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Heterosis for Seed Cotten Yield, Yield Components and Some Fibre Quality Characters in Upland Cotton (*Gossypium hirsutum* L.)

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ABSTRACT

An experiment was conducted to study the extent of heterosis for seed cotton yield, yield components and fibre quality characters in upland cotton (*Gossypium hirsutum* L.). Twenty out of 21 hybrids expressed significant relative heterosis ranging from 6.92 to 203.9 per cent for seed cotton yield. Out of these, 13 hybrids each for bolls per plant and dry weight, six hybrids each for fibre fineness and uniformity ratio and five hybrids for average boll weight recorded significant relative heterosis. The hybrid 'G-67 x G. Cot-10' recorded the highest *per se* performance and also possessed heterobeltosis to the extent of 151.2 per cent.

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INTRODUCTION

Knowledge of magnitude of heterosis and type of gene action involved for different characters is helpful in breeding. Since in India production of hybrid cotton seed is feasible through hand emasculation because of the availability of cheap manual labour and simple technique for crossing (Patel, 1955), hybrids are being extensively cultivated in Gujarat, Karnataka, Maharashtra, Andhra Pradesh, etc. Many reports on heterosis in intervarietal crosses of upland cotton are available in the literature (Al-Rawi and Kohel, 1970; El-Adl and Miller, 1971; Singh and Murty, 1971; Meredith and Bridge, 1972; Baker and Verhalen, 1975). Such information on newly developed varieties of cotton is rather scanty. The present report describes the extent and nature of heterosis for various characters including fibre quality characters in inter-varietal crosses of upland cotton.

MATERIALS AND METHODS

The experimental material comprised of seven cultivars of *G. hirsutum* (Gujarat-67, G.Cot-10, DHY-286, MCU-5, Pramukh, C.P. 5/5 and P.S.10) exhibiting wide spectrum of variation in different plant characters, obtained from different cotton breeding stations of India. These cultivars were crossed in all possible combinations excluding reciprocals. Seven parents alongwith their 21 crosses were grown in a randomised block design with four replications during rainy season of 1975 at

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the Main Cotton Research Station, Surat. Each plot consisted of three rows 9 m long accommodating ten plants with inter and intra-row spacing of 120 cm and 90 cm respectively. Recommended agronomic practices were followed to raise the experimental crop. Observations were recorded on 14 agronomic and fibre quality characters on five randomly selected plants from each plot. The data were subjected to analysis of variance as per standard statistical procedure (Panse and Sukhatme, 1961). The degree of heterosis in F_1 over the mid parent and better parent (hetreobeltosis) was calculated by the method suggested by Turner (1953) and Hays, Immer and Smith (1955). The statistical significance of heterosis was tested by 't' test as per method given by Mani (1972).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed significant varietal differences for most of the characters under study except plant height, boll weight, seed index and fibre maturity coefficient. The parent *vs* F_1 comparison was significant for majority of characters under study indicating the presence of considerable mean heterosis. This comparison for ginning percentage, seed index,

TABLE 1

Analysis of variance for design of the experiment.

Source	*Mean Squares*							
	d.f.	*Plant height*	*Petiole length*	*Bolls/ plant*	*Boll weight*	*Ginning percentage*		
Block	3	102.7	5.3**	201.7*	1.3	24.7**		
Treatment	27	202.3	4.7**	368.2**	2.2**	33.6**		
Parents	6	234.0	17.1**	801.6**	1.1	43.6**		
Hybrids	20	121.4	1.2*	77.0	2.1**	31.3**		
Parent *vs* Hybrids	1	1630.0*	0.1**	3594.0**	9.5**	20.8		
Error	81	247.1	0.6	70.2	0.8	5.4		
	Mean Squares							
Dry weight	*Seed index*	*Lint index*	*Mean fibre length*	*2.5% span length*	*Fibre fineness*	*Fibre uniformity ratio*	*Fibre maturity coeff.*	*Seed cotton yield*
900.8	19.3	4.5**	3.5	5.3	0.57*	9.2*	0.447**	25.4
12389.9**	5.0	3.1**	15.6**	23.1**	0.75**	12.0**	0.004	9087.7*
7168.3**	5.5	1.5*	28.7**	43.5**	0.70**	18.8**	0.008	7738.0**
11055.4**	5.1	3.6**	12.1**	15.9**	0.68**	10.8**	0.002	5482.3**
10412.1**	0.5	2.4	7.2	45.8**	2.3**	23.1**	0.015	98294.7**
343.8	6.9	0.6	1.8	2.8	0.14	3.2	0.091	78.3

