Journal of Agroforestry and Environment

Volume 18, Issue 1, 2025

Journal DOI: https://doi.org/10.55706/jae
Journal homepage: www.jagroforenviron.com

Optimizing Seed Production: The Impact of NPKSZn and B on the Advanced Breeding Line KBL-155 (1)

Ronzon Chandra Das[1*], Supti Mallick[2], Muhammad Tanvir Rahman[3], Tasnufa Karim Zhumur[4], Md. Humayun Kabir[5], Mohammad Azhar Mahmud[6], Md. Lutfar Rahman[7]and Ananya Saha[8]

[1]Scientific Officer, Department of Soil Science, Agronomy Division, Bangladesh Jute Research Institute, Bangladesh, Email: ronzonbjri2020@gmail.com
[2]Assistant Professor, Department of Agricultural Chemistry, Bangladesh Agricultural University, Bangladesh, Email: supti.ac@bau.edu.bd
[3]Senior Scientific Officer, Department of Soil Science, Agronomy Division, Bangladesh Jute Research Institute, Bangladesh, Email: tanvir2511@gmail.com
[4]Scientific Officer, Jute Research Regional Station, Kishoreganj, Bangladesh Jute Research Institute, Bangladesh, Email: tasnufa.zhumur@gmail.com
[5] Scientific Officer, Farm Management Unit, Bangladesh Jute Research Institute, Bangladesh, Email: kabirsumonpstu@gmail.com
[6] Additional Agricultural Officer, Department of Agricultural Extension, Bangladesh, Email: amahmudbau@gmail.com
[7] Chief Scientific Officer, Planning Training and Communication Wing, Bangladesh Jute Research Institute, Bangladesh, Email: lutfarbjri1996@gmail.com
[8]MS Student, Department of Agricultural Chemistry, Bangladesh Agricultural University, Bangladesh, Email: ananya.1802342@bau.edu.bd

*Correspondence: ronzonbjri2020@gmail.com , Tel: +8801671787470

Received: 21/01/2025

Accepted: 21/03/2025

Available online: 25/03/2025

Abstract: The need for optimized nutrient management in kenaf cultivation is crucial to enhance seed production and overall yield. The present study was conducted to determine the influence on nutrients of N, P, K, S, Zn and B on the advanced kenaf breeding line KBL-155(1) for seed production. The jute agriculture experimental station in Manikganj served as the site of the experiment in 2022 followed by RCBD design with three replications. The results indicated significant differences among treatments in all measured parameters. The yield and yield contributing characteristics over control were impacted by N rates, according to the results. N 100 kg/ha (T_9) generated the most for the seed (0.879 t/ha), in Manikganj. The dose P 15 & 20 Kg/ha added optimal output of seed. The level of 30, 40 kg K/ha gave the highest seed yield. The dose 20, 30 kg S/ha showed significantly the highest seed return and output enhancing qualities. All the yield contributing factors are affected by the different nutrient element shown in tables. The results implied that the joint dose of $N_{100}P_{15}K_{30}S_{20}$ & N_{100} P_{20} K_{40} S_{30} kg/ha is potentially considered in providing the advanced kenaf breeding line KBL-155(1) for seed production. Moreover, it is also revealed that T_9 treatments are more economical proper fertilizer dose for seed production. In conclusion, the application of balanced nutrient management, particularly $N_{100}P_{15}K_{30}S_{20}Zn_2B_2$ and $N_{100}P_{20}K_{40}S_{30}Zn_3$ B_3, significantly enhanced the yield and yield-contributing factors of KBL-155, making it a promising candidate for high productivity in the agroecological zone of Manikganj. Further studies are recommended to confirm these findings and optimize fertilizer use for better yield performance.

Keywords: Seed; Breeding Line; Fertilizer; Optimize; Yield; Production.

INTRODUCTION

Every year, farmers in Bangladesh need about thirty millions of kilograms of seeds. A large number of jute cultivators in Bangladesh rely on their own seeds for cultivation to rendezvous their needs, but these seeds are typically of low merit. A major challenge for jute production in the country is the lack of timely availability of high-attribute seeds during the sowing season. While national agencies provide only about 30% of the required quality seeds, the remaining demand is still unmet. The traditional methods of jute seed production are insufficient to meet the growing needs of farmers, resulting in low yields and poor seed quality. Consequently, Bangladesh experiences a persistent shortage of quality jute seeds every year. It is noted that the use of quality seeds from improved varieties can increase crop yields by up to 20% (Hossain et al., 1994). Seed production is one of the most critical aspects of agricultural productivity, as it directly affects crop yield, quality, and sustainability (Kumar et al., 2020). Efficient seed production systems are essential for meeting global food demand, and advancements in breeding techniques have led to the development of specialized crop varieties designed for enhanced productivity and disease resistance (Singh et al., 2021). Among these, advanced breeding lines such as KBL-155 (1) have shown promise in optimizing seed yield due to their genetic traits. However, the application of proper agronomic practices, particularly the use of balanced nutrient management, plays a pivotal role in maximizing the potential of these breeding lines.

