

Nutrient management with sulphur and non-sulphur bearing fertilizers and farmyard manure for sustaining productivity of rice (*Oryza sativa*) under intensive cropping system

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ABSTRACT

A field experiment was conducted on clay loam soils of Kalyani, West Bengal, during rainy (*kharif*) and winter (*rabi*) seasons of 2000–2001 and 2001–2002, to study the best integrated system of nutrient management with sulphur and non-sulphur bearing fertilizers and farmyard manure (FYM) on the productivity and nutrient uptake of *kharif* and *boro* rice (*Oryza sativa* L.) under intensive cropping system. Maximum grain yields of both rainy season (4.66 tonnes/ha) and winter (5.47 tonnes/ha) rice were obtained in the sequence where greengram (*Phaseolus radiatus* L.) and lathyrus (*Lathyrus* sp.) were green manured before transplanting of rainy season and winter rice in addition to 75% of the recommended dose of N, P and K through non-sulphur bearing fertilizers (urea, diammonium phosphate and muriate of potash) along with FYM @ 10 tonnes/ha. Rice crop grown after greengram and lathyrus as green-manure or fodder crop along with 100% of the recommended dose of N, P and K through sulphur-bearing fertilizers (ammonium sulphate, diammonium phosphate and muriate of potash) also improved the grain yield of both rainy season and winter season rice. Higher uptake of nutrients by rice crops (rainy + winter season) also observed with the combined application of organic (FYM or green-manure) and inorganic fertilizers.

Key words : Rice, Green-manure, Yield components, Grain yield, FYM, Sulphur, Nutrient uptake

Of late, special attention is being given on evolving new cropping pattern and fertilizer management for increasing production without affecting the soil fertility. To maintain soil fertility, the most effective way is to use bulky organic manure and to practise manuring before transplanting of rice crop, wherever possible. But organic manure or green-manure alone cannot sustain the higher productivity, required these days. Therefore, fertilizers are to be integrated with organic sources to replenish the continuous removal of plant nutrients. Incorporation of farmyard manure or green-manure in combination with inorganic fertilizers improves the productivity of rice, sustains soil health and economizes fertilizer need (Tripathi and Chaubey, 1996). Hence present investigation was undertaken to find out the best integrated nutrient management with sulphur and non-sulphur-bearing fertilizers along with farmyard manure (FYM) for sustaining productivity of rice under intensive cropping system.

MATERIALS AND METHODS

The field experiment was conducted during rainy (*kharif*) and winter (*boro*) seasons of 2000–2001 and 2001–2002 at University farm, Kalyani, West Bengal. The

soil was clay loam, having 0.063% total N, 18.10 kg/ha available P, 239 kg/ha available K, 8.10 ppm available sulphur and pH 7.2. The experiment was laid out in split-plot design with 4 different cropping sequences, viz. CS₁, *kharif* rice–oat (fodder)–*boro* rice–greengram (green manure); CS₂, *kharif* rice–lathyrus (green-manure)–*boro* rice–maize (fodder); CS₃, *kharif* rice–lathyrus (fodder)–*boro* rice–greengram (fodder); and CS₄, *kharif* rice–oat (fodder)–*boro* rice–maize (fodder), in main plots. In the sub-plot, there were 4 different types of fertilizer management treatments, viz. F₁, 100% of the recommended dose (RD) of N, P and K through non-sulphur-bearing fertilizers (urea, DAP and MOP) applied to *kharif* and *boro* rice; F₂, 75% of the recommended dose of N, P and K through non-sulphur-bearing fertilizer (urea, DAP and MOP) applied to *kharif* and *boro* rice; F₃, 75% of the recommended dose of N, P and K through non-sulphur-bearing fertilizers (urea, DAP and MOP) along with FYM @ 10 tonnes/ha applied to *kharif* and *boro* rice respectively; F₄, 100% of the recommended dose of N, P and K through sulphur-bearing fertilizers (ammonium sulphate, DAP and MOP) applied to *kharif* and *boro* rice respectively. The above treatments were replicated 3 times. According to treat-

Table 1. Effect of cropping sequence on yield components, grain yield and total uptake of nutrients by rainy and winter season rice under different fertilizer management treatments (pooled data)

Treatment	Effective tillers		Grains/panicle		1,000-grain weight (g)		Grain yield (tonnes/ha)		Nutrient uptake (kg/ha annum)			
	Kharif season	Boro season	Kharif season	Boro season	Kharif season	Boro season	Kharif season	Boro season	N	P	K	S
<i>Cropping sequence</i>												
CS ₁	389.58	365.91	80.42	84.04	23.62	23.00	4.13	4.36	161.00	45.00	204.82	34.64
CS ₂	331.92	415.54	72.47	80.71	22.97	23.06	3.56	4.92	163.18	48.13	205.48	34.81
CS ₃	353.33	433.10	77.28	87.70	23.27	23.46	3.93	4.48	158.92	44.09	202.17	33.92
CS ₄	343.45	459.66	75.35	95.70	22.64	23.51	3.44	3.89	153.72	42.33	197.68	32.76
CD (P=0.05)	2.64	9.82	3.97	5.36	NS	NS	0.13	0.07				
<i>Fertilizer management</i>												
F ₁	339.71	402.41	69.30	86.93	23.01	23.29	3.55	4.18	154.72	43.64	199.34	32.95
F ₂	316.54	383.75	66.26	82.71	22.53	22.67	3.28	3.83	149.79	39.97	192.91	30.95
F ₃	398.99	469.45	91.23	93.59	23.78	23.60	4.25	4.99	170.25	49.34	213.04	35.61
F ₄	363.04	428.95	78.72	89.47	23.47	23.48	3.98	4.65	162.06	46.61	204.87	36.62
CD (P=0.05)	3.19	7.15	4.82	3.19	NS	NS	0.06	0.05				

