Research Journal of Agriculture and Biological Sciences, 2(6): 365-368, 2006

Effect of Rock Phosphate Incubated with FYM on Nutrient Uptake and Yield of Lowland Rice

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Abstract: Field experiments were conducted during 2001 and 2002 at Tamil Nadu Agricultural University, Coimbatore to study the effect of different sources of phosphorus on nutrient uptake and yield of rice. The experiments were conducted in a randomized block design replicated four times. The treatments consisted of 0 Kg P, 60 Kg P as SSP, 60 Kg P as MRP incubated with FYM, 60 Kg P as MRP incubated with press mud and STCR based P application. Among the P sources tested, MRP incubated with FYM @ 60 Kg ha^{-1} resulted in higher yield, nutrient uptake and maintained higher soil available P throughout the crop growth period. This was followed by P application @ 60 $Kgha^{-1}$ as SSP. STCR based P application resulted in comparable yield with SSP application even with lower dose. In terms of efficiency, MRP incubated with FYM recorded higher relative agronomic efficiency and apparent P recovery.

Key words: Rock phosphate, apparent recovery, STCR value, relative agronomic efficiency

INTRODUCTION

Rice is the most important food grain in India contributing 41.5% to the total food grain production. Rice occupies an area of 2.75 m ha in Tamil Nadu, which is the largest area among the cultivated as well as irrigated crops. Phosphorus is an essential nutrient for plants because of its vital role in photosynthesis and much energy transformation process.It also has a significant role in sustaining and building up soil fertility, particularly under intensive agriculture. In recent years, some non - conventional P fertilizers such as phosphate rocks (PR's) and partially acidulated phosphate rocks have been tested as potential alternative to conventional water – soluble P fertilizers. A number of reports indicate the efficacy of fertilizer nutrient being increased when they are used in combination with organic manure[2,7]. Rock Phosphate enriched manures maintain higher levels of P in soil solution for a longer period than the fertilizer alone. Besides a low input technology, it has been claimed that composting manures with PRs enhances the dissolution or rocks. Keeping all these in view, the present study was envisaged with different doses and sources of P, to find out the effect of P on the yield of rice.

MATERIALS AND METHODS

Field experiments were conducted in wetlands of Tamil Nadu Agricultural University, Coimbatore. Both the crops was raised in Thaladi, October 2001- February 2002 and October 2002- February 2003, respectively. The rice variety tested was ADT 39. The soils of the experimental fields were moderately drained, clay loam classified under Vertic haplustalf. The fertility status of the soil was low, medium and high in available N, P and K respectively.

There were five treatments;

P_1 - 0 Kg $P_2 0_5$ ha^{-1}
P_2 - 60 kg $P_2 0_5$ ha^{-1} as SSP
P_3 - 60 Kg $P_2 0_5$ ha^{-1} as MRP incubated with FYM
P_4 - 60 kg $P_2 0_5$ ha^{-1} as MRP incubated with pressmud
P_5 - STCR Based P application

The experiments were conducted in a randomized block design with same set of treatments in both the years replicated four times. The gross and net plot size was 4.5m x 3.2m and 4.0m x 2.8m respectively.

A total quantity of 150 kg N and 50 Kg $K_2 0$ ha^{-1} was applied to the crop in the form of urea and murate of potash respectively. Half of N and full dose of K were applied at the time of final land preparation and rest of N was applied in equal proportion at 20 and 40 DAT. P was applied to the rice crop basally as per treatment. In MRP applied treatments, 60 kg $P_2 0_5$ ha^{-1} as MRP was added with either FYM or perssmud @ 100Kg ha^{-1}. The manure mixtures were kept in polythene bags after addition of moisture to bring the moisture content to around 60% and incubated for 30 days. Grain yield was recorded and reported at 14 % moisture content. Relative agronomic efficiency (RAE), i.e. the yield with PR to the yield with SSP, when both fertilizers are applied at same rate of P[4] was computed by using the following equation.

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Table 1: Effect of rock phosphate incubated with FYM on the yield and harvest index of low land rice

Treatment	2001-2002 Grain yield (Kg ha^{-1})	Straw yield (Kg ha^{-1})	Harvest (Kg ha^{-1})	2002-2003 Grain yield index	Straw yield (Kg ha-1)	Harvest index
P_1 - 0 Kg $P_2 0_5$ ha^{-1}	4386	5287	45.3	4291	5325	44.6
P_2 - 60 kg P_2 0_5 ha^{-1} as SSP	5367	6185	46.5	5644	6483	46.5
P_3 - 60Kg $P_2 0_5$ ha^{-1} as MRP incubated with FYM	5625	6266	47.3	5832	6561	47.0
P_4 - 60 kg $P_2 0_5$ ha^{-1} as MRP incubated with press mud	5120	6027	45.9	5230	6281	45.7
P_5 - STCR Based P application	5258	6129	46.2	5378	6357	45.8
SEd	159	56.3	NA	118	84	NA
CD (P=0.05)	347	123		257	183	

NA- Not Analyzed

Table 2: Effect of rock phosphate incubated with FYM on nutrient uptake by rice, relative agronomic efficiency and apparent recovery of P

