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Performance of genotypes and hybrids for seed cotton yield and yield contributing traits in desi cotton (*Gossypium arboreum* L.)

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Abstract
Fifty six hybrid combinations developed by crossing 7 lines and 8 testers were tested along with their parents including 4 checks in Line X Tester design for fibre quality characters. These lines, testers and hybrids along with four checks were sown during *kharif*, 2016 at three locations *viz.*, Cotton Research Station, Nanded (L-1), Experimental farm of Department of Agricultural Botany, VNMKV, Parbhani (L-2) and Experimental farm, Agricultural Research Station, Badnapur (L-3).Among the parents, line PA 812 possessed highest mean performance across the environments for seed cotton yield per plant along with desirable mean performance for many other characters. For earliness parameters, parents AKA 8, HD 514 and PA 801 were found to be the best amongst all parents. They were also involved as a parent in the crosses with early flowering, early boll bursting and early maturity. Among the crosses PAIG 346 X JLA 794, PAIG 346 X DWDa 1402, PA 809 X AKA 8, PA 785 X CNA 449, PAIG 346 X CNA 449 and PAIG 346 X HD 514 were also found superior for seed cotton yield per plant across the environments along with most of yield contributing traits. In these superior cross combinations at least one of the parent was promising for yield and its reflection was found in the combination. For earliness parameters, PA 801 X AKA 8 was found promising along with high seed cotton yield.

Keywords: Desi cotton, harvest index, seed cotton yield, upper half mean length

Introduction
Asiatic cottons are known for their inherent ability of resistance against major pests and diseases in addition to high ginning outturn, low cost of management and wide adaptability under rainfed cultivation due to deep root system. In order to remain competitive in the world market, several cotton breeding efforts needed to be placed on priority in research. The economic importance of cotton in agriculture and industry lies in its yield and fibre quality. Global competition in the production and use of cotton fibre with advanced plant improvement technologies in yield and yarn manufacturing had accelerated the efforts to increase yield and improve fibre quality.

Since the time India attained independence, research efforts in cotton were intensified with the three major objectives of increasing the total production, raising productivity per hectare and to produce adequate long and extra-long staple cottons to meet the demands of the large Indian textile industry and ever growing population. Several factors like geographical and genetic diversity, agronomic performance, adaptability and genetic base of parental lines are reported to play an important role in the manifestation of heterosis in cotton. Cotton is a long duration crop and grown over a wide range of environments. It is, therefore necessary to evaluate cotton genotypes in different environments to know its stability in varying environmental conditions.

Materials and Methods
The present study comprised of seven females (lines) and eight males (testers) with four standard checks thus making 56 F_1s using Line x Tester mating design. These lines, testers and hybrids along with four checks were sown during *kharif*, 2016 at three locations *viz.*, Cotton Research Station, MB Farm, Parbhani (L_1), Cotton Research Station, Nanded (L_2), and Agricultural Research Station, Badnapur (L_3). The observations recorded on days to 50% flowering, days to 50% boll bursting, plant height (cm), number of sympodia per plant, number of boll per plant, boll weight (g), seed cotton yield per plant (g), seed index (g), lint

index (g), harvest index (%).Analysis was carried out as per the method suggested by Panse and Sukhatme (1985).

Results and Discussion

For sustaining to changing environmental fluctuations plant breeder always need to carry out the research to develop a variety or hybrid which can out yield the best existing hybrids or varieties. Therefore, in this research the check hybrid PKVDH 1, PKV Suvarna, private sector hybrid NACH 12 and check variety PA 255 were used as checks to compare the performance of resultant crosses. The mean performance over check hybrid PKVDH 1, PKV Suvarna, NACH 12 and PA 255 is tabulated in Table 1, 2.

