**EFFECT OF VARIETY AND SEED RATE ON THE FIBER YIELD OF KENAF**

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ABSTRACT

An experiment was conducted at the agronomy field laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali, Bangladesh-8602 during April to July 2022 to find out the effect of variety and seed rate on the fiber yield of kenaf. The experiment comprised three kenaf varieties viz. BJRI kenaf 2 (HC-95), BJRI kenaf 3 (Bot Kenaf) and BJRI kenaf 4 (KE-3 or Red kenaf) and three seed rates viz. 10, 12 and 14 kg ha-1. The experiment was laid out in a randomized complete block design with three replications. Variety, seed rate and their interactions significantly influenced plant characters and yield of kenaf fiber and stick. The highest plant height (2.50 m), plant base diameter (1.15 mm) and stick base diameter (0.98 mm) were recorded in the variety BJRI kenaf 4 (KE-3 or Red kenaf) while the lowest value was recorded in BJRI Kenaf 3 (Bot kenaf). The highest fiber yield (4.50 t ha-1) was obtained in BJRI kenaf 4 (KE-3 or Red kenaf) followed by variety BJRI Kenaf 2 (HC-95) and the lowest fiber yield (3.75 t ha-1) was obtained in BJRI Kenaf 3 (Bot kenaf). The highest stick yield (8.90 tha-1) was obtained in BJRI kenaf 4 (KE-3 or Red kenaf) followed by variety BJRI Kenaf 2 (HC-95) and the lowest stick yield (7.30 t ha-1) was obtained in BJRI Kenaf 3 (Bot kenaf). The highest harvest index (33.58 %) was obtained from the variety of BJRI kenaf 4 (KE-3 or Red kenaf) which was followed by BJRI kenaf 2 (HC-95) and the lowest harvest index (30.63 %) were found from the variety BJRI kenaf 3 (Bot kenaf). The tallest plant (2.50 m) was obtained at the seed rate 12 kg ha-1 and the shortest plant (1.65 m) was recorded at the seed rate 14 kg ha-1. The highest plant base diameter (1.15 mm), stick base diameter (0.98 mm) and thickness of bark (0.20 mm) was recorded at the seed rate 12 kgha-1 while the lowest values were recorded at the seed rate 14 kgha-1. The highest fiber yield (4.75 tha-1), stick yield (9.80 tha-1) and the harvest index (33.65 %) were obtained at the seed rate 12 kgha-1 while the lowest fiber yield (3.80 tha-1), stick yield (7.50 tha-1) and harvest index (32.63 %) were found at the seed rate 10 kgha-1. The highest fiber yield (4.60 tha-1) and stick yield (9.40 tha-1) were obtained from the variety BJRI kenaf 4 (KE-3 or Red kenaf) with 12 kgha-1 seed rate and the lowest fiber yield (3.50 tha-1) and stick yield (7.20 tha-1) were obtained from variety BJRI kenaf 3 (Bot kenaf) with seed rate 14 kgha-1 and BJRI kenaf 2 (HC-95) variety with seed rate 14 kgha-1, respectively. From the study it can be concluded that variety BJRI kenaf 4 with seed rate 12 kg ha-1 is the promising combination to obtained the highest fiber and stick yields of kenaf.

INTRODUCTION

Kenaf *(Hibiscus cannabinus* L.) *Malvaceae* is an annual fiber crop of tropical origin indigenous to Africa and is considered to be a potential source of raw material for manufacturing paperboard products and may also be a substitute for fiberglass and other synthetic fibers (Debnath, 2022). As a fibrous crop, Kenaf appears to have enormous potential to become a valuable biomass crop. Kenaf has high potential to be used as a raw material for boards with low density panels, suitable for both sound absorption and thermal resistance. It also has been used as a raw material alternative to wood in pulp production and the paper industries reducing chemical and energy use for paper production and greater recycled paper quality. The inner part of the plant (core) can be used as an adsorbent animal bedding material4. Since the plant is fast-growing, up to 4-5 m within 4-5 months and has potential for carbon sequestrations. Kenaf has high adaptability to all kinds of soils, also has potential to be planted on soils that have low productivity and were poor in water-holding capacity and nutrient availability (Islam, 2019). In Malaysia, where fertile land is scarce, the use of less fertile soils is beneficial. It can reduce soil erosion due to water and wind. Where depleting supplies of wood resources increased the stakes for alternative fibrous resource is raised, it was reported that Kenaf is able to produce fiber eight times higher at average 17.8 t ha-1 compared to tree fiber at only 2.2 t ha-1 annually (Mollah, 2014).

