Reprint **ISSN 1991-3036 (Web Version)**

International Journal of Sustainable Crop Production (IJSCP)

(*Int. J. Sustain. Crop Prod.*)

Volume: 9 **Issue: 1** **February 2014**

Int. J. Sustain. Crop Prod. 9(1): 23-28 (February 2014)

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ISSN-1991-3036 (Online)
Int. J. Sustain. Crop Prod. 9(1):23-28(February 2014)

EFFECT OF VARIETY AND SEED RATE ON THE YIELD OF KENAF

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Accepted for publication on 25 January 2014

ABSTRACT

Nasreen SS, Salim M, Paul SK (2014) Effect of variety and seed rate on the yield of kenaf. *Int. J. Sustain. Crop Prod.* 9(1), 23-28.

An experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensigh during April to September 2011 to study the effect of variety and seed rate on the fibre yield of Kenaf. The experiment comprised three varieties *viz.* HC-2, HC-95 and HC-3 and three seed rates *viz.* 10, 15 and 20 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. The highest plant height (193.04 cm), plant diameter (0.94 cm) and stick diameter (0.74 cm) were recorded in variety HC-2 while the lowest value was recorded in HC-95. The highest fibre yield (6.55 t ha^{-1}) and stick yield (11.36 t ha^{-1}) were obtained in HC-2 followed by variety HC-95 and the lowest fibre yield (4.99 t ha^{-1}) and stick yield (8.44 t ha^{-1}) were obtained in HC-3. The tallest plant (198.58 cm) was obtained at the seed rate 10 kg ha^{-1} and the shortest plant (184.74 cm) was recorded at the seed rate 15 kg ha^{-1}. The highest plant diameter (1.11 cm), stick diameter (0.91 cm) and thickness of skin (0.19 cm) was recorded at the seed rate 15 kg ha^{-1} while the lowest values were recorded at the seed rate 20 kg ha^{-1}. The highest fibre yield (6.35 t ha^{-1}), stick yield (10.28 t ha^{-1}) and harvest index (38.21%) were obtained at the seed rate 15 kg ha^{-1} while the lowest fibre yield (5.36 t ha^{-1}) and harvest index (35.95%) were found at the seed rate 15 kg ha^{-1}. The highest fibre yield (7.21 t ha^{-1}) and stick yield (12.12 t ha^{-1}) were obtained from the variety HC-2 with 15 kg ha^{-1} seed rate and the lowest fibre yield (4.28 t ha^{-1}) and stick yield (8.11 t ha^{-1}) were obtained from variety HC-3 with seed rate 15 kg ha^{-1} and HC-3 with seed rate 20 kg ha^{-1}, respectively. From the study it can be concluded that variety HC-2 with seed rate 15 kg ha^{-1} is the promising combination to obtain the highest fibre and stick yields of kenaf.