*Significant at P=0.05

**Significant at P=0.01

TABLE 2

Heterosis over mid-parent for different characters in *G. hirsutum.*

Crosses/Characters	*Plant height*	*Petiole length*	*Bolls/ plant*	*Boll weight*	*Dry weight/ plant*	*2.5% span length*	*Fibre fineness*	*Uniformity ratio*	*Yield plant*
G67 x G.Cot.10	11.2	5.0	91.9**	54.8**	44.6**	3.5	0.3	5.3	193.4**
G67 x DHY 286	12.5	2.0	50.5	2.0	25.3**	-1.4	6.7	2.7	55.8**
G67 x MCU 5	7.0	-15.1**	69.7**	63.5**	38.2**	1.1	13.9	3.8	143.2**
G67 x Pramukh	13.1	2.3	117.8**	0.6	51.0**	3.5	15.6*	1.1	110.0**
G67 x CP 5/5	5.2	1.1	36.5	14.4	-9.3*	0.7	2.2	-0.5	38.8**
G67 x PS 10	7.3	4.4	185.7**	11.1	10.6**	-8.7*	16.8**	-1.3	203.9**
G.Cot.10 x DHY 286	5.6	6.7	15.0	6.4	44.3**	-8.1*	36.0**	8.8**	6.9**
G.Cot.10 x MCU 5	10.7	-6.4	10.2	10.6	12.1**	-13.0**	31.8**	10.6**	28.1**
G.Cot.10 x Pramukh	5.9	6.3	41.8*	-7.2	34.6**	1.9	1.1	1.5	33.5**
G.Cot.10 x CP 5/5	-0.3	9.0	-13.2	27.9	-13.8**	-4.3	12.2*	6.1*	14.5**
G.Cot.10 x PS 10	15.0	4.9	57.9**	62.6**	2.9	0.6	1.0	-1.7	152.7**
DHY 286 x MCU 5	7.5	-8.5	36.4*	-1.3	14.1**	-9.9*	9.5	7.0**	37.4**
DHY 286 x Pramukh	12.2	2.4	41.8**	2.4	40.8**	0.6	-0.3	-3.1	49.8**
DHY 286 x CP 5/5	12.2	-10.0*	35.3*	2.4	13.1**	-1.1	7.4	1.0	69.1**
DHY 286 x PS 10	21.3	-0.3	74.4**	13.9	16.5**	-2.9	0.5	-3.8	101.5**
MCU 5 x Pramukh	15.1	1.1	36.3*	40.5**	58.2**	-14.9**	27.4**	8.0**	82.8**
MCU 5 x CP 5/5	-4.5	-6.9	0.1	-3.4	8.1*	-5.0	4.6	3.7	1.8
MCU 5 x PS 10	19.4	1.6	21.1	9.8	-5.1	-8.4*	-4.8	1.3	35.4**
Pramukh x CP 5/5	5.8	-10.1	45.2**	5.7	35.3**	8.7*	4.4	-3.0	55.6**
Pramukh x PS 10	9.7	-2.4	56.3*	46.4**	8.3	2.4	10.8	-1.2	119.5**
CP 5/5 x PS 10	10.7	-9.0	3.3	30.2	4.6	4.6	5.5	0.7	24.1**

*Significant at P=0.05

**Significant at P=0.01

TABLE 3

Heterosis over better parent for different characters in *G. hirsutum.*

Crosses/Characters	*Plant height*	*Petiole length*	*Bolls/ plant*	*Boll weight*
G67 x G.Cot.10	10.6	–20.0**	28.4	52.0**
G67 x DHY 286	11.1	–6.4	–2.1	–2.2
G67 x MCU 5	1.6	–28.1**	13.3	40.4*
G67 x Pramukh	9.1	–21.4**	51.9*	0.0
G67 x CP 5/5	2.4	–14.4**	–10.9	6.5
G67 x PS 10	–2.0	–14.0**	168.9**	–2.2
G.Cot.10 x DHY 286	5.2	–13.0	8.7	3.9
G.Cot.10 x MCU 5	8.4	–17.7**	9.7	9.5
G.Cot.10 x Pramukh	2.8	–1.2	31.6	–9.4
G.Cot.10 x CP 5/5	–3.4	–4.1	–17.4	17.1
G.Cot.10 x PS 10	4.6	–5.0	9.2	45.5*
DHY 286 x MCU 5	4.8	–16.3**	29.6	–4.5
DHY 286 x Pramukh	9.2	–11.3*	25.1	–2.3
DHY 286 x CP 5/5	9.7	–17.7**	34.3*	8.7
DHY 286 x PS 10	8.6	–11.4*	17.0	4.2
MCU 5 x Pramukh	9.3	–4.7	26.0	38.6*
MCU 5 x CP 5/5	–8.9	–6.9	1.4	–10.7
MCU 5 x PS 10	10.7	–1.6	–16.5	–2.6
Pramukh x CP 5/5	5.4	–15.2*	28.9	–1.1
Pramukh x PS 10	–3.0	–5.2	13.1	28.3
CP 5/5 x PS 10	–1.8	–12.0*	–30.4	–7.8