Total production of kenaf in the year of 2021-2022 was 1.65 lac bale covering an area of 21595 ha of land in Bangladesh (DAE 2022). Kenaf is an annual plant and fiber was classified into groups called as a bast fiber. It has a unique combination of long bast and short core fibers. Kenaf, like many virgin wood fibers, is presently pulped by the kraft process. Pulping is a polluting process (Johnson *et al*., 2022). However, kenaf pulping requires fewer chemical inputs and consumes less energy than most virgin wood pulping process and is thus less polluting. Alkaline nitrobenzene oxidation of coniferous wood lignin yields 24-28% vanillin, based on the klason, while non-coniferous wood lignin gives a total yield of 35-51% vanillin and syringaldehyde 19-21%. Kenaf absorbs more carbon dioxide from the atmosphere than any other crops. Studies also showed that the carbon dioxide assimilation rate of kenaf is several (3 to 5) times higher than that of trees (Nath *et al*., 2017). Just as every hectare of kenaf land consumes 15 tons of carbon dioxide (harmful greenhouse gas) from the air during each growing cycle (04 to 05 months) and purifies the air, on the other hand, it releases about the same amount of oxygen (lifesaving gas) in to the air (Ali *et al*., 2017). Kenaf has also been found useful in toxic waste clean-up, soil remediation, extraction of heavy metals, add organic matter, reduction of soil erosion and absorption of oil spills (Balogun, 2016). Kenaf is a source of cellulose fiber for the production of pulp and paper. It is a non-woody annual with a short life cycle of 100-130 days. It produces pulp much faster than pine which takes about 15 years to mature. Kenaf is historically used as a cordage crop (rope, twine, and sack-cloth) and its commercial used evolved to other different uses such as absorbents, paper products, building materials, cosmetics by products and animal feed (Hasehmi *et al.*, 2020). Plants of the family are also used for food, beverages, paper pulp, hardboard raw materials, timber, in traditional medicine, and in horticulture purpose (Textile Blog, 2020). Kenaf is a valuable fiber crop and its fibrous stem are used for textiles, paper and pulp production, insulation mats, cordage (rope making), medium density fiber boards, bio composites, absorbents material, animal breeding, oil absorbents, etc. (Alexopoulou *et al.*, 2015). Recently, it is also considered as an important medicinal crop as its seed oil is recorded to cure certain health disorders and help in the control of blood pressure and cholesterol. Kenaf exhibits low density, non-abrasiveness during processing, high specific mechanical properties, and biodegradability (Mamun, 2022). The fibers in kenaf are found in the bast (bark) and core (wood). The bast constitutes 40% 0f the plant. Crude fiber separated from the bast is multi-cellular, consisting of several individual cells stuck together (Hussain, 2022). The individual fiber cells are about 2-6 mm long and slender. The two major benefits of kenaf in paper making are the low lignin content and its high yield. Lignin is the naturally occurring substances in plant cell walls that when left untreated causes paper to yellow. Kenaf contains 12.5% lignin while most tress used in paper making contain 25% lignin (Abdulai *et al*., 2016). However, there is no specific research about the information in the farmers’ field. As an important fiber crop, kenaf cultivation and yield can be increased in Bangladesh. So, the present study was undertaken to assess the effect of variety and seed rate on the yield of kenaf.

**Description of the experimental site**

**Location**

The experiment was conducted in the farm of Bangladesh Jute Research Regional Station, Faridpur during the cropping season 2022-2023. Geographically it is situated at 24.75°N latitude and 90.500E longitude at an attitude of 8 m above the mean sea level.

