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Direct and residual effect of fertilizers on yield and nutrient uptake of jute (*Corchorus capsularis*) and rice (*Oryza sativa*) grown in a cropping sequence in rainfed lowlands

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ABSTRACT

A field experiment was conducted at Kharagpur during 1991 and 1992 to study the effect of varying levels of N and P applied to capsularis jute (*Corchorus capsularis* L.) and their residual benefits to the succeeding rice (*Oryza sativa* L.) crop. Jute crop showed response up to N_{40} P_{20} level. Sizeable amount of jute biomass was recycled in soil through root stubbles (1,605 kg/ha) and leaf fall (387 kg/ha) supplying 23 kg N/ha and 10 kg P_2O_5/ha. Advantage of residual fertility to rice improved the grain yield significantly by direct application of chemical fertilizer at sub-optimal dose, i.e. N_{40} P_{20}. Thus, a saving of 20 kg N/ha and 10 kg P_2O_5/ha could be achieved due to residual fertility derived from jute biomass in jute-rice cropping sequence.

***Key words*:** Jute, Rice, Residual fertility, Nutrient uptake, Nitrogen, Phosphorus

In rainfed lowlands, the cropping system with rice (*Oryza sativa* L.) often includes capsularis jute (*Corchorus capsularis* L.). The application of nitrogenous fertilizers to rice directly is questionable under higher water depth resulting in low fertilizer use efficiency (Roa *et al.,* 1985). The residue from jute crop in the form of leaf and root biomass may contribute towards betterment of soil fertility and benefit the succeeding rice crop. Considering this, the present investigation was undertaken to study the different doses of nitrogen and phosphorus on yield and uptake of nutrients by jute and their residual effect on rice under rainfed lowlands.

MATERIALS AND METHODS

A field experiment was conducted at Kharagpur during summer and autumn

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season of 1991 and 1992 in acids lateritic and sandy clay-loam soil with 6.8 pH, 0.46% organic carbon and 234, 17 and 283 kg/ha available N, P and K respectively. Jute crop received 4 combinations of N and P levels, viz. N_0P_0 (control), N_{20} P_{10}, N_{40} P_{20} and N_{60} N_{30} applied as basal dose. In the jute field there remained standing water of 5 to 10 cm from 50 days after sowing to harvest. After harvest of jute each plot was divided into 5 subplots and these subplot were fertilized randomly at varying levels of N and P, viz. N_0P_0 (control), $N_{20}P_{10}$, $N_{40}P_{20}$, $N_{60}P_{30}$ and $N_{40+20}P_{30}$ applied as basal except in treatment $N_{40+20}P_{30}$ where 40 kg N was applied as basal dose and 20 kg N/ha was top-dressed 30 days after transplanting of rice. The design was randomized complete block in case of jute and split plot in case of rice with 3 replications. The water depth in rice field ranged from 15 to 35 cm during the crop growth period. Observations were recorded on yields on jute fibre and sticks and of grains in rice. The jute crop was harvested at the early stage of flowering (105 days after sowing). Dry matter of roots, leaf, barks and sticks were recorded at early flowering stage of crop growth.

RESULTS AND DISCUSSION

Yield and N uptake by jute

Both fibre and stick yields were increased considerably by 65.9% and 58.1% respectively (average of 2 years) with the application of nitrogen and phosphorus up to $N_{40}P_{20}$. Further increase in fertilizer level at $N_{60}P_{30}$ was not beneficial in yields (Fig. 1). The uptake of N and P by the plant was considerably higher when fertilizer was applied at $N_{40}P_{20}$ than control or $N_{20}P_{10}$ level

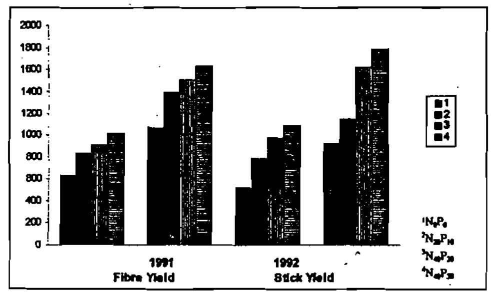

Fig. 1. Effect of different doses of nitrogen and phosphorus on yield (kg/ha) of jute

