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Effect of integrated nutrient management on fibre yield, nutrient uptake and soil fertility in jute (*Corchorus olitorius*)

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ABSTRACT

A field experiment was conducted during 2004–06 to study the effect of combined application of inorganic fertilizer and organic manures on yield, nutrient utilization of jute (*Corchorus olitorius* L.) along with soil fertility. Substitution of 25% N through water hyacinth compost or farmyard manure in recommended dose of NPK recorded significantly higher fibre yield (2.63, 2.62 tonnes/ha) over the 100% NPK treatment. Maximum N and K uptake (68.22 and 174.41 kg/ha) were observed when 25% N was replaced by water hyacinth compost while maximum P uptake (31.33 kg/ha) was recorded with 50% substitution of N through farmyard manure. Post-harvest soil analysis revealed that integrated nutrient management with water hyacinth compost enriched the fertility status of the experimental soil. Thus, substitution of chemical N-fertilizer to the tune of 25% through water hyacinth compost or farmyard manure increased the fibre productivity in jute and also maintained the fertility status of the soil under Aquic Ustifluvent.

Key words: Farmyard manure, Jute, Nutrient uptake, Soil fertility, Water hyacinth compost, Yield

Despite tremendous increase in jute (*Corchorus olitorius* L.) fibre productivity, considerable regional disparity still exists in the yield level. Poor nutrient management practice is one of the major contributing factors to that. The marginal jute-growing farmers are unable to bear the escalating prices of synthetic fertilizers. Due to inadequate and imbalanced fertilizer application, farmers are not able to harness the full yield potential of jute crop. The organic matters being the storehouses of nutrients, combined application of organic and inorganic fertilizer can increase the fibre yield of jute, improve the fertility status of soil, improve the input-use efficiency by the system and can certainly cut down the expenditure on costly fertilizers (Laxminarayana and Patiram 2006). Hence, a field experiment was undertaken to study the effect of combined application of inorganic fertilizers and organic manures on fibre yield of jute and its effect on soil properties.

MATERIALS AND METHODS

The trial was conducted under All India Network Project on Jute and Allied Fibres at Uttar Banga Krishi Viswavidyalaya, Coochbehar for consecutive 3 years during 2004–06 to study the effect of integrated nutrient management on soil fertility as well as fibre yield and mineral nutrition of jute. The soil was Aquic Ustifluvent, sandy loam in texture, having *p*H 5.8, organic carbon 0.78%, available N 170 kg/ha, available P 16.6 kg/ha and available K 91 kg/ha. The experiment was laid out in a randomized block design with 10 treatments comprising different combinations of inorganic fertilizers and organic manures or green manures were replicated thrice. The details of the treatments were T_1, 100% NPK; T_2, 75% N through urea + 25% N through water hyacinth compost; T_3, 75% N through urea + 25% N through farmyard manure; T_4, 75% N through urea + 25% N through *dhaincha* green manuring; T_5, 75% N through urea + 25% N through vermicompost; T_6, 50% N through urea + 50% N through water hyacinth compost; T_7, 50% N through urea + 50% N through farm yard manure; T_8, 50% N through urea + 50% N through *dhaincha* green manuring; T_9, 50% N through urea + 50% N through vermicompost and $T_{10,}$ control. The recommended N, P_2O_5 and K_2O for jute were 40, 20 and 20 kg/ha respectively. Nitrogen, phosphorus and potassium were applied in the form of urea, single superphosphate and muriate of potash, respectively. Organic manures were added on the basis of nitrogen percentage (oven dry weight). The nitrogen content in water hyacinth compost,

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vermicompost, farmyard manure and *dhaincha* (*Sesbania aculeata* (Willd.) Pers.) were 1.42, 1.30, 0.8 and 2.03%, respectively. The well decomposed organic manures were incorporated in the soil 15 days before sowing of the crop. *Dhaincha*, as green manure, was ploughed in the soil at 2 month crop age. The jute was sown during first week of April and was harvested at 110–120 days. The plant samples were collected at harvest, oven dried at 70°C, processed and analyzed for total N, P and K following standard procedures. Similarly, initial and the post-harvest soil samples were collected at the end of third year, dried, processed and analyzed for oxidizable organic C by Walkley and Black method; available N by alkaline permanganate method; available P by Olsen's method and available K by flame photometer following standard procedures (Jackson 1967).

RESULTS AND DISCUSSION

Fibre yield

The perusal of data revealed that all the fertilizer treatments increased the fibre yield of jute significantly over the control throughout the period of experimentation (Table 1). Application of 75% N from inorganic and 25% N from organic source ie from water hyacinth compost (T_2) recorded significantly higher fibre yield of the crop (2.69 tonnes/ha during 2004 and 2.96 tonnes/ha in 2005) over 100% N through inorganic source (T_1). An increase in fibre yield was also observed due to 25% N through farmyard manure + 75% N through inorganic fertilizer though the increase was not statistically significant. Similar trend was observed in the pooled data also. Substitution of inorganic N to the tune of 25% through organics (pooled data) showed an increasing trend in fibre yield of jute over 100% inorganic N treatment which was not observed at 50% substitution level (Table 1). Improvement in fibre yield due to combined application of inorganic fertilizer and organic manure might be attributed to control release of nutrients in the soil through mineralization of organic manure which might have facilitated better crop growth. Saha *et al.* (2008) also observed significant increase in fibre yield of *mesta* due to combined application of inorganic fertilizer and organic manures.

