World Applied Sciences Journal 16 (1): 63-66, 2012
ISSN 1818-4952

An Investigation on Fiber Production of Different Kenaf (*Hibiscus cannabinus* L.) Genotypes

[1]Amir Bahtoee, [1]Kaveh Zargari and [2]Ebadollah Baniani

[1]Department of Agronomy, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran
[2]Agricultural Research and Natural Resources of Tehran Province, Iran

Abstract: Kenaf (*Hibiscus cannabinus* L.) was widely grown in northern areas of Iran in the past for its fibers but it is almost 30 years that is not been cultivated in large scale. Hence, this study was conducted to evaluate the potential of yield components and qualitative traits of 10 different kenaf cultivars. Due to climate and weather conditions in Varamin region (40 Km south-east Tehran), cultivars started flowering from 15th July to 15th September and resulted in not full filling vegetative growth and reduction in traits such as: Plant height, stem diameter, fibers weight, fibers yield. Stem diameter and plant height had direct influence on fibers yield. Also the analysis of variance showed significant differences in all traits. The results of this experiment showed that fibers yield increased (148.45%) by the increment of plant height and stem diameter. Cultivar 7552 produced the highest amount of fiber per hectare (2641 kg $^{ha-}$1) as it had the highest height and thickest stems.

Key words: Kenaf · Fibers yield · Cultivars · Biomass · Traits correlations

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is a native plant to hot and humid regions and has been cultivated in some countries such as India, Bangladesh, Pakistan, China, Sudan, Cuba, Brazil, Thailand, Argentina, Italy, Russia and Hungary for centuries.

Kenaf research in Iran has undergone in its history over the years and highly influenced by its area cultivation and therefore there is no recent research on new commercial cultivars over the past few decades as it is not been cultivated by farmers [1]. Cultivar, planting date, plant height, stem diameter, plant density, cambial duration [2] and harvest time [3] are the most effective factors on fibers yielding. Kenaf is sensitive to photoperiod and different cultivars show various performance which could be categorized to three groups; early, mediate and late maturity cultivars. Early maturity cultivars growth period last 70-100 days and their height rarely exceeds 2-2.5 meters. These cultivars usually produce high seed and low fiber. Mediate maturity cultivars growth period range 100-120 days and their height is 2.5-3.5 [4]. These are appropriate cultivars to be cultivated in Iran [1]. Late maturity cultivars growth period is 140 days or more and its height is 3.5 to 4.5 meters. Their fiber quality ranges from good to excellent [4]. Late cultivars produce more dry matter than the early and mediate cultivars as they possess longer vegetative phase [2]. Accurate cultivation time benefits the spring rainfall for seeds to germinate quickly and early growth stage completes better, resulting increment of height and stem diameter which finally results on fiber yield [2]. Delay in seed planting cause early flowering and seed production which reduces the vegetative phase and thus reduce stem diameter and Fibers production. Factors which increase the height and stem diameter are cultivar, long days and long growth season. Cultivars with low height and stem are due early flowering which result in significant low fiber production [5]. According to Shakhes *et al*. [6] increment of plant height and growth period increases the fiber yield per hectare. If the aim is to produce fibers, the amount of 20-25 Kg/ha seed with 15-20 cm between rows 5cm between plants will be suitable. If fiber is the purpose of cultivation, more seed with more condense cultivation pattern must be considered [7]. Prolong of cambial duration increase fiber in the plant which result in yield increment. Typically in terms of physiology, fiber-forming cells are not mature. They are thin and nearly 40% of fibrous cells wall are thin. These fibers are soft and be destroyed during extraction and therefore result in yield reduction. Therefore harvest must be done after fibers are completely mature [2].

Corresponding Author: Kaveh Zargari, Department of Agronomy, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran.

MATERIALS AND METHODS

This experiment was conducted in 2010 in Varamin Agricultural Research Center (40 kilometers southeast Tehran Province-IRAN) with latitude 35°, 19/ north and longitude 51°, 39/ east, located at an elevation of 915 meters above sea level. According to Koppen climate division, Varamin climate is arid and semi desert. Seasonal temperature fluctuation and even day and night are high. Annual rate of evaporation is higher than rainfall so the weather is dry. The maximum and minimum temperature is 42°C and-1°C respectively. The soil texture of the research site was loam-clay with a pH of 7.56 and the Electrical Capacity (EC) was 3.02 ds/m.

