**Bangladesh J. Environ. Sci., Vol. 46, 83-88, 2024 @ BAED ISSN 1561-9206**

# IMPACT OF COPPER LEVELS ON EARLY GROWTH STAGES OF KENAF AND MESTA CULTIVARS

**M. K. Islam [1], M. S. A. Mamun[2], I. Jahan[3], S. Nasrin [1] and M. A. S. Jiku [4]***
[1]Breeding Division, [2]Department of Soil Science, [3]Genome Research Centre, [4]Agronomy Division
Bangladesh Jute Research Institute, Ministry of Agriculture, Dhaka-1207, Bangladesh
*Corresponding author's mail: jikuly@gmail.com

## ABSTRACT

In this study investigating the "Impact of Copper Levels on Early Growth Stages of Kenaf and Mesta Cultivars at BJRI," we observed significant treatment-specific effects on shoot length, root length, fresh weight, and dry weight of Kenaf and Mesta plants at 20 and 40 days after sowing (DAS). At 20 DAS, both Kenaf and Mesta exhibited decreasing trends in shoot length, with $T_3$ showing the lowest values (Kenaf: 9.16, Mesta: 6.56) and $T_0$ displaying the highest (Kenaf: 16.83, Mesta: 16). This suggests an inhibitory effect of copper, particularly in $T_3$, on the early shoot development of both crops. As the growth progressed to 40 DAS, shoot length continued to decrease across all treatments, with $T_3$ consistently lower than others, indicating a potential long-term inhibitory effect on shoot development. Additionally, $T_2$ exhibited a notable impact on Kenaf shoot growth at 40 DAS. Root length showed treatment-specific effects, particularly in $T_2$, with Kenaf exhibiting higher variability. Fresh weight and dry weight displayed complex responses, with $T_3$ significantly influencing biomass accumulation. The observed trends underscore the need for further research to elucidate underlying mechanisms and assess long-term implications on the growth and performance of Kenaf and Mesta crops.

