Heterosis Component Studies in Upland Cotton (*Gossypium hirsutum L.)*

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ABSTRACT

Heterosis is by far the most important and effective tool in the hand of crop breeders for effecting rapid improvement in the yield and others economic attributes. Study of heterosis and inbreeding depression has a direct bearing on the breeding methodology to be employed for genetic improvement. In the present study, four diverse parents present of American Upland Cotton, g Bikaneri Narma, Model, Ganganagar Ageti and DP-16 were crossed to make hybrids. Data were recorded for seed cotton yield per plant and on its contributing traits. From the weighted least square estimates of components of generation means, components of heterosis were calculated. Heterosis in the F_1 could be obtained if no mutual cancellation of components of heterosis occur. Over the over dominance as the predominant assignable cause of the heterosis was ruled out by observation of a higher magnitude of dominance (h) and its interaction components than of the additive (d) component.

Introduction

G.H. Shull coined the term heterosis in 1914. The phenomenon of hetesosis or increased vigour over the parents has been known ever since 1716 whenby development of the first artificial plant hybrid was developed. Hybrid vigour has been known in cotton since 1894 when Mell reported increases in some agronomic and fiber properties in hybrids compared with their parents. Patel (1971) exploited it when he released hybrid-4, an intra-*hirsutum,* hybrid for commercial cultivation in India. In order to formulate an efficient breeding approach for improving cotton through heterosis breeding, an understanding of the nature and magnitude of gene action controlling yield characters is essential. A relationship between presence or absence of heterosis and the presence or absence of non-allelic interactions was expressed by Jinks and Jones (1958) in terms of genetic parameters d, h, I, j, and l, (Hayman and Mather, 1955). Heterosis observed in the absence of non-allelic interactions could be of a lower frequency and with lower mean expression. The present investigation was undertaken to examine heterosis in terms of genetic components in upland cotton (*Gossypium hirsutum*).

Material and Methods

The experimental material consisted of the parents P_1, P_2, P_3, P_4, F_1, F_2 first back cross generation B_1, B_2 second back cross generations B_{11}, B_{12}, B_{21}, B_{22} and selfed generations B_{1S} and B_{2S}. The material was grown in a randomized-block design with three replications at the agricultural research station, Sri Ganganagar. Each replication consisted of 40 plants for non-segregating generations (Parents and F_1) and 100 plants of each of F_2 and back cross generations of the two crosses. Data were recorded on individual plants on seed cotton yield per plant, number of bolls, boll weight, seed-index and ginning-outturn. Based on the generation means m, d(additive), h (dominant), i (additive x additive), j (additive x dominant), l (dominant x dominant), w (additive x additive x additive), x (additive x additive x dominant),, y (additive x dominant x dominant) and z (dominant x dominant x dominant) gene effects and their standard errors were obtained as suggested by Hill (1996) and Jinks and Perkins (1969). Difference between the means of the F1 generation and that of its better parent were taken as a measure of heterosis. Components of heterosis were calculated from the weighted least square estimates of components of generation means.

Results and Discussion

The mean values for 4 parents and the different filial generations for 5 characters are presented in Table 1.

Heterosis, its Components and inbreeding depression

Heterosis over better parent in B.N. x Model was significant for seed cotton yield (Table 2). Various workers reported heterosis for seed cotton yield (Kumar *et al.* 1974; Singh *et al.* 1983). In this cross presence of heterosis could be explained on the basis of various epistatic effects rather than due to dominance. Significant inbreeding depression was observed for this trait because of high contribution by (h) component and its interaction towards heterosis. Since (z) component was positive and significant it would lead to non-liner depression of diminishing type, (Table 3). For boll number significant and positive heterosis in GA x DP-16 cross over better parent percent was noticed. Kalsy and Garg (1989) reported heterosis for bolls per plant. In this trait (j), (w), (d) and (h) were the major components responsible for heterosis. For boll weight, positive and significant heterosis was observed in both the crosses. Meredith and Bridge (1972) and Waheed *et al.* (1979) also reported heterosis for boll weight. along with (h), dominance x dominance (l) and dominance x dominance x dominance (z) interaction components are responsible for producing heterotic effects for this trait. None of the crosses showed significant heterosis over the better parent for seed index, and also there was no evidence of inbreeding depression in both the crosses for this trait. For ginning outturn, heterosis studies revealed that along with the dominance component (h) dominance x dominance (l), dominance x dominance x dominance (z) and additive x additive x dominance (x) contributed maximum for heterosis in the cross G.A. x DP-16 where positive and significant heterosis was observed. Waheed *et al.* (1979) reported heterosis for ginning outturn.

