The Pharma Innovation Journal 2023; 12(2): 491-495

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(2): 491-495

www.thepharmajournal.com
Received: 22-12-2022
Accepted: 24-01-2023

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Heterosis study on yield, yield contributing and fibre quality traits in desi cotton (*Gossypium arboreum* L.)

Yogesh Hottigodar, HV Kalpande and VN Chinchane

Abstract
Eighteen hybrid combinations developed by crossing three lines and six testers in Line X Tester mating design were evaluated along with their parents including three checks with two replications in Randomised Block Design for seed cotton yield, yield contributing and fibre quality traits in desi cotton during kharif, 2021 at Cotton Research Station, Mahboob Baugh, VNMKV, Parbhani. Heterosis was estimated in relation to better parent (Heterobeltiosis) and standard checks (Standard heterosis). The magnitude of heterosis, heterobeltiosis and standard heterosis for all the characters in the current study was highly appreciable. Among eighteen crosses, the crosses showed the highest and desirable significant standard heterosis for various traits *viz*., cross PA 833 x JLA 505 for days to 50 per cent flowering; PA 904 x CNA 1032 for plant height, boll weight and ginning percentage; PA 899 x PA 740 for number of sympodial per plant; PA 833 x CNA 1032 for number of bolls per plant, seed cotton yield per plant, seed index and lint index; PA 904 x PA 785 for upper half mean length and fibre strength; PA 833 X AKA 7 for fibre fineness; PA 904 x AKA 7 for uniformity ratio over standard check PKVDH 1,PKV Suvarna and NACH 12, respectively. The crosses PA 899 x CNA 1032, PA 833 x CNA 1032 and PA 833 X AKA 7 for seed cotton yield and yield contributing traits, while crosses PA 904 x PA 785 and PA 833 X JLA 794 for fibre quality traits hold promise for further evaluation and commercial exploitation of heterosis.

Keywords: Yield, yield contributing, fibre quality traits, *Gossypium arboreum* L.

Introduction
Cotton (*Gossypium* spp.) is one the most important fibre crops of India and it is also called as king of fibre and white gold. It is the oldest among the commercial crops of the world. India is the only country in the world where all the four cultivated species of cotton are grown on a commercial scale besides hybrids. But more recently, due to the outbreak of bollworm resistance and attack by new biotype bollworms & viral diseases, the yield is decreasing in Bt cotton & *hirsutum* hybrids. Also, they yield less under rain fed conditions & gives fewer marginal returns to the farmers. So, the shift is now changing to use the vast genetic diversity of desi cotton in India since, desi cottons are known for their inherent ability of resistance against major pests and diseases.

Exploiting heterosis is one of the methods to improve yield and fiber quality traits in cotton. The term heterosis was coined by Shull (1914) [13], it is the superiority of F1 hybrid over the mid-parents or the better parent or over the standard check with regard to agriculturally useful traits. In India, heterosis has been heavily utilized in cotton breeding programs. The development of heterosis in cotton is said to be influenced by a number of factors, including genetic and geographical variety, agronomic performance, adaptability and the genetic foundation of the parental lines.

Materials and Methods
In the current study, three lines and six testers were crossed in L x T mating design to produce eighteen crosses. All these crosses along with their parents and three checks *viz*., PKVDH 1, PKV Suvarna, NACH 12 were sown during kharif 2021 at Cotton Research Station, Mahboob Baugh, VNMKV, Parbhani. The observations were recorded on different morphological, yield and yield contributing traits *viz*., days to 50% flowering, plant height (cm); number of sympodial per plant, number of bolls per plant, boll weight (g) and seed cotton yield per plant (g). Analysis was carried out as per the method suggested by Fonesca and Patterson (1968) [5].