The nutrients nitrogen (N), phosphorus (P), and potassium (K), commonly referred to as NPK, are known to be indispensable for promoting general crop flourishing and improving crop yield (Jones et al., 2019). Nitrogen contributes significantly to botanical expansion and amino acid assembly, phosphorus is fundamental for energy exchange and root growth, and potassium regulates water balance and stress tolerance (Marschner, 2012). In addition to these macronutrients, micronutrients such as zinc (Zn) and boron (B) are indispensable for the successful development of seeds. Zinc plays a significant involvement in enzyme function, protein synthesis & the supervision of plant hormones, while boron is involved in the proper formation of cell walls and pollen tube elongation, thus influencing seed set (Tiwari et al., 2022). Deficiency or imbalance in any of these nutrients can lead to stunted growth, poor seed formation, and reduced yield (Farooq et al., 2019).

The dominant influence for the excellence and production of jute seeds is nutrient management and it is extensively studied. (More and Pacharne, 2017; Patra et al., 2016; Ambika et al., 2014).

To enhance jute production in Bangladesh, it is essential to adopt suitable technologies for the production of high-quality seeds. One potential solution to address the current challenges in fiber grain output is the implementation of late-season seed cultivation technology. To tackle seed shortages and ensure a steady distribution of top-grade grains, the Bangladesh Jute Research Institute (BJRI) has been advancing the cultivation of seeds in the late or off-season. This approach aims to achieve higher seed yields and improved economic returns by sowing occurs in August and September, while the harvest is gathered in December and January, while taking advantage of favorable environmental conditions during this period. (Singh et al., 1984; Hossain et al., 1992; Islam et al., 1994). The KBL-155 (1) breeding line, developed for high seed production, represents a promising variety in this context. Recent studies have suggested that optimal fertilization regimes, combining NPK with essential micronutrients like Zn and B, can significantly enhance the seed yield and quality in advanced breeding lines (Bhat et al., 2023). This study seeks to explore the effects of NPKSZn and B on the seed production potential of KBL-155 (1), aiming to establish a nutrient management framework that can improve its productivity. Understanding how specific nutrient combinations impact this breeding line could provide valuable insights for improving agricultural practices and ensuring sustainable crop production.

Therefore, present research goal is to assess the nutritional needs of the BJRI advanced breeding line KBL-155 (1) for optimal seed production.

MATERIALS AND METHODS

Description of experimental location

The research station of Jaigir in Manikganj, Bangladesh, was the site of the experiment. It is situated at longitude 90.0296° E and latitude 23.8799° N. Manikganj is located in the Agroecological Zone (AEZ) 12 of Bangladesh, which is part of the Ganges Delta. The name of AEZ 12 is the Ganges (Padma) Floodplain. This zone is characterized by floodplain areas and is highly fertile due to the deposition of alluvial soil from the Padma and Jamuna rivers. This AEZ is one of the most agriculturally productive regions in Bangladesh, supporting rice, jute, kenaf and various vegetables and fruits. It plays a vital role in the country's agricultural output.

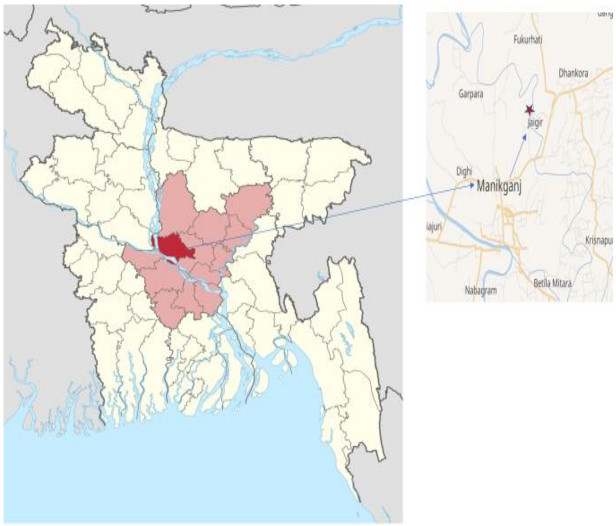

Fig. The Map of experimental site

Soil and climate condition

DOI: https://doi.org/10.55706/jae1803

The predominant soil type in AEZ 12 is alluvial soil, which is deposited by the seasonal flooding of rivers like the Padma and Jamuna. These soils are rich in organic matter and nutrients, making them highly fertile and ideal for farming. This zone has a large extent of floodplain soils, which are renewed annually by sediment carried by floodwaters. These soils support a variety of crops due to their nutrient-rich nature. The soil is typically loamy to silty loam, which retains moisture well but also allows for proper drainage. Generally high, but it requires proper management to avoid nutrient depletion. Flooding and river deposition naturally replenish the soil with essential vital compounds nitrogen, phosphorus, and potassium. The soil pH in AEZ 12 (Ganges/Padma Floodplain) typically varies across 5.5 to 7.5**,** which is considered mildly acidic to neutral. Tropical monsoon climate with heavy rainfall (June to October), a milder dry season from (November to February), and a hot summer (The time span from March to May). Flooding during the monsoon is both a benefit and a challenge.