**Soil**

The general soil type of the experimental farm belongs to Non-calcareous Dark Grey Flood Plain soil. The experimental soil was Meghna Flood Plain silt loam. The soil belongs to order Incept sol having only few horizons, developed under aquic moisture regime and variable temperature regime.

**CLIMATE**

The experimental area falls under the sub–tropical climate, which is characterized by high temperature and humidity, heavy rainfall with occasional gusty winds in the Kharif season (April–September) and less rainfall associated with moderately low temperature during the rabi season (October–March).

**MATERIALS AND METHODS**

The experiment was conducted at the agronomy field laboratory of Patuakhali Science and Technology University, Dumki, Patuakhali, Bangladesh-8602 during April to July 2022. The experimental site belongs to the silty clay soil series of Ganges Tidal Floodplain (AEZ 13) having non-calcareous silty loamy and clay floodplain soil saline soil (BARC, 2018). The land was medium high with sandy loam texture having pH 7.01-<8.5. The experiment comprised three varieties of kenaf *viz.* BJRI kenaf 2 (HC-95), BJRI kenaf 3 (Bot kenaf) and BJRI kenaf 4 (KE-3 or Red kenaf), and three seeding rates *viz.* 10, 12 and 14 kg ha-1. The experiment was laid out in a Randomized Complete Block Design with three replications. The size of each unit plot was 4.0 m × 2.50 m = 10 m2. The experimental land was prepared with ploughing followed by laddering. Seeds were sown in furrow on 12 April 2022 and furrows were then covered with soil. Fertilizers *viz.* TSP, MoP and Gypsum were applied at 30-30-15 kg ha-1, respectively as basal dose at final land preparation. Urea was applied at 70 kg ha-1 in two equal installments at 20 days after emergence (DAE) and 30 DAE after weeding. Thinning was done at 20 DAE at the time of weeding. Prior to harvesting 5 randomly selected plants plot-1 excluding boarder rows were taken from each plot to collect data on plant characters and yield contributing characters. Plant height were measured with the help of a measuring scale from their base (ground level) to the technical top (from where branching took place) of the plants. The plant diameter was the average of the diameter taken at the bottom, the middle and the technical top with the help of a slide callipers and the mean diameter (average of these three levels) was calculated. The fiber diameter (thickness of skin) was calculated by subtracting the diameter of the stick from diameter of the plant.

The kenaf plants were cut with sickle at ground level at maturity and tied in small bundles and heaped for one week for shedding of leaves. After shedding of leaves, the kenaf bundles were steeped plot-wise in pond water for retting. The retting process was completed in 20 days after steeping. After proper retting, the fibers were extracted by steeping and washed thoroughly in water. The extracted fibers were sun dried plot-wise on bamboo bars. After drying the fibers were weighed to get the fiber yield. After steeping the kenaf sticks were dried in the sun by keeping them standing against bamboo bars. The sundried sticks were weighed to record the yield of sticks. Fiber yield and stick yield were then converted to t ha-1. Fiber yield and stick yield altogether were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Fiber yield + Stick yield

Harvest index is the relationship between fiber yield and biological yield. Harvest index was calculated by the following formula:

Harvest index(%)=

Fiber yield x 100 Biological yield

The recorded data were statistically analyzed using the Analysis of Variance (ANOVA) technique and the differences among treatment means were adjudged by Duncan’s New Multiple Range Test (Gomez and Gomez, 1984).