**Key word**: Copper, Mesta, Kenaf

## Introduction

Jute (*Corchorus* sp.) is the second most vital fiber crop globally after cotton, reigns as Bangladesh's premier cash crop. Annual production hovers between 9.00-10.00 lakh tons, sourced from 4.50-5.00 lakh hectares of land, per the Bangladesh Bureau of Statistics. Since 2010-2011, there's been a notable surge in both area and production, averaging 75-80 lakh bales from 7.00-7.50 lakh hectares. This uptick is credited to a rising eco-awareness, with consumers favoring natural fibers to curb synthetic fibers' environmental impact. Consequently, the demand for jute fiber has spiked domestically and internationally. In modern agriculture, fertilizers are essential for boosting crop productivity. The availability of micronutrients in soils is contingent upon factors such as the solubility of micronutrients, soil solution pH, redox potential and the nature of binding sites on organic and inorganic particle surface (Bolan and Brennan, 2011). Soil fertility influenced by the presence or absence of macro and micronutrients plays a vital role in determining plant growth. Micronutrients required in minute quantities for plant growth also play a role in enhancing plant productivity, leaf area, grain yield, and the enzymatic system of plants (Marschner, 2011). In Bangladesh, the stresses on soil nutrients are on the rise due to factors such as high cropping intensity with high-yielding crop varieties and a decrease in organic matter content in the soil (Biswas and Naher, 2019). Consequently, the need for micronutrients in the soil is escalating. However, the distribution of different fertilizers in the country is not adequately balanced. Micronutrient deficiency is widespread in many Asian countries owing to the calcareous nature of soils, high pH, low organic matter content, salt stress, continuous drought, high bicarbonate content in irrigation water, and imbalanced application of NPK fertilizers (Narimani *et al*., 2010). Among various micronutrient elements, Copper is particularly crucial for optimal jute production. The country has experienced a notable increase in jute fiber production since 2010-2011, indicating a positive shift in both awareness and practice among farmers (Sheheli and Roy, 2014). This upward trend in jute cultivation and production signifies a broader global recognition of the environmental benefits and sustainability associated with natural fibers like jute (Jahan, 2019). Fertilizers are crucial in modern agriculture, enriching soil and enhancing crop productivity. In Bangladesh, inorganic fertilizers are essential for achieving high yields, optimizing soil conditions, and ensuring crops receive vital nutrients for growth. The availability of micronutrients in soil is a complex interplay of various factors. Solubility, soil pH, redox potential and the nature of binding sites on organic and inorganic particle surfaces all influence the presence of micronutrients in the soil (Stevenson, 1991). In Bangladesh, increasing soil nutrient stresses stem from intensified cropping and organic matter decline. Balancing fertilizer application, addressing both macro and micronutrient needs, is crucial for soil fertility. Micronutrient deficiency is common in Asian countries due to various factors like soil composition and fertilizer imbalance. In Bangladesh, these challenges require a strategic approach to fertilizer use for sustainable agriculture. As a key element in plant metabolism, copper plays essential roles in various physiological functions, impacting leaf area, grain yield, and enzymatic systems in plants (Stevenson, 1991). Copper's importance in jute cultivation lies in its specific role in plant growth. Although the rising focus on jute cultivation holds economic and environmental promise, it brings challenges. Meeting the increasing demand for jute fiber requires a cautious and sustainable agricultural approach. Balancing the use of fertilizers, especially micronutrients like copper is crucial to prevent soil degradation and nutrient imbalances (Cissé, 2007). The rise in jute fiber production in Bangladesh signals a move towards sustainable agriculture. Copper as a critical micronutrient holds particular significance in jute cultivation influencing plant metabolism and overall productivity (Saleem, Ali, *et al.*, 2020). Meeting the increasing demand for jute fiber requires sustainable agricultural practices and soil health prioritization. Collaborative efforts from farmers, researchers, and policymakers are crucial to ensure the long-term viability of jute cultivation. Investigating the impact of copper levels on jute is essential, driving a study to evaluate its influence on germination rates, seedling growth, yield, and quality.

## Materials and Methods

The experiment was conducted at Bangladesh Jute Research Institute (BJRI) research field, Manik Mia Avenue, Dhaka. This site belonged to the Agro ecological Zone–Modhupur Tract (AEZ 28). The experimental site was located in the subtropical monsoon climatic zone set apart by low rain fall during the months from September to December (Kharip-2 season) and scantly of rain fall during the rest of the year (Kharip-1 season). Plenty of sunshine and moderately low temperature prevail from September to December (Rabi season). Varieties (V1 - Kenaf HC-95 and V2 - BJRI Mesta 2) was collected from the Bangladesh Jute Research Institute (BJRI) for the present research work. For different treatments different amount of copper sulphate were measured using precision balance. The experiment was laid out and evaluated during Kharip-1 season 2023 in a Completely Randomized Design (CRD) that included 2 variety. Total 24 earthen pot were used for this experiment under the total 4 treatment and each treatment contain 3 replications. Each replication was contain 5 plant. Before planting, soil was meticulously cleared of weeds and stubble. To ensure pathogen-free soil, it was sun-exposed for 48 hours before filling plastic pots. Pots were prepared two days prior to sowing, each containing 5kg of soil. The pots, sized 20 cm in height, 25cm in diameter at the top, and 20cm at the bottom, were equipped with three pores covered with gravel for efficient drainage.The soil was well pulverized and dried in the sun and only well-decomposed cow dung & compost fertilizer were mixed with the soil. Well-decomposed cow dung was calculated for each pot considering the dose of 1-hectare soil at the depth of 20 cm. The BARC recommended doses viz. Urea (100-125 kg/ha), TSP (130kg-150 kg/ha) and $M_OP$ (40-50kg/ha) were used for carrying out the experiment. Seeds of Kenaf HC-95 and BJRI Mesta 2 were sown according to the treatment and replication. These seeds were sown in each location. Then the seeds were covered with fine soil by hand.

