Indian J. Agron. 38 (3) : 374–377 (September 1993)

Response of lowland rice (*Oryza sativa*) to green-manuring, levels and sources of phosphatic fertilizer in coastal Orissa

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Received: February 1992

ABSTRACT

An experiment was conducted during the rainy seasons of 1987 and 1988 to study the effect of green-manuring with and without chemical nitrogen and with different sources and levels of phosphatic fertilizer on lowland rice (*Oryza sativa* L.). Green-manuring with *dhaincha* or prickly sesban [*Sesbania cannabina* (Retz.) Pers.; syn. *S. aculeata* Pers.] alone gave yield of 3.48 tonnes, whereas green-manuring + 20 kg N/ha top-dressed at panicle initiation gave 3.81 tonnes/ha of unhusked rice which was on a par with 60 kg N/ha through prilled urea. No significant difference in grain yield due to Mussoorie rockphosphate (100%) and Mussoorie rockphosphate + single superphosphate (50% each) was evident. But both the treatments were superior to single superphosphate (100%). Lowland rice did not respond to higher levels of phosphatic fertilizer and 40 kg P/ha gave as much yield as that of 60 kg P/ha. Similar trend was observed for N and P uptake. Inherent soil fertility and productivity was sustained. Soil-available P and K status were found either equal to or higher than initial values at the end of 2 seasons showing sustained fertility.

Rice (*Oryza sativa* L.) productivity is low in large parts of North-Eastern Coastal Plain Zone of Orissa during the rainy season. Green-manuring with prickly sesban [*Sesbania cannabina* (Retz.) Pers.; syn. *S. aculeata* Pers.] is more promising in increasing the yield by augmenting the organic matter status of the soil as well as enhancing nitrogen and phosphorus availability (Mohapatra and Pradhan, 1990). Very little information is available in this zone on the effect of green-manuring with and without chemical N and with different sources and level of phosphatic fertilizer on soil organic matter content, relative efficiency of N and P fertilizers, optimization in the use of P and soil productivity. Hence an experiment was conducted to optimize the use of P by rice through green-manuring methods.

MATERIALS AND METHODS

The field experiment was conducted during the rainy seasons of 1987 and 1988 at Ranital. The soil of the experimental site was sandy loam with pH 6.6, organic carbon 0.55%, available P and K 13.5 and 130 kg/ha respectively, and available Zn 0.41 ppm. The experiment was laid out in double split-plot design with green-manuring treatments in the main plot, levels of phosphate in the subplot and sources of phosphate in sub-

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subplot with 3 replications. Both Mussoorie rockphosphate and single superphosphate were applied to green-manuring crop prickly sesban, which was turned into soil at 45 days growth stage. Transplanting of rice variety 'Jaganath' was done on 15 July with a common dose of 30 kg K_2O/ha to all the treatments. The data on yield and yield attributes were recorded. Uptake of N and P in both the seasons and available nutrient status of soil at the end of 2 rainy seasons were also estimated.

RESULTS AND DISCUSSION

Green-manuring with prickly sesban gave 3.48 tonnes/ha of unhusked rice, whereas green-manuring + 20 kg N/ha (top-dressed) at panicle-initiation stage recorded an increased yield of 0.33 tonne/ha over green-manuring alone. Application of 60 kg N/ha through prilled urea as 50% at basal + 25% at tillering + 25% at panicle stage yielded at par with prickly sesban + 20 kg N/ha given at panicle-initiation stage. All the treatment combinations were significantly superior to no green-manuring and no nitrogen (control) (Table 1). This suggests contribution of at least 40 kg N/ha by green-manuring with prickly sesban in lowland rice. Beri *et al.* (1989) and Sharma and Mitra (1989) also reported the usefulness of green-manuring in combination with fertilizer on lowland rice.