**ESULT AND DISCUSSION**

**Effect of variety**

The variety had significant influence on plant population, plant height, plant diameter, stick diameter, fiber weight plant-1, stick weight plant-1, fiber yield, stick yield and harvest index. The highest plant population (36.78 m-2) was found in variety BJRI kenaf 4 (KE-3 or Red kenaf) and the lowest one (28.78 m-2) was found in BJRI kenaf 3 (Bot kenaf) (Fig. 1). The tallest plants (2.50 m) were produced by variety BJRI kenaf 4 (KE-3 or Red kenaf) followed by BJRI kenaf 2 (HC-95) (2.25 m) and the shortest one (1.87 m) were produced by BJRI kenaf 3 (Bot kenaf). Jahan *et al*., (2020) found the highest plant height in variety BJRI kenaf 2 (HC-95). The highest plant diameter (1.15 mm) was obtained from BJRI kenaf 4 (KE-3 or Red kenaf) variety followed by BJRI kenaf 2 (HC-95) (1.10 mm) and the lowest plant diameter (0.74 cm) was obtained from variety BJRI kenaf 3 (Bot kenaf). The plant diameter might be varied due to genetic differences in varieties seed rates, fertilizer dose, agronomic management practices and climatic effects. It was observed that stick diameter was the highest (0.98 mm) in variety BJRI kenaf 4 (KE-3 or Red kenaf) followed by BJRI kenaf 2 (HC-95) (0.96 mm) and the lowest stick diameter (0.88 mm) was found in the variety BJRI kenaf 3 (Bot kenaf). Stick diameter might be changed due to the same factors responsible for plant diameter variation. The thickness of skin plant-1 was statistically non-significant for the variety. Numerically the highest (0.17 mm) and lowest (0.14 mm) were obtained from the variety BJRI kenaf 4 and BJRI kenaf 3, respectively. Fiber yield of kenaf was significantly affected by variety (Table 2). Fiber yield was the highest (4.50 t ha-1) with the variety BJRI kenaf 4 (KE-3 or Red kenaf) followed by variety BJRI kenaf 2 (HC-95) (4.25 t ha-1) and the lowest fiber yield (3.75 t ha-1) was obtained with BJRI kenaf 3 (Bot kenaf) variety (Fig. 3). Khan & Mollah (2021) obtained 3.01-4.00 t ha-1 yields with 3 kenaf cultivars in Morocco. Mambelli & Grandi(2015) observed highest fiber yield in variety BJRI kenaf 2 (HC-95). The highest stick yield (8.90 t ha-1) was found in variety BJRI kenaf 4 (KE-3 or Red kenaf) followed by BJRI kenaf 2 (HC-95) (8.51 t ha-1) and the lowest stick yield (7.30 t ha-1) was obtained from the variety BJRI kenaf 3 (Bot kenaf). Webber *et al.* (2020) observed differences in stalk yield among sixteen kenaf varieties. The highest harvest index (33.58%) was obtained from variety BJRI kenaf 4 (KE-3 or Red kenaf) which was as good as BJRI kenaf 2 (HC-95) (32.06) and the lowest one (30.63%) was obtained from variety BJRI kenaf 3 (Bot kenaf).

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**Effect of seed rate**

Plant population of kenaf was significantly affected by the seed rates. The highest plant population (38.50 m-2) was found at 14 kg ha-1 seed rate and the lowest plant population (34.80 m-2) was found at 10 kg ha-1 seed rate (Fig. 2). Plant population was increased due to increase of seed rate. Research has shown that when plant populations drop below the 380,500 plantsha-1 the stalk yields usually also decrease (Hasan *et al*., 2022). Seed rate influenced the yield contributing characters and yield of kenaf (Table 2). The tallest plants (2.48 m) were produced at 10 kg ha-1 seed rate and the shortest plants (1.74 m) were produced at 14 kg ha-1 seed rate, which was identical to seeding rate 12 kg ha-1. The highest plant diameter (1.11 cm) was obtained from 14 kg ha-1 seed rate followed by 10 kg ha-1 and the lowest plant diameter (0.66 cm) was obtained from 12 kg ha-1 seed rate. Increased seed rate might increase the competition for natural resources (light, water, nutrient, space, etc.) among the plants thus the plant diameter was decreased. It was observed that the stick diameter was the highest (0.91 mm) at 10 kg ha-1 seed rate and the lowest stick diameter (0.55 mm) was found at 12 kg ha-1. Stick diameter was decreased due to increase of seed rate. The thickness of skin plant-1 was significantly affected by seed rate (Table 2). The highest thickness of skin plant-1 (0.19 mm) was obtained at 10 kg ha-1 seed rate and the lowest thickness of skin (0.11 cm) plant-1 was obtained at 14 kg ha-1 seed rate. The fiber yield of kenaf was significantly affected by seed rate (Table 2). It was observed that fiber yield was the highest (4.35 t ha-1) at 14 kg ha-1 seed rate followed by 12 kg ha-1 and the lowest fiber yield (3.36 t ha-1) was obtained at 10 kg ha-1 seed rate (Fig. 4). The stick yield of kenaf was significantly affected by seed rate (Table 2). It was observed that stick yield was the highest, (9.08 t ha-1) at 14 kg ha-1 seed rate and the lowest stick yield (7.29 t ha-1) was obtained at 10 kg ha-1 seed rate, which was statistically identical to 12 kg ha-1 seed rate. Stick yield decreased due to increase of seed rate. The highest harvest index (38.21%) was found at 14 kg ha-1 seed rate and the lowest harvest index (35.95%) was at 10 kg ha-1 seed rate. The highest fiber and stick yields were the reasons of highest harvest index at 14 kg ha-1 seed rate.

