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EFFECTS OF N, P, K AND S APPLICATION ON YIELD AND QUALITY OF WHITE JUTE (*CORCHORUS CAPSULARIS* L.) VAR. BJC-2197

SAYMA KHANOM, SONIA HOSSAIN AND SHAHID AKHTAR HOSSAIN*

Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

Key words: Jute (*C. capsularis*), var. BJC-2197, Fertilizer requirements, Fiber yield, Fiber quality

Abstract

A field experiment was conducted at Bangladesh Jute Research Institute (BJRI) to observe the response of N, P, K and S on a pre-released white jute (*Corchorus capsularis*) var. BJC-2197. The experiment was carried out by applying N, P, K, S fertilizers in ten combinations including control. From the experiment it was observed that all the treatments had significant positive effect over control on growth, yield and quality parameters. The highest fiber yield (3.21 t/ha) and stick yield (6.58 t/ha) were recorded with $N_{90}P_5K_{30}S_{10}$ kg/ha treatment. However, the best quality fiber was found with combination of $N_{90}P_{15}K_{30}S_{10}$ kg/ha treatment. From the economic analysis point of view, it was found that combination of $N_{90}P_5K_{30}S_{10}$ kg/ha was higher (2.30) than $N_{90}P_{15}K_{30}S_{10}$ kg/ha (2.04). So the former can be considered as the best combination for var. BJC-2197 in terms of BCR, yield and quality.

Introduction

Jute, an important and the largest natural fiber crop belonging to the genus *Corchorus*, family Tiliaceae, is an eco-friendly and the major cash crop of Bangladesh. Jute fiber is produced mainly from white jute (*C. capsularis*), and tossa jute *(C. olitorius*). In Bangladesh, jute sector accounts as a whole for 10% labour and 7% of GDP. Jute and jute-based products are put to a wide range of uses. Food and Agricultural Organization (FAO) has declared 2009 as the International Year for Natural Fiber which reflects the importance of this group of commodities to many countries.

Considering all these facts, improvement of fiber yield and quality of jute is the prime need of Bangladesh. In this aspect, research regarding development of new high yielding variety of jute and determination of its fertilizer requirement is very important. In fact, these requirements vary within the same type of crop. For example, fertilizer demand of *olitorius* variety is higher than *capsularis*. The importance of N, P, K and S on the growth, yield and quality of fiber crops is well established.

*Author for correspondence: < sahossain55@yahoo.com>

It is necessary to find a fertilizer combination which is economically profitable and at the same time gives yield very close to maximum yield potential. Therefore, much attention should be given towards the improvement of yield and quality of jute fiber to bring back the past glory of Bangladeshi jute. Considering the above facts the present study has been undertaken to observe the effects of N, P, K and S fertilizers on the growth, yield and quality of the pre-released jute variety, BJC-2197 and to find out the optimum requirement of all of these nutrients to achieve the maximum yield potential of this new jute variety.

Materials and Methods

The experiment was set up at the Jute Agricultural Experimental Station (JAES) of BJRI, Jagir, under Sadar Upazila of Manikganj district. Initial soil analysis showed that the experimental field soil contains 0.09% total nitrogen with 15.67 C : N ratio, 19.75 ppm of available P, 68 ppm of available K and 18 ppm of available S.

The experiment was laid out in randomized complete block design (RCBD) with three replications. A total 10 treatment combinations along with a control were distributed randomly in each plot as one replication (Table 1). The dimension of unit plots was 3 m × 3 m having 1 m space between the plots, blocks and around the field. There was 20 cm deep drain around each block and plot. Each replication was divided into 10 unit plots and the total land required of 13 m × 41 m. At the beginning of the experiment, the land was well prepared and fertilizers were applied as per treatment.

Table 1. Treatment combinations of N, P, K and S.

Treatment combinations	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)	Sulfur (kg/ha)
$N_0P_0K_0S_0$ (T1)	00	00	00	00
$N_{45}P_5K_{30}S_{10}$ (T2)	45	5	30	10
$N_{90}P_5K_{30}S_{10}$ (T3)	90	5	30	10
$N_{135}P_5K_{30}S_{10}$ (T4)	135	5	30	10
$N_{90}P_{10}K_{30}S_{10}$ (T5)	90	10	30	10
$N_{90}P_{15}K_{30}S_{10}$ (T6)	90	15	30	10
$N_{90}P_5K_{60}S_{10}$ (T7)	90	5	60	10
$N_{90}P_5K_{90}S_{10}$ (T8)	90	5	90	10
$N_{90}P_5K_{30}S_{20}$ (T9)	90	5	30	20
$N_{90}P_5K_{30}S_{30}$ (T10)	90	5	30	30