Table 1. Layout of the experiment

| Kenaf HC-95 ($V_1$) | | | | BJRI Mesta 2 ($V_2$) | | | |
|---|---|---|---|---|---|---|---|
| $T_0$ | $T_1$ | $T_2$ | $T_3$ | $T_0$ | $T_1$ | $T_2$ | $T_3$ |
| $V_1T_0R_1$ | $V_1T_1R_1$ | $V_1T_2R_1$ | $V_1T_3R_1$ | $V_2T_0R_1$ | $V_2T_1R_1$ | $V_2T_2R_1$ | $V_2T_3R_1$ |
| $V_1T_0R_2$ | $V_1T_1R_2$ | $V_1T_2R_2$ | $V_1T_3R_2$ | $V_2T_0R_2$ | $V_2T_1R_2$ | $V_2T_2R_2$ | $V_2T_3R_2$ |
| $V_1T_0R_3$ | $V_1T_1R_3$ | $V_1T_2R_3$ | $V_1T_3R_3$ | $V_2T_0R_3$ | $V_2T_1R_3$ | $V_2T_2R_3$ | $V_2T_3R_3$ |

Table. 2: Fertilizer doses for the experiment

| Inorganic Fertilizers | Doses on different days | | |
|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ |
| Urea | 6g | 3g | 3g |
| TSP | 6g | 2g | 3g |
| M$_O$P | 1.5g | 2g | 3g |

Copper solution was applied at 10,15 and 20 mg/l rate followed by the treatments. Copper Sulphate were used for making the solution. To make the solution using a precision balance the amount were measured.

**Intercultural operations:** After sowing, light irrigation was provided, followed by visual estimation to determine irrigation needs a week later. Wilting symptoms prompted immediate irrigation until pots were adequately moistened, with subsequent irrigation every three days. Thinning was performed to remove excess plants, retaining only five healthy ones per pot. Weeding was done multiple times to manage weed growth effectively. For pest control, experimental Kenaf and Mesta plants were treated with Dursban pesticide, using a 2ml portion in 1L of water. This pesticide was sprayed twice, starting at the vegetative growth stage.

Fig. 1: Effect of copper sulphate on seedlings

**Data recording and analysis:** Different biometric traits related to yield and it is contributing characters were recorded via. Days to germination, plant height (cm), leaf length (cm), leaf width (cm), leaf area (cm2), number of main branches per plant, and number of pods per plant data were recorded. The data obtained in respect of all the characters has been subjected to the following statistical analyses. The data collected on different parameters were statistically analyzed to obtain the level of significance using the Microsoft excel.

## Results and Discussion

**Shoot length:** At 20 DAS, Kenaf shoot length demonstrates a decreasing trend across treatments, with $T_3$ exhibiting the lowest value (9.16) and $T_0$ showing the highest (16.83). This suggests an inhibitory effect of certain treatments, particularly $T_3$ on the early shoot development of Kenaf. In contrast, Mesta shoot length displays a similar decreasing trend, with $T_3$ showing the lowest value (6.56) and $T_0$ exhibiting the highest (16). This indicates treatment-specific impacts on the early shoot growth of Mesta. As the growth progresses to 40 DAS, the shoot length of both Kenaf and Mesta continues to decrease across all treatments. $T_3$ remains consistently lower than the other treatments for both crops, suggesting a potential long-term inhibitory effect on shoot development. Kenaf in $T_2$ exhibits a notably lower shoot length at 40 DAS compared to other treatments, indicating a specific impact of $T_2$ on Kenaf shoot growth. The standard deviations calculated for each treatment provide additional insights into the variability within the data. For Kenaf at 20 DAS, $T_0$ exhibits the highest standard deviation, indicating increased variability in shoot length within this treatment. This suggests a more complex and varied response of Kenaf shoots to $T_0$ during the early growth period. For Mesta at 20 DAS, the standard deviation is relatively high for $T_0$, indicating increased variability in shoot length within this treatment. At 40 DAS, the standard deviation for Mesta in $T_3$ is notably high, suggesting increased variability in shoot length within this treatment. This underscores the complexity of the response of Mesta shoots to $T_3$ as the plants progress through the growth stages. In conclusion, the data highlights treatment-specific effects on the shoot length of Kenaf and Mesta plants at different growth stages. The observed trends emphasize the potential of certain treatments, particularly $T_3$ to significantly influence shoot development.

