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INFLUENCE OF TEXTILE EFFLUENT AND CHEMICAL FERTILIZERS ON THE YIELD OF TOSSA JUTE (*Corchorus olitorius*)

Begum, M., M. N. Gani[1] and M. D. Alam[2]

Department of Soil and Environmental Sciences, University of Barishal, Bangladesh; [1]Fiber Quality Improvement Division, Bangladesh Jute Research Institute, Dhaka Bangladesh; [2]Department of Soil, Water and Environment, University of Dhaka, Bangladesh

Abstract

A field experiment was conducted to evaluate the effects of textile effluent and chemical fertilizer on growth and yield of tossa jute (O-795). The experiment was conducted in a randomized complete block design (RCBD) replicated thrice with six treatments. Growth parameters, *viz.* plant height, base diameter, green weight, dry matter weight, fiber yield and stick yield were assessed. The highest height (3.7 m), maximum base diameter (16.17 mm), maximum green plants yield with leaves (58.65 t ha^{-1}), maximum green plants yield without leaves (37.46 t ha^{-1}), highest fiber yield (2.87 t ha^{-1}) and highest stick yield (6.2 t ha^{-1}) were recorded with T_2(100% RDF + 0% effluent). From the economic analysis point of view, it was found that T_4 (50% RDF + 50% effluent) showed higher BCR (2.73) than T_2 (100% RDF + 0% effluent). Although the best growth performance was observed in T_2 (100% RDF + 0% effluent), but in terms of BCR T_4 (50% RDF + 50% effluent) was the best.

***Key words**:* Textile effluent; Tossa jute; Yield; Cost and return.

INTRODUCTION

Jute is called the golden fiber of Bangladesh. The country is able to supply the highest quality of jute fiber in the world market. In terms of world export of jute fiber, Bangladesh's share is more than 70% which makes the country the largest exporter of jute fiber in the world. It is one of the cheapest and strongest of all natural fibers and considered as the fiber of the future. India, Bangladesh, China and Thailand are the leading producers of jute. It is also produced in southwest Asia and Brazil. India is the largest producer of jute goods in the world, while Bangladesh is the largest cultivator of raw jute (Ghosh and Jethi 2013). About 90% of jute products produced in Bangladesh is exported (Rahman 2001). Jute, as a natural fiber, is a biodegradable and eco-friendly. It has many advantages over synthetics and protects the environment and maintains the ecological balance (Hossain and Abdulla 2015). At present, eco-friendly products and services are highly demandable in the world. Jute and jute products have brought the ecological balance from the environmental pollution caused by synthetics (Mohiuddin 2015).

Textile industry is one of the most important and rapidly developing industrial sectors in Bangladesh (Begum *et al.* 2018). Textile industry releases highly polluted and toxic effluent which are discharged into sewers and drains without any kind of treatment (Islam *et al.* 2011). Effluent containing nutrients can be used extensively for jute cultivation as it has wide ecological adaptability for growing in the marginal lands like lands with unfavorable/ stress conditions, such as drought, salt, flooding, low pH and low fertility (Begum 2020). Recently, the cost of cultivation of jute has increased substantially in comparison to its market price due to the raise of various input cost. The low price of fiber and low yield production due to depleted soil in the country are also a great problem to increase jute production. But, the present world demand of using the natural fiber instead of synthetic (to save the environment) is also regaining the past glory of jute. Bangladesh government has also taken different steps for strengthening the jute sector for lifting country's economy (Gani 2014).

Considering all these facts, the improvement of fiber yield is the prime need of Bangladesh. It is also necessary to find the fertilizer requirement which is economically profitable and at the same time gives yield very close to maximum yield potential. The present study was carried out to assess the effects of textile effluent and chemical fertilizers on the growth and yield of Tossa jute (O-795).

