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Study of heterosis for seed cotton yield and related characters in intra-specific (*Gossypium arboreum* L.) cotton hybrids

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Forty-five hybrids from 10 x 10 diallel of *Gossypium arboreum* L. genotypes were tested with their parents at Anand in *kharif*, 2006 for Heterobeltiosis and Standard heterosis. The heterobeltiosis for seed cotton yield ranged from -32.48 to 154.2 per cent and the value of standard heterosis ranged from -39.05 to 41.89 per cent. The hybrid CINA-343 x *Jawahar Tapti* (higher economic heterosis) and hybrids CINA-333 x CINA-344 and CINA-329 x DLSA-17 (high Heterobeltiosis) were the promising hybrids identified in this study for seed cotton yield per plant. The desirable heterosis was also observed in the cross combinations *viz*; CINA-344 x 824 for boll weight, number of sympodia per plant and number of bolls per plant; CINA-333 x CINA 344 for number of sympodia per plant and number of bolls per plant.

Key words : Heterosis, Seed cotton yield, Diploid cotton, Diallel.

INTRODUCTION

Cotton, the king of fibre, is one of the momentous and important cash crops exercising profound influence on economics and social affairs of the world. It is also called as “White Gold”. Out of total growing area in the Gujarat state, about 15 per cent is under diploid cottons. *i.e.*Gossypium herbaceum and G. arboreum. The farmer’s attraction to this group of cotton is because of some of their outstanding characteristics such as, high ginning out turn and considerable resistance to insect, pest and drought. India is the pioneer country in the world for commercial exploitation of heterosis in cotton. The evolution of Hybrid-4 from Main Cotton Research Station, Surat is a splendid example for successful utilization of hybrid vigour in cotton on commercial scale for the first time in the world. Attempts made at various research stations in the country for development of desi hybrids resulted in the release of few desi hybrids *viz*. G.Cot.DH-7 in 1984 and G.Cot.DH-9 in 1989 in Gujarat, DDH-2 in 1992 from Karnataka, MDCH-201 by Mahyco from Maharashtra and LDH-11 from Punjab. However, these hybrids were conventional and could not spread over wide area in the country. This is because of small and tender flower buds that make emasculation difficult in conventional seed production resulting in low seed production. The present study was carried out with the objectives of finding out the extent of heterosis over better parent and standard check (G. Cot. MDH-11) for seed cotton yield and related characters.

MATERIALS AND METHODS

Ten parental lines, *viz*., CINA-315, CINA-316, CINA-318, CINA-329, CINA-333, CINA-334, CINA-344, DLSA-17, *Jawahar Tapti* and 824 and their 45 F_1s along with the standard check G.Cot.MDH-11 were evaluated during *kharif*, 2006 at Regional Research Station Farm, Anand Agriculture University, Anand in a randomized block design, replicated thrice. Each entry was represented by a single row plot of ten plants, spaced 120 x 45 cm.

All the agronomic and plant protection measures were followed as per the recommended package of practices. Observations were recorded on five plants for the characters, *viz*., yield per plant, bolls per plant, boll weight, sympodia per plant, seed index and ginning percentage. Statistical analysis of the data was conducted as per Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The results of analysis of variance of parents and their hybrids for various traits are given in the Table 1. Mean squares due to genotypic differences were found significant for all the traits studied. This indicated that experimental material under study had sufficient genetic diversity for different traits. Further, partitioning of sum of squares due to genotypes indicated that the differences among parents were significant for all the characters. In case of hybrids, significant differences were obtained for all the characters except yield per plant. However, mean

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Table 1 : Mean Squares for various characters in cotton *G. arboreum* L.

Source of Variation	d.f.	Boll weight (gm)	No. of Sympodia / plant	No. of Bolls per plant	Ginning percentage (%)	Seed Index	Yield / plant (gm)
Replication	2	4.30**	13.15	28.74	1.94	2.53**	79.70**
Treatment	55	0.70**	127.56**	545.46**	12.12**	1.40**	2197.86**
Genotype	54	0.69**	120.39**	500.55**	12.31**	1.42**	2220.02**
Parent	9	0.82**	131.12**	681.63**	16.91**	2.52**	2838.67**
Hybrids	44	0.45**	118.83**	344.78**	8.99**	1.22**	1320.89
Parent Vs Hybrid	1	10.30**	92.04**	5724.41**	116.81**	0.61	36215.5**
Control Vs Rest	1	1.24	514.74**	2970.6**	1.86	0.32	1001.2**
Error	110	0.11	12.40	180.33	2.79	0.26	949.37

* and ** Significance of values at P= 0.05 and 0.01, respectively.

squares due to parents vs hybrids were significant for boll weight, number of sympodia per plant, number of bolls per plant, ginning percentage and yield per plant. Mean squares due to control vs. rest were significant for number of sympodia per plant, number of bolls per plant and yield per plant. The heterobeltiosis and standard heterosis in 45 crosses for six characters is presented in the Table 2.