The hybrids have shown considerable differences in yield and boll number with divergent mechanisms in terms of (d) and (h) and interactions as evident from the components of heterosis. Heterosis in cotton could be considered a complex genetically phenomenon depending upon the balance of additive, dominance and interactions as well as material. To utilize heterotic effects, a breeding procedure that would utilize fixable gene effects (additive, additive x additive, additive x additive x additive and complementary epistasis) while maintaining considerable heterozygosity for exploiting the dominant gene effects, would prove most efficient.

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Table 1. Mean performance of different population in two crosses of upland cotton.

Crosses/ Generations	SeedCotton Yield per Plant(g)	Boll Number (g)	Boll Weight (g)	Seed Index (%)	Ginning Outturn
B.N. x Model					
P_1	96.11	50.47	1.89	6.85	34.07
P_2	62.71	48.67	2.07	7.66	35.23
F_1	114.86	50.60	2.38	7.67	35.40
F_2	84.86	41.80	2.17	8.00	34.83
B_1	89.89	42.97	1.98	7.21	35.43
B_2	90.07	34.37	2.30	7.44	35.05
B_{11}	100.52	41.47	2.07	7.16	34.77
B_{12}	101.01	39.73	2.16	7.23	35.23
B_{21}	99.51	42.00	1.99	7.61	36.02
B_{22}	76.12	49.80	2.11	7.40	34.30
B_1S	83.74	41.67	2.04	7.68	33.60
B_2S	77.43	37.47	1.85	7.83	34.37
GAxDP-16					
P_1	56.49	20.93	2.28	7.21	35.33
P_2	49.39	21.00	2.00	7.87	34.20
F_1	64.67	32.93	2.88	7.90	36.83
F_2	69.69	26.63	2.16	7.54	36.95
B_1	67.78	27.53	2.07	7.72	36.43
B_2	76.55	30.80	2.13	8.04	36.52
B_{11}	78.56	26.23	2.12	7.69	37.47
B_{12}	83.48	32.37	2.20	8.27	37.42
B_{21}	88.47	38.93	2.24	7.85	37.68
B_{22}	79.03	31.37	1.90	7.83	35.58
B1S	79.88	28.47	2.15	6.95	36.43
B2S	65.50	23.33	2.27	7.23	36.46

B.N. = Bikaneri Narma
G.A. = Ganga Nagar Ageti

Table 2. Heterosis and inbreeding depression for 5 characters in upland cotton.

Crosses	Seed Cotton yield per plant (g)		Boll number		Boll Weight (g)		Seed index (g)		Ginning outturn (%)	
	Het (%)	Ibd (%)	Het	Ibd	Het	Ibd	Het	Ibd	Het	Ibd
B..N.xModel	19.50**	26.17**	0.25	17.39**	14.97**	8.82	0.13	-0.94	0.48	1.61
G.A.xDP-16	14.48	22.15	56.8**	19.13**	30.70**	27.51**	0.80	4.67	4.24**	-0.32

Het = Heterosis over better parent
Ibd = Inbreeding depression

Table 3. Estimates of components of heterosis in two crosses of upland cotton.

Character	Cross	Components of Heterosis							
		h	-(I)	½ (x)	¼ (z)	(d)	½ (j)	w	¼ (y)
Yield/Plant (g)	B.N. x Model	440.48	118.18	88.54	148.08	1566	-13.49	0.33	-10.07
	G.A. x DP-16	-112.82	-39.62	63.80	-21.74	20.71	10.50	17.13	31.50
Boll Number	B.N. Model	-32.75	36.53	12.09	7.79	15.81	-22.0	-6.08	6.04
	G.A. x DP-16	23.15	2.49	15.70	2.67	29.18	-40.12	29.17	13.23
BollWieght (g)	B.N.xModel	3.50	-0.76	0.85	0.41	0.45	-0.31	-1.81	-0.42
	G.A.xDP-16	2.28	1.02	0.52	0.75	-0.04	-0.31	-0.18	0.43
Seed Index (g)	B.N.Model	3.16	3.47	3.14	2.17	0.18	0.58	-0.56	0.40
	G.A.xDP-16	5.61	3.25	0.69	-0.58	-0.75	1.95	0.42	-0.93
GOT (%)	B.N.xModel	21.35	8.25	7.83	4.89	-1.79	2.72	0.12	1.45
	G.A.xDP-16	30.51	6.47	5.64	6.63	1.09	-1.75	-0.12	-0.87