Biological Forum – An International Journal 14(2): 429-433(2022)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Assessment of Genetic Variability for Fibre Yield and its Attributing Traits in Kenaf (*Hibiscus cannabinus* L.) under Multilocational Trials

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(Received 01 February 2022, Accepted 08 April, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Four major yield and fibre yielding-contributing traits were investigated in five Kenaf genotypes. The experiment was conducted in two years 2009 and 2011 laid out in Randomized Block Design with four replications. The superior kenaf variety HC-583 was used as a standard check. This Multilocational testing of advanced genotypes was conducted over two years to monitor the performance of newly created promising genotypes and phase out non-performing genotypes that donot match our criteria. As kenaf is not a mainstream fibre crop, so very less research work has been done to release a variety. Genetic parameters like variability, heritability, genetic advance were estimated and path analysis was done. For the traits under consideration, the test genotypes exhibited a wide range of variability. These traits also confirmed to have a significant heritability. In all the traits assessed, the (PCV) was shown to be greater than the (GCV). Basal diameter had the highest heritability, followed by plant height, while green weight and fibre yield had lowest heritability. Basal diameter and plant height showed significant heritability paired with strong genetic advances, implying that an additive gene was important in determining these traits. Plant height showed a high positive and significant association with green weight. As a result, simple selection on the basis of plant height can be used to improve this green weight and subsequently the fibre yield for the set of five kenaf genotypes under study.

Keywords: Phenotypic Coefficient of Variation, Genotypic Coefficient of Variation, Heritability, Genetic advance, Path analysis.

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is an annual herbaceous plant that grows quickly and is grown for its stem fibre. (Sultana *et al*., 2016). It belongs to Malvaceae family that is closely related to cotton. (Webber *et al*., 2002). It is mostly grown in the tropical and sub-tropical region of Africa and Asia (Le Mahieu *et al*., 2003). It is a very fast-growing plant that provides a wide range of commercial value with low maintenance costs (Ramesh *et al*., 2018). The kenaf fibres are used in the fibre industry to produce paper, building materials, livestock feeds, absorbents, etc., (Webber *et al*., 2002).

Kenaf crop has high adaptability to grow in a wide geographical and climate range (Danalatos &

Archontoulis., 2010). It yields 3-5 times greater than the southern pine tree which takes 7-40 years to yield 6-10 tonnes of dry mass per acre each year (Le Mahieu *et al*. 2003). Due to the property of scavenging extensive amounts of carbon dioxide from the atmosphere, Kenaf was given a 'Green tag' which makes the crop one of the resources to go green (Lee *et al*., 2021). Since kenaf, produces a large volume of biomass; it can also be used as a resource material for sustainable energy supply in the future. It also contains many useful phyto compounds and phytol which can be extracted and used for medicinal purposes (Ryu *et al*., 2013).These above qualities make the crop important to grow and such crops need genetic improvement. Those improvements can be made through proper selection and evaluation of genetic variability among the diverse genetic population for the development of agronomically superior variety. Among many parameters, fibre yield is mainly targeted for the improvement of quality production. Hence, the present investigation was carried out to evaluate the genetic variability, heritability, genetic advance, and correlation between fibre yield and other yield components in kenaf for effective selection in a further breeding program.

Multilocational testing of advanced genotypes is essential for any breeding programme and it is a valuable source of genetic material since it allows for checking the performance of newly developed promising genotypes and phasing out of older non performing genotypes. The success of any breeding program is determined by the amount of usable variation in the population and the degree to which characteristic features are heritable. Hence the study of genetic variability, heredity, and genetic advance in the germplasm will aid in determining the true potential of a genotype. One of the major reasons for the poor progress in crop breeding has been assumed to be a lack of diversity. The study and application of existing variability are becoming increasingly important and the present investigation was taken up in this direction

