

## THE INHERITANCE OF LEAF-LACINIATION IN COTTON

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LEAF shape in cotton is dependent upon the length of the leaf and the number, width and depth (sinus-length or laciniation) of the lobes, the latter, being the most prominent characteristic determining leaf-shape. Leaf shape varies widely between species and between varieties within a species and this character has been used as one of the criteria in taxonomic classification. Several workers have utilized leaf-indices, based on the different components of leaf shape, referred to above, in grouping cotton varieties (Afzal, 1930; Hutchinson, 1934; Silow, 1939; Stephens, 1944).

Several workers, studying the inheritance of leaf-shape, more particularly the lobe-length and lobe-width, in crosses within Asiatic and within New World cottons, including those between *Gossypium hirsutum* and *G. barbadense*, have reported single gene control for lobe-depth and lobe-width (Fyson, 1905; Shoemaker, 1909; Leake, 1911; Balls, 1912; McLendon, 1912; Peebles and Kearney, 1923; and Kottur, 1923), with the possibility of modifiers also operating (Afzal, 1930). Others considered a series of multiple alleles to be responsible for different leaf shapes (Hutchinson, 1934; Stephens, 1944a, 1944b). Studies made by Rana (1952, unpublished) in *arboreum* cottons have indicated that the shallow leaf-lobed types are better yielding than the deep-lobed types.

Since leaf-shape is the resultant of the interaction between genes for leaf-length, width and laciniation of lobe, it was felt that a quantitative approach would be useful in understanding the genetics of leaf-laciniation and its relationship with yield and some other characters. Accordingly, an investigation on the quantitative inheritance of leaf-laciniation, involving two Upland cottons of diverse leaf-shape, was undertaken and the results are reported here.

### MATERIALS AND METHODS

Two varieties of Upland cotton, H. 14 with shallow lobes and SA. 594 (a type received from the U.S.A.) with deep lobes, which on the basis of Stephen's (1944) classification based on indices C and D would be called 'normal broad' ( $C=0.54$ ,  $D=0.57$ ) and intermediate ( $C=0.31$ ,  $D=0.314$ ) respectively, were crossed in 1959. In 1962, the two parents, the  $F_1$ , the  $F_2$  and  $F_3$  generations were grown in the fields of Botany Division of the Indian Agricultural Research Institute, New Delhi in a randomised block design with three replica-

tions. Two plots (with 10 plants per plot) each of the parents and  $F_1$ , 12 plots of  $F_2$  and 16 plots of  $F_3$  families were grown in each replication at a spacing of  $91.5 \times 45.7$  cm. Normal cultivation practices were followed in raising the crop.

Leaf-lacination was determined by calculating index C (as suggested by Stephens, 1944) with a slight modification of substituting middle lobe-length for sinus-length; there being a strong correlation ( $r=0.91$ ) between the two characters. Thus the leaf-lacination in this case was the ratio of the middle lobe-length (B) to the total leaf-length (from apex to the base of the lamina, at the leaf spot) called A.

The variance components, D, H,  $E_1$ ,  $E_2$ ,  $E_3$ , were estimated by the method of least squares (Mather, 1949). The interaction components, d, h, i, j and l, (additive, dominance, additive  $\times$  additive, additive  $\times$  dominance and dominance  $\times$  dominance interactions respectively), were obtained from generation means as suggested by Hayman (1958). Heritability in broad sense and narrow sense was also calculated. The magnitude of dominance was calculated by  $\sqrt{H/D}$  and that of heterosis by  $[(h-i) - (d - \frac{1}{2}j)]$ . The estimate of the effective number of factors was calculated by using D and H parameters. The relation between the leaf-shape on the one hand and the boll-number per plant and yield per plant on the other was determined by calculating the coefficients of correlation.

