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Heterosis study for seed cotton yield and its yield attributing traits in hybrids of upland cotton (*Gossypium hirsutum* L.)

D Shashibhushan and UG Patel

Abstract
A study was made in upland cotton to assess the extent of heterosis over standard check for seed cotton yield and its related attributes traits at three locations *viz*., Surat, Bharuch and Hansot. The standard heterosis ranged from -23.47 to 21.45 per cent. The three hybrids viz., G (B) 20 x G.Cot.10, G (B) 20 x DHY-286-1 and LRK-516 x DHY-286-1 showed significant and positive standard heterosis, in which the cross G(B) 20 x G.Cot.10 showed maximum value of standard heterosis for seed cotton yield per plant and manifested heterotic effects for its contributing characters like number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, and number of seeds per boll and seed index.

Keywords: Cotton, seed cotton yield, standard check, standard heterosis

Introduction
Cotton, the king of the fibre, is also called White Gold. The increased productivity can be achieved by developing superior varieties/hybrids through genetic improvement and by proper management practices. Thus, the situation offers immense scope for geneticists in general and cotton breeders in particular both at national and state level. To meet the challenges of increasing productivity, *Gossypium hirsutum* L. offers better scope for genetic improvement among the four cultivated species of cotton. Majority of cotton produced by *G. hirsutum* species is medium and long staple. This species has very high adaptability with rich diversity for yield and yield related characters. On account of its versatility, the area under cultivation has increased tremendously in most cotton growing countries of the world with no exception to India and has created an increased interest in research on cultivation of G. hirsutum species. India is pioneer country in commercial exploitation of heterosis in cotton by developing several interspecific and intraspecific, hybrids forgeneral cultivation.

Materials and methods
The present investigation was conducted with 24 *Gossypium hirsutum* entries comprising of 14 F_1s, 7 females and 2 males and 1 check were evaluated during kharif 2002 at three locations *viz*., Surat, Bharuch and Hansot. The experiment was laid out in a *Randomized Complete Block design* (RBD) with three replications. The parents and F_1s with standard checks were represented by a single row plot of 14 plants, placed at 120 cm x 45 cm. All the agronomical practices and plant protection measures were followed as and when required to raise a good crop of cotton.The seeds of these parents were obtained from Main Cotton Research Station, Surat. For obtaining the cross seeds, parents were grown at Main Cotton Research Station, Surat. Dock (1934) [8] method of emasculation was adopted for conventional hybrid seed production. The 7 females and 2 males were crossed in L x T mating design to obtain 14 crosses of conventional hybrids making it totally 14crosses. All the F_1s and selfed seeds of parents were stored properly in thick paper bags for sowing in the next season at three locations.

Results
The estimates of heterosis measured as per cent increase or decrease over standard check (standard heterosis) in individual environment and on pooled basis are presented in Table 1a to1d. In days to 50 per cent flowering, the standard heterosis ranged from -32.55 to 15.10 per cent. Eight crosses exhibited significant negative heterosis over standard check.

