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Heterosis study for yield and yield attributing characters in inter-specific asiatic cotton hybrids

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ABSTRACT

Thirty two intrer-specific hybrids of Asiatic Cotton (*Gossypium herbaceum* and *Gossypium arboreum*) along with their sixteen parents were evaluated at Anand Agricultural University. The data on heterosis calculated over better parent and standard checks DH-7 and DH-9 revealed outstanding superiority of some cross combinations. The analysis of variance revealed significant differences among genotypes for all the traits. Three hybrids *viz*., 832 x CINA – 316, 592 x CINA – 343 and 832 x CINA – 344 showed higher economic heterosis for seed cotton yield per plant, however, study of other yield attributing characters for these crosses revealed that the crosses were either at par or poor than standard checks. The desirable heterosis was also observed in the cross combinations *viz*., G.cot – 13 x CINA – 344 for days to 50% flowering, 832 x CINA – 343 for boll weight and 832 x CINA – 344 for number of bolls per plant.

Key words : Asiatic cotton, Heterosis, *Gossypium herbaceum*, *Gossypium arboreum*

INTRODUCTION

Cotton is the most important textile fiber crop and second most important oil seed crop of the world exercising profound influence on the economic and social affairs of the world and hence, is also known as "White Gold". Cotton supplies five basic products: lint, oil, seed meal, hulls and linters.

The diploid 'old world' cottons *viz., G. arboreum* and *G. herbaceum* are endemic and well adapted to the Indian subcontinent and possess several valuable traits such as, high ginning out turn and considerable resistance to insects, pests and drought. Their morphological characteristics such as deep root system, smaller leaves with short petiole, thin stem, smaller boll and seed coupled with efficient physiological system enable them to withstand moisture stress. In India during 1947-48, acreage occupied by diploid cottons was 97%, which has been reduced to approx. 28% in 2000.

Several attempts have been made in the past by various research workers in the country for the development of desi hybrids and which have resulted in the release of many desi hybrids also *viz.*, G.Cot.DH-7 in 1984 and G.Cot.DH-9 in 1989 in Gujarat, DDH-200 in 1992 in Karnataka and MDCH-201 by Mahyco in Maharashtra and LDH-11 in Punjab, G.Cot.MDH-11 was also released in Gujarat by Gujarat Agricultural University, Surat for commercial cultivation.

Keeping in mind the economic importance of Asiatic cotton the present investigation was undertaken to develop interspecific hybrids between elite *G. herbaceum* and *G. arboreum* lines, and study the extent of heterosis for yield and yield attributes in hybrids.

MATERIALS AND METHODS

The experimental material selected for the present investigation comprised of seven genotypes of *G. herbaceum* as female parents and nine genotypes of *G. arboreum* as male parents. All 63 crosses were attempted during *Kharif* 2005. Out of 63 crosses, nearly half of the crosses did not set sufficient seed; so finally 32 hybrids were used in present study. Thus, experimental material consisted of 50 entries comprising 32 hybrids, 16 parents and 2 checks was tested in randomized block design with three replications at Regional Research Station Farm, Anand Agricultural University, Anand during *Kharif* 2006. Seeds were sown by dibbling in single row of ten plants each; keeping a distance of 120 cm between rows and 45 cm between plants. The border rows were provided all around each replication. All the recommended cultural practices along with necessary plant protection measures were adopted for raising a good crop. The various morphological observations except phenological traits were recorded on randomly selected five plants leaving border plants of each experimental unit. Phenological traits were recorded on population basis.

The recorded data were subjected to analysis of variance technique for each of the characters reported by Panse and Sukhatme (1978). Heterosis over mid-parent, better parent and standard check were worked out as per the standard procedure given by Briggle (1963), Fonseca and Patterson (1968) and Meredith and Bridge (1972), respectively.

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RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the genotypes for all the characters (Table 1) indicating the existence of considerable amount of genetic variability in the experimental materials. The magnitude of heterosis for the hybrids differed significantly for the traits *viz.*, days to flowering, boll weight, no. of monopodia per plant, no. of sympodia per plant, no. of bolls per plant, plant height (Table 2).

