Pak J. Agri. Sci., Vol. 20 (3-4), 1983

DIALLEL ANALYSIS FOR GENE ACTION AND COMBINING ABILITY ON COTTON (*GOSSYPIUM HIRSUTUM* L.)

A. S. Khan, M. A. Khan, I. A. Khan and A. Khaliq*

ABSTRACT

The gene action controlling different characters of cotton (Gossypium hirsutum L.) was studied in a 6×6 diallel cross experiment. Yield of seed cotton and ginning outturn percentage were found to be controlled by overdominance while staple length by additive type of gene action. Non-allelic interaction was important in the expression of all the characters. For combining ability, AC 134 and B 557, the local varieties, performed better as compared to the introductions involved in these studies.

INTRODUCTION

Biometrical techniques dealing with the genetic analysis of varietal differences in different field crops have led to the development of specific procedures which have helped the plant breeder to synthesize the superior genotypes of various crop plants and thus increasing the production on a unit area basis. Hayman's (1954) diallel technique for genetic analysis of different genotypes has also been frequently advocated by various plant breeders and geneticists like allard (1956), Whitehouse *et al.* (1958), Khan (1963), White and Kohel (1964), Mirza (1969) and Khan *et al.* (1980) for its efficiency and usefulness,

Whereas cotton is an important cash crop of Pakistan, its yield on a unit area basis is drastically lower when compared with other cotton growing countries of the world. It occupies 29th position in this respect (I. C. A. C., 1981). This vulnerability in cotton provokes the national cotton breeders to look into its genotypes for further improvement and develop better yielding varieties.

* Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

In this connection the inheritance pattern of different characters of the plant and also the estimates of combining ability of different genotypes to be used in future breeding programmes are the pre-requisites for the breeders.

With this in view, a 6×6 diallel cross experiment on cotton to study gene action and combining ability for various plant characters was started in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, during the year 1977-79 and the information collected is presented in the following pages.

MATERIALS AND METHODS

Six varieties of upland cotton (*G. hirsutum* L.) including two local viz., AC 134 and B 557 and four exotic i. e,, Max 12, Menair 210, Hybee 200 and Delfos were crossed in all possible combinations during the year 1977 and the F_1 seed of all the crosses (including reciprocals thus obtained alongwith selfs were sown in the field in May, 1978. The layout of the experiment was according to randomized complete block design with three replications. Sowing was done by dibbling three seeds per hole to ensure uniform stand, later thinned to only one plant per hill. Out of nine, middle five plants of each family were treated as experimental. The distance between and within the rows was 30" and 15", respectively. The data in respect of yield of seed cotton per plant, ginning outturn and staple length were collected according to the standard techniques prevalent in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

Fisher's (1958) analysis of variance was used for the statistical analysis of data for these characters. For genetic analysis diallel cross technique developed by Hayman (1954) and Jinks (1954) and as applied by Whitehouse *et al.* (1958) and Khan (1963) was used.

RESULTS AND DISCUSSION

The averaae values for yield of seed cotton, ginning outturn and staple length are shown in Tables 1, 2 and 3 and the Vr/Wr graphs are depicted in Fig. i, ii and iii, respectively.

A study of Fig. 1 (yield of seed cotton) reveals that the regression line passes through the Wr axis below the origin thus signifies overdominance. As the regression line deviates significantly from the unit slope; the phenotypic manifestation of this character appears to be complicated with some interaction of genes. Mex 12 being the most proximate to the origin had most dominant genes while B557 possessed the recessive genes for this character. Further a study of Table 1, indicates that AC134 having the highest array mean is better general combiner as compared with others, and is closely followed by B557 in this respect. Within AC 134 array, the cross of AC134 and Hybee 200 has the highest value which establishes its superiority for specific combining ability for this character.

