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EFFICIENCY OF PHOSPHORUS SOLUBILISING ORGANISMS IN ACIDIC LATERITE SOIL

Efficiency of phosphobacterin culture to increase the solubility of phosphorus from rock phosphate and maintaining a high status of available P in soil was evaluated by carrying out an incubation study in the laboratory. Independent and combined effects of phosphobacterin and FYM on increasing P solubility are revealed. Solubilisation of inorganic P by microbes under pure culture conditions was first reported in Russia (Menkina, 1950; Murumtsev, 1958). Banik and Dey (1981) obtained higher levels of available P in soils when rock phosphate was applied along with FYM and cultures of *Bacillus* and *Penicillium* sp. The objective of the experiment was to study the pattern of P solubilisation from Mussorie rock phosphate inoculated with phosphorus solubilising organisms in the acid soil of Kottarakkara.

The effect of phosphobacterin, a mixed culture of P solubilising bacteria and fungi obtained from TNAU, Madurai on the maintenance of available P status in soil was monitored by carrying out an incubation study in the laboratory at FSRS, Kottarakkara during 1993-96. The soil belonged to the taxonomical class Plinthic Kandiustult with a pH of 5.7, organic carbon 0.91%, available N (280 kg ha^{-1}), available P (6.21 kg ha^{-1}) and available K (71.68 kg ha^{-1}). The P fixing capacity was 47.87%. Available P was extracted with Bray No.1 and estimated colorimetrically (Jackson, 1958). The laboratory incubation study was conducted in CRD with seven treatments and three replications. The treatments tried were

- T_1 Soil alone (5 kg)
- T_2 Soil + Mussorie rock phosphate to give 100 ppm P
- T_3 Soil + P solubilising organisms (4 g per pot)
- T_4 Soil + farm yard manure (50 g per pot)
- T_5 Soil + Mussorie rock phosphate + P solubilising organisms
- T_6 Soil + Mussorie rock phosphate + farm yard manure + P solubilising organisms
- T_7 Soil + Mussorie rock phosphate + farm yard manure

Five kg soil sample collected from the experimental field of FSRS, Kottarakkara after thoroughly mixing with different materials was incubated in plastic containers at a moisture content of 60% WHC for a period of 90 days. Soil samples were withdrawn after 3, 6, 8, 10, 15, 20, 25, 30,45, 60, 75 and 90 days and analyzed for pH and available P content (Jackson, 1958) after making allowances for the moisture content in the soil sample.

The results revealed that the quantity of available P in soil due to different treatments progressively increased with increasing period of incubation and reached a maximum value of 19.31 ppm in T_6 on the 90th day (Table 1). This was closely followed by T_5 (15.73 ppm) and T_7 (14.56 ppm), which though significantly lower than T_6, were higher than the other treatments including control. Maximum P solubilisation in T_6 may be attributed to the beneficial effect of phosphorus solubilising organisms applied along with MRP and FYM to the soil. The progressive increase in soluble P in treatments T_2 to T_7 indicates a greater solubilisation of P under the influence of different inputs. A careful scrutiny of the results show that incubation of the soil with the PS organisms (T_3) or FYM (T_4) alone has brought into solution more P from the soil at the end of 90 days compared to the untreated control, showing the positive effect of these two independent factors on releasing P from native sources in the soil. At the same time, MRP applied to the soil (T_2) has undergone solubilisation resulting in a much greater amount of P during 90 days compared to T_3 and T_4. While soil inoculation with MRP alone had released an additional quantity of 10.33 ppm available P compared to T_1, incorporation of FYM with MRP in T_7 has resulted in a numerical increase of only 0.33 ppm P. On the other hand, addition of phosphorus solubilising organisms along with MRP (T_5) has solubilised an additional amount of 2.50 ppm P. The greater effectiveness of phosphorus solubilising organisms than FYM in solubilising P from MRP is thus evident from these results. T_6 recorded the highest value of available P (12.54 ppm) and it was significantly superior to all other treatments. This was followed by T_5 with a value of 10.93 ppm. The capacity of phosphorus solubilising organisms to produce effective chelating materials in a micro-environment

Table 1. Available P in soil at different period of incubation, ppm

Treatments	Period (days) 0	3	6	8	10	15	20	25	30	45	60	75	90	Mean
T1	2.48	2.49	2.56	2.80	2.81	2.90	2.94	2.95	2.95	3.48	3.78	3.79	3.90	3.07
T2	2.27	2.79	2.95	3.35	5.20	7.48	7.71	7.90	8.62	10.23	11.76	13.71	14.23	7.58
T3	2.46	2.75	2.91	4.40	5.52	8.42	8.75	8.78	8.74	9.20	10.02	11.51	11.64	7.32
T4	2.37	2.63	3.15	3.64	4.97	6.40	6.70	6.89	7.63	8.79	8.89	9.17	9.21	6.19
T5	2.32	3.47	4.90	9.52	10.13	11.30	11.93	12.50	12.92	14.27	15.50	16.53	16.73	10.93
T6	2.64	4.68	5.67	10.58	11.21	12.41	12.91	13.50	13.88	18.09	18.99	19.11	19.31	12.54
T7	2.39	2.63	2.80	5.85	6.26	8.74	8.93	9.08	9.52	11.59	13.66	14.08	14.56	8.44
Mean	2.42	3.06	3.56	5.74	6.60	8.24	8.60	8.80	9.18	10.81	11.80	12.56	12.80	

	Treatment	Period	Treatment x Period
F	2203.89**	3168.76**	116.46**
SE	0.066	0.063	0.167
CD	0.200	0.175	0.462

** Significant at 1% level

such as in the immediate vicinity of root zone or phosphatic materials or in the rhizosphere has been noted by and Tinker (1980). According to Kucey (1988), under these conditions, P could be solubilised and be present in an available form in concentrations sufficient to be plant available.

P solubilising effect was maximum when combined application PS organisms, FYM and MRP was made. Phosphate solubilising fungi like *Aspergillus* spp., *Penicillium* spp., and *Rhizopus* spp. have been reported (Narsian *et al.* 1994) to solubilise 9.0 to 34.6% of total P in synthetic medium under ideal conditions of incubation. From incubation studies on the dissolution of rock phosphate by PS organisms under laboratory conditions, Misra and Sahoo (1995) have shown that maximum P solubilisation could be achieved by 18 days of incubation beyond which the concentration of soluble P decreased. In the present study, however, P solubilisation continued up to 90 days of incubation. Salih *et al* (1989) reported that PS fungi showed maximum efficiency in releasing P after 55 days of incubation.

According to Mengel and Kirkby (1987) phosphate incubation in a moist soil is ideal to provide a realistic picture with regard to P adsorption and P concentration in soil solution because incubation period for some weeks helps in maintaining equilibrium between these two processes. The incubation study has thus provided valuable information in the possible status of P that can be retained in an available form in soil solution for plant uptake by the use of Mussorie rock phosphate under different methods of fertilizer management in laterite soils.

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REFERENCES

Banik, S and Dey, B.K. 1981 Solubilisation of inorganic phosphate and production of organic acids by micro-organisms isolated in sucrose tricalcium phosphate agar plate. *Zentralblat. Bakterol. Parasilenkl. Infektionskr. Hyg.* 11.136:478-486

Jackson, M.L.1958. *Soil Chemical Analysis.* Constable and Co Ltd., London, pp.141-151

Kucey, R.M.N. 1988. Effect of *Penicillium bilaji* on the solubility and uptake of P and micronutrients from soil by wheat. *Can. J. Soil Sci.* 68: 261-270

Mengel, K. and Kirkby, E.A. 1987. *Principles of Plant Nutrition.* International Potash Institute, Berne p-420

Menkina, R.A. 1950. Bacteria which mineralise organic phosphorus compounds. *Mikrobiologiya* 19: 308-316

Misra, U.K . and Sahoo, R.N. 1995. Dissolution of rock phosphate as affected by phosphate solubilising micro-organisms. A laboratory incubation study. International Seminar on Development in Soil Science, 60th Annual convention Nov. 2-5, 1995

Muromtsev, G.S. 1958. The dissolving action of some root and soil microorganisms as calcium phosphate insoluble in water, *Agrobiologia* 5: 9-14

Narsian, V., Thakkar, J. and Patel, H.H.1994. Isolation and screening of phosphate solubilising fungi. *Indian J. Microbiol.* 34:113-118

Salih, H.M., Yahya, A.I., Rahem, A.M.A. and Manam, B.H. 1989. Availability of P in calcareous soil treated with RP or SP as affected by P dissolving fungi. *Pl. Soil.* 120: 181-185

Tinker, P.B. 1980. *The Role of Phosphorus in Agriculture* (ed.) Kasawneh, F.E, Sample, E.C. and Kamprath, E.J) *Am. Soc. Agron.* Madison, Wisconsin, p. 617-654