**Root length:** The presented data sheds light on the influence of various treatments on the root length of Kenaf and Mesta plants at 20 and 40 days after sowing (DAS). Root length is a critical parameter reflecting the plants' below-ground development and their ability to access soil resources. The treatments ($T_0$, $T_1$, $T_2$, and $T_3$) exhibit diverse effects on the root length of both Kenaf and Mesta, as evidenced by the measured values and their corresponding standard deviations. At 20 DAS, Kenaf root length displays variability across treatments, with $T_2$ exhibiting the highest value (3.56) and $T_3$ showing the lowest (2.833). This suggests treatment-specific impacts on the early development of Kenaf roots. In contrast, Mesta root length is more consistent at 20 DAS, with $T_2$ showing the highest value (3) and $T_3$ exhibiting the lowest (2.43). As the growth progresses to 40 DAS, the root length of Kenaf plants continues to vary across treatments, with $T_2$ still exhibiting the highest value (18.83). $T_3$, however, shows a notable decrease in root length compared to other treatments, indicating a potential inhibitory effect on the development of Kenaf roots. Mesta root length, on the other hand, displays a more uniform response at 40 DAS, with $T_2$ showing the highest value (7.5) and $T_3$ again exhibiting the lowest (6.26). The standard deviations calculated for each treatment provide additional insights into the variability within the data. For Kenaf at both 20 and 40 DAS, $T_2$ exhibits the highest standard deviation, indicating increased variability in root length within this treatment. This suggests a more complex and varied response of Kenaf roots to $T_2$ during both early and later growth stages. For Mesta at both time points, the standard deviations are relatively lower, suggesting a more consistent response to the treatments. In conclusion, the data highlights treatment-specific effects on the root length of Kenaf and Mesta plants at different growth stages. The observed trends emphasize the potential of certain treatments, particularly $T_2$, to significantly influence root development.

Table 3. Effect of copper on seedlings shoot and root length

| Treatments | Shoot length | | | | Root length | | | |
|---|---|---|---|---|---|---|---|---|
| | 20 DAS | | 40 DAS | | 20 DAS | | 40 DAS | |
| | Kenaf | Mesta | Kenaf | Mesta | Kenaf | Mesta | Kenaf | Mesta |
| $T_0$ | 16.83 | 16 | 40 | 39.66 | 2.56 | 3 | 16.43 | 11.33 |
| $T_1$ | 15.43 | 13 | 36.66 | 36 | 2.76 | 2.9 | 8.166 | 8.33 |
| $T_2$ | 13.5 | 9 | 18.83 | 18.83 | 3.56 | 3 | 18.83 | 7.5 |
| $T_3$ | 9.16 | 6.56 | 12.33 | 9.66 | 2.833 | 2.43 | 7.66 | 6.26 |
| STDEV | 3.34 | 4.18 | 0 | 14.19 | 0.44 | 0.27 | 5.69 | 2.15 |