Similarly, ginning outturn is also controlled by overdominance type of gene action as the regression line cuts the Wr axis below the origin. As the line deviates significantly from the unit slope, therefore, some kind of gene interaction is also involved in the expression of this character. The position of the array points on the regression line indicates that Mex 12 being closer to the origin possesses maximum dominant genes, while AC134 being away from the origin has most of the recessive alleles (Fig II). A study of Table 2 shows that Mcnair 210 array has maximum mean values; thus signifies better general combining ability and is closely followed by AC134. Within Mcnair 210 array, the cross of Mcnair 210 and AC134 has the highest value showing the highest specific combining ability. Jinks (1954) concluded from a diallel analysis in tobacco that interaction of genes and overdominance were responsible for a large proportion of observed heterosis in the F_1 progeny. Jinks (1955) further reported that where overdominance occurred, there was also an interaction between the non-allelic genes. Similarly, Salam and Khan (1969) and Mirza (1969) have observed while working on cotton that overdominance occurred in a set of diallel crosses when most of the progenies scored more values than the parents.

A perusal of Fig III for staple length depicts that regression line passes the Wr axis above the origin showing additive types of gene action. As the

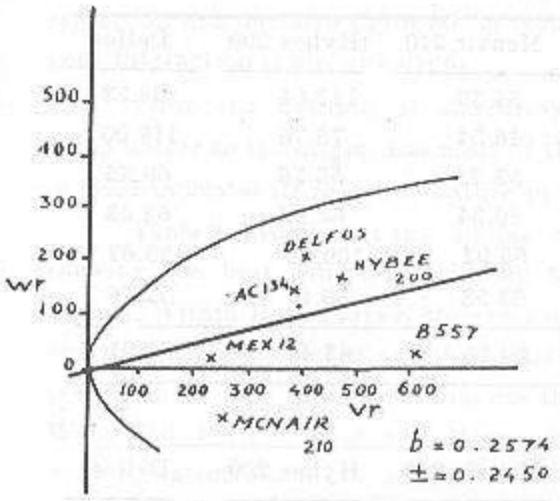

FIG. I. Vr/Wr GRAPH. YIELD OF SEED COTTON

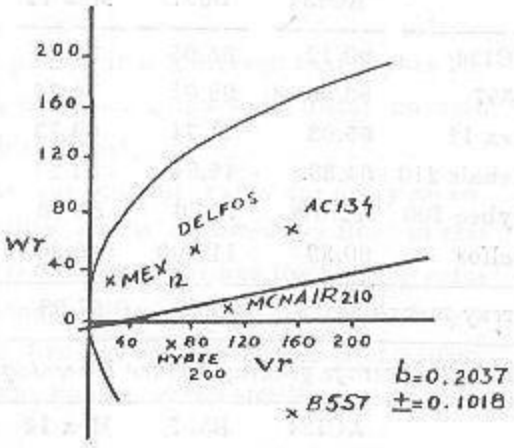

FIG. II. Vr/Wr GRAPH. GINNING OUTTURN % AGE

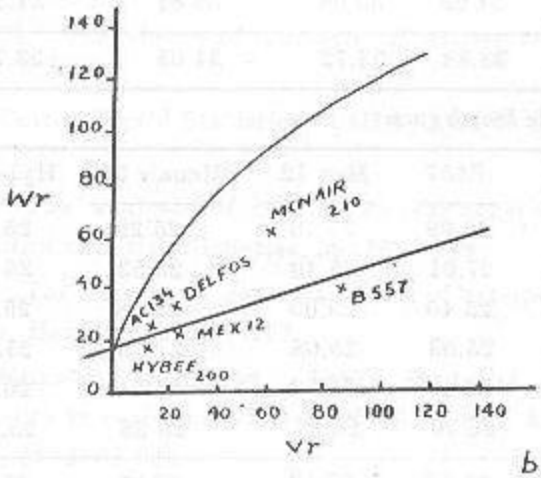

FIG. III. Vr/Wr GRAPH. STAPLE LENGTH

Table 1. *Average yield of seed cotton per plant (gm)*

	AC134	B557	Mex 12	Menair 210	Hybee 200	Delfos
AC134	90.12	96.05	85 03	54.39	112.84	90.33
B557	96.05	99.01	74 74	46.54	76.76	118.00
Mex 12	85.03	74.74	69.73	53.29	55.26	69.85
Menair 210	54.39	46.54	53.29	80.34	65.92	63.53
Hybee 200	112.84	76.76	55.26	65.92	100.32	89.67
Delfos	90.33	118.00	69.85	63.53	89.67	72.70
Array means	88.12	85.18	67,98	60.66	83.46	84.01