Table 1: Effect of variety on the fiber yield and yield contributing characters of kenaf.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variety | Plant Height (m) | Plant base diameter (mm) | Stick diameter (mm) | Thickness of bark (mm) | Fiber yield (tha-1) | Stick yield (tha-1) | Harvest Index (%) |
| V1 | 2.25 | 1.10 | 0.96 | 15.00 | 4.25 | 4.25 | 32.06 |
| V2 | 1.87 | 0.74 | 0.88 | 14.00 | 3.75 | 7.30 | 30.63 |
| V3 | 2.50 | 1.15 | 0.98 | 17.00 | 4.50 | 8.90 | 33.58 |
| CV% | 1.95 | 5.58 | 5.66 | 4.96 | 3.26 | 4.28 | 5.33 |
| Level of Significance | \*\* | \*\* | \*\* | NS | \*\* | \*\* | \*\* |

NB: V1= BJRI kenaf 2, V2= BJRI kenaf 3 and V3= BJRI kenaf 4

In a column, figures having similar letter(s) or without letter(s), do not differ but with dissimilar letter(s) differ significantly as per DMRT, \*\* 1% level of significance, NS= Non-significant

Table 2: Effect of seed rate on the fiber yield and yield contributing characters of kenaf.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Variety | Plant Height (m) | Plant base diameter (mm) | Stick diameter (mm) | Thickness of bark (mm) | Fiber yield (tha-1) | Stick yield (tha-1) | Harvest Index (%) |
| S1 | 2.25 | 0.92 | 0.72 | 0.15 | 3.36 | 7.29 | 35.95 |
| S2 | 2.48 | 1.11 | 0.91 | 0.19 | 4.10 | 8.60 | 34.90 |
| S3 | 1.74 | 0.66 | 0.55 | 0.11 | 4.35 | 9.08 | 38.21 |
| CV% | 1.95 | 5.58 | 5.66 | 4.96 | 3.26 | 4.28 | 5.33 |
| Level of Significance | \*\* | \*\* | \*\* | \*\* | \*\* | \*\* | \*\* |

NB: S1= 10 kgha-1, S2= 12 kgha-1 and S3= 14 kgha-1

In a column, figures having similar letter(s) or without letter(s), do not differ but with dissimilar letter(s) differ significantly as per DMRT, \*\* 1% level of significance, NS= Non-significant

