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Soil fertility management for productivity enhancement of jute under some constrained acidic soils of West Bengal

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ABSTRACT

Jute crop plays a pivotal role in the farming economy of number of eastern Indian states like West Bengal (*Paschimbanga*), Asom, Bihar and Odisha. In spite of available sound production technology, the main concern in jute fibre production system in India is the non-uniform productivity over 87 jute-growing districts located in varying agro-climatic regions of the country including 17 jute-growing districts of West Bengal having relatively higher productivity in South Bengal than in North Bengal. The major reasons of technical nature for low productivity in North Bengal are initially identified as soil acidity. The participatory farmers' field experiments were conducted at Balurghat (*p*H 5.06, EC 0.024 dS/m, OC 0.59%, available N, P, K= 246, 29, 90 kg/ha) and Kumarganj (pH 4.45, EC 0.002 dSm^{-1}, OC 0.51%, available N, P, K= 314, 15, 98 kg/ha) blocks of Dakshin Dinajpur district of North Bengal with an aim to enhance the productivity of jute through proper soil fertility management. The results of the field experiment revealed that application of lime (based on LR value) coupled with soil test-based balanced fertilization enhanced the productivity of olitorius jute [over farmers' practice Balurghat [(2.42 tonnes/ha) and Kumarganj (1.52 tonnes/ha)] by 29.1% and 45.7% in the constrained acidic block of Balurghat and Kumarganj (of Dakshin Dinajpur district) respectively. The same treatments also improves the B:C ratio and reduced insect pests and disease incidence.

Key words: Constrained acidic soils, Jute fibre, Productivity enhancement, Resource management, Soil fertility

Jute (*Corchorus olitorius*, tossa jute and *Corchorus capsularis*, white jute; Family: Tiliaceae) is a stupendously important commercial fibTablere crop of West Bengal (*Paschimbanga*), Asom, Bihar and Odisha. Jute, due to its biodegradability and its ability to be used as an annual renewable resource, has become an integral part of farming life of West Bengal. Jute farming involves four million farm families and generates employment to the tune of 10 million paid man days. In the entire life-cycle of jute from cultivation to usage and disposal, it is friendly to the environment and produces no toxic material (Sarkar 2008). Jute fibre productivity has increased from mere 1 138 kg/ha in 1947–48 to around 2200 kg/ha in 2005–06, indicating a rise of 190%. But the difference between the realizable potential yield and farmers' yield has remained as much as 2.0 tonnes/ha. National Academy of Agricultural Sciences (1997) feels that in view of shrinking land resources, scientific use of necessary fertilizers will be a key input to meet the national needs of food, fibre and fuel. The foremost reasons for such yield gap is the non-uniform productivity due to soil factor and non-adoption of recommended package of practices over the 87 jute-growing districts located in varying agro-climatic regions of the country. West Bengal even though contributes about 81% of total jute fibre production of the country is not free from the menace of uneven productivity of jute grown in its 17 districts. For example, productivity of jute fibre widely varied between 16.8 and 3.35 tonnes/ha, the higher productivity being in South Bengal than the North Bengal situation. No attempt has so far been made to address the problem of low productivity of jute in the inefficient and constrained locations of northern part of West Bengal. Considering the magnitude of the problem which affecting the interest of the mammoth jute farming community of northern part of West Bengal in particular, the present study was undertaken to enhance the productivity of jute through proper soil fertility management in low productive constrained jute growing areas of West Bengal.

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MATERIALS AND METHODS

All the north Bengal (northern part of West Bengal)

Table 1 The *p*H values of the soils of higher and lower productive jute-growing areas

	Gram Panchayat	*p*H			*Gram Panchayat*	*p*H	
		Surface soil	Sub-surface soil			Surface soil	Sub-surface soil
Balurghat Block (Higher productivity area)	ChakBhrigu	4.65	5.55	Kumarganj Block (Lower productivity area)	Safanagar	5.14	5.22
	Patiram	5.00	5.32		Samjhia	4.78	4.65
	Jalghar	5.12	5.10		Jakhirpur	4.58	4.44
	Danga	5.37	5.00		Ramkrishnapur	4.88	4.74
	Amritakhanda	5.24	5.00		Bhomar	5.66	5.66
	Nazirpur	4.96	5.10		Deor	4.95	4.98
	Chingispur	5.27	4.50		Mohana	5.08	5.08
	Bhatpara	5.14	5.10		Batun	4.82	5.00
	Boaldar	4.42	5.26				
	Bolla	5.18	5.10				
	Gpopalbati	4.90	5.10				