Yield / plant:

The range of heterobeltiosis for yield per plant was -32.48 to 154.2 per cent. Out of seven hybrids which showed positive and significant heterobeltiosis, the highest value was observed for the cross CINA-333 x 824 (154.20 %) followed by CINA-333 x CINA-344 (131.35 %) and CINA-344 x 824 (99.64 %). The value of standard heterosis ranged from -39.05 to 41.89 per cent. One hybrid showed positive and significant standard heterosis. The highest value was observed for the cross CINA-343 x *Jawahar Tapti* (41.89 %).Only one hybrid showed better performance than standard check variety. High heterosis for seed cotton yield was also reported by Bhatade *et al.* (1980), Amolik *et al.* (1997), Rajput *et al.* (1997), Patel *et al.* (2000), Solanke *et al.* (2002), Karande *et al.* (2004) and Patel *et al.* (2006).

Bolls / plant:

The range of heterobeltiosis for number of boll per plant was -45.32 to 103.3 per cent. Out of six hybrids which showed positive significant heterobeltiosis, the highest value was observed for the cross CINA-329 x DLSA-17 (103.3 %) followed by CINA-333 x CINA-344 (99.47%) and CINA-344 x 824 (86.56 %). The value of standard heterosis ranged from -56.68 to -5.73 per cent. None of the crosses manifested positive and significant standard heterosis. The findings are in accordance with the results of Krishnamurthy and Henry (1979), Bhatade (1981a), Naik and Patel (1982) and Amolik *et al.* (1996).

Boll weight:

The range of heterobeltiosis for boll weight was -16.13 to 35.3 per cent. Out of 17 hybrids which showed positive and significant heterobeltiosis, the maximum value was observed for the cross DLSA-17 x 824 (35.3%) followed by CINA-316 x CINA- 344 (28.81%) and CINA-344 x 824 (24.88%). The value of standard heterosis ranged from -4.41 to 32.45 per cent. Out of 30 hybrids which showed positive and significant standard heterosis, the maximum value was observed for the cross CINA-329 x DLSA-17 (32.45 %) followed by CINA-315 x 824 (32.22 %) and DLSA-17 x 824 (31.34 %). High heterosis for Boll weight was also reported by Bhatade (1981a), Grakh and Chaudhary (1985) and Nairania *et al.* (1992).

Sympodia / plant:

Estimate of heterosis for number of sympodia / plant over better parent varied between -52.16 and 66.21 per cent. Out of seven hybrids which showed positive and significant heterobeltiosis, the maximum value was observed for the cross CINA-318 x 824 (66.21 %) followed by CINA-329 x *Jawahar Tapti* (35.22 %) and Jawahar Tapti x 824 (22.07 %). The value of standard heterosis ranged from -60.33 to -7.00 per cent. None of the crosses manifested positive and significant standard heterosis. High heterosis for sympodial branches per plant was also reported by Bhatade (1981a), Amolik *et al.* (1996), Tuteja and Singh (2001).

Seed index:

The range of heterobeltiosis for seed index was -21.71 to 14.86 per cent. Out of two hybrids which showed positive and significant heterobeltiosis, the highest value was observed for the cross CINA-344 x DLSA-17 (14.86 %) followed by CINA-315 x CINA-329 (12.77 %). The value of standard heterosis ranged from -13.38 to 28.15 per cent. Out of seven hybrids which showed positive and significant standard heterosis, the highest value was

Table 2 : Heterosis in percentage in F_1 hybrids over batter parent and standard check for various characters in Cotton *G. arboreum* L