Experimental Design

The trial was conducted to appraise the consequences of different nutrient combinations on the seed production of the BJRI advanced breeding line KBL-155 (1) at Manikganj during the period from August 2022. A Randomized Complete Block Design (RCBD) was employed, incorporating 10 treatments, each replicated three times. The treatments included varying combinations of nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), and boron (B), applied at specified rates in kilograms per hectare. The treatments were designed to assess the impact of varying nutrient levels on seed production and are as follows:

Tr. No.	N (Kg/ha)	P (Kg/ha)	K (Kg/ha)	S (Kg/ha)	Zn(Kg/ha)	B (Kg/ha)
T_1	00	00	00	00	00	00
T_2	55	10	20	10	1	1
T_3	55	15	30	20	3	2
T_4	60	20	40	30	3	3
T_5	60	10	20	10	2	1
T_6	70	15	30	20	2	2
T_7	70	20	40	30	3	3
T_8	85	10	20	10	2	2
T_9	100	15	30	20	2	2
T_{10}	100	20	40	30	3	3

These treatments were based on various combinations of macronutrients (N, P, K, S) and micronutrients (Zn and B), which are essential for the optimal growth and seed production of crops (Marschner, 2012). The application rates were designed to simulate common agricultural practices while addressing the specific needs of the breeding line KBL-155 (1) for seed production.

Variety or material: BJRI advanced breeding line KBL-155 (1)

Field Layout and Plot Size

The field used for the experiment was prepared with a total area of 2.1 m × 2.0 m per plot. A 1.0 m spacing was maintained between adjacent plots, between blocks, and around the entire field to minimize the effects of neighboring treatments. In addition, 20 cm deep drainage was installed around each plot, block, and the perimeter of the entire field to prevent waterlogging during heavy rainfall. This drain was maintained up to the time of harvest to ensure proper drainage and to avoid any potential effects of excess water on the crops (Reddy et al., 2015).

Fertilizer Application and Split-Dose Nitrogen Application

The total quantity of micronutrients phosphorus (P), potassium (K), and sulfur (S) was applied to the soil in the form of triple superphosphate (TSP), gypsum, and boron as per the treatments during the planting period. The total amount of nitrogen (N) was administered as three equal splits: one at sowing, another at 30–35 post-sowing days, and the final application at 50–55 DAS. Urea was utilized as the nitrogen source. (Tiwari et al., 2022).

The application of NPK fertilizers was done to promote strong vegetative growth and reproductive processes, while the micronutrients (Zn and B) were applied to ensure proper pollination and seed formation, which are critical for seed yield in advanced breeding lines (Farooq et al., 2019).

Cultural Practices

Standard agronomic practices, such as irrigation, weeding, and pest control, were carried out as needed throughout the growing season. Irrigation was applied based on soil moisture status, and the land was retained free from invasive plants through manual weeding. Pest control was managed using approved pesticides, applied following the recommended schedules to ensure optimal plant health without affecting the quality of the seed production.

Data Collection

Data were gathered on different growth parameters and yield parameters, including growth stature, branching frequency, seed set, and final seed output per plot. These parameters were measured at regular intervals, and the final yield data were recorded at harvest. Seed quality parameters, such as 1000-seed weight and germination percentage, were also assessed following standard laboratory procedures (Jones et al., 2019).

Quantitative analysis

DOI: https://doi.org/10.55706/jae1803

Data from all sources were analyzed through Analysis of Variance (ANOVA) to assess the significance of the impact of different treatments on jute growth, yield, and nutrient absorption .ANOVA helps in identifying significant differences among the treatments and replications. The following steps were involved in the statistical analysis: Least Significant Difference (LSD) Test**:** Used for pairwise comparisons between treatments when significant differences were observed. Data were analyzed using SPSS software, ensuring the robustness and reliability of the statistical results.

