Pak. J. Agri. Sci., Vol. 30, No. 1, 1993

GENETIC ANALYSIS OF SOME QUANTITATIVE PLANT CHARACTERS IN UPLAND COTTON I. YIELD AND ITS COMPONENTS

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Mean squares for both general and specific combining ability, and reciprocal effects were highly significant for the expression of yield of seed-cotton, number of bolls, boll weight, seed index and lint index. The larger proportion of variance resulting from specific combining ability revealed genetic effects to be predominantly non-additive for all the characters. An old and obsolete variety LSS proved to be the best general combiner for yield of seed-cotton and boll number, whilst E 288, an exotic, displayed its superiority for the manifestation of boll weight, seed and lint indices.

INTRODUCTION

The manifestation of variation in seed-cotton yield and its components had been reported under both additive and non-additive genetic effects. Greater magnitude of variance due to specific combining ability for seed-cotton yield, number of bolls plant^{-1} and boll weight than that due to general combining ability, revealed action of the genes non-additive for these characters (Desai *et al.*, 1980; Walida *et al.*, 1980; Duhoon and Singh, 1983; Azhar *et al.*, 1983). In contrast Azhar and Akbar (1992) noted that variation in seed-cotton yield and number of bolls plant^{-1} was conditioned by the genes showing additive effects. The seed index and lint index were shown to be under additive genetic control (Ghafoor and Khan, 1987), however the data reported by Walida *et al.* (1980), Duhoon and Singh (1983) and Azhar and Akbar (1992) revealed that both additive and non-additive gene actions were equally important for the manifestation of seed index and lint index.

The present study envisages the analysis of plant material comprising a small sample of cotton genotypes/lines in order to find the genetic mechanism of yield and its components.

MATERIALS AND METHODS

The plant material used in the present investigations was developed by crossing four diverse varieties/lines, viz. PO/695-FG, ABG0904, E288 and LSS, all belonging to *hirsutum* species. The four parents were grown under controlled conditions during the month of December, 1990. The temperature required for germination, proper growth and development (80-120°F) was maintained by using electric heaters. The daylight during winter was supplemented by lighting mercury vapour lamps of 400 watts. When the parental lines started to flower these were crossed in all possible combinations. Some of the buds of the parents were also selfed. Maximum number of crosses were made to develop sufficient F_1 seed. All the necessary precautions were taken at the time of emasculation and pollination to avoid alien pollen contamination.

The F_1 seeds of the twelve hybrids (including reciprocals) and the parents were planted in the field during normal planting season, 1992. The seeds of the 16 entries were dibbled in triplicate in single row plot, each 2.1 m long having eight plants spaced 30 cm within the rows which were 75 cm apart. Planting was done according to randomized complete block design. At maturity, number of bolls born on the central six plants from each of the families in three replications were counted, and all of them were picked to record yield of seed-cotton of individual plant. One plant on either end of the row was left as non-experimental. The data on boll weight, seed index and lint index were recorded in the laboratory.

The mean values of the 16 entries in each replication were analysed according to analysis of variance technique to determine the genotypic differences for all the characters. Combining ability analysis of the data was made following 'Method 1' and 'Model 11' of Griffing technique (Griffing, 1956).

RESULTS AND DISCUSSION

The analysis of variance revealed that all the genotypes were significantly different ($P \leq 0.01$) from each other for all the characters (Table 1). The variation observed in each of the characters might be due to general combining ability (gca) and specific combining ability (sca) as suggested by Sprague and Tatum (1942), and reciprocal effects (Griffing, 1956). The importance of each of the causal components was ascertained. The results of the combining ability analysis (Table 2) revealed that the variation

Table 1. Mean squares from analysis of variance for yield of seed-cotton and its components

Source of variance	df	Yield of seed-cotton	Number of bolls	Boll weight	Seed index	Lint index
Blocks	2	22.93^{NS}	2.13^{NS}	0.10^{NS}	0.01^{NS}	0.24*
Genotypes	15	1085.01**	61.78**	0.80**	1.18**	0.68**
Error	30	58.04	3.63	0.08	0.03	0.05

Table 2. Mean squares from combining ability analysis for yield of seed-cotton and its components

Source of variance	df	Yield of seed-cotton	Number of bolls	Boll weight	Seed index	Lint index
gca	3	329.04**	36.54**	0.76**	0.77**	0.19*
sca	6	637.28**	25.85**	0.17**	0.37**	0.23**
Reciprocals	6	102.46**	5.50*	0.07^{NS}	0.21**	0.24**
Error	30	19.35	1.21	0.03	0.01	0.02

*, ** denotes differences significant at $P \leq 0.05$ and 0.01, respectively, whilst NS shows non-significant ($P \geq 0.05$).

in yield of seed-cotton, number of bolls plant^{-1}, boll weight, seed and lint indices appeared to be significantly ($P \leq 0.01$) affected by the three components, except boll weight in which case reciprocal effects were non-significant.

dex (57.89) and lint index (54.17) than those resulting from gca and reciprocal effects. According to Griffing (1956) the greater contribution of sca towards the expression of variation was due to the presence of genes acting non-additively, and thus the charac-

Table 3. Estimates of components of variance for yield of seed-cotton and its components. The values in parenthesis are the percentage of variance due to respective sources