On the basis of seed cotton yield per plant, parental (53.01 g) and hybrid (67.72 g) mean of E_1 (Parbhani) was higher followed by E_2 (Nanded) whose parental (51.16 g) and hybrid (63.65 g) mean was moderate. Whereas, E_3 (Badnapur) showed lower parental (48.31 g) and hybrid (57.04 g) mean. This indicates E_1 as a better environment for yield than E_2 and E_3. The difference in location wise performance of parental mean was lower than hybrid mean indicating the ability of homozygotes buffering capacity in low yielding environments than heterozygous parents. Under favourable environmental conditions any advantage associated with increased rate of growth would be negated by parental genotypes exploiting a full season of favourable conditions. Similar results were also reported by Wells and Meredith (1986) [19] for lint yield in cotton.

The vigorous growth of hybrids as compared to parents is also evident from the difference in plant height. Plant height is the measure of a level of a vegetative growth and vigour of crops. The mean plant height of the hybrids (111.01cm) across the environments was higher than that of the parents (101.11cm). These results supported the high and vigorous growth of the crosses than parents across the environments which thereby take advantage of the favourable early season and be prepared for later occurring unfavourable conditions (droughts, insect pests etc.) Greater plant height also determined the stature and potential carrying capacity of plant. Similar results were also reported by Oosterhuis *et al.*, (1996) [8].

A perusal to mean values of different parents and their cross combinations for various traits revealed that a few crosses exceeded the hybrid checks NACH 12 and PKV Suvarna in respect of seed cotton yield and other characters pertaining to earliness. But most of the cross combinations exceeded the hybrid checks for fibre parameters.

Among the parents, line PA 812 possessed highest mean performance across the environments for seed cotton yield per plant (60.88 g) along with desirable mean performance for the other characters like days to 50% flowering (71.00 days), days to 50% boll bursting (116.33 days), number of sympodia per plant (15.50), number of bolls per plant (26.67), harvest index (36.78%) and days to maturity (156.33 days) over the parental mean. Among the male parents, tester AKA 8 exhibited highest seed cotton yield per plant (56.57 g) with maximum performance for the characters *viz.* days to 50% flowering (70.00 days), days to 50% boll bursting (115.00 days), number of sympodia per plant (16.17), number of bolls per plant (24.33), lint index (3.69 g), ginning percentage (37.35%) and days to maturity (155.50 days).This tester was also involved as a parent in top ranking combinations for yield. Similarly other parents like PA 809 (58.30 g /plant) and HD 514 (55.75 g/plant) also exhibited higher seed cotton yield with promising performance for the characters like days to 50% flowering, days to 50% boll bursting, plant height, number of bolls per plant, boll weight, seed index, harvest index etc. These parents also involved in high ranking crosses with respect to yield. For earliness parameters like days to 50% flowering, days to 50% boll bursting and days to maturity parents AKA 8, HD 514 and PA 801 were found to be the best amongst all parents. They were also involved as a parent in the crosses with early flowering, early boll bursting and early maturity.

Further, among the crosses PAIG 346 X JLA 794 recorded highest seed cotton yield per plant (85.00 g). It was also found promising for other traits like plant height, number of sympodia per plant, number of bolls per plant, boll weight, seed index and harvest index while it was found acceptable for days to maturity and lint index. Similarly, other crosses like PAIG 346 X DWDa 1402 (84.80 g/plant), PA 809 X AKA 8 (84.50 g/ plant), PA 785 X CNA 449 (79.43 g/ plant), PAIG 346 X CNA 449 (78.50 g/ plant) and PAIG 346 X HD 514 (77.17 g /plant) were also found superior for seed cotton yield per plant across the environments along with most of yield contributing traits. The superiority of these crosses seemed to have resulted from higher values of their yield contributing characters. That's why these newly developed crosses have good mean performance over the environments and seems to be promising for seed yield and other associated traits. In above mentioned superior combinations at least one of the parent was promising for yield and its reflection was found in the combination.

For earliness parameters, PA 801 X AKA 8 was found promising for days to 50% flowering, days to 50% boll bursting and days to maturity along with high seed cotton yield. Crosses PA 812 X AKA 8 (70.43 g/plant) and PA 812 X HD 514 (69.70 g/plant) were found promising for days to 50% flowering, days to 50% boll bursting and days to maturity. The earliness of these parents was partly attributable to the early habit of one of the parent of these combinations.

