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DIALLEL ANALYSIS OF SOME IMPORTANT CHARACTERS IN INTER-VARIETAL CROSSES OF COTTON (*G. HIRSUTUM L.*)

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Diallel analysis of some important characters like boll number, boll weight, yield of seed cotton, ginning out-turn, staple length, fineness and strength was made using six varieties of upland cotton, three local and three exotic from U. S. A., The inheritance pattern of yield, bolls per plant, and fibre strength appeared to be over-dominance with interaction of genes, while in the case of boll weight it was additive without interaction. Characters like ginning percentage, staple length and fibre fineness exhibited additive effects with partial dominance, involving some interaction of genes.

INTRODUCTION

The cotton plant (*G. hirsutum L*) which is being grown in this country for the last sixty years, has been the subject of continuous improvement, both with regard to yield and quality. A lot of hybridization work has been undertaken to synthesize better genotypes for the local environment For this purpose, promising exotic varieties are being crossed with local types. Diallel analysis provides an excellent means to obtain information on the type of gene action involved in various characters in early generations of crosses, This technique developed by Hayman (1954) and Jinks (1954, 1955 and 1955) has been successfully applied by Whitehouse *et. al.* (1958) on Wheat, by Breese (1960) on *Lolium perenne*, Kheiralla and Whittington (1962) on *Lycopersicum esculentum* and L, *pimpinellifolium L.* and Khan (1963) for the analysis of varietal differences in linseed and Flax. Miller and Marani (1963), White (1966), White and Richmond (1963), and Verhalen and Murray (1957) also used this technique to investigate the genetic mechanism controlling various economic characters in cotton. The present study was aimed at finding out the genetic mechanism controlling some of the important characters in inter-varietal crosses by the diallel technique, to help accelerate the current breeding work.

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MATERIALS AND METHODS

The present studies were conducted in the department of Plant Breeding and Genetics, University of Agriculture, Lyallpur. Three local varieties of cotton viz, L.S.S., AC 134 and L 15 and three from U.S.A., viz, Coker Carolina Queen, Fox and stoneville, were crossed in all possible combinations, including selfs and reciprocals. The hybrid seed of 30 families along with the parents was planted in the field in a randomized complete block design with 4 replications. The sowing was done by dibbling three seeds per hole, to obtain a uniform stand later thinned to one. The distance between the rows was 2½ feet and one foot between the plants in rows. Seven plants of each family were grown in each row. of which the middle five were treated as experimrntal plants. The data with respect to boll number, boll weight, yield of seed cotton, ginning out-turn, staple length, fibre fineness and fibre strength were recorded on the first-generation hybrids and their parents at the appropriate plant growth stages according to standard methods.

Statistical Analysis

The data were subjected to the analysis of variance technique and comparisons of the varieties and their hybrids were based on LSD. Only those characters were analysed genetically by the diallel fashion in which the differences were statstically significant.

For diallel analysis all the crosses were arrangad into arrays. Two statistics, the variance (Vr) of the family mean with in an array, and the covariance (Wr) of the family means with the non-recurrent parental values were culculated from each diallel table and information on gene interation was obtained by plotting the covariance (Wr) of each array against its variance (Vr) (Fig. 1—7). The slope and the position of the regression line fitted to the array points within the limiting perabola ($Wr^2 = \frac{V}{P} Vr$) indicated the degree of dominance and presence or absence of gene interaction. All the conditions of diallel analysis were assumed to hold good.

RESULTS AND DISCUSSION

The results for boll numbers boll weight, yield of seed cotton, ginning outturn, staple length, fibre fineness and fibre strength were highly significant which were analysed by the diallel technique. The average array means for all the characters ere given in Table I and diallel figures plotted for each character separately.