MATERIALS AND METHODS

The present investigation was carried out during the two Kharif seasons of 2009 and 2011 at Uttar Banga Krishi Vishwavidyalaiya (UBKV), Cooch Behar, West Bengal under IET (Initial Evaluation Trial) and AVT-II (Advanced Varietal Trial-II) under the project AINP on Jute & Allied Fibres (AINP-JAF). The AVT-I (Advanced Varietal Trail-I) experiment during Kharif 2010 was totally damaged by natural calamity. Seeds of five kenaf genotypes namely JRKM-9-1, JRKM-9-2, JRKM9-3, JRKM-9-5 and HC-583 were obtained from Central Research Institute for Jute and Allied Fibres (ICAR-CRIJAF), Barrackpore, West Bengal for the AINP-JAF trial at UBKV. The experiment was laid out in Randomized Block Design with four replications during both the years. The superior kenaf variety HC-583 was used as a standard check. Data was recorded for four different yield attributing traits such as plant height (cm), basal diameter (cm), green weight (q/ha) and fibre yield (q/ha). To raise a good crop, standard recommended agronomic procedures were used. The data for plant height and basal diameter were recorded from five plants, excluding border plants from each replication. The data for green weight and fibre yield was recorded on per plot basis and it was converted to quintal per hectare (q/ha). The data for analysis of variance (ANOVA) was done for the data to compare the significant difference between the genotypes. The genetic parameters were estimated as suggested by Al. (Jibouri *et al*., 1958) the genotypic correlation was calculated as suggested by (Johnson *et al.*, 1955) and the path analysis was done by the method suggested by (Dewey and Lu., 1959). The statistical analysis of the data was done using the software Windostat® ver. 8.5.

RESULTS AND DISCUSSION

In the present investigation, analysis of variance revealed significant differences among the testing kenaf genotypes only for the year component for the traits plant height and basal diameter whereas, the genotypes and the year × genotypes interaction component was found to be not differing significantly for all the four fibre yield attributing traits studied (Table 1). In the present investigation therefore, only a numerical assessment for the kenaf traits under study could be done since the kenaf genotypes did not differ significantly. The check variety HC-583 had the greatest mean value of 276.55 cm among all the plant height mean values, indicating that HC-583 was the best variety to employ as a check in a plant height choosing criteria (Table 2). In addition, the variety JRKM-9-3, which had a similar height of 275.63 cm, was appreciable. Basal diameter was thought to be a good indicator of fibre yield (Alam *et al*., 2021). As a result, the variety JRKM-9-3, which had the highest mean of 2.34 cm, can be employed to increase fibre yield. Green weight referred to the combined weight of the plant and its green leaves. According to the findings, the variety JRKM-9-5 had the highest mean value for fibre yield with 34.63 q/ha, despite having a low mean value for plant height, basal diameter, and green weight which can be attributed to higher fibre thickness. This is in contrast to (Maity *et al*., 2012) findings, which claim that fibre yield is highly dependent on plant height, basal diameter, and green weight which can be attributed to higher fibre thickness. As a result, the JRKM-9-5 variety can be employed in recombination breeding and as a promising parent for any hybridization and selection process. In case of plant height the highest performer was the check genotype HC – 583 (276.55 cm) itself. For basal diameter JRKM -9 -3 was the best performer (2.34 cm) which out yielded the check HC-583 by

0.43% only, which was not significant. In case of green weight, JRKM -1 was the highest performer (610.86 q/ha) which outperformed the check HC-583 by 4.11% which was also not significant. For fibre yield it was observed that JRKM -9-5 (34.63 q/ha) was the highest yielder, out yielding the check HC-583 by 18.27%. This kind of result was found due to the fact that the five kenaf genotypes under present study did not differ significantly for fibre yield and the other three attributing traits.

The high biomass kenaf plant will play an important role in boosting fibre content, and the leaves can also be used to increase soil fertility (Mukul *et al*., 2020). As a result, among all genotypes, the variety JRKM-9-1 achieved the highest mean value of 610.86 q/ha, making it suitable for hybridization. The goal of the kenaf crop is to produce a lot of fibre.

The degree of variability in the five kenaf genotypes is mentioned in (Table 3) for four genetic parameters namely phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advance. The goal of the study was to screen and select a high-yielding genotype that would outperform existing check cultivar and be released as a new variety. The available genetic variations in the gene pool allow for the selection of superior types. Identification of possible parents is required before beginning a successful breeding operation.