The high mean performance for yield and yield contributing characters was also observed by Naik and Patel (2004) [6], Giri *et al.* (2006) [2], Patel *et al* (2009) [11], Jyotiba *et al.* (2010) [4]; Patel *et al.* (2010) [9], Sarvanan and Koodalingam (2011) [15] for interspecific crosses; Kumar *et al.* (2003) [5], Patel *et al.* (2008) [9], Neelam *et al.* (2008) [7], Patil *et al.* (2009) [12], Sekhar *et al.* (2012) [16], Singh *et al.* (2013) [17] and Sonawane *et al.* (2013) [18] for intra *arboreum* crosses.The heterosis for high yield with earliness traits was also reported by Potdukhe *et al.* (2002) [13], Giri *et al.* (2006) [2], Patel *et al.* (2010) [9], Balu *et al.* (2012) [1], Jaiwar *et al.* (2012) [3] and Pushpam *et al.* (2015) [14].

Table 1: Mean performance of parents, F_1 hybrids and checks for various characters

Sr. No.	Parents/Crosses /Checks Lines	Days to 50% flowering	Days to 50% boll bursting	Plant height (cm)	Number of sympodia/plant	Number of bolls/plant	Boll weight (g)	Seed cotton yield/plant (g)
1	PA 801	23.50	115.33	106.30	14.83	23.50	2.63	54.47
2	PA 740	24.00	118.66	104.96	13.50	24.00	2.70	52.15
3	PA 812	26.67	116.33	99.53	15.50	26.67	2.56	60.88
4	PA 809	25.60	117.00	104.70	15.77	25.60	2.66	58.30
5	PA 785	24.23	118.50	102.10	16.43	24.23	2.61	60.67
6	PA 832	21.87	117.50	107.03	15.87	21.87	2.67	52.25
7	PAIG 346	23.60	119.16	103.40	13.50	23.60	2.73	59.28
	Testers							
8	AKA 8	24.33	115.00	98.20	16.17	24.33	2.37	56.57
9	Phule Dhanwantary	19.33	116.16	71.00	12.23	19.33	2.27	39.30
10	CNA 449	21.93	118.00	106.23	14.93	21.93	2.61	47.20
11	HD 514	25.90	115.83	87.70	13.80	25.90	2.49	55.75
12	DWDa 1402	22.47	117.00	111.20	16.03	22.47	2.67	49.28
13	JLA 794	19.47	117.66	113.70	11.83	19.47	2.65	47.43
14	Digvijay	19.30	132.83	101.43	16.30	19.30	2.60	34.38
15	G.Cot 23	18.10	131.33	99.23	15.43	18.10	2.90	34.52
	Crosses							
16	PA 801 x AKA 8	29.80	110.16	106.93	21.90	29.80	2.72	71.03
17	PA 801 x Phule Dhanwantary	22.93	116.00	93.86	16.23	22.93	2.75	55.40
18	PA 801 x CNA 449	28.50	119.00	115.56	21.20	28.50	2.83	71.47
19	PA 801 x HD 514	33.47	115.00	117.96	23.33	33.47	2.75	74.67
20	PA 801 x DWDa 1402	28.97	113.83	120.90	21.60	28.97	2.81	66.93
21	PA 801 x JLA 794	30.20	117.50	122.60	21.63	30.20	2.81	69.43
22	PA 801 x Digvijay	20.87	125.16	111.16	15.97	20.87	2.64	47.40
23	PA 801 x G.Cot 23	21.30	124.50	110.86	16.83	21.30	2.67	49.13
24	PA 740 x AKA 8	27.03	116.33	112.73	17.67	27.03	2.65	60.33