MATERIAL AND METHODS

A field experiment was conducted in Bangladesh Jute Research Institute (BJRI) Dhaka to find out the effect of textile effluent on the growth and yield of Tossa Jute (O - 795). Initial soil analysis showed that the experimental field soil contain organic matter 2.42%, total N 0.121%, K 0.31 Cmol(+)K^{-1}, Ca 3.27 Cmol(+)K^{-1}, Mg 0.93 Cmol(+)K^{-1}, available P 26.51 $mgkg^{-1}$, available S 29.11 $mgkg^{-1}$, available Co 0.74 $mgkg^{-1}$, available Fe 199.80 $mgkg^{-1}$, available Mn 2.42 $mgkg^{-1}$, available Zn 20.15 $mgkg^{-1}$, available Pb 29.78 $mgkg^{-1}$, available Cd 0.238 $mgkg^{-1}$, available Ni 23.48 $mgkg^{-1}$ and available Cr 31.12 $mgkg^{-1}$. In the textile effluent of Narayanganj, pH was 7.5, EC 2.09 dS/m, TDS 752 mg kg^{-1}, DO 1.19 mg kg^{-1}, BOD 15.39 mg kg^{-1}, the values of total N 0.07%, K 0.52 mg kg^{-1}, Ca 0.58 mg kg^{-1}, Mg 0.20 mg kg^{-1}, P 64.32 mg kg^{-1}, S 113.72 mg kg^{-1}, Co 1.12 mg kg^{-1}, Fe 1.34 mg kg^{-1}, Mn 0.097 mg kg $^{-1}$, Zn 0.08 mg kg $^{-1}$, Pb 0.0001 mg kg $^{-1}$, Cd 0.0095 mg kg $^{-1}$, Ni 0.482 mg kg $^{-1}$ and Cr 0.1 mg kg $^{-1}$. Treatments with three replications were T_1: Control (-TE and -RDF), T_2: 100% RDF (Recommended dose of fertilizer) + 0% effluent, T_3: 50% RDF + 25% effluent, T_4: 50% RDF + 50% effluent, T_5: 50% RDF + 75% effluent, T_6: 50% RDF + 100% effluent. Each treatment has three replications and in Figure 7 these are denoted as R_1, R_2 and R_3. The numbers of plots were 18 (each plot was 3m x 3m). The space between the plots, blocks and around the field was 1.0 meter. Half of N from urea and full dose of P as triple super phosphate (TSP), K as muriate of potash (MoP), S as gypsum were applied before sowing seeds. The rest half amount of N was top dressed at 45 days of sowing after final thinning.

Seeds were sown in line at a distance of 30 cm interval at depth of 2.5 cm and after sowing, seeds were covered with soil by hand on 3rd May 2017. All cultural operations were done as and when necessary. Each plot was irrigated with fresh water or textile effluent when required as per treatment. The jute plants were harvested at the early pod stage after total growth duration of 120 days. The plant population of each plot was counted at the time of harvest. Then plants were cut at ground level, the jute plants were made into small bundles and kept standing on the ground for 4 days for shedding of leaves. After the shedding of jute leaves, the bundles were steeped plotwise in pond water for retting. The retting process was completed in 21 days after steeping. In the retting process fibre on the bark got loosened and separated from the woody stalk. After proper retting the fibres were extracted by stripping and washed thoroughly in water. The extracted fibres were seen dried plotwise on bamboo bars. After drying, the fibres were weighed out to get the fibre yield. After stripping, the jute sticks were seen dried for several days and weighed out to record the yield of sticks. At harvest time randomly selected 5 plants were uprooted from each plot and attached soil was removed carefully without damaging the root and root hair and tagged in the field to note plant height, base diameter, green weight, dry matter weight, fiber yield and stick yield.

