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RELEASE OF AVAILABLE PHOSPHORUS FROM ROCKPHOSPHATES AND SUPERPHOSPHATE DURING INCUBATION UNDER SUBMERGENCE

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In India, the consumption rate of phosphatic fertilizers has not been kept pace with that of nitrogeneous fertilizers. The main reason for such a growth pattern is the relatively high cost of chemically processed phosphatic fertilizers. Direct application of cheap, reactive, ground rockphosphates to the **soil** is a fruitful attempt in this direction. Rice, the major **food** crop of Kerala being grown in a flooded condition, a knowledge regarding the release of P from various phosphatic fertilizers under submergence will be essential for evaluating the efficiency of rockphosphates.

Materials and Methods

A laboratory incubation study was carried out in order to study the release of P from Rajastan rockphosphate (RRP) and Mussoorie rockphosphate (MRP) in comparison with that of superphosphate (SP) in two acid rice soils of **Kerala** namely laterite collected from Kodakara, Trichur district and kari (Kuttanad alluvium) from Karumadi, Alleppey district in a completely randomized design with two replications. RRP (100 mesh) was supplied by Rajastan State Mineral Development Corporation and MRP (100 mesh) was supplied by M/s. Pyrites Phosphates and Chemicals Ltd. The phosphatic fertilizers were applied in two levels (45 and 90 kg P_2O_5/ha). The treatment combinations were

Treatment No.	Notation	Forms and level of P_2O_5 kg/ha		Soil
1	OL	NO	P (control)	Laterite
2	RRP 45L	RRP	45	,,
3	RRP 90L	RRP	90	,,
4	MRP 45L	MRP	45	,,
5	MRP 90L	MRP	90	,,
6	SP45L	SP	45	,,
7	SP90L	SP	90	,,
8	OK	NO	P (control)	kari
9	RRP 45K	RRP	45	,,
10	RRP 90K	RRP	90	,,
11	MRP 45K	MRP	45	,,
12	MRP 90K	MRP	90	,,
13	SP45K	SP	45	,,
14	SP 90K	SP	90	,,

Surface soil samples (0-15 cm depth) were collected, dried, seived and taken (500 g) in plastic containers. The phosphatic fertilizers as per the treatments described above were added and mixed thoroughly with the soil. The soils were continuously waterlogged, maintaining water at the level of 2 cm above the soil and incubated at room temperature (28-31°C) for 180 days. Soil samples were drawn regularly at 15 days interval for the determination of available P. Available P was extracted in Bray and Kurtz No. 1 and No. 2 extractants and P was determined by chlorostannous acid reduced molybdophosphoric blue colour method in hydrochloric acid system (Jackson, 1958). The mechanical analysis of the soils was carried out by the International Pipette method (Piper, 1942). The pH, electrical conductivity, organic carbon, total P, P fixing capacity, free iron oxides and available Fe were determined by standard procedures described by Jackson (1958).

Results and Discussion

The laterite soil collected was a sandy clay loam with a pH of 5.4. It contained 2.65 percent of free iron oxides and 221.9 ppm of available Fe (DTPA extractable). The P fixing capacity of the soil was relatively high (332.04 ppm P). The total P content of the soil was 887.2 ppm and contained 1.08 percent of organic carbon. The kari soil collected was a sandy loam and was more acidic (pH 3.1) than laterite soil with 1.82 percent of organic carbon. The P fixing capacity was relatively high (329.6 ppm) and the content of free iron oxide and available Fe were 2.14 percent and 211.1 ppm respectively.

Effect of various sources and levels of applied P on the available P content of the soil at different periods of incubation in laterite and kari soils are given in Table 1 to 4.

The original content of Bray No. 1 extractable P was 4.79 ppm in laterite soil and 3.84 ppm in kari soil and this low content of available P in these soils make them to be rated under the class 'low' as per the soil fertility rating norms followed by the soil testing laboratories of the state (Table 1). The low content of available P was mainly attributed to their high P fixing capacity.

Even in the absence of added P, the content of available P (Bray 1 and 2) in the soil increased on incubation and this increase was more pronounced in laterite soil. In laterite soil, the increase in available P on incubation was 9.64 and 20.13 ppm for Bray 1 and 2 respectively, while it was 7.59 and 19.61 ppm respectively for Bray 1 and 2 in kari soil (Table 1 and 2). The increase in the content of available P on incubation may be due to the increased content of saloid-P and enhanced solubility of Fe-P and Al-P brought about by the reduction reactions occurring as a result of flooding. In addition to this process, mineralization of organic P would also have contributed to the pool of available P. The relatively higher content of available P in laterite soil was attributed to its higher content of total P and enhanced rate of reduction reactions occurring in the soil due to its highly oxidized nature compared to kari soil.

