

# **Precision Fertilization Strategies for Maximizing Jute Yield in Alluvial Soils of Seemanchal region of Bihar**

## **ABSTRACT**

Jute, known as the "golden fiber," holds significant economic and ecological importance in India. This study focuses on precision fertilization strategies to maximize jute yield in the alluvial soils of the Seemanchal region of Bihar. Jute cultivation is crucial for the livelihoods of small and marginal farm families in the eastern Indian states. The Soil Test Targeted Yield (ST-TY) approach, based on targeted yield and soil testing, is explored as an alternative to conventional fertilizer practices.

The experiment, conducted over two years in the Seemanchal region, evaluated the impact of different fertilizer treatments on soil properties, jute growth attributes, fiber yield, and economic viability. The ST-TY approach was compared with conventional practices. The results indicate that the ST-TY approach had a limited impact on soil properties, but a significant decrease in available nitrogen and phosphorus levels raised concerns about nutrient management. The study assessed yield attributing characteristics of jute, including plant height, basal diameter, green weight, fiber yield, and targeted yield deviation. Treatment T<sub>3</sub>, incorporating specific fertilizer doses and organic matter, consistently outperformed other treatments, demonstrating higher plant growth and fiber production. Economic analysis revealed that T<sub>3</sub> resulted in the highest net income and the most favorable benefit-cost (B:C) ratio, indicating its economic superiority. These findings underscore the importance of tailored fertilizer treatments, including organic matter, in optimizing jute cultivation. The incorporation of precise nutrient management practices can serve as a model for similar agro-ecological zones, providing a holistic framework for enhancing jute cultivation practices in Seemanchal and beyond. T<sub>3</sub> emerges as a promising treatment for wider adoption in jute cultivation, emphasizing both productivity and economic sustainability.

**Keywords:** jute, STTY, Fertilization Strategies, Alluvial Soils

## **1. Introduction:**

Jute is an important natural fiber crop of India, ranking next to cotton in significance. It holds a prestigious position in India's industrial and agricultural economy. The eastern Indian states of West Bengal, Assam, Bihar, Odisha, Meghalaya, and Tripura have well-established jute cultivation, which also plays an integral role in the lives of around 40 lakh small and marginal farm families in the region. Originally considered solely as a raw material for packaging industries, jute has now emerged as a versatile resource with diverse applications. Its uses extend to textile industries, paper industries, building and automotive sectors, as well as for soil conservation, decorative, and furnishing materials. Being biodegradable and an annually renewable source, jute is recognized as an environment-friendly crop, contributing to the maintenance of ecological balance. Over the last decade, the jute cultivation area in India has remained between 7.5 to 8.0 lakh hectares, with total jute production varying between 96.34 and 115.38 lakh bales. The evolution of newer jute varieties and improved agronomic management

practices, including nutrient management, has reduced the crop duration from over 150 days in the early 1970s to 120 days or even lesser. The response of crop yield to nutrient application is influenced by nutrient requirements, availability from indigenous sources, and the fate of fertilizer application in the soil. The indiscriminate use of fertilizers without considering crop-specific nutrient requirements and soil nutrient availability can adversely affect both soil health and crop productivity. Given the increasing demand for chemical fertilizers and depleting soil fertility, a shift towards integrated organic and inorganic sources of nutrients is imperative for sustainable crop production.

The targeted yield approach, originally conceptualized by Ramamoorthy *et al.* (1967) and later modified by Kanwar (1971), offers a more effective alternative to general fertilizer recommendations. By applying soil testing and target yield-based fertilizer doses to crops, this approach ensures a greater response ratio and benefit-cost ratio. Nutrient imbalances in the soil can be rectified as nutrients are applied proportionally to address specific deficiencies. In light of the above, this study aims to evaluate the effectiveness of the Soil Test Targeted Yield (ST-TY) approach in jute cultivation within the Seemanchal area of eastern India. The research compares this approach with conventional farmer practices to assess its impact on soil properties, jute growth attributes, fiber yield, and economic viability. The findings of this study will contribute valuable insights to optimize nutrient management strategies for jute cultivation, leading to enhanced productivity and improved economic returns for jute farmers in the region.

