid (FYM) showed little and inconsistent effect on extractable-P from applied P after 14 days of incubation which was continued up to 84 days. The effect of FYM on the basis of humic acid content on extractable P, during incubation has been studied rarely and so to explain is somewhat difficult. Moreso rate of mineralization of P in animals manure are usually vary a great deal, depending on the nature of the material and condition of storage prior to application (Islam and Ahmed, 1973). Most of the workers concluded that the increase in available P could be attributed mostly to the role of FYM in converting a portion of native P and not the applied P which transform into compounds which are not easily extractable and result in the build up of total P in soil (Rahate et. al., 1979). For example Dashrath et al., (1976) reported that application of FYM at the rate of 30g kg^{-1} soil showed little effect on the availability of P from applied P. Similar results were also reported by Khanna et al (1979).

To sum up, the mean effects showed that addition of humic acid (FYM) increased the availability of P, but did not increase the amount of mineralized-P from the applied super-phosphate with time. On the whole humic acid (FYM) treated soils showed higher amount of available-P than the no humic acid (FYM) treatment and is attributed to mineralization some of organic-P of FYM. However, this mineralized-P transform into compounds with time, which are not easily extractable and result in the build up of total-P retained in the soil.

Table-1. Increase of bicarbonate extractable-P (mg kg^{-1} soil) over control due to humic acid (FYM).

P_2O_5	**Humic Acid** (mg kg^{-1}soil)	**Days**					
		0	**7**	**14**	**28**	**56**	**84**
34	0.0	-	-	-	-	-	-
34	0.1	3.6	1.2	3.0	1.0	1.0	0.7
34	0.2	1.7	0.6	0.7	2.2	2.2	1.1
34	0.4	1.7	0.8	2.1	1.0	1.5	1.4
34	0.8	1.3	0.1	0.7	1.5	1.7	1.8
34	1.0	3.4	1.7	2.5	2.4	2.5	2.7

Humic Acid

Changes in extractable soil phosphate influenced by the amount of humic acid (lignitic coal) and incubation time of both treated and untreated soils are shown in Table-2. Untreated soil showed as constant level of extractable-P irrespective of incubation time. Humic acid applied @ 200g ha^{-1} caused initial decline in the first 7 days followed by rapid release up to 56 days and then slow rise continued up to 84 days, indicating slight further changes. Rest of all the humic acid treatments, after the initial but rapid decline in the first two weeks followed by rapid release of PO_4 up to 56 days.

The rate of change of extractable-P and mineralized-P ranged from 0.06 to 0.7mg P kg^{-1} $week^{-1}$ and 6 to 60kg ha^{-1} $year^{-1}$, respectively (Table-3). Although, the magnitude of mineralized-P varied, little difference was found between lower (H_1) and higher (H_{10}) level of humic acid. Similarly, humic acid applied @ 0.1 (H_1) mg kg^{-1} soil increased the availability of P at both 0 and 34mg p kg^{-1} soil of P addition. The percent P recovered was also higher in case of both H_1 with and with out applied-P. The results further revealed that P recovery decrease with the increase of humic acid beyond 0.1mg kg^{-1} soil (200g ha^{-1}), and therefore the un-recovered bicarbonate-P was retained in unavailable from.

Table-2. Increase of bicarbonate extractable-P (mg kg^{-1} soil) over control due to humic acid (Lignitic coal).

P_2O_5	Humic Acid (mg kg^{-1} soil)	Days					
		0	7	14	28	56	84
0	0.0	9.3	10.7	9.3	9.0	10.0	10.0
34	0.0	20.0	11.3	16.1	24.7	27.0	28.0
34	0.1	23.4	16.0	18.8	23.7	26.7	27.0
34	0.2	18.7	14.3	14.6	17.0	20.0	19.3
34	0.4	18.7	12.6	11.5	17.6	20.0	20.7
34	0.8	20.7	20.6	12.1	24.3	24.0	23.7
34	1.0	23.4	16.0	13.5	20.3	24.7	27.3

Table-3. Effect of Phosphatic fertilizer alone and reinforced with humic acid on P transformation.

P- Rate	Humic Acid	P-Recovery	Weekly Turnover	Mineralization Potential	Mean Available -P
(mg kg^{-1} soil)		%	(mg kg^{-1} soil)	Kg ha^{-1} $Year^{-1}$	(mg kg^{-1} soil)
0	0.0 H_0	100	0.06* Bc	6.0	9.7
34	0.0 H_0	62	0.72 A	60.0	30.9
34	0.1 H_1	67	0.36 B	34.0	32.3
34	0.2 H_2	51	0.11 Bc	10.0	26.5
34	0.4 H_4	49	0.22 B	21.0	26.6
34	0.8 H_8	62	0.31 B	30.0	30.6
34	1.0 H_{10}	62	0.38 B	37.0	30.6

* Means sharing same letters do not differ significantly.

CONCLUSION

It may be concluded from this study that the amount of FYM calculated on the basis of humic acid is of limited value for calcareous soils in increasing the availability of applied phosphate. Further study is needed to sort out additional parameters which may hold promise for improving its predictive ability to fulfill the actual FYM requirements on the basis of humic acid which could help in increasing the P mineralization potential and thus available P of the soil. The present study also suggests that the low P mineralization and high adsorption potential inherited in these soils (Ali, M. and et. al., 2000) may aggravate the problem of the utilization of applied phosphate reinforced with FYM. The present study also revealed that humic coal applied @ 200g ha^{-1} (0.1mg kg^{-1} soil) seem to be more conducive for P availability and suppress P fixation either through chelation, acidifying mechanism or microbially induced mineralization processes.

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