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HETEROSIS FOR YIELD AND YIELD COMPONENTS OVER ENVIRONMENTS IN DESI COTTON (*GOSSYPIUM ARBOREUM* L.)

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ABSTRACT

Nature and magnitude of heterosis was studied for ten quantitative characters in a line x tester mating design in desi cotton. The values of average heterosis recorded for days to flower initiation, bolls/plant, seed-cotton yield/plant, seed yield/plant, and lint yield/plant were 3.6, 22.1, 21.2, 21.7 and 20.3%, respectively. Twenty six cross combinations outyielded significantly the best parent RG-10. Heterosis for seed-cotton yield was related mainly to number of bolls, seed yield and lint yield and to some extent on lateness and tallness. Crosses involving G-121, K-7, Shyamali, G-27, RG-10, SD-5, BH-113, BH-112, BH-99, BH-98, RG-8 and Lohit are expected to be more effective for exploitation of genetic variability for yield and its components. For halo length, ginning percentage and seed and lint indices F_1s exhibited least deviation from better parent, suggesting that these characters were governed by additive genes.

Key words: Heterosis, desi cotton, environment.

India is a pioneer country for the development of hybrids in cotton for commercial cultivation. Due to exploitation of heterosis in desi cotton hybrid DDH2 came into existence in 1988 for commercial cultivation for South Zone and DH9 for Gujarat State in 1988. However, suitable hybrids have not been developed for North Zone where it still exists under cultivation on a large scale. Successful cultivation of above hybrids have created interest for the development of such hybrids in desi cotton for Northern Zone. The present study was, therefore, conducted to find out possibility of developing high yielding hybrids in desi cotton under different agroclimatic conditions for Uttar Pradesh.

MATERIALS AND METHODS

Twenty lines (G-121, RG-1, LD-135, BH-113, BH-112, SC-136, G-1, CJ-73, BH-99, BH-98, 7250, BH-53, BS-11, 438, 35/4, K-7, 103, RG-8, RG-10 and SD-5), representing wide spectrum

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of variation in different quantitative characters were crossed with three (Lohit, Shyamali and G-27) well adapted testers in a line x tester mating design. All 23 parents and their 60 F_1s were raised at three locations (Cotton Research Station, Bulandshahr; Western Campus, Modipuram, Meerut; and Rice Research Station, Nagina, Bijnor) in randomised block design with three replications. The material was planted at a distance of 60 cm between the rows and 30 cm between the plants within the row. Each plot was represented by a 5 m long single row. The data on ten quantitative characters (Table 1) were recorded on ten random plants in each plot. Heterosis was computed over mid-(MP) and better parents (BP) for each character in mean data of three environments.

RESULTS AND DISCUSSION

It is observed from the analysis of variance that parents and hybrids were differing significantly for most of the characters under study (Table 1).

Table 1. Analysis of variance (mean squares) for parents and hybrids for different characters in desi cotton

Source	d.f.	Days to flower initiation	Plant height	Bolls per plant	Seed-cotton yield per plant	Seed yield per plant	Lint yield per plant	Halo length	Ginning %	Seed index	Lint index
Replications	2	3.03	62.6	2.68	8.43	2.05	0.94	0.21	0.58	0.038	0.026
Locations	2	3.28	154.3**	3.74**	12.68**	6.34**	2.33**	0.56**	0.50	0.044	0.023
Genotypes	82	22.06**	211.3**	14.39**	59.93**	20.65**	10.31**	3.73**	6.09**	0.138**	0.136**
Parents	22	10.16**	141.4**	4.83**	20.54**	8.36**	3.03**	1.05**	2.81**	0.145**	0.096**
Hybrids	59	25.63**	230.0**	15.61**	64.86**	22.17**	11.40**	3.73**	6.48**	0.121**	0.126**
Lines	19	11.15**	553.6**	46.1**	190.81**	64.33**	33.88**	3.18**	19.05**	0.107**	0.297**
Testers	2	150.59**	564.9**	6.52**	28.88**	10.47**	3.45**	34.02**	0.75	0.483**	0.189**
Line x tester	38	26.29**	50.5**	0.89	3.78	1.70**	0.58**	2.41**	0.50**	0.109**	0.038**
Hybrid x location	118	1.42	34.0**	1.12**	5.86**	2.95**	1.65**	0.07	0.27	0.021**	0.014**
Line x location	38	3.42**	38.3**	2.08**	6.54**	3.62**	1.65**	0.23**	0.23	0.014	0.015**
Tester x location	4	3.97	92.3*	2.85*	10.18*	6.31**	2.04**	0.52**	0.36	0.023	0.018
Line x tester x location	76	0.28	28.8	1.73**	5.30**	2.43**	1.64**	0.11	0.28	0.024**	0.013**
Error	328	1.55	30.3	0.90	3.90	1.58	0.55	0.14	0.29	0.018	0.011