districts except Malda suffer from low jute fibre productivity than the national average (2.25 tonnes/ha). In spite of marginally higher productivity among the low productive north Bengal districts, Dakshin Dinajpur district (lies between 26.59° and 25.18° N latitude and 89.01° and 87.81° E longitude) was selected for the study considering the large acreage under jute, land situation and land holding size of the farmers. The district is drained by a number of North-South flowing rivers like *Atreyee*, *Punarbhaba*, *Tangon* and *Brahmani*. It is predominantly an agricultural district with large area of land being under cultivation. In the district 79.3% land of the total geographical area (221.48×10^3 ha) is under cultivation with a cropping intensity of 183%. About 81.62% land holdings have less than 1 ha of land area and 16.20% have land between 1 and 2 ha and the remaining only 2.18% holdings are above 2 ha area (Anonymous 2011). The higher and the lower productivity regions of the district at the level of block to gram panchayat (GP) were identified on the basis of area, production and productivity data of jute collected from the State Department of Agriculture. Out of eight blocks in the district, Kumarganj (25.44° N, 88.74° E) is the lowest productive block for jute (1.62 tonnes/ha) while the Balurghat (25.24° N, 88.79° E) is the highest productive block (2.62 tonnes/ha). The experiment was conducted with tossa jute (*Corchorus olitorius* L.) for fibre in those two blocks of Dakshin Dinajpur district of West Bengal in collaboration with Dakshin Dinajpur Krishi Vigyan Kendra of Uttar Banga Krishi Viswavidyalaya.

To narrow down the experimental area within a manageable unit, initial soil fertility status of the *gram panchayats* of corresponding blocks of each category was determined and accordingly the experimental fields were selected from each block. For determination of the soil fertility status of the experimental area, surface and subsurface soils were taken from randomly selected five villages of each GPs of both the blocks having different productivity levels of jute. The soils were ground, meshed and processed for analysis of soil *p*H, organic carbon, available N, available P and available K by the standard procedure as outlined by Jackson, 1967. The lime requirement value of the experimental soils was determined by the SMP buffer method as described by Mclean, 1982. The *p*H value obtained from the SMP buffer-soil solution (Table 2) was extrapolated to the lime requirement calibration table (Sims, 1996) in order to obtain exact amount of lime required for these soils. The required amount of lime was applied 15 days before the final land preparation.

After selection of the experimental field on the basis of soil acidity, the farmers' field experiment was conducted for two consecutive years (2007 and 2008) laid in randomized block design (RBD) with four treatments and five to eight replications (each farmer's field was taken as replication where all the treatments were employed). The treatments were, (i) farmer's practice, (ii) farmer's practice + lime (according to lime requirement), (iii) recommended doses of NPK based on soil test values and (iv) recommended doses of NPK based on soil test values + lime (according to lime requirement). Different growth parameters, disease and insect pest incidence, fibre and stick yield, economics involved – net income, comparative advantage, i e B:C ratio, yield advantage, etc. were taken from farmer's field in a participatory mode. Prior to the initiation of the experiment the soil samples were collected and analyzed according to the procedure as outlined by Jackson, 1967. Statistical analyses were performed by following standard statistical software.

RESULTS AND DISCUSSION

The surface soils of Balurghat block, in general, showed acidic in reaction and *p*H ranged from 4.42 to 5.37, and particularly the soils of Chakbhrigu, Boaldar, Nazirpur and Gopalbati GPs showed high acidity (*p*H<5.0) as compared to the soils of other GPs with an increasing trend towards the lower horizon of soil (Table 1). In Kumarganj Block, the *p*H

values of most of the GPs are alarmingly low (<5.0) and the *p*H of surface soils of these blocks ranged from 4.58 to 5.66 (Table 1). Selection of farmers for the experiment was made according to the soil *p*H and soil test values of the corresponding farmers' field in a GP. Accordingly, Jalghar, Boaldar and Amritakhanda for Balurghat block and Bhomar, Ramkrishnapur and Batun GPs for Kumarganj Block were selected.

The soils of the selected GPs showed *p*H values ranges from 4.13 to 5.18 and the *p*H value obtained from the SMP buffer-soil solution was found to be varied between 5.43 and 6.39, irrespective of the year of cultivation (Table 2). Accordingly, the lime requirement (LR) was determined from the calibration table to reduce the adverse effects of soil acidity. There was slight increase in the organic carbon status in the soils during second year of cultivation which may be attributed to addition of jute leaf in soil throughout the growing season. On an average in one ha land about 15 tonnes of green jute leaves are added to the soil, which besides improving the organic matter status of the soil, supplements considerable amount of plant nutrients for utilization by the succeeding crop (Saha and Ghorai 2004). The soils are, in general, low to medium in nitrogen, phosphorus and potassium content (Table 3).