Among eight crosses LRK 516 x G.Cot.10, PH 93 x G.Cot.10, G.Cot.100 x G.Cot.10 and LRA 5166 x G.Cot.10 recorded maximum values of standard heterosis. The heterosis over standard check ranged from -41.77 to 7.30 per cent in plant height (cm). The crosses showing significant and negative standard heterosis were eight. Three crosses viz., LRK 516 x G.Cot.10, LRK 516 x DHY 286-1 and LRA 5166 x G.Cot.10 recorded maximum values of standard heterosis. For number of monopodia per plant, the standard heterosis varied from -18.07 to 64.26 per cent and 10 hybrids showed significant and positive standard heterosis. The crosses viz., G(B) 20 x G.Cot.10, LRK 516 x DHY 286-1, G(B) 20 x DHY 286-1 and G.Cot.100 x DHY-286-1 showed maximum values of standard heterosis. In number of sympodia per plant, the heterosis over standard check fluctuated between -29.32 and 14.01 per cent and only two crosses viz., G(B) 20 x G.Cot.10 and G.Cot.100 x DHY 286-1 showed significant and positive standard heterosis. The heterosis over standard check ranged from -12.62 to 27.14 per cent in number of bolls per plant. The crosses showing significant and positive standard heterosis were eight. Among these the crosses viz., LRA 5166 x DHY 286-1, LRA 5166 x G.Cot.10, G(B) 20 x G.Cot.10, PH 93 x G.Cot.10 and 76 IH 20 x DHY 286-1 showed maximum values of standard heterosis. For boll weight (g), Standard heterosis ranged from -5.67 to 24.23 per cent. Twelve crosses exhibited significant and positive heterosis over standard check. The crosses viz., G.Cot.100 x G.Cot.10, G(B) 20 x G.Cot.10, G(B) 20 x DHY 286-1, LRK 516 x G.Cot.10 and LH 900 x DHY 286-1 recorded maximum values of standard heterosis. In number of seeds per boll, the heterosis over standard check ranged from -24.56 to 18.77 per cent and six crosses exhibited significant and positive standard heterosis, in which five crosses viz., G.Cot.100 x DHY 286-1, lRK 516 x DHY 286-1, G (B) 20 x DHY 286-1, LH 900 x DHY 286 1, LRA 5166 x DHY 286-1 showed maximum values. Standard heterosis varied from -11.63 to 26.68 per cent in seed index (g). Five hybrids viz., G.Cot.100 x DHY 286-1, LRK 516 x G.Cot.10, LRK 516 x DHY 286-1, G.Cot.100 x G.Cot.10 and 76 IH 20 x G.Cot.10 showed positive and significant standard heterosis. For ginning percentage (%), the heterosis over standard check varied from -6.42 to 29.69 and five hybrids viz., PH 93 x DHY 286-1, PH 93 x G.Cot.10, LRA 5166 x G.Cot.10, G.Cot.100 x DHY 286-1 and 76 IH 20 x G.Cot.10 exhibited significant and positive standard heterosis. In seed cotton yield per plant (g), the standard heterosis ranged from -23.47 to 21.45 per cent. Three hybrids viz., G (B) 20 x G.Cot.10, G (B) 20 x DHY 286-1 and LRK 516 x DHY 286-1 showed significant and positive standard heterosis. In 2.5 per cent span length (mm), the heterosis over standard check ranged from -19.48 to -2.51 per cent. None of the crosses showed positive and significant heterosis over standard check. The standard heterosis ranged from -5.37 to 9.95 per cent in fibre strength (g/tex), two hybrids viz., LRK 516 x G.Cot.10 and G.Cot.100 x G.Cot.10 showed significant and positive heterosis over standard check.

Table 1a: Estimates of standard heterosis for different agro morphological characters in cotton

