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Effect of nutrient management in white jute *(Corchorus capsularis)*–rice *(Oryza sativa)* cropping system under rainfed condition

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ABSTRACT

A field experiment was carried out during 2000–01 to 2002–03, at Kendrapara, to study the effect of nutrient management on yield, nutrient uptake and economics of white jute *(Corchorus capsularis* L.)–rice *(Oryza sativa* L.) cropping system in rainfed medium land. Application of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha (recommended dose for white jute) along with $MgSO_4$. $7H_2O$ @ 10 kg/ha + lime (0.5 lime requirement) to jute crop recorded the highest fibre yield (2.28 tonnes/ha), and maximum grain yield (3.89 tonnes/ha) of succeeding rice crop were obtained with a fertilizer dose of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha in the system. This resulted in an increased yield of 26.7% in jute fibre and 10.2% of rice grain over the recommended fertilizer dose in both the crops. The nutrient uptake (N,P,K, Ca, Mg and S) of individual crop and the system increased owing to NPK + 10 kg $MgSO_4$. $7 H_2O$ + lime (0.5 lime requirement) in jute, followed by rice with only recommended fertilizer dose in comparison to other treatments. The maximum net returns (Rs 22,628/ha) and the highest benefit : cost ratio (1.71) were recorded with the recommended NPK to both crops along with $MgSO_4$ and lime to jute only in jute-rice cropping system under rainfed condition.

Key words : Nutrient management, Crop productivity, Nutrient uptake, Cropping system, Jute, Rice

Raw jute plays an important role in rural economy of eastern and north-eastern states of India. About 4 million farm families derive their sustenance by cultivating jute in the country. Moreover, about 0.25 million people are employed in the jute industry and 2.5 million people are engaged in jute-based ancillary sector (Chaudhury and Sinha, 2004). In rainfed lands of these areas, the cropping system with rice often includes white jute. Continuous use of S-free NPK fertilizers in jute-based cropping system under rainfed areas leads to S deficiency (Saha *et al.,* 2002). In addition to NPK, magnesium is the next effective nutrient for increasing fibre yield of jute (Ray and Chowdhury, 2000). However, systematic information on comparison of inorganic fertilizer, organic manure, soil amendments and secondary nutrient-management practices are meagre in jute–rice cropping system. Considering this, the present investigation was undertaken to study the effect of nutrient management on yield, nutrient uptake and economics of jute–rice cropping system under rainfed situation.

MATERIALS AND METHODS

The experiment was conduced at Jute Research Station, Kendrapara, Orissa, in rainfed medium land during 2000–01 to 2002–03. The soil was acid lateritic and clay loam, with 5.1 pH, 0.551% organic carbon, and 178, 12.8 and 127.9 kg/ha of available N, P and K respectively. Six nutrient-management practices, viz. NPK recommended dose (60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha, i.e. $N_{60}P_{30}K_{30}$), NPK + FYM (5 tonnes/ha), NPK + $MgSO_4$. $7H_2O$ (10 kg/ha), NPK + lime (0.5 lime requirement (LR)], NPK + $MgSO_4$. $7H_2O$ (10 kg/ha) + lime (0.5 LR) and farmers' practice (20 kg N and 10 kg P_2O_5/ha, i.e. $N_{20}P_{10}$), were tried in a fixed plot study for jute crop with 4 replications in randomized block design. Jute 'JRC 212' was sown in the first week of May in every year and was grown with all other recommended package of practices. Lime requirement was estimated by SMP Single-buffer method (McLean, 1982) and accordingly 2.9, 1.6 and 0.9 tonnes/ha of lime was applied in 2000–01, 2001–02 and 2002–03, respectively, at 0.5 L.R. Rice 'Lalat' was transplanted in the last week of August after the harvest of jute crop every year with recommended dose of fertilizer (60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha) and also with other package of practices. The crop received rainfall 1,261; 1,202 and 1,196 mm during growing season of 2000–01, 2001–02 and 2002–03 respectively. Plant samples of jute and rice were analysed for their N, P, K, Ca, Mg and S content for estimating the uptake of respective nutrients by following standard procedure.