## **2. MATERIALS AND METHODS:**

The experiment was conducted in farmers' fields under the jurisdiction of Krishi Vigyan Kendra, Katihar, affiliated with Bihar Agriculture University, Sabour, Bhagalpur. The study spanned two consecutive years, 2019 and 2020, aiming to investigate the impact of soil test-based optimal fertilizer doses on achieving target jute yields in the alluvial soils of the Seemanchal region. The experimental site is positioned within Latitude 25'N to 26'N and Longitude 87' to 88'E, at an elevation of 32 meters above Mean Sea Level (MSL). The climate of the region is characterized as sub-tropical and humid, with an average temperature (Max. & Min.) of 42°C and 4°C, respectively, and an average annual rainfall of about 1298 mm.

### **2.1 Experimental site and soil analysis**

The experimental soils were non-calcareous in nature belonging to the Alluvial Tract under Agro ecological zone-II lies between three major rivers Mahananda, Kosi and Ganga. The soil samples were collected from experimental plots before the experiment start on and after harvest jute crop. Both years soil samples from depths 0-15 cm were taken before sowing and after harvesting of jute crop from each plot at random using double cylinder core samplers with sample holder (inner cylinder) diameter and height of 50 mm high (Black and Hartge, 1986). The sampler was pressed vertically into the soil surface

enough to fill the sampler, but not so far to compress the soil in the compound space of the sampler. The sampler and its contents were carefully removed to preserve the natural structure and packing of the soil as best as possible. The two cylinders were sorted, retaining the undisturbed soil in the inner cylinder. The soil extending beyond each end of the sample holder was trimmed to flush with a straight edged knife. The soil sample volume was thus established to be the same as the volume of the sampler holder. The soil cores were wrapped in paper, transported and safely stored in the laboratory safely. Air-dry the soil sample in shade for chemical analysis. Crush the soil and grind with the help of grinder and pass through 0.2 to 0.5 mm sieves before analysis and record. Bulk density (B.D.) of soil was determined by core sampler method (Bodman, 1942), Particle density by Pycnometer method and porosity determined with the help of formula based on BD and PD (Chopra and Kanwar, 1991). Organic carbon content was determined by the Walkley and Black method (1934). Available nitrogen was determined by the alkaline  $\text{KMNO}_4$  method (Subbaiah and Asija, 1956), and available phosphorous (Olsen's method, 1954) and available potash were determined Flamphotometrically method (Tandon, 1993). The EC and pH of soil were estimated after preparing 1:2 soil water suspension by conducto-metrically and electro metrically using glass electrode methods (Piper, 1996), respectively.

The experiment was design in RBD with three treatments [( $T_1$  – FP (23:20:15 :: N:P:K),  $T_2$  – ST-TY (35 qha<sup>-1</sup>) = 123:49:27:: N:P:K and  $T_3$  - ST-TY (35 qha<sup>-1</sup>) = 83:35:19:: N:P:K + FYM @ 5 t ha<sup>-1</sup>)] and ten replications. The unit plot size was 10.0 m X 10.0 m. and ten replications. The land was prepared in early April and manure & fertilizers applied as par recommendation of STCR based nutrients recommendation. All the fertilizers were applied as per treatments dose in each individual plot during the final land preparation and rest nitrogenous fertilizer were applied at different stages recommended in different treatments. Jute seed var JRO 204 in plot was sown on 12<sup>th</sup> and 14<sup>th</sup> April 2019 at the rate of 5 kg ha<sup>-1</sup>. The growth and yield parameters of individual plant were recorded of 10 plants in each plot. A total of five harvests (5 plants / replication / harvest) were received for recording data on some morpho-physiological attributes of jute. The first crop sampling was done at 30 days after sowing and subsequently at 10 days interval upto 100 DAS. The plants were separated into roots stems and leaves and the corresponding dry weights were recorded after oven drying at 80<sup>0</sup>C for 72 hours. The total dry matter was calculated from the summation of dry weights of roots, stems and leaves. Other morpho-physiological attributes of jute were also calculated by respective method. The following growth parameters were also computed using the formula given by Hunt (1978).

## **2.2 Statistical analysis:**

The data collected on different parameters under the experiment were statistically analyzed to obtain the level of significance using the computer MSTAT package program developed by Russel (1986). The differences between pairs of means were compared by Duncan's multiple range test (DMRT) as stated by Gomez and Gomez (1984).

### Absolute growth rate (AGR):

$$\text{AGR} = \frac{W_2 - W_1}{T_2 - T_1} \text{ gram plant}^{-1} \text{ day}^{-1}$$

Where;

$W_2$  and  $W_1$  are the dry mass (DM) at time  $T_2$  and  $T_1$ , respectively.

