

## GENETIC, PHENOTYPIC AND ENVIRONMENTAL VARIANCES AND CHARACTER ASSOCIATIONS IN KENAF

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### ABSTRACT

Kenaf (*Hibiscus cannabinus* L.) is an important food and livestock feed in Nigeria, which has hitherto been ignored in genetic improvement. Data obtained from evaluating fifty-seven diverse genotypes of Kenaf for two years in Samaru in the Nigerian Guinea Savanna ecological zone were used to study genetic variability and interrelationships between seed yield and its components. The results indicate a preponderance of genetic components of variance for seed yield, plant height, number of seeds per pod and 1000 seed weight indicating that selection for these traits should result in heritable improvements. Seed yield was found to be positively and significantly correlated with plant height, number of seeds per pod and 1000 seed weight. Significant and positive correlations were also obtained between plant height and number of capsules per plant and between 1000 seed weight and number of seeds per pod. The path-coefficient analysis indicates that number of seeds per pod and 1000 seed weight had the highest direct effects on seed yield. It is suggested that for a meaningful seed yield improvement programme, efforts should be directed towards the best balance between number of seeds per pod and 1000 seed weight.

*Key Words:* *Hibiscus cannabinus*, Nigeria, path-coefficient analysis

### RÉSUMÉ

Kenaf (*Hibiscus cannabinus* L.) est une importante nourriture et un aliment pour les animaux au Nigeria, qui a été littéralement ignoré dans l'amélioration génétique. Les données récoltées durant l'évaluation de cinquante sept divers gènes de Kenaf pour deux ans en Samaru dans la zone écologique de la savane guinéenne du Nigeria étaient utilisées pour étudier la variation génétique et l'interrelation entre le rendement en graines et ses composantes. Les résultats indiquent une prépondérance des composantes génétiques dans la variance du rendement en graines, la taille de la plante, nombre de graines par gousse et le poids de 1000 graines indiquant une sélection pour ces races conduirait à une amélioration de l'héritage. Le rendement en grains était positivement et significativement corrélé avec la taille de la plante et le nombre des capsules par plante et le poids de 1000 graines, et nombre de graines par gousse. L'analyse des coefficients des corrélations indique que le nombre de graines par gousse et le poids de 1000 graines avaient l'effet direct le plus élevé sur le rendement en graines. Il est recommandé que des efforts soient orientés vers l'équilibre entre le nombre des graines par gousse et le poids de 1000 graines, pour que l'impact du programme d'amélioration de rendement soit significatif.

*Mots Clés:* *Hibiscus cannabinus*, Nigeria, analyse des coefficients de corrélations

## INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) is cultivated widely in the tropics as a fibre plant and is used as a jute substitute in the manufacture of sacs, twines, carpets and other products. The leaves and flowers are used as vegetables. The former contain 25-30% crude protein (Killinger, 1965; Wing, 1965; Kumar *et al.*, 1985). The leaf is acceptable to cattle as silage. Kenaf seeds contain 20% edible oil (Berger, 1969), which compares favourably with cotton seed oil and can be used for making margarine and protein stock feed. The cake obtained after oil extraction can be used for compounding animal feeds, while the pulp obtained from the stems could be useful in the manufacture of paper.

Although Kenaf is potentially an important crop in Nigeria, it has largely been ignored in the genetic improvement programmes. Knowledge of the genetic variation present among Kenaf cultivars is a pre-requisite for genetic improvement. Correlations and path-coefficient analysis of traits will also help in choosing component characters in a breeding programme whose selection would result in the improvement of complex traits that are positively correlated (Aruna *et al.*, 1989; Singh and Tuteja, 1991). The objective of this study was to investigate the extent and quality of genetic variability in a diverse population of Kenaf. The interrelationship between seed yield, an important but complex character and other yield components were also studied.