RESULTS AND DISCUSSION

Crop productivity

Pooled data revealed that nutrient-management practices involving recommended NPK for white jute along with $MgSO_4$. $7H_2O$ + lime recorded the maximum plant height, highest basal diameter and more green weight of the harvested plant (Table 1). The highest fibre yield was recorded under the same treatment (Table 2) which was at par with NPK + lime and NPK + FYM treatments, and significantly higher than the other treatments. This treatment showed fibre yield increase of 26.7 and 52% over is recommended dose of fertilizer and farmers' practice respectively. Application of FYM (5 tonnes/ha), $MgSO_4$. $7H_2O$ (10 kg/ha) and lime (0.5 LR) increased the fibre yield of 0.31, 0.19 and 0.35 tonnes/ha, respectively, over the recommended dose of nutrients, which indicated greater response of lime application. This might be owing to their higher yield attributes and more availability of required nutrients in the soil and thus more uptake by crop plants. Jana and Ghorai (2004) reported that sustainable and potential fibre yield of jute could be obtained by applying recommended NPK along with FYM, lime and $MgSO_4$. Ray and Chowdhury (2000) also reported beneficial effect of such nutrients in increasing the jute fibre yield.

The jute field applied with recommended dose of fertilizer along with Mg SO_4. $7H_2O$ (10 kg/ha) + lime (0.5 LR) showed the maximum yield attributes (Table 1) and the highest rice grain yield with application of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha to rice (Table 2). This nutrient-management practice resulted in an increase of rice grain yield of 10.2 and 12.7% over the recommended dose of fertilizer and farmer's practice to white jute respectively. Nayak *et al.* (2000) also reported the beneficial effect of recommended NPK + farmyard manure applied to jute showed an increase in seed yield of mustard in the sequential cropping. These results are also in close conformity with the findings of Ray and Chowdhury (2000).

Nutrient uptake

Nitrogen, phosphorus, potassium, calcium, magnesium and sulphur uptake was significantly influenced by different nutrient-management practices in jute and rice (Table 3). In jute crop the uptake was 56.4, 15.8, 77.3, 89.1, 27.6 and 12.6 kg/ha of N, P, K, Ca, Mg and S, respectively, with recommended dose of fertilizer along with Mg SO_4 + lime. This resulted in an increase in uptake of 4.6 kg N, 2.6 kg P, 6.9 kg K, 8.6 kg Ca, 5.2 kg Mg and 3.3 kg S/ha over the recommended fertilizer dose. Similarly, rice showed uptake of 70.3, 13.5 76.2, 22.4, 16.6 and 13.8 kg/ha of N, P, K, Ca, Mg and S, respectively, when grown in jute field fertilized with recommended dose +

Table 1. Yield attributes of jute–rice cropping system as influenced by nutrient management (pooled means of 3 years data)

Treatment	Jute			Rice		
	Plant height (cm)	Basal diameter (cm)	Green weight (tonnes/ha)	Plant height (cm)	Effective tillers/hill	Filled grains/panicle
NPK ($N_{60}P_{30}K_{30}$ kg/ha)	260	1.82	31.5	75.6	6.8	87.4
NPK + FYM (5 tonnes/ha)	272	1.89	35.0	78.6	7.6	90.3
NPK + $MgSO_4$ (10 kg/ha)	263	1.87	33.8	76.4	7.3	88.2
NPK + lime (0.5 lime requirement)	274	1.99	35.1	78.1	7.6	90.8
NPK + $MgSO_4$ + lime	281	2.07	37.4	79.2	8.1	91.6
Farmer's practice ($N_{20}P_{10}$)	236	1.69	28.4	68.2	6.2	85.2
CD (P=0.05)	29	0.31	2.8	4.1	1.3	2.9

Table 2. Yields and economics of jute–rice cropping system as influenced by nutrient management (pooled means of 3 years data)

Treatments	Jute		Rice		Jute–rice system	
	Fibre yield (tonnes/ha)	Stick yield (tonnes/ha)	Grain yield (tonnes/ha)	Straw yield (tonnes/ha)	Net return (Rs/ha)	Benefit : cost ratio
NPK ($N_{60}P_{30}K_{30}$ kg/ha)	1.80	5.16	3.53	3.37	16,991	1.61
NPK + FYM (5 tonnes/ha)	2.11	6.11	3.59	3.64	19,759	1.64
NPK + $MgSO_4$ (10 kg/ha)	1.99	5.78	3.46	3.49	18,366	1.62
NPK + lime (0.5 lime requirement)	2.15	6.15	3.70	3.73	21,379	1.71
NPK + $MgSO_4$ + lime	2.28	6.57	3.89	3.85	22,628	1.71
Farmer's practice ($N_{20}P_{10}$)	1.50	4.08	3.45	3.53	14,115	1.52
CD (P=0.05)	0.22	0.78	0.18	0.78	972	0.07