Nutrient uptake

In the first year, all the integrated nutrient management (INM) treatments increased N uptake by jute significantly over 100% NPK with maximum value (71.86 kg/ha) observed in T_9 treatment (Table 2). Almost similar trend was observed in the second year also with the highest N uptake recorded in T_2 treatment (76.92 kg/ha). Maximum N uptake (65.03 kg/ha) in the third year was observed in T_7 treatment. The pooled data of 3 years revealed that almost all the INM treatments recorded significantly higher N uptake except T_5 as compared to inorganic treatment (T_1), though there was no significant variation in N uptake among the INM treatments (Table 2). The higher nutrient uptake with organic manure might be attributed to solubilization of native nutrients, chelation of complex intermediate organic molecules produced during decomposition of added organic manures, their mobilization and accumulation of different nutrients in different plant parts. The results are in agreement with the findings of Mohapatra *et al.* (2008). In case of green manuring, faster decomposition of succulent legume crop *dhaincha* might have led to early release of N to soil. Similar results had been obtained by Mondal *et al.* (2008) in rice (*Oryza sativa* L.) – lathyrus (*Lathyrus sativus* L.) – sesame (*Sesamum indicum* L.) cropping system.

Phosphorus uptake by jute was also influenced by combined application of inorganic nutrients and organic/ green manure. Almost all the INM treatments except T_4 and T_5 recorded significantly higher P uptake by jute compared to 100% NPK treatment during first and second year (Table 2). Similar increase in P uptake was observed in the

Table 1 Effect of integrated nutrient management on fibre yield of jute

Treatment	Fibre yield of jute (tonnes/ha)			
	2004	2005	2006	Pool
T_1, 100% NPK	2.31	2.70	2.37	2.46
T_2, 75% N through urea + 25% N through WHC	2.69	2.96	2.23	2.63
T_3, 75% N through urea + 25% N through FYM	2.51	2.85	2.50	2.62
T_4, 75% N through urea + 25% N through *dhaincha* green manure	2.56	2.73	2.40	2.57
T_5, 75% N through urea + 25% N through vermi- compost	2.60	2.83	2.12	2.48
T_6, 50% N through urea + 50% N through WHC	2.45	2.69	2.21	2.45
T_7, 50% N through urea + 50% N through FYM	2.53	2.69	2.43	2.55
T_8, 50% N through urea + 50% N through *dhaincha* green manure	2.62	2.61	2.09	2.44
T_9, 50% N through urea + 50% N through vermi-compost	2.63	2.67	2.19	2.50
T_{10}, control	1.36	1.42	1.53	1.44
SEm±	0.12	0.09	0.09	0.06
CD (*P*=0.05)	0.34	0.26	0.28	0.17

WHC, Water hyacinth compost; FYM, farmyard manure

Table 2 Effect of integrated nutrient management on nutrient uptake by jute

Treatment	Nutrient uptake (kg/ha)											
	N				P				K			
	2004	2005	2006	Pool	2004	2005	2006	Pool	2004	2005	2006	Pool
T_1, 100% NPK	56.47	65.98	57.92	60.12	22.74	26.57	23.32	24.21	138.09	161.33	141.61	147.01
T_2, 75% N through urea + 25% N through WHC	69.73	76.92	58.02	68.22	28.28	31.16	23.51	27.65	178.37	196.57	148.29	174.41
T_3, 75% N through urea + 25% N through FYM	64.32	73.03	64.01	67.12	27.65	31.39	27.50	28.85	164.34	186.60	163.49	171.48
T_4, 75% N through urea + 25% N through *dhaincha* green manure	66.93	71.34	62.73	67.00	25.97	27.68	24.35	26.00	168.89	180.03	158.40	169.11
T_5, 75% N through urea + 25% N through vermi-compost	64.23	69.89	52.26	62.13	25.43	27.67	20.69	24.60	159.80	173.87	130.00	154.56
T_6, 50% N through urea + 50% N through WHC	65.76	72.17	59.35	65.76	26.82	29.43	24.20	26.82	154.56	169.63	139.49	154.56
T_7, 50% N through urea + 50% N through FYM	67.49	71.87	65.03	68.13	31.04	33.05	29.90	31.33	165.96	176.73	159.91	167.53
T_8, 50% N through urea + 50% N through *dhaincha* green manure	70.50	70.32	56.17	65.66	28.91	28.83	23.03	26.92	177.37	176.90	141.32	165.20
T_9, 50% N through urea + 50% N through vermi-compost	71.86	73.03	59.90	68.26	29.97	30.47	25.00	28.48	171.00	173.87	142.61	162.49
T_{10}, control	32.99	34.55	37.92	35.15	13.06	13.68	14.78	13.84	83.60	87.55	94.58	88.58
SEm±	1.29	1.46	1.45	0.81	1.12	1.10	1.28	0.71	1.21	2.56	2.12	1.20
CD (*P*=0.05)	3.83	4.34	4.31	3.91	3.33	3.27	3.80	3.43	3.59	7.61	6.29	5.79