Table 1: Analysis of variance for different traits of Kenaf over two years.

Sources of variation	df	Mean sum of squares			
		Plant height (cm)	**Basal diameter (cm)**	**Green weight (g/plant)**	**Fibre yield (g/plant)**
Year	1	73051.21**	10.080**	43356.94	3.26
Error	6	786.95	0.185	25280.91	48.38
Genotypes	4	457.39	0.303	7978.32	31.05
Year× genotypes	4	878.06	0.094	25175.79	12.26
Error	24	342.59	0.069	10702.09	18.98

**Significant at 1% probability level

Table 2: Mean performance of Kenaf genotypes over two years.

Genotype	Plant height (cm)	Basal diameter (cm)	Green weight (q/ha)	Fibre yield (q/ha)
JRKM-9-5	257.95	2.20	525.12	34.63
JRKM—1	268.28	2.25	610.86	32.22
HC-583 (Check)	276.55	2.33	586.71	29.28
JRKM-9-3	275.63	2.34	566.00	31.49
JRKM-9-2	272.48	2.33	566.15	30.83
Mean	270.18	2.29	570.97	31.69
CV(%)	6.85	11.47	18.12	13.75
SEm(±)	6.54	0.09	36.58	1.54

Table 3: Genetic parameters for the five genotypes of Kenaf.

Traits	GCV	PCV	h^2 (Broad sense)	GAM
Plant height (cm)	15.86	16.33	0.94	31.74
Basal diameter (cm)	23.26	23.74	0.96	46.94
Green weight (q/ha)	6.63	10.11	0.43	8.96
Fibre yield (q/ha)	5.02	7.27	0.48	7.15

GCV = Genotypic coefficient of variation; PCV= Phenotypic coefficient of variation; h^2 = Broad sense heritability; GAM = Genetic advance as percentage of mean

Two critical yield-affecting features were found to have a wide range and significant variability. The basal diameter (23.74 and 23.26) had the highest phenotypic and genotypic coefficient of variation (PCV and GCV), followed by plant height (16.33 and 15.86), with similar results reported by Sawarkar *et al*. (2014). Bhagasara *et al*. (2017) found similar results, indicating that the trait basal diameter had little environmental influence and hence had a high potential for improvement through additional selection. The lowest value for PCV and GCV was shown by fibre weight (7.27 and 5.02). As a result, additional variation for these features must be developed by selection, either through hybridization or mutation breeding (Tiwary *et al*., 2011). As seen by the narrow margin between genotypic and phenotypic coefficients of variation, the environmental effect on the expression of these traits was minimal. Because of the heterogeneity in the variable between genotypes, selection among genotypes with higher values of PCV and GCV will be advantageous for improving the trait. In general, the estimates of broad-sense heritability revealed the highest value for basal diameter (96%) followed by plant height (94%) In terms of selection, estimates of genetic advance are more informative than heritability. For starting a crop improvement program for the development of new varieties, a detailed understanding of the degree of genetic variability, heritability, and genetic advance present for specific features is required.

High heritability and genetic advance were found for basal diameter and plant height, showing that these traits are influenced by additive gene effects. Selection for these qualities could be utilized to generate high fibre yielding cultivars, implying that additive gene action to these traits. It is also possible to deduce that selection based on these features will be more beneficial for improving and achieving higher fibre production. Green weight and fibre weight have low genetic advance and heritability, indicating that these variables are mostly regulated by non-additive gene action in contrast to the findings of Biswas *et al.* (2018) in Jute.

Plant height had a positive and highly significant relation (0.99) with green weight and a negatively significant (-0.97) relationship with basal diameter, according to correlation studies given in (Table 4). Plant height was the only trait that had a statistically meaningful relationship with fibre yield. Both Rehman *et al.* (2020); Khatun *et al.*, (2007) found similar findings.

