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Estimation of heterosis in F_1 generation for morphological and yield contributing characters in *desi* cotton

ANIL KUMAR*, H. V. KALPANDE, KULDEEP SINGH CHANDRAWAT AND P. U. DHONE
Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402
**E-mail: agusaiwal@gmail.com*

ABSTRACT : The present investigation was undertaken to study the heterosis for morphological and yield contributing traits in line × tester programme involving twenty four hybrid combinations which were derived by crossing six *arboreum* lines (PA 720, PA 08, PA 528, PA 532, PA 255, PA 402) with four *arboreum* testers (AKA 7, GAM 162, Dwd-arb 10-1, JLA 802). These crosses and parents including 2 checks (PKVDH 1 and NH 615) were evaluated in randomized block design with three replications at Cotton Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2012-2013. The analysis of variance showed highly significant differences in genotypes for all the studied characters. The cross PA 528 × AKA 7 for seed cotton yield and PA 720 × JLA 802 for bolls / plant was found superior and can be used in future breeding programmes. Further, the crosses *viz.*, PA 402 × GAM 162, PA 255 × AKA 7 and PA 08 × AKA 7 for days to maturity; PA 255 × AKA 7 for seed oil content; PA 532 × JLA 802 and PA 532 × AKA 7 for plant height and PA 532 × JLA 802 and PA 720 × AKA 7 for sympodia / plant, showed higher heterosis so these can be utilized in breeding programmes.

Key words : *Gossypium arboreum*, heterosis, morphological traits, seed cotton yield

Cotton is also called as **'King of Apparel Fibre'**. It is the premier cash crop in India and plays important role in agriculture, industry and social affairs of country's economy (Choudhary *et al.*, 2014). Cotton has four cultivated species, classified into new world cotton (*Gossypium hirsutum* L. and *Gossypium barbadense* L.,) which are tetraploids (2n = 4x = 52) and old world cotton (*Gossypium herbaceum* L. and *Gossypium arboreum* L.) which are diploids (2n = 2x = 26). It was observed in the last few years that, there has been a significant reduction in area of *G. arboreum* cotton across the country because of lower productivity and inferior fiber properties as compared to tetraploid cotton. Besides this, *desi* or diploid cotton varieties are still preferred in many areas because of their strong resistance to biotic and abiotic stresses so genetic improvement is strictly needed for these species.

Genetic improvement in *desi* cotton could be achieved by exploitation of hybrid vigour and development of hybrid varieties is the quickest