RESULTS AND DISCUSSION

Plant height

It was observed that the application of different combinations of effluent showed a positive effect on the plant height of jute as compared to control (Fig.1). The result also showed that T_2 (100% RDF + 0% effluent) and T_4 (50% RDF + 50% effluent) performed similar positive effect on the plant height of jute which were significantly ($P \leq 0.05$) varied with other treatments. The tallest plant height (3.7 m), the second tallest plant height (3.50 m) were found with T_2 and T_4 treatments, respectively. The lowest plant height (3.0 m) was obtained with T_1 (control).

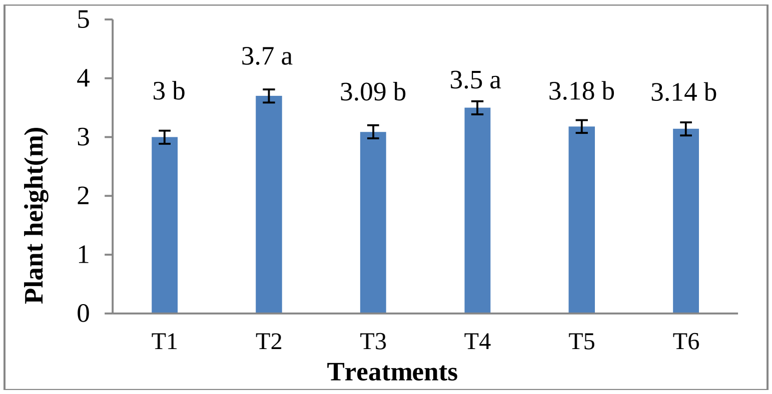

Fig.1. The effects of textile effluent and RDF on the height of jute plant.

Base diameter of tossa jute plant

The base diameter of jute plant with different concentration of effluent irrigation is presented in Fig. 2. The results showed that the maximum base diameter (16.17 mm) was found in T_2 (100% RDF + 0% effluent), which was also varied significantly ($P \leq 0.05$) with other treatments. The second highest base diameter of the jute plant (15.27mm) was observed in T_4 (50% RDF + 50% effluent). The lowest base diameter of the plant (13.47mm) was found in T_3 (50% RDF + 25% effluent). The base diameter (14.15 mm) achieved in T_5 (50% RDF + 75% effluent). The application of different combinations of effluent significantly ($P \leq 0.05$) increased the base diameter of the jute plant as compared to the control except T_3 (50% RDF + 25% effluent).

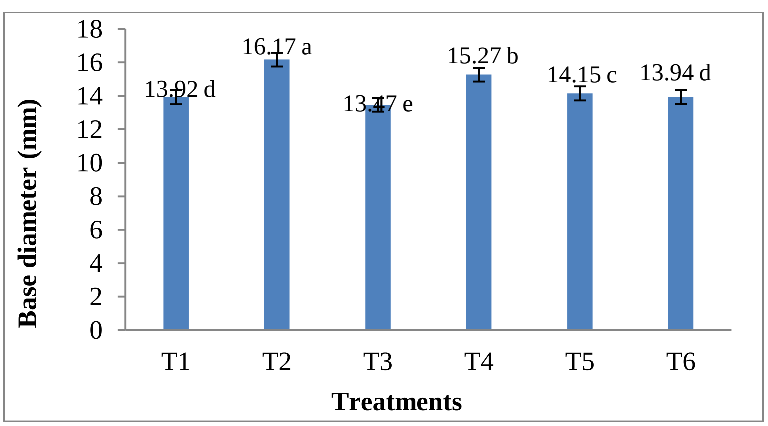

Fig. 2. The effects of textile effluent and RDF on base diameter of tossa jute plant.