Details of treatments are given under Materials and Methods

ment, FYM @ 10 tonnes/ha (containing 0.44% N, 0.22% P, 0.38% K and 0.13% S) was applied in both *kharif* and *boro* rice during final land preparation. After harvesting of greengram (containing 0.80% N, 0.25% P, 0.76 K and 0.19% S) and lathyrus (0.53% N, 0.23% P, 0.62% K and 0.15% S) as green-manure crop were chopped in pieces and mixed with soil before transplanting of rice crop.

The available nutrients in FYM and crop residues incorporated in the system were calculated at 25% of the total nutrient present in the material incorporated as per suggestion of Daji and Iyenger (1971).

RESULTS AND DISCUSSION

Cropping sequence

Yield components and grain yield of rice increased appreciably when *kharif* and *boro* rice were grown after legume crops (Table 1). The highest yield components, grain yield (4.13 in *kharif* and 4.92 t/ha in *boro* season) and uptake of nutrients were recorded in the sequence where either *kharif* or *boro* rice was green-manured with greengram and lathyrus. The yield increase in rice under green-manured plots over no green manured plots was 16.7 and 20.9% during *kharif* and *boro* season respectively. Similar results were reported by Vinod Kumar *et al.* (1999). Rice crop grown after legume as fodder crop also increased the yield components, grain yield and uptake of nutrients in both *kharif* and *boro* season compared to non-legume crop (oat and maize) grown in the sequence indicating that legume fodder crops certainly have residual effects on succeeding rice crop in the sequence. Our results confirm the findings of Dwivedi *et al.* (1998).

Fertilizer management

Yield components, grain yield and uptake of N, P and K by rice crop increased with different levels of fertilizer management with or without FYM in both *kharif* and *boro* rice had significant effects on yield components and grain yield of rice; however, the maximum was recorded with the application of 75% of the recommended N (urea), P (DAP) and K (MOP) along with FYM @ 10 tonnes/ha (Table 1). This might be because of increased availability of nutrients to the crop plants applied through organic and inorganic sources. This finding supports the results of Mondal and Chettri (1998). In case of sulphur nutrient,

Table 2. Interaction effect of different cropping sequences and fertilizer management on grain yield of rice during *kharif* and *boro* season (pooled data)

Cropping sequence	Fertilizer management			
	F ₁	F ₂	F ₃	F ₄
<i>Kharif season</i>				
CS ₁	3.93	3.63	4.66	4.32
CS ₂	3.39	3.14	4.03	3.68
CS ₃	3.71	3.43	4.43	4.17
CS ₄	3.18	2.93	3.88	3.77
<i>Boro season</i>				
CS ₁	4.13	3.76	4.96	4.58
CS ₂	4.79	4.36	5.47	5.08
CS ₃	4.17	3.81	5.14	4.80
CS ₄	3.63	3.39	4.40	4.14
CD (P=0.05)	At the same level of C		At the same level of F	
<i>Kharif season</i>	0.015		0.153	
<i>Boro season</i>	0.010		0.140	

the uptake was highest when rice crop was fertilized with 100% of the recommended dose of sulphur-bearing fertilizers (ammonium sulphate, DAP, MOP). Further, the yield components and grain yield of *kharif* and *boro* rice, recorded under 100% of the recommended dose of N (ammonium sulphate), P (DAP) and K (MOP), significantly higher than 100% of the recommended dose of N (urea), P (DAP) and K (MOP). The observed results under present investigation are in close conformity with the findings of Mondal and Mondal (1996).

Interaction effect on grain yield

The grain yield of rice interacted significantly with cropping sequence and fertilizer management during *kharif* and *boro* season respectively (Table 2). In both *kharif* and *boro* seasons, the maximum grain yields (4.66 and 5.47 tonnes/ha) were obtained in a sequence where greengram and lathyrus were green-manured before transplanting of *kharif* and *boro* rice and rice crop was fertilized with 75% of the recommended dose of N, P and K through non-sulphur-bearing fertilizers (urea, DAP and MOP) in conjunction with 10 tonnes FYM/ha. Higher grain yield of rice was also noticed with the application of 100% of the recommended dose of sulphur-bearing fertilizers (ammonium

sulphate, DAP and MOP) in the sequence where greengram and lathyrus (as fodder crop) were grown before *kharif* and *boro* rice.

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