	Days to 50 per cent flowering				Plant height (cm)				Monopodia per plant			
Crosses	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**
76 IH 20 x G.Cot.10	-14.29**	-7.28	-13.36**	-11.57**	7.58	11.34	2.63	7.30*	5.00	42.91**	44.58**	30.12**
76 IH 20 x DHY 286-1	-6.90	2.91	-1.60	-1.85	3.97	9.78	2.25	3.99	-33.46*	53.85**	-41.67*	-7.23
LH 900 x G.Cot.10	0.98	-9.71*	-13.36**	-7.22**	-34.49**	-30.84**	-34.32**	-33.17**	-15.38	-35.22*	11.25	-13.25
LH 900 x DHY 286-1	-5.42	-0.50	-1.60	-2.51	-26.98**	-33.02**	-40.16**	-33.28**	12.69	72.87**	13.75	32.96**
PH 93 x G.Cot.10	-23.64**	-14.56**	-25.12**	-20.98**	-0.09	-10.76	3.25	-2.72	58.58**	45.75**	-5.42	33.73**
PH 93 x DHY 286-1	-7.89	-3.41	-5.87	-5.71*	-11.42*	0.21	-6.99	-5.97	12.69	-8.10	-33.33*	-18.07*
LRA 5166 x G.Cot.10	-15.77**	-15.06**	-17.65**	-16.10**	-37.56**	-34.47**	-32.23**	-34.78**	51.15**	78.14**	-11.25	40.16**
LRA 5166 x DHY 286-1	-6.90	-0.98	6.42	-0.67	-36.97**	-32.90**	-15.49**	-28.71**	20.38	-13.77	63.75**	23.29**
LRK 516 x G.Cot.10	-32.02**	-30.10**	-34.83**	-32.55**	-42.04**	-36.64**	-47.08**	-41.77**	7.69	-48.58**	72.08**	9.64
LRK 516 x DHY 286-1	-10.34*	-8.74	-12.83**	-10.58**	-45.83**	-41.62**	-31.22**	-39.71**	76.92**	29.55*	75.00**	60.64**
G(B) 20 x G.Cot.10	-18.24**	-17.97**	-14.44**	-16.95**	-3.48	-3.64	10.62*	0.97	53.85**	75.04**	69.58**	64.26**
G(B) 20 x DHY 286-1	0.49	-2.43	2.68	0.16	-29.12**	-27.69**	-4.49	-20.76**	43.46**	40.49**	50.00**	44.58**
G.Cot.100 x G.Cot.10	-0.99	2.91	12.31**	4.53	-0.04	1.58	1.66	0.00	23.08	-21.86	58.33**	19.68*
G.Cot.100 x DHY 286-1	14.28**	10.19**	21.40**	15.10**	-7.58	-10.81	-12.77*	-10.36**	79.62**	13.36	38.75*	44.58**
S.E. ±	3.29	2.97	2.17	1.64	7.30	7.91	6.43	4.18	0.38	0.34	0.37	0.21

Discussion

The heterotic response of an F_1 is indicative of genetic diversity among the parents involved (Moll *et al*., 1962) [24]. In the present investigation, standard heterosis ranged from -23.47 to 21.45 per cent and three hybrids showed significant and positive standard heterosis, in which the cross G(B) 20 x G.Cot.10 showed maximum value of standard heterosis. Several workers, Joshi *et al.* (1960), Marani (1963) Miller and Lee (1964), Al-Rawi and Kohel (1969), Baker and Verhalen (1975), Khan and Ali (1980), Patil and Sheriff (1980), Singh and Singh (1981), Desai *et al.* (1982), Duhoon *et al.* (1983), Patil and Chopde (1985), Duhoon (1990), Tuteja *et al.* (1993), Patel *et al.* (1993), Bhatade *et al.* (1994), Vadodaria and Patel (1995), Indal *et al.* (1996) and Pavasia *et al.* (1999) [14, 20, 21, 1, 2, 18, 27, 38, 7, 9, 28, 10, 43, 25, 4, 46, 13, 29] reportedheterosis for seed cotton yield in American cotton.

The crosses viz., G (B) 20 x G.Cot.10, G (B) 20 x DHY-286-1 and LRK-516 x DHY-286-1 performed better for standard heterosis. It was observed that hybrids showing high heterosis for seed cotton yield per plant in general, also manifested heterotic effects for its contributing characters like number of monopodia per plant, number of sympodia per plant, number of bolls per plant, boll weight, and number of seeds per boll and seed index. The standard heterosis ranged from –23.47 to 21.45 per cent in conventional system. Similar results have been reported by Kajjidoni *et al*. (1999), Bhale and Bhat (1990), Srinivasan and Gururajan (1983), Tuteja *et al*. (2000), Tuteja and Singh (2001) [15, 3, 40, 44, 45].

Singh and Murty (1971) [37] reported heterosis to the extent of -76.2 to 137.2 per cent and -87.4 to 68.2 per cent over mid parent and better parent respectively in intra specific crosses of G. hirsutum L. Vadodaria and Patel (1995) [46] reported high heterosis to the extent of -8.30 to 15.93 per cent and -23.94 to 112.09 per cent over better parent and standard check

respectively in intraspecific crosses of *G. hirsutum* L.