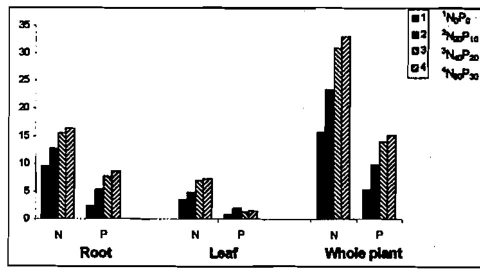

Fig. 2. Uptake of nutrients (kg/ha) at harvest by root, leaf and whole plant of jute following application of different levels of nitrogen and phosphorus (mean of two years)

of fertilizer application. Total uptake of N and P by plant was increased with increase in level of fertilizer (Fig. 2). However, there was marginal increase in nutrient uptake when the fertilizer level was increased beyond N_{40} P_{20} level. Of the total N-uptake, roots contributed 54.6% and that of leaf 10.3%. Thus the contribution of nutrient through root stubbles and leaf of jute crop waste to benefit the succeeding rice crop was to the extent of 23 kgN/ha and 10 kg P_2O_5/ha which was recycled in a jute-rice cropping sequence.

Grain yield of rice

Pooled yield analysis data for 2 years

indicated appreciable increase in grain yield of rice due to interaction effect of residual fertility derived from jute as well as direct application of fertilizer to rice. It is observed from Table 1 that there was significant increase in grain yield when the crop received residual fertility at $N_{20}P_{10}$ level from jute and also due to direct application of fertilizer at $N_{40}P_{20}$ level. This treatment combination was comparable with direct application of fertilizer at $N_{60}P_{30}$ level to rice and the jute crop received no fertilizer

Table 1. Interaction between residual fertility and direct fertilizer effect evidenced from grain yield (kg/ha) of rice (mean of 2 years)

Treatment	Residual fertilizer added to jute				
	N_0P_0	$N_{20}P_{10}$	$N_{40}P_{20}$	$N_{60}P_{30}$	Mean
Direct fertilizer levels					
N_0P_0	2,032	2,450	2,491	2,635	2,402
$N_{20}P_{10}$	2,409	2,831	2,943	3,094	2,819
$N_{40}P_{20}$	2,761	3,163	3,248	3,216	3,097
$N_{60}P_{30}$	2,902	3,466	3,579	3,557	3,376
$N_{40+20}P_{30}$	3,047	3,198	3,239	3,537	3,255
Mean	2,630	3,021	3,100	3,207	

CD (P = 0.05) for direct fertilizer 368
CD (P = 0.05) for residual fertilizer 360
CD (P = 0.05) for interaction 1053

Table 2. Residual and direct effects of different levels of nitrogen (N) and phosphorus (P) on N and P uptake (kg/ha) by rice

Treatment	Grain		Straw	
	N	P	N	P
Residual fertilizer added to jute				
N_0P_0	26.08	5.07	22.58	4.18
$N_{20}P_{10}$	32.44	6.17	30.08	5.31
$N_{40}P_{20}$	38.15	6.93	37.62	6.13
$N_{60}P_{30}$	39.81	7.5	39.53	6.78
CD (P= 0.05)	2.76	0.55	1.93	0.41
Direct effect				
N_0P_0	23.13	4.58	21.72	3.51
$N_{20}P_{10}$	29.87	5.82	27.56	5.07
$N_{40}P_{20}$	35.54	7.09	33.65	6.36
$N_{60}P_{30}$	41.97	7.41	39.97	6.36
$N_{40+20}P_{30}$	40.11	7.16	39.97	6.36
CD (P = 0.05)	1.48	0.87	1.48	0.95

(N_0P_0). This finding shows that the rice crop can be grown at sub-optimal dose of N and P fertilizer, i.e. at $N_{40}P_{20}$ level if it receives adequate residual fertility from the jute crop. Thus, a saving of 20 kg N and 20 kg P_2O_5/ ha was achieved due to jute crop waste through root stubbles and leaves. Such residual fertility was from 1,605 kg/ha of root and 378 kg/ha of leaf biomass of jute besides contributing from chemical fertilizer sources. Such practice is considered important in lowland situation, where direct application of chemical fertilizer to rice poses risk due to greater losses under higher water depth.

Nutrient uptake by rice

Under residual fertility there was significant increase in nutrient uptake by rice crop. The increase was noted with increasing level of fertilization applied to the previous jute crop up to $N_{60} P_{40}$ level (Table 2). As expected direct application of fertilizer to rice crop increased the uptake of N and P significantly up to $N_{60} P_{30}$ during both the years. However there was no significant variation in nutrient uptake between the treatments split and single basal application of N fertilizer i.e., $N_{60} P_{30}$ and $N_{40+20} P_{30}$.

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