25	PA 740 x Phule Dhanwantary	19.53	119.66	94.63	17.07	19.53	2.67	46.13
26	PA 740 x CNA 449	25.63	118.50	118.43	21.07	25.63	2.80	64.90
27	PA 740 x HD 514	70.00	114.66	100.61	21.23	30.43	2.72	68.58
28	PA 740 x DWDa 1402	71.50	116.16	119.23	20.77	27.27	2.87	64.80
29	PA 740 x JLA 794	72.00	116.83	121.23	16.73	21.90	2.89	53.70
30	PA 740 x Digvijay	73.50	118.16	114.26	22.30	27.53	2.97	65.73
31	PA 740 x G.Cot 23	74.00	117.50	112.80	21.33	26.47	2.87	60.83
32	PA 812 x AKA 8	67.33	111.83	105.83	21.40	28.63	2.71	70.43
33	PA 812 x Phule Dhanwantary	69.33	114.33	90.00	15.83	23.73	2.65	51.60
34	PA 812 x CNA 449	70.50	115.5	112.33	21.13	29.03	2.75	68.87
35	PA 812 x HD 514	67.50	112.00	96.16	24.17	30.30	2.66	69.70
36	PA 812 x DWDa 1402	71.33	116.50	113.10	18.30	25.30	2.82	63.18
37	PA 812 x JLA 794	71.33	116.66	116.10	20.10	25.80	2.80	63.83
38	PA 812 x Digvijay	71.83	117.16	113.80	17.93	24.20	2.76	55.07
39	PA 812 x G.Cot 23	72.83	118.50	111.66	20.33	25.13	2.67	60.57
40	PA 809 x AKA 8	70.16	113.16	109.80	27.17	36.60	2.71	84.50
41	PA 809 x Phule Dhanwantary	72.00	116.83	96.06	16.93	24.00	2.66	55.72
42	PA 809 x CNA 449	73.33	119.00	124.46	24.23	33.43	2.81	73.97
43	PA 809 x HD 514	70.66	115.16	97.93	21.93	30.23	2.74	65.23
44	PA 809 x DWDa 1402	71.00	115.50	122.86	20.53	27.87	2.85	68.53
45	PA 809 x JLA 794	72.50	117.83	121.70	20.93	29.30	2.91	70.50
46	PA 809 x Digvijay	74.16	119.33	112.20	17.90	21.93	2.68	53.67
47	PA 809 x G.Cot 23	73.83	120.66	115.13	20.07	28.27	2.82	60.88
48	PA 785 x AKA 8	69.33	114.00	110.86	22.03	29.50	2.64	68.53
49	PA 785 x Phule Dhanwantary	72.50	117.50	94.26	18.07	28.50	2.66	62.60
50	PA 785 x CNA 449	73.33	118.66	113.13	25.23	34.57	2.79	79.43
51	PA 785 x HD 514	68.83	112.33	95.90	21.27	23.87	2.72	57.22
52	PA 785 x DWDa 1402	72.83	118.16	116.90	20.80	26.43	2.71	62.62
53	PA 785 x JLA 794	73.66	119.33	115.86	20.73	28.77	2.80	65.87
54	PA 785 x Digvijay	73.00	118.33	111.50	19.40	23.43	2.56	56.10
55	PA 785 x G.Cot 23	73.33	119.50	107.93	18.10	23.75	2.76	54.97
56	PA 832 x AKA 8	68.33	113.33	112.66	17.87	24.63	2.66	52.77
57	PA 832 x Phule Dhanwantary	71.83	116.66	94.66	16.73	19.90	2.54	44.97
58	PA 832 x CNA 449	72.00	117.00	118.40	24.50	29.08	2.81	70.57
59	PA 832 x HD 514	66.83	112.16	100.40	16.13	21.47	2.61	51.73
60	PA 832 x DWDa 1402	70.83	115.50	118.26	18.20	25.70	2.84	57.00
61	PA 832 x JLA 794	72.33	117.50	119.03	18.33	27.50	2.81	62.40
62	PA 832 x Digvijay	73.16	119.66	114.70	16.57	17.47	2.61	43.57
63	PA 832 x G.Cot 23	74.83	118.50	111.20	16.90	22.37	2.78	49.47