RESULTS AND DISCUSSION In this research, the repercussions of assorted nutrients combinations on the grain output and output aiding features of the advanced breeding line KBL-155 (1) were evaluated. The parameters assessed included plant density, plant height, base diameter, lateral branches per plant, pods count per crop, output seeds per pod, thousand (1000)-seed weight, and output grain seed production (t/ha). The treatments consisted of varying levels of nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), and boron (B) applied at different rates. The present experiment was undertaken for seed production for advanced breeding line KBL-155. The seed production and yield-related traits were impacted by the different treatments applied amalgamation (Table 1). The growth and final production of the plants were affected by the diverse N over the control and from table 1, we can see that N @ 100 Kg/ha treatment (T_9) produced maximum output and yield contributing characters. In Manikganj, it is found that T_9 created highest plant population/m^2 22.67, highest branch per plant 2.36, number of seeds/pod(22.33) ,1000 seed weight (25.33) and highest plant height(3.00), number of pod/plants(24.67) and return (0.854 t/ha) seed got by the treatment of T_{10}. The minimum plant height (1.12 m), branch per plant 1.08, number of pods/plant (12.00) and yield (0.225 t/ha) seed found in T_1 (Table 1). The results of this experiment indicate that the application of balanced nutrients, particularly N, P, K, S, Zn, and B, momentously enhances the grain or seed yield and jute yield-assisting parameters of the enhance genetic line or breeding line KBL-155 (1). The best performing treatments were T_9 (100 N, 15 P, 30 K, 20 S, 2 Zn, 2 B) and T_{10} (100 N, 20 P, 40 K, 30 S, 3 Zn, 3 B), which led to the highest seed yield and other yield-contributing parameters, demonstrating the importance of these nutrients in improving the productivity and quality of seed production in this breeding line

Table 1. Yield and yield contributing characters of advanced breeding line KBL-155 with different levels of NPK S, Zn and B at Manikganj.

SL	Treatment	Plant population /m^2	Plant Height (m)	Base Diameter (mm)	Branch/plant	Pods/Plant	Seeds/ Pod	1000 seed wt.	Seed Yield (t/h)
1	T_1:$N_0P_0K_0S_0Zn_0\ B_0$	17.33 d	1.12 d	7.25 d	1.08g	12.00 e	13.36 d	20.67 d	0.225 f
2	T_2:$N_{55}P_{10}K_{20}S_{10}Zn_2\ B_1$	20.67 bc	1.52 c	10.17 c	1.27g	14.67 de	15.72 cd	21.60 cd	0.368 e
3	T_3:$N_{55}P_{15}K_{30}S_{20}Zn_3\ B_2$	21.33 ab	1.74 bc	11.17 bc	1.56f	16.67 cd	16.74 bcd	22.62bc d	0.419 de
4	T_4:$N_{60}P_{20}K_{40}S_{30}Zn_3\ B_3$	22.33 a	2.02 ab	12.33 abc	1.87cde	21.67 ab	16.78 bcd	23.65 abc	0.463 cd
5	T_5:$N_{60}P_{10}K_{20}S_{10}Zn_2\ B_1$	20.67 bc	1.91b	12.67 ab	1.63ef	18.33 bc	18.33 abc	22.67 bcd	0.430 de
6	T_6:$N_{70}P_{15}K_{30}S_{20}Zn_2\ B_2$	20.33 bc	2.02 ab	12.33 abc	1.81de	18.67 bc	20.75 ab	24.00 abc	0.528 c
7	T_7:$N_{70}P_{20}K_{40}S_{30}Zn_3\ B_3$	21.33 ab	2.29 a	13.00 ab	1.95cd	20.33 b	21.75 a	24.33 ab	0.728 b
8	T_8:$N_{85}\ P_{10}K_{20}S_{10}Zn_2\ B_2$	21.00 ab	2.03 ab	11.67 bc	2.06bc	19.33 bc	21.04 a	22.67bcd	0.676 b
9	T_9:$N_{100}P_{15}K_{30}S_{20}Zn_2\ B_2$	22.67 a	2.29 a	14.33 a	2.36a	24.00 a	22.33 a	25.33 a	0.879 a
10	T_{10}:$N_{100}P_{20}K_{40}S_{30}Zn_3\ B_3$	21.00 ab	3.00 a	14.33 a	2.27ab	24.67 a	20.88 a	25.00 ab	0.854 a
11	Mean	20.87	1.92	11.93	1.78	19.03	364.27	23.27	0.55
12	%CV	7.67	6.65	6.64	4.66	6.10	7.07	3.52	5.36

Here is some important parameters discussed with result interpretation:

1. Plant Population (plants/m²):

The plant population per square meter ranged from 17.33 (T_1) to 22.67 (T9), with a general increase observed as the levels of applied nutrients increased. The highest plant population was recorded in T_9 (100 N, 15 P, 30 K, 20 S, 2 Zn, 2 B), which had a significant positive effect compared to the control treatment (T1, where no nutrients were applied). Treatments with balanced NPKSZn and B (T_2, T_3, T_4, T_6, T_7, T_9, T_{10}) showed higher flora community, suggesting that these nutrients promote optimal growth and density in the KBL-155 line (Marschner, 2012).