Table 1

Mean values af available P (Bray 1) as influenced by sources of P, soils and levels of P application, ppm

Period of incubation	Sources of P			Soils		Levels of P_2O_5 kg/ha		Mean	Control (No P)	
	RRP	MRP	SP	Laterite	Kari	45	90		Laterite	Kari
0	7.40	7.43	8.25	7.23	8.15	7.53	7.85	7.69	4.79	3.84
1	9,16	9,19	9.45	8.30	10.22	9.22	9.30	9.26	5,38	5.27
2	10.89	10.94	11.15	9.45	12.53	10.91	11.08	10.49	8.74	8.04
3	14.05	14.18	14.35	12.65	15.93	14.12	14.27	14.19	9,26	10.19
4	16.60	16.54	16.56	15 54	17.59	16.49	16.64	16.57	14.43	11.43
5	16.70	16.75	16.69	14.33	19.10	16,50	16.93	16.71	14.18	11,41
6	16.89	16.98	16.86	14.83	19.13	16.82	17.00	16,91	14.21	11.39
7	16.71	16.78	16.58	14.60	18.78	16.61	16.77	16.69	11.51	11.31
8	16.56	16.33	16.38	14,28	18.56	16.28	16.57	16.62	9.84	11.14
9	16.25	16.36	16.23	14.13	18.43	16.26	16.30	16.28	9.58	10.89
10	16.03	15.89	16,00	13.73	18.21	15.90	16.04	15.97	9.49	10.73
11	15.94	16.03	15.96	13.83	18.12	16.00	15.95	15.98	9.69	10.67
12	15.65	15.76	15.65	13.48	17.90	15.63	15.74	15.69	9.51	10.45
Mean	14.53	14.55	14.62	12.77	16.36	14.48	14.65		9.95	9.69

C. D. (0.05) for soils = 0.325
,, ,, periods = 0.829
,, ,, soil x period = 1.172

Table 2

Mean values of available P (Bray 2} as influenced by sources of P, soils and levels of P application, ppm

Period of incubation	Sources of P			Soils		Levels of P_2O_5 kg/ha		Mean	Control (No P)	
	RRP	MRP	SP	Laterite	Kari	45	90		Laterite	Kari
0	20.26	20.14	21.84	19.86	21.63	20.50	20.99	20.75	15.04	12.64
1	23.06	22.96	23.68	21.33	25.14	22.98	23.48	23.23	16.34	14.43
2	28.45	28.55	28.73	27.27	29.88	28.36	28.79	28.58	24.37	20.60
3	34.28	34.29	34.34	33.10	35.50	34.26	34.34	34.30	27.81	23.84
4	39.70	39.30	39.65	38.03	41.08	39.24	39.86	39.00	35.17	32.25
5	37.53	37,45	37.45	36.05	33.90	37.33	37.62	37.48	29.37	30.42
6	38.83	39.06	38.73	37.57	40.18	38.75	38,99	38.87	30.51	32.01
7	38.84	39.40	38.83	38.31	39.73	38.70	39.34	39.02	35.04	31.68
8	38.00	38.29	37.94	37.12	39.03	38.01	38.14	38.08	29.70	30.85
9	38.01	38.20	37.61	36.92	38.96	38.02	37.89	37.94	29.35	31.30
10	37.63	37.54	37.64	36.93	38.28	37.70	37.50	37.60	29,01	30.60
11	37.71	37.72	37.53	36.98	38.32	36.59	37.71	37.60	28,35	30.35
12	37.06	37.34	37.08	36.42	37.90	37.08	37.23	37.16	28.41	30.33
Mean	34.57	34.63	34.93	33.53	35.73	34.51	34.76		27.58	27.04

C. D. (0.05) for soils = 0.744
" " periods = 1.896

Tabie 3

Mean values of available P as influenced by levels of P application, ppm

Levels of P_2O_5 kg/ha	Soil: Laterite	Soil: Kari	Sources of P: RRP	Sources of P: MRP	Sources of P: SP
			(Bray No.1)		
45	12.27	12.85	14.43	14.45	14.57
90	12.69	16.44	14.62	16,65	14.68
			(Bray No, 2)		
45	33.40	35.61	34.41	34.53	34.57
90	33.66	35.86	34.72	34,74	34.82

Table 4

Mean values of available P as influenced by sources of P and soils, ppm

Soil	Control (No. P)	Sources of P: RRP	Sources of P: MRP	Sources of P: SP
		(Bray No.1)		
Laterite	9.95	12.69	12.74	12.88
Kari	9.69	16.35	16.36	16.36
		(Bray No.2)		
Laterite	27.58	33.42	33.46	33.71
Kari	27.04	35.71	35.81	36.15

By the addition of phosphatic fertilizers, there was a significant increase of 2,45 and 4.81 ppm of Bray No.1 and 2 available P in laterite soil and 4.33 and 8.99 ppm available P (Bray 1 and 2) in kari soil over the control (no P) during the first period, which changed to 3.98 ppm (Bray 1) and 8.08 ppm (Bray 2) in laterite soil and 7.54 ppm (Bray 1) and 7.69 ppm (Bray 2) in kari soil with the advancement of period of incubation (Tables 1 and 2). This indicated that though the transformation of added P to different inorganic fractions has taken place its contribution to the available phosphate pool is considerably low.

