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Management options for judicious use of phosphatic fertilizers in a rice (*Oryza sativa*)-based cropping system

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ABSTRACT

A field experiment comprising rice (*Oryza sativa L.*)-rapeseed [*Brassica campestris* (L.) var brown *sarson*] crop rotation was conducted during 1990 to 1995 with 3 P_2O_5 levels and 6 phases of its application at Shalimar. Application of phosphorus recorded significant increase in grain yields with increase in P_2O_5 levels from 30 to 90 kg ha, the effect being more pronounced in rice than rapeseed. Phosphorus applied @ 60 kg/ha every year to both crops proved superior to other phases (frequencies) of application which was also reflected in rice yield equivalent (RYE). *Kharif* applied P_2O_5 (to rice) registered maximum overall RYEs as compared to *rabi* applied P_2O_5 (to rapeseed). Higher P rates and its repeated application every year resulted in higher P build up in soil. Though long term application every year resulted in higher P build up in soil.

Key words : Rice-based cropping system, Phosphorus-management, Rice yield equivalent

Intensive crop rotations with sustainable yield levels entails increased removal of major as well as secondary or micronutrients. Nitrogen is one mobile nutrient which needs regular application to make up for various losses. On the other hand phosphorus is not lost from soil and is known to leave residual effect. This slow mobility of applied P and its marked fixation results in low crop recoveries of the order of 20 to 25%, which calls for ways and means for its judicious use (Singh, 1993). Though the direct application of P to individual crops seems to be one of management options to sustain productivity, there is a need to explore other factors which can economize P use in a crop rotation. In quantitative terms, the direct and residual effects of P depend on rates and frequencies or phases of its application. The present investigation was therefore conducted with the objective of devising suitable options in terms of phosphorus rates and phases for a sustainable crop production under Kashmir conditions.

MATERIALS AND METHODS

The field trial was conducted for 5 consecutive years (1990 to 1995) with rice-

rapeseed cropping system, on a fixed site of Shalimar Research Campus of Sher-e-Kashmir. University of Agricultural Sciences and Technology. The experimental soil was a silty clay loam, low in available nitrogen and phosphorus and medium in available potash. The treatments as per Table 1 were allocated with same randomization throughout in a split plot design with 3 replications, and comprised 3 levels of P_2O_5 in main plots and 6 phases (frequencies) of application in subplots. Nitrogen and K_2O were applied to both crops as per recommendation. Rice ('K 39') was transplanted by second week of June at 15 x 15 cm and rapeseed ('KOS 1') sown by second week of October with 30 cm row spacing. Post- harvest soil analysis for available P_2O_5 was done by the Olsen's method. RYEs were calculated for various treatments on 1991-92 price basis. The total annual precipitation (mm) recorded at Shalimar observatory was 744, 687, 962, 754, 1,050 and 1,177 for 1990 to 1995. Mean maximum temperature was between 4.62 and 30°C, mean minimum temperature - 1.2 and 19.2°C and relative humidity 53 to 90%.

RESULTS AND DISCUSSION

Effect of P levels

There was significant increase in rice yields with each increment of P_2O_5 dose from 30 to 90 kg ha, maximum being at the highest dose (Table 1). Initially for 3 years successive dose of P_2O_5 resulted in significant increases up to 90 kg P_2O_5 ha but after that the differences levelled off with 60 and 90 kg dose producing similar effect. Based on mean of 5 years, 60 kg P_2O_5 produced rice grain yield which was 16.5% higher than a 30 kg level, and 90 kg dose producing only 6.1% higher over 60 kg dose. Significant effect of P_2O_5 levels in winter crop of rapeseed was recorded in 3 out of 5 years. In this study, the *kharif* crop of rice responded significantly to P_2O_5 levels during initial period of 3 years. Giri (1993) reported similar findings for a groundnut-wheat system when groundnut responded significantly to direct application of P during initial season only. Our study clearly shows the quantitative advantage of increasing P rates in *kharif* and to some extent in *rabi.*

Effect of frequency (phases)

Effect of frequency (phases) of P application on grain yield (Table 1) remained significant for all years in *kharif* (summer) and most of the years in *rabi* (winter). Based on means of 5 years the study indicated that P applied to both seasons i.e. *kharif* and *rabi,* produced maximum rice and rapeseed yields. The response was however more marked in summer applied P. As temperature of the region during crop season has profound influence on P sorption-desorption, and residual P contributed more to crop nutrition when the crop feeding on P-residue is taken in the warm wet seasons (Tandon, 1993). The response of summer applied P was more.