## RESULTS

The mean and variance of the parents, the  $F_1$ , the  $F_2$ , the  $F_3$ , with mid-parent value and per cent. increase or decrease are given in Table 1, while the estimates of genetic components D, H,  $E_1$ ,  $E_2$  and  $E_3$  alongwith those of relative dominance, heritability values, effective factors and selective limit of leaf-lacination are given in Table 2.

TABLE 1

*Mean and variance for leaf-index in a  
hirsutum cotton cross*

Generation		Mean	Variance
H. 14	$P_1$	0.610	0.00244
SA 594	$P_2$	0.805	0.00146
H. 14 $\times$ SA. 594	$F_1$	0.745	0.00564
" "	$F_2$	0.709	0.00845
" "	$F_3$	0.680	0.00698
(a) $\bar{P}=0.7075$ ;		(b) $\bar{F}_1-\bar{P}=2.86\%$ ;	
(c) $\bar{F}_1-\bar{F}_2=4.83\%$ ;		(d) $\bar{P}_2-\bar{F}_3=4.09\%$ .	

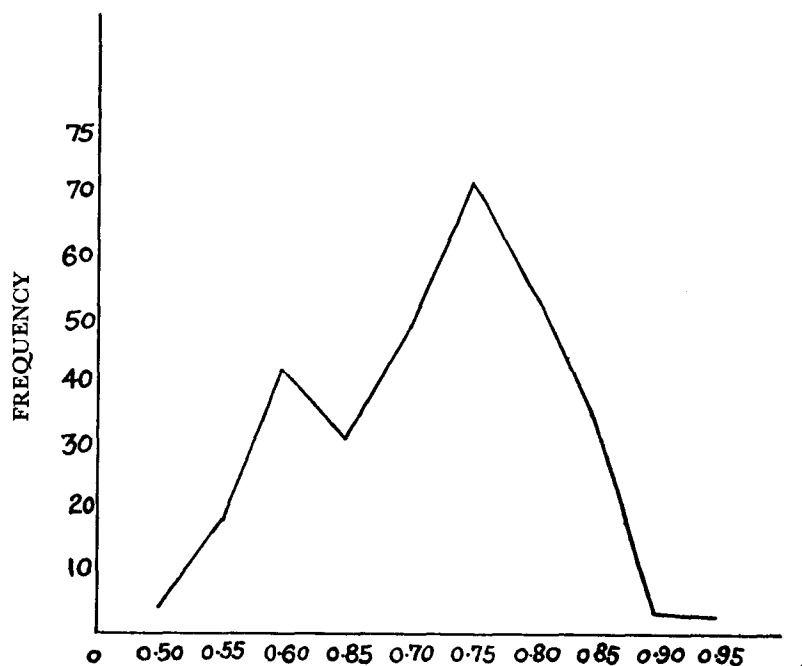
TABLE 2

*Genetic components with relative dominance and heritability values*

Variations observed	Parameter	Value	Parameter	Value
$\hat{V}_{F_2} = 0.00845$	$\hat{D}$	0.0112*	Relative dominance	0.866
$\hat{V}_{F_3} = 0.00698$	$\hat{H}$	-0.0084	Heritability (Narrow sense)	53.17%
$\bar{V}_{F_3} = 0.00471$	$\hat{E}_1$	0.00447*	Heritability (Broad sense)	58.64%
$\hat{E}_1 = 0.00400$	$\hat{E}_2$	0.00146	Effective factor ( $\hat{K}_1$ )	0.604
$\hat{E}_2 = 0.00102$	$\hat{E}_3$	0.00343*	Effective factor ( $\hat{K}_2$ )	1.495
$\hat{E}_3 = 0.00391$			Selective limit $\sqrt{K_2 D}$	0.129

\*Significant at 5 % level.

The estimates of  $D$ ,  $E_1$  and  $E_3$  are significant at 5 per cent. level while  $H$  and  $E_2$  are not significant, the observed  $F_2$  variance is lower than  $2\bar{V}_{F_3}$ , probably due to slightly skewed distribution in the  $F_2$  (Fig. 1).