Crosses	Yield / Plant		No. Bolls per plant	
	BP	SC	BP	SC
CINA-315 x CINA-316	9.24	- 15.90	28.50	- 24.79*
CINA-315 x CINA-318	- 6.46	- 28.00	- 26.13	- 56.07**
CINA-315 x CINA-329	34.13	3.25	59.20*	- 26.54*
CINA-315 x CINA-333	33.17	2.50	60.70*	- 25.85*
CINA-315 x CINA-343	- 32.48	- 33.79	- 45.32**	- 57.99**
CINA-315 x CINA-344	22.08	- 6.01	57.21*	- 27.46*
CINA-315 x DLSA-17	- 0.57	- 16.85	47.52	- 31.59*
CINA-315 x Jawahar Tapti	21.89	- 6.16	4.92	- 33.05**
CINA-315 x 824	- 14.73	- 34.35	- 10.45	- 58.68**
CINA-316 x CINA-318	48.02	- 3.65	12.36	- 33.20**
CINA-316 x CINA-329	21.50	- 8.68	21.11	- 29.10*
CINA-316 x CINA-333	40.37	- 8.63	18.56	- 30.59*
CINA-316 x CINA-343	1.47	- 0.50	0.70	- 22.64
CINA-316 x CINA-344	68.93*	9.95	37.25	- 19.66
CINA-316 x DLSA-17	22.72	2.61	10.59	- 35.26**
CINA-316 x Jawahar Tapti	31.16	- 7.49	- 6.83	- 40.54**
CINA-316 x 824	54.70	0.69	29.15	- 24.40
CINA-318 x CINA-329	16.01	- 12.80	13.51	- 32.51**
CINA-318 x CINA-333	42.49	- 20.83	15.44	- 31.36*
CINA-318 x CINA-343	- 23.52	- 25.01	- 16.73	- 36.03**
CINA-318 x CINA-344	81.80*	1.00	19.05	- 29.22*
CINA-318 x DLSA-17	29.97	8.68	9.52	- 34.89**
CINA-318 x Jawahar Tapti	39.20	- 1.75	5.16	- 32.89**
CINA-318 x 824	49.74	- 16.80	- 2.57	- 42.07**
CINA-329 x CINA-333	28.37	- 3.51	53.60	- 33.12**
CINA-329 x CINA-343	- 1.57	- 3.49	- 15.74	- 35.26**
CINA-329 x CINA-344	12.44	- 15.49	35.50	- 41.00**
CINA-329 x DLSA-17	46.12*	22.18	103.30**	- 5.73
CINA-329 x Jawahar Tapti	18.70	- 10.78	- 0.48	- 36.49**
CINA-329 x 824	- 18.90	- 39.05*	0.88	- 56.07**
CINA-333 x CINA-343	- 11.66	- 13.38	- 25.80	- 42.99**
CINA-333 x CINA-344	131.35**	11.94	99.47**	- 14.30
CINA-333 x DLSA-17	- 17.05	- 30.64	4.95	- 51.33**
CINA-333 x Jawahar Tapti	14.86	- 18.99	38.25	- 40.39**
CINA-333 x 824	154.20**	- 11.18	41.94	- 39.02**
CINA-343 x CINA-344	7.00	4.91	- 8.07	- 29.38*
CINA-343 x DLSA-17	- 24.75	- 26.21	- 24.30	- 41.84**
CINA-343 x Jawahar Tapti	44.72*	41.89*	19.92	- 7.87
CINA-343 x 824	3.79	1.77	- 10.06	- 30.90*
CINA-344 x DLSA-17	- 8.38	- 23.52	23.76	- 42.61**
CINA-344 x Jawahar Tapti	14.60	- 19.17	11.03	- 29.15*
CINA-344 x 824	99.64*	- 3.39	86.56**	- 20.34
DLSA-17 x Jawahar Tapti	27.69	6.77	24.58	- 20.49
DLSA-17 x 824	2.85	- 13.99	26.24	- 41.46**
Jawahar Tapti x 824	16.75	- 17.65	- 19.66	- 48.73**
S.E. ±	25.35	25.35	10.91	10.91
Range	-32.48 to 154.2	-39.05 to 41.89	-45.32 to 103.3	-58.68 to -5.73