Yield with and without leaves

The results of green plants yield with and without leaves of jute with different concentrations of effluent irrigation are presented in Figures 3 and 4. The highest green plants yield with leaves (58.65 t ha^{-1}) and without leaves (37.46 t ha^{-1}) were found in T_4 (50% RDF + 50% effluent) which varied significantly ($P \leq 0.05$) with other treatments. The lowest green plants yield with and without leaves were 35.5 and 21.95 t ha^{-1}, respectively achieved in T_1 (control). The results of green plants yield with leaves (52.18 t ha^{-1}) in T_2 (100% RDF + 0% effluent) were significantly ($P \leq 0.05$) higher than T_1, T_3 and T_5 treatments. But, the results showed that green plants yield without leaves (36.44 t ha^{-1}) in treatment T_2 (100% RDF + 0% effluent) had no significant difference with the achievement of T_4, T_5 and T_6 treatments. Results also reflected that leaves yield significantly ($P \leq 0.05$) increased with different doses of textile effluent irrigation as compared to T_1 (control).

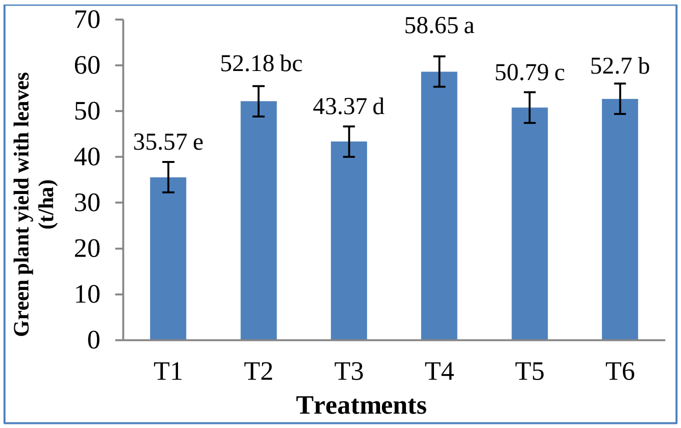

Fig. 3. The effects of textile effluent and RDF on green plant yield with leaves

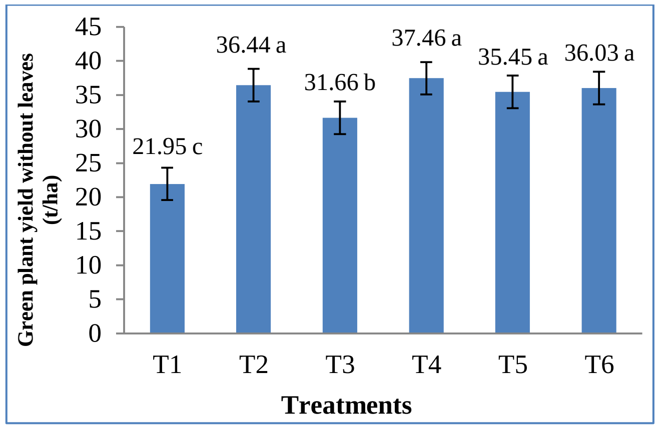

Fig. 4. The effects of textile effluent and RDF on green plant yield without leaves

Fiber and stick yield

The effects of textile effluent on the fiber and stick yield of jute are presented in Figures 5 and 6 respectively. It showed that the irrigation of different doses of textile effluent significantly increased both in fiber and stick yields. In producing the yield of fiber there was no significant treatment difference between T_2 (100% RDF + 0% effluent), T_4 (50% RDF + 50% effluent) and T_5 (50% RDF + 75% effluent). Results indicated that 50% and 75% textile effluent combined with 50% RDF may produce a significant yield which was found with 100% RDF.

The highest yield of fiber was (2.87 t ha^{-1}) found with T_2 (100% RDF + 0% effluent). The second highest yield of fiber was (2.84 t ha^{-1}) found with T_4 (50% RDF + 50% effluent). The lowest yield of fiber was 1.52 t ha^{-1}, which was found in the treatment T_1 (control). Highest stick yield 6.2 t ha^{-1} was recorded in T_2 (100% RDF + 0% effluent) which was significantly ($P \leq 0.05$) higher than other treatments. The second highest stick yield (5.94 t ha^{-1}) was found with T_4 (50% RDF + 50% effluent). The lowest yield of stick was (3.37 t ha^{-1}) found with T_1 (control).