Results and Discussion

Amongst all the crosses, five and three crosses showed significant positive standard heterosis over PKVDH 1 and PKV Suvarna respectively. The cross PA 833 x CNA 1032 exhibited highest standard heterosis over PKVDH 1 (27.41%), PKV Suvarna (21.14%), NACH 12 (6.22%) for seed cotton yield per plant. It also showed second highest heterobeltiosis (42.83%) for seed cotton yield per plant. It also exhibited high heterobeltiosis and standard heterosis over standard checks for number of sympodial per plant (BPH= 49.46%, SH-1= 36.71%, SH2=26.18%, SH-3=19.25%), number of bolls per plant (BPH= 26.87%, SH-1= 40.18%, SH-2=25.86%, SH-3=19.23%), seed index (BPH= 18.67%, SH-1= 21.61%, SH-2=17.69%, SH-3=16.91%), lint index (BPH= 1.89%, SH-1= 10.45%, SH-2=10.45%, SH-3=19.27%), boll weight (BPH= 7.00%, SH-1= 12.24%, SH-2=10.89%) and also for days to 50% flowering (BPH= -10.53%, SH-1= 0%, SH-2=-2.86%, SH-3=-4.90%).

Another cross PA 899 X CNA 1032 ranked second and forth in relation to standard heterosis and heterobeltosis respectively, for seed cotton yield per plant (BPH= 37.65%, SH-1= 23.47%, SH-2=17.39%, SH-3=2.93%). Besides yield, it also showed high desirable heterosis for number of sympodial per plant (BPH= 70.52%, SH-1= 32.26%, SH-2=22.08%, SH-3=15.36%), number of bolls per plant (BPH= 44.29%, SH-1= 37.01%, SH-2=23.02%, SH-3=16.54%), seed index (BPH= 2.50%, SH-1= 12.04%, SH-2=8.43%, SH-3=7.72%), boll weight (BPH= 7.91%, SH-1= 11.43%, SH-2=10.08%.

The cross PA 833 X AKA 7 ranked third in both standard heterosis and heterobeltiosis for seed cotton yield per plant (BPH=38.60%, SH-1= 23.47%, SH-2=17.39%, SH-3=2.93%). It also showed desirable heterosis for number of sympodial per plant (BPH= 47.97%, SH-1= 35.35%, SH-2=24.93%, SH3=18.06%), number of bolls per plant (BPH=18.27%, SH-1= 30.68%, SH- 2=17.34%, SH-3=11.15%), plant height (BPH=1.92%, SH-1= 22.97%, SH2=2.89%, SH-3=4.01%), boll weight (BPH= 3.89%, SH-1=8.98%, SH-2=7.66%), seed index (BPH=6.67%, SH-1= 9.31%, SH-2=5.79%, SH-3=5.09%).

The standard heterosis for the character, number of bolls per plant ranged from -14.54% to 40.18% over PKVDH 1, from -23.26% to 25.86% over PKV Suvarna and from -27.31% to 19.23% over NACH 12. Amongst all the crosses, seven, four and two crosses showed significant positive standard heterosis over PKVDH 1, PKV Suvarna and NACH 12 respectively. The cross PA 833 x CNA 1032 exhibited highest standard heterosis over PKVDH 1 (40.18%), PKV Suvarna (25.86%), NACH 12 (19.23%) followed by PA 899 x CNA 1032 (37.01% over PKVDH 1, 23.02% over PKV Suvarna, 16.54% over NACH 12) and PA 833 x AKA 7 (30.68% over PKVDH 1, 17.34% over PKV Suvarna, 11.15% over NACH 12). The standard heterosis for the character, number of sympodial per plant ranged from -4.82% to 37.82% over PKVDH 1, from -12.15% to 27.21% over PKV Suvarna and from -16.98% to 20.22% over NACH 12. Amongst all the crosses, eight, six and five crosses showed significant positive standard heterosis over PKVDH 1, PKV Suvarna and NACH 12 respectively. The cross PA 899 x PA 740 exhibited highest standard heterosis over PKVDH 1 (37.82%), PKV Suvarna (27.21%), NACH 12 (20.22%) followed by PA 833 x CNA1032 (36.71% over PKVDH 1, 26.18% over PKV Suvarna, 19.25% over NACH 12) and PA 833 x AKA 7 (35.35% over PKVDH 1, 24.93% over PKV Suvarna, 18.06% over NACH 12).