The moderate to high heterosis observed in present study has also been reported by several workers for number ofbolls per plant (Desai *et al*., 1982; Duhoon *et al*., 1983; Tiwari *et al*., 1987; Kalsy and Garg 1989; Duhoon 1990; Patil *et al*., 1991; Singh and Narayanan 1992; Siddique 1993 and Bhatade and Rajewar 1994) [7, 9, 42, 16, 10, 26, 39, 35, 4]; boll weight (Desai *et al*., 1982; Patil and Chopde 1985; Duhoon 1990; Patil *et al*., 1991; Singh and Narayanan 1992 and Bhatade *et al*. 1994) [7, 28, 10, 26, 39, 5]; number of monopodia per plant (Khan and Ali 1980; Duhoon *et al*., 1983) [18, 9]; number of sympodia per plant (Singh and Singh 1981; Duhoon *et al*., 1983) [38, 9]; seed index (Singh and Singh 1981; Nadarajan and Sree Rangasamy 1990; Siddiqui 1993; Bhatade *et al*. 1994) [38, 23, 35, 4]; ginning percentage (Singh and Singh 1981;Duhoon*et al*., 1983; Tiwari *et al*., 1987; Duhoon 1990, Gururajan and Basu 1992; Singh and Narayanan 1992;Siddiqui 1993 and Bhatade and Rajewar 1994) [38, 9, 42, 10, 12, 39, 35, 5]; early maturity (Patil and Sheriff 1980, Singh and Singh 1981, Patil and Chopde 1985, Siddiqui 1993, Vadodaria and Patel 1995) [27, 38, 28, 35, 46]; plant height (Singh and Singh 1981, Patil and Chopde 1985, Bhatade and Rajewar 1994) [38, 28, 5]; fibre length (Prakash 1982, Gururajan and Basu 1992, Duhoon *et al*., 1983, Duhoon 1990, Sidiqui 1993, Bhatade *et al*. 1994) [30, 12, 9, 10, 35, 5] and fibre strength (Prakash 1982; Singh and Narayanan 1992) [30, 39].

Table 1b: Estimates of standard heterosis for different agro morphological characters in cotton

Method	Sympodia per plant				Number of bolls per plant				Boll weight (g)			
Crosses	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**
76 IH 20 x G.Cot.10	-38.49**	-40.28**	-4.20	-29.32**	-16.43**	8.93	16.52*	2.38	8.81*	26.49**	-18.03**	6.39*
76 IH 20 x DHY 286-1	-20.99*	-2.71	-14.00	-12.30*	-14.12**	17.85**	21.86**	8.00*	43.47**	28.58**	-27.87**	15.98**
LH 900 x G.Cot.10	-2.59	-37.53**	-35.34**	-24.73**	11.68*	-3.76	0.00	2.64	5.17	32.44**	22.30**	20.00**
LH 900 x DHY 286-1	-33.92**	-3.00	-24.12*	-19.82**	-18.27**	19.73**	-13.21	-2.86	47.42**	30.95**	7.54	29.28**
PH 93 x G.Cot.10	-10.65	-3.00	-17.83	-9.91	-2.00	-4.09	38.18**	8.83**	29.18**	28.57**	-32.46**	9.79**
PH 93 x DHY 286-1	9.18	-32.06**	44.73**	4.32	5.53	-16.73**	38.73**	6.93*	7.90	-3.87	-22.62**	-5.67
LRA 5166 x G.Cot.10	-12.37	31.81**	-4.93	5.90	15.83**	22.17**	4.24	14.81**	16.11**	28.27**	-8.20	12.58**
LRA 5166 x DHY 286-1	-29.61**	-24.09*	7.66	-16.93**	17.35**	32.98**	31.38**	27.14**	13.93**	-1.19	-16.72**	-1.03
LRK 516 x G.Cot.10	-15.52	-20.26	12.59	-19.19	0.07	-30.13**	-5.51	-12.62	24.62**	27.68**	41.31**	30.82**
LRK 516 x DHY 286-1	25.86**	-3.82	1.73	8.11	5.99	13.96**	16.40	11.05**	44.07**	20.83**	7.21	24.64**
G(B) 20 x G.Cot.10	18.66*	0.58	25.49**	14.01*	11.52*	10.65*	15.25*	12.29**	24.62**	39.88**	35.08**	32.99**
G(B) 20 x DHY 286-1	5.73	17.26	-3.51	7.30	-2.47	15.41**	22.57**	11.33**	47.72**	26.79**	16.07**	30.52**
G.Cot.100 x G.Cot.10	21.85*	-19.44	27.95**	8.51	9.06	13.53**	-14.12	4.02	34.35**	13.69*	57.05**	34.23**
G.Cot.100 x DHY 286-1	9.18	29.88*	-2.10	13.51*	-18.43**	11.37*	11.20	1.05	34.35**	30.65**	-17.05**	16.91**
S.E. ±	2.12	2.75	1.73	1.29	2.22	2.18	2.18	1.61	0.13	0.20	0.16	0.10