Performance of parents. None of the parents exhibited high mean values for all these characters. However, cv. Shayamali was the earliest with the highest ginning percentage, whereas RG-8 was found to be the shortest. Similarly RG-10 had the highest number of bolls/plant, seed-cotton yield/plant, seed yield/plant and lint yield/plant, seed and lint indices and G-1 had highest halo length (Table 2).

Average heterosis. The average parental ($\bar{P}$) and hybrids ($\bar{F}_1$) mean values with average mid parent heterosis are presented in Table 2. $\bar{F}_1$ was significantly higher than $\bar{P}$ for days to flower initiation, number of bolls/plant, seed-cotton yield/plant, seed yield/plant and lint yield/plant and not significantly different from $\bar{P}$ for plant height, halo length, ginning %, and seed and lint indices.

Frequency of hybrids showing heterosis. The 60 hybrids are classified into five groups on the basis of their significantly higher performance over MP and BP (Table 2). Significant positive MP heterosis was observed in 35 hybrids for bolls/plant, followed by 34 hybrids for seed-cotton yield/plant, 32 for lint yield/plant, 31 for seed yield/plant, 26 for halo length, 25 for days to flower initiation, 21 for seed index, 17 for lint index, 7 for ginning (%), and 2 hybrids for plant height. None of the hybrids was earlier than the better parent and the number of hybrids deviating positively and significantly over their respective better parents were 36 for days to flower initiation, followed by 32 for bolls/plant and lint yield/plant, 31 for seed-cotton yield/plant, 28 for seed yield/plant, 13 for halo length, 12 for seed index, 10 for plant height, 8 for lint index and one for ginning %. However, least number of hybrids with high heterosis were observed for halo length, ginning %, plant height, seed and lint indices, which deviated from the better parent in positive direction. Thus, expression of these characters was governed largely by additive genes.

In general, the trend of heterosis was towards positive direction for days to flower initiation (lateness), bolls/plant, seed-cotton yield/plant, seed yield/plant, lint yield/plant, halo length, seed and lint indices. The trend of heterosis for ginning % was in negative direction and for plant height it was not variable. There was distinct manifestation of BP heterosis for seed-cotton yield, ranging from –31.7 to 49.3% in 31 hybrids. Twenty six hybrids significantly outyielded the best parent. Similarly, Aher et al. [1] recorded maximum positive MP and BP heterosis for seed-cotton yield, followed by number of bolls. The findings of the present investigation are consistent with those of other workers [2–7].

Significant deviation of selected hybrids from MP (+ or –) and BP (++ or – –) for each character are presented in Table 3. The hybrid K-7 x Lohit exhibited positive MP or BP heterosis for all the ten characters. The hybrids showing heterosis for seed-cotton yield were mostly also heterotic for number of bolls, seed yield and lint yield, exhibiting a positive

Table 2. Generation means ($\bar{P}$), average heterosis ($\bar{F}$), range of heterosis, best parents and hybrids showing best parent heterosis and number of crosses deviating significantly from mid- and better parents for 10 characters in three environments in cotton (estimated from pooled data)