The standard heterosis for the character, boll weight ranged from -2.86% to 16.94% over PKVDH 1, from -4.03% to 15.52% over PKV Suvarna and from -17.00% to -0.09% over NACH 12. Amongst all the crosses, ten and seven crosses showed significant positive standard heterosis over PKVDH 1 and PKV Suvarna respectively.

Similar results were also obtained by Patel *et al.* (2010) [10], Lalage *et al.* (2011) [7], Choudhary *et al.* (2016) [4], Pundir *et al.* (2017) [11], Anil *et al.* (2018) [1], Chinchane *et al.* (2018) [3], Thombre *et al.* (2018) [9], Shinde *et al.* (2020) [8], Chinchane *et al.* (2021) [2], Giri *et al.* (2021) [6], Yehia and El-Hashash (2022) [12].

Table 1: Analysis of variance for morphological, yield contributing and fibre characters in cotton

Sr. No	Traits	Replication	Genotypes	Error
1	Days to 50% flowering	3.750	21.276**	3.853
2	Plant height (cm)	4.080	24.1739**	3.736
3	Number of sympodial per plant	1.635	18.421**	1.484
4	Number of bolls per plant	2.231	15.922**	3.387
5	Boll weight (g)	0.021	0.047**	0.007
6	Seed cotton yield per plant (g)	36.473	148.984**	31.862
7	Ginning percentage (%)	1.851	6.920**	1.416
8	Seed index (g)	0.094	0.293**	0.047
9	Lint index (g)	0.022	0.089**	0.007
10	Upper Half Mean Length (mm)	0.247	6.008**	0.605
11	Fibre strength (g/ tex)	0.026	5.994**	0.173
12	Fibre fineness (µg/inch)	0.001	0.325**	0.008
13	Uniformity ratio (%)	0.523	7.944**	2.307

Table 2: Estimates of heterosis in percentage over mid parent (M.P.), better parent (B.P.) and standard checks (S.C.) for various characters

Sr. No	Crosses	Days to 50% Flowering					Plant Height (cm)				
		SH1	SH2	SH3	AH	BPH	SH1	SH2	SH3	AH	BPH
1	PA 899 X JLA505	-3.68	-6.43*	-8.39**	-15.65**	-13.82**	34.36**	12.42*	13.64*	15.01*	10.94*
2	PA 899 X CNA 1032	7.35*	4.29	2.10	0.68	-3.31	33.92**	12.06*	13.27*	8.87	8.91
3	PA 899 X PA 740	-2.94	-5.71	-7.69*	-7.20*	-12.58**	32.61**	10.96*	12.16*	7.45	6.65
4	PA 899 X AKA 7	2.21	-0.71	-2.80	-4.68	-7.95*	21.11**	1.34	2.44	0.19	0.00
5	PA 899 X JLA 794	1.47	-1.43	-3.50	-5.43	-8.61**	20.65**	0.95	2.05	-3.52	-6.25
6	PA 899 X PA 785	0.74	-2.14	-4.20	-5.11	-9.27**	12.62*	-5.77	-4.74	-14.34*	-17.45**
7	PA 904 X JLA 505	11.76**	8.57**	6.29*	5.26	0.00	1.86	-14.77*	-13.85*	-8.21	-10.00*
8	PA 904 X CNA 1032	-1.47	-4.29	-6.29*	-2.61	-3.60	38.58**	15.96*	17.22**	14.80*	12.70*
9	PA 904 X PA 740	2.21	-0.71	-2.80	3.60	2.21	19.04**	-0.40	0.68	0.23	-4.27
10	PA 904 X AKA 7	1.47	-1.43	-3.50	0.00	-1.43	19.83**	0.26	1.35	2.43	-0.68
11	PA 904 X JLA 794	-2.21	-5.00	-6.99*	-3.76	-5.00	20.16**	0.54	1.64	-0.64	-6.63
12	PA 904 X PA 785	3.68	0.71	-1.40	3.19*	2.92	24.54**	4.20	5.34	-0.21	-8.71
13	PA 833 X JLA 505	-5.88	-8.57**	-10.49**	-18.75**	-15.79**	29.07**	7.99	9.17	15.93*	17.61**
14	PA 833 X CNA 1032	0.00	-2.86	-4.90	-6.99*	-10.53**	20.19**	0.56	1.66	3.19	-2.26
15	PA 833 X PA 740	-2.21	-5.00	-6.99*	-6.77*	-12.50**	29.07**	7.99	9.17	9.32	3.80
16	PA 833 X AKA 7	7.35*	4.29	2.10	0.00	-3.95	22.97**	2.89	4.01	6.32	1.92
17	PA 833 X JLA 794	-2.21	-5.00	-6.99*	-9.77*	-12.50**	1.87	-14.77*	-13.84*	-17.03**	-20.84*
18	PA 833 X PA 785	0.00	-2.86	-4.90	-6.25*	-10.53**	9.05	-8.76	-7.76	-12.87*	-20.07**
	S. E ±	1.45	1.45	1.45	1.45	1.45	4.58	4.58	4.58	4.58	4.58
	CD at 5%	4.29	4.29	4.29	4.29	4.29	13.53	13.53	13.53	13.53	13.53