Table 1c: Estimates of standard heterosis for different agro morphological characters in cotton

	Number of seeds per boll				Seed index (g)				Ginning percentage (%)			
Crosses	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**	**Loc-I**	**Loc-II**	**Loc-III**	**Pooled**
76 IH 20 x G.Cot.10	-6.66	-18.25*	9.45	-5.47	25.00*	32.05**	-15.27	14.92*	-8.37	5.47	25.58**	7.42*
76 IH 20 x DHY 286-1	2.40	33.45**	-10.58	8.86	37.50**	-13.93	-14.46	3.29	-10.50	9.15	15.09**	4.39
LH 900 x G.Cot.10	-9.32	-12.51	8.03	-4.88	-8.38	-12.73	-13.92	-11.63	0.03	-6.31	11.80*	1.88
LH 900 x DHY 286-1	5.77	35.66**	4.25	14.52**	12.50	0.84	22.97*	11.63	-8.06	9.12	3.39	1.33
PH 93 x G.Cot.10	-14.47	-24.57**	-35.29**	-24.56**	12.50	-12.36	-28.78*	-9.10	15.18**	23.74**	24.79**	21.15**
PH 93 x DHY 286-1	-9.45	-18.25*	-18.75	-15.42**	12.50	-23.53*	-2.30	-4.80	22.70	36.69**	29.99**	29.69**
LRA 5166 x G.Cot.10	6.52	9.28	11.81	9.14	12.50	-12.36	-13.51	-2.91	8.43	18.24**	15.77**	14.07**
LRA 5166 x DHY 286-1	7.41	17.68*	15.87	13.61*	0.00	-13.21	-14.86	-9.23	-7.89	-2.00	5.93	-1.38
LRK 516 x G.Cot.10	-9.59	-31.20**	28.15*	-4.93	8.38	21.25*	50.41**	26.04**	11.49*	-17.43	3.71	-0.51
LRK 516 x DHY 286-1	39.24**	6.36	14.93	20.26**	12.50	3.60	36.89**	17.07--	6.38	-2.96	12.79*	5.50
G(B) 20 x G.Cot.10	16.29	-1.46	27.54*	13.84*	12.50	10.08	11.76	11.38	-1.70	5.68	0.91	1.56
G(B) 20 x DHY 286-1	26.50**	-9.41	29.35**	18.36**	0.00	10.08	25.68*	11.50	-9.96	-2.15	-1.64	-4.64
G.Cot.100 x G.Cot.10	16.60	-8.53	-17.34	-2.80	12.50	10.08	27.43*	16.36**	7.18	-12.32	-14.72*	-6.42
G.Cot.100 x DHY 286-1	17.10	17.68*	32.26**	18.77**	33.38**	44.90**	-0.95	26.68**	8.91	18.39**	0.64	9.23**
S.E. ±	2.18	1.70	2.23	1.20	0.91	0.82	0.81	0.49	1.93	2.10	1.88	1.13

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