Required amounts of N, P, K, S fertilizers were applied in the form of urea, TSP, MoP and gypsum. Urea was applied in two splits: two-third (2/3) amount was applied at sowing and the rest one third (1/3) was top dressed at 45 DAS (days after

sowing) while all other fertilizers were applied at the time of sowing. Jute seeds were broadcasted at the rate of 8 kg/ha on 29 March, 2007. All cultural operations were done as and when necessary. The crop was harvested on the first week of July, 2007 when 80% of the plants showed the sign of maturity. After shedding of leaves, the bundles were steeped plot-wise in pond water for 15-20 days for retting and fiber was extracted. At harvesting time, six plants were selected at random from each plot and tagged in the field to note plant height (PH), base diameter (BD), green weight (GW), dry matter weight (DMW), fiber yield (FY) and stick yield (SY) and to determine nutrient uptake. Similarly, plant samples were also collected at 45 days after sowing (at mid stage of cropping) to evaluate nutrient status. Three main quality parameters of jute i.e. brightness, bundle strength and fineness were determined by standard methods using Photo Voltmeter, Pressly Fiber Strength Tester with zero gauge length and Airflow method, respectively. Statistical and economic analyses were also carried out.

Results and Discussion

Application of combined fertilizers showed significant positive effect on all the growth parameter like plant height, base diameter, green weight, dry weight (Table 2). The maximum PH (3.03 m) and BD (23.22 mm) were found in T_8 ($N_{90}P_5K_{90}S_{10}$) treatment, which were 23.67 and 40.73% higher over the control, respectively. Similarly, maximum

Table 2. Effects of different combined treatments on growth and yield of jute.

Treatment combinations	Plant height (m)	Base diam. (mm)	Green weight (t/ha)		Dry matter weight (t/ha)	Fiber yield (t/ha)	Stick yield (t/ha)
			(without leaves)	(with leaves)			
$N_0P_0K_0S_0$	2.45	16.50	35.72	39.81	10.29	1.28	2.57
$N_{45}P_5K_{30}S_{10}$	2.75	20.81	44.06	50.76	13.33	2.22	4.48
$N_{90}P_5K_{30}S_{10}$	2.86	21.38	47.74	53.25	13.42	3.21	6.58
$N_{135}P_5K_{30}S_{10}$	2.93	21.41	58.23	66.57	17.41	2.62	5.34
$N_{90}P_{10}K_{30}S_{10}$	2.86	19.24	41.05	46.13	11.58	2.92	5.86
$N_{90}P_{15}K_{30}S_{10}$	2.92	22	49.41	56.37	15.18	2.94	5.96
$N_{90}P_5K_{60}S_{10}$	2.96	20.65	47.82	53.94	13.88	2.82	5.75
$N_{90}P_5K_{90}S_{10}$	3.03	23.22	45.53	51.68	12.73	3.2	6.43
$N_{90}P_5K_{30}S_{20}$	2.74	22.02	44.15	49.3	13.27	2.15	4.38
$N_{90}P_5K_{30}S_{30}$	2.77	19.8	60.02	68.56	18.15	2.76	5.63
LSD at 5% level	0.473	4.067	0.0122	0.015	0.015	0.058	0.658

green weight without leaves (60.02 t/ha), green weight with leaves (68.56 t/ha), and dry matter weight (18.15 t/ha) were recorded in T_{10} ($N_{90}P_5K_{30}S_{30}$) treatment which were 72.22, 68.03 and 76.38% higher than the control, respectively (Table 2).

From Table 2, it appears that high dose of K (90 kg/ha) may cause highest plant height and base diameter. Some studies revealed that yield, PH and BD increase with increasing rate of K dose.[1-8] On the other hand, higher green weight (both with and without leaves) and dry matter weight might be due to high S dose (30 kg/ha). Similar trend of results was also reported by some other studies.[9-12] In case of PH (R = 0.695) and BD (R = 0.292), K was the most influential factor though P (R = 0.605) and S (R = 0.612) were also very important for PH. On the other hand, N was the most influential factor both for GW (R = 0.936) and DMW (R = 0.953).