***Key words**: kenaf, variety, seed rate, stick yield, fibre yield*

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is a warm season annual fibre crop closely related to cotton that can be successfully produced in Bangladesh. Total production of kenaf in the year of 2010-2011 was 1.5 lac bale covering an area of 19595 ha of land in Bangladesh (DAE 2011). The possibility of bringing more area under kenaf cultivation seems to be limited because of other competitive crops in the same growing season like *Aus* rice. As the commercial use of kenaf continues to diversify from its historical role as a cordage crop (rope, twine, and sackcloth) to its various new applications including paper products, building materials, absorbents, and livestock feed, choices within the decision matrix will continue to increase and involve issues ranging from basic agricultural production methods to marketing of kenaf products. Kenaf has a unique combination of long bast and short core fibres which makes it suitable for a range of paper and cardboard products. The top leafy portion of the kenaf plant is not useful for pulping. Therefore, this part of the plant would be useful as forage if harvest equipment could be practically adapted to a dual collection operation. The bark, which contains long soft bast fibres, makes up 30 to 40% of the dry weight of the stem. The central core of the stem contains weakly disbursed pith cells surrounded by a thick cylinder of short woody fibres. The kenaf plant has an ideal blend of long and short fibres for many paper and paperboard products (Grower's 1989). Newspapers made from kenaf pulp have been shown to be brighter and better looking, with better ink lay down, reduced rub off, richer color photo reproduction and good print contrast. Quality analyses showed kenaf newsprint to have superior tear, tensile and burst ratings. Additionally, kenaf newsprint manufacturing requires less energy and chemicals for processing, an important advantage, both economically and environmentally. The plant has a long effective taproot system and a relatively deep, wide-ranging lateral root system making the plant drought tolerant (Grower's 1989). The inner part of the plant (core) is applicable as an adsorbent animal bedding material (Lips *et al*. 2009). Since the plant is fast-growing, kenaf also has a good ability to sequester carbon and can produce a large quantity of biomass. In recent times, the interest in growing kenaf throughout the world for its high biomass yield and elevated fibre content has been increased. Kenaf is a fast growing crop and has high potential to be used as an industrial crop globally. As fibrous crop, kenaf appears to have enormous potential to become a valuable biomass crop of the future (Alexopoulou *et al*. 2000). The plant whole-stalk material can also be used in non-pulping products like building materials, such as particle board (Webber *et al*. 1999), and within injection molded and extruded plastics (Webber and Bledsoe, 1993). Nowadays, kenaf is being considered as an alternative and cheaper source of material for producing panel products, such as fibreboard and particleboard. The farmers generally sow this crop without following a definite seed rate. It is claimed by the Bangladesh Jute Research Institute (BJRI) that about 30% higher yields can be obtained if 15 kg ha^{-1} seed rate is followed. Hence, it is necessary to have a clear idea about optimum seed rate for this less known crop. Average yield of kenaf appears to be considerably low, whereas with proper care and management, much higher yield has been reported to be obtained (Talukder and Ali, 1962). However, there is no specific research about the information in the farmers' field. As an important fibre 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.

MATERIALS AND METHODS

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University Mymensingh, Bangladesh Mymensigh during April to September 2011. The experimental site belongs to the Sonatola Soil Series of Old Brahmaputa Floodplain (AEZ 9) having non calcareous dark grey floodplain soil. The land was medium high with sandy loam texture having pH 5.9-6.5. The experiment comprised three varieties of kenaf *viz.* HC-2, HC-95 and HC-3, and three seeding rates *viz.* 10, 15 and 20 kg ha^{-1}. The experiment was laid out in a Randomized Complete Block Design with three replications. The size of each unit plot was 5.0 m × 4.0 m. The experimental land was prepared with ploughing followed by laddering. Seeds were sown in furrow on 26 April 2012 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 fibre 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 fibre 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. Fibre yield and stick yield were then converted to t ha^{-1}. Fibre yield and stick yield altogether were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Fibre yield + Stick yield

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

$$\text{Harvest index (\%)} = \frac{\text{Fibre yield}}{\text{Biological yield}} \text{ x } 100$$

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).

