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GENETIC ANALYSIS OF COMPONENTS OF GROWTH IN *GOSSYPIUM HIRSUTUM* L.

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A diallel analysis involving cotton varieties, LSS, M4, 4F and Acala 1517C was made during the year 1967-68 to investigate the mechanisms of control for the characters, dry weight, leaf area, relative growth rate (RGR) and net assimilation rate (NAR). The inheritance pattern indicated for the characters like dry weight, leaf area and RGR varied from full dominance to over-dominance while, for NAR, the results were non-significant.

INTRODUCTION

Considerable work on understanding the nature of genetic control of yield and quality characters in *Gossypium hirsutum* L. has been done in Pakistan, but very little information is available on the inheritance pattern of components of growth of cotton plant under our conditions.

The works of Crowther (1934), Tiver (1942), Tiver and Williams (1943), Watson (1947 & 1952) and Khan (1963) give an indication of the magnitude of variability of these characters within, and between, different crop species and also their influence on the final crop yield. This type of information is essential to the synthesis of an efficient genotype and thus is the intent of the present study.

MATERIALS AND METHODS

Four varieties of cotton viz., LSS, 4F, M4 and Acala 1517C (*G. hirsutum* L.) were used in making reciprocal crosses in 1968.

The hybrid seed of 12 crosses along-with the parents was sown in 1968 in 12" x 12" earthern pots placed in the open, in a completely randomized design, with three repeats. In all, 192 pots were used for the study. The

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pots were filled with clay mixed with farmyard manure. Eight seeds were sown per pot, but later seedlings were thinned to only three vigorous plants and for various determinations mean of these was taken. Irrigation was applied thrice a week. Three harvests were taken at fortnightly from sowing and the fourth one at maturity.

Leaf area was determined at first, second and third harvests, while dry weight was taken at all harvests. The data with regard to dry plant weight and total leaf area were recorded and two components of growth, net assimilation rate (NAR) and relative growth rate (RGR) were calculated. In the case of dry weight, plant parts from harvest numbers 1 to 4 were dried by placing them in the oven at 60°C and then dry weights were obtained. Leaf areas from harvest numbers 1 to 3 were determined from leaf prints on ammonex paper. The print area/weight ratio was determined, and the area was calculated from the weight of the leaf prints excised from the paper.

The parameters employed in this section are NAR and RGR. RGR was calculated by the following formula derived by Blackman (1919) :-

$$RGR = \frac{\log_e W_2 - \log_e W_1}{(t_2 - t_1)}$$

Where W_1 and W_2 represented dry weights at the beginning and end of a time interval $(t_2 - t_1)$.

NAR was calculated from the formula of Williams (1946) :-

$$NAR = \frac{(W_2 - W_1)(\log_e L_2 - \log_e L_1)}{(t_2 - t_1)(L_2 - L_1)}$$

Where L_1 and W_1 were the leaf area and dry weight, respectively, at first harvest, and L_2 and W_2 were the leaf area and dry weight at the second harvest. The difference between t_2 and t_1 was the time interval between harvests.

STATISTICAL ANALYSIS.

The method of analysis applied to the present experiment was Fisher's (1958) analysis of variance technique. Comparison of varieties and their hybrids was made on the basis of the critical difference calculated from the following formula :-

$$\text{Critical difference} = \sqrt{\frac{2 \times \text{variance for error}}{\text{number of replications}}} \times t \text{ value}$$

Only those characters were analysed by the diallel fashion for which the differences were statistically sigificant. The diallel cross technique developed by Hayman (1954) and Jinks (1954, 1955 and 1956) was used for the genetic analysis.

RESULTS

Varietal differences for dry weight and leaf area were significant at the first harvest but changed to highly significant at the remaining harvests studied. The differences for RGR were highly significant for first and second harvests but significant for second and third. All these characters were genetically analysed using diallel technique. The differences for NAR were non-significant, hence diallel analysis was not applied. The average array means for all the characters from all harvests are given in Table I, and their variance (Vr) and Covariance (Wr) are plotted in figures 1 to 9.