Application of different treatments showed statistically significant positive effect on fiber yield (FY) and stick yield (SY) of jute (Table 2). Highest FY (3.21 t/ha) and SY (6.58 t/ha) were accounted with T_3 (N_{90}-P_{05}-K_{30}-S_{10} kg/ha) treatment, which were 150.78 and 156.03% higher than control (Figs 1 and 2). Based on FY and SY, the treatment can be ranked in the order of T_3> T_8> T_6> T_5> T_7> T_{10}> T_4> T_2> T_9> T_1. The best FY and SY were found with the combination of N_{90}-P_{10}-K_{40}-S_{20}, N_{135}-P_{15}-K_{90}-S_{30}, N_{100}-P_{15}-K_{10}-S_{30} and N_{135}-P_5-K_{30}-S_{10}, respectively for different *C. capsularis* varieties[12-16]. Simple regression analysis for FY showed positive relationship with all the NPKS fertilizers and S (R = 0.687) was the most influential factor followed by K (R = 0.643). Similarly, S (R = 0.670) and K (R = 0.624) were two most influential factor for SY.

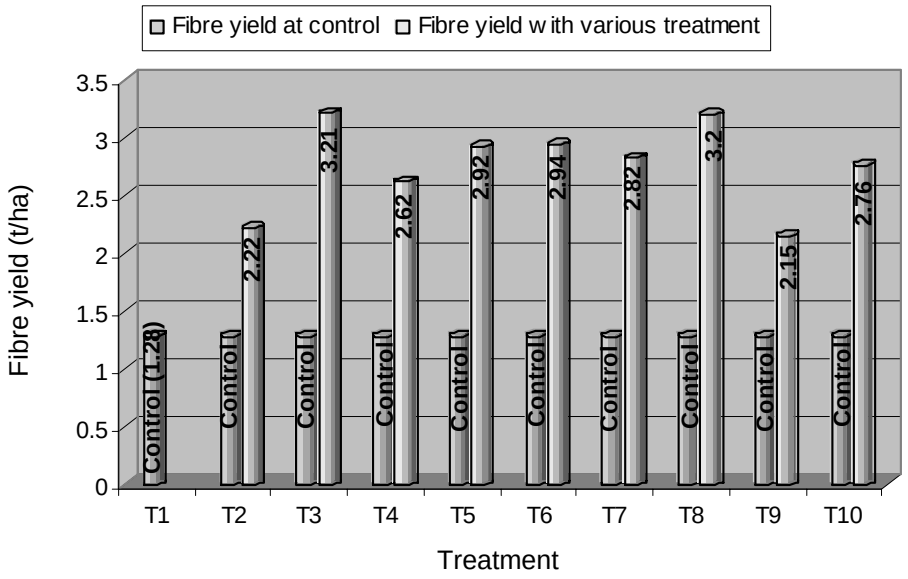

Fig. 1. Response of fiber yield at various treatments compared to control treatment.

While producing jute for marketing purpose, fiber quality is an important factor. Higher value of brightness and bundle strength and lower value of fineness indicate the good quality of jute fiber. Highest brightness (31.17%) was registered with T_5

($N_{90}P_{10}K_{30}S_{10}$ kg/ha) treatment and both bundle strength (10.40 lbs/mg) and finest fiber (28.99 μ) were found with T_6 ($N_{90}P_{15}K_{30}S_{10}$ kg/ha) treatment (Table 3). The effect of combined fertilizers on brightness, bundle strength and fineness was statistically significant. In case of brightness (R = 0.130) and bundle strength (R = 0.480), P was most influential factor while N (R = 0.322) and K (R = 0.335) both were influential for fineness[17].