RESULTS AND DISCUSSION

Effect of variety

The variety had significant influence on plant population, plant height, plant diameter, stick diameter, fibre weight $plant^{-1}$, stick weight $plant^{-1}$, fibre yield, stick yield and harvest index. The highest plant population (76.78 m^{-2}) was found in variety HC-2 and the lowest one (48.78 m^{-2}) was found in HC-3 (Fig. 1). The tallest plants (193.04 cm) were produced by variety HC-2 followed by HC-95 (188.65 cm) and the shortest one (187.58 cm) were produced by HC-3. Hossain *et al.* (2011) found the highest plant height in variety HC-2. The highest plant diameter (0.94 cm) was obtained from HC-2 variety followed by HC-3 (0.81 cm) and the lowest plant diameter (0.74 cm) was obtained from variety HC-95. The plant diameter might be varied due to genetic differences in varieties and climatic effects. It was observed that stick diameter was the highest (0.78 cm) in variety HC-2 followed by HC-3 (0.66 cm) and the lowest stick diameter (0.58 cm) was found in the variety HC-95. 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 cm) and lowest (0.14 cm) were obtained from the variety HC-2 and HC-3, respectively. Fibre yield of kenaf was significantly affected by variety (Table 2). Fibre yield was the highest (6.55 t ha^{-1}) with the variety HC-2 followed by variety HC-95 (5.75 t ha^{-1}) and the lowest fiber yield (4.99 t ha^{-1}) was obtained with HC-3 variety. Boulanger (1976) obtained 3.01-4.00 t ha^{-1} yields with 3 kenaf cultivars in Morocco. Hossain *et al.* (2011) observed highest fibre yield in variety HC-2. The highest stick yield (11.36 t ha^{-1}) was found in variety HC-2 followed by HC-95 (9.31 t ha^{-1}) and the lowest stick yield (8.44 t ha^{-1}) was obtained from the variety HC-3. Webber *et al.* (1997) observed differences in stalk yield among sixteen kenaf varieties. The highest harvest index (38.12%) was obtained from variety HC-95 which was as good as HC-3 and the lowest one (36.54%) was obtained from variety HC-2.

Effect of seed rate

Plant population of kenaf was significantly affected by the seed rates. The highest plant population (68.11 m^{-2}) was found at 20 kg ha^{-1} seed rate and the lowest plant population (54.89 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 185,000 plants/ha the stalk yields usually also decrease (Higgins and White, 1969). Seed rate influenced the yield contributing characters and yield of kenaf (Table 2). The tallest plants (198.58 cm) were produced at 10 kg ha^{-1} seed rate and the shortest plants (184.74 cm) were produced at 15 kg ha^{-1} seed rate, which was identical to seeding rate 20 kg ha^{-1}. The highest plant diameter (1.11 cm) was obtained from 15 kg ha^{-1} seed rate followed by 10 kg ha^{-1} and the lowest plant diameter (0.66 cm) was obtained from 20 kg ha^{-1} seed rate. Increased seed rate might increase the competition for natural resources (light, water, nutrient, etc.) among the plants thus the plant diameter was decreased. It was observed that the stick diameter was the highest (0.91 cm) at 15 kg ha^{-1} seed rate and the lowest stick diameter (0.55 cm) was found at 20 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 cm) was obtained at 15 kg ha^{-1} seed rate and the lowest thickness of skin (0.11 cm) $plant^{-1}$ was obtained at 20 kg ha^{-1} seed rate. The fibre yield of kenaf was significantly affected by seed rate (Table 2). It was observed that fibre yield was the highest (6.35 t ha^{-1}) at 15 kg ha^{-1} seed rate followed by 20 kg ha^{-1} and the lowest fibre yield (5.36 t ha^{-1}) was obtained at 10 kg ha^{-1} seed rate. The stick yield of kenaf was significantly affected by seed rate (Table 2). It was observed that stick yield was the highest, (10.28 t ha^{-1}) at 15 kg ha^{-1} seed rate and the lowest stick yield (9.29 t ha^{-1}) was obtained at 20 kg ha^{-1} seed rate, which was statistically identical to 10 kg ha^{-1} seed rate. Stick yield decreased due to increase of seed rate. The highest harvest index (38.21%) was found at 15 kg ha^{-1} seed rate and the lowest harvest index (35.95%) was at 10 kg ha^{-1} seed rate. The highest fibre and stick yields were the reasons of highest harvest index at 15 kg ha^{-1} seed rate.