Table 2. *Average ginning outturn percentage*

	AC134	B557	Mex 12	Menair 210	Hybee 200	Delfos
AC134	35.46	32.67	34.27	35.42	32.50	33 41
1 557	32.67	35.29	33.25	32.27	34.84	34 99
Mex 12	34.27	33.25	34.04	34.14	35.58	33.08
Menair 210	35.42	32.27	34.14	34.64	33.96	33.87
Hybee 200	32.50	34 84	33 58	33.96	33 23	34.38
Delfos	33.41	34 99	33 08	33 87	34.38	32.53
Array means	33.95	33.88	33.72	34.05	33.74	33.71

Table 3. *Average staple length (mm)*

	AC134	B557	Mex 12	Menair 210	Hybee 200	Delfos
AC134	25.94	26.09	25 10	25.29	25.85	25.94
B557	26.09	27.01	25.40	25.53	26.49	26.70
Mex 12	25.10	25.40	25.00	25.08	25.62	26 37
Menair 210	25.29	25.53	25.08	27.16	25.54	26.38
Hybee 200	25.85	26.49	25.62	25.54	26.22	25.86
Delfos	25.94	26.70	26.37	26.38	25.86	27.27
Array means	25.70	26.20	25.42	25.83	25.93	26.42

regression line deviates significantly from the unit slope therefore, some kind of gene interaction is also involved.

From the position of the array points it is observed that Hybee 200 being nearer to the origin, has most of the dominant genes while distal position of B557 indicates its recessive nature in this respect.

Table 3 reveals that the Delfos has the highest value for array mean, showing the best general combining ability and is followed by B557 in this respect. Within Delfos array, the cross of Delfos and B557 has the highest value and thus indicates better specific combining ability so far as the staple length is concerned. This situation supports the findings of Whitehouse *et al.* (1958), White and Kohel (1964) and Mirza (1969) who observed similar results while working on cotton.

REFERENCES

Allard, R. W. 1956 The analysis of genetic environmental interaction by means of diallel crosses. Genetics, 41: 305—318.

Fisher, R. A 1958, Statistical Methods for Research Workers (13th ed). Oliver and Boyd, London, pp 248—298.

Hayman, B. I. 1954. The theory of analysis of diallel crosses. Biometrics, 10:235—24 .

I. C. A. C. 1981. Cotton World Statistics. I. C. A. AC., U. S. A. 34 (9):1—139 (Part—II).

Jinks, J. L. 1954 The analysis of continuous variation in diallel cross of *Nicotiana rustica* varieties. Genetics, 39: 767 – 788.

Jinks, J. L. 1955. The survey of genetical basis of heterosis in a variety of diallel crosses. Heredity, 9:223—237.

Khan, I. A., I. A. Khan and M. Ahmad. 1980. Study of gene action and combining ability in various characters of cotton (*G. hirsutum* L.) The Pak. Cottons, 24 (3):57-62.

Khan, M. A. 1963. Physiololgical and genetic analysis of varietal differences

within *Linum usitatissium* (Flax and Linseed). Ph. D. Thesis, Univ. of Wales (U. K.)

Mirza, M. A. 1969. Genetic studies in some interspecific crosses of *G. hirsutum* L. M. Sc. Thesis, WPAU, Lyallpur.

Salam, A. and M. A. Khan. 1969. Diallel analysis of yield of seed cotton ginning outturn and staple length in *G. hirsutum* L. Pak. J. Agri. Sci. 6: 185—193.

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 prediction. Euphytica, 7: 146—169.

White, T. G. and R. J. Kohel. 1964. A diallel analysis of agronomic characters in selected lines of cotton. Crop Sci. 4:252—257.