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Genetic Analysis of Yield and its Components in *Gossypium hirsutum (L.)*

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ABSTRACT

Nine strains belonging to *G. hirsutum viz.*, MCU 1, MCU 4, MCU 5, MCU 6, MCU 7, MCU 8, ELS 250, P 216 F and PRS 72 were crossed in all possible combinations to study the nature of gene action. The additive component (D) appeared to have a predominent role compared to dominance (H) in plant height while the dominance components (H1) and (H2) were higher than the additive component (D) for boll production. The additive (D) and dominance (H) components appeared to be of equal importance in deciding the yield expression. However the ratio $\left(\frac{H1}{D}\right)^{\frac{1}{2}}$ indicated the role of over dominance and low heritability value and large number of group of factors involved also confirmed the existence of over dominance. The graphic analysis indicated over dominance for all the characters.

INTRODUCTION

Maximum genetic improvement for quantitative traits can be achieved through a clear understanding of the types and amount of variability present in genetic stocks of interest. For this, the diallel cross technique is a systematic method available to the breeder in identifying those parents and hybrids that have superior combinations of the traits of economic interest. Much of the breeder's efforts can be saved if a thorough knowledge of the genetic make up of leading varieties is already available. With this end in view, nine local cultivars representing *Gossypium hirsutum* genotypes which were bred for different environmental conditions such as summer, winter, rainfed, and irrigated areas were chosen for the analysis. The nature of gene action, for yield of seed cotton and its closely related attributes of plant height and number of bolls per plant were studied and the results of the investigations are reported in this paper.

MATERIALS AND METHODS

The nine *hirsutum* varieties chosen for the diallel analysis were MCU 1, MCU 4, MCU 5, MCU 6 (Bharathi), MCU 7, MCU 8, ELS 250, P 216 F and PRS 72. MCU 1 was an intra-*hirsutum* (Co 2 x A 12) cross derivative with wide adaptability especially for winter conditions. MCU 4, MCU 5 and MCU 6

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were multiple cross hybrid derivatives, which involved a *barbadense* variety in their initial parentage, and were developed for irrigated summer, irrigated winter and rainfed winter condition respectively. MCU 7 was a mutant strain also obtained from a multiple cross derivative subjected to X-irradiation which possessed earliness and was suitable for summer irrigated condition. PRS 72 was an entirely new type with big bolls and short fruiting branch habit which was isolated from exotic Russian germ plasm. P 216 F was an earlier introduction from Punjab for the short rice fallow areas. ELS 250 was an advanced *hirsutum* culture with good adaptability for irrigated winter areas.

These varieties were crossed in a full diallel fashion and the F1's were raised in a randomised block design in two replications. Each row had 20 plants spaced 75 cm x 30 cm. Observations were recorded on all the individual plants for plant height at maturity, number of opened bolls and seed cotton yield. The data were subjected to statistical analysis as per the procedure given by Aksel and Johnson (1962) based on the model of Haymen (1954) and further improved upon by Mather and Jinks (1971).

RESULTS AND DISCUSSION

Estimates of additive and dominance effects and heritability are presented in Table 1 and the graphical

Table 1. Estimates of genetic effects

	D	F	H1	H2	$\left(\frac{H1}{D}\right)^{\frac{1}{2}}$	$\frac{H2}{4H1}$	$\frac{h2}{H2}$	E	Heritability (%)	T2-test of significance
Height of plant (cm)	-56.60	-122.40	-53.70	+25.92	0.77	0.192	19.70	64.04	6	0.0003 N. S.
Number of bolls per plant.	4.04	-22.39	-55.10	-41.36	-3.70	0.188	4.168	39.94	46	0.01 N. S.
Yield of kapas per plant (g)	522.21	810.48	574.80	152.80	1.05	0.066	14.90	174.79	25	0.003 N. S.

analysis of the characters under study is presented in figures 1 to 3. The materials under study was first tested for the agreement with the assumptions of Haymen (1954) namely diploid segregation, absence of reciprocal diifferences, epistasis, multiple allelism, homozygosity of parents and uncorrelated gene distribution.

