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AVAILABILITY OF SOIL ORGANIC PHOSPHORUS TO CROPS

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Abstract

The influence of each of potassium dihydrogen phosphate, ammonium sulphate, compost and glucose at the rate of 100 kg ha $^{-1}$ and liming of soil to pH 7.0, on the uptake of phosphorus from organic fraction by rice, jute, wheat, soybean and tomato plants has been studied. All the crops absorbed mineralized soil organic phosphorus significantly. Plants absorbed more organic phosphorus from soil treated with ammonium sulphate and lime.

Introduction

Soil organic matter contains a fairly uniform proportion of phosphate (Anderson,1967) comprising a significant fraction of total phosphorus (Cosgrove. 1967). According to Bray and Kurtz (1945) organic P is important in soil fertility as an indirect source of available forms. It helps to counter balance the effect of crop removal and in highly organic soils a good level of available forms is often maintained over a period of years despite crop removal, but it contributes very little (Eid *et al.*, 1951) or no direct value (Wild and Oke, 1966) to phosphorus assimilation by plants unless mineralized. Mineralization depends largely upon the environmental conditions under which the biochemical transformation takes place (Bear, 1975). The role of organic phosphorus in plant nutrition under equitorial conditions is not known, but the higher proportion of this form for forest soils suggests that it may be following its mineralization, an important source of inorganic phosphorus (Enwezor and Moore, 1966). Thus, greenhouse experiments were conducted to assess the availability of soil organic phosphorus to crops under different conditions in some humid tropical soils of Bangladesh.

Materials and Methods

Materials: Samples of surface soils (0-15 cm) representing three series were collected from two tracts namely Gangetic alluvium and Tista floodplain of Bangladesh on the basis of their high organic phosphorus content and varying in their physical and chemical properties (Table 1).

Green House Experiment : 100 g of 2 mm air-

Table 1. General characteristics of the soil samples

Soil series	General soil type	Texture	pH	Clay (%)	Organic carbon (%)	Available phosphorus	Organic phosphorus	Inorganic phosphorus	Total phosphorus
						μg^{-1} soil			
Harta	Peat	Clay	5.8	50	12.94	7.5	560	250	810
Naldanga	NDGFS	Silt	5.9	30	12.04	6.8	530	250	780
Paysa	NDGFS	Silt loam	6.6	28	7.09	10.6	450	230	680

NDGFS=noncalcareous grey floodplain soil

dried soil was taken in each plastic pot (12 cm × 10 cm). The influence of each of lime, compost, potassium dihydrogen phosphate, glucose and ammonium sulphate on availability of soil organic phosphorus to crops has been examined. Calcium carbonate was added to bring the pH of the samples to 7.0. Potassium dihydrogen phosphate, ammonium sulphate, compost and glucose were each added at the rate of 100 kg ha^{-1} separately. A control was also maintained. The plant varieties subjected to absorption tests were rice *(Oryza sativa* BR-3*)*, jute *(Chorcorus capsularis* cultivar D-154*)*, wheat *(Triticum aestivum* sonalika-74*)*, soybean *(Giycine max* Mervill cv Lee-74*)* and tomato *(Lycomersicon esculentum* oxheart*)* crops. Seeds of each variety were sown at the rate of 8 seeds/pot at a regular distance from one another. Three plants were kept finally in each pot after germi nation by proper thinning. Every effort was made to keep the moisture content constant during the experiments by the addition of distilled water whenever needed. The experiments were arranged in a completely randomized block design with two replications. Plants were removed carefully from the soil after 60 days of germination, oven dried for 24 hours at 60°C ± 1°C and powdered finely for phosphorus analysis.

Chemical analyses : pH was measured electrochemically by using a Pye glass electrode, the soil and water ratio being 1:2.5. Organic carbon was determined by wet oxidation method as described by Walkley and Black (1934). The method of Mehta *et al.* (1954*)* was used for estimating organic and inorganic phosphorus content of the samples. Plant phosphorus was estimated colorimetrically following wet oxidation (Jackson, 1958). Available phosphorus was determined from 0.002 N H_2SO_4 (pH, 3.0 ; Truog, 1930) extract colorimetrically (Dickman and Bray, 1941) using a Coleman Junior II spectrophotometer.

Results and Discussion

The amount of phosphorus absorbed by the crops from soil organic phosphorus fraction was measured from the following equations assuming that the whole amount of initial available phosphorus was absorbed by the crops and ignoring the amount absorbed, if any, rendered available from native inorganic fraction during growing period.

Table 2. Uptake of organic phosphorus (mg pot $^{-1}$) by rice, jute and wheat

Treatment	Rice			Mean	Jute			Mean	Wheat			Mean
	H	N	P		H	N	P		H	N	P	
Control	3.3	5.2	5.1	4.5	6.2	5.3	5.0	5.5	3.1	6.4	3.3	4.3
KH_2PO_4	7.2	11.5	9.2	9 3	14.0	15.1	12.1	13.7	5.1	7.2	6.4	6.3
$(NH_4)_2SO_4$	10.7	15.3	13.5	13.2	17.5	18.2	14.9	16.7	7.4	10.2	10.3	9.3
Compost	8.0	13.3	11.6	11.0	13.0	13.0	13.1	13.0	4.4	7.1	8.1	6.5
Glucose	7.4	9.2	8.3	8.3	12.4	10.9	11.2	11.5	3 7	6 0	5.1	6.1
Lime	11.6	14.3	14.0	13.3	18.2	14.0	17.1	16.4	6.3	9.2	12.2	9.2
Mean	8.0	11 5	10.3		13.6	12.8	12.2		5.0	7.7	7.6	
Soil mean		59.6				77.1				40.5		
LSD Trt.		70 9				0.50				0.62		
at Soil		0.56				0.39				0.45		
0.1% Trt. × Soil		1.35				0.90				1.07		
Trt. × Soil × Crop		NS				NS				NS		

H, Harta Soil ; N, Naldanga Soil ; P, Paysa Soil ;
NS, nonsignificant

Table 3. Uptake of organic phophorus (mg pot $^{-1}$) by soybean and tomato

Treatment	Soybean			Mean	Tomato			Mean	Mean
	H	N	P		H	N	P		
Control	9.2	8.8	8.2	8.7	1.4	2.3	2 2	2.0	5.0
KH_2PO_4	15 2	14.2	14.2	14.5	3.2	4.4	4.9	4 2	9.6
$(NH_4)_2SO_4$	18.1	18.8	17.2	18.0	6.0	8.8	8.1	7.6	13 0
Compost	11.3	11.2	12.2	11.6	5.2	7.1	6.2	6.2	9.7
Glucose	10 3	7.2	8.1	8.5	2.1	5.2	4.2	3.8	7.4
Lime	14.1	10.3	9 3	11.2	5.0	3.7	5 2	4.6	11.0
Mean	13.0	11.8	11.5		3.8	5.3	5.1		
Soil mean		72.6				28 4			
LSD Trt.		0.39				2.41			
at Soil		0.28				1.68			
0.1% Trt. × Soil		0.67				NS			
Trt. × Soil × Crop		NS				NS			

Legend same as Table 1.

Mineralized Organic P = Initial Organic P —Organic P remained after cropping.

Organic P absorbed (Total P absorbed)= Mineralized Organic P =(Initial available P+ available P remained after cropping).

Analysis of variance showed that the overall effect of treatments produced significant effect on uptake of mineralized organic phosphorus by rice, jute, wheat, soybean and tomato crops at the probability level 0.1 per cent. The soils alone and the interaction between treatment and soil also showed significant effect on removal of organic phosphorus by crops following its mineralization at the same probability level. The interaction resulted nonsignificant effect in this respect only for tomato plants.

Results presented in Tables 2-3 indicate that a significant proportion of mineralized phosphorus was absorbed by all the crops from organic phosphorus fraction of all the soils and the amounts absorbed varied significantly with conditions prevailed. Control treatment supplied minimum amount of phosphorus to all the crops under study. The efficiency of the treatments in rendering organic phosphorus available to crops may be arranged as follows.

Treatment $(NH_4)_2SO_4$ > Lime > Compost > KH_2PO_4 > Glucose > Control

Amount absorbed (mg P por $^{-1}$) 13.0 > 11.0 > 9 > 7 > 7 > 9.6 > 7.4 > 5.0

It is noted that amount of mineralized organic phosphorus absorbed by crops varied from soil to soil. Rice, wheat, soybean and tomato plants absorbed maximum amount from Naldanga soil. The amounts accumulated were 11.5, 7.7, 11.8 and 5.3 mg P pot $^{-1}$. Harta soil showed the best performance to supply organic phosphorus (11.5 mg P pot $^{-1}$) to jute plant only. Naldanga and Paysa soils were found to be almost equally effective to provide organic phosphorus to crops. The ingeneral low availability of phosphorus from Harta soil might be the cause of high clay content (50%) (Table-1). Clay minerals can inhibit the enzymatic hydrolysis of phosphate esters by adsorbing the enzymes. Moreover, the presence of less humified organic materials in comparison to other soils might affected the availability of phosphorus to growing crops from Harta soil.

The relative root efficiency of test crops was calculated in terms of absorption of organic phosphorus from soil as the amount represented by soil mean by ignoring the effect of individual treatment. In practice, this comparative efficacy study of crops indicated a wide range of phosphorus accumulation varying from 28.4 to 77.1 mg P pot $^{-1}$. Such a variation in phosphorus uptake might be associated with root physiology of the crops. Best efficiency of roots was exerted by jute and the decreasing sequence of their performance may be summarized below.

Jute (77.1 mg P pot $^{-1}$) > Soybean (72.6mg P pot $^{-1}$) > Rice (59.6 mg P pot $^{-1}$) > Wheat (40.5 mg P pot $^{-1}$) > Tomato (28.4 mg P pot $^{-1}$).

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