Table 1. Effect of green-manuring, sources and levels of phosphate on grain and straw yields, yield attributes, N and P uptake in lowland rice (pooled mean of 1987 and 1988)

Treatment	Grain yield (tonnes/ha)	Straw yield (tonnes/ha)	Panicles/ m^2	Filled grains/ panicle	1,000-grain weight (g)	N uptake (kg/ha)	P uptake (kg/ha)
Green-manuring							
No green-manuring, no N (control)	3.05	4.25	255	102	17.4	21.4	6.7
Green-manuring with prickly sesban	3.48	4.62	274	118	18.2	28.7	9.3
Green-manuring with prickly sesban + 20 kg N/ha	3.81	4.94	287	135	18.7	36.5	13.8
60 kg N/ha	3.82	4.96	287	135	18.7	36.4	13.4
CD (P = 0.05)	0.28	0.32	11	14	0.3	4.7	2.4
P_2O_5 (kg/ha)							
20	3.22	4.40	264	112	18.0	24.5	6.5
40	3.60	4.82	280	125	18.5	30.2	9.8
60	3.60	4.82	282	127	18.5	30.4	11.4
CD (P = 0.05)	0.32	0.37	14	12	0.2	3.8	3.1
Sources of P							
SSP (100%)	3.45	4.70	275	120	18.1	29.2	8.4
SSP + MRP (50% each)	3.78	4.95	288	134	18.9	35.6	9.8
MRP (100%)	3.82	4.98	291	136	18.9	35.8	11.5
CD (P = 0.05)	0.30	0.20	10	10	0.6	5.2	1.4

SSS, Single superphosphate; MRP, Mussoorie rockphosphate

Singh *et al.* (1987) found that green-manuring with prickly sesban resulted in saving of at least 60 kg N/ha in lowland rice. Straw yield and yield attributes also followed the same trend.

Effect of level and source of phosphatic fertilizer

Lowland rice did not respond to higher levels of phosphatic fertilizer. Application of 40 kg and 60 kg P/ha recorded at par yields (3.60 tonnes/ha). However, the yields of these treatments were significantly superior to 20 kg P/ha. Application of P fertilizer through Mussoorie rockphosphate (100%) and through single superphosphate + Mussoorie rockphosphate (50%) were at par but significantly superior to application of P fertilizer through single superphosphate (100%). Superiority of Mussoorie rockphosphate to single superphosphate can be explained in the light of its inherent characteristics. The soil of the experimental field had low pH value and available phosphorus status. Rockphosphate has been found to be best suited for soils which are acidic in reaction and deficient in P. Moreover, green-manuring with prickly sesban might have helped in releasing the native soil P and enhanced recovery of applied P as well (Mohapatra and Pradhan, 1990).

N and P uptake

Green-manuring treatments significantly influenced the N and P uptake. Green-manuring alone recorded significantly higher uptake of N and P than no green-manuring, whereas green-manuring + 20 kg N/ha recorded similar uptake as that of 60 kg N/ha. Increased uptake of both N and P might have been due to release of more native and applied soil P in green-manuring treatments which in turn helped in better N uptake over no green-manuring control.

Level and sources of phosphate also significantly affected the N and P uptake. Increasing trend of both N and P uptake was observed up to 40 kg P/ha. Application of either single superphosphate + Mussoorie rockphosphate (50% each) or Mussoorie rockphosphate 100% proved significantly superior to application of single superphosphate 100% alone.

Soil productivity

Soil-nutrient status after the end of 2 rainy seasons showed that soil fertility with respect to major nutrients was either

Table 2. Available nutrient status of soil at the end of rainy seasons of 1987 and 1988

Treatment	Organic carbon (%)	Available nutrient (kg/ha)	
		P	K
Green-manuring			
No green-manuring, no nitrogen (control)	0.56	17.2	138
Green-manuring with prickly sesban	0.58	19.4	146
Green-manuring with prickly sesban + 20 kg N/ha	0.58	20.5	148
60 kg N/ha	0.57	20.6	145
P_2O_5 (kg/ha)			
20	0.56	20.8	142
40	0.57	21.7	144
60	0.55	22.0	145
Sources of P			
SSP (100%)	0.57	18.5	138\
SSP + MRP (50% each)	0.58	19.8	142
MRP (100%)	0.59	20.6	143

SSP, Single superphosphate; MRP, Mussoorie rockphosphate

maintained or improved. The available P in soil was 17.2–22.0 kg/ha and available K 138-148 kg/ha in different treatments compared with initial values of 13.5 kg P and 130 kg K/ha (Table 2).

It was concluded that green-manuring with prickly sesban, saves about 40 kg N/ha and maintain soil productivity. Application of 40 kg P/ha is adequate for economic grain yield and 60 kg P/ha is uneconomic. Mussoorie rockphosphate can be an alternative, effective and cheaper substitute for highly-priced synthetic phosphatic fertilizer.

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