Days to 50 per cent flowering :

For this trait, negative heterosis is desirable. The data showed that out of 32 hybrids, 32, 0, 22 and 29 hybrids showed significant negative heterosis over mid-parent, better parent, standard check-1 and standard check-2, respectively (Table 2).

The value of heterosis over mid parent ranged from -8.12 to -24.16 per cent. The range of heterobeltiosis for days to 50 % flowering was -4.09 to 18.94 per cent. Significant negative heterobeltiosis was not observed in any cross. Heterosis over standard variety DH-7 was recorded by 22 crosses, ranging from -11.72 to 3.35 per cent, maximum value was observed for the crosses G.cot – 13 x CINA – 344 (-11.72 %) followed by Gvhv – 235 x Jawahar tapti (-10.04 %). Heterosis over standard variety DH-9 was recorded by 29 crosses, ranging from -16.60 to -2.37 per cent. The results confirmed the findings of Holla *et al.* (1984) and Chavan *et al.* (1999).

Plant height :

The analysis revealed that, the positive significant heterosis over mid-parent, better parent, standard check-1 and standard check-2 was expressed by 21, 8, 15 and 14 hybrids, respectively (Table 2).

The estimates of heterosis over mid parent ranged from -18.80 per cent (592 x CINA – 329) to 39.44 per cent (Gvhv – 235 x CINA – 316). The extent of heterosis over better parent ranged from -33.22 per cent (592 x CINA – 329) to 28.17 per cent (832 x CINA – 344). The hybrid 592 x Jawahar tapti recorded the highest 30.23 % and 26.42 % standard heterosis over standard check DH-7 and standard check DH-9, respectively. The present findings are in accordance with those of Holla *et al.* (1984), Kajjidoni (1986) and Rajput *et al.* (1997).

No. of monopodia / plant :

The data revealed that 15, 8, 3 and 3 hybrids manifested significant positive heterosis over mid-parent, better parent, standard check-1 and standard check-2, respectively (Table 2).

The highest heterosis over mid-parent and better parent was recorded by hybrid 832 x CINA – 316 (55.13 %) and 832 x CINA – 318 (50.83 %), respectively. Maximum heterosis over standard check DH-7 and DH-9 was recorded by the hybrid 832 x CINA – 318 to the magnitude of 16.64 and 21.25 per cent, respectively. These results confirms the conclusion drawn by Holla *et al.* (1984), Kajjidoni (1986), Chavan *et al.* (1999), Patel *et al.* (1990), Singh *et al.* (1990) Tuteja and Singh (2001) and Solanke *et al.* (2002).

No. of sympodia / plant

Significant positive heterosis over mid-parent, better parent and standard check DH-9 was expressed by 22, 6 and 11 hybrids, respectively (Table 2). All the crosses failed to express heterosis over standard check DH-7. It means that none of the hybrids was superior to standard check hybrid DH-7 for this trait.

The value of heterosis over mid parent lies between -4.05 per cent (832 x 824) to 72.03 per cent (Gvhv – 235 x Jawahar tapti). The range of heterobeltiosis for number of sympodia per plant was -17.43 per cent (832 x 824) to 63.64 per cent (Gvhv – 235 x Jawahar tapti). The value of heterosis over standard check DH-9 ranged from -28.87 per cent (Gvhv – 544 x 824) to 37.24 per cent (Gvhv – 235 x CINA – 316 and Gvhv – 235 x Jawahar tapti). High heterosis for sympodial branches per plant was also reported by Holla *et al.* (1984), Kajjidoni (1986), Holla (1986) and Tuteja and Singh (2001).

Boll weight (gm) :

Out of 32 hybrids, 6, 1, 12 and 5 hybrids expressed significant positive heterosis over mid-parent, better parent, standard check-1 and standard check-2, respectively (Table 2).

