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Studies on levels and methods of phosphorus application in green manure-rice (*Oryza sativa*) system under varying nitrogen levels

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ABSTRACT

A field experiment was conducted during 1993-94 and 1994-95 at Madurai (T.N.) to study the effect of rock phosphate application directly to rice (*Oryza sativa* L.) and through pre-season green manure (GM) (*Sesbania rostrata)* with different levels of nitrogen on growth and yield of rice. Phosphorus application at 60 kg P_2O_5/ha applied half each to GM and rice registered higher rice grain yield. Application of 120 kg N/ha favourably influenced the yield of rice.

Key words: Green manure, *Sesbania rostrata*, Rock phosphate, Yield

Efficient utilisation of applied P is of utmost importance in rice based cropping systems. Since, P is costly input and its fixation and immobilisation leading to poor utilisation by individual crops in the soil are some of the principal reasons which have attracted the attention to formulate more efficient P management in rice based cropping system. The efficiency of rock phosphate in neutral rice soils can be increased by the addition of pyrites. Recently, *Sesbania rostrata* that grows widely in waterlogged soils was reported to be a potential green manure for application in rice ecosystem. The direct and carryover effects of green manuring on rice crop yield, accumulation of nutrients in plants and their availability in soil are substantial. Thus applying P to preceding green manure may exert a great residual effect on the succeeding rice grown under submerged conditions.

MATERIALS AND METHODS

A field experiment was conducted at Agricultural College and Research Institute, Madurai during single rice crop season of 1993-94 and 1994-95. Experimental field was sandy clay loam having organic carbon 0.4% with pH 7.1, available N, P and K 240, 13 and 291 kg/ha respectively. Treatments comparing 3 P levels (30, 45 and 60 kg P_2O_5/ha), three methods of application (100% P_2O_5 to GM, 50%. P_2O_5 each to preceding GM and rice and 100% P_2O_5 to rice) and 3 N levels (60,90 and 120 kg/ha) were

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tried in split-split-plot design and replicated thrice with P levels in main plot, method of application in sub-plot and N levels in sub-sub plots. The rice cv. was IR 20 and *Sesbania rostrata* was raised as pre-season green manure. Phosphorus was applied as rock phosphate as basal both for GM and succeeding rice. Nitrogen levels were imposed on rice crop only. The green manure crop was sown on 15 July in 1993 and 25 July in 1994, and harvested 55 days after sowing. The rice crop was sown on 20 August in 1993 and 27 August in 1994, and harvested on 5 and 13 January in 1994 and 1995 respectively.

RESULTS AND DISCUSSION

Effect of P on Sesbania rostrata

Phosphorus had a significant effect on nodule number/plant, nodule weight/plant and green matter yield. Higher level of 60 kg P_2O_5/ha registered higher green matter yield of 28.08 and 28.17 t/ha in 1993-94 and 1994-95, respectively (Table 1). Phosphorus promoted early root proliferation favouring the development of lateral and fibrous roots which in turn increased the absorbing surface of nutrients. This resulted in higher uptake of NPK at the higher level of P application. This was also attributed to the increased nodulation and green matter yield of green manure (Hundal *et al.*, 1992).

Effect of P on rice

Application of 60 kg P_2O_5/ha being on par with 45 kg P_2O_5/ha produced significantly taller plants than 30 kg P_2O_5/ha (Table 2). Increasing levels of P up to 60 kg P_2O_5/ha significantly increased panicles/m^2 and grain yield. Over the seasons, 60 kg P_2O_5/ha produced 4.3 and 10.8% higher grain yield over 45 and 30 kg P_2O_5/ha respectively. Phosphorus application at higher level initiated early tillering and took lesser time for the completion of flowering and thus the available nutrients were diverted to the production of not only more number of panicles (Rama Rao *et al.*, 1992) but also more number of filled grains/panicle. These

Table 1. Effect of levels and methods of P application on *Sesbania rostrata*

Treatment	Plant height (cm)		Nodules/ plant		Nodule weight (g/plant)		Green matter yield (t/ha)	
	1993	1994	1993	1994	1993	1994	1993	1994
P (kg ha)								
30	161.7	160.8	262.0	285.5	157.0	156.4	24.23	22.39
45	165.6	164.1	295.1	297.4	161.7	161.2	26.32	25.41
60	171.2	170.6	309.4	308.8	166.5	166.6	28.08	28.17
CD (P = 0.05)	NS	NS	13.1	10.7	3.8	3.6	1.79	2.51
Methods of P application								
100% to GM	174.1	174.7	316.7	324.5	173.3	174.1	27.97	28.67
50% each to GM and rice	163.1	163.8	295.2	295.1	164.0	162.1	25.06	24.96
100% to rice	154.7	150.1	263.6	272.9	148.1	148.1	22.10	21.80
CD (P = 0.05)	12.6	12.9	13.1	10.7	3.8	3.6	1.79	2.51

Table 2. Effect of levels, methods of P application and N levels on rice

Treatments	Plant height (cm) at flowering		Panicles/ m^2		Filled grains/panicle		Test weight (g)		Grain yield (kg/ha)	
	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95	1993-94	1994-95
P (kg/ha)										
30	76.4	78.5	368.5	371.7	118.9	123.2	20.74	21.25	5815	5863
45	78.1	80.9	376.5	379.5	126.5	129.5	21.08	21.63	6151	6258
60	79.0	82.2	385.0	389.2	134.5	136.8	21.14	21.93	6422	6518
CD (P = 0.05)	0.8	1.4	1.53	1.28	3.36	1.43	NS	NS	147	128
Method of P application										
M_1-100% to GM	78.6	78.0	377.5	382.1	127.4	129.8	21.10	21.62	6087	6170
M_2-50% each to GM and rice	82.3	82.5	384.9	387.7	131.4	133.8	21.75	21.77	6517	6638
100% to rice	77.8	78.7	367.6	370.5	121.0	125.9	20.10	21.43	5784	5831
CD (P = 0.05)	1.0	1.5	4.44	4.38	3.51	1.48	NS	NS	138	157
N (kg/ha)										
60	72.8	90.5	365.7	368.7	120.5	118.1	19.93	20.80	5713	5776
90	80.3	94.8	377.6	379.4	126.1	128.2	21.10	21.82	6143	6237
120	85.6	97.5	385.9	390.9	133.2	142.9	21.92	22.18	6432	6527
CD (P = 0.05)	0.8	1.2	3.16	2.84	2.86	1.25	0.52	0.29	125	113

favourable yield traits finally led to increased grain yield.

Effect of method of P application on rice

Application of 50% P to GM and 50% P to rice produced taller plants, panicles/m^2 and filled grains/panicle as compared with 100% to GM and 100% to rice (Table 2). Split application to GM and rice also produced significantly higher grain yield of 6,517 and 6,638 kg/ha in respective years. This method maintained a high rate of dissolution of rock phosphate and released more of P to the crop. The steady and balanced availability of P increased the nutrient uptake which in turn promoted growth and yield attributes. The better growth and development of plants under congenial nutritional environment consequently contributed to increased yield (Halepyati and Sheelavantar, 1989).

Effect of N on rice

Application of 120 kg N/ha produced taller plants and increased yield attributes (panicles/m^2, filled grains/panicle and test weight) (Table 2). Increasing levels of N up to 120 kg/ha resulted in increased grain yield. This could be attributed to higher values of yield attributes at this level of N.

This study revealed that P as rock phosphate at 60 kg P_2O_5/ha applied half each to pre-season GM and succeeding rice along with 120 kg N/ha was the best nutritional schedule for realizing maximum yield.

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