Experimental design used in this study was a complete randomized block design with four replications. Treatments included 10 lines and varieties of kenaf (Evin 333, 7551, 7552, Cuba Simple Green, Cuba Red, 2432, Cuba 2032, Purple Avish, P12 and 237). Kenaf seeds were provided by Tehran province Agriculture Natural Resource Research Center.

Each plot contained 4 rows, each 10 meters in length and 80 cm apart. Kenaf seeds were sowed on each row with a 20 cm distance. To avoid marginal effects, the two middle lines of each plot were used for required measurements. Six plants from each plot were cut from crown, the investment packaged, labeled and transferred to the fermentation tank. Statistical analysis for plant height, stem diameter, wet biomass, dry biomass, fiber yield and fiber harvest index was calculated using MSTAT-C software.

RESULTS AND DISCUSSION

Plant Height: According to the results of analysis of variance (Table 1), a significant difference (P<0.01) was observed in plant height between treatments. As shown in Table 2 (mean comparison), the highest average of plant height belonged to line 7551 (3.077m) and the lowest in line 237 (2.68m). Purple Avish and P12 also had low heights. The reason cultivar 7551 had the highest height could be explained because of maximum usage of climate conditions, water, food and genetic factors, while Purple Avish and P12 cultivars are long days and due to lack of day light, they did not complete physiological growth and so had shorter height.

It should be considered that yield increment is directly influenced with increment of stem length [8]. As Varamin is a warm and dry region, average Kenaf height is about 2m to 3m and is less than regions with warm and humid weathers such as northern parts of the country which height reaches to 4m. Plant height shortening in Varamin region is due to short vegetative period and cultivars with quick flowering [9]. Davoodi *et al*. [10] compared 10 kenaf cultivars for fiber production in Lasht-e-nesha region. The results showed that the highest height was 2.8m at begining of flowering and 3.2 m at harvest time. Difference in plant height in dry and humid regions could be due to different climates, long growing season and amount of rainfall. The difference among varieties used in this study is also another reason for this difference. Nor Aini *et al*. [5] reported that appropriateness of cultivars photoperiodism and day light increases plant height.

Table 1: Analysis of variance of the traits (Mean Squares)

SOV	df	Plant Height	Stem Diameter	Wet Biomass	Dry Biomass	Fiber Yield	Fibers Harvest Index
Replication	3	0.001	0.004	0.016	0.004	16796.892	0.887
Variety	9	0.075**	0.236**	0.178**	0.036**	866383.6**	3.309**
Error	27	0.006	0.016	0.004	0.001	5801.517	0/566
CV (%)		2.70	7.52	8.94	12.4	5.05	10.30

**: significant at 1% levels of probability.

Table 2: Mean comparison of main effects and interactions of traits

	Plant Height (m)	Stem Diameter (cm)	Wet Biomass (Kg)	Dry Biomass (Kg)	Fiber Yield (kg ha^{-1})	Fibers Harvest Index
Evin 333	2.78^{de}	1.59^{c}	0.674^{d}	0.304^{de}	1297^{e}	6.84^{cd}
7551	3.077^{a}	1/64^{c}	0.891^{bc}	0.417^{b}	1641^{c}	6.313^{de}
7552	3.015^{ab}	2.237^{a}	1.106^{a}	0.503^{a}	2641^{a}	8.413^{a}
Cuba Red	2.923^{bc}	1.655^{c}	0.968^{b}	0.425^{b}	1453^{d}	5.55^{e}
Cuba Simple Green	2.838^{cd}	1.572^{c}	0.579^{de}	0.246^{efg}	1203^{ef}	7.905^{abc}
2432	2.755^{de}	1.842^{b}	0.805^{c}	0.386^{bc}	1641^{c}	6.932^{cd}
Cuba 2032	2.888^{cd}	1.95^{b}	0.822^{c}	0.352^{cd}	1781^{b}	8.235^{ab}
237	2.68^{e}	1.472^{c}	0.615^{d}	0.285^{ef}	1266^{e}	7.17^{bcd}
Purple Avish	2.713^{e}	1.48^{c}	0.468^{f}	0.217^{g}	1063^{g}	7.83^{abc}
P12	2.685^{e}	1.54^{c}	0.490^{ef}	0.226^{fg}	1109^{fg}	7.835^{abc}

Means with the same letter in each column have no significant difference (P<0.05).