DRY WEIGHT PER PLANT (gm) AT FIRST, SECOND, THIRD AND FINAL HARVESTS.

Graphic presentation of dry weight at first harvest (Fig. 1) revealed over-dominance with gene interaction but it changed to additive with partial dominance involving some interaction of genes at second and third harvests (Fig. 2 and 3). This expression reversed again to overdominance with gene interaction at final harvest (Fig. 4). From the position of array points on the regression line (Fig. 1) it was evident that Acala 1517C possessed maximum dominant genes while 4F had maximum recessive. This relation, however, changed at second harvest where 4F due to its proximity to origin (Fig. 2) appeared to possess maximum dominant genes and M4 the minimum. At third harvest Acala 1517C emerged again as the carrier of maximum dominant genes with LSS of recessive genes. While at final harvest 4F (Fig. 4) regained its proximal position to origin, thus it appeared to possess maximum dominant genes with M4 possessing the minimum.

LEAF AREA PER PLANT (sq. cm) AT FIRST, SECOND AND THIRD HARVESTS.

Genetic expression for leaf area at first harvest (Fig. 5) was of over-dominance type and followed complete dominance with interaction of genes

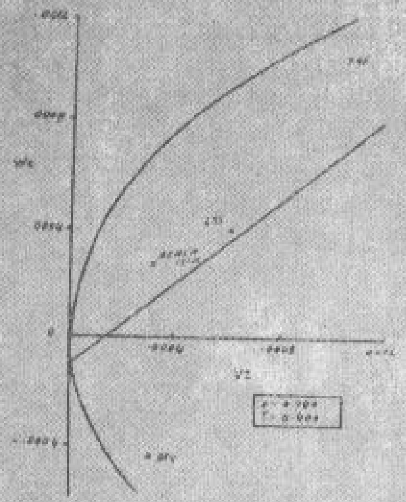


FIG 1: DRY WEIGHT AT FIRST HARVEST.

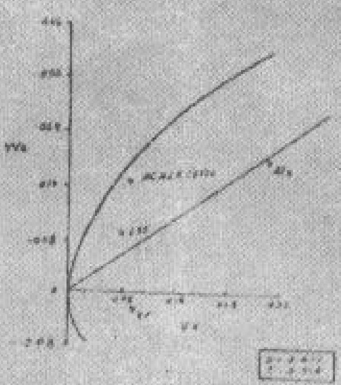


FIG 2 DRY WEIGHT AT SECOND HARVEST.

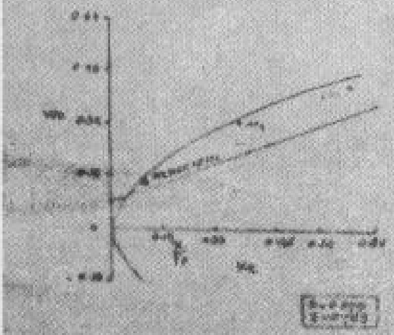


FIG 3. DRY WEIGHT AT THIRD HARVEST.

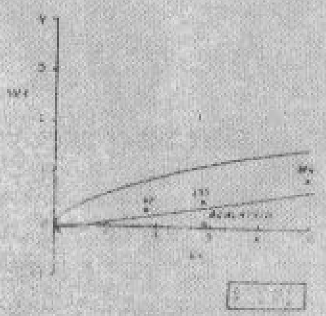


FIG 4. DRY WEIGHT AT FINAL HARVEST.

at second and third harvests (Fig. 6 and 7). From the study of the position of array points on the regression line, it was obvious that Acala 1517C being nearer to the origin in all three harvests possessed maximum dominant genes and 4F due to its position farthest from the origin in the first two harvests and LSS in the third, possessed recessive genes.

RELATIVE GROWTH RATE PER PLANT (gm/gm/day).