## MATERIALS AND METHODS

Fifty seven Kenaf genotypes with diverse genetic backgrounds were evaluated at Samaru (Lat. 11°11'N; Long. 7°38'E; 686m above sea level) in the northern Guinea Savanna of Nigeria during the rainy seasons (June-October) of 1994 and 1995. The soil type was sandy loam.

Each plot consisted of four rows, measuring 2m long and 50cm between stands. A randomised complete block design with three replications was used. Fertilisers were broadcasted to supply 60 kg N, 45 kg P<sub>2</sub>O<sub>5</sub> and 60 kg K<sub>2</sub>O per hectare. The fertilisers were incorporated into the soil before sowing. Weeding was done once to keep the plots weed free.

Observations were recorded on plant height at flowering, butt diameter at harvest, number of capsules per plant, number of seeds per pod, 1000 seed weight and seed yield.

A combined analysis of variance was used on the data for each trait. Components of variance  $\sigma_{ph}^2$ ,  $\sigma_g^2$  and  $\sigma_c^2$  were obtained by setting observed mean squares to expected mean squares and solving for the desired component. Genetic coefficients of variation were calculated as  $\sigma_g^2 / \sqrt{\text{mean}} \times 100$ . Genetic correlation coefficients were estimated using standard variance and co-variance procedures (Singh and Chaudhary, 1985; Steel *et al.*, 1997).

The correlations obtained between the traits were further subjected to the path-coefficient analysis following the procedure outlined by Dewey and Lu (1959). This method allows the determination of direct and indirect influence of different variables on seed yield. Seed yield was considered as a resultant variable, while plant height, butt diameter, number of capsules per plant, number of seeds per pod and 1000 seed weight were the main causal variables.

## RESULTS AND DISCUSSION

The estimates of the phenotypic, genotypic and environmental components of variance for the six traits are presented in Table 1, along with the genotypic coefficients of variation. Considerable variation was observed for all the traits in Kenaf population as evidenced by the values of the coefficient of variation. The values ranged from 5.90 for 1000 seed weight to 34.36 for seed yield, suggesting that there is an opportunity for selection for these traits. It appears that environmental variance was relatively small. This indicates that selection for these traits will result in heritable improvement. This result conforms with those of Kumar *et al.* (1985) on kenaf; Khan, (1987) on mung beans; and Singh and Tuteja (1991) on ramie. There was a preponderance of genotypic components of variance for plant height, number of seeds per pod, 1000 seed weight and seed yield. These also recorded high heritability estimates of 0.51, 0.85, 0.54 and 0.87, respectively (Table 1). Thus, these traits are highly and quantitatively heritable with minimal genotype by environmental interaction. The number of capsules/plant and

butt diameter are more influenced by genotype by environmental interaction as evidenced by their  $\sigma_{gc}^2$  and  $\sigma_c^2$  components. Similar results were reported by Aruna *et al.* (1989) in roselle and Zaria *et al.* (1994) in cowpea.

The genotypic correlation coefficients for the different pairs of traits are presented in Table 2. Generally, low correlations were obtained between all pairs of characters. Seed yield was positively and significantly correlated with plant height, number of seeds per pod and 1000 seed weight. Significant and positive correlations were also obtained between plant height and number of seeds per pod. These results indicate that selection for plant height, number of seeds per pod and 1000 seed weight should result in improved seed yields in Kenaf. The effectiveness of improvement in seed yield through these characters will, however, vary depending on the direct and indirect relationships with yield, their heritabilities as well as genetic control (Khan, 1987; Aruna *et al.*, 1989; Singh and Tuteja, 1991; Zaria *et al.*, 1994).