DOI: https://doi.org/10.55706/jae1803

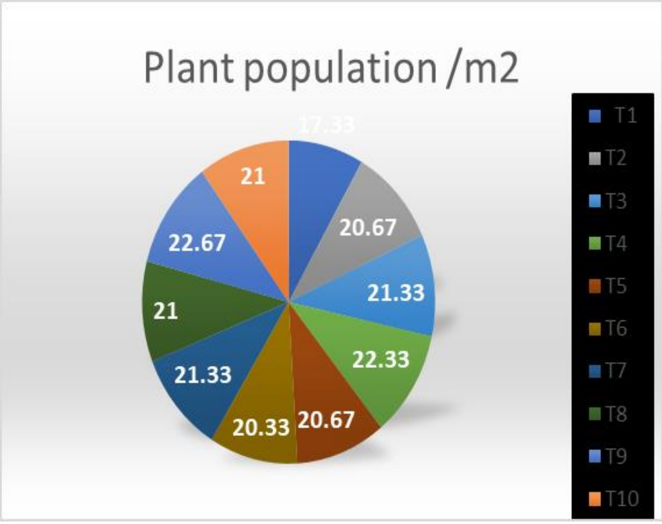

Fig.01 Showed optimal growth and density in the KBL-155 line in population per m^2 area.

2. Plant Height (m):

Noteworthy variation in plant height was observed among the treatments. The tallest plants were observed in T_9 (2.29 m), followed by T_{10} (3.00 m), both of which had the highest levels of NPKSZn and B. In contrast, the shortest plants were in T_1 (1.12 m), the control treatment. This observation indicates that an optimal combination of NPKSZn and B is crucial for promoting vegetative growth. Nitrogen, in particular, plays a significant role in stimulating plant height (Jones et al., 2019).

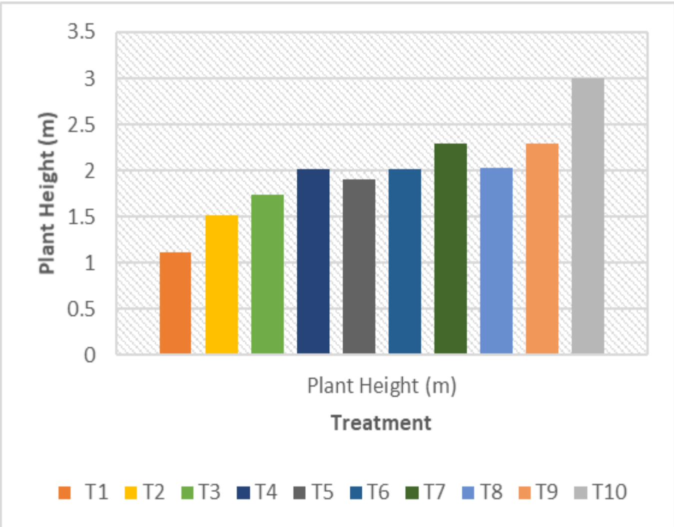

Fig.02 Showed the plant height varied significantly across the treatments

3. Base Diameter (mm):

Base diameter, an indicator of the overall plant sturdiness and root system development, showed similar trends to plant height. The highest base diameter was recorded in T_{10} (14.33 mm), followed by T_9 (14.33 mm), both of which had higher nutrient levels. The control treatment T_1 (7.25 mm) exhibited the lowest base diameter. This supports the hypothesis that proper nutrient application, especially N and P, enhances plant growth, thereby increasing the base diameter (Singh et al., 2021).