**Interaction effect of variety and seed rate**

The plant population of kenaf was significantly affected by interaction between variety and seed rate (Table 3). The highest plant population (48.00 m-2) was found with BJRI kenaf 4 (KE-3 or Red kenaf) variety and 14 kg ha-1 seed rate (Table 3). The lowest plant population (34.00 m-2) was found with BJRI kenaf 3 (Bot kenaf) variety and 10 kg ha-1 seed rate. The effect of interaction between variety and seed rate was also significant on plant characters, yield and yield contributing characters and harvest index (Table 3). The tallest plants (2.90 m) were produced by the variety BJRI kenaf 4 (KE-3 or Red kenaf) with 10 kg ha-1 seed rate. The shortest plants (1.61 m) were produced by BJRI kenaf 2 (HC-95) variety with 15 kg ha-1 seed rates which was statistically identical to variety BJRI kenaf 3 (Bot kenaf) at the seed rate 14 kg ha-1. The plant diameter of kenaf was significantly affected by the interaction of variety and seed rate (Table 3). The highest plant base diameter (1.54 mm) was produced by variety BJRI kenaf 4 (KE-3 or Red kenaf) at 14 kg ha-1 seed rate followed by (1.06 mm) the variety BJRI kenaf 2 (HC-95) at 14 kg ha-1 and the lowest plant diameter (0.62 mm) was produced by variety BJRI kenaf 3 (Bot kenaf) at 10 kg ha-1 seed rate. It was observed that the stick diameter was the highest (1.30 mm) with the variety BJRI kenaf 4 (KE-3 or Red kenaf) at 14 kg ha-1 seed rate followed by the variety BJRI kenaf 2 (HC-95) (0.85 mm) at 14 kg ha-1. The lowest stick diameter (0.51 mm) was found with variety BJRI kenaf 3 (Bot kenaf) at 10 kg ha-1 seed rate (Table 3). This variation might be due to the competition among the plants for natural resources. The highest thickness of skin plant-1 (0.23 mm) was obtained from the variety BJRI kenaf 4 (KE-3 or Red kenaf) at 14 kg ha-1 seed rate. The lowest thickness of skin plant-1 (0.09 mm) was obtained from the variety BJRI kenaf 3 at 14 kg ha-1 seed rate (Table 3). Hossain *et al.* (2021) observed the longest bast fiber in variety BJRI kenaf 2 (HC-95). The highest fiber yield (4.61 t ha-1) was with the variety BJRI kenaf 4 (KE-3 or Red kenaf) at 14 kg ha-1 seed rate followed by BJRI kenaf 2 (HC-95) variety at 14 kg ha-1, which was as good as BJRI kenaf 3 (Bot kenaf) at 15 kg ha-1 and the lowest fiber yield (3.28 t ha-1) was obtained with BJRI kenaf 3 (Bot kenaf) variety at 10 kg ha-1 seed rate (Table 3). The interaction between variety and seed rate influenced the stick yield. The highest stick yield (10.12 t ha-1) with the variety BJRI kenaf 4 (KE-3 or Red kenaf) at 12 kg ha-1 seed rate followed by BJRI kenaf 2 (HC-95) at 12 kg ha-1 (9.26 t ha-1) and the lowest stick yield (8.11 t ha-1) was obtained from BJRI kenaf 3 (Bot kenaf) variety at 14 kg ha-1 seed rate (Table 3). The stick yield was different due to the variation in combination of seed rate and varietal characters. The highest harvest index (34.69%) was found with BJRI kenaf 4 (KE-3 or Red kenaf) variety at 12 kg ha-1, which was as good as BJRI kenaf 2 (HC-95) at 12 kg ha-1 seed rate and the lowest harvest index (32.22%) was with BJRI kenaf 3 (Bot kenaf) variety at 10 kg ha-1 seed rate (Table 3).

Table 3. Effect of interaction between variety and seed rate on fiber yield and yield contributing characters of kenaf