The causal relationship and the results of the path-coefficient analyses are presented in Table 3. The variables with the highest direct effects on seed yield were number of seeds per pod and 1000 seed weight. The direct effect of 1000 seed weight on seed yield was, however, reduced by the negative indirect effect through number of seeds per pod (Table 3). The path-coefficient analysis (Fig. 1) also shows negligible effects of butt diameter and number of capsules per plant on seed yield. The results suggest that in order to perform a successful breeding programme aimed at improving seed yield in Kenaf, it is necessary to pay less attention to butt diameter and number of capsules per plant when selection is practiced. Focus should be on number of seeds per pod and 1000 seed weight which are determinants of seed yield in Kenaf. Singh and Tuteja (1991), Gravois and Helms (1992), Zaria *et al.* (1994) and Board *et al.* (1997) considered seed weight, number of seed per pod and plant height as important characters in crop improvement.

TABLE 1. Components of variance and heritability for seed yield and other agronomic characters in Kenaf

	*GCV	$\sigma_{ph}^2$	$\sigma_g^2$	$\sigma_e^2$	$\sigma_{ge}^2$	$\sigma_{er}^2$	$h^2$
Plant height	9.96	0.13	0.07	0.04	0.01	0.01	0.54
Butt diameter	12.48	0.28	0.08	0.04	0.02	0.14	0.29
Capsules/plant	14.63	109.02	30.32	25.60	15.03	38.06	0.28
Seeds/pod	25.23	29.78	23.54	3.72	2.38	0.24	0.79
1000 seed weight	5.90	5.09	2.73	1.02	0.94	0.40	0.54
Seed yield	36.36	9015.95	7855.03	643.40	389.22	128.30	0.87

\*GCV= genotypic coefficient of variability;  $\sigma_{ph}^2$ ,  $\sigma_g^2$ ,  $\sigma_{ge}^2$ ,  $\sigma_e^2$  and  $\sigma_{er}^2$  = phenotypic, genotypic, genotype by environment, environmental and error variance, respectively

TABLE 2. Genetic correlations between seed yield and its components in kenaf

	Plant height	Butt diameter	Capsules per plant	Seeds per pod	1000 seed weight	Seed yield
Plant height	1.00					
Butt diameter	0.06	1.00				
No. of cap. per plant	0.36*	0.18	1.00			
No. of seeds per pod	0.07	-0.24	0.16	1.00		
1000 seed weight	0.22	0.07	0.26	0.33*	1.00	
Seed yield	0.31*	-0.05	0.017	0.51**	0.41*	1.00

\*,\*\* = Significant at 5% and 1% level of probability, respectively

TABLE 3. Path-coefficient analysis of seed yield and its components in kenaf

Variable correlated	Path-coefficient
<b>Plant height vs. seed yield</b>	
Direct effect of plant height on seed yield	0.225
Indirect effect via butt diameter	-0.020
Indirect effect via number of capsules per plant	0.013
Indirect effect via number of seeds per pod	0.039
Indirect effect via 1000 seed weight	0.051
Total	0.308
<b>Butt diameter vs. seed yield</b>	
Direct effect of butt diameter on seed yield	0.005
Indirect effect via plant height	-0.007
Indirect effect via number of capsules per plant	0.005
Indirect effect via number of seeds per pod	-0.070
Indirect effect via 1000 seed weight	0.018
Total	-0.049
<b>Number of capsules per plant vs. seed yield</b>	
Direct effect of number of capsules per plant on seed yield	-0.051
Indirect effect via plant height	-0.041
Indirect effect via butt diameter	0.000
Indirect effect via number of seeds per pod	0.047
Indirect effect via 1000 seed weight	0.062
Total	0.017
<b>Number of seeds per pod vs. seed yield</b>	
Direct effect of number of seeds per pod on seed yield	0.584
Indirect effect via plant height	0.008
Indirect effect via butt diameter	-0.001
Indirect effect via number of capsules per plant	-0.004
Indirect effect via 1000 seed weight	-0.076
Total	0.51
<b>1000 seed weight vs. seed yield</b>	
Direct effect of 1000 seed weight on seed yield	0.463
Indirect effect via plant height	0.025
Indirect effect via butt diameter	0.000
Indirect effect via number of capsules per plant	0.018
Indirect effect via No. of seeds per pod	-0.100
Total	0.406

The residual effect (R) obtained in this study (0.32), though small and positive, indicates that only 68% of the total variations in Kenaf seed yield was explained. Other factors (about 32%) have not been considered in the present study.