### 3. Result and discussion:

The data related to soil is presented in table 1. It is clear from the table that the initial pH of the soil was 5.89, which slightly decreased to 5.87 by the end of the experiment. This small change in pH is not statistically significant (NS), suggesting that the treatment did not have a substantial impact on soil pH. Like pH, ECe this change is also statistically nonsignificant (NS), indicating that the treatment did not significantly affect the soil's electrical conductivity. Organic carbon content in the soil increased from 0.58% initially to 0.60% after the experiment. This minor increase is statistically nonsignificant (NS), suggesting that the treatment did not lead to a significant change in organic carbon levels. The concentrations of available nutrients (N, P, K) in the soil were evaluated in  $\text{kg ha}^{-1}$ . After the experiment, the available nitrogen (N) content decreased from  $324 \text{ kg ha}^{-1}$  to  $305 \text{ kg ha}^{-1}$ , which is a statistically significant change. Similarly, available phosphorus (P) decreased from  $31 \text{ kg ha}^{-1}$  to  $28 \text{ kg ha}^{-1}$ , which is also statistically significant. Available potassium (K) decreased from  $245 \text{ kg ha}^{-1}$  to  $235 \text{ kg ha}^{-1}$ ; however, this change is not statistically significant.

The treatment applied in this study had a limited impact on the soil's physico-chemical properties, with minor changes observed in organic carbon content. However, the significant decrease in available nitrogen and phosphorus levels raises questions about nutrient management practices and their effects on crop performance, warranting further research and consideration in future agricultural practices. These findings are in conformity with Ray *et al.* (2000), Doharey *et al.* (1980), Ray and Gupta (1979), Majumdar *et al.* (2014).

#### 3.1 Yield Attributes:

It is clear from the table 2 that the yield attributing characteristics of jute (*Corchorus olitorius*) influenced by different treatments, including plant height (cm), basal diameter (cm), green weight of plant ( $\text{q ha}^{-1}$ ), fiber yield ( $\text{q ha}^{-1}$ ), and the deviation from the targeted yield (%) for each treatment. The plant

height varied significantly among the treatments. Treatment  $T_3$  resulted in the tallest plants with an average height of 385 cm, followed by  $T_2$  with 372 cm, and  $T_1$  with 292 cm. The critical difference (CD) for plant height was 7.01 cm, indicating that these differences are statistically significant. The taller plants in  $T_2$  and  $T_3$  suggest that these treatments might have provided conditions more conducive to vertical growth.

**3.2 Basal Diameter (cm):** Basal diameter, like plant height, showed significant variation among the treatments.  $T_3$  had the largest basal diameter at 1.96 cm, followed by  $T_2$  at 1.88 cm, and  $T_1$  at 1.38 cm. The CD for basal diameter was 0.23 cm, indicating that these differences are statistically significant. A larger basal diameter typically indicates sturdier and healthier plants.

**3.3 Green Weight of Plant ( $q\ ha^{-1}$ ):** The green weight of the jute plants also differed significantly among the treatments.  $T_3$  had the highest green weight  $412.71q\ ha^{-1}$ , followed by  $T_2$  at  $381.27q\ ha^{-1}$ , and  $T_1$  at  $246.37q\ ha^{-1}$ . The CD for green weight was  $2.36qha^{-1}$ , indicating that these differences are statistically significant. A higher green weight suggests more vigorous plant growth and biomass accumulation.

**3.4 Fiber Yield ( $q\ ha^{-1}$ ):** Fiber yield, a crucial measure for jute cultivation, showed significant variations among the treatments.  $T_3$  yielded the highest fiber yield at  $32.52q\ ha^{-1}$ , followed by  $T_2$  at  $30.26q\ ha^{-1}$  and  $T_1$  at  $19.38qha^{-1}$ . The CD for fiber yield was  $1.02qha^{-1}$ , signifying that these differences are statistically significant. The higher fiber yield in  $T_2$  and  $T_3$  indicates the effectiveness of these treatments in promoting jute fiber production.

**3.5 Targeted Yield Deviation (%):** Targeted yield deviation represents the percentage deviation from the expected or targeted yield (fig 1 & table 2).  $T_1$  had the highest deviation from the targeted yield at 44.63%, followed by  $T_2$  at 13.54%, and  $T_3$  at 7.09%. The CD for targeted yield deviation was 1.86%, indicating that these differences are statistically significant. A lower deviation percentage suggests that  $T_3$  achieved a yield closer to the targeted yield.