Table 3: Correlation coefficients between traits

	Plant Height	Stem Diameter	Wet Biomass	Dry Biomass	Fiber Yield	Fibers Harvest Index
Plant Height	1					
Stem Diameter	0.544**	1				
Fiber Weight	0.654**	0.850**				
Wet Biomass	0.776**	0.666**	1			
Dry Biomass	0.735**	0.633**	0.963**	1		
Fiber Yield	0.654**	0.850**	0.852**	0.823**	1	
Fibers harvest index	-0.195	0.269	-0.288	-0.392*	0.184	1

* and **: Significant at 5 and 1% levels of probability respectively

Stem Diameter: Based on Analysis of variance (Table 1) a significant difference (P<0.01) was observed for stem diameter among the cultivars and according to Table 2 (mean comparison) the highest mean of stem diameter was produced in cultivar 7552 (2.237cm, group a) while cultivar 237 had the lowest (1.472cm, group c). This result was similar to those reported by Hosseini Nezhad *et al*. [11]. According to Singh [2] findings, cultivar, prolong of vegetative growth and increase of cambial period results in stem diameter increment. In general, increase in stem diameter increases crop yield.

In Varamin region flowering stage happen in short time and plants do not get the opportunity to complete their growth. According to Gonzales *et al*. [12], irrigation and nitrogen fertilizer have great impact on stem diameter. Nitrogen fertilizer overdose reduce stem diameter. Reduction of growth rates (height, biomass and stem diameter) is obvious in varieties which start their flowering stage earlier and spend energy for seed production [5].

Wet Biomass: According to Table 1 a significant difference (P<0.01) was observed among the cultivars for wet biomass. Due to Table 2, cultivars 7552 and Purple Avish had the most and least wet biomass respectively. As cultivar 7552 has more leaves than other cultivars, some plants may tilt. According to Webber [4], kenaf wet biomass is affected by cultivar type and leaf area index.

Dry Biomass: According to Analysis of variance (Table 1), a significant difference (P<0.01) was observed in treatments for dry biomass. As shown in Table 2, cultivars 7552 and Purple Avish had the most and least wet biomass respectively.

Dry biomass increase during growing season and growth stops with the arrival of cold season [4]. It must also be considered that irrigation and nitrogen fertilizers both have an important impact on dry biomass [12]. Also Danalatos and Archontoulis [13] showed that dry biomass in kenaf depends on cultivar, irrigation and nitrogen fertilizer applications.

Fiber Yield: According to analysis of variance results (Table 1) a significant difference (P<0.01) was observed for fiber yield between the treatments. Due to Table 2, the highest and lowest mean for fiber yield was produced in cultivar 7552 (2641 kg ha^{-1}) and Purple Avish (1063 kg ha^{-1}) respectively. Fiber yield depends on cultivar, stem length, stem diameter, plant density and cambial duration [2]. In this study cultivars 7552 and 7551 had the most stem diameter (Table 3) which explains these cultivars high fiber yielding.

A 2000 kg ha^{-1} yield would be appropriate [7], therefore according to our results, cultivar 7552 with a yield of 2641 kg ha^{-1} is acceptable. Fiber production in Davoodi *et al*. [10] research in Lasht-e-nesha region was 2525 kg.

It must be considered that in 1966 kenaf landraces yield in Iran due to Khodabandeh [7] was 700 to 800 kg ha^{-1}. In this study the lowest fiber yield was produced by cultivar Purple Avish (1063 kg ha^{-1}) which in comparison to the old land-race's, it was at least 200 kg ha^{-1} higher. But according to Varamin climate, short growth period, cambial short period and quick start of flowering stage, kenaf yield reduction is expected. Zhang [3] reported that kenaf harvest time is an important factor on fiber yield. Early harvest before complete maturity and fiber development significantly reduces yield. Shakhes *et al*. [6] reported that increment of plant height and growing time increases yield. In this study, in order to obtain maximum yield, harvest was done when stems were completely dried.

Fibers Harvest Index: As shown in Table 1, a significant difference (P<0.01) was observed for fibers harvest index. According to means comparison (Table 2) the highest fibers harvest index belong to cultivar 7552 (8.413) while the least belongs to Red Cuban cultivar (5.55). As fiber production is the main goal of kenaf cultivation, it is obvious that cultivars with higher harvest index should be considered. Harvest index expresses the distribution of photo-assimilate between economical and total performance [14].