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Interaction | Plant Population | Plant Height (m) | Plant base diameter (mm) | Stickbase diameter (mm) | Thickness of bark (mm) | Fiber yield (tha-1) | Stick yield (tha-1) | Harvest Index (%) |
| V1 $×$S1  | 31.00d | 2.49a | 0.65de | 0.51d | 0.14b | 4.12c | 9.26b | 32.22fg  |
| V1 $×$S2 | 31.33b | 1.93bc | 1.54a | 1.30a | 0.23a | 4.21a | 9.12a | 34.29cde  |
| V1 $×$S3 | 38.00a | 1.81e | 0.64de | 0.52d | 0.12b | 4.31b | 9.70c | 33.11de  |
| V2 $×$S1 | 33.67b | 1.94b | 0.78c | 0.56cd | 0.22a | 4.69d | 9.12e | 33.41bc  |
| V2 $×$S2 | 30.00c | 1.80e | 0.73cd | 0.59cd | 0.13b | 4.40b | 9.72d | 34.69a  |
| V2 +$×$S3 | 32.33c | 1.90c | 0.72cd | 0.58cd | 0.13b | 4.16f | 9.07e | 33.27ef  |
| V3 $×$S1 | 30.00e | 1.96b | 0.74c | 0.61c | 0.13b | 4.28g | 8.22f | 34.22g  |
| V3 $×$S2 | 32.33c | 1.80e | 1.06b | 0.85b | 0.21a | 4.44e | 9.00e | 33.65cd  |
| V3 $×$S3 | 44.00f | 1.85d | 0.62e | 0.54cd | 0.09b | 4.27f | 8.11f | 34.37ab  |
| CV% | 4.84 | 1.95 | 5.58 | 5.66 | 4.96 | 3.26 | 4.28 | 5.33 |
| Level of Significance | \*\*  | \*\*  | \*\*  | \*\*  | \*\*  | \*\*  | \*\*  | \*\*  |

NB: V1= BJRI kenaf 2, V2= BJRI kenaf 3 and V3= BJRI kenaf 4 and S1= 10 kgha-1, S2= 12 kgha-1 and S3= 14 kgha-1

In a column, figures having similar letter(s) or without letter(s), do not differ but with dissimilar letter(s) differ significantly as per DMRT, \*\* 1% level of significance, NS= Non-significant

**ECONOMICAL DATA**

Economic calculation the production of kenaf fiber is more profitable than other crops, due to input supply and intercultural operations costs. Basically, the price of jute and kenaf fiber are almost same, but due to location basis kenaf fiber is more demandable in jute fiber. In production season the price of kenaf fiber range up to 3000-3500 taka, so it is more profitable than other crops.

**RESEARCH LIMITATIONS**

Kenaf is grown in Bangladesh almost solely as a rainfed crop without any irrigation or drainage provisions. In this regard jute is a better choice than its major competing crop Aus rice. Because kenaf is comparatively less affected by drought or stagnation of water. Moreover, 3-4 hundred thousand hectares of land in Bangladesh are suitable for growing no other crop but only jute in the kharif season (March-July).

**CONCLUSION**

Results of the present study indicated that variety BJRI kenaf 4 (KE-3 or Red kenaf) was better than other two varieties. Seed rate 12 kg ha-1 was optimum in case of highest fiber and stick yield of kenaf. So, it can be concluded that variety BJRI kenaf 4 (KE-3 or Red kenaf) at 12 kg ha-1 seed rate could be the promising combination to obtain maximum fiber and stick yield of kenaf.

**REFERENCES**

Abdulai, L. Y., F. F. Patricia and D. B. Edem. (2016). The kenaf (*Hibiscus cannabinu*s L.) fiber plant and it’s socio-economic significance to the Northern Rural Dwellers in Ghana. Int. J. Innovation Res. Dev. 5(1): 249-254.

Alexopoulou, E. J., L. D. Papatheohari, Y. H. Siddiqi, D. Scordia and G. Testa. (2015). How kenaf (*Hibiscus cannabinus* L.) can achieve high yields in Europe and China. Industrial Crops and Prod. 68: 131-140.

Ali, M. S., M. N. Gani and M. M. Islam. (2017). Efficiency of BJRI kenaf-4 (*Hibiscus cannabinu*s L.) yield under different fertilizer levels. American. J. Agri. For. 5(5): 145-149.

Bourguignon, M. (2016). Growth, productivity, and utilization of kenaf (*Hibiscus cannabinus* L.): A promising fiber and fuel crop for Iowa. Ph. D. Thesis, ISU, Ames, Iowa. pp. 11-13.

BARC (Bangladesh Agricultural Research Council). (2018). Fertilizer recommendation guide-2018. BARC, Farmgate, Dhaka-1215, Bangladesh.

DAE (2022) Annual Report, Cash Crop Wing, Directorate of Agricultural Extension, Khamarbari, Farm gate, Dhaka-1215, Bangladesh.