The results highlight the significant influence of different treatments on the yield attributing characters of jute. Treatment  $T_3$  consistently outperformed the other treatments in terms of plant height, basal diameter, green weight of plants, and fiber yield. This indicates that  $T_3$ , which involved specific fertilizer doses and the application of organic matter (FYM), was the most effective in promoting jute growth and fiber production. Overall, these results emphasize the importance of tailored fertilizer treatments, including the addition of organic matter, in optimizing jute cultivation. Treatments  $T_2$  and  $T_3$  show promise for improving jute yields, with  $T_3$  being particularly noteworthy for its comprehensive positive impact on jute growth and fiber yield. This result conformity to the findings of Ray *et al.* (2000), Kumar *et al.* (2016), Ray and Gupta (1979) and Majumdar *et al.* (2014).

### 3.6 Economics:

Net income represents the profit obtained from jute cultivation after deducting the cost of cultivation from the gross income (table 3 & fig 2). T<sub>3</sub> yielded the highest net income at Rs 96,884 per hectare, followed by T<sub>2</sub> at Rs 89,692 per hectare, and T<sub>1</sub> at Rs 44,896 per hectare. The CD for net income was 41.07 Rs ha<sup>-1</sup>, indicating statistically significant differences. The B:C ratio is a critical economic indicator that assesses the profitability of an agricultural venture. It is calculated by dividing the gross income by the cost of cultivation. T<sub>3</sub> had the highest B:C ratio at 3.44, followed by T<sub>2</sub> at 3.40, and T<sub>1</sub> at 2.23. The CD for the B:C ratio was 0.06, signifying statistically significant differences.

The economic analysis indicates that T<sub>3</sub>, despite its higher cultivation cost, resulted in the highest gross and net income and the most favorable B:C ratio. This suggests that T<sub>3</sub> not only promotes better jute growth and fiber yield (as shown in Table 2 & fig 1) but is also economically superior to the other treatments. T<sub>2</sub> also performed well economically, but T<sub>3</sub> appears to be the most economically viable treatment for jute cultivation. These findings also conformity with the findings of Kumar *et al.* (2016), and emphasize the importance of optimizing fertilizer and nutrient management practices for maximizing both crop yield and profitability in jute farming.

The studies collectively emphasize the significance of precise nutrient management, tailored fertilizer application, and the inclusion of organic matter for maximizing jute yield and profitability in the Seemanchal region. The incorporation of precise nutrient management practices, informed by soil testing and tailored fertilizer application, can serve as a model for optimizing agricultural productivity in similar agroecological zones. By focusing on both agronomic practices and economic sustainability, these studies provide a holistic framework for enhancing jute cultivation practices in Seemanchal and potentially beyond. T<sub>3</sub> stands out as the most promising treatment in terms of both crop productivity and economic returns, suggesting its potential for wider adoption in jute cultivation practices.

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**Table 1: Physico-chemical Properties of experimental Soil (pooled data)**

Treatments	pH (1:2.5)	ECe (dSm <sup>-1</sup> )	O.C. (%)	Available Nutrients (kg ha <sup>-1</sup> )		
				N	P	K
Initial	5.89	0.17	0.58	324	31	245
Final	5.87	0.18	0.60	305	28	235

CD (p=0.05)	NS	NS	NS	2.45	0.47	2.7
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**Table 2: Yield attributing characters of Jute (*Corchorous olitorius*) (pooled data)**

Treatments	Plant height (cm)	Basal diameter (cm)	Green weight of Plant (q ha <sup>-1</sup> )	Fiber Yield (q ha <sup>-1</sup> )	Targeted yield deviation (%)
T <sub>1</sub>	292	1.38	246.37	19.38	44.63
T <sub>2</sub>	372	1.88	381.27	30.26	13.54
T <sub>3</sub>	385	1.96	412.71	32.52	7.09
CD (p=0.05)	7.01	0.23	2.36	1.02	1.86

**Table 3: Economics of Jute (*Corchorous olitorius*) (pooled data)**

Treatments	Cost of cultivation (Rs ha <sup>-1</sup> )	Gross income (Rs ha <sup>-1</sup> )	Net Income (Rs ha <sup>-1</sup> )	B:C ratio
T <sub>1</sub>	36500	81396	44896	2.23
T <sub>2</sub>	37400	127092	89692	3.40
T <sub>3</sub>	39700	136584	96884	3.44
CD (p=0.05)	26.07	85.36	41.07	0.06