In kenaf, the vegetative growth determines economic performance. The production of sap before flowering (source) and its use in construction growth (sink) is almost equal. Regarding stem leaves, wood and stem skin are the main destinations [15].

Traits Correlation Coefficient: Table 3 shows the correlation coefficient between the studied traits. As shown, plant height had a positive correlation with, stem diameter, weight and performance fibers yield. Also stem diameter had a positive correlation with plant height, fiber weight, wet biomass, dry biomass and fiber yield. Fibers harvest index had no significant correlation with all traits except with dry biomass which had a negative correlation ($P<0.05$).

All other traits showed significant correlation ($P<0.01$) with each other. This indicates that all the traits studied in this experiment have a high correlation with fiber yield and the increment of each trait will increase yield.

REFERENCES

1. Baniani, E., 2008. Restore and reproduction of kenaf germplasm in Iran. Agriculture and Natural resources research centre, Tehran province, pp: 13.
2. Singh, D.P., Mesta (*Hibiscus Cannabinus and Hibiscus Sabdariffa*). Central Research Institute for Jute and Allied Fibers. BARRACKPORE, 743: 24-parganas (North), West Bengal, India, pp: 28. http://assamagribusiness.nic.in/Mesta.pdf
3. Zhang, T., 2003. Improvement of kenaf yarn for apparel application. Master Thesis of Louisiana State University, US., pp: 77.
4. Webber, C. and V.K. Bledsoe, 2002. Kenaf Production: Fiber, feed and seed. in Janick, J. and whip key, A (eds). Trends in new crops And new uses. ASHS press. Alexandria, V., pp: 327-339.
5. Nor Aini, A.B. Shukor, H. Mohd Basri, A.H. Hazandy, S. Ghizan, M.N. Fadzhel and J. Pertanika, 2009. Growth and Phenology of Kenaf (*Hibiscus cannabinus* L.) Varieties. Trop. Agric. Sci., 32(1): 29-33.
6. Shakhes, J., M. Dehghani Firouzabadi, M.H. Pahlavani and E. Zeinali, 2009. Effect of genotype and harvest time on relative parameter to yield in kenaf. EJCP., 2(1): 91-103.
7. Khodabandeh, N., 2006. Industrial crops cultivation. Sepehr publications, pp: 503.
8. Rouxlene, C., 2004. Characterization of Kenaf cultivars in South Africa.Faculty of Natural and Agricultural Sciences Deparement of plant Sciences. Plant Breeding University of the State Bloemfontein, pp: 128.
9. Baniani, E., P. Karbasi and R. Arabhalvaee, 1999. A study on kenaf commercial cultivars and comparison of all cultivars in Iran. Varamin center for seed and crop breeding, pp: 14.
10. Davoodi, B., G. Sharifi, A. Hadjizadeh and R. Norouzi, 1994. Study and comparison of kenaf culivars for fibers production. Varamin center for seed and crop breeding, pp: 13.
11. Hosseini Nejad, Z. and H. Donyavian, 1994. Storage, maintenance, evaluation and reproduction of 20 cultivars of kenaf and identification their morphological characteristics. Varamin center for seed and crop breeding, pp: 14.
12. González Moreno, E.F., I. de Andrés, J.L. Walter, I.N.I.A. Tenorio and Dpto. Medio Ambiente, 2002. Kenaf Responses to Irrigation and Nitrogen Fertilization in Central Region of Spain. http://www.aaic.org/05progrm.htm.
13. Danalatos, N.G. and S.V. Archontoulist, 2004. Irrigation and N-fertilization effects on kenaf growth and biomass productivity in central Greece. 2005 AAIC Annual Meeting: International Conference on Industrial Crops and Rural Development. Murcia, Spain. http://www.aaic.org/05 progrm.htm.
14. Kochaki, A. and G.M. Sarmadnia, 1998. Crops Physiology. Mashhad Jehad-e-daneshgahi publications, pp: 400.
15. Poostini, K., A. Siosemardeh, M. Zavareh and A. Madah Hosseini, 2006. Crops yielding; Physiology and Processes. Tehran University publications, pp: 614.