In general, the peak content of available P (Bray 1 and 2) was observed during the sixth and seventh periods of incubation and after attaining the maximum value it tended to decrease upto the twelfth fortnight. But the values at the twelfth period were also still higher than the initial cancentration. The linear coefficient of correlation between available P and period of incubation was 0.474 for Bray 1 and 0.69 for Bray 2. Prediction equations were worked out to establish available P (Bray 1 and 2) from RRP, MRP and SP separately and afso for the two soils. In all the cases the response was found to be quadratic. The equations were

Bray 7 P (y_1)

1 For soils

a) Laterite $y_1 = 4.823 + 2.355x - 0.135x^2$ ($R^2 = 0.88$)

b) Kari $y_1 = 5.29 + 3.142x - 0.173x^2$ ($R^2 = 0.95$)

2 For fertilizers

a) RRP $y_1 = 4.74 + 2.82x - 0.158x^2$ ($R^2 = 0.94$)

b) MRP $y_1 = 4.83 + 2.799x - 0.156x^2$ ($R^2 = 0.94$)

«) SP $y = 5.627 + 2.594x - 0.145x^2$ ($R^2 = 0.93$)

Bray 2 P (y_2)

1 For soils

a) Laterite $y_2 = 14.51 + 5.352x - 0.292x^2$ ($R^2 = 0.92$)

b) Kari $y_2 = 17.14 + 5.416x - 0.367x^2$ ($R^2 = 0.91$)

2 For fertilizers

a) RRP $Y_2 = 15.38 + 5.496x - 0.306x^2$ ($R^2 = 0.92$)

b) MRP $y_2 = 15.16 + 5.569x - 0.309x^2$ ($R^2 = 0.93$)

c) SP $y_2 = 16.92 + 5.088x - 0.283x^2$ ($R^2 = 0.91$)

x= period of incubation

Observations revealed that the concentration of available P in the soil was not significantly affected by the variations in the form of applied P. The contents of available P (Bray 1) retained in the laterite soil when RRP, MRP and SP were added, were 4.58, 4,60 and 4.67 ppm respectively when the effects of levels and periods of incubation were pooled (Table 4). In kari soil, the contribution from RRP, MRP and SP to the available phosphate pool was 4.84, 4.86 and 4.92 ppm respectively. The mean values of Bray 2 extractable P from RRP, MRP and SP were 34.57, 34.63 and 34,93 ppm respectively when the soils, levels and periods of incubation were pooled (Table 2). These values indicated that whether the phosphatic fertilizer is applied as superphosphate or rockphosphate, its contribution to available phosphate pool remains to be the same. This observation was in line with that of Sahu *et al.*, 1974; Sarangamath *et al.*, 1977; Kadrekar *et al.*, 1983; Luthra *et al.*, 1983.

When the levels of P application was at the rate of 45 kg P_2O_5/ha, only 4.68 ppm P was recovered as available P (Bray 1) and when the rate of application was increased from 45 kg to 90 kg P_2O_5/ha, the additional increase in the available P recovered was practically nil (0.17 ppm). In general, the increase in the level of application increased the available P (Bray 1) content from 12.27 to 12.69 ppm in laterite soil and from 12.85 to 16.44 ppm in kari soil (Table 3). The increase in the concentration of Bray 2 extractable P due to the increase in the level of P application was also negligible. This shows that in the acid soils under study under submerged condition, only a constant level of P out of the P added can be retained in available form and further increase in the rate of application results in the retention of P in the unavailable pool in the soil.

Summary

Increase in the available P (Bray 1 and 2) content of the taterite and kari soils due to the addition of P fertilizers did not depend on the water solubility of the added P fertilizers. Increasing the level of application of P from 45 to 90 kg P_2O_5/ha did not increase the available P (Bray 1 and 2) conspicuously in the laterite and kari soils.

സംഗ്രഹം

മണ്ണിൽ ജലം കെട്ടിനില്ക്കുന്ന അവസ്ഥയിൽ ജലലേയ രൂപത്തിലും ജലത്തിൽ ലയിക്കാത്ത രൂപത്തിലും മണ്ണിൽ ചേർത്തിരുന്ന ഭാവഹം കേരളത്തിലെ വെട്ടുകൽ മണ്ണിലും കരിമണ്ണിലും സസ്യലഭ്യമായി തീരുന്നതിലുള്ള വ്യത്യാസങ്ങൾ പഠിക്കുകയുണ്ടായി. ഭാവഹവളം ജലലേയമാണോ ,rar&gjtsau;) എന്ന വസ്തുത സസ്യലഭ്യ ഭാവഹത്തിന്റെ അളവിനെ (Bray 1 and 2) സാരമായി ബാധിക്കുന്നില്ലെന്ന് മനസ്സിലായി.

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