International Scholars Journals

African Journal of Agricultural Economics and Rural Development ISSN 2375-0693 Vol. 8 (10), pp. 001-004, October, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Effect of plant spacing on seed yield and yield components in kenaf (*Hibiscus cannabinus*) variety, Ifeken 400

Agbaje G. O, Aluko O. A* and Olasoji J. O

Institute of Agricultural Research and Training, Obafemi Awolowo University, P.M.B. 5029, Moor Plantation, Ibadan, Oyo State, Nigeria.

Accepted 19 September, 2020

Plant spacing required for optimum crop productivity depends on morpho-physiological traits between varieties, and the interaction between genotype and the environment. Studies were conducted in Ibadan (7°38′N 3°84′E) Nigeria, at the Institute of Agricultural Research and Training (IAR and T) during 2006 and 2007 to determine the influence of row spacing on seed yield in kenaf variety, Ifeken 400, bred for adaptation to the South Western Nigeria agro-ecologies. The experiment was carried out using split plot experimental design with two inter-row spacing (25 cm and 50 cm) as main plot and five intra-row spacing (5, 10, 15, 20 and 25 cm) as sub-plot. Results showed that plant height was not influenced by the inter-row or intra-row spacing. Height ranged from 1.91-2.03 m in 2006 and 2.31-2.58 m in 2007. Mid stem girth varied significantly within inter and intra-row densities, while butt girth increased with intra-row spacing. Number of capsules was not influenced by the intra-row spacing. An average of 25 and 18 capsules per plant were recorded in 2006 and 2007 respectively. Although, 100 Seed weight (g) was not influenced by inter or intra-row spacing, it was lower in 2006 (0.44 g) than in 2007 (2.21 g). Seed yield was highest from 50 cm inter-row spacing and 20 cm intra-row with 260 kg/ha and 540.5 kg/ha in 2006 and 2007 respectively. The difference in seed yield between the row spacing was significant in 2007. However, it was observed that time of planting and rainfall pattern in 2007 has more effect on higher seed weight and seed yield than in 2006.

Key words: Kenaf, row spacing, seed yield, plant height, stem girth.

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) has been cultivated for over six millennia for cordage production and for livestock feed. The investigation into the crop led to the discovery of diverse utilization of kenaf fibre for textile fabrics, automobile seats, insulators and in non-woven biocomposites for car door panels, dash boards, plastic fencing, livestock feed, coffee and tea filters and hygienic tissues (Scott and Cook, 1995a; Scott and Taylor, 1988). It is used in making carpet barking, ceiling tiles low and medium density particle boards (Kulger, 1998). Kenaf is a source of quality protein for livestock and media for growing edible mushrooms. The core is used as absorbent in oil spills, substrate for ethanol production and in newsprint manufacture. The seeds are good source of low cholesterol vegetable oil and also for biodiesel production (Webber and Bledsoe, 1992). Kenaf core is highly absorbent, hence it is used as poultry litter and bedding (Tilman and Black, 1998). It has been found to produce large amount of biomass (20 tons/acre), this can be put to use in the production of syngas for electricity generation in rural areas.

Kenaf is now grown under different climatic conditions and a wide range of yield had been reported (Bhangoo et al., 1986). However, the sustainable commercial production of kenaf depends on the availability of good seeds in enough quantity. Seed yield in kenaf is influenced by the population density or plant spacing and plant genotype (Scott, 1982; Scott and Cook, 1995b; Mullens, 1998; Webber and Bledsoe, 2002). Closer row spacing has been reported to reduce seed yield per

*Corresponding author: bunmialuko2010@gmail.com.

Table 1. Influence of spacing on plant height (m), stem girth (cm) and seed yield on Kenaf grown during (2006).

Treatment	Height (m)	Mid stem girth (cm)	Butt girth (cm)	Capsule no. per plant	100 Seed weight (g)	Seed yield (kg/ha)
M_1 (25 cm)	2.02±0.15[a]	1.27±0.01[b]	1.76±0.31[a]	25.04±3[a]	0.46±0.01[a]	250.83[a]
M_2 (50 cm)	1.94±0.11[a]	1.35±0.02[a]	1.88±0.18[a]	25.27±4[a]	0.42±0.02[a]	259.40[a]
SE	0.10	0.03	0.06	1.78	0.01	6.63
S1 (5 cm)	2.03±0.09[a]	1.19±0.01[b]	1.54±0.04[b]	20±3[b]	0.46±0.06[a]	245.71[a]
S2 (10 cm)	1.99±0.12[a]	1.30±0.02[ab]	1.81±0.03[a]	20±3[b]	0.42±0.04[a]	250.51[a]
S3 (15 cm)	1.99±0.08[a]	1.33±0.01[a]	1.93±0.05[a]	28±5[a]	0.41±0.03[a]	267.98[a]
S4 (20 cm)	1.91±0.13[a]	1.36±0.03[a]	2.00±0.09[a]	31±3[a]	0.45±0.02[a]	260.46[a]
S5 (25 cm)	1.99±0.20[a]	1.50±0.04[a]	2.08±0.05[a]	27±4[a]	0.43±0.05[a]	258.71[a]
SE	0.16	0.05	0.11	2.72	0.025	10.15