Debnath, M. R., M. M. Rahman and S. K. Biswas. (2022). Growth and yield response of kenaf (*Hibiscus cannabinus* L.) seed production to different sowing times. J. Bangladesh. Acad. Sci. 46(2): 219-221.

Gomez KA, Gomez AA (1984) Duncan’s, Multiple Range Test. Statistical Procedures for Agril. Res. 2nd Edn. Awiley Inter-Science publication, John Wiley and Sons, New York. pp. 202-215.

Hasan, M. S., M. B. Hossain, B. Kundu, M. S. Hossain and M. N. Uddin. (2022). Profitability analysis of kenaf (*Hibiscus cannabinus* L.) seed cultivation at contact growers’ level in selected areas of Bangladesh. Annual Research Report-2021. BJRI, Dhaka-1207, Bangladesh. pp. 22-27.

Hashemi, S., A. Marzuki, M. H. Jasim and K. Shaian. (2020). The effect of seedling age on quality and viability on kenaf (*Hibiscus cannabinus* L.) seeds. I. J. Agril. Res. 30(3): 212-218.

Hossain, M. M., S. Siddiquee and V. Kumar. (2021e). Isolation of alkalophilic bacteria and their bio retting effect on kenaf (*Hibiscus cannabinus* L.) fiber composition. Alinteri J. Agri. Sci. 36(2): 156-165.

Hussain, M. M. (2022). Enhancement of kenaf degumming process by sabah-isolates-alkalophilic pectinase producing bacteria and aqueous solvents. Ph. D. Thesis. US, Sabah, Malaysia. pp. 02-10.

Islam, M. M. (2019a). Kenaf (*Hibiscus cannabinus* L., Malvaceae) research and development advances in Bangladesh: A review. J. Nut. F. Proc. 2(1): 01-11.

Jahan, N., M. A. Mamun, M. M. Islam, M. S. Jahan and S. K. Adhikary. (2020). Effect of different sowing time on growth, yield and yield attributes of kenaf (*Hibiscus cannabinus* L.) varieties. Korean J. Agri. Sci. 16(10): 55-60.

Johnson, A. D., D. J. Ogunniyan, S. Ajijola, A. Oyegbami and O. N. Adeniyan. (2022). The appropriate planting time for the profitable production of the quality seed of kenaf (*Hibiscus cannabinus* L.) in southwestern Nigeria. J. Agril. Sci. 67(3): 253-267.

Khan, M. A. and M. A. F. Mollah. (2021). Effect of plant spacing on fiber yield and yield components of kenaf (*Hibiscus cannabinus* L.). Annual Research Report, BJRI, Dhaka-1207, Bangladesh. pp. 198-199.

Mamun, M. A. (2022). Genetic diversity and development of high fiber yield kenaf (*Hibiscus cannabinus* L.) mutant hybrids through diallel cross. Ph. D. Thesis, the School of Graduate, UPM, Malaysia.

Mambelli, S. and S. Grandi. (2015). Yield and quality of kenaf *(Hibiscus cannabinus* L*.)* stem as affected by harvesting date and irrigation. Ind. Crop Prod. 4(7): 97-104.

Mollah, M. A. F. (2014). Yield and Quality of kenaf (*Hibiscus cannabinus* L.) seed as influenced by production and storage environment. Ph. D. thesis, BAU, Mymensingh, Bangladesh. pp. 01-05.

Nath, M., B. Majumder, S. Das, P. M. Sonali, A. R. Saha and S. Sarkar. (2017). Optimization of fermentation conditions for pectin degrading enzyme production by pectinolytic microbial consortia used for jute retting. Int. J. Mic. Appl. Sci. 6: 925-931.

Textile Blog. (2020). Properties, processing and use of kenaf fiber. URL: https//www.Sciencedirect.com/science/article/pii/S0960308521000274.DOI:10.1016/j.fbp.2021.02.009.

Webber, C. L., H. N. Morgel and R. E. Bledsoe. (2020). Kenaf: production, harvesting, processing, and products. Int. J. Agri. Sci. pp. 416-421.