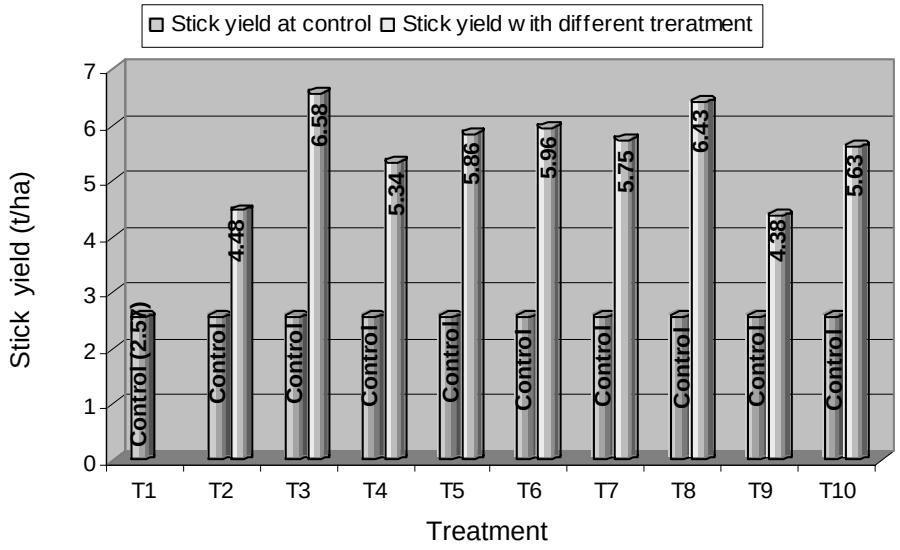

Fig. 2. Response of stick yield at various treatments compares to control treatment.

Table 3. Effects of different combined treatments on fiber quality of jute.

Treatment combinations	Brightness (%)	Bundle strength (lbs/mg)	Fineness (μ)
$N_0P_0K_0S_0$	28.80	9.25	30.12
$N_{45}P_5K_{30}S_{10}$	28.81	9.28	30.25
$N_{90}P_5K_{30}S_{10}$	29.00	9.55	29.98
$N_{135}P_5K_{30}S_{10}$	29.20	9.55	30.13
$N_{90}P_{10}K_{30}S_{10}$	31.17	9.69	32.19
$N_{90}P_{15}K_{30}S_{10}$	30.20	10.40	28.99
$N_{90}P_5K_{60}S_{10}$	30.25	10.10	29.98
$N_{90}P_5K_{90}S_{10}$	30.60	10.11	29.99
$N_{90}P_5K_{30}S_{20}$	30.55	10.13	30.00
$N_{90}P_5K_{30}S_{30}$	30.00	10.09	30.10
LSD at 5% level	0.053	0.119	0.020

Economic analysis was made considering the variable cost of fertilizers, seeds, labor and price of fiber and stick (Table 4). This reveals that T_3 ($N_{90}P_5K_{30}S_{10}$ kg/ha) treatment was the most cost effective treatment as it gives the highest gross return (Tk. 32832.00/ha) with benefit cost ratio (BCR) of 2.30 which is highly profitable.

Table 4. Cost and return analysis for var. BJC-2197.

Treatment combinations	Gross return (Tk./ha)	Total variable cost (Tk./ha)	Gross margin (Tk./ha)	BCR
$N_0P_0K_0S_0$	23060	20280	2780	1.14
$N_{45}P_5K_{30}S_{10}$	40040	24674	15366	1.62
$N_{90}P_5K_{30}S_{10}$	58100	25268	32832	2.30
$N_{135}P_5K_{30}S_{10}$	47360	25854	21506	1.83
$N_{90}P_{10}K_{30}S_{10}$	52600	25643	26957	2.05
$N_{90}P_{15}K_{30}S_{10}$	53080	26018	27062	2.04
$N_{90}P_5K_{60}S_{10}$	50980	26168	24812	1.95
$N_{90}P_5K_{90}S_{10}$	57660	27068	30592	2.13
$N_{90}P_5K_{30}S_{20}$	38860	25602	13258	1.52
$N_{90}P_5K_{30}S_{30}$	49900	25935	23965	1.92

Input Cost: Price of urea = Tk. 6.00/kg, TSP = Tk. 15.00/kg, gypsum = Tk. 6.00/kg, MP = 15.00/kg, Jute seed = Tk. 80.00/kg; and per labour wage = Tk. 110.00/day/person. Output cost: Fiber = Tk. 14.00/kg; and stick = Tk. 2.00/kg.

Conclusions

All the treatments had significant positive impact over control on growth, yield and quality parameters and effect of combined fertilizers on them were explained by simple and multiple regression analysis. The most important parameter, fiber yield (3.21 t/ha) and stick yield (6.58 t/ha), were recorded highest with N_{90}-P_{05}-K_{30}-S_{10} kg/ha (T_3) treatment. On the other hand, among the fiber quality, best quality fiber was found with $N_{90}P_{15}K_{30}S_{10}$ kg/ha (T_6) treatment. From the results of economic analysis, combination of N_{90}-P_{05}-K_{30}-S_{10} kg/ha showed higher BCR (2.30) than $N_{90}P_{15}K_{30}S_{10}$kg/ha (2.04). In fact, it is higher than widely used varieties BJC-7370 and BJC- 83, which have BCR of 1.7-2.0. It also gave high yield (3.21 t/ha of FY and 6.58 t/ha of SY) which is very close to maximum yield potential of the varieties BJC-7370 and BJC-83 (3.5 - 4 t/ha). Considering all these aspects, specially yield and BCR, T_3 (N_{90}-P_{05}-K_{30}-S_{10} kg/ha) treatment seems to be the best combination for this variety (BJC-2197).