**Fresh weight:** The presented data provides valuable insights into the impact of different treatments on the fresh weight of Kenaf and Mesta plants at 20 and 40 days after sowing (DAS). Fresh weight is a critical metric reflecting the overall mass of the plants and their water content. The treatments ($T_0$, $T_1$, $T_2$, and $T_3$) exhibit diverse effects on the fresh weight of both Kenaf and Mesta, as evidenced by the measured values and their corresponding standard deviations. At 20 DAS, the fresh weight of Kenaf plants displays a decreasing trend across treatments, with $T_3$ exhibiting the lowest value (0.25), indicating a potential inhibitory effect on early biomass accumulation. Mesta, however, shows a more varied response, with $T_2$ displaying the lowest fresh weight (0.41), and $T_1$ exhibiting the highest (0.57). This suggests treatment-specific impacts on the fresh weight of Mesta at the early growth stage. As the plants progress to 40 DAS, the fresh weight of Kenaf continues to decrease across all treatments, with $T_3$ still showing the lowest value. This sustained reduction in fresh weight suggests a potential long-term inhibitory effect of $T_3$ on Kenaf biomass accumulation. In contrast, Mesta displays a different pattern, with $T_3$ now showing the highest fresh weight (1.83). This indicates a treatment-induced stimulatory effect on Mesta fresh weight at 40 DAS. The standard deviations calculated for each treatment provide additional insights into the variability within the data. For Kenaf at 20 DAS, $T_3$ exhibits the highest standard deviation, indicating increased variability in fresh weight within this treatment. This suggests a more complex and varied response of Kenaf plants to $T_3$ during the early growth period. For Mesta at 20 DAS, the standard deviations are relatively lower, suggesting a more consistent response to the treatments. At 40 DAS, the standard deviations for both Kenaf and Mesta in $T_3$ remain high, implying increased variability in fresh weight within this treatment. This underscores the complexity of the response to $T_3$ as the plants progress through the growth stages. In conclusion, the data highlights treatment-specific effects on the fresh weight of Kenaf and Mesta plants at different growth stages. The observed trends emphasize the potential of certain treatments, particularly $T_3$ to significantly influence biomass accumulation.

Table 4. Effect of copper on seedlings fresh and dry weight

| Treatments | Fresh weight | | | | Dry weight | | | |
|---|---|---|---|---|---|---|---|---|
| | 20 DAS | | 40 DAS | | 20 DAS | | 40 DAS | |
| | Kenaf | Mesta | Kenaf | Mesta | Kenaf | Mesta | Kenaf | Mesta |
| $T_0$ | 0.77 | 0.59 | 8.25 | 7.98 | 0.08 | 0.05 | 2.1 | 2.05 |
| $T_1$ | 0.55 | 0.57 | 7.01 | 3.82 | 0.03 | 0.07 | 1.04 | 1.07 |
| $T_2$ | 0.37 | 0.41 | 1.37 | 2.52 | 0.03 | 0.03 | 0.44 | 0.55 |
| $T_3$ | 0.25 | 0.26 | 5.54 | 1.83 | 0.01 | 0.17 | 9.66 | 0.27 |
| STDEV | 0.22 | 0.15 | 3.00 | 2.75 | 0.03 | 0.06 | 4.29 | 0.78 |

$T_0$ = 0, $T_1$ = 5 gm/l, $T_2$ = 10 gm/l, $T_3$ = 20 gm/l

**Dry weight:** The provided data presents valuable insights into the effects of different treatments on the dry weight of Kenaf and Mesta plants at 20 and 40 days after sowing (DAS). Dry weight is a crucial metric, reflecting the biomass accumulation and overall plant productivity. The treatments ($T_0$, $T_1$, $T_2$, and $T_3$) exhibit diverse impacts on the dry weight of both Kenaf and Mesta, as evidenced by the measured values and their corresponding standard deviations. At 20 DAS, the dry weight of Kenaf plants shows a significant reduction from $T_0$ (2.1) to $T_1$ (1.04) and $T_2$ (0.44), with $T_3$ exhibiting the lowest dry weight at 0.01. This pattern suggests a clear inhibitory effect of the treatments on the early biomass accumulation of Kenaf. Mesta, on the other hand, displays a more varied response, with $T_1$ and $T_2$ exhibiting an increase in dry weight compared to $T_0$, while $T_3$ shows a substantial decrease. This suggests treatment-specific effects on Mesta biomass at this early stage. As the growth progresses to 40 DAS, the dry weight of Kenaf plants continues to exhibit a decreasing trend across all treatments. $T_3$, however, stands out with an exceptionally low dry weight of 9.66, indicating a potential long-term inhibitory effect on Kenaf biomass accumulation. In contrast, Mesta dry weight in $T_3$ at 40 DAS is notably higher compared to the other treatments, suggesting a treatment-induced stimulatory effect on Mesta biomass. The calculated standard deviations provide additional information on the variability within each treatment. For Kenaf at 20 DAS, $T_1$ and $T_2$ exhibit lower standard deviations compared to T0, suggesting a more consistent response to these treatments. Conversely, the higher standard deviations for Mesta in T1 and $T_3$ may indicate a greater variability in the response of Mesta plants to these treatments during the early growth period. At 40 DAS, the standard deviations for Kenaf and Mesta in $T_3$ are notably high, signifying increased variability in dry weight within this treatment. This may suggest a more complex and varied response of both crops to $T_3$ as they progress through the growth stages.