Vr/Wr graph for RGR between first and second harvests was plotted in Fig. 8, which indicated complete dominance with some interaction of genes. From the position of array points on the regression line it was clear that Acala 1517C being nearer to origin appeared to possess the dominant genes while 4F being away from it had recessive genes. The gene action for RGR between second and third harvests (Fig. 9) changed to additive type with partial dominance. The gene interaction appeared to be present here, too. The array points had also shifted their position, 4F, being closer to the origin, possessed maximum dominant genes while LSS being away from it had recessive genes.

DISCUSSION

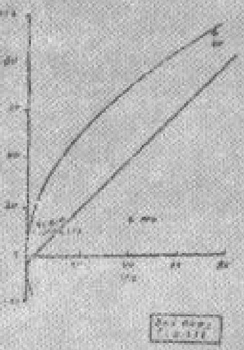
Crowther (1934), Tiver (1942), Tiver and Williams (1943) and Watson ((1947 and 1952) emphasised the importance of components of growth and their relationship with the final yield. They also showed significant differences with respect to leaf area, relative growth rate (RGR) and net assimilation rate (NAR) in different crops and also within the varieties of the same species. The results already described indicated significant differences with respect to leaf area and RGR but the results appeared to be in disagreement in respect of NAR in which case varietal differences were non-significant, at least within the limits of this experiment.

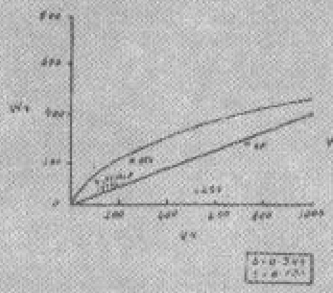
During the early growth stages the phenotypic manifestation of most of the components of growth was conditioned to different patterns of inheritance. It was overdominance to partial daminance for dry weight, overdominance to dominance with interaction for leaf area, and dominance to additive with partial dominance for RGR. Overdominance in a set of diallel crosses is obtained (Jinks 1954 and 1955 and Hayman 1958) when most of the progenies score more than either of their reciprocal parents. It appears that the F_1 progenies showed heterosis (Khan 1963 and Miller and Marani 1963).

In the case of dry weight (Table 1) Acala 1517C array had given the maximnm average values (0.163 at first harvest and 0.779 at second harvest) as compared to the rest of the array means, which means that Acala 1517C had better general combining ability at first and second harvests. Within the array, the cross, LSS x Acala 1517C gave better values (0.169 at first harvest and 0.837 at second harvest) as compared to other crosses, hence it appeared to possess better specific combining ability. This situation changed at third and final harvests, and 4F array had the better mean values (3.662 at third harvest and 13.12 at final harvest) as compared to the rest of the arrays, hence this variety seems to possess better general combining ability. Further, a study of the Table 1 showed that within the array, the cross LSS x 4F (4.166 at third harvest and 13.47 at final harvest) and 4F x M4 (3.730 at the third harvest and 14.61 at final harvest) gave the maximum values and thus appeared to possess better specific combining ability as compared to other crosses.

In the case of leaf area (Table 1) Acala 1517C array at first harvest had the higher average value (27.411) as compared to the other arrays, and possessed high general combining ability. Within the array, cross; 4F x Acala 1517C (27.971) appeared to possess the highest specific combining ability. But this situation altered at second and third harvests. At second harvest, LSS array (126.235) appeared to possess better general combining ability. Within the array. 4F with LSS (157.736) gave the maximum leaf area and thus possessed better specific combining ability. At third harvest the array situation changed again and 4F array gave a better mean value (327.355) and within array, cross, 4F x LSS (388.790) appeared to possess the highest specific combining ability in this respect.