64	PAIG 346 x AKA 8	70.66	115.33	110.93	25.27	32.00	2.72	74.90
65	PAIG 346 x Phule Dhanwantary	76.33	117.66	97.33	17.97	23.23	2.65	51.50
66	PAIG 346 x CNA 449	73.50	118.50	119.23	25.57	31.90	2.96	78.50
67	PAIG 346 x HD 514	71.50	115.33	99.80	25.67	31.53	2.78	77.17
68	PAIG 346 x DWDa 1402	70.83	115.66	121.33	27.90	35.73	2.81	84.80
69	PAIG 346 x JLA 794	73.00	117.66	123.23	27.03	34.63	2.90	85.00
70	PAIG 346 x Digvijay	72.83	117.66	119.83	17.47	19.57	2.85	45.13
71	PAIG 346 x G.Cot 23	73.83	118.66	116.56	18.93	23.00	2.86	53.80
72	PKVDH 1 (Checks 1)	72.33	117.66	104.83	16.18	23.83	2.37	57.53
73	PKV Suvarna (Check 2)	72.66	118.00	105.83	17.53	24.63	2.54	63.80
74	NACH 12 (Check 3)	74.66	119.16	109.13	18.53	26.00	2.69	66.50
75	PA 255 (Check-4)	72.83	119.00	107.13	18.00	22.90	2.64	60.52
	Parental Mean	73.11	119.08	101.11	14.80	22.68	2.61	50.82
	Hybrid Mean	71.88	116.85	111.01	20.40	26.85	2.75	62.80
	Population Mean	72.14	117.32	108.92	19.21	25.97	2.72	60.27
	S.E. +	0.83	1.08	3.04	1.62	1.94	0.05	3.81
	CD @ 5%	2.35	3.05	8.57	4.59	5.48	0.15	10.76

Table 2: Show the Parents Crosses /Checks

Sr. No.	Parents/Crosses /Checks Lines	Seed index (g)	Lint index (g)	Harvest index (%)	Days to maturity
1	PA 801	5.91	3.54	35.37	155.83
2	PA 740	5.97	3.60	34.86	158.16
3	PA 812	6.10	3.43	36.78	156.33
4	PA 809	6.40	3.54	36.28	157.33
5	PA 785	5.66	3.53	35.69	158.33
6	PA 832	6.00	3.44	34.47	157.16
7	PAIG 346	6.47	3.68	35.65	158.00
	Testers				
8	AKA 8	5.71	3.69	35.21	155.50
9	Phule Dhanwantary	5.67	3.43	33.70	156.50
10	CNA 449	6.46	3.59	35.31	158.16
11	HD 514	5.44	3.73	35.52	156.00
12	DWDa 1402	5.93	3.58	36.24	156.16
13	JLA 794	6.53	3.56	35.95	157.33
14	Digvijay	6.40	3.69	33.18	169.00
15	G.Cot 23	6.76	3.88	31.76	167.33
	Crosses				
16	PA 801 x AKA 8	6.06	3.90	37.57	150.66
17	PA 801 x Phule Dhanwantary	5.88	3.65	36.01	154.50
18	PA 801 x CNA 449	6.85	3.68	39.30	158.00
19	PA 801 x HD 514	5.96	3.89	41.37	154.00
20	PA 801 x DWDa 1402	6.26	3.64	37.82	153.66
21	PA 801 x JLA 794	6.91	3.65	38.87	158.33
22	PA 801 x Digvijay	6.43	3.69	35.74	163.83
23	PA 801 x G.Cot 23	6.65	3.91	35.96	164.33
24	PA 740 x AKA 8	6.00	3.65	37.44	155.33
25	PA 740 x Phule Dhanwantary	5.93	3.69	36.45	157.00
26	PA 740 x CNA 449	6.98	3.69	38.38	157.33
27	PA 740 x HD 514	6.13	3.85	100.61	21.23
28	PA 740 x DWDa 1402	6.68	3.59	119.23	20.77
29	PA 740 x JLA 794	7.11	3.72	121.23	16.73
30	PA 740 x Digvijay	7.03	3.83	114.26	22.30
31	PA 740 x G.Cot 23	6.81	3.86	112.80	21.33
32	PA 812 x AKA 8	6.36	3.60	105.83	21.40
33	PA 812 x Phule Dhanwantary	6.06	3.73	90.00	15.83
34	PA 812 x CNA 449	6.88	3.63	112.33	21.13
35	PA 812 x HD 514	6.67	4.11	96.16	24.17
36	PA 812 x DWDa 1402	6.51	3.65	113.10	18.30
37	PA 812 x JLA 794	6.95	3.84	116.10	20.10
38	PA 812 x Digvijay	6.77	3.64	113.80	17.93
39	PA 812 x G.Cot 23	6.60	3.83	111.66	20.33
40	PA 809 x AKA 8	6.50	3.81	109.80	27.17
41	PA 809 x Phule Dhanwantary	6.24	3.71	96.06	16.93
42	PA 809 x CNA 449	7.19	3.58	124.46	24.23
43	PA 809 x HD 514	6.46	3.89	97.93	21.93
44	PA 809 x DWDa 1402	6.77	3.61	122.86	20.53
45	PA 809 x JLA 794	7.17	3.65	121.70	20.93

