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Phosphorus Sorption and Desorption Pattern in Four Rice Soils of Orissa

By

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ABSTRACT

The nature of soil phosphorus has been the subject of much controversy. The data presented here suggest that the pattern of P supply can be predicted for different soils. The release pattern can be predicted by assuming a desorption type of reaction. The initial level of phosphate in the soil solution is not a good criterion of phosphate supplying pattern over a growing period of plants.

INTRODUCTION

If the plants feed only from solution phosphorus, the instantaneous supply of phosphorus from solution might be considered as an intensity factor analogous to pH in the hydrogen system. The ability of soil to renew the phosphorus in solution might be considered as the capacity factor analogous to the total acidity in hydrogen system. Fried and Shapiro (1956) indicated that the phosphorus supplying pattern of low phosphorus fixing soils could be predicted by assuming that the phosphorus release was a desorption phenomenon as described by langmuir adsorption isotherm. The present investigation was undertaken with a view to measure both sorption capacity of added water soluble phosphate and to evaluate the continuous release of sorbed phosphorus under the influence of extracting agent in 4 rice growing soils of Orissa.

MATERIALS AND METHODS

The soil samples for the present investigation were collected from rice growing region of Orissa representing different soil groups *viz.* CRRI (alluvial), Berhampur (red loam), Sukinda (laterite) and R. E. Farm (shallow black). The soils were dried, powdered, sieved and used for sorption and desorption studies.

Two grams of soil was weighed into clean polyethylene 50 ml capacity tubes in the series and one ml of potassium dihydrogen orthophosphate was added into series of soils so that the quantity of phosphorus added ranged from 0, 50, 100, 150, 200, 250, 300, 400, 500 and 600 μg/g of soil. The tubes were covered and incubated for 3 days for completion of sorption process by the soil. At the end of the incubation period, the phosphorus was so extracted with Olsen's reagent at pH 8.5. The quantity of phosphorus so extracted was measured by chlorostannous reduced molybdophosphoric acid blue colour at 660 (Jackson 1958) the first extraction, the soils were utilized for desorption studies, by extracting with Olsen's extracting solution successfully for 5 times. The

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phosphorus thus, desorbed was measured colorimetrically. The data were also fitted to the straight line relationship by using Langmuir adsorption which is stated as

$$\frac{c}{x/m} = \frac{c}{b} + \frac{1}{b.xm} \cdots\cdots$$

RESULTS AND DISCUSSION

The results of phosphorus desorption in different soils over 6 successive extractions are presented in Table. It is seen that the quantity of phosphoru desorbed decreased at each extraction However, it is noted that the decreas is large between first to second tha the remaining successive ones. Th quantity of phosphorus desorbed afte third extraction remains more or les constant thereafter indicating that firs two extractions are effective in removin the greater part of the phosphoru sorbed. However, it is observed tha even after the sixth extraction th

TABLE. Quantities of phosphorus desorbed in relation to the quantity of phosphorus added (μg/ml

Soils	No. of extraction	Quantity of P added μg/g									
		0	50	100	150	200	250	300	400	500	600
C. R. R. I.	1	16.2	36.5	71.3	32.5	140.0	165.0	190.0	240.0	330.0	460.0
	2	13.1	31.0	40.1	49.4	54.0	68.0	80.1	101.7	119.8	128.0
	3	9.6	21.0	28.0	30.4	36.9	40.8	49.0	54.1	60.9	63.0
	4	4.1	11.9	16.3	18.1	20.4	21.6	24.0	24.4	24.6	25.0
	5	4.0	8.4	8.9	9.0	9.4	9.4	10.1	11.0	11.9	11.5
	6	3.9	7.4	8.1	8.3	8.6	8.5	7.9	8.0	9.1	8.8
Berhampur	1	15.9	30.4	64.9	84.6	129.4	171.0	199.8	253.8	310.8	446.0
	2	12.3	21.0	39.1	56.3	59.1	69.1	90.9	114.0	122.2	136.0
	3	8.0	13.1	16.6	18.9	18.1	22.6	23.9	28.4	31.0	35.5
	4	7.4	9.8	9.0	10.1	12.4	15.1	14.8	15.5	17.1	17.0
	5	7.0	8.1	9.4	8.6	8.7	10.2	9.9	10.6	11.1	13.0
	6	6.6	7.7	8.1	7.9	7.8	9.0	8.8	9.3	9.1	8.7
Sukinda	1	19.6	40.1	68.4	79.3	154.1	176.3	193.9	258.6	338.0	430.6
	2	14.6	31.0	43.8	50.9	58.8	74.7	90.4	109.8	127.0	133.3
	3	11.3	19.8	24.9	30.8	35.9	41.8	50.6	53.3	58.1	64.0
	4	9.4	11.8	14.1	15.6	17.7	22.1	26.1	25.3	24.9	25.8
	5	8.1	8.9	9.3	8.8	9.6	10.1	11.4	12.6	11.9	12.1
	6	7.8	8.4	8.6	8.0	7.9	7.8	8.3	8.9	8.4	7.9
R. E. Farm	1	6.0	40.4	83.1	99.1	163.0	190.0	240 0	310.0	430.0	520.0
	2	5.0	10.6	15.1	26.8	31.4	46.8	58.1	60.7	69.1	75.0
	3	3.1	8.2	10.1	13.3	15.0	16.6	18.4	20.0	21.2	24.0
	4	1.9	5.3	6.4	6.6	6.0	5.9	6.4	6.9	7.3	7.5
	5	1.5	5.0	5.8	5.3	4.9	5.4	5.3	4.8	4.9	5.2
	6	1.6	5.1	5.4	5.3	4.6	5.0	5.4	5.2	4.8	4.6