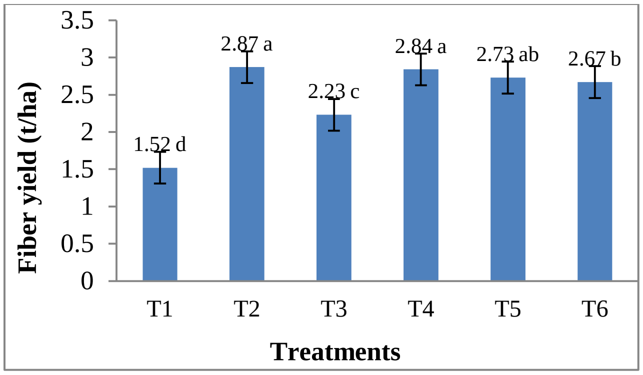

Fig. 5. The effects of textile effluent and RDF on fiber yield of tossa jute

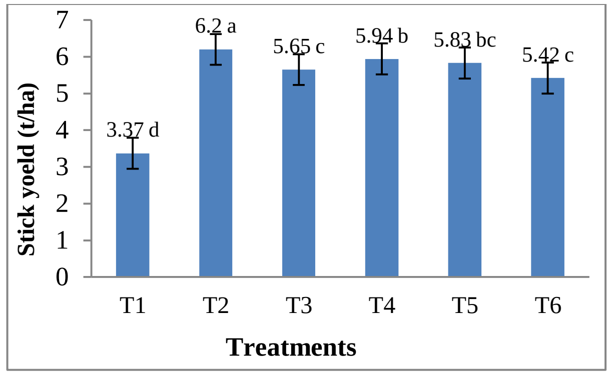

Fig. 6. The effects of textile effluent and RDF on stick yield of tossa jute

Dry matter production of jute

There were significant effects of textile effluent and NPK fertilizers on the dry matter production of jute (Table 1). The highest amount of total dry matter yield (12.95 t ha^{-1}) was obtained with T_2 (100% RDF + 0% effluent). Considering the production of total dry matter, the yield (12.46 t ha^{-1}) with T_4 (50% RDF + 50% effluent) could be ranked in second position. All the treatments showed the increased rate of dry matter yield than the control. Total dry matter yield (7.46 t ha^{-1}) was found lowest in T_1 (control). Dry matter yield increased, maximum 73.59% with T_2 and second highest 67.02% found with T_4 treatment over the control. Results varied significantly ($P \leq 0.05$).

Table 1. Effect of textile effluent on dry matter production of tossa jute.

Treatments	Green weight of 5 plants/plot (g)			Oven dry weight of 5 plants/plot (g)			Total dry weight (t ha^{-1})
	Leaves	**Shoot**	**Root**	**Leaves**	**Shoot**	**Root**	**L+S+R**
T_1: Control	130.25	352.94	103.11	46.36	155.99	33.92	7.46 f
T_2:100% RDF + 0% Effluent	320.00	680.00	193.98	102.40	296.48	66.40	12.95 a
T_3: 50% RDF + 25% Effluent	134.61	394.23	108.01	46.70	174.24	34.56	9.33 e
T_4:50% RDF + 50% Effluent	269.60	661.76	185.60	90.85	291.83	60.87	12.46 b
T_5:50% RDF + 75% Effluent	301.98	589.10	125.37	99.65	262.14	41.37	12.02 c
T_6:50% RDF +100% Effluent	160.19	537.96	127.03	53.66	220.54	40.12	11.38 d
LSD at 5% level	2.07	2.51	1.20	1.05	1.32	0.95	0.87

Begum *et al.* (2021) found that different concentration of effluent have positive impact on the dry matter yield and nutrient content of jute vegetables on non-contaminated soils over the control. Begum *et al.* (2018) reported that textile effluent have positive impact on jute vegetables due to having rich nutrients, i.e. N, P, K and S, in it, which nourish the crop better than the control one. Kumar *et al.* (2018) observed that the application of inorganic fertilizer in the presence of distillery effluent was highly beneficial to rice and wheat crop. Pre-sowing irrigation with (spent wash methanated) distillery effluent along with inorganic fertilizers proved most effective in increasing the grain and straw yields of rice and wheat crop. The findings are similar to the results reported earlier by Kumar *et al.* (2018) for the soil irrigated with textile effluent.