Table 3. Nutrient uptake in jute–rice cropping system as influenced by nutrient management (pooled means of 3 years data)

Treatment	Uptake by jute (kg/ha)						Uptake by rice (kg/ha)					
	N	P	K	Ca	Mg	S	N	P	K	Ca	Mg	S
NPK ($N_{60}P_{30}K_{30}$ kg/ha)	51.8	13.2	70.4	80.5	22.4	9.3	65.2	11.6	72.4	19.1	14.5	11.4
NPK + FYM (5 tonnes/ha)	53.2	14.6	74.3	83.5	24.7	10.1	67.1	12.3	74.6	20.4	15.2	12.8
NPK + $MgSO_4$ (10 kg/ha)	52.6	14.4	72.6	82.2	26.4	11.8	66.6	11.8	73.3	20.6	15.0	13.6
NPK + lime (0.5 lime requirement)	54.6	15.3	74.2	86.8	25.2	10.5	68.8	12.6	75.8	21.8	15.8	12.9
NPK + $MgSO_4$ + lime	56.4	15.8	77.3	89.1	27.6	12.6	70.3	13.5	76.2	22.4	16.6	13.8
Farmer's practice ($N_{20}P_{10}$)	44.4	11.6	66.3	68.4	20.1	8.2	63.4	9.8	70.1	17.6	12.4	9.6
CD (P=0.05)	2.6	1.4	3.8	4.9	1.9	0.9	3.8	1.2	2.6	1.4	1.6	1.2

$MgSO_4$ + lime. This also showed an increase in uptake of 5.1 kg N, 1.9 kg P, 3.8 kg K, 3.1 kg Ca, 2.1 kg Mg and 2.4 kg S/ha over recommeded fertilizer to jute. Only liming with recommended NPK had very good effect on various nutrient uptake in jute and rice which was on a par with NPK + $MgSO_4$ + lime except Mg and S uptake. Das *et al.* (1985) reported similar results of liming on fibre yield of *tossa* jute. Ray and Choudhury (2000) also reported that combination of organic and inorganic fertilizers increased the fibre yield of jute and that of subsequent crops.

Application of NPK along with $MgSO_4$. $7H_2O$ + lime resulted in 2.28 tonnes/ha production of white jute fibre and subsequent application of 60, 30, 30 kg NPK/ha to the succeeding rice crop yielded 3.89 tonnes/ha of rice grain. At this production level and nutrient-management practices, jute–rice cropping system removed 126.7 kg N, 29.3 kg P, 153.5 kg K, 111.5 kg Ca, 44.2 kg Mg and 26.4 kg S/ha/annum under rainfed medium land condition. Uptake of all macronutrients was very high when recommended fertilizers with additional lime and $MgSO_4$ were applied. This indicated that balanced fertilization could greatly influence the uptake of macronutrients. Khan *et al.* (2002) also reported an increase in uptake of nutrients with balanced fertilization in jute–rice cropping system.

Economics

The 3 years mean data (Table 2) revealed that jute–rice cropping system gave the highest net return with recommended NPK along with $MgSO_4$ and lime, followed by NPK + lime. The lowest net return was obtained with farmer's practice. The NPK + lime application increased the net profit by Rs 4, 388/ha and NPK + lime + $MgSO_4$ application by Rs 5, 637/ha over NPK only. The highest benefit : cost ratio (1.71) was obtained with NPK + $MgSO_4$ + lime or NPK + lime. This might be owing to higher fibre yield of jute and grain yield of rice owing to the treatment in the cropping system.

Thus farmers following white jute–rice system in rainfed medium lands should apply 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha along with $MgSO_4$. $7H_2O$ @ 10 kg/ha + lime (0.5 lime requirement) to jute crop and 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha to the succeeding rice crop for higher production and more monetary gains.

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