Dry weight plant	*2.5% span length*	*Fibre fineness*	*Uniformity ratio*	*yield/ plant*
37.2**	–7.5*	8.4	2.6	151.2**
21.2**	–5.7	9.9	1.0	11.3
28.9**	1.0	20.0*	2.7	100.0**
33.1**	–9.0*	17.8*	–1.5	70.8**
–15.4**	–8.6*	–13.0	–4.5	–14.5*
9.6*	–19.1**	29.5**	–6.3*	187.9**
36.7**	–14.3**	42.6**	7.7**	24.0**
–0.8	–22.3**	50.7**	6.7*	26.9**
13.1**	0.0	11.6	1.5	30.1*
–15.1**	–6.0	14.2*	4.5	0.1
–3.7	–0.4	3.4	–4.4	98.3**
3.1	–13.9**	19.0*	4.2	35.7**
20.7**	–7.9	4.7	–4.1	43.5**
8.8*	–6.3	15.1*	–1.5	57.6**
11.6**	–10.4*	8.0	–7.3**	45.2**
49.1**	–25.3**	31.7**	4.1	78.2**
–5.6	–13.8**	22.2*	–1.5	–11.4*
–10.7*	–19.0**	11.7*	–4.9	–19.7*
8.4*	4.9	17.8*	–4.5	37.8**
–3.7	1.5	25.0**	–3.9	67.6**
–3.5	1.8	5.7	–0.5	–39.6**

* Significant at P=0.05

**Significant at P=0.01

lint index, mean fibre length and fibre maturity coefficient was not significant. Though parents did not differ significantly for boll weight, the significant variance due to hybrids for average boll weight suggested that inspite of phenotypic similarity they possessed genetic differences for this trait.

The estimates of percentage of heterosis over the mid-parent and better parent for different characters under study are presented in Table 2 and Table 3 respectively.

Plant height:

The magnitude of variability in parents was more than their hybrids. In general, the crosses with 'Pramukh' possessed higher plant height. However, the increase in plant height of hybrids over mid-parental value or better parent was not significant indicating thereby the predominance of additive gene action. These results are in partial agreement with those of Young and Murray (1966) and Singh and Murty (1971) in intra-*hirsutum* crosses.

Petiole length:

Petiole length is an important indication of the leaf placement and canopy of the plant. The varieties with longer petiole tend to possess somewhat open plant habit. The parent 'G-67' possessed the longest petiole whereas 'G-Cot-10' had the shortest one. Out of 21 crosses, only two crosses, viz. 'G-67 x MCU-5' and 'DHY-286 x CP 5/5' showed significant negative heterosis while significant heterobetosis was observed in 13 crosses which indicated the presence of partial dominance. However, the effect was towards reduced petiole length.

Bolls/plant:

This is one of the most important yield contributing characters in cotton. In majority of the crosses, heterosis expressed over mid-parent was significant and in the positive direction which indicated the predominance of non-additive type of gene effects in these crosses. Out of 14 crosses which significantly departed from mid-parental value, three crosses viz. 'G-67 x Pramukh', 'G-67 x P.S.10' and 'DHY-286 x CP 5/5' were significantly better than their respective better parent indicating thereby overdominance in these crosses. These results are in close agreement with the findings of Singh *et al.* (1964), and Singh and Murty (1971). This indicated that heterosis breeding would be useful for obtaining more bolls/plant which may ultimately result in higher seed cotton yield.

Average boll weight:

This is an important direct component of yield and heterosis for boll size contributed to favourable yield increases in hybrids (Miller and Marani, 1963; Miller and Lee, 1964). Only six crosses showed significant and positive heterosis for this character. Out of these, four crosses viz. 'G-67 x G.Cot-10', 'G-67 x MCU-5', 'G.Cot-10 x P.S. 10', and 'MCU-5 x Pramukh' exhibited significant positive heterobeltosis indicating thereby the overdominance for this character in these crosses. Almost identical results have been reported by Miller and Lee (1964), Bhatol (1971) and Meredith and Bridge (1972) in *G. hirsutum*.