Sr. No	Crosses	Number of Sympodial per plant					Number of Bolls per plant				
		SH1	SH2	SH3	AH	BPH	SH1	SH2	SH3	AH	BPH
1	PA 899 X JLA 505	2.60	-5.31	-10.51	20.93**	16.90*	5.36	-5.40	-10.38	4.98	0.09
2	PA 899 X CNA 1032	32.26**	22.08**	15.36*	42.52**	70.52**	37.01**	23.02**	16.54*	31.65**	44.29**
3	PA 899 X PA 740	37.82**	27.21**	20.22**	42.71**	65.19**	29.73**	16.48*	10.35	21.58*	19.54*
4	PA 899 X AKA 7	13.72	4.96	-0.81	34.38**	52.07**	13.05	1.50	-3.85	12.00	8.70
5	PA 899 X JLA 794	6.92	-1.31	-6.74	21.82**	15.33*	9.43	-1.75	-6.92	4.34	-4.35
6	PA 899 X PA 785	11.87	3.25	-2.43	24.72**	19.08*	6.94	-3.98	-9.04	5.18	-0.84
7	PA 904 X JLA 505	17.89*	8.81	2.83	27.52**	34.33**	9.43	-1.75	-6.92	2.83	1.89
8	PA 904 X CNA 1032	19.28*	10.10	4.04	32.64**	43.49**	14.18	2.52	-2.88	12.53	6.32
9	PA 904 X PA 740	28.37**	18.48*	11.97	35.12**	53.85**	19.35*	7.17	1.52	9.55*	9.98
10	PA 904 X AKA 7	9.21	0.80	-4.74	27.70**	31.38**	22.22*	9.74	3.96	13.52	13.81
11	PA 904 X JLA 794	-3.58	-11.01	-15.90*	8.81	4.00	-1.42	-11.49	-16.15*	-12.50	-13.83
12	PA 904 X PA 785	-4.82	-12.15	-16.98*	6.98	1.32	-14.54	-23.26**	-27.31**	-25.93**	-20.75*
13	PA 833 X JLA 505	1.99	-5.86	-11.04	12.13	11.50	10.78	-0.53	-5.77	2.62	0.27
14	PA 833 X CNA 1032	36.71**	26.18**	19.25*	38.18**	49.46**	40.18**	25.86**	19.23*	27.65**	26.87**
15	PA 833 X PA 740	31.21**	21.11**	14.45*	33.35**	43.45**	24.98**	12.22	6.31	12.38	13.12
16	PA 833 X AKA 7	35.35**	24.93**	18.06*	38.58**	47.97**	30.68**	17.34*	11.15	17.93*	18.27*
17	PA 833 X JLA 794	-2.78	-10.27	-15.20*	5.28	4.87	-5.27	-14.94	-19.42*	-18.70*	-17.19*
18	PA 833 X PA 785	-1.27	-8.87	-13.88	6.10	5.10	5.36	-5.40	-10.38	-3.62	-4.64
	S. E ±	0.89	0.89	0.89	0.89	0.89	1.33	1.33	1.33	1.33	1.33
	CD at 5%	2.63	2.63	2.63	2.63	2.63	3.94	3.94	3.94	3.94	3.94

