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RESPONSE OF RICE TO PHOSPHORUS SOLUBILISING BACTERIAL CULTURE FOR ITS P UTILISATION UNDER WATERLOGGED CONDITION

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Abstract: The response of P solubilising bacterial culture to waterlogged rice was evaluated in a field experiment. The bacterial culture had no effect on P availability in soil and P uptake by plants at any stage of crop growth There was no marked advantage for the bacterial culture on yield or in reducing the recommended dose of P to waterlogged rice where there is little response to applied P.

Key words: Bacterial culture, P availability, P solubilisaticn, P uptake, rice yield.

INTRODUCTION

The response to application of fertiliser P in most of the wetland soils under submergence has been marginal (Mohanty and Mandal, 1989) and the cost of water soluble P fertiliser has shown marked escalation of cost in recent years. On the other hand, many biofertilisers are available in the market, which can be exploited for soil improvement and economic crop production. Keeping this in view, the effect of P solubilising bacterial culture was evaluated for its efficiency in P utilisation under waterlogged condition. An attempt has also been made to study the periodical availability and uptake pattern of P, following the application of bacterial culture.

MATERIALS AND METHODS

A field experiment was conducted during the kharif season (July-September) of 1994 at the Research Station farm on a sandy loam soil (Fluventic Dystropepts) having the following characteristics : pH 5.6, organic C 1.38%, available N 172 kg ha^{-1}, available P_2O_5 26 kg ha^{-1} and available K_2O 172 kg ha^{-1} respectively. The experiment was laid out in randomised block design with three replications. The treatments were:

1. Seedling treatment with P solubilising bacterial culture (PSB) @ 1 kg per 10 litre of water + NK; 2. Seedling treatment with PSB + NPK; 3. Seedling treatment with PSB + main field application of PSB @ 25 kg ha^{-1} + NPK at the recommended level (90 kg N; 45 kg P_2O_5 and 45 kg K_2O per ha); 4. Seedling treatment with PSB + 75% P + full dose of N and K; 5. Main field application of PSB + NPK; 6. Main field application of PSB + 75% P + NK; 7. No PSB, full dose of NPK and 8. No PSB and no fertiliser P; Full dose of N and K.

P solubilising bacterial culture *(Bacillus megatherium* var. *phosphaticum)* was applied in the field at the time of transplanting and in seedling dip treatment the seedlings were root-dipped in the culture solution for 15 min before transplanting. N was applied @ 90 kg ha^{-1} as urea, P_2O_5 @ 45 kg ha^{-1} as mussoorie rock phosphate and K_2O @ 45 kg ha^{-1} as muriate of potash. Entire amount of P and 50 per cent of N and K were applied and incorporated into the soil at puddling just before transplanting, 25 per cent N top dressed one month after transplanting and 25 per cent N and 50 per cent K were applied at panicle initiation stage of the crop growth. The rice cultivar Athira (Ptb 51) was transplanted at a spacing of 20 cm x 15 cm. Wet soil samples were collected at tillering, panicle initiation and 50 per cent flowering stages of crop growth and were extracted with Bray-II reagent and available P was estimated by chlorostannous reduced molybdophosphoric blue colour method in sulphuric acid system (Jackson, 1958). Plant samples were also collected at the above intervals and P content was estimated by vanadomolybdic yellow colour method after wet digestion with triple acid mixture (Jackson, 1958). The uptake was also computed.

Table 1. Effect of phosphorus solubilisiag bacterial culture on the growth and yield of rice

No.	Treatments	Plant height, cm	Total no. of tillers / m^2	No. of productive tillers / m^2	Grain yield kg ha^{-1}	Straw yield kg ha^{-1}
1	Seedling root dip with PSB + NK	99.7	256.6	178.9	2393	2319
2	Seedling root dip with PSB + NPK	107.0	255.5	187.7	2051	3109
3	Seedling root dip + field application of PSB + NPK	105.3	271.1	188.9	2372	3133
4	Seedling root dip + field application of PSB + 75% P + NK	104.9	270.0	197.7	2521	3032
5	Field application of PSB + NPK	105.7	283.3	198.9	2158	2825
6	Field application of PSB + 75% P+ NK	105.9	254.4	184.4	2201	3049
7	NPK alone (no PSB)	106.2	264.4	191.1	2135	3083
8	NK alone (control)	94.4	231.1	144.4	1859	2011
	CD (0.05)	4.39	NS	NS	NS	684

Table 2. Effect of P solubilising bacterial culture on soil P availability and P uptake at different stages of crop growth

No.	Treatments	Soil available P kg ha^{-1}			P uptake, kg ha^{-1}				
		Tl	PI	Fl	Tl	PI	50% Fl	Grain	Straw
1	Seedling root dip with PSB + NK	30.3	34.2	28.9	1.22	5.96	6.92	4.94	3.71
2	Seedling *mat* dip with PSB + NPK	33.4	36.3	31.3	1.32	6.03	7.79	5.55	4.12
3	Seedling root dip + field application of PSB + NPK	34.1	38.4	30.2	1.53	6.94	7.96	5.65	4.32
4	Seedling root dip + field application of PSB + 75% P + NK	32.8	36.3	31.8	1.43	7.02	8.21	5.72	4.52
5	Field application of PSB + NPK	34.2	35.8	30.9	1.62	7.31	8.42	5.37	4.18
6	Field application of PSB + 75% P+ NK	32.8	38.2	32.7	1.48	6.92	8.28	6.01	4.51
7	NPK alone (No PSB)	33.7	35.2	30.1	1.41	7.18	8.41	5.88	4.66
8	NK alone (control)	29.2	33.1	29.0	1.12	5.71	6.84	4.76	3.66
	CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

PSB = P solubilising bacterial culture; Tl = Tillering; PI » Panicle initiation; Fl = Flowering

RESULTS AND DISCUSSION

Growth and yield

P solubilising bacterial culture applied either directly in the field or through seedling root dip failed to exert any influence on the grain yield (Table 1). Even with the treatments having recommended dose of P with bacterial culture or without bacterial culture had no significant effect over control. This implies the poor response of applied P fertiliser in submerged soils. The marginal response to applied P to this type of soil have been reported earlier by Anilakumar *et al.* (1994) the reasons being the transformation and increased availability of native P under submerged conditions (Mohanty and Mandal, 1989). On the other hand, the treatment effects were significant with respect to straw yield, where the highest yield was obtained for the treatment receiving bacterial culture and recommended dose of P. However, this treatment was on par with other treatments except for those having no P viz., seedling root dip with bacterial culture alone and control. This might be due to the nutrient imbalance resulting from application of N and K alone. With respect to straw yield also, there was no marked response for applied bacterial culture. Among the biometric observations recorded, the treatment effects were significant only for the plant height measured at the time of maturity. Increased plant height was recorded for the treatments receiving fertiliser P partly or fully together with or without bacterial culture treatments. This effect was well reflected on the straw yield.

Phosphorus availability

The availability of soil P increased up to tillering stage, then decreased with crop growth (Table 2). The initial increase might be due to the increased availability of soil P due to submergence (Anilakumar *et al.,* 1994) and the decrease can be attributed to crop uptake as evidenced from uptake values. On the other hand, the effect of P solubilising bacterial culture on the P availability in soil was marginal. This might be either due to the inability of the bacteria to release more native P over and above the added fertiliser or due to the conversion of water soluble P to Al-P and Fe-P. Sadanandan *et al.* (1980) reported that considerable proportion of water soluble P was converted into Fe-P and Al-P in all the soils, the former being more predominant.

Phosphorus uptake

Phosphorus removed by rice increased with increase in growth period of plants and maximum uptake was recorded at panicle initiation stage irrespective of treatments (Table 2). However, the treatment effects were not significant either in any of the stages of crop growth or in grain and straw uptake indicating the marginal response of P solubilising bacterial culture.

The response of P solubilising biofertilisers on the growth, yield and P uptake and P availability in soil was marginal in waterlogged rice. There was no added advantage for the bacterial culture either on yield or in reducing the recommended dose of P to rice in areas where there is little response to applied P.

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