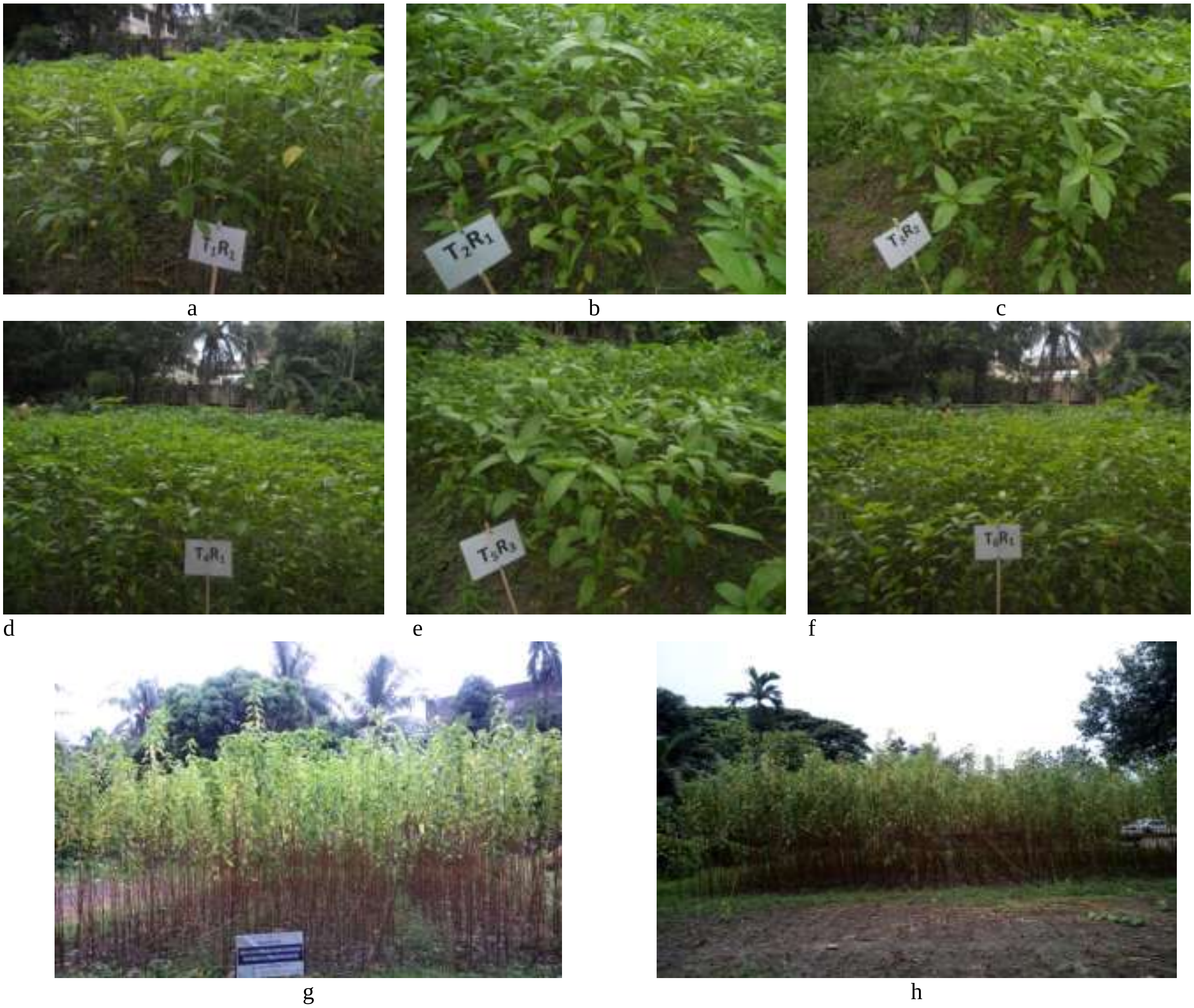

Fig. 7. Pictures of tossa jute plants at different growth stages with different treatments. a) T_1(control) at 45 days of after sowing; b) T_2 (100% RDF + 0% effluent) at 45 days of after sowing; c) T_3 (50% RDF + 25% effluent) at 45 days of after sowing; d) T_4 (50% RDF + 50% effluent) at 45 days of after sowing; e) T_5 (50% RDF + 75% effluent) at 45 days of after sowing; f) T_6 (50% RDF + 100% effluent) at 45 days of after sowing; g) Tossa jute plant at 90 days after sowing; and h) Tossa jute plant at the time before harvest (120 days after sowing).

Yaseen *et al.*(2016) found that the application of liquid NPK fertilizer with end drain textile effluent increased plant height, spike length, flag leaf length, root length, number of tillers (m^{-2}), number of fertile tillers (m^{-2}), 1000 grain weight, grain yield and straw yield of wheat. Results of this experiment are in agreement with Yaseen *et al.* (2016).

Najam-us-Sahar *et al.* (2017) found that the effect of textile wastewater on dilution level 10, 20 and 30% on growth parameters of wheat was statistically at par with control. Maximum reduction in growth parameters of wheat was observed on application of concentrated textile effluent (100% dilution level) as plant height, spike length, root mass and root length of wheat was decreased by up to 17, 22, 68 and 24%, respectively, as compared to control (tap water).

The findings of the present study were homologous to the findings reported by Saravanamoorthy and Kumari (2007). They found that the increase in shoot and root dry weights was observed at 25% effluent treatments and textile effluent treatment could increase the yield of the plants at 25% and 50% treatments.