quantity of phosphorus sorbed did not reach the value zero. At least 6-8 μg/g of P was being released. The results clearly show that the phosphorus is being released slowly at a constant rate to the solution and the lost phosphorus due to plant uptake replenished. The phosphorus pool in solution is always maintained at a constant concentration. A similar trend of results is also noticed with remaining three soils but in magnitude the values differ from one another. It is seen from the results that R. E. Farm soil released high amount of phosphorus at the first extraction and subsequently decreased very much when compared to other soils.

The Figure 1 indicates the fixation curves for phosphorus for different soils and it is found that except Berhampur soil, remaining soils had shown a clear-cut inflection point where the fixation is completed, beyond which fixation of phosphorus is very negligible. However in the case of Berhampur soil, there is no clear-cut inflection point to decide the completion of the fixation of phosphorus. Although soils employed in the present study vary widely in their properties the phosphorus fixing capacity of these soils does not vary very much.

The desorption type of reaction is further indicated in Fig. 2 when the Langmuir plot of data was made from the second extraction, considering amount of phosphorus left on the surface after second extraction. The results of the Langmuir plot indicate that the behaviour of these soils on extraction can be predicted by assuming Langmuir type of adsorptions (Fried and Shapiro, 1956). The same data could be used to determine the amount of surface phosphate present without assuming any predetermined figures. It is observed that the value 'b' maximum releasing capacity of phosphorus ranged from 16 to 270 μg/g and the soils can be arranged in increasing order, as Sukinda, CRRI, Berhampur, R. E. Farm. The Sukinda soil being llaterite in nature have higher potentia in releasing high quantity of phosphorus at a time than other soils in question. However, the R. E. Farm soil being medium black in character has low 'b'

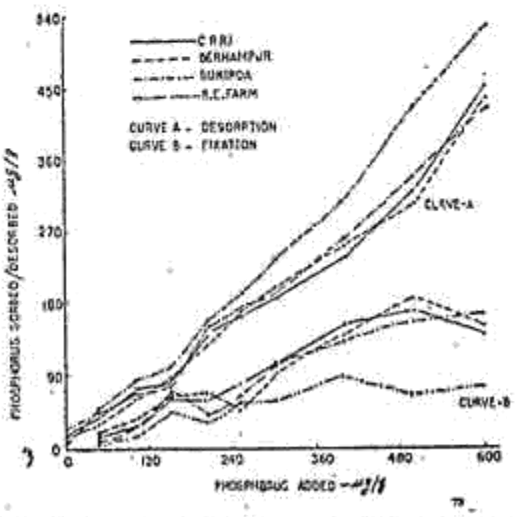

FIG. 1. Sorption and Description of Phosphorus in Relation to added Phosphorus in Four Rice Soils of Orissa.

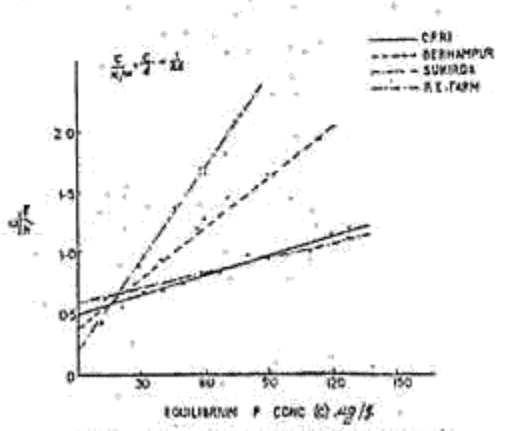

FIG 2 LANGMUIR ADSORPTION ISOTHERM FOR PHOSPHORUS RELEASE AT SECOND EXTRACTION STAGE IN FOUR RICE SOILS OF ORISSA

value and the capacity to release phosphorus in a given time is low. Thereby, its replenishing power is also very low. Hence the demand for phosphorus by the plants will not be adequately met unless sufficient phosphatic fertilization is made. Berhampur stands second. Of course the desorption of phosphorus is more in Sukinda and CRRI soils where the replenishment of phosphorus will also be more occur at higher rate.

As far as 'k' value, the energy with which the phosphorus is released is concerned, the trend is quite reverse to that of 'b' value. In the descending order the soils can be arranged as Sukinda, CRRI, Berhampur, R. E. Farm. The higher the release of phosphorus, he lower will be the energy of release.

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