TABLE 1. *Mean performance of various cotton characters.*

Geno-type	Boll number	Boll weight (gm)	Yield of seed of cotton (gm)	G.O.T. (%)	Staple length in (gm)	Fibre fineness (ug/inch)	Fibre strength (thousand lbs/sq inch)
L.S.S.	17.22	2.50	43.37	32.76	21.92	5.86	91.95
AC 134	20.53	3.27	65.16	36.41	26.51	4.37	96.07
L. 15	13.27	3.97	52.54	35.65	26.93	4.11	97.95
C.C. Queen	10.78	5.03	54.63	39.29	28.10	4.75	100.10
Fox	12.99	3.97	47.62	38.54	25.79	4.58	92.77
Stoneville	11.19	3.13	46.34	37.67	26.28	4.61	96.10
LSS x AC 134	18.91	3.05	57.94	35.65	23.37	4.93	95.34
LSS x L 15	21.61	3.33	69.79	35.80	25.87	4.91	94.69
LSS x C.C. Queen	27.81	3.12	86.88	36.05	26.10	4.55	93.48
LSS x Fox	16.28	3.65	55.42	34.10	25.09	4.95	91.30
LSS x Stoneville	17.28	3.03	52.12	34.60	25.52	5.13	97.35
AC 134 x L. 15	13.61	4.22	57.59	35.30	25.78	4.49	92.56
AC 134 x C.C. Queen	17.09	4.55	77.29	36.56	26.93	4.33	94.38
AC 134 x Fox	26.03	3.36	72.03	35.60	25.44	4.52	89.80
AC 134 x Stone-ville	18.09	3.87	70.20	25.86	26.13	4.64	99.30
L. 15 x C.C. Queen	13.70	3.97	55.12	35.64	25.44	4.17	89.99
L. 15 x Fox	23.23	3.68	73.31	34.83	26.13	4.34	90.29
L. 15 x Stone-ville	15.20	4.18	64.50	35.22	25.66	4.38	97.09
C.C. Queen x Fox	10.95	4.46	49.17	38.20	26.31	4.22	97.63
C.C. Queen x Stoneville	12.41	4.36	53.27	37.87	25.42	4.32	94.50
Fox x Stoneville	17.75	3.32	69.50	35.05	25.50	4.35	92.76

Average Boll Numbers per Plant

It is clear from Fig 1 that Vr/Wr regression line cuts the Wr axis below the point of origin, which indicates over-dominance for this character. Since the regression line deviates significantly from a unit slope, interaction of gene is also involved. The variety stonevill lying closer to the point of origin, possesses most of the dominant genes, while C. C. Queen being away from it, contains recessive genes. Bolls per plant is conditioned by over-dominance with interaction of genes, so this character also shows heterosis. These results are similar to those of Miller and Marani (1963) and Salam (1967) who reported number of bolls in cotton were conditioned by over-dominance. Dominant genes carried by stoneville cause increase in the number of bolls on crossing with most of the varieties under test.

Average Boll Weight

It is seen from Fig. 2 that the Vr/Wr regression line with almost a unit slope interceptes the Wr axis above the origin thus indicating additive type of gene action with partial dominance of this character. The position of array points on the regression line indicates that L-15 being near the origin has maximum dominant genes, while C. C. Queen carries most recessive ones, being away from it. In view of this, L 15 can be used to obtain segregates with heavy boll weight in the present set of crosses.

Yield of Seed Cotton.

A study of Fig 3 shows that the Vr/Wr regression line passes through the Wr axis on the negative side, signifying over-dominance for this character. As the regression line deviates significantly from the unitslope, some non-allelic interaction also appears, involved in the expression of this. The character also exhibited heterosis as also for boll numbers.

From the position of array points on the regression line it is clear that AC 134 carries maximum dominant genes, which gave higher yield when crossed with all the exotic types. CC. Queen though carrying recessive genes gave higher yield when crossed with local varieties. The results are in agreement with Miller and Marani (1963) and Salam (1957), who observed heterosis in varietal crosses of cotton.

Ginning Outturn.

A reference to variance (Vr) and co-variance (Wr) graph plotted in Fig. 4 reveals that Vr/Wr regression line intercepted the Wr axis just near the

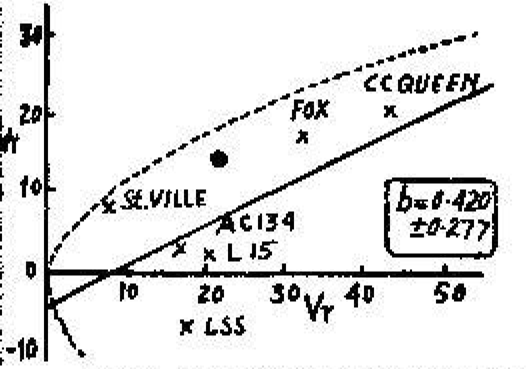

FIG. 1. NO. OF BOLLS PER PLANT.