Table 1 : Analysis of variance for 7 characters of *G. herbaceum* and *G. arboreum*

Source of variation	D.f.	Days to 50% flowering	Plant height (cm)	No. of monopodia / plant	No. of sympodia / plant	Boll weight (g)	No. of bolls per plant	Yield / plant (g)
Replication	2	1.64	499.17**	2.42**	3.50	0.07*	200.50*	828.15
Treatment	49	483.22**	2118.14**	1.13**	75.28**	0.37**	1636.82**	9279.14**
Error	98	7.68	77.21	0.24	11.72	0.01	150.72	731.11

* and ** indicate significant of values at P=0.05 and 0.01, respectively

Table 2 : Estimation of per cent heterosis over mid parent, better parent and standard checks for yield and yield attributing traits

Hybrids	50 per cent flowering				Plant height (cm)				Number of monopodia per plant				Number of sympodia per plant			
	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)
G.cot – 13 x CINA – 344	-24.16**	-4.09	-11.72**	-16.60**	-2.30	-6.74	-15.03**	-17.52**	14.39	7.57	-7.39	-3.73	41.72**	30.30*	-14.09	13.95
G.cot – 21 x CINA – 318	-11.48**	12.25**	2.93	-2.77	8.57*	-13.58**	3.72	0.68	31.45**	29.38**	3.30	7.38	32.69**	0.90	-5.89	24.83*
G.cot – 21 x CINA – 329	-20.17**	3.30	-8.37**	-13.44**	23.77**	-0.98	17.25**	13.81**	12.09	-2.59	5.38	9.55	49.73**	28.91*	-13.25	15.06
G.cot– 21 x Jawahar tapti	-21.83**	0.00	-9.62**	-14.62**	-0.66	-21.17**	-4.59	-7.39	37.07**	33.62**	12.34	16.78	31.58*	16.28	-26.39**	-2.37
G.cot – 21 x DLSA – 17	-18.20**	6.16	-6.28*	-11.46**	27.76**	6.30	13.73**	10.40*	13.48	5.12	-16.07	-12.75	57.00**	32.39**	-6.31	24.27*
Gvhv – 544 x CINA – 329	-18.94**	2.36	-9.21**	-14.23**	21.30**	-3.21	14.60**	11.24**	6.34	-12.14	-4.95	-1.19	47.24**	41.72**	-4.63	26.50*
Gvhv – 544 x CINA – 343	-18.65**	1.86	-8.37**	-13.44**	5.75	-13.90**	-3.33	-6.16	15.37	-1.09	-2.30	1.57	35.28**	26.96*	-9.88	19.53
Gvhv – 544 x CINA – 344	-19.03**	0.00	-7.95**	-13.04**	-5.42	-16.09**	-23.55**	-25.79**	19.13*	8.40	-6.67	-2.98	18.46	15.15	-24.08**	0.70
Gvhv – 544 x Jawahar tapti	-19.91**	0.00	-9.62**	-14.62**	-4.93	-24.76**	-8.93*	-11.60**	2.41	-5.80	-20.80*	-17.67*	43.89**	42.69**	-9.67	19.80
Gvhv – 544 x 824	-18.90**	-2.18	-6.28**	-11.46**	18.96**	-2.49	7.59	4.44	13.74	0.86	-7.96	-4.33	-2.58	-13.85	-46.37**	-28.87*
Gvhv – 235 x CINA - 315	-8.12**	18.94**	3.35	-2.37	17.52**	-2.70	6.39	3.27	8.56	3.19	-14.06	-10.66	22.79	8.66	-19.56*	6.69
Gvhv – 235 x CINA – 316	-18.59**	2.35	-6.69*	-11.86**	39.44**	18.34**	21.69**	18.13**	40.92**	32.03**	-0.93	2.98	40.97**	15.22	3.47	37.24**
Gvhv – 235 x CINA – 318	-20.97**	-0.98	-9.21**	-14.23**	-8.76*	-27.12**	-12.53**	-15.09**	4.71	3.15	-20.23*	-17.08	15.89	-6.65	-12.93	15.48