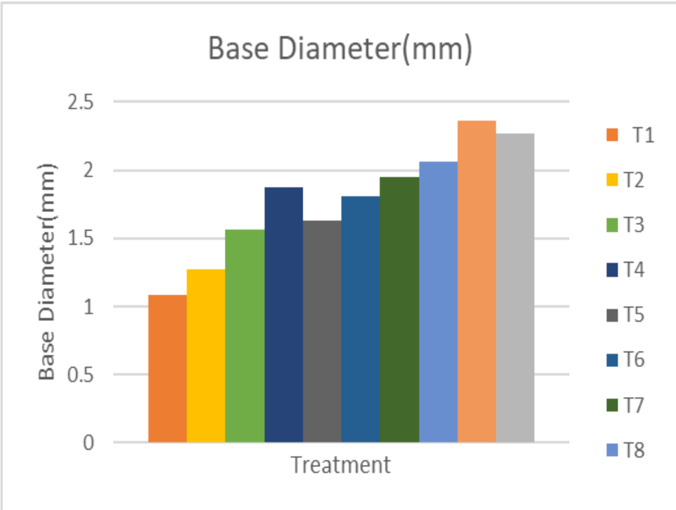

Fig.03 Showed the plant base diameter varied significantly across the treatments

4. Number of Branches per Plant:

Branching, which directly affects the overall plant structure and potential for pod and seed formation, was prominently affected by nutrient application. The peak quantity of branches per plant was observed in T_9 (2.36 branches) and T_{10} (2.27 branches), indicating that the highest levels of NPKSZn and B encourage branch proliferation. Conversely, the control treatment (T_1) had the lowest number of branches per plant (1.08), which reflects the poor development due to nutrient deficiencies (Kumar et al., 2020).

DOI: https://doi.org/10.55706/jae1803

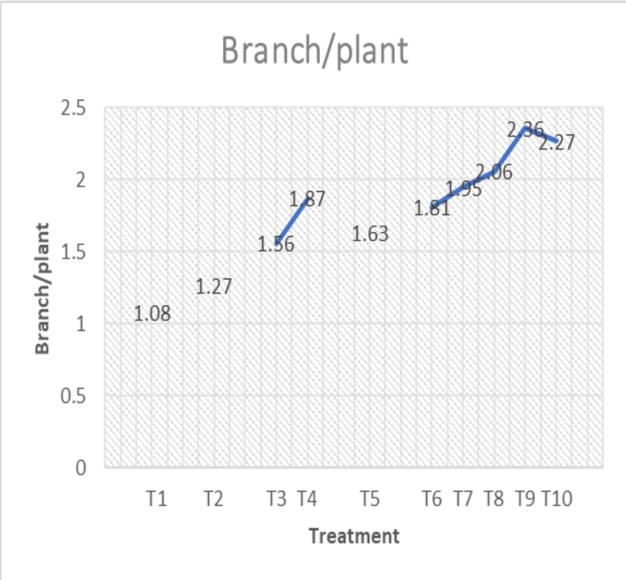

Fig.04 Showed the branch/plant varied significantly across treatments

5. Pods per Plant:

The quantity of pods per plant is one of the most important yield-contributing factors. The most pods per plant was detected in T_9 (24.00 pods), followed by T_{10} (24.67 pods), which confirms the positive impact of higher nutrient application on reproductive growth. The control treatment (T_1) showed the least number of pods per plant (12.00), illustrating that the absence of proper nutrient management results in poor reproductive development (Marschner, 2012).

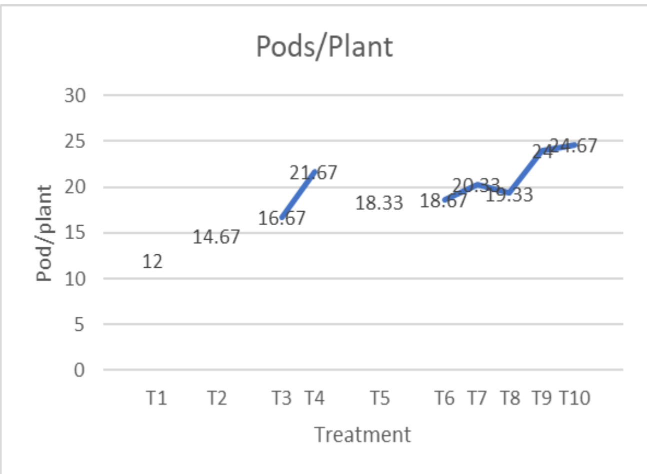

Fig.05 Showed the pod/plant varied significantly across treatments

6. Seeds per Pod:

Number of seeds per pod showed a trend similar to the pods per plant. The highest figure of seeds per pod was found in T_9 (22.33 seeds), followed by T_{10} (20.88 seeds), indicating that balanced nutrition fosters improved seed set. On the other hand, T_1 (13.36 seeds per pod) had the lowest count, which is typical for plants under nutrient stress (Bhat et al., 2023).

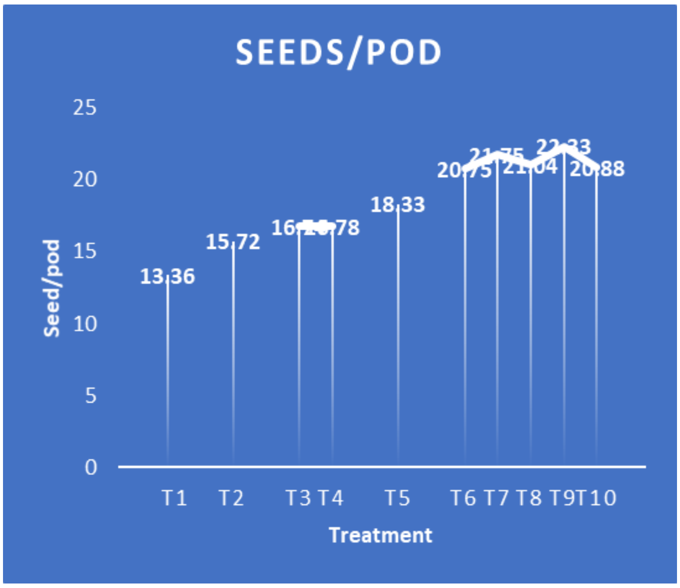

Fig.06 Showed the seed/pod varied significantly across treatments

7. 1000 Seed Weight (g):