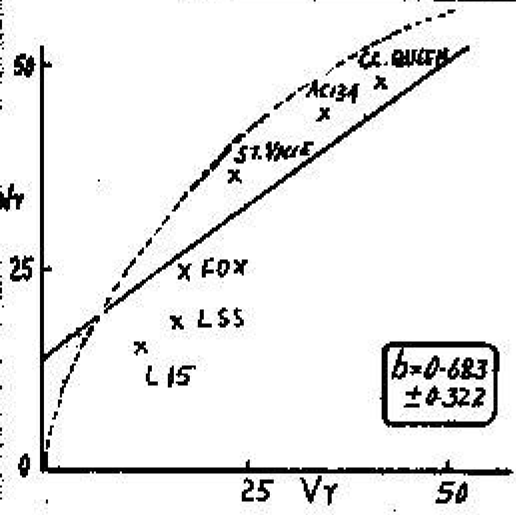

FIG. 2. AVERAGE BOLL WEIGHT.

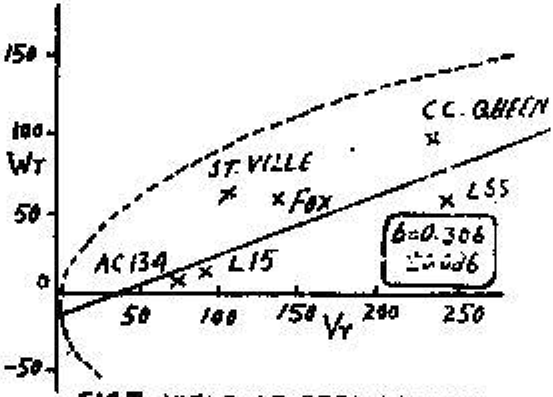

FIG. 3. YIELD OF SEED COTTON.

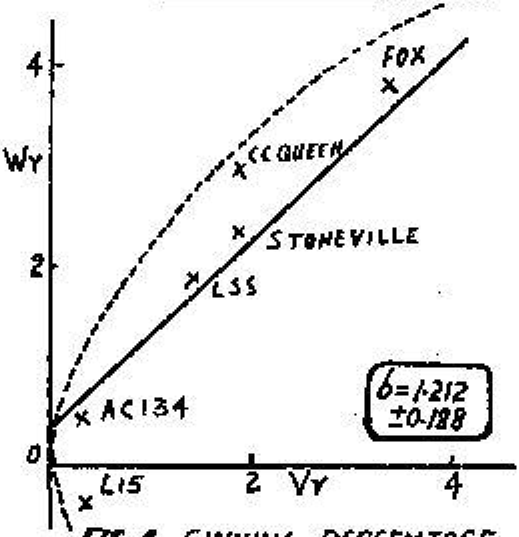

FIG. 4. GINNING PERCENTAGE.

origin but deviating from a unit slope: thus indicating additive type of gene action with partial dominance complicated with genic interaction. Since AC 134 lies closer to the origin, it possesses most dominant genes. White (1966) and Salam (1967) reported that additive gene action influenced lint percentage. The present results partially agree with those of these workers.

Staple length.

Fig. 5 shows that the regression line touches the Wr axis just above the point of origin and it also deviates from a unit slope. The position of array points on the regression line shows that stoneville being nearest to the origin carries most dominant genes, while the distal position of L.S.S. indicates that it has the maximum recessive genes for staple length. This character appears to be controlled by the additive type of gene action with partial dominance, involving also interaction of genes. The results appear to agree partially with Harland (1939) christidis and Harrison (1955) who found F_1 to be intermediate in staple length. Verhalen and Murray (1967) reported that long fibre was on the average partially dominant over Short, and Salam (1967) found staple length to be inherited additively with little dominance in a diallel cross of *G. arboreum* L.

Fibre Fineness.

It can be seen from Fig. 6 that the regression line passes through the Wr axis just above the origin, indicating additive type of gene action with partial dominance. Some interaction of genes is also involved. as the regression line deviates from a unit slope. The position of array points on the regression line indicates that C.C. Queen contains most of the dominant genes, while L.S.S. the recessive ones for this character, because of their relative position from the point of origin.

Charistidis and Harrison (1955) stated that coarsness was dominent over fineness. Varhalen and Murray (1967) in a set of diallel crosses reported that dominant genes increased fibre coarsness while other decreased it. In the present crosses, dominant genes carried by C.C. Queen tend to increase fibre fineness when crossed with any of the remaining five varieties. In view of interaction present with additive gene action controlling fibre fineness; chances of getting transgressive segregates in the subsequent generations appear modest.