The basal diameter had a negative and non-significant (-0.69) association with green weight and a negative and significant (-0.91) relationship with fibre yield which was contrary to Mukul and Akter (2021) who found a positive interaction with fibre yield. Green weight had a non-significant and negative relationship with fibre yield (-0.66). From (Table 5) it was observed that the three traits plant height, basal diameter and green weight had negative direct effect on fibre yield with no positive co-relations, which implied that direct selection for these traits won't improve fibre yield for the present kenaf genotypes under study. Plant height showed negative direct effect on fibre yield whereas basal diameter revealed a significantly negative effect and green weight revealed a non-significant direct negative effect on fibre yield. So, focusing on plant height will enhance the improvement of the selection process for the quality fibre yield (Fig. 1). In the present study no generalized trend of trait association was observed due to the inclusion of only a few fibre yield distributing traits. The traits under present study are not able to explain the the total variation. Hence inclusion of more fibre yield attributing traits is recommended. The high residual effect of 0.2749 also highlights the same fact to include more traits for better conclusion.

Table 4: Genotypic correlation between the four Traits of Kenaf.

Traits	Basal diameter(cm)	Green weight (q/ha)	Fibre yield (q/ha)
Plant height (cm)	-0.97*	0.99*	0.75
Basal diameter (cm)		-0.69	-0.91*
Green weight (q/ha)			-0.66

*Significant at 5% probability level

Table 5: Direct (diagonal) and indirect (off-diagonal) effects of different attributing traits on the yield of Kenaf.

Traits	Plant height (cm)	Basal diameter (cm)	Green weight (q/ha)	Correlation co- efficient with fibre yield (q/ha)
Plant height (cm)	**-4.11**	5.01	-0.15	0.75
Basal diameter (cm)	4.11	**-5.12**	0.10	-0.91*
Green weight (q/ha)	-4.07	3.57	**-0.15**	-0.66

*Significant at 5% probability level, Residual effect = 0.27491

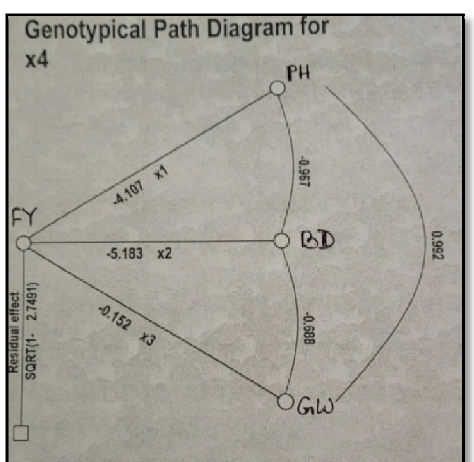

Fig. 1. Genotypic path diagram for fibre yield.

CONCLUSION

Variability parameters are mandatory components that must be incorporated in a feasible crop improvement program for optimal selection. The results of the research showed that plant height was an important criterion to be considered in any selection procedure that would increase the fibre yield as in the present study the plant height was directly correlated with green weight. Increase in green weight also amounts to increase in fibre yield. Furthermore, the residual effect (0.27) in the path analysis implied that the four traits in the present study are insufficient to account for total variability. This suggests that in future line of work by the researchers, various other traits must be considered that would be directly or indirectly correlated with fibre yield for holistic conclusions not leaving any room for ambiguity.

Acknowledgement. The authors would like to thank AINP on Jute & Allied Fibres at UBKV and ICAR-CRIJAF for funding the experiment under AINP-JAF trials. The help received from the Directorate of Research, UBKV for the conduction of the field experiments is duly acknowledged.
Conflicts of Interest. None.

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How to cite this article: Suvendu Kumar Roy, Bandan Thapa, S. Vishnupriya, S. Pavithra, Bijaya Sur, N. Umamaheshwar, Bilin Maying, Sahanob Nath, Avralima Sarkar, Lakshmi Hijam, Moumita Chakraborty, Rupsanatan Mandal, Dinesh Tulsiram Surje and Sanghamitra Rout (2022). Assessment of Genetic Variability for Fibre Yield and its Attributing Traits in Kenaf (*Hibiscus cannabinus* L.) under Multilocational Trials. *Biological Forum – An International Journal*, *14*(2): 429-433.