*Values followed by the same letter in the column are not significantly different at P=0.05.

hectare (Webber and Bledsoe, 2002), there is need to determine the response of new varieties to varying population pressures. This may differ from previous varieties (Scott, 1982; Scott and Cook, 1995a; Mullens, 1998; Webber and Bledsoe, 2002). Other factors like maturity ratings of cultivar, photosensitivity of varieties, latitudinal location and cultural practices influence kenaf seed yield (Mullens, 1998, Webber and Bledsoe, 2002).

This study therefore seeks to determine inter and intra-row spacing that will affect on optimum seed yield from Ifeken 400 in the South West rainforest ecology and its influence on yield-determining traits. Ifeken 400 is an isolate mutant of Tianung 1 and Cuba 108 and matures within 120 DAP. It was released in 2005 by the National Variety Release Committee in Nigeria.

MATERIALS AND METHODS

Location, soil characteristics and meteorological data (rainfall)

The experiment was conducted in 2006 and 2007 at the Institute of Agricultural Research and Training (IAR and T), Ibadan to determine the effect of different spacing on seed yield and yield components of kenaf variety Ifeken 400. Ibadan (7^o 38' N 3^o 84' E) is located in the semi-humid rainforest belt of South-Western Nigeria. The soil of the experimental site is Rhodic haplustalf. The average soil characteristics are pH 6.80, sand 88%, silt 10%, clay 2 %, Exchangeable bases (Me/100g), Ca 0.88, Mg 2.0, K 0.37, Na 0.47, H^+ 0.07, CEC 3.79% base 98%, %OC 0.68,% N 0.07, average P (ppm) 13.54, average Zn (ppm) 9.85. Rainfall (mm) records were kindly supplied from IAR and T during the experimental period for both years (Table 3).

Experimental design, treatments and agronomic practices

The experimental design was split plot with **t**wo inter-row spacing (25 and 50 cm) as main plot and five intra-row spacing (5, 10, 15, 20 and 25 cm) as the sub-plot.

The sub-plot treatments were completely randomized within the main plots and replicated four times. Each sub-plot was (3 × 5) m2 in size. Planting was done on 17th July and 11th June in 2006 and 2007 respectively. Plots were ploughed and harrowed and a pre-emergence herbicide, Pendimethalin (500 EC) was applied at the rate of 1.7 kg ai ha^{-1}, using a Knapsack sprayer. Weeding was done 4WAP and NPK fertilizer was applied 2 days after weeding at the rate of 80:30:30 in both years. Monoforce® (Monocrotophos) was applied at the concentration of 0.68 kg ha^{-1} active monocrotophos in 225 L of water at 4 WAP and at 50% flowering to protect plants from leaf beetle attack (Podagrica spp) and pod sucking insects respectively.

Agronomic data collection

Ten plants were tagged randomly within the inner rows at 4 WAP for the assessment of height (m), stem girth (cm) and capsule number. The tagged plants were cut and separated from others at harvest. Harvesting of plant was done manually by cutting stems with cutlass on 23rd and 5th November, 2006 and 2007 respectively. The height of the plant (m) was determined from the above ground level using graduated meter rule. The stem diameter was taken at the middle and bottom portions using Vernier Calipers. The number of capsules per plant was counted to obtain the mean values in each treatment. Harvested stems were allowed to be further air-dried before manual threshing. The seed yield from each plot was determined after the manual threshing and converted into kilogram/hectare. 100 seeds were taken randomly from the threshed seeds for weight determination using a gravimeter scale model GF-2000.

The traits measured were analyzed for each year using SAS Procedure mixed model technique with the replicates as random effect while other treatments are fixed effects according to Schabenberger and Pierce (2001).

RESULTS

There was no significant difference (P<0.05) between the inter-row spacing on traits assessed (Table 1) except for mid stem girth. Intra-row spacing had similar (P<0.05) plant height, 100 seed weight and seed yield (t/ha). However, the inter-row spacing at 5 cm and 10 cm had similar mid stem girth, butt girth and capsule number which were significantly lower than those of 15 cm to 25 cm. the characteristics were similar in the latter intra-row spacing. The correlation between seed yield and other traits were not significant (Table 4).