The species *G. hirsutum* behaves cytologically as a diploid (Kimber, 1961; Endrizzi, 1962). The varieties selected for the study are stabilised for several

generations through selfing and even if small degree of heterozygosity is present it is not likely to seriously distort the general interpretations. There were no significant reciprocal differences in any of the characters and varieties studied. The assumptions of no epistasis, no multiple allelism and no linkage are difficult to evaluate and partial failure of certain assumptions, where they are not likely to disturb the genetic analysis (Crumpacker and Allard, 1960).

Yield

The additive (D) and dominance component (H) appeared to be equal in importance in deciding the yield expression. The value of $\frac{H2}{4H1}$ was lesser than 0.25 suggesting assymetry in the distribution of genes and a positive (F) value confirmed this, pointing to the existence of more dominant genes than the recessives. However the ratio $\left(\frac{H1}{D}\right)^{\frac{1}{2}}$ was more than unity indicating the possible role of over dominance. The low heritability value and the larger number of groups of factors involved also confirmed the existence of over dominance. The graphical analysis largely brought out the importance of over dominance since the regression line originated below the origin and it deviated significantly from unity indicating the involvement of non allelic interaction.

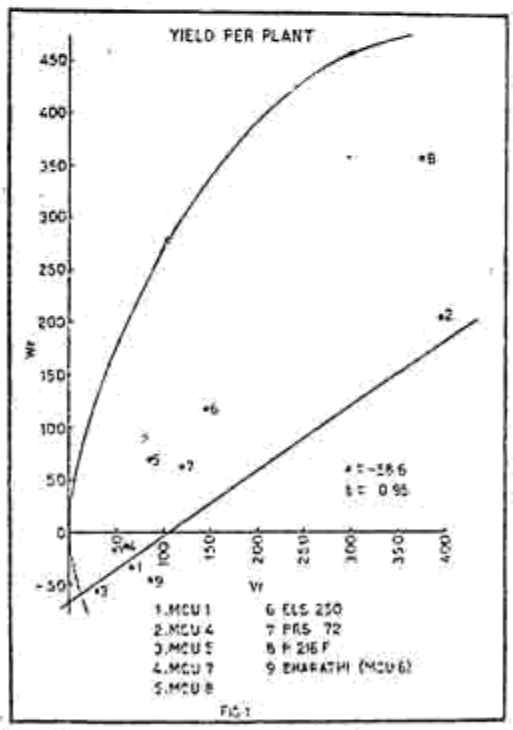

FIG 1

The varieties MCU 8, EL 250 and PRS 72 formed a group, separate from MCU 5, MCU 7, MCU 1 and MCU 6 (Bharathi) which had more number of dominant alleles. The varieties P 216F and MCU 4 had more of recessive alleles and appear to be distantly related to both the groups. Such conglomeration established the extent of diversity between the varieties. Partial heterozygosity in the varieties MCU 7, MCU 8 and ELS 250, PRS 72 and P 216 F was also indicated. The importance of dominance and its inflation into over-dominance and low heritability values indicated the complexity of the inheritance and difficulty in fixation of this character.

Plant Height

The additive component(D)appeared to have predominant role compared to dominance (H). The negative values

for additive components also point to the predominance of decreasing alleles. The negative (F) value on the other hand