Character	Range of heterosis (%)		$\bar{P}$	$\bar{F}$	$\frac{\bar{F}_1 - \bar{P}}{\bar{P}} \times 100$	No. of crosses					Best parents	Hybrids superior tobest parents
	MP	BP				<MP	>MP	>BP (NS)	= MP > MP	Total		
Days to flower initiation	–3.5–18.5	–0.7–19.8	69.3	71.8	3.6*	—	25	36	35	25	Shyamali	—
Plant height, cm	–10.8–13.2	–7.1–17.7	120.7	120.8	0.1	7	2	10	51	2	RG-8	SD-5x Lohit, SD-5 x Shyamali RG-10 x Lohit, RG-10 x Shyamali, RG-8 x Lohit, RG-8 x G-27
Bolls/plant	–17.2–55.5	–25.7–48.2	9.5	11.6	22.1**	4	3	32	21	35	RG-10	Total 36 28 deviating significantly
Seed-cotton yield/plant, g	–20.8–55.5	–31.7–49.3	18.9	22.9	21.2**	2	3	31	24	34	RG-10	Total 35, 26 deviating significantly
Seed yield per plant, g	–18.8–52.7	–28.3–46.8	12.0	14.6	21.7**	—	3	28	29	31	RG-10	Total 30 24 deviating significantly
Lint yield per plant, g	–25.4–54.3	–38.3–42.2	6.9	8.3	20.3**	4	—	32	24	32	RG-10	Total 33 23 deviating significantly
Halo length, mm	–10.4–24.2	–16.1–20.7	19.4	19.5	0.5	8	13	13	26	26	G-1	RG-10 x Lohit, G-1 x Shyamali SD-5 x Lohit, Cj-73 x Shyamali
Ginning %	–5.7–5.9	–9.4–4.9	36.2	36.8	1.7	19	6	1	34	7	Shyamali	BH-113 x Lohit
Seed index, %	–6.7–25.7	–10.3–16.8	4.5	4.6	2.2	7	9	12	32	21	RG-10	RG-8 x Lohit, G-1 x Lohit, RG-10 x Lohit
Lint index, %	–13.3–18.9	–19.7–12.5	2.6	2.7	3.8	6	9	8	37	17	RG-10	RG-8 x Lohit, G-1 x Lohit RG-10 x Lohit RG-10 x G-27

Table 3. Hybrids showing significant MP (+ or –) and BP heterosis (++ or – –) for different characters over three locations in desi cotton

Hybrid	Flowering days	Plant height	Bolls per plant	Seed cotton yield	Seed yield	Lint yield	Halo length	Ginning %	Seed index	Lint index	Total ++	Total +	Total –	Total – –
BH-113 x Lohit			++	++	++	++	++	+	+	++	6	2	0	0
BH-112 x Lohit	–		++	++	++	++	+		+	+	4	3	1	0
G-1 x Lohit	++		– –	– –		– –	– –	– –	++	+	2	1	0	5
G-1 x Shyamali			– –	– –	– –	– –	+	– –	– –	– –	0	1	0	7
CJ-73 x Lohit	+	++	++	++	++	++	++		++	++	8	1	0	0
CJ-73 x Shyamali			++	++	++	++	++				5	0	0	0
CJ-73 x G-27	++	++	++	++	++	++	++				7	0	0	0
BH-53 x Lohit			++	++	++	++	– –		++	++	6	0	0	1
BH-53 x G-27	++		++	++	++	++	– –	++	– –		6	0	0	2
K-7 x Lohit	++	++	++	++	++	++	++	+	+	++	8	2	0	0
K-7 x Shyamali	++	++	++	++	++	++	+		++	+	7	2	0	0
K-7 x G-27			++	++	++	++		+	++	++	6	1	0	0
RG-8 x Lohit	++	– –	++	++	++	++	++		+	++	7	1	0	1
RG-8 x G-27			++	+		++	+	+	– –		2	3	0	1
RG-10 x Lohit	+		++	++	++	++	++		+	+	5	3	0	0
RG-10 x Shyamali	++	–	++	++	++	++	– –		– –	– –	5	0	1	3
RG-10 x G-27			++	+	+	++	++	++	++	+	5	3	0	0
SD-5 x Lohit		–	++	++	++	++	++		++	++	7	0	1	0
SD-5 x Shyamali	++	–	++	++	++	++	– –			+	5	1	1	1
SD-5 x G-27	++		++	++	+	++	– –	+			4	2	0	1