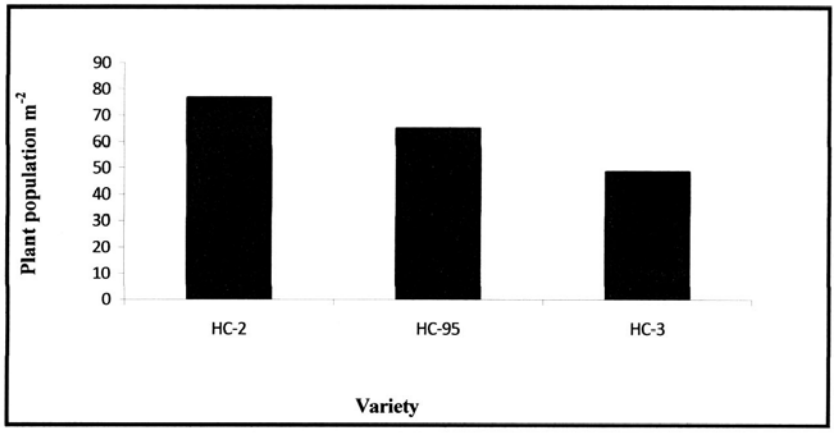

Fig. 1. Effect of variety on plant population of kenaf

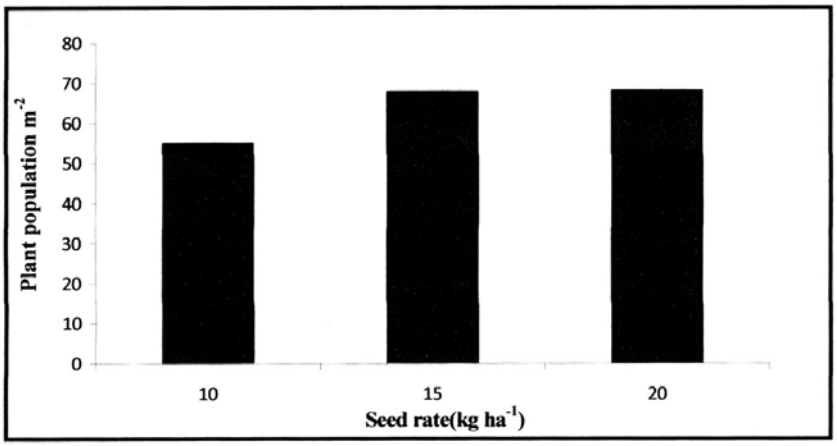

Fig. 2. Effect of seed rate on plant population of kenaf

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

Variety	Plant height (cm)	Plant diameter (cm)	Stick diameter (cm)	Thickness of skin plant^{-1} (cm)	Fibre yield (t ha^{-1})	Stick yield (t ha^{-1})	Harvest index (%)
HC-2	193.04a	0.94a	0.78a	0.17	6.55a	11.36a	36.54b
HC-95	188.65b	0.74c	0.58b	0.16	5.75b	9.31b	38.12a
HC-3	187.58b	0.81b	0.66b	0.14	4.99c	8.44c	37.08ab
CV (%)	1.95	5.58	5.66	4.96	3.26	4.28	5.33
Level of significance	**	**	**	NS	**	**	**

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 = Not significant

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

Seed rate (kg ha^{-1})	Plant height (cm)	Plant diameter (cm)	Stick diameter (cm)	Thickness of skin plant^{-1} (cm)	Fibre yield (t ha^{-1})	Stick yield (t ha^{-1})	Harvest index (%)
10	198.58a	0.72b	0.56b	0.16b	5.36c	9.53b	35.95b
15	184.74b	1.11a	0.91a	0.19a	6.35a	10.28a	38.21a
20	185.96b	0.66c	0.55b	0.11c	5.58b	9.29b	37.58ab
CV (%)	1.95	5.58	5.66	4.96	3.26	4.28	5.33
Level of significance	**	**	**	**	**	**	**