Gvhv – 235 x CINA – 343	-18.90**	2.79	-7.53**	-12.65**	-5.33	-22.43**	-12.90**	-15.46**	-2.85	-14.52	-15.57	-12.23	59.57**	43.85**	2.10	35.43**
Gvhv – 235 x CINA – 344	-18.54**	1.82	-6.28*	-11.46**	28.65**	14.96**	4.74	1.67	34.72**	26.06**	8.54	12.83	48.67**	38.60**	-8.62	21.20
Gvhv – 235 x Jawahar tapti	-21.24**	-0.46	-10.04**	-15.02**	13.04**	-9.99**	8.93*	5.74	22.81*	16.21	-2.30	1.57	72.03**	63.46**	3.47	37.24**
Gvhv – 235 x 824	-19.86**	-2.18	-6.28*	-11.46**	13.72**	-6.18	3.52	0.48	-2.42	-11.08	-18.87*	-15.66	22.57	12.73	-35.75**	-14.78
832 x CINA – 315	-11.41**	11.72**	-2.93	-8.30**	14.31**	4.60	14.37**	11.02*	25.19**	18.35	-1.43	2.46	25.84*	19.32	-11.67	17.15
832 x CINA – 316	-17.60**	0.97	-7.95**	-13.04**	30.61**	22.94**	26.43**	22.72**	55.13**	46.13**	8.39	12.68	0.34	-12.76	-21.66*	3.91
832 x CINA – 318	-16.30**	2.21	-6.28*	-11.46**	13.63**	-0.22	19.75**	16.24**	53.98**	50.83**	16.64	21.25*	6.72	-8.68	-14.83	12.97
832 x CINA – 329	-10.25**	11.79**	-0.84	-6.32*	22.12**	7.86*	27.71**	23.97**	15.42	-2.72	5.24	9.40	43.51**	42.50**	-4.10	27.20*
832 x CINA – 343	-10.00**	11.16**	0.00	-5.53*	-7.02	-15.93**	-5.60	-8.37	18.29*	3.56	2.30	6.34	41.04**	36.44**	-3.15	28.45*
832 x CINA – 344	-16.81**	1.36	-6.69*	-11.86**	28.41**	28.17**	16.77**	13.35**	11.09	3.40	-10.98	-7.46	41.34**	40.89**	-6.52	23.99*
832 x Jawahar tapti	-15.06**	4.63	-5.44	-10.67**	15.56**	1.11	22.37**	18.79**	40.25**	32.00**	10.98	15.36	12.25	9.67	-27.23**	-3.49
832 x 824	-10.48**	6.55*	2.09	-3.56	6.63	-2.83	7.22	4.07	23.24**	11.71	1.94	5.97	-4.05	-17.43	-45.22**	-27.34*
592 x CINA – 315	-19.26**	4.98	-8.79**	-13.83**	39.38**	18.36**	29.43**	25.63**	15.59	9.85	1.58	5.59	46.76**	30.40*	-3.47	28.03*
592 x CINA – 329	-17.33**	6.13	-5.86*	-11.07**	-18.80**	-33.22**	-20.93**	-23.24**	8.26	0.40	8.61	12.90	6.15	-1.56	-33.75**	-12.13
592 x CINA – 343	-15.96**	6.98*	-3.77	-9.09**	14.02**	-4.22	7.55	4.40	16.65*	12.93	11.55	15.96	40.92**	27.56*	-9.46	20.08
592 x Jawahar tapti	-20.85**	0.46	-9.21**	-14.23**	31.95**	7.60*	30.23**	26.42**	30.60**	24.67**	15.28	19.84*	36.47**	30.23*	-17.56*	9.34
592 x DLSA – 17	-13.87**	10.90**	-2.09	-7.51**	34.34**	15.11**	23.16**	19.55**	23.15*	6.90	-1.15	2.76	40.98**	27.79*	-9.57	19.94
592 x 824	-16.27**	2.62	-1.67	-7.11**	20.12**	1.63	12.14**	8.85*	0.66	0.00	-7.53	-3.88	37.72**	26.14	-27.44**	-3.77
V – 797 x CINA – 315	-18.29**	4.98	-8.79**	-13.83**	-1.67	-12.99**	-4.86	-7.65	9.83	3.01	-14.20	-10.81	43.90**	34.80**	-0.21	32.36**