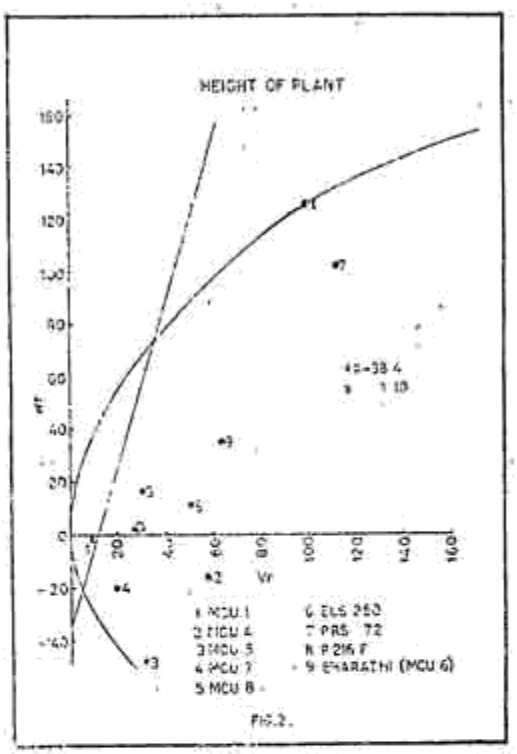

FIG.2.

pointed to assymetry in the gene distribution leaning towards recessive allele. The ratio of $\left(\frac{H2}{4H1}\right)$ was also less than 0.25 in conformity with the above inferences. The dominance in this case seemed to be only partial as indicated by the ratio $\left(\frac{H1}{D}\right)^{\frac{1}{2}}$.

The Vr; Wr graph indicated the existence of over dominance since the regression line originated between the origin and deviated from the line of unit slope. Again, a low heritability estimate and large number of groups of factors suggested the predominant role of dominance effect. The variety MCU 1, appear to be distinctly different from other parents which possessed the maximum number of recessive alleles. This variety seemed to be completely homozygous as it was right on the line of unit slope.

Number of Bolls Produced

The dominant components (H1) and (H2) were higher than the additive component (D) indicating a greater contribution of dominance in the expression of this trait, while the negative (F) value pointed to excess of recessive alleles. The ratio of $\left(\frac{H2}{4H1}\right)$ was lesser than 0.25 which pointed to assymetry in the distribution of genes. The ratio $\left(\frac{H1}{D}\right)^{\frac{1}{2}}$ was more than 1 indicating inflation of dominance to over-dominance. This was also confirmed by the graphical analysis. The regression line started below the origin and deviated significantly from the line of unit slope. Heritability was only moderate. Varieties PRS 72 and MCU 6 (Bharathi) appeared to be fairly homo-

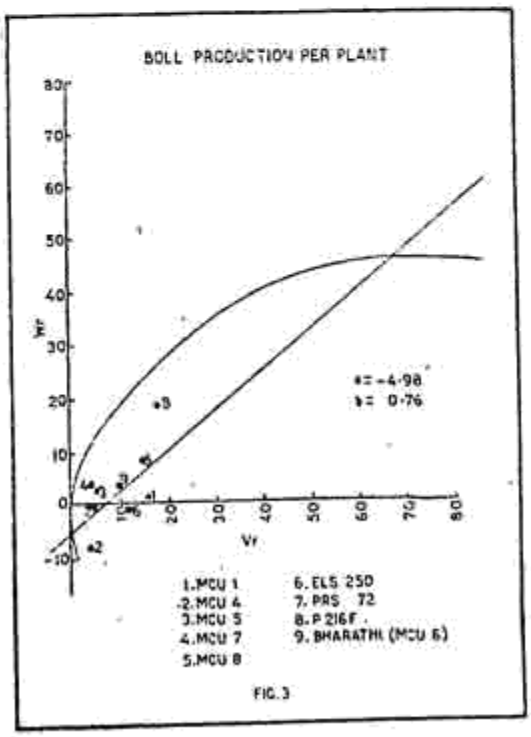

FIG.3

zygous, while partial heterozygous nature of MCU 5, MCU 7, MCU 8 and P216 F was indicated by their location in between the limiting parabola and the regression line The closer location of the varieties indicated the limited genetic diversity among the varieties for this character. The predominant role of dominance to overdominance relating to additive gene effect in this character indicated that phenotypic selection will be infructuous. Therefore efforts should be made to shift the epistasis to high dominance background. For this purpose the varieties with more dominant alleles namely MCU 5 and MCU 7 can be profitably exploited.

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