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References

1. Alam AKMM, S Khandker, MN Gani, S Khandker and SA Ahmed 2000. Uptake addition and balance of nutrients under integrated fertilizer management in jute based cropping patterns. B. J. Sci. and Tech. **2**(2)**:** 147-153.
2. Alim MA 2003. Impact of N and K on soil properties and growth, yield and nutrient uptake of jute. M. S. thesis. BSMRAU, Salna, Gazipur. Bangladesh.
3. Sarker AK, and PK Bandopaddhay 2000. Effect of potassium, boron and crop age on the yield and quality of white jute (*Corchorus capsularis*). Indian Agr. **26:** 212-216.
4. Das K, B Guha and D Pathak 1996. Response of *Capsularis* to potassium fertilization. Ann. Agril. Res. **17**(2)**:** 188-189.
5. Sarkar SK, RK Ghosh, G Sounda, S Maitra, DK Rux and K Ghosh 1997. Effect of levels of nitrogen, potassium and soil moisture tension on growth, nutrient uptake and water use efficiency of jute. J. Interacademia **1**(3)**:** 183-188.
6. Zheng ZH, YX Huang and XJ Peng 1984. Effects of additional K application to jute. China's Fiber Crops. No. 2. 14-15.
7. Rafique ZA 2003. Yield performance of mesta (*Hibiscus sabdariffa* L.) as influenced by fertilizer and population levels. M. S. Thesis. Department of Agronomy, Bangabandhu Sheikh Muzibur Rahman Agricultural University, Salna, Gazipur, Bangladesh.
8. Chew WY, MAA Malek and K Ramli 1982. Nitrogen and potassium fertilization of congo jute (*Urena lobata*) and kenaf (*Hibiscus cannabinus*) on Malaysian peat. MARDI-Res. Bulletin **10:** 3, 317-322.
9. Gani MN, AKMM Alam, S Khandker and SA Ahamed 1999. Biomass estimation of jute and its effect on soil. Bangladesh J. Sci. Res. **17**(2)**:** 157-162.
10. Das NR and M Roy 1999. Effect of N and seed rate on biomass production of rainfed jute (*Corchorus olitorius* L.). Ad. Plant Sci. Res. India **9:** 15-18.
11. Shaha PK 2005. Influence of nutrients on seed yield and optimum fertilizer evaluation of recently released jute variety, O-72. M. S. Thesis. Department of Soil, Water and Environment, University of Dhaka.
12. Hossain ATM 2006. Effect of NPK and S fertilizer on growth and yield of white jute advanced line BJC-370. M. S. Thesis. BSMRAU, Salna, Gazipur, Bangladesh.
13. Alam MM, AKMM Alam, MN Gani, MA Ali and S Khandker 2003. Studies on the requirement of NPKS fertilizer for promising breeding line BJC 2142. Annual Report (Agric), Bangladesh Jute Research Institute, Dhaka, Bangladesh. pp. 56-57.
14. Alim MA, MS Ali, B Ahmed, MN Gani and AKMM Alam 2006-2007. Study on the requirements of NPK and S fertilizer for the advance breeding line BJC-370. Annual Report (Agri), Bangladesh Jute Research Institute, Dhaka, Bangladesh. pp. 97-100.
15. Khandker S, MN Gani, and MA Alim 2006. Studies on the requirement of NPK and S fertilizer for advanced line BJC-2142. Annual Report (Agric), Bangladesh Jute Research Institute, Dhaka-1207, Bangladesh. pp. 68-71.

16. Maity PK, P Palchowdhury, BK Mandal and AN Dasmahapatra 1989. Effect of different sources and levels of Nitrogen on jute (*C. olitorius* L. and *C. capsularis* L.). Soil and Fertilizer. **54**(8): 1270.

17. Gani MN, MA Alim, AKMM Alam, MA Samad, S Khandker and SMB Rahman 2006. Integrated effect of cowdung and chemical fertilizer on growth, yield and quality of jute. Bangladesh. J. Life Sci. **18**(1)**:** 19-25.

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