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

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 (88.00 m^{-2}) was found with HC-2 variety and 20 kg ha^{-1} seed rate (Table 3). The lowest plant population (44.00 m^{-2}) was found with HC-3 variety and 20 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 (204.90 cm) were produced by the variety HC-2 with 10 kg ha^{-1} seed rate. The shortest plants (180.61 cm) were produced by HC-95 variety with 15 kg ha^{-1} seed rates which was statistically identical to variety HC-3 at the seed rate 15 kg ha^{-1}. The plant diameter of kenaf was significantly affected by the interaction of variety and seed rate (Table 3). The highest plant diameter (1.54 cm) was produced by variety HC-2 at 15 kg ha^{-1} seed rate followed by (1.06 cm) the variety HC-3 at 15 kg ha^{-1} and the lowest plant diameter (0.62 cm) was produced by variety HC-95 at 20 kg ha^{-1} seed rate. It was observed that the stick diameter was the highest (1.30 cm) with the variety HC-2 at 15 kg ha^{-1} seed rate followed by the variety HC-3 (0.85 cm) at 15 kg ha^{-1}. The lowest stick diameter (0.51 cm) was found with variety HC-2 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 cm) was obtained from the variety HC-2 at 15 kg ha^{-1} seed rate. The lowest thickness of skin plant^{-1} (0.09 cm) was obtained from the variety HC-3 at 20 kg ha^{-1} seed rate (Table 3). Hossain *et al.* (2011) observed the longest bast fiber in variety HC-2. The highest fibre yield (7.21 t ha^{-1}) was with the variety HC-2 at 15 kg ha^{-1} seed rate followed by HC-95 variety at 15 kg ha^{-1}, which was as good as HC-2 at 20 kg ha^{-1} and the lowest fibre yield (4.28 t ha^{-1}) was obtained with HC-3 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 (12.12 t ha^{-1}) with the variety HC-2 at 15 kg ha^{-1} seed rate followed by HC-2 at 10 kg ha^{-1} (11.26 t ha^{-1}) and the lowest stick yield (8.11 t ha^{-1}) was obtained from HC-3 variety at 20 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 (39.69%) was found with HC-95 variety at 15 kg ha^{-1}, which was as good as HC-3 at 20 kg ha^{-1} seed rate and the lowest harvest index (34.22%) was with HC-3 variety at 10 kg ha^{-1} seed rate (Table 3).

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

Interaction (V X S)	Plant population (plants m^{-2})	Plant Height (cm)	Plant diameter (cm)	Stick diameter (cm)	Thickness of skin $plant^{-1}$ (cm)	Fibre yield (t ha^{-1})	Stick yield (t ha^{-1})	Harvest index (%)
V_1 X S_1	61.00d	204.90a	0.65de	0.51d	0.14b	6.12c	11.26b	35.22fg
V_1 X S_2	81.33b	193.01bc	1.54a	1.30a	0.23a	7.21a	12.12a	37.29cde
V_1 X S_3	88.00a	181.22e	0.64de	0.52d	0.12b	6.31b	10.70c	37.11de
V_2 X S_1	53.67e	194.50b	0.78c	0.56cd	0.22a	5.69d	9.12e	38.41bc
V_2 X S_2	70.00c	180.61e	0.73cd	0.59cd	0.13b	6.40b	9.72d	39.69a
V_2 X S_3	72.33c	190.85c	0.72cd	0.58cd	0.13b	5.16f	9.07e	36.27ef
V_3 X S_1	50.00e	196.33b	0.74c	0.61c	0.13b	4.28g	8.22f	34.22g
V_3 X S_2	52.33e	180.61e	1.06b	0.85b	0.21a	5.44e	9.00e	37.65cd
V_3 X S_3	44.00f	185.81d	0.62e	0.54cd	0.09b	5.27f	8.11f	39.37ab
CV (%)	4.84	1.95	5.58	5.66	4.96	3.26	4.28	5.33
Level of significance	**	**	**	**	**	**	**	**

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

Variety: V_1 = HC-2, V_2 = HC-95 and V_3 = HC-3

Seed rate: S_1 = 10 kg ha^{-1}, S_2 = 15 kg ha^{-1} and S_3 = 20 kg ha^{-1}

CONCLUSION

Results of the present study indicated that variety HC-2 was better than other two varieties. Seed rate 15 kg ha^{-1} was optimum in case of highest fibre and stick yield of kenaf. So, it can be concluded that variety HC-2 at 15 kg ha^{-1} seed rate could be the promising combination to obtain maximum fibre and stick yield of kenaf.

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