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Crosses	Boll weight		Sympodia per plant	
	BP	SC	BP	SC
CINA-315 x CINA-316	- 8.62	1.32	- 12.40	- 29.69**
CINA-315 x CINA-318	8.49	20.30**	- 22.17*	- 50.68**
CINA-315 x CINA-329	4.65	19.42**	19.63*	- 24.21**
CINA-315 x CINA-333	9.81*	26.93**	- 8.51	- 30.79**
CINA-315 x CINA-343	- 3.18	7.50	- 5.47	- 21.64**
CINA-315 x CINA-344	2.92	14.12*	5.28	- 16.81**
CINA-315 x DLSA-17	- 4.24	6.18	- 0.18	- 19.66**
CINA-315 x Jawahar Tapti	3.18	14.56*	11.96	- 24.64**
CINA-315 x 824	19.10**	32.22**	- 8.31	- 41.90**
CINA-316 x CINA-318	0.27	10.15	- 40.02**	- 51.86**
CINA-316 x CINA-329	- 16.13**	- 4.41	- 7.66	- 25.87**
CINA-316 x CINA-333	- 5.35	9.27	- 3.19	- 22.30**
CINA-316 x CINA-343	0.13	11.03	- 3.71	- 20.17**
CINA-316 x CINA-344	28.81**	11.92	- 5.20	- 23.90**
CINA-316 x DLSA-17	23.94**	20.30**	- 18.55*	- 34.43**
CINA-316 x Jawahar Tapti	2.98	6.62	- 31.63**	- 45.12**
CINA-316 x 824	22.55**	15.89**	- 7.20	- 25.52**
CINA-318 x CINA-329	10.45*	26.04**	8.81	- 41.24**
CINA-318 x CINA-333	- 1.53	13.68*	- 30.37**	- 47.32**
CINA-318 x CINA-343	3.71	15.01*	- 32.83**	- 44.31**
CINA-318 x CINA-344	- 1.21	8.38	6.48	- 15.86**
CINA-318 x DLSA-17	14.75**	26.04**	- 4.18	- 22.89*
CINA-318 x Jawahar Tapti	18.77**	30.46**	13.26	- 23.77**
CINA-318 x 824	12.06*	22.95**	66.21**	- 19.38**
CINA-329 x CINA-333	- 0.64	14.79*	5.61	- 20.10**
CINA-329 x CINA-343	- 2.71	11.03	- 8.47	- 24.12**
CINA-329 x CINA-344	- 3.10	10.59	5.93	- 16.30**
CINA-329 x DLSA-17	16.13**	32.45**	- 2.27	- 21.35**
CINA-329 x Jawahar Tapti	10.58*	26.04**	35.22**	- 8.97
CINA-329 x 824	2.06	16.33**	- 13.82	- 53.46**
CINA-333 x CINA-343	- 9.17	4.85	- 3.80	- 20.25**
CINA-333 x CINA-344	5.22	21.63**	17.69*	- 7.00
CINA-333 x DLSA-17	0.00	15.45**	- 12.55	- 29.60**
CINA-333 x Jawahar Tapti	- 5.48	9.27	19.34*	- 9.72
CINA-333 x 824	8.28	25.16**	- 18.57*	- 38.38**
CINA-343 x CINA-344	7.96	19.86**	- 5.91	- 22.01**
CINA-343 x DLSA-17	6.76	18.54**	- 1.50	- 18.34**
CINA-343 x Jawahar Tapti	16.71**	29.58**	- 52.16**	- 60.33**
CINA-343 x 824	7.56	19.42**	- 41.04**	- 51.11**
CINA-344 x DLSA-17	20.30**	16.77**	- 5.27	- 23.77**
CINA-344 x Jawahar Tapti	7.53	11.47	0.09	- 20.91**
CINA-344 x 824	24.88**	18.10**	16.76*	- 7.74
DLSA-17 x Jawahar Tapti	19.89**	24.28**	- 0.45	- 19.88**
DLSA-17 x 824	35.30**	31.34**	- 44.36**	- 55.22**
Jawahar Tapti x 824	18.04**	22.29**	22.07*	- 17.84**
S.E. ±	0.27	0.27	2.85	2.85
Range	-16.13 to 35.30	-4.41 to 32.45	-52.16 to 66.21	-60.33 to -7.00