The results for RGR (Table 1) also established the superiority of LSS array and within array 4F x M4 appeared to give the highest value (0.118). At the second and third harvests, 4F array with a mean value of (0.110) appeared to possess better general combining ability and within array, 4F x LSS gave the maximum value (0.113) and had better specific combining ability. In the case of NAR, no statistical varietal differences came out under the present environmental conditions. Further, it was seen that in the majority of the characters, the results were complicated by interaction of genes hence it seems rather difficult to operate straight forward selection for obtaining transgressive segregates. From these results it is also clear that it is not easy to define dominance relationships of genes for quantitative characters such as studied in this experiment. Within the limits of this experiment the same variety appeared to possess dominant genes under one harvest condition and recessive under another.





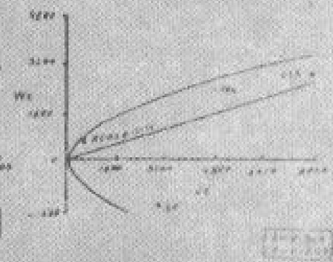


FIG 5: LEAF ARE AT FIRST HARVEST. FIG 6: LEAF AREA AT SECOND HARVEST. FIG 7: LEAF AREA AT THIRD HARVEST.

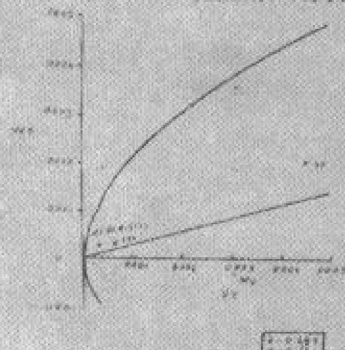


FIG 8: RELATIVE GROWTH RATE FROM FIRST & SECOND HARVESTS.

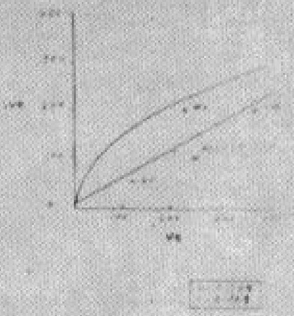


FIG 9: RELATIVE GROWTH RATE FROM SECOND & THIRD HARVESTS.

TABLE 1 *Mean Values for Parents and F_1 Hybrids for Various Characters.*

Genotype	Dry weight at first harvest	Dry weight at second harvest	Dry weight at third harvest	Dry weight at final harvest	Leaf area at first harvest	Leaf area at second harvest	Leaf area at third harvest	RGR from Ist & IInd harvests	RGR from IInd & IIIrd harvests
LSS	0.116	0.617	2.436	10 71	18.173	115.673	226.986	0.110	0.093
4F	0.190	0.568	3.645	11.37	36.710	100.596	297.423	0.070	0.120
M4	0.130	0.396	2.640	12.02	12.496	81.746	211.903	0.076	0.126
Acala 1517C	0.180	0.883	2.620	10.48	28.136	90.840	259.196	0.110	0.106
LSSx4F	0.135	0.765	4.166	13.47	22.513	157.736	388.790	0.111	0.113
LSSxM4	0.158	0.729	2.369	10.55	23.344	114.998	272.698	0.094	0.104
LSSxAcala 1517C	0.169	0.837	2.535	9.45	26.686	116.533	223.413	0-104	0.069
4FxM4	0.116	0.788	3.730	14.61	16.000	116.665	354.754	0.118	0.113
4Fx Acala1517C	0.164	0.710	3.106	13.04	27.971	99.939	268.453	0.104	0.095
M4x Acala 1517C	0.138	0.684	2.469	9.44	26.851	102.181	228.293	0.096	0.091
ARRAY MEAN									
LSS	0.145	0.737	2.877	11.05	22.679	126.235	262.972	0.105	0.094
4F	0.151	0.708	3.662	13.12	25.798	118.734	327.355	0.101	0.110
M4	0.136	0.649	2.802	11.66	19.673	103.898	251.912	0.096	0.108
Acala 1517C	0.163	0.779	2.683	10.60	27.411	102.373	244.839	0.104	0.090

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