The experimental results showed that plant height was significantly increased by soil test based fertilizer (NPK) application solely and also coupled with LR-based lime application (Table 4). Through sole application of lime or soil test based NPK application, plant height was increased by 20% to 28% over farmers' practice in both the blocks. However, coupling of soil test based NPK application with LR-based lime increased the plant height to the tune of 33 to 46% in both the blocks. Like plant height, basal diameter also increased by the application of soil test-based NPK application and LR based lime application. In Balurghat soil, the increment pattern of basal diameter was found to be in the order of soil test-based NPK application + LR-based lime application (37%) > LR-based lime application in farmers' practice (29%) > Soil test-based NPK application (16%) as compared to farmers' practice. But in Kumarganj block the trend was soil test-based NPK application + LR-based lime application (36%) > soil test based NPK application (18%) < LR based lime application in farmers' practice (16%) over farmers' practice. The effect of liming on basal diameter was low in Kumarganj block due to higher acidity as compared to Balurghat block. Regarding the yield increment in Balurghat block, the trend was observed in the order of soil-test based NPK application + LR-based lime application (30.9%) > LR-based lime application in farmers' practice (20.9%) > soil test-based NPK application (11%) over farmers' practice. However, for Kumarganj block the trend was Soil test based NPK application + LR-based lime application (49.5%) > LR-based lime application in farmers' practice (41.7%) > soil test-based NPK application (33.7%) as compared to farmers' practice. Relatively, the soils of Kumarganj block showed higher response to the treatments over farmers' practice as compared to Balurghat block which may be due to the lower *p*H of Kumarganj soil. Liming was found to be the critical factor for yield enhancement of jute, as it solely increased the yield by 20.9% to 41.7% in those two blocks. Stick yield followed the similar trend as observed in case of fibre yield. In a study on the acid soils of Asom (Sorbhog of Barpeta district), Saha *et al.* (2008) also observed that application of lime improved the soil *p*H and subsequently the fibre yield of jute.

The intensive cultivation of high yielding, fertilizer responsive cultivars of jute brought forth the problem of insect pests, mites and disease incidence. The incidence of pests like Jute semilooper, Jute stem weevil, grey weevil, Bihar hairy caterpillar and diseases like stem rot and root rot are common with the progress of cultivation, particularly in acidic soils. The pest and disease incidence in jute was recorded and presented in Table 4. The significant reduction of disease was recorded from application of lime in combination with farmers' practice or soil test-based fertilizer. Pest incidence was reduced to a greater extent (>45%) by

Table 2 Initial average soil fertility parameters of the experimental soils of Balurghat and Kumarganj Block

Block	Name of the GP	*p*H of soil		*p*H of soil and buffer suspension		EC (dS/m)		Org. C (%)		Available N. (kg/ha)		Available P_2O_5 (kg/ha)		Available K_2O (kg/ha)	
		1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
Balurghat Block	Jalghar	5.01	5.07	6.02	6.02	0.03	0.031	0.59	0.63	248	251	30	31.2	53.9	55.4
	Boaldar	4.96	5	5.87	5.88	0.026	0.026	0.53	0.62	229	228	31.4	31.6	55.6	53.9
	Amritakhanda	5.12	5.15	6	6.02	0.02	0.019	0.55	0.57	295	296	14.8	15.6	161	168
	Patiram	5.18	5.18	6.14	6.17	0.019	0.022	0.71	0.76	211	214	41.1	43.2	87.5	88.7
Kumarganj Block	Bhomar	4.35	4.39	6.39	6.39	0.0004	0.0003	0.6	0.64	301	305	15.8	17.6	23.2	21.6
	Ramkrishnapur	4.87	4.87	5.95	5.97	0.003	0.0031	0.56	0.55	307	309	20.9	20.2	88	92.1
	Batun	4.13	4.23	5.43	5.45	0.003	0.0034	0.37	0.45	336	339	7.6	8.3	184	189