association between these characters [6–7]. The hybrids, CJ- 73 x Lohit, CJ-73 x G-27, K-7 x Lohit, K-7 x Shyamali, K-7 x G-27, RG-8 x Lohit and SD-5 x Lohit, in that order, manifested BP heterosis for the largest number of characters including seed-cotton yield, but were late.

Overall, majority of hybrids involving the parents G-121, BH-113, BH-112, CJ-73, BH-99, BH-98, K-7, RG-8, RG-10, SD-5, Lohit, Shyamali and G-27 were generally more heterotic and the hybrids involving RG-1, LD-135, SC-136, G-1, 7250, BH-53, BS-11, 438, 35/4 and 103 were least heterotic. The best parents as well as the hybrids significantly superior than the better parent for different characters are summarized in Table 2. The seed-cotton yield and its contributing characters were highest in the crosses K-7 x Shyamali and SD-5 x Lohit which significantly outyielded the best parent. The hybrids superior to the best parent were SD-5 x Lohit, SD-5 x Shyamali, RG-10 x Lohit, RG-8 x G-27, RG-10 x Shyamali and RG-8 x G-27 for dwarfness. Twenty eight hybrids were superior for number of bolls, 26 for seed-cotton yield, 25 for lint yield and 24 for seed yield. The crosses RG-10 x Lohit, G-1 x Shyamali, SD-5 x Lohit and CJ-73 x Shyamali were distinguished for halo length, BH-113 x Lohit for ginning per cent, and RG-8 x Lohit, G-1 x Lohit and RG-10 x Lohit for seed and lint indices.

The cross combinations with high heterosis for seed-cotton yield involved parents of different ecogeographic origin. For instance, the highly heterotic crosses K-7 x Shyamali, K-7 x Lohit, RG-8 x Lohit, RG-10 x Lohit, LD-135 x Lohit, RG-10 x G-27, CJ-73 x Lohit, BH-99 x G-27, G-121 x Shyamali and RG-1 x Shyamali were, in general, having one indigenous *bengalense* parent adapted to the conditions of U.P., whereas the other parent was genetically divergent adapted to other cotton growing states. This indicates that genetic diversity between the parents played an important role in the manifestation of heterosis. These results were in agreement with the earlier findings of several workers [6–8].

One significant finding of the present study is that the cross combination of low x low yielding parents (G-121 x Lohit, K-7 x Lohit, RG-8 x Lohit, LD-135 x Lohit and G-121 x G-27) showed good amount of heterosis although their mean yields were low as compared to the best performing hybrids. On the other hand, the crosses involving high x high yielding parents (K-7 x Shyamali, BH-113 x Shyamali, RG-10 x Lohit, RG-10 x Shyamali and SD-5 x Shyamali) showed relatively lower degree of heterosis. Similarly, low x high yielding crosses (G-121 x G-27, G-1 x Shyamali, CJ-73 x Shyamali, RG-8 x Lohit, RG-10 x G-27 and RG-8 x G-27) also showed high heterosis. The probable reason for such behaviour is that the poor yielding parent in these crosses had a different constellation of genes which showed complementary interaction in the hybrid. Similar results were reported earlier [6–8].

On the basis of above results, it is suggested that genetically diverse parents having high per se performance should be selected for hybridization programme. The multiple crosses involving G-121, K-7, Shyamali, G-27, RG-10, SD-5, BH-113, BH-99, RG-8 and Lohit may

also be expected to prove more effective for the exploitation of genetic variability for yield and its components from the present set of parents. The cross K-7 x Lohit may be exploited straightway as it was found heterotic for all the ten characters studied.

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