Where, MP=mid parent, BP=better parent, SC-1=standard check-1 (DH-7), SC-2=standard check-2 (DH-9), * and ** indicates significance of values at P = 0.05 and 0.01, respectively

Table 2 Contd….

Contd…… Table 1

Hybrids	Boll weight (gm)				Number of bolls per plant				Seed cotton yield per plant (g)			
	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)	MP (%)	BP (%)	SC - 1 (%)	SC - 2 (%)
G.cot – 13 x CINA – 344	-7.06	-12.61**	-0.15	-9.15*	18.89	-4.94	-41.43**	-23.02	-1.29	-32.21	-51.58**	-47.51**
G.cot – 21 x CINA – 318	5.34	1.10	-17.12**	-24.59**	136.42**	109.13**	5.90	39.18**	109.50**	63.71*	-27.31*	-21.19
G.cot – 21 x CINA – 329	-8.39	-25.35**	-10.66*	-18.72**	139.21**	123.91**	0.00	31.42*	155.63**	98.01**	-9.89	-2.31
G.cot– 21 x Jawahar tapti	0.26	-9.98	-14.71**	-22.40**	126.92**	88.95**	10.60	45.36**	128.14**	68.17**	-11.37	-3.92
G.cot – 21 x DLSA – 17	18.04**	2.65	4.65	-4.78	145.88**	131.43**	2.14	34.24*	289.39**	245.88**	11.33	20.69
Gvhv – 544 x CINA – 329	-8.90*	-18.44**	-2.40	-11.20*	106.12**	95.33**	-2.56	28.06	131.15**	110.02**	-4.42	3.62
Gvhv – 544 x CINA – 343	1.54	-8.94*	8.56	-1.23	31.02	11.90	-21.17	3.61	55.33**	13.92	-9.24	-1.61
Gvhv – 544 x CINA – 344	-12.15**	-19.71**	-8.26	-16.53**	79.43**	62.36**	0.04	31.47*	67.04**	27.00	-9.28	-1.66
Gvhv – 544 x Jawahar tapti	10.07*	9.98	4.20	-5.19	68.79**	56.33**	-8.50	20.26	99.78**	70.38**	-10.21	-2.66
Gvhv – 544 x 824	18.39**	13.56**	16.97**	6.42	170.29**	98.49**	-0.98	30.14*	322.74**	226.47**	21.42	31.63*
Gvhv – 235 x CINA - 315	10.22*	8.54	6.91	-2.73	101.37**	71.53**	-5.79	23.81	127.91**	78.15**	-1.89	6.36
Gvhv – 235 x CINA – 316	-8.38	-13.95**	-6.46	-14.89**	125.23**	96.87**	1.69	33.65*	123.31**	80.92**	-9.52	-1.92
Gvhv – 235 x CINA – 318	9.98*	2.20	-2.40	-11.20*	72.38**	51.97*	-23.05*	1.14	105.38**	74.43*	-22.54	-16.03
Gvhv – 235 x CINA – 343	-16.36**	-24.69**	-10.21*	-18.31**	52.58**	18.14	-16.77	9.39	35.23	-6.05	-25.16	-18.86
Gvhv – 235 x CINA – 344	-8.38*	-15.90**	-3.90	-12.57**	89.80**	54.42**	-4.85	25.05	78.27**	27.85	-8.68	-1.00
Gvhv – 235 x Jawahar tapti	-1.03	-1.42	-5.86	-14.34**	102.55**	68.14**	-1.58	29.35*	119.53**	74.38**	-8.10	-0.37
Gvhv – 235 x 824	6.51	2.62	5.71	-3.83	116.24**	73.54*	-32.93**	-11.86	215.75**	160.95**	-19.05	-12.24
832 x CINA – 315	-2.31	-15.56**	14.11**	3.83	75.39**	67.83**	-7.82	21.15	95.11**	94.97**	7.37	16.40
832 x CINA – 316	-9.36**	-18.22**	10.51*	0.55	145.70**	142.21**	25.11*	64.43**	184.08**	171.21**	49.15**	61.69**
832 x CINA – 318	23.93**	-0.44	34.53**	22.40**	64.88**	64.14**	-16.88	9.24	124.78**	103.14**	11.71	21.11
832 x CINA – 329	3.83	-2.11	32.28**	20.36**	48.55*	40.37	-29.55**	-7.41	95.76**	78.88**	-1.63	6.64
832 x CINA – 343	6.38	0.11	35.29**	23.09**	5.39	-9.77	-36.43**	-16.45	15.22	-2.62	-22.42	-15.90
832 x CINA – 344	-19.93**	-26.11**	-0.15	-9.15*	133.22**	111.59**	30.38**	71.34**	128.89**	102.56**	44.69**	56.85**
832 x Jawahar tapti	-11.56**	-24.78**	1.65	-7.51	74.48**	62.04**	-5.15	24.65	91.42**	87.43**	3.07	11.74
832 x 824	0.76	-11.22**	19.97**	9.15*	147.22**	81.20**	-9.06	19.52	190.36**	98.65**	9.24	18.43
592 x CINA – 315	-10.17**	-26.89**	14.71**	4.37	108.97**	94.52**	6.84	40.42**	139.77**	136.88**	30.46*	41.43**
592 x CINA – 329	-16.18**	-26.12**	15.92**	5.46	102.78**	97.06**	-6.73	22.58	19.80	10.62	-40.55**	-35.55*
592 x CINA – 343	-4.73	-16.17**	31.53**	19.67**	72.74**	44.40*	1.73	33.70*	122.47**	86.28**	48.40**	60.88**
592 x Jawahar tapti	0.00	-19.81**	25.83**	14.48**	49.64**	35.32	-20.79	4.10	81.16**	79.40**	-3.58	4.53
592 x DLSA – 17	-17.63**	-32.06**	6.61	-3.01	145.46**	137.17**	12.26	47.53**	169.35**	115.33**	15.73	25.46
592 x 824	-14.73**	-29.38**	10.81*	0.82	210.15**	131.69**	9.66	44.12**	238.26**	132.86**	25.16	35.68*
V – 797 x CINA – 315	-3.49	-5.18	-6.61	-15.03**	94.62**	53.59**	-15.64	10.87	91.56**	31.74	-27.45*	-21.35