Dry weight per plant:

The dry weight of the plant is an indication of the efficiency of the plant

for total uptake of the nutrients for its growth. Among parental group, 'CP 5/5' had the highest dry weight per plant while 'Pramukh' possessed the lowest. Majority of the crosses (15) showed significant and positive heterosis over mid-parental value indicating the presence of dominant gene action. Out of these 15 crosses, 12 crosses exhibited significant positive heterobeltosis indicating the presence of overdominance. Patil (1973) in *G. herbaceum* also reported dominance and overdominance to be operative for this character. Two crosses over mid-parental values and three over better parent exhibited significant negative heterosis. In general, crosses with negative trend in heterosis involved either 'CP 5/5' or 'P.S.10'.

2.5% span length:

This is a new concept of measurement of fibre length parameter to be recorded by Digital Fibrograph and corresponds well with the American Classer's staple length. Majority of the crosses showed negative heterosis over mid-parent and better parent. Only one cross ('Pramukh x CP 5/5') resulted in high order positive heterosis over mid parent. It is interesting to note that this cross claimed high significant positive heterosis for yield as well as a high *per se* performance for yield. This showed a possibility of getting high yielding hybrids with long span length. These results are in partial agreement with the results obtained by Marani (1968) and Chinnadurai and Sree Rangasamy (1975) in *G. hirsutum* crosses. However, Meredith and Bridge (1972) and Baker and Verhalen (1975) recorded considerable magnitude of positive heterosis for this character.

Fibre fineness (Micronaire value):

This is an important criterion in judging lint quality of long staple cottons. Six crosses recorded significant increase in fibre weight (coarse) over mid-parental value indicating dominance in these crosses. Out of these six crosses, three crosses viz. 'G.Cot-10 x DHY-286', 'G-Cot-10 x MCU-5' and 'MCU-5 x Pramukh' possessed higher fibre weight than their respective better parent indicating overdominance. These results are in accordance with the findings of Patel (1974) and Baker and Verhalen (1975). The increase in micronaire value is indicative of coarseness and is not desirable beyond certain limit since the fibres above 3.9 MV are considered coarse. Heterobeltosis considering lower micronaire value as better parent indicated that 12 crosses were significantly superior over their respective better parent. Out of these, five crosses, viz. 'G-67 x MCU-5', 'G-67 x Pramukh', 'DHY-286 x MCU-5', 'MCU-5 x CP 5/5' and 'Pramukh x CP 5/5' possessed fine fibre (MV < 3.9).

Uniformity ratio:

Fibre uniformity ratio indicates the magnitude of length irregularities in cotton sample. In most of the cases under study, F_1s had higher uniformity ratio than mid-parental values or either of the parents. Significant positive heterosis was observed for six crosses while two crosses showed significant positive heterobeltosis. Other crosses had intermediate values for this trait between better parent and mid-parent. This indicated that the character is determined by additive and non-additive genes with more influence of additive genes. Baker and Verhalen (1975) also observed signifi-

cant positive and negative deviations from mid-parental values in different crosses for this character.

Seed cotton yield per plant:

Twenty out of 21 crosses exhibited significant positive heterosis over mid-parental values. The heterosis ranged from 1.8 to 203.9 per cent with the highest relative heterosis observed in 'G-67 x P.S.10'. The heterobeltosis for yield ranged from -39.6 to 187.9 per cent. Fifteen crosses showed significant superiority over their respective better parental values with 'G-67 x P.S.10' possessing the highest heterobeltosis to the extent of 187.9 per cent. These results indicated pre-dominance of non-additive gene action for seed cotton yield, which is in confirmity with the findings of Singh and Murty (1971), Meredith and Bridge (1972), Kumar, Pathak and Singh (1974) and Patel (1974).

Though the cross 'G-67 x P.S. 10' recorded the highest heterosis as well as heterobeltosis, its *per se* performance was not very high. Under such circumstances, crosses with higher *per se* performance alongwith considerable magnitude of superiority over better parent should be considered for commercial exploitation of heterosis for yield. In this context cross 'G-67 x G.Cot-10' deserves merit since its *per se* performance was the highest and it possessed heretobeltosis to the extent of 151.2 per cent.

Out of 20 hybrids which showed relative heterosis for seed cotton yield, 13 crosses each for bolls per plant and dry weight per plant, six crosses each for fibre fineness and uniformity ratio and five crosses for average boll weight recorded significant relative heterosis. This indicated that heterosis in these components contributed towards heterosis for seed cotton yield.

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