Economic analysis

Economic analysis was made considering variable cost of fertilizers, seeds, irrigation, labour and price of fiber and sticks (Table 2). It was observed that T_4 (50% RDF + 50% Effluent) was the most cost effective treatment, as it gave the highest gross return (Tk. 69010.00/ha) with benefit cost ratio (BCR) of 2.73 which was highly profitable.

Table 2. Cost and return analysis for tossa jute (O - 795).

Treatments	Gross return (Tk./ha)	Total variable cost (Tk./ha)	Gross margin (Tk./ha)	BCR
T_1: Control	58480	37300	21180	1.57
T_2:100% RDF + 0% effluent	110900	42100	68800	2.63
T_3: 50% RDF + 25%Effluent	89500	39825	49675	2.25
T_4:50% RDF + 50%Effluent	108960	39950	69010	2.73
T_5:50% RDF + 75%Effluent	105220	40075	65145	2.63
T_6:50% RDF +100%Effluent	101780	40200	61580	2.53

The experiment revealed that all the treatments had significant positive impact over control on growth and yield. The highest fiber yield (2.87 t ha^{-1}) and stick yield (6.2 t ha^{-1}) were recorded with T_2 (100% RDF + 0% effluent). On the other hand, from the economic analysis, T_4 (50% RDF + 50% effluent) showed higher BCR (2.73) than T_2 (100% RDF + 0% effluent). T_4 (50% RDF + 50% effluent) also gave high yield (2.84 t $ha^{-1}$of FY and 5.94 t $ha^{-1}$of SY) which was very close to maximum yield with T_2 (2.87 t ha^{-1} of FY and 6.2 t ha^{-1} of SY). Considering all these aspects, specially yield and BCR, T_4 (50% RDF + 50% effluent) seems to be the best for tossa jute (O-795) cultivation.

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