Table 3 Response of yield attributes of jute to liming and fertilization

Parameter	Treatment	Balurghat Block				Kumarganj Block			
		Plant height (cm)	Basal diameter (cm)	Fibre yield (tonnes/ ha)	Stick yield (tonnes/ ha)	Plant height (cm)	Basal diameter (cm)	Fibre yield (tonnes/ ha)	Stick yield (tonnes/ ha)
First year	Farmers' practice	175	1.28	2.26	5.43	180	1.25	1.45	3.61
	Farmers' practice + Lime (LR based)	225	1.65	2.73	6.79	219	1.46	2.05	5.13
	Recommended doses of NPK (soil test based)	218	1.48	2.50	6.17	217	1.47	1.94	4.82
	Recommended doses of NPK (soil test based) + lime (LR based)	256	1.75	2.95	7.19	241	1.70	2.16	5.40
	CD at 5%	17.2	0.203	0.188	0.657	21.9	0.071	0.286	0.861
	(CV)	(4.93)	(8.25)	(4.50)	(6.42)	(6.41)	(3.06)	(7.07)	(8.52)
Second year	Farmers' practice	286	1.78	2.59	5.38	219	1.38	1.59	3.96
	Farmers' practice + Lime (LR based)	299	2.18	2.95	6.14	236	1.55	2.04	5.18
	Recommended doses of NPK (soil test based)	312	2.00	2.87	6.10	236	1.55	2.04	5.18
	Recommended doses of NPK (soil test based) + lime (LR based)	323	2.34	3.31	6.85	273	1.93	2.27	5.78
	CD at 5%	12.5	0.250	0.259	0.399	22.5	0.208	0.262	0.342
	(CV)	(2.56)	(7.54)	(5.53)	(4.07)	(5.85)	(7.99)	(8.40)	(4.29)

Table 4 Response of pest and disease incidence on jute to liming and fertilization

Treatment	Parameter	Balurghat Block		Kumarganj Block	
		Pest incidence	Disease incidence	Pest incidence	Disease incidence
		(Av. No. of infected plant/m^2)			
First year	Farmers' practice	3	4	4.5	5.25
	Farmers' practice + Lime (LR based)	1.25	1.5	2.75	2.5
	Recommended doses of NPK (soil test based	1.25	2	2.75	3
	Recommended doses of NPK based (soil test based) + lime (LR based)	1.25	0.5	2	1.5
	CD at 5%	0.766	0.998	1.07	1.01
Second year	Farmers' practice	2.5	2.25	2.75	3.00
	Farmers' practice + lime (LR based)	0.5	1.00	1.5	1.75
	Recommended doses of NPK (soil test based)	1.25	1	1.5	1.25
	Recommended doses of NPK based (soil test based) + lime (LR based)	1	0.5	0.75	0.25
	CD at 5%	1.20	0.854	0.961	0.766

soil test-based fertilizer application alone, irrespective of the blocks and year of cultivation. A combined application of lime along with potash might be quite effective in controlling the pest and disease incidence in jute grown in acidic soil (Mandal *et al.* 1976, De and Chattopadhya 1992). Similar observation was also recorded in cotton in Pakistan, where potassium reduced the disease incidence by 38% (Pervez *et al*., 2007). It is well understood that potassium has a pivotal

Table 5 Economic assessment of the experiment on jute to liming and fertilization

Parameters	Treatments	Balurghat Block			Kumarganj Block		
		Cost of cultivation	Gross returns	B:C ratio	Cost of cultivation	Gross returns	B:C ratio
		(₹/ha)			(₹/ha)		
First year	Farmers' practice	13 800	36 367	2.64:1	10 096	23 502	2.33:1
	Farmers' practice + lime (LR based)	15 234	44 306	2.91:1	12 771	33 341	2.61:1
	Recommended doses of NPK (soil test based)	14 123	40 545	2.87:1	11 795	31 421	2.66:1
	Recommended doses of NPK based (soil test based) + lime (LR based)	16 235	47 635	2.93:1	13 100	35 144	2.68
Second year	Farmers' practice	14 902	47 281	3.17:1	11 897	30 210	2.54:1
	Farmers' practice + lime (LR based)	17 201	53 883	3.13:1	14 007	38 988	2.78:1
	Recommended doses of NPK (soil test based)	16 208	52 728	3.25:1	12 078	36 901	3.06:1
	Recommended doses of NPK based (soil test based) + lime (LR based)	18 278	60 438	3.31:1	15 105	43 573	2.88:1

role in making crops tolerant to disease resistance and bringing about improvements in crop yield and quality (Sekhon 1999). Due to development of acidity, soil gets depleted in calcium, potassium and other bases and the availability of iron, manganese and aluminums increases.

Economic aspects of this experiment are presented in Table 5. It was observed that by sole LR-based lime application the net returns could be increased by ₹ 7000/ha in both the blocks over farmers' practice. Soil test-based fertilizer application coupled with liming gives an additional income of ₹ 2000/ha with a considerable improvement in B:C ratio in both the blocks.

Foremost reasons for low productivity in North Bengal were initially identified as soil acidity and nutrient deficiency besides socio-economic constraints, as jute is mainly cultivated by small and marginal farmers. It may be concluded that application of lime coupled with soil test-based balanced fertilization will certainly enhance the productivity of jute and improve the benefit:cost ratio in the constrained acidic soils of old alluvial tracts of North Bengal. It not only enhanced the productivity, but also improves the crop resistance against insect pests and diseases. The production and productivity of jute in acidic soils can be sustained through liming.

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