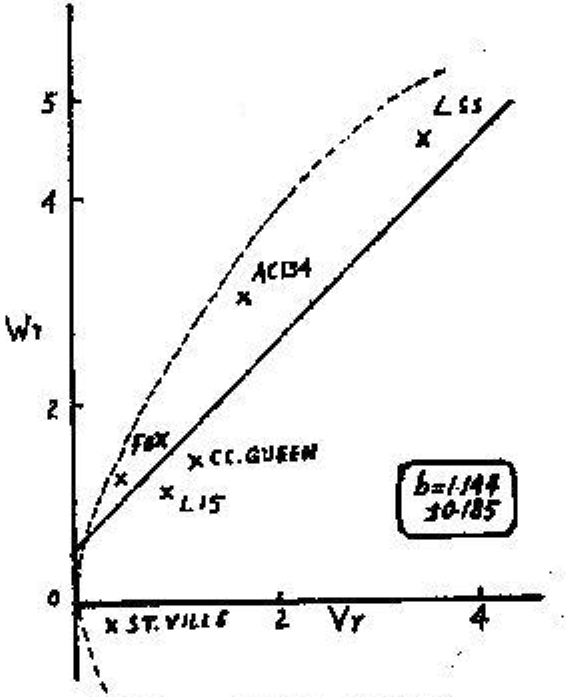

FIG. 5. STAPLE LENGTH.

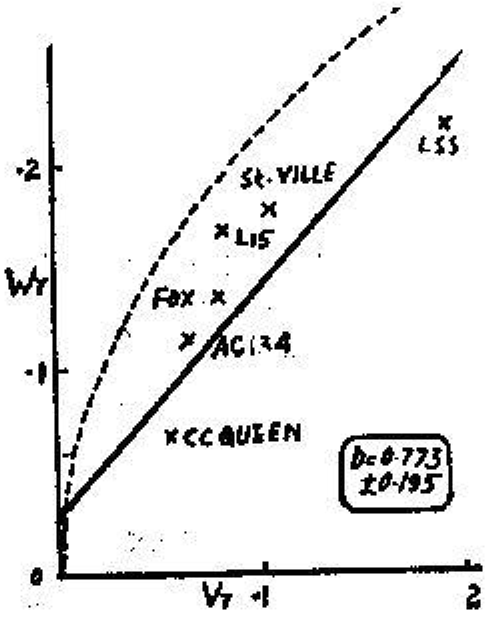

FIG. 6. FIBRE FINENESS.

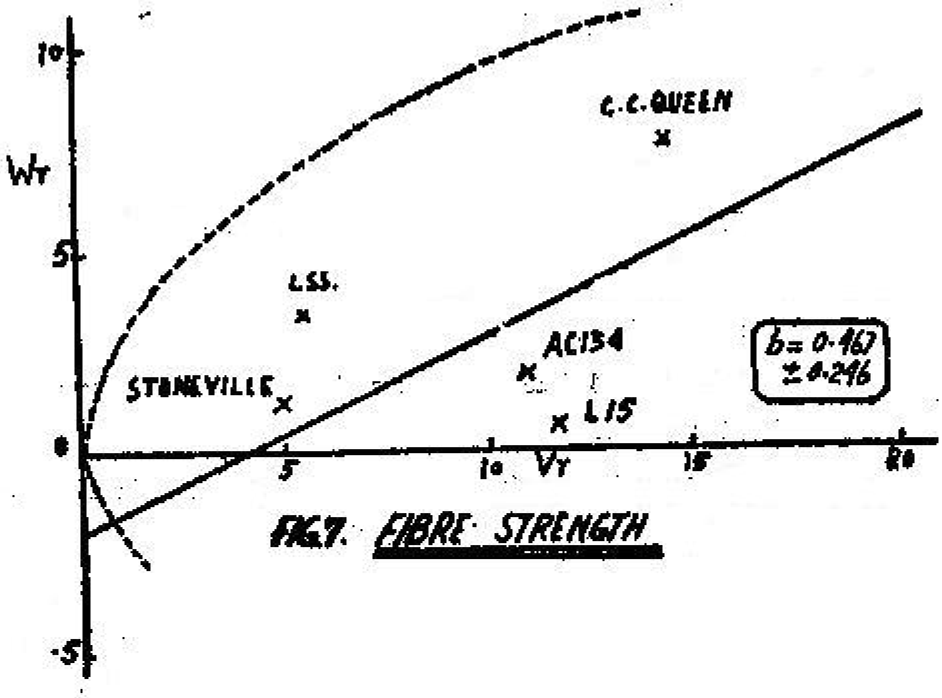

FIG. 7. FIBRE STRENGTH

Fibre Strength.