Table 2. Influence of spacing on height (m), stem girth (cm) and seed yield on Kenaf grown during (2007).

Treatments	Height (m)	Mid stem girth (cm)	Butt girth (cm)	Capsule number	100 Seed weight (g)	Seed yield (kg)
M_1(25 cm)	2.43±0.14^{a}	1.01±0.02^{b}	1.60±0.03^{a}	18±3^{a}	2.20±0.07^{a}	426.64^{b}
M_2(50 cm)	2.45±0.30^{a}	1.08±0.04^{a}	1.75±0.12^{a}	19±2^{a}	2.22±0.09^{a}	508.22^{a}
SE	0.06	0.03	0.07	1.6	0.10	12.14
S1 (5 cm)	2.31±0.12^{a}	0.98±0.03^{b}	1.54±0.02^{b}	17±3^{a}	1.96±0.08^{a}	378.07^{e}
S2 (10 cm)	2.38±0.17^{a}	0.97±0.02^{b}	1.56±0.04^{b}	18±4^{a}	2.23±0.07^{a}	444.87^{cd}
S3 (15 cm)	2.45±0.18^{a}	1.09±0.04^{a}	1.67±0.01^{ab}	18±2^{a}	2.20±0.06^{a}	478.23^{b}
S4 (20 cm)	2.58±0.21^{a}	1.09±0.02^{a}	1.77±0.02^{a}	20±3^{a}	2.33±0.10^{a}	540.50^{a}
S5 (25 cm)	2.47±0.15^{a}	1.11±0.01^{a}	1.78±0.03^{a}	21±2^{a}	2.29±0.08^{a}	495.48^{b}
SE	0.09	0.05	0.09	2.60	0.17	18.60

*Values followed by the same letter in the column are not significantly different at P=0.05.

Table 3. Relationship among Kenaf Yield parameters in 2006.

Parameter	Yield	Height	Seed weight	Capsule number	Mid stem girth	Butt stem girth
Yield	-					
Height	ns	-				
Seed weight	ns	ns	-			
Capsule number	ns	ns	ns	-		
Mid stem girth	ns	0.53**	- 0.34*	Ns	-	
Butt stem girth	ns	0.62**	ns	Ns	0.88**	-

** Correlation is significant at the 0.01 level (2 tailed) *correlation is significant at the 0.05 level (2 tailed).

Table 4. Relationship among Kenaf Yield parameters in 2007.

Parameter	Yield	Height	Seed weight	Capsule number	Mid stem girth	Butt stem girth
Yield	-					
Height	ns	-				
Seed weight	0.34*	0.48**	-			
Capsule number	0.41**	0.52**	ns			
Mid stem girth	0.35*	0.55**	ns	0.32*	-	
Butt stem girth	0.38*	0.44**	ns	Ns	0.53**	-

** Correlation is significant at the 0.01 level (2 tailed), * Correlation is significant at the 0.05 level (2 tailed).

In 2007, mid stem girth and seed yield were significantly higher at 50 cm than 25 cm inter-row spacing (Table 2). Other traits had similar values in the two inter-row spacing. Plant height, capsule number and 100 seed weight were not different between the inter-roe spacing from 5 cm to 25 cm. Mid stem girth was higher for 15 to 25 cm than in 5 to10 cm. seed yield was highest for 20 cm intra-row and lowest from, 5 cm intra-row. A significant correlation was between seed yield, seed weight and capsule number. Although plant height was not correlated significantly to seed yield, it was highly correlated to seed weight and capsule number (Table 2).

DISCUSSION

The plant height (m) was not significantly affected by inter and intra-row spacing. Plant height ranged from 1.94 to 2.03 m in 2006 and 2.31 to 2.58 m in 2007 (Tables 1 and 2). The non significant variation in height could be due to the ability of kenaf to reduce its population when the competition for space is intense (Webber and Bledsoe, 2002). The plant populations are adjusted through natural death of weak plants (Webber and Bledsoe, 2002).

Mid and butt stem girth were not affected by the inter-row effect but were thinnest at 5 and 10 cm intra-row spacing. At intra-row spacing of 15 to 25 cm, mid and butt girths were similar at $P<0.05$ in both 2006 and 2007 (Tables 1 and 2). The higher butt diameter from 15 to 25 cm intra-row spacing confirmed the earlier observation by Bhangoo et al. (1986).