Sr. No	Crosses	Boll weight (g)					Seed Index (g)				
		SH1	SH2	SH3	AH	BPH	SH1	SH2	SH3	AH	BPH
1	PA 899 X JLA 505	7.14	5.85	-8.46*	5.90	5.85	6.58	3.14	2.46	-2.40	-2.50
2	PA 899 X CNA 1032	11.43*	10.08*	-4.80	8.61*	7.91*	12.04*	8.43	7.72	8.23	2.50
3	PA 899 X PA 740	9.39*	8.27*	-6.54	10.26*	8.94*	16.31*	12.56*	11.82*	9.10*	6.41
4	PA 899 X AKA 7	9.18*	7.86*	-6.89*	10.11*	8.54*	8.97	5.45	4.76	4.31	-0.31
5	PA 899 X JLA 794	2.04	0.81	-12.82*	3.40	1.63	20.92**	17.02**	16.26**	8.69	8.42
6	PA 899 X PA 785	-2.86	-4.03	-17.00**	-2.52	-3.25	0.26	-2.98	-3.61	-2.73	-8.28
7	PA 904 X JLA 505	-1.22	-2.42	-15.61**	-1.03	-2.42	10.33*	6.78	6.08	5.11	1.25
8	PA 904 X CNA 1032	16.94**	15.52**	-0.09	13.79**	13.24**	14.43*	10.74*	10.02*	14.03*	13.95*
9	PA 904 X PA 740	8.16*	6.85	-7.59*	10.19*	9.96*	12.55*	8.93*	8.21	10.02*	10.20*
10	PA 904 X AKA 7	7.14	5.65	-8.63*	9.35*	8.71*	10.16*	6.61	5.91	9.38*	9.69*
11	PA 904 X JLA 794	15.71**	14.31**	-1.13	15.70**	17.63**	9.31*	5.79	5.09	3.05	-1.99
12	PA 904 X PA 785	2.86	1.61	-12.12**	4.17	4.13	1.79	-1.49	-2.13	3.19	1.36
13	PA 833 X JLA 505	3.27	2.02	-11.77*	0.20	-1.56	8.80	5.29	4.60	2.83	-0.16
14	PA 833 X CNA 1032	12.24*	10.89*	-4.10	7.27*	7.00*	21.61**	17.69**	16.91**	18.26**	18.67**
15	PA 833 X PA 740	11.43*	10.08*	-4.80	9.89*	6.23	4.70	1.32	0.66	2.28	2.17
16	PA 833 X AKA 7	8.98*	7.66	-6.89*	8.05*	3.89	9.31*	5.79	5.09	7.73	6.67
17	PA 833 X JLA 794	8.16*	6.85	-7.59*	6.79*	3.11	12.55*	8.93*	8.21	4.93	0.92

18	PA 833 X PA 785	4.90	3.63	-10.37*	2.92	0.00	12.04*	8.43	7.72	11.13*	9.33*
	S. E ±	0.07	0.07	0.07	0.07	0.07	0.18	0.18	0.18	0.18	0.18
	CD at 5%	0.19	0.19	0.19	0.19	0.19	0.53	0.53	0.53	0.53	0.53

