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PHOSPHORUS DISSOLUTION PATTERN OF DIFFERENT ROCK PHOSPHATES AND ITS INFLUENCE ON BIOMASS PRODUCTION AND NODULATION OF *PUERARIA PHASEOLOIDES*

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Dissolution of four indigenous rock phosphates in comparison with an imported (Jordan) material was studied in an acid soil from rubber growing tract under field capacity for a period of ten weeks. Significant increase in Bray Extractable P was obtained for all the treatments. Dissolution of imported (Jordan) rock phosphate was the highest followed by that of Mussoorie rock phosphate. Rock phosphates from different geographical regions differed in their effect on dry matter yield and P uptake of *Pueraira phaseoloides*. Among the Indian sources, Mussoorie rock phosphate was the most effective for *Pueraria phaseoloides* and it was on par with imported rock phosphate. The relative agronomic effectiveness of the different sources of rock phosphates followed the order – Jordan, Mussoorie, partially acidulated Maton, Purulia, Udaipur, Maton.

Key words:- *Pueraria phaseoloides*, Indigenous rock phosphate, Phosphorus dissolution pattern.

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INTRODUCTION

Leguminous crops grown as ground cover in rubber plantations contribute much to the nitrogen requirement of rubber plants (Shorrocks, 1965). The beneficial effect of P application to cover crops have been reported by Mathew *et al.* (1978). Mussoorie rock phosphate is reported as a suitable fertilizer for application in rubber growing soils (Karthikakutty Amma *et al.*, 1978). Most of the phosphorus required to establish cover crops in rubber plantations is supplied as Mussoorie rock phosphate. Recently, large quantities of ground rock phosphate reserves of low grade, unsuitable for use in phosphate industry, have been discovered. Some of the important sources are Udaipur, Maton and Purulia mined from Rajasthan and West Bengal. Laboratory and pot culture studies were undertaken to assess P release characteristics of these rocks and to compare their efficiency.

MATERIALS AND METHODS

Phosphate rocks from Mussoorie (Uttar Pradesh), Maton (Rajasthan), Udaipur (Rajasthan) and Purulia (West Bengal) were utilised for the studies, along with an imported phosphate rock (Jordan). A partially acidulated form of Maton rock phosphate was also employed. Simple super phosphate was also included as one of the treatments for comparison.

The soil selected for incubation study was sandy clay loam, collected from the experiment station of the Rubber Research Institute of India. The different sources of phosphorus were added to one kg of the soil at the rate required to give 30 kg P_2O_5 ha^{-1} and 70 kg P_2O_5 ha^{-1} each replicated twice. The moisture content of the soil was maintained at field capacity throughout the experimental period. The soil samples were incubated at room temperature for 75 days at constant moisture regime. Soil samples were extracted with Bray II solution (0.03N NH_4F + 0.1N HCl) after 10, 20, 30, 40, 50 and 75 days of incubation and the concentration of P in the extract was estimated (Jackson, 1958).

A pot culture study, with three replications in a completely randomised design, was conducted using the same soil type. Glazed porcelain pots of 30 cm diamater and 30 cm depth were used for the experiment. Each pot was filled with 35 kg soil and seeds of *Pueraria phaseoloides*, pretreated with hot water, were sown in the pots. Four weeks later seedlings were thinned down to four per pot. Rock phosphate as per treatment were applied in two equal splits to give 30 kg P_2O_5 ha^{-1}. A common dose of 30 kg K_2O ha^{-1} as muriate of potash was applied uniformly to all the treatments. The first dose was given four weeks after sowing and the second four weeks after the first. Treatment without application of rock phosphate served as control.

Three and a half months after sowing, the plants were uprooted and dry weight of shoots, roots and nodules was determined. Root and shoot samples were analysed for total phosphorus content and uptake of phosphorus per pot was calculated.

Relative agronomic efficiency (RAE) of different phosphorus sources was worked out, as described by Lau and Mahmud (1990) using the formula:

$$RAE = \frac{YT-YC}{YJRP-YC} \times 100$$

where YT, YC and YJRP represent dry matter weight or uptake of treatment T, control C and Jordan rock phosphate, respectively.

RESULTS AND DISCUSSION

Results of pretreatment analysis on the physico-chemical properties of the soil used in both incubation and pot culture studies are given in Table 1. It was indicated that the soil was highly deficient in available phosphorus and potassium and highly acidic with a pH of 4.8. Chemical composition of different rock phosphate sources is given in Table 2. Total P_2O_5 of the different sources varied from 19.17 to 28.96 per cent.

Table 1. **Physico-chemical properties of soil**

pH	Available nutrients mg 100^{-1} g soil			Orgainc carbon %	Total Fe_2O_3	Total Al_2O_3	Partial size distribution(%)			Texture
	P	K	Mg				Sand	Silt	Clay	
4.8	Trace	0.62	1.67	0.75	12.5	4.5	41.5	20	36.4	Sandy clay loam

Table 2. **Chemical composition (%) of rock phosphate**

Source	P_2O_5	CaO	Al_2O_3	Fe_2O_3
Mussoorie	23.06	38.5	0.73	4.41
Maton	25.00	33.6	0.29	1.75
Udaipur	19.17	48.3	2.04	1.76
Jordan	28.96	52.8	0.20	1.12
Purulia	23.37	36.2	2.24	10.90

A perusal of the data given in Table 3 reveal that significant increase in available P was obtained for both doses tried for Jordan, Mussoorie, partially acidulated Maton and single super phosphate throughout the experimental period over other treatments as well as control. For Purulia and Udaipur rock phosphates significant increase in available P was obtained for 70 kg ha^{-1} P_2O_5 throughout the experimental period over the control. For 30 kg P_2O_5 ha^{-i} significant increase was obtained