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Crosses	Ginning percentage		Seed Index	
	BP	SC	BP	SC
CINA-315 x CINA-316	5.68	- 3.12	3.82	4.61
CINA-315 x CINA-318	7.87	0.00	6.26	7.07
CINA-315 x CINA-329	0.00	- 10.40*	12.77*	14.15*
CINA-315 x CINA-333	- 4.21	- 5.21	- 6.31	- 5.69
CINA-315 x CINA-343	9.30*	- 2.09	- 7.57	- 2.92
CINA-315 x CINA-344	8.89*	2.09	0.56	1.23
CINA-315 x DLSA-17	- 2.94	3.12	- 8.55	- 7.84
CINA-315 x Jawahar Tapti	11.96**	7.28	- 6.21	- 5.53
CINA-315 x 824	6.98	- 4.15	- 4.29	28.15**
CINA-316 x CINA-318	11.24*	3.12	4.45	2.30
CINA-316 x CINA-329	2.27	- 6.25	- 6.28	- 5.07
CINA-316 x CINA-333	- 3.16	- 4.15	4.95	3.38
CINA-316 x CINA-343	5.68	- 3.12	- 9.62	- 5.07
CINA-316 x CINA-344	8.89*	2.09	5.56	- 8.46
CINA-316 x DLSA-17	- 4.90	1.03	11.37	2.92
CINA-316 x Jawahar Tapti	8.70*	4.15	- 8.90	- 11.84
CINA-316 x 824	- 6.82	14.59**	- 12.48**	17.23**
CINA-318 x CINA-329	4.49	- 3.12	- 3.75	- 2.61
CINA-318 x CINA-333	8.42*	7.28	1.98	0.46
CINA-318 x CINA-343	11.24*	3.12	- 0.29	4.76
CINA-318 x CINA-344	14.44**	7.28	1.30	- 12.15
CINA-318 x DLSA-17	0.00	6.25	- 6.96	- 8.76
CINA-318 x Jawahar Tapti	9.78*	5.21	- 3.35	-5.23
CINA-318 x 824	8.99*	1.03	6.86	4.76
CINA-329 x CINA-333	2.11	1.03	7.35	8.61
CINA-329 x CINA-343	15.29**	2.09	- 6.40	- 1.69
CINA-329 x CINA-344	7.78	1.03	- 5.52	- 4.30
CINA-329 x DLSA-17	- 7.84*	- 2.09	- 14.44*	-13.38*
CINA-329 x Jawahar Tapti	2.17	- 2.09	- 7.29	- 6.15
CINA-329 x 824	- 1.18	- 12.50**	- 18.15**	9.69
CINA-333 x CINA-343	- 3.16	- 4.15	1.27	6.30
CINA-333 x CINA-344	6.32	5.21	- 10.93	- 12.30
CINA-333 x DLSA-17	- 6.86	- 1.03	0.00	- 1.53
CINA-333 x Jawahar Tapti	2.11	1.03	- 1.46	- 2.92
CINA-333 x 824	- 9.47*	- 10.40*	- 5.21	26.92**
CINA-343 x CINA-344	12.22**	5.21	8.35	13.84*
CINA-343 x DLSA-17	- 4.90	1.03	- 2.05	2.92
CINA-343 x Jawahar Tapti	1.09	- 3.12	2.29	7.38
CINA-343 x 824	6.10	- 9.37*	- 13.82**	15.38*
CINA-344 x DLSA-17	- 3.92	2.09	14.86*	6.15
CINA-344 x Jawahar Tapti	6.52	2.09	- 5.14	-8.15
CINA-344 x 824	2.22	- 4.15	- 17.50**	10.46
DLSA-17 x Jawahar Tapti	- 4.90	1.03	0.58	-2.61
DLSA-17 x 824	- 10.78**	- 5.21	- 14.51**	14.46*
Jawahar Tapti x 824	- 5.43	- 9.37*	- 21.71**	4.92
S.E ±	1.35	1.35	0.42	0.42
Range	-10.78 to 15.29	-14.59 to 7.28	-21.71 to 14.86	-13.38 to 28.15

* and ** Significance of values at P= 0.05 and 0.01, respectively.

observed for the cross CINA-315 x 824 (28.15 %) followed by CINA-333 x 824 (26.92 %) and CINA-316 x 824 (17.23). High heterosis for seed index was also reported by Krishnamurthy and Henry (1979) and Tomar and Singh (1993).

Ginning percentage:

The range of heterobeltiosis for ginning percentage was -10.78 to 15.29 per cent. Out of 13 hybrids which showed positive and significant heterobeltiosis, the maximum value was observed for the cross CINA-329 x CINA-343 (15.29 %) followed by CINA-318 x CINA-344 (14.44 %) and CINA-343 x CINA-344 (12.22 %). The value of standard heterosis ranged from -14.59 to 7.28 per cent. None of the crosses manifested positive and significant standard heterosis. On the contrary six crosses exhibited significant negative and standard heterosis. High heterosis for ginning % was also reported by Krishnamurthy and Henry (1979) and Kapoor *et al.* (2002).

The study revealed that although the parental material utilized for this investigation had sufficient variability,the hybrids except the cross combination, CINA-343 x *Jawahar Tapti* couldn't surpass the standard check G.Cot.MDH-11in yield and yield contributing characters. This indicated rigid linkage groups existing in diploid cottons requiring fresh infusion of genetic blood for breaking genetic constellations.

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