Where, MP=mid parent, BP=better parent, SC-1=standard check-1 (DH-7), SC-2=standard check-2 (DH-9), * and ** indicate significance of values at P=0.05 and 0.01 levels, respectively

Relative heterosis and heterobeltiosis ranged from -19.93 per cent (832 x CINA – 344) to 23.93 per cent (832 x CINA – 318) and -32.06 per cent (592 x DLSA – 17) to 13.56 per cent (Gvhv – 544 x 824), respectively. Maximum heterosis over standard check DH-7 and DH-9 was recorded by the hybrid 832 x CINA – 343 to the magnitude of 35.29 and 23.09 per cent, respectively. These results are accordance with Kajjidoni *et al.* (1984) and Holla *et al.* (1984) and Singh *et al.* (1990).

No. of bolls per plant :

The value of heterosis over mid parent lies between 5.39 per cent (832 x CINA – 343) to 210.15 per cent (592 x 824). Out of 32 hybrids; 29 showed positive significant heterosis over mid parent (Table 2). The range of heterobeltiosis for number of boll per plant was -9.77 per cent (832 x CINA – 343) to 142.21 per cent (832 x CINA – 316). Out of 32 hybrids; 26 showed positive significant heterobeltiosis. Maximum heterosis over standard check DH-7 and DH-9 was recorded by the hybrid 832 x CINA – 344 in the magnitude of 30.38 and 71.34 per cent, respectively. The findings are in accordance with results of Naik and Patel (1982), Holla *et al.* (1984), Kajjidoni (1986), Waedia and Tomar (1980) and Chakresh Kumar *et al.* (1992).

Seed cotton yield per plant

The value of heterosis over mid parent lies between -1.29 per cent (G.cot-13 x CINA-344) to 322.74 per cent (Gvhv-544 x 824). Out of 32 hybrids; 28 showed positive significant heterosis over mid parent (Table 2). The range of heterobeltiosis for seed cotton yield per plant was -32.21 per cent (G.cot-13 x CINA-344) to 245.88 per cent (G.cot-21 x DLSA-17). Out of 32 hybrids; 24 showed positive significant heterobeltiosis. Maximum heterosis over standard check DH-7 and DH-9 was recorded by the hybrid 832 x CINA-316 in the magnitude of 49.15 and 61.69 per cent, respectively. High heterosis for seed cotton yield was also reported by Kajjidoni *et al.* (1984), Holla *et al.* (1984), Ansingkar *et al.* (1990), Singh *et al.* (1990), Solanke *et al.* (2001), Solanke *et al.* (2002), Karande *et al.*(2004) and Patel *et al.* (2006).

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