Variance components	Yield of seed-cotton	Number of bolls	Boll weight	Seed index	Lint index
gca (σ^2_g)	-32.59 (-7.98)	1.57 (7.81)	0.08 (36.36)	0.05 (13.16)	-0.02 (-8.33)
sca (σ^2_s)	380.26 (93.07)	15.16 (75.46)	0.09 (40.91)	0.22 (57.89)	0.13 (54.17)
Reciprocal (σ^2_r)	41.56 (10.17)	2.15 (10.70)	0.02 (9.09)	0.10 (26.32)	0.11 (45.83)
Error (σ^2_e)	19.35 (4.74)	1.21 (13.64)	0.03 (2.63)	0.01 (8.33)	0.02 (8.82)

Table 4. Estimates of gca of four parental lines for yield of seed-cotton and its components

Varieties	Yield of seed-cotton	Number of bolls	Boll weight	Seed index	Lint index
LSS	9.47	2.72	-0.14	0.24	-0.22
ABG0904	-1.60	0.10	-0.07	-0.01	0.04
E288	-3.88	-2.47	0.45	0.44	0.10
PO/695-FG	-3.99	-0.33	-0.24	0.19	0.09
cd (g_i - g_j)	12.85	3.21	0.53	0.29	0.41

The comparison of percentage of the variance components (Table 3) depicted that magnitude due to sca was greater for yield of seed-cotton (93.07), number of bolls plant^{-1} (75.46), boll weight (40.91), seed in-

ters may have low heritability (Falconer, 1981). This information suggests that segregating populations originating from the crosses reported here may not be amenable to direct selection, and therefore, the

Table 5. Estimates of sca and reciprocal effects of yield of seed-cotton and its components. The values given in parenthesis are reciprocal effects for the characters

Cross combinations	Yield of seed-cotton	Number of bolls	Boll weight	Seed index	Lint index
E288 x LSS	16.85 (2.77)	2.59 (1.33)	0.26 (-0.17)	-0.57 (0.13)	-0.17 (0.02)
ABG0904 x LSS	14.15 (0.93)	4.15 (-0.70)	-0.06 (0.16)	-0.04 (0.26)	-0.02 (0.39)
PO/695-FG x LSS	10.43 (-14.71)	2.26 (-2.87)	0.09 (0.02)	0.02 (0.66)	0.09 (0.61)
PO/695-FG x ABG0904	3.50 (-5.07)	0.13 (-0.11)	0.14 (-0.23)	0.07 (-0.25)	0.28 (-0.81)
PO/695-FG x E288	2.68 (6.43)	0.21 (1.95)	0.20 (-0.17)	0.52 (-0.11)	0.29 (0.38)
E288 x ABG0904	1.06 (-3.94)	-0.50 (-1.50)	0.26 (0.26)	0.12 (0.11)	0.12 (-0.20)
cd (S_{ij} - S_{ik})	14.12	3.52	0.56	0.30	0.44
cd (r_{ij} - r_{ki})	16.31	4.08	0.63	0.33	0.52

breeders will have to be careful and imaginative while looking for desirable plants from the segregating progenies. Similar genetic behaviour of variation in the characters studied here have been reported in the literature (Desai *et al.,* 1980; Waldia *et al.,* 1980; Ghafoor and Khan, 1987; Azhar *et al.,* 1983). However, the data reported recently (Azhar and Akbar, 1992) showed that variation in seed-cotton yield and number of bolls was controlled by additive genetic effects suggesting that these two components of yield are heritable. This sort of controversy in the findings may be due to different genetic makeup of the plant materials used in the studies. This situation suggests that before pursuing the breeding programme, the information reported here needs to be substantiated.

The comparison of performance of gca of the parents (Table 4) revealed that the old local variety LSS with its highest positive values, i.e. 9.48 and 2.72 for yield of seed-cotton and number of bolls plant^{-1}, respectively proved, under the limits of the present investigation, to be the best general combiner for both the characters. The line E288 exhibited its best gca for boll weight, seed index and lint index. The better gca of these two parental lines may be used to exploit the existing variation for breeding desirable plants showing harmonious combinations of the characters studied here. For example, the comparison of the crosses for their sca

(Table 5) indicated that the cross E288 x LSS was the best varietal combination as it attained higher numerical values, i.e. 16.85 and 0.26 for yield of seed-cotton and boll weight, respectively. For number of bolls single cross ABG0904 x LSS with its higher value of 4.15 proved to be better than other combinations. Similarly for seed and lint indices the cross PO/695-FG x E288 appeared to be the promising with numerical values of 0.52 and 0.29, respectively. From these results it my be concluded that the increased performance of hybrids might have resulted due to the best gca of LSS and E288 for all the characters. Similar reports about the potential of parental lines to nick with each other are available in literature (Azhar *et al.*, 1983; Khan *et al.*, 1991; Azhar and Akbar, 1992).

The reciprocal crosses, i.e. E288 x PO/695-FG for yield of seed-cotton and number of bolls plant^{-1}, ABG0904 x E288 for boll weight, and LSS x PO/695-FG for both seed and lint indices remained the best ones (Table 5). The significant reciprocal differences for yield of seed cotton, boll number, seed index and lint index (Table 2) suggested that single crosses involving these lines could not be composited with their reciprocals if these four characters may be considered as criterion for selecting plants with increased yield of seed-cotton, as has been suggested in case of wheat (Azhar *et al.*, 1984) and also in cotton (Azhar and Akbar, 1992).

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