In conclusion, plant height, number of seeds pod<sup>-1</sup>, 1000 seed weight and seed yield are less influenced by the environment and its interaction. Plant height, number of seeds/pod and 1000 seed

weight were found to be important yield components.

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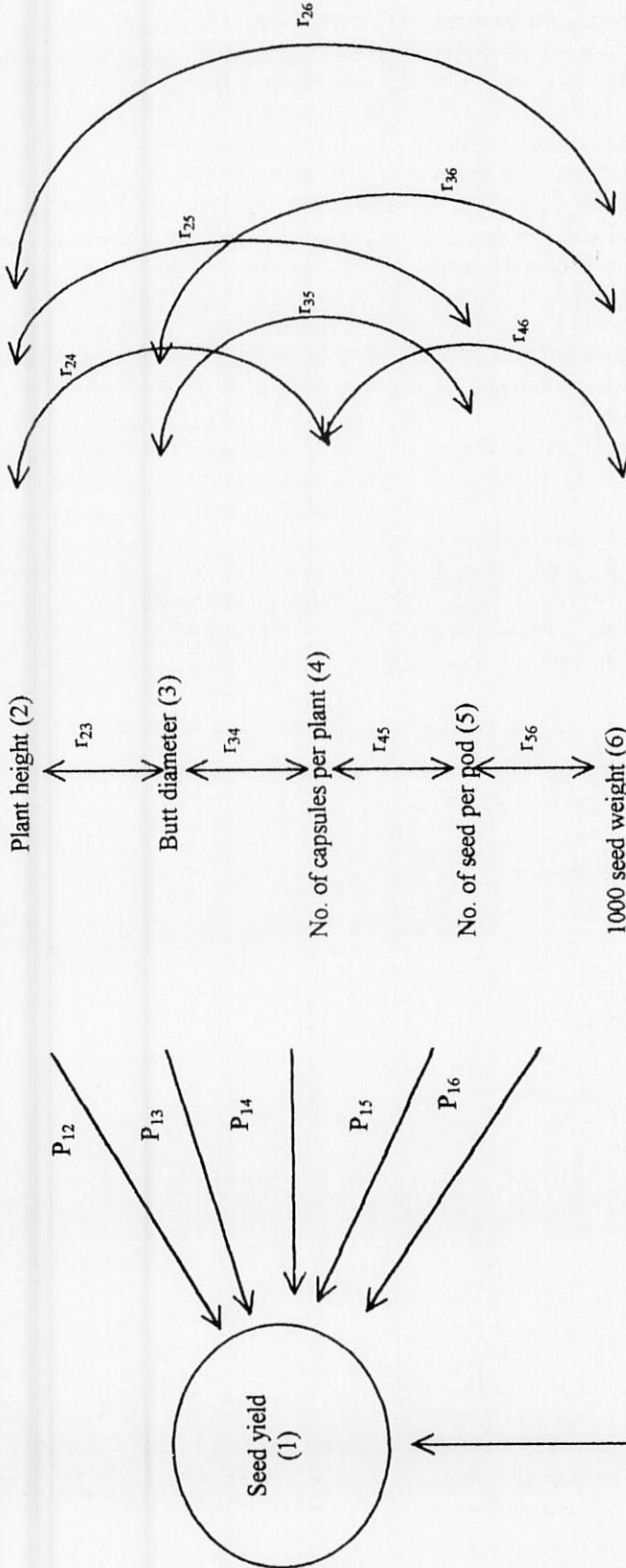


Figure 1. Diagrammatic representation of path-coefficient analysis;  $r_{ij}$  represent correlation coefficient between  $i^{th}$  and  $j^{th}$  trait,  $P_{ij}$  represents direct effect of  $i^{th}$  trait on trait number 1, and R is residual factor not accounted for.

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