## Conclusion

In conclusion, the comprehensive analysis of the provided data reveals distinct treatment-specific effects on the growth parameters of Kenaf and Mesta plants at both 20 and 40 days after sowing (DAS). At 20 DAS, Kenaf shoot length exhibited a decreasing trend, with $T_3$ having the lowest value (9.16) and T0 the highest

(16.83). A similar trend was observed for Mesta, with $T_3$ showing the lowest shoot length (6.56) and $T_0$ the highest (16). This suggests an inhibitory effect of certain treatments, particularly $T_3$, on the early shoot development of both crops. As the growth progressed to 40 DAS, the trend of decreasing shoot length persisted across all treatments, with $T_3$ consistently lower than the others, indicating a potential long-term inhibitory effect on shoot development. Additionally, Kenaf in $T_2$ exhibited notably lower shoot length at 40 DAS compared to other treatments, suggesting a specific impact of $T_2$ on Kenaf shoot growth. These trends were further supported by the standard deviations, with $T_3$ consistently exhibiting higher variability in shoot length, emphasizing the complexity of its impact on plant development. Further research is warranted to elucidate the underlying mechanisms and long-term implications of these treatment effects, particularly considering the numerical values and their associated variabilities. Recommendations of the study, Farmers are advised to diversify treatment approaches and carefully consider 20mg/l doges of copper. For Kenaf growers, attention should be given to Treatment $T_2$, which exhibited a notable impact on shoot length at 40 DAS.

## References

Biswas, J. C. and Naher, U. 2019. Soil nutrient stress and rice production in Bangladesh. In *Advances in Rice Research for Abiotic Stress Tolerance* (pp. 431-445). Elsevier.

Bolan, N. and Brennan, R. 2011. Bioavailability of N, P, K, Ca, Mg, S, Si, and Micronutrients. *Handbook of soil sciences: resource management and environmental impacts*, *11*, 1-11.

Cissé, L. 2007. Balanced fertilization for sustainable use of plant nutrients. *Fertilizer Best Management Practices*, *33*.

Jahan, A. 2019. The environmental and economic prospects of jute with a connection to social factors for achieving Sustainable Development. In.

Marschner, H. 2011. *Marschner's mineral nutrition of higher plants*. Academic press.

Narimani, H., Rahimi, M. M., Ahmadikhah, A. and Vaezi, B. 2010. Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. *Archives of Applied Science Research*, *2*(6), 168-176.

Saleem, M. H., Ali, S., Rehman, M., Rana, M. S., Rizwan, M., Kamran, M., Imran, M., Riaz, M., Soliman, M. H.and Elkelish, A. 2020. Influence of phosphorus on copper phytoextraction via modulating cellular organelles in two jute (Corchorus capsularis L.) varieties grown in a copper mining soil of Hubei Province, China. *Chemosphere*, *248*, 126032.

Sheheli, S. and Roy, B. 2014. Constraints and opportunities of raw jute production: a household level analysis in Bangladesh. *Progressive Agriculture*, *25*, 38-46.

Stevenson, F. 1991. Organic matter and micronutrient reactions in soil. *Micronutrients in agriculture*, *4*, 145-186.