46	PA 809 x Digvijay	6.37	3.70	112.20	17.90
47	PA 809 x G.Cot 23	5.95	3.73	115.13	20.07
48	PA 785 x AKA 8	6.35	3.84	110.86	22.03
49	PA 785 x Phule Dhanwantary	6.09	3.69	94.26	18.07
50	PA 785 x CNA 449	6.56	3.89	113.13	25.23
51	PA 785 x HD 514	5.96	3.85	95.90	21.27
52	PA 785 x DWDa 1402	5.87	3.58	116.90	20.80
53	PA 785 x JLA 794	6.60	3.73	115.86	20.73
54	PA 785 x Digvijay	6.50	3.69	111.50	19.40
55	PA 785 x G.Cot 23	6.31	3.80	107.93	18.10
56	PA 832 x AKA 8	6.37	113.33	112.66	17.87
57	PA 832 x Phule Dhanwantary	5.90	116.66	94.66	16.73
58	PA 832 x CNA 449	6.76	117.00	118.40	24.50
59	PA 832 x HD 514	6.15	112.16	100.40	16.13
60	PA 832 x DWDa 1402	6.52	115.50	118.26	18.20
61	PA 832 x JLA 794	7.20	117.50	119.03	18.33
62	PA 832 x Digvijay	6.26	119.66	114.70	16.57
63	PA 832 x G.Cot 23	6.73	118.50	111.20	16.90
64	PAIG 346 x AKA 8	6.56	115.33	110.93	25.27
65	PAIG 346 x Phule Dhanwantary	5.93	117.66	97.33	17.97
66	PAIG 346 x CNA 449	7.20	118.50	119.23	25.57
67	PAIG 346 x HD 514	6.36	115.33	99.80	25.67
68	PAIG 346 x DWDa 1402	7.01	115.66	121.33	27.90
69	PAIG 346 x JLA 794	7.40	117.66	123.23	27.03
70	PAIG 346 x Digvijay	6.32	117.66	119.83	17.47
71	PAIG 346 x G.Cot 23	7.03	118.66	116.56	18.93
72	PKVDH 1 (Checks 1)	5.74	117.66	104.83	16.18
73	PKV Suvarna (Check 2)	6.05	118.00	105.83	17.53
74	NACH 12 (Check 3)	6.09	119.16	109.13	18.53
75	PA 255 (Check-4)	6.19	119.00	107.13	18.00
	Parental Mean	6.09	119.08	101.11	14.80
	Hybrid Mean	6.52	116.85	111.01	20.40
	Population Mean	6.43	117.32	108.92	19.21
	S.E. +	0.15	1.08	3.04	1.62
	CD @ 5%	0.41	3.05	8.57	4.59

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