FIG. 1. Frequency distribution for leaf-lacination index (B/A) in the  $F_2$  of H. 14 x S.A. 594.

The interaction components, based on generation means are given in Table 3. As the backcross population was not available, ( $\hat{d}-j$ ) only could be estimated. As expected from the previous analysis (Table 2) only ( $\hat{d}-j$ ) component was found to be significant.

TABLE 3

*Interaction components*

Parameter	Value
$\hat{m}$	0.709
( $\hat{d}-j$ )	0.0975 $\pm$ 0.0137*
$\hat{h}$	-0.0590
$\hat{i}$	0.1010
$\hat{l}$	0.0380

\*Significant at 5% level.

*Leaf-lacination index (L.L.I.).*—The frequency array of leaf-lacination index B/A in the  $F_2$  is given in Fig. 1. The minimum frequency class has been omitted, as suggested by Hoshimo. The observed ratio of segregates with a L.L.I.  $>0.65$  to those with and L.L.I.  $<0.65$  was 215 : 64 ( $\chi^2$  for a 3:1 ratio, 0.638). These results indicate a single gene control for leaf lacination.

*Relationship between leaf-lacination and other characters.*—The coefficient of correlation between leaf-lacination index (B/A) on the one hand and boll-number per plant and single plant yield on the other was very small and non-significant ( $r = -0.00155$  and  $-0.0165$  respectively).

## DISCUSSION

The inheritance of leaf-lacination or leaf-shape, has, so far, been studied mainly as a qualitative character. The present study on leaf-lacination in a cross between two varieties of Upland cotton, based on quantitative values shows that the nature of gene action for this character is mainly additive. Since the value of  $2\bar{V}_{F_3}$  ( $=0.00942$ ) is not very much different from that of  $V_{F_2}$  ( $=0.00845$ ), there does not appear to be any probability of linkage.

In the case of the two characters, boll-number per plant and single plant yield, studied by us, exhibited a very small and non-significant coefficient of correlation with leaf-lacination. These results also indicate that leaf-shape

has no selective advantage with regard to the two most important characters in cotton viz. boll-number per plant and yield. Our findings also confirm the views of Stephens (1944) who, disagreeing with the observations of Hutchinson (1936) and Gadkari (1941) that narrow leaf had a selective advantage over the broad leaf in certain parts of India, considered that the leaf-shape of *Gossypium* had no appreciable selective advantage on its own account. Our results in the *hirsutum* cottons are also at variance with those of Rana (1952, unpublished) in *arboreum* cottons in which he found that the broad leaf-lobed types gave higher yield than the narrow-lobed ones.

The values of  $K_1$  and  $K_2$  suggest the possibility of one effective factor or major gene along with certain modifiers controlling the expression of leaf-lacination. The actual  $F_2$  segregation and the bi-modal curve obtained (Fig. 1) confirm the results obtained by quantitative analysis. Afzal (1930), while indicating the action of a single pair of genes controlling leaf-lacination, also suspected the presence of certain modifiers or minor genes interacting with the major gene.

The range given by the mid-parent value,  $(\pm\sqrt{K_2D})$  was from 0.61 to 0.871 which is not very much different from the range for  $F_3$  family means ( $=0.616$  to  $0.848$ ) and indicates little possibility of selection for leaf-lacination.

The partitioning of interaction effects, confirm the result obtained earlier that the gene action in this case was mainly additive with considerable additive  $\times$  additive component.

#### SUMMARY

The genetics of leaf-lacination was studied quantitatively in an intra-hirsutum cross between varieties H. 14 and SA 594. The gene effect was mainly additive, with considerable additive  $\times$  additive component. One major gene with some modifiers controlled the expression of leaf-lacination. These results were also confirmed by the actual  $F_2$  segregation.

There was no correlation between leaf-lacination on the one hand and boll-number per plant and single plant yield on the other.

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