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Moisture Regime Influencing Different Fractions of Applied Phosphorus in Calcareous Soil of North Bihar

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The soil under study was of calcareous in nature having 30% calcium carbonate. Fractionation of different inorganic bound P in soil *viz* Al-P and occ. Al-, Fe-P occ. Al-P and Ca-P periodically followed the weathering sequence of Ca-P > occ. Fe-P > Fe-P which is expected of young alluvium soil of calcareous origin. Neither Al-P nor occ Fe-P, Al-P was detected in the soil under both the situations, *i.e.*, at field capacity and water logged condition irrespective of change in incubation period or levels of P_2O_5 applied.

INTRODUCTION

The state of Bihar covering an area of 1,73,865 square kilometre and stretching between 27°31′ N to 21°58′ N latitude and 88°18′ E to 83°20′ E longitude is divided into three physiographic regions *viz.* (i) alluvial plains north of the river Ganges, (ii) alluvial plains south of the river Ganges and (iii) plateau region of Chhotanagpur. Alluvial plains north of the Ganges are further sub-divided into three groups: (a) young alluvium non-calcareous, (b) young alluvium calcareous and (c) young alluvium calcareous saline alkali.

The typical soils belonging to the last two groups cover about 80% of the total cultivated area of north Bihar. There is no denying the fact that phosphate plays a major role as one of the plant neutrient without which no successful crop husbandry can be thought. No systematic studies have so far been made to understand transformation of applied -P to calcareous soil of north Bihar. Thus the present studies has been confined to fractionate inorganic bound P like Al-P and occluded Al-P, Fe-P occluded Fe-P and Ca-P in the soils of different time intervals maintained at two water regimes, *i.e.*, at field capacity and saturated condition.

EXPERIMENTAL

Soil sample were collected at 0 to 15 cms depth from two sides *viz.*, Khabra Muzaffarpur. Characterisation of the soil indicated that it was calcareous in nature. Soil samples were passed through 4 mm. sieve for experimental purpose. the soil samples were analysed for pH, E.C. and different fractions of -P mentioned above according to Jackson[1], water holding capacity (W.H.C.), free $CaCO_3$ and organic C, as determined by Keen and Reazkowki[2].

An incubation experiment was conducted in plastic beakers each containing 500 g of the soil at two water regimes, *i.e.*, at field capacity (80% of the W.H.C.) and fully saturated condition, *i.e.*, water logged condition.

The soils were fertilised with single super phosphate using three levels of P_2O_5: 0, 40 and 80 ppm. The soils were fractionated for inorganic bound P like Al-P, Fe-P, occ Fe-P and Al-P and Ca-P periodically 0, 20, 40 and 60 days of incubation according to the method mentioned above.

RESULTS AND DISCUSSION

The data in respect of analysis of original soil samples, different fractions of P in calcareous soil maintained at field capacity and water logged conditions were presented in Tables-1, 2 and 3 respectively.

TABLE-1
CHARACTERISTICS OF THE EXPERIMENTAL SOIL

Parameters	Calcareous	Remarks
pH	8.4	1 : 2.5 soil: water ratio
E.C. (m.mhos/cm)	0.836	Saturation extraction
W.H.C.	37.18%	Keen Box experiment
F.C.	32.27%	80% of W.H.C.
$CaCO_3$ (free)	30%	HCl treatment
Organic carbon	0.375%	Walkely and Blackman
Organic matter	0.65%	–
Texture	Sandy loan	–
Fe	15 ppm	DTPA extractable
Mn	58 ppm	DTPA extractable
Available P_2O_5	10 ppm	Olsen's P
Al-P	Nil	
Fe-P	Nil	Jackson (1957)
Occluded Al-P	Nil	
Occluded Fe-P	495 ppm	
Ca-P	330 ppm	

Data presented in Table-1 suggested that the soil was calcareous in nature having low organic carbon and available P_2O_5 and alkaline in reaction (pH 8.4).

Table-2 and 3 clearly indicate that neither Al-P nor occ. Al-P was detected in any of the treatments under different situations though Fe-P containing higher fractions of occ. form was detected along with Ca-P. This conspicuous chemical behaviour of alluvial soils provides and opportunity for the quantitative measurements of soil chemical weathering. Chang and Jackson[3] have pointed out that the distributions of soil inorganic phosphorus was found to measure the degree of the chemical weathering sequence being Ca-P > Al-P > Fe-P > occluded P. Higher proportion of occluded Fe-P in the soil as well as Fe-P reflect that degree of

chemical weathering of these soils have gone to such an extent that activities of aluminosilicate and gibbsite have been gradually subdued resulting into Fe-P and occluded Fe-P as reported by Chang and Jackson[3] and Kitrick and Jackson[4]. It is a well established fact that young alluvium of north Bihar mostly contains clay of illitic nature which has been formed during weathering sequence after montmorillonite and perhaps it was due to this reason Al-P was not detected because aluminosilicate ions were not available to react with phosphorus. In this connection the work of Chakravarty and Mazumdar[5] is worth noting who studied that inorganic phosphorous was in the following order covering three major type of soils.