Table 3. **Effect of incubation on Bray II P (ppm)**

Phosphorus source	Incubation intervals (days)						Mean
	10	20	30	40	50	75	
Mussoorie rock phosphate							
30 kg P_2O_5 ha^{-1}	2.5	3.5	5.0	9.5	6.5	4.5	6.1
70 kg P_2O_5 ha^{-1}	2.8	5.0	7.0	7.0	8.0	5.0	6.5
Maton rock phosphate							
30 kg P_2O_5 ha^{-1}	0.2	2.3	3.0	6.0	5.0	3.5	3.0
70 kg P_2O_5 ha^{-1}	0.5	3.5	4.5	6.5	5.0	4.5	4.0
Purulia rock phosphate							
30 kg P_2O_5 ha^{-1}	0.7	2.5	5.5	5.0	4.5	3.5	4.4
70 kg P_2O_5 ha^{-1}	2.9	4.5	4.0	9.6	8.5	4.5	6.0
Partially acidulated Maton							
30 kg P_2O_5 ha^{-1}	2.7	4.5	6.0	9.0	6.5	2.5	5.2
70 kg P_2O_5 ha^{-1}	3.3	4.5	6.5	9.6	8.5	4.5	5.7
Udaipur rock phosphate							
30 kg P_2O_5 ha^{-1}	0.4	4.5	5.5	7.0	7.5	4.5	4.2
70 kg P_2O_5 ha^{-1}	2.2	4.5	7.5	9.0	7.5	4.5	5.9
Imported (Jordan) rock phosphate							
30 kg P_2O_5 ha^{-1}	8.6	7.8	9.5	10.4	9.0	5.0	8.4
70 kg P_2O_5 ha^{-1}	11.0	10.3	16.0	18.6	14.5	9.0	13.3
Single super phosphtate							
30 kg P_2O_5 ha^{-1}	1.95	3.0	4.5	6.5	5.5	3.0	4.0
70 kg P_2O_5 ha^{-1}	2.5	7.5	8.0	9.5	7.5	4.5	6.6
Control	+	+	+	+	+	+	
CD at 5% level	1.6	2.8	3.9	4.3	4.0	2.5	

+Trace

only from 30th day of incubation for Purulia and from 20th day onwards for Udaipur rock phosphates. For Maton rock phosphate significant increase in available P was noticed only from 40th day for both the doses tried. During the initial period (10–30 days) of incubation, differences in P concentration between the imported and indigenous rock phosphates were quite marked, while with increase in incubation period, these differences tended to be narrow. This may be due to the fact that after prolonged incubation, factors other than apatite composition such as soluble Fe and Al in acid soil affect the dissolution of phosphate rock in acid soil (Bhujbal and Mistry, 1985). Highest available P was noticed at the 40th day of incubation, after which a reduction was noticed. This may be due to the temporary immobilisation of phosphorus by soil micro organisms (Buckman and Brady, 1960).

The effectiveness of the different phosphates in terms of P uptake, dry matter weight and nodule weight of *Pueraria phaseoloides* is given in Table 4. Significant increase in dry matter production, weight of nodules and uptake of phosphorus was observed for all the sources. Jordan rock phosphate recorded the highest dry matter yield, nodule weight and phosphorus uptake. Among the indigenous ones, Mussoorie rock phosphate was the most effective and it was on par with Jordan rock phosphate. The effect due to the application of Maton rock phosphate was low and that due to the application of Purulia and Udaipur rock phosphate intermediate. It is likely this difference among the sources of phosphate rocks is related to their reactivity (Dash *et al.*, 1982).

The dry weight, nodule weight and P uptake are much higher due to the application of partially acidulated Maton rock phosphate than that of Maton rock phosphate. Acidulation leads to an increase in water soluble P, as a result of which root growth is stimulated even on severely P deficient soil, thus allowing the plant to utilise the applied phosphate rock more effectively (Khasawneh and Doll, 1972). For dry

Table 4. **Effect of different phosphorus sources on P uptake, dry matter and nodule weight of *Pueraria phaseoloides***

Treatments	Dry matter yield (g pot^{-1})	Nodule weight (g pot^{-1})	Phosphorus uptake (g pot^{-1})
Control (no P)	15.62	0.05	0.016
Imported (Jordan)	53.47	1.57	0.119
Mussoorie	48.06	1.39	0.106
Maton	30.97	0.34	0.048
Purulia	36.40	0.59	0.060
Udaipur	35.72	0.63	0.055
Partially acidulated Maton	42.57	1.10	0.080
Single super phosphate	42.00	0.95	0.076
CD at 5% level	6.95	0.18	0.03

Table 5. **Relative agronomic effectiveness of different indigenous sources in relation to imported Jordan rock phosphate**

Phosphorus source	RAE %
Mussoorie	87.37
Partially acidulated Maton	62.14
Purulia	42.72
Udaipur	37.86
Maton	31.07

matter production, nodule weight and phosphorus uptake Mussoorie and imported rock phosphates were superior to super phosphate.

The relative agronomic effectiveness of different indigenous sources in relation to imported rock phosphate is presented in Table 5. The results show that among the indigenous rock phosphates, Mussoorie and partially acidulated Maton rock phosphate have more agronomic effectiveness for *Pueraria phaseoloides*, the overall ranking being of the order: Jordan Rock Phosphate, Mussoorie Rock Phosphate, partially acidulated Maton Rock Phosphate, Udaipur Rock Phosphate and Maton Rock Phosphate.

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