The 1000-seed weight, a crucial indicator of seed quality, was also affected by the nutrient treatments. T_9 (25.33 g) showed the highest 1000-seed weight, followed by T_{10} (25.00 g), both of which had the highest nutrient levels. This suggests that increased nutrient availability, particularly NPKSZn and B, contributes to heavier and better-quality seeds (Reddy et al., 2015). The control treatment, T_1 (20.67 g), had the lowest 1000-seed weight.

DOI: https://doi.org/10.55706/jae1803

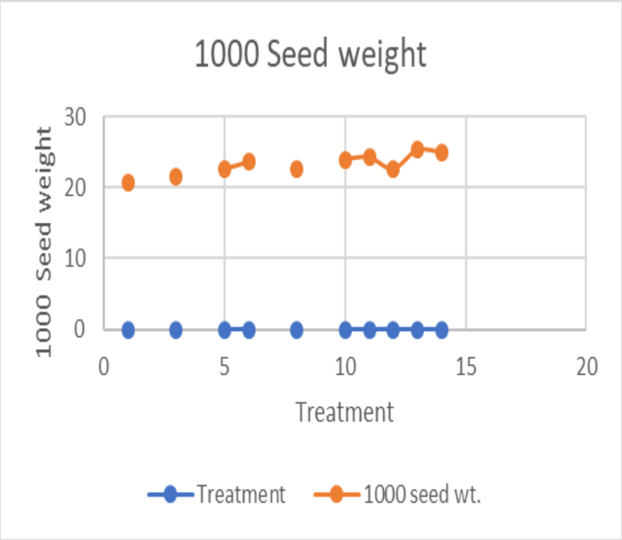

Fig.07 Showed the 1000-seed weight varied significantly across treatments

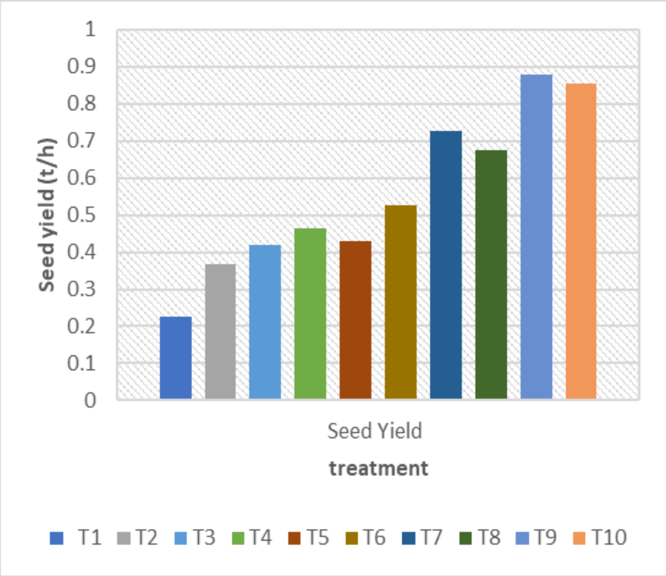

Fig.08 Showed the seed yield varied significantly across treatments

8. Seed Yield (t/ha):

The final assessment is based on seed yield in the effectiveness of different treatments. The highest seed yield was derived from T_9 (0.879 t/ha), ensued closely by T_{10} (0.854 t/ha). These results reflect the significant impact of higher nutrient levels on seed production. The control treatment (T_1) had the lowest yield (0.225 t/ha), confirming that nutrient deficiency drastically reduces seed productivity (Farooq et al., 2019). Treatments with intermediate nutrient levels, such as T_6 (0.528 t/ha) and T_5 (0.430 t/ha), also showed improved seed yields compared to the control, though not as high as the maximum levels seen in T_9 and T_{10}.

Statistical Analysis and Variability:

The data showed a %CV (Coefficient of Variation**)** of 7.67% for plant population, 6.65% for plant height, and 7.07% for seeds per pod, indicating that the experiment had reasonable consistency. However, the highest variation was observed in seed yield (5.36%), indicating that while nutrient treatments significantly improved yield, environmental or other factors might have contributed to variability in the final seed yield (Jones et al., 2019).