RYE and residual P

Maximum RYE was obtained with the highest dose of P_2O_5 (70.6 q of RYE/ha). Similarly, maximum RYE was recorded with P applied to both *kharif* and *rabi* (71.8 q/ha). In general *kharif* applied P recorded more overall yields as compared to *rabi* applied P. This confirms the findings of Tandon (1993). Higher P rates along with its repeated

Table 1. Grain/seed yields (q/ha) as influenced by levels and frequencies of phosphorus application

Treatment	Grain yield of rice						Seed yield rapeseed					
	1990	1991	1992	1993	1994	Mean	1990-91	1991-92	1992-93	1993-94	1994-95	Mean
P_2O_5 (kg/ha)												
30	42.1	46.6	31.7	45.9	31.6	39.60	4.9	7.7	9.7	6.8	7.0	7.27
60	53.7	55.0	40.0	50.1	38.3	47.42	7.5	8.6	9.3	6.7	8.0	8.0
90	57.2	60.0	43.0	52.8	39.6	50.52	8.7	9.7	9.9	8.5	9.2	9.20
CD (P = 0.05)	2.3	4.2	3.5	4.2	1.9		0.5	NS	NS	0.3	0.9	
Frequency of P_2O_5 application												
To both crops every year	58.8	60.9	42.2	64.9	40.0	53.36	7.0	9.5	8.8	8.5	8.5	8.45
To rice only every year	58.0	56.0	49.0	53.5	35.0	50.32	6.6	8.2	7.1	7.6	7.4	7.38
To winter crop every year	36.3	53.3	28.8	46.0	37.5	40.38	8.0	7.3	10.1	7.6	8.2	8.25
To rice in alternate years	60.6	49.1	41.4	44.6	34.2	45.98	7.4	8.7	10.2	6.7	8.2	8.25
To winter crop in alternate years	34.2	50.0	36.2	43.6	36.0	40.00	7.0	9.1	10.7	5.9	8.2	8.18
To both crops in alternate years	58.0	54.0	38.7	44.6	36.5	46.36	6.3	9.5	10.8	7.8	8.6	8.60
CD (P = 0.05)	3.0	2.1	3.1	3.8	3.0		0.8	NS	1.2	0.5	0.4	

Table 2. Rice yield equivalent (RYE) and residual soil P status as influenced by various treatments

Treatment	RYE (q/ha) (based on 5 years means)	Available P (kg/ha)		
		Initial	Final	Balance
P_2O_5 (kg/ha)				
30	55.0	11.5	12.0	+0.5
60	64.9	11.5	15.9	+4.4
90	70.6	11.5	18.7	+7.2
Frequency of P_2O_5 application				
To both crops every year	71.8	11.5	18.5	+7.0
To rice only every year	66.4	11.5	15.0	+3.5
To winter crop every year	58.4	11.5	15.3	+3.8
To rice in alternate years	64.0	11.5	11.0	-0.5
To winter crop in alternate years	57.8	11.5	11.2	-0.3
To both crops in alternate years	65.1	11.5	15,7	+4.2

applications resulted in higher P-build up in soil. The maximum P-build up in soil. The maximum P build up was found when both seasons were adequately supplied with P every year (17.0 kg/ha of available P). Similar results were reported by Sharma and Mitra (1991) and Gill and Meelu (1982). Nambiar (1994) also reported that available soil-P at optimal to super-optimal (100-150%) NPK doses was raised from low to medium and high status in various Indian soils over a 16-year period. It is quite likely that the accumulated P residues could adequately nourish 1 or 2 crops after which fresh application become necessary to sustain grain yields at higher level.

Results of our study indicated that application of P_2O_5 @ 60 kg/ha to both rice and rapeseed every year could help in realizing sustainable crop yields on a long term basis.

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