Intra-row spacing had influence on capsule number in 2006. Capsule number was lowest at 5 and 10 cm (20capsules/plant) while at 15-25 cm it was between 27 to 31capsules/plant. However, capsule number was not influenced by inter and intra-row in 2007 and it ranged from 17 to 1 capsules/plant. 100 Seed weight (g) was not influenced by inter and intra-row spacing. It ranged from 0.41 to 0.46 g in 2006 and 1.96 to 2.33g in 2007 (Tables 1 and 2). The lower capsule number in 2007 was compensated for by higher seed weight while the reverse was the case of 2006 planting.

Seed yield (kg/ha) was not influenced by inter-row and intra-row and it ranged from 245 to 267 kg/ha in 2006. In 2007, inter-row spacing at 50 cm gave the highest yield of 508 kg/ha and the intra-row at 20 cm gave the highest yield 540.5 kg/ha (Table 2).

Capsule number and seed weight (g) are important in the determination of final yield. However, capsule number was not dependent on height (m). In 2006, the plants had more number of capsules in spite of shorter plant height when compared to 2007 (Tables 1 and 2). The shorter plant height in 2006 was due to late planting and higher capsule number per plant can be attributed to early flowering in response to day-length (Webber and Bledsoe, 2002). The lower seed weight in 2006 could be due to higher number of capsules, indicating negative correlation between seed weight and capsule number. The negative relationship between seed weight and seed number or capsule number had been reported (Tollenaar et al., (1992). Hence, seed weight is important in determining final seed yield in kenaf as observed in the higher seed yield in 2007 (Table 2).

In general, there was no significant correlation between the yield parameters and grain yield in 2006 (Table 4). This could have resulted from low plant performance in 2006 compared with 2007. The situation was quite different in 2007 when the crop was sown early and had fair distribution of rainfall throughout the year. This resulted into significantly positive relationship between yield parameters and the grain yield in 2007 (Table 2).

In Tables 1 and 2, there existed a linear relationship between yield and spacing. The progressive increase in yield with spacing occurred due reduction in the competition for growth factors as the space increased. The upper yield limit was attained at 20 cm intra row spacing. This can be explained as the spacing at which Ifeken 400 can give the optimum yield per unit area. Further increase in the plant population by planting at less than 20 cm may give lower seed yield as observed in 2007 (Table 2). When the spacing increased to 25 cm, the plant population per unit area reduced, which in turn affected the seed yield per unit area (Table 2).

Planting Ifeken 400 early in 2007 enhanced its height and by inference its total dry matter yield. Although, seed yield was highest at 50 × 20 cm row spacing, the remaining waste after seed threshing can be converted into kenaf flour to generate additional income.

REFERENCES

Bhangoo MS, HS Tehrani, J Henderson (1986). Effects of planting date, Nitrogen levels, Row spacing and plant population on Kenaf performance in the San Joaquin Valley, California. Agron. J., 78: 600-604.

Cook CG, Scott AW Jr. (1995). Plant population effects on kenaf seed production. Proc. Int. Kenaf Assoc.. Conf. Irving, TX., 7: 153-158.

Kulger KD (1998). The physiology of tropical crop protection. CAB Int., Cambridge, UK., pp. 211-213.

Mullens DB (1998). Critical considerations in commercial kenaf seed production. Proc. Am. Kenaf Soc., pp. 90-95.

Schabenberger O, Pierce FJ (2001). Contemporary Statistical models for plant and soil sciences. CRC Press Boca Raton USA., pp. 465-505.

Scott A (1982). Kenaf Seed production: 1981-82. Rio Farms, Inc. Biennial Report for 1980-81. Monte Alto, TX., pp 60-63.

Scott AW Jr., Cook CG (1995a). Growing kenaf for seed in south Texas. Proc. Int. Kenaf Assn. Conf. Irving, TX., 7: 133-135.

Scott MC, Cook DK (1995b). An agro-economic survey of kenaf production in peninsula Malaysia. Ding Ting Hung, vimala purolohanian and Yusoh (Eds.) Malaysia Agric. Res. Dev. Inst. Serolang, Selanger, p. 139.

Tilman S, Black CA (1998). Kenaf: A bedding material for animals. An overview of Kenaf plant specie. Cliathen UK Natural response Institute/AC PEU Technical Centre for Agricultural and Rural Cooperation, pp. 1-25.

Tollenaar M, Dwyer LM, Stewart DW (1992). Ear and Kernel formation in maize hybrids representing 3 decades of grain yield improvement in Ontario. Crop Sci., 32(2): 432-438.

Webber CL, Bledsoe VK (2002). Kenaf yield components and plant composition. In: J.Janick and A. Whipkey (eds.), Trends in new crops and new uses. ASHS Press, Alexandria, VA., pp. 348-357.