Sr. No	Crosses	Lint Index (g)					Ginning Percentage (%)				
		SH1	SH2	SH3	AH	BPH	SH1	SH2	SH3	AH	BPH
1	PA 899 X JLA 505	10.04**	10.04**	18.83**	3.34	-0.55	3.52	13.66**	3.46	6.95	7.00
2	PA 899 X CNA 1032	-2.72	-2.72	5.05	-4.85	-12.08**	-0.90	8.81*	-0.95	2.46	2.43
3	PA 899 X PA 740	-0.05	-0.05	7.93*	-5.33*	-9.66*	-0.49	9.26*	-0.55	2.37	2.01
4	PA 899 X AKA 7	6.97*	6.97*	15.51**	2.56	-3.32	6.09	16.48**	6.03	7.65	6.96
5	PA 899 X JLA 794	9.90**	9.90*	18.68**	3.10	-0.67	5.54	15.88**	5.48	8.57*	9.08*
6	PA 899 X PA 785	-0.36	-0.36	7.60*	-3.35	-9.94*	4.59	14.83**	4.53	9.13*	8.10
7	PA 904 X JLA 505	5.52*	5.52*	13.95**	4.80	3.37	5.21	15.52**	5.16	8.27	8.35*
8	PA 904 X CNA 1032	2.90	2.90	11.11**	6.61*	4.11	13.37**	24.48**	13.31**	14.59**	16.75**
9	PA 904 X PA 740	9.59*	9.59*	18.35**	9.32*	9.69*	6.63	17.08**	6.57	8.73*	9.32*
10	PA 904 X AKA 7	6.52*	6.52*	15.02**	7.69**	7.77*	5.84	16.21**	5.78	7.27	6.71
11	PA 904 X JLA 794	8.51*	8.51*	17.17**	7.29*	6.01*	0.08	9.89*	0.03	3.41	3.06
12	PA 904 X PA 785	-0.90	-0.90	7.02*	2.04	0.27	2.67	12.74**	2.62	7.26	5.73
13	PA 833 X JLA 505	2.79	2.79	11.00**	-2.38	-5.17	0.76	10.64**	0.71	8.57*	5.07
14	PA 833 X CNA 1032	10.45**	10.45**	19.27**	8.67*	1.89	-1.09	8.60*	-1.15	6.52	2.43
15	PA 833 X PA 740	8.09*	8.09*	16.72**	3.64	-0.28	1.12	11.03**	1.06	8.08	3.67
16	PA 833 X AKA 7	-5.78*	-5.78*	1.74	-9.43*	-13.08*	2.59	12.65**	2.54	8.60*	3.44
17	PA 833 X JLA 794	8.99*	8.99*	17.70**	3.32	0.55	-1.26	8.42*	-1.31	6.53	2.61
18	PA 833 X PA 785	-5.45*	-5.45*	2.10	-7.73*	-12.77**	4.28	14.50**	4.23	12.89**	11.74**
	S. E ±	0.06	0.06	0.06	0.06	0.06	0.85	0.85	0.85	0.85	0.85
	CD at 5%	0.19	0.19	0.19	0.19	0.19	2.50	2.50	2.50	2.50	2.50

Sr. No	Crosses	Seed cotton yield per plant (g)				
		SH1	SH2	SH3	AH	BPH
1	PA 899 X JLA 505	4.31	-0.83	-13.04	15.84	16.29*
2	PA 899 X CNA 1032	23.47**	17.39	2.93	27.55**	37.65**
3	PA 899 X PA 740	14.25	8.63	-4.75	21.07**	26.04**
4	PA 899 X AKA 7	12.12	6.59	-6.54	27.23**	24.99**
5	PA 899 X JLA 794	12.29	6.76	-6.39	22.51**	25.18**
6	PA 899 X PA 785	-4.45	-9.16	-20.34*	1.12	-3.73
7	PA 904 X JLA 505	0.35	-4.59	-16.35*	19.41*	16.86*
8	PA 904 X CNA 1032	22.55*	16.52*	2.17	32.65**	37.38**
9	PA 904 X PA 740	20.37*	14.44	0.35	30.83**	32.79**
10	PA 904 X AKA 7	10.08	4.66	-8.23	32.17**	45.10**
11	PA 904 X JLA 794	5.68	0.48	-11.90*	24.21**	25.32**
12	PA 904 X PA 785	-17.61	-21.67**	-31.31**	-6.27	-16.99*
13	PA 833 X JLA5 05	-0.55	-5.45	-17.09*	12.04	11.64
14	PA 833 X CNA 1032	27.41**	21.14**	6.22	30.03**	42.83**
15	PA 833 X PA 740	19.21	13.34	-0.62	24.61**	31.51**
16	PA8 33 X AKA 7	23.47**	17.39*	2.93	34.17**	38.60**
17	PA 833 X JLA 794	0.30	-4.64	-16.39*	13.55	12.59
18	PA 833 X PA 785	-0.54	-5.44	-17.08*	5.32	0.21
	S. E ±	3.82	3.82	3.82	3.82	3.82
	CD at 5%	11.29	11.29	11.29	11.29	11.29

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