INM treated plots in third year also, though the increase was not statistically significant over 100% inorganic nitrogen treatment plots in all the cases. Supplementation of 50% of the recommended dose of N through organic manures recorded higher P uptake by jute except water hyacinth compost during all the 3 years with maximum in farmyard manure treatment. Similar trend was observed in pooled data also and the magnitude of increase was about 29% over that with 100% NPK (Table 2). The solubilizing action of organic acids produced during decomposition of organic manures or green manure might have increased the release of native P, stimulated microbial growth in soil, and favoured root growth which had finally led to increased P uptake by jute. The higher P uptake in farmyard manure treatment may be attributed to its prolonged and consistent P availability due to its well decomposed nature. Panwar *et al.* (2008) also recorded higher P uptake in maize (*Zea mays* L.) due to application of farmyard manure.

Potassium uptake was found significantly higher in almost all the INM treatments as compared to 100% NPK (T_1) in all the years. Similar trend was observed in the pooled data also (Table 2). The magnitude of increase in K uptake due to T_2 and T_3 treatments over 100% NPK treatment (T_1) was 18.6 and 16.6% respectively. The increased uptake of K by jute may be ascribed to the release of K from the K-bearing minerals by complexing agents and organic acids produced during decomposition of green manure and organic manures. Similar results were also observed by Mohapatra *et al.* (2008) in jute–potato (*Solanum tuberosum* L.) cropping system.

Soil fertility

Soil *p*H declined in all the fertilizer treatments as compared to the initial value (Table 3). This decline in soil *p*H may be ascribed to the formation of organic acids due to the decomposition of organic manure and crop residues.

The organic C and the available N content of the experimental soil was found to increase over the initial value in all the INM treatments. Maximum increase in available N was observed when 25% of inorganic N was supplemented through water hyacinth compost (T_2) (Table 3). The available soil N was also found to increase in all the INM treatments at 50% substitution level. This increase may be attributed to higher microbial activity in the INM treatments which favoured the conversion of the organically bound nitrogen to inorganic form (Panwar *et al.* 2008). Similar increase in available N in soil due to addition of organics was observed in rice (Singh *et al.* 2006). The soil available P was either maintained or slightly improved due to addition of different organic manures over the initial value (16.6 kg/ha) (Table 3). Organic manures, on decomposition, solubilize insoluble organic P fractions through release of various organic acids, thus resulting into a significant improvement in available P status of the soil (Laxminarayana 2006). Maitra *et al.* (2008) also found similar improvement in soil available P status due to integrated nutrient management in sunnhemp. The available K content of the soil was also found to increase in

Table 3 Available nutrient status of experimental soil at the end of third year (2006)

Treatment	*p*H	Organic C (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
Initial	5.80	0.78	170.0	16.6	91
T_1, 100% NPK	5.34	0.98	190.0	12.7	122
T_2, 75% N through urea + 25% N through WHC	5.20	1.10	216.0	22.5	133
T_3, 75% N through urea + 25% N through FYM	5.51	1.05	192.0	18.1	129
T_4, 75% N through urea + 25% N through *dhaincha*	5.23	0.78	192.0	14.9	129
T_5, 75% N through urea + 25% N through vermi compost	5.28	0.96	192.0	15.7	120
T_6, 50% N through urea + 50% N through WHC	5.56	1.05	216.0	16.3	134
T_7, 50% N through urea + 50% N through FYM	5.39	0.98	210.0	17.1	130
T_8, 50% N through urea + 50% N through *dhaincha*	5.35	1.13	210.0	17.3	122
T_9, 50% N through urea + 50% N through vermi-compost	5.38	0.96	206.0	15.9	118
T_{10}, control	5.18	0.82	165.0	15.7	103

all the INM treatments as compared to the initial K status, both at 25 and 50% substitution level. This increase in available K content in soil due to addition of organic manures might be attributed to the direct addition of potassium into the available K pool in soil and release of K due to the interaction of organic matter with clay (Das *et al*. 2004). The results are in conformity with Laxminarayana and Patiram (2006).

Thus it may be concluded that substitution of 25% N in recommended chemical fertilizer dose through organics particularly through water hyacinth compost or farm yard manure increased the productivity of jute fibre, improved the nutrient utilization by the crop, reduced the use of chemical fertilizers and also enriched the fertility status of soil.

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