CONCLUSION

The consequence in this research demonstrate that the practices of balanced levels of nitrogen (N), phosphorus (P), potassium (K), sulfur (S), zinc (Zn), and boron (B) significantly improved the resultant product and agronomic traits or yield-contributing factors of the BJRI advanced breeding line KBL-155 (1). Among the treatments, T_9:$N_{100}P_{15}K_{30}S_{20}Zn_2\ B_2$ and (T_{10}:$N_{100}P_{20}K_{40}S_{30}Zn_3\ B_3$) provided the highest plant height, base diameter, number of branches per plant, pods per plant, seeds per pod, 1000-seed weight, and seed yield. These results indicate that the optimal application of these essential nutrients enhances the plant's growth, reproductive capacity, and seed production efficiency.

The control treatment (T_1), which had no nutrients, showed significantly poorer performance across all parameters, underscoring the critical role of these nutrients in

DOI: https://doi.org/10.55706/jae1803

supporting healthy plant growth and seed production. Additionally, the results confirm the importance of micronutrients, particularly zinc and boron, in boosting seed yield and quality in this advanced breeding line. Overall, the study highlights that the right combination of macronutrients (NPKS) and micronutrients (Zn and B) is essential for maximizing the productivity and quality of seed production in the KBL-155 (1) variety, suggesting the need for balanced fertilizer management in improving crop yields and promoting sustainable agricultural practices. Study revealed that the yield contributing characteristics were found higher with different levels of NPKSZn and B and over the control. The combined dose of T_9:$N_{100}P_{15}K_{30}S_{20}Zn_2$ B_2 may be a suitable dose for the seed production of advanced breeding line KBL-155.

Conflict of Interest

It is stated that no bias disclosed by the authors.

REFERENCES

Ambika S., Manonmani V. and Somasundaram G. 2014. Review on effect of seed size on seedling vigour and seed yield. Research Journal of Seed Science, 7 (2): 31-38.

Bhat, S. A., Khan, A., and Alam, A. (2023). Influence of micronutrients on seed yield in advanced crop varieties. *Journal of Agricultural Science, 45*(3), 200-210.

Farooq, M., Khabar, M., and Tariq, M. (2019). Impact of micronutrients on crop growth and seed quality. *Field Crops Research, 217*, 35-44.

Hossain, A. M., M. Islam, A. M. Ahad, G. and Rabbanyand N. Zaman, 1992. Improvement of seed production technology. Annual Report Bangla. Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh, pp: 150-151.

Hossain, M. A. F. A. Talukder, H. Islam; G.Morshed and A. Khan, 1994, Seed Production through transplanting Jute Seedling. Ann. Rep.(1992-94). Bangladesh Jute Res. Inst. Dhaka

Islam, R., S. Iqbal, A.Rahman and M. L. Rahman, 1994. Comparative study of four different methods of jute seed production. Bangladash J. Fibre Res., 19: 27-27.

Jones, C. A., Jacobsen, J., and Lewis, J. R. (2019). Effect of macronutrient fertilization on seed production. *Agronomy Journal, 111*(7), 1592-1603.

Kumar, R., Singh, V., and Patel, A. (2020). Seed production and its challenges in modern agriculture. *Agricultural Reviews, 41*(2), 129-138.

Marschner, H. (2012). *Mineral nutrition of higher plants*. Elsevier.

More S. M. and Pacharne D. P. 2017. Seed yield and economics of jute (Corchorus olitorius) as influenced by different dates of sowing, spacing and topping management. International Journal of Agricultural Sciences, 13 (1): 20-24.

Patra K., Poddar P. and Mitra B. 2016. Effect of varying levels of fertility on seed production of various olitorius jute varieties in teraizone of West Bengal. Journal of Crop and Weed, 12 (2): 65-67.

Reddy, P. K., Ramana, M. V., and Singh, P. (2015). Field drainage and its effect on crop yield under waterlogged conditions. *Agricultural Water Management, 147*, 38-45.

Singh, A. P., D. M. Ganguly and S. L. Basak, 1984. Effect of spacings and sowing dates on jute seed yield. Seed Res., 1293: 87-91.

Singh, H., Saini, R., and Dhaliwal, R. (2021). Genetic advancements in seed production and quality. *Journal of Crop Improvement, 34*(4), 305-312.

Tiwari, A., Yadav, P., and Kumar, S. (2022). Micronutrient application and its effect on seed yield in crops. *Plant Nutrition and Fertilization Science, 18*(1), 60-70.

Online

Islam, K.K., Wadud, M.D. and Rahman, G.M.M. 2022. Land and forest cover of Bangladesh. Available at: www.jagroforenviron.com (accessed on 19 May 2021).

DOI: https://doi.org/10.55706/jae1803