As seen from Fig. 7, the regression line passes through the Wr/axis below the origin and also deviates significantly from a unit slope which indicates over-dominance with interaction of genes. The relative position of array points on the regression line indicates that Fox and Stoneville have the maximum number of dominant genes while C. C. Queen has most regessive genes for this character. Verhalen and Murray (1967) observed that additive gene action appeared to govern strength in a set of diallel crosses in upland cotton and some dominant genes appeared to increase it, while other decrease it. In the present crosses, however, fibre strength appears to be inherited by over-dominance with interaction of genes and the results thus partially agree with those of Ware and Harrel (1944) Richmond (1950) and Self and Henderson (1954). Dominant genes carried by stoneville tend to increase strength in most of the local and exotic crosses.

LITERATURE CITED

1. Breese, E. L. 1960. The genetic assessment of breeding material. Proc. 8th Internat. Grassl. Congr, 45-48.
2. Christidis, B. G. and G. J. Harrison 1955. Cotton Growing Problems. Mc-Graw Hill Book Co. New York, U.S,A. Ist Ed. 37 and 50.
3. Harland, S. C. 1939. The genetics of cotton. Jonathan Cape, London, 1st Ed. 122-124 and 139.
4. Hyman B. L. 1954. The theory of analysis of diallel crosses. Biometrics. 10: 235-45.
5. Jinks J. L. 1954. The analysis of continuous variation in diallel crosses of *Nicotiana rustica* varieties. Genstics. 39: 767-768.
6. Jinks J. L. 1955. A survey of genetical basis of heterosis in a variety of diallel crosses. Heredity. 9: 223-238. (Plt. Breed. Abst. 26 (2): 828, 1956).

7. Jinks J. L. 1956. The F_2 and backcross generations from a set of diallel crosses. Heredity. 10: 1-30. (Plt. Breed. Abst. 127 (2)$_a$: 1011, 1957).

8. Khan M. A. 1963. Physiologic and genetic analysis of varietal differences within *Linum* usitatissimum (flax and linseed) Ph. D. thesis: University of Wales (U.K.)

9. Kheiralla, A. I., and W. J. Whittington 1962. Genetic analysis of growth in tomatoes. The F_1 generation. Ann. Bot. N. S. 26: 489-504.

10. Marani, A. 1963. Heterosis and Combining ability for yield and component of yield in diallal crosses of two species of cotton. Crop Sci. 3 : 552-555.

11. Miller. P. A., and A. Marani 1963. Heterosis and combining ability in diallel crosses of upland cotton (*G. hirsutum* L.) Crop Sci. 3: 441-444.

12. Richmond, T. R. 1950. The genetics of certain factors responsible for lint quality in American upland cottons. Texas Agr. Expt. Sta. Bult. 716: 42.

13. Salam, A. 1967. Genetic analysis of varietal differences within varieties of Desi cotton (*G. arboreum* L.) M. Sc. Thesis, WPAU., Lyallpur.

14. Self. F. W. and M. T. Henderson 1954. Inheritance of fibre strength in crosses between the upland cotton varieties AHA 50 and, Half and Half. Agron. Jour. 46 : 151-154.

15. Verhalen, L. M., and J. C. Murray, 1967. A diallel analysis of several fibre properties traits in upland cotton (*G. hirsutum* L.) Crop Sci. 7 : 501-505.

16. Ware J. C. and D. C. Harrell. 1944. Inheritance of strength of lint in upland cotton. Jour. Amer. Sci. Agron. 36 : 976-87.

17. Whitehouse R. N. H., J. B. Thompson and M. A. M. Ribeiro, 1958. Studies on the breeding of self pollinated cereals. The use of diallel cross analysis in yield predication. Eyphytica. 7 : 147-169

18. White, T. G. 1966. Diallel analysis of quantitatively inherited characters in *G. hirsutum* L. Crop Sci. 6 : 253-255.

19. White, T. G. and T. R. Richmond 1963. Heterosis and Combining ability in top and diallel crosses among primitive, foreign and cultivated American Upland Cotton. Crop Sci. 3: 58-63.