New alluvial > old alluvial > hill and forest

Al-P and Fe-P : New alluvial > hill and forest > old alluvial

Ca-P : New alluvial > old alluvial > hill and forest

TABLE-2
FRACTION OF INORGANIC BOUND P AT DIFFERENT PERIOD OF INCUBATION OF SOIL MAINTAINED AT FIELD CAPACITY (ppm)

levels of P_2O_5 (ppm)	period of incubation (in days) values in ppm				Mean	Inorganic bound -P
	0	20	40	60		
	–	–	–	–	–	Al-P
	3	–	–	–	0.75	Occ. Al-P
0	–	–	40	30	17.50	Fe-P
	492	335	383	337	386.75	Occ. Fe-P
	330	494	640	660	531.00	Ca-P
Total	825	829	1063	1027	936.00	
	–	3	–	–	0.75	Al-P
	–	–	3	–	0.75	Occ. Al-P
40	–	–	90	50	35.00	Fe-P
	492	335	351	165	335.75	Occ. Fe-P
	330	524	645	665	541.00	Ca-P
Total	822	862	1089	880	913.25	
	–	–	–	–	–	Al-P
	5	–	–	–	1.25	Occ. Al-P
80	–	–	120	100	55.00	Fe-P
	492	375	337	170	343.50	Occ. Fe-P
	330	524	650	667	542.75	Ca-P
Total	827	899	1107	937	942.50	

Fate of Fe-P: It was observed from Table-2 and 3 that so far Fe-P was concerned it could be detected after 20 days of the incubation with and without P-carriers under both the situation. In general there was decrease in Fe-P at field capacity but reverse trend under waterlogged condition. It seems that incubation

of soil at field capacity had created a temporary situation of hydrolysis which had released Fe-P after 20 days of incubation but in due course of time perhaps due to oxidation decreasing trend was visible. This agrument was subtantiated under waterlogged condition due to reversion of the reaction. Gupta and Nayan[6] and others[7,8], also observed that Fe-P content decreased at field capacity but increased under waterlogged condition. Waterlogging increase the Fe-P was also reported by Chang *et al.*[9, 10] and others[11–15].

TABLE-3
FRACTION OF INORGANIC BOUND PHOSPHORUS AT DIFFERENT PERIOD OF INCUBATION OF SOIL MAINTAINED AT WATERLOGGED CONDITION (ppm)

levels of P_2O_5 (ppm)	period of incubation (in days) values in ppm				Mean ppm	Inorganic bound -P
	0	20	40	60		
	–	3	–	–	0.75	Al-P
	–	–	–	–	–	Occ. Al-P
0	–	–	70	130	50.00	Fe-P
	492	469	422	278	415.25	Occ. Fe-P
	330	516	558	750	538.50	Ca-P
Total	822	988	1050	1158	1004.50	
	–	3	–	–	0.75	Al-P
	–	–	–	–	–	Occ. Al-P
40	–	–	50	100	37.50	Fe-P
	492	490	390	270	410.50	Occ. Fe-P
	330	508	588	790	554.00	Ca-P
Total	822	1001	1028	1160	1002.75	
	–	–	–	–	–	Al-P
	–	–	–	–	–	Occ. Al-P
80	–	–	90	170	65.00	Fe-P
	492	516	453	287	437.00	Occ. Fe-P
	330	524	556	750	540.00	Ca-P
Total	822	1040	1099	1207	1042.00	

Fate of occluded Fe-P: In general there was fall in this fraction of P with time with and without P-carrier under both the situation. It seems that young alluvium of calcareous origin has undergone weathering to such an extent that in due course of time occluded Fe-P decreased as also reported by Chang and Jackson[3]. Application of phosphatic fertilizer like single super phosphate could not increase this fraction which might be due to the fact that PO_4^{3-} ions might have reacted with Ca, Al, Fe present in the soil not allowing this fraction to form occluded Fe.

Fate of Ca-P: It is interesting to report that this fraction recorded higher values with time under both the conditions. Such type of general reaction is

expected in calcareous soil which is rich in Ca^{2+}. Concomittant increase of Ca-P with time has also been observed by Ivanov and Sauerbeck[16] and others[17-21] have studied the effect of pH on phosphate adsorption by soils.

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