Treatments	2001-2002 Uptake (Kg ha^{-1}) N	P	K	RAE (%)	Apparent Recovery (%)	2002-2003 Uptake (Kg ha^{-1}) N	P	K	RAE (%)	Apparent Recovery (%)
P_1 - 0 Kg $P_2 0_5$ ha^{-1}	107	21.0	85.5	--	--	107	21.5	85.4	--	--
P_2 - 60 kg P2 05 ha^{-1} as SSP	115	27.3	92.2	--	10.5	121	28.2	97.5	--	11.0
P_3 - 60Kg $P_2 0_5$ ha^{-1} as MRP incubated with FYM	117	28.6	95.5	104.8	12.6	124	30.1	102.0	103.3	14.3
P_4 - 60 kg $P_2 0_5$ ha^{-1} as MRP incubated with Press mud	110	23.8	87.3	95.5	4.6	114	25.2	90	92.7	6.2
P_5 - STCR Based P application1	113	25.4	90.7	--	7.9	116	27.1	93.3	--	9.3
SEd	1.8	1.1	2	--	--	2.5	1.3	3.3	--	--
CD (P=0.05)	3.9	2.4	4.3	--	--	5.5	2.9	7.2	--	--

$$\text{RAE (\%)} = \frac{\text{Yield with PR}}{\text{Yield with SSP}} \times 100$$

Apparent recovery also known as recovery fraction was computed by using the formula[6].

$$\text{Apparent recovery of P (\%)} = \frac{Ui - Uo}{Pi} \times 100$$

Where,

Ui = Uptake of P in particular treatment (Kg ha^{-1})
Uo = Uptake of P in unfertilized plot (Kg ha^{-1})
Pi = Quantity of P applied for the treatment (Kg ha^{-1})

RESULTS AND DISCUSSIONS

Yield: Different P sources tested had significant influence on grain and straw yield of rice with varying magnitudes in both the years. The highest grain yield of 5625 and 5832 Kg ha^{-1} was recorded with P application @ 60 Kg P_2O_5 ha^{-1} through MRP incubated with FYM during 2001and 2002 respectively. However, it was comparable with the yield obtained with application of SSP @ 60 Kg P_2o_5 ha^{-1}. In both the years, P application through SSP based on STCR values recorded yields comparable with application of 60 Kg P_2O_5 ha^{-1} MRP incubated with pressmud. However, FYM incubated with MRP resulted in significantly higher yield as compared to press mud incubated with MRP (Table 1).

Increase in grain and straw yield due to incubation with FYM may be attributed to the reason that composting of organic manures with rock phosphate might have helped in the solubility of P and thereby its availability to crops. As was the case in the present investigation, increase in yield and P uptake was obtained with the application of MRP with FYM. Bangar *et al*[1] has shown that PR enriched compost was as effective as single super phosphate with regard to

crop yield and P uptake. These investigators suggested that higher effectiveness of PR enriched compost was due to the solubilisation of PR, resulted by microbial production of organic acid during composting.

In the treatment with P application based on STCR values, reduced dose might have been the reason for low increase in yield over control. In case of press mud incubated MRP, the decrease in yield compared to other treatments might be due to low uptake of rice at early stage caused by slow release. Dingkuhan *et al*[3] has reported similar P release pattern.

Harvest index, a ratio between economic and biological yield, was the highest in MRP incubated with FYM applied plots (47.31% and 47.01%) where as it was lower in other treatments with different sources. Increased DMP with more P uptake might have helped in increasing economic yield over biological yield as MRP enhanced the P availability during growth period after incubated with FYM.

Nutrient Uptake: There was marked difference in nitrogen uptake by rice between different P sources applied to rice. N uptake of rice was higher with application of MRP incubated with FYM. This might have been due to the increased root dry weight and DMP which resulted in more nutrient uptake especially N. In other P treatments, since the DMP was lower, the nutrient N removal was also found to be less. Mohod *et al*[5] reported in confirmation with this that different levels of P under variable P sources increased N uptake of grain and straw.

In case of Phosphorus, uptake by crop was significantly influenced by different sources of P applied. Among different treatments, SSP applied @ 60 Kg ha^{-1} as basal resulted in more P uptake at tillering. This might be due to higher solubility of SSP, which enhanced the availability of P, which in turn increased the root dry weight resulted in more P uptake as well as more P content. At later stages, MRP incubated with FYM resulted in higher P uptake by rice over other sources of P. This was attributed to increased and sustained release of P all along the cropping period with enhanced root and shoot growth. Increase in availability of P from MRP after 30 days of incubation with FYM was also reported by Tiwari *et al*[8]. Moreover, increase in P uptake might have been due to increased root CEC that had a positive correlation with P uptake. P uptake in MRP enriched with FYM applied plots was 28.6 and 30.1 Kg ha^{-1}, a greater range as compared to other treatments in the study. Regarding K also, the uptake was higher with application of MRP enriched with FYM applied plots, since the root growth and DMP was more (Table 2).

Efficiency Indices for applied P: The relative agronomic efficiency was higher i.e. 104.8 and 103.3 per cent in MRP incubated with FYM. However, MRP incubated with pressmud was found to be less effective as compared to SSP (Table 2). This indicates the superiority of MRP incubated with FYM over SSP. The efficiency of absorption of applied P evaluated as apparent recovery was the highest (12.6 and 14.3 % respectively) with application of MRP incubated FYM application followed by application of SSP @ 60 Kg ha^{-1} and STCR based P application. So in a cropping system with rice, P applied to rice had a recovery of 10 -15% and remaining 85-90% of applied P is left in the soil either as fixed or available as residual P to the follow up crop.

Conclusions: The study revealed that application of MRP incubated with FYM recorded the highest grain yield; harvest Index and N, P and K uptake. In a cropping system with rice, P applied to rice had a recovery of 10 -15% and remaining 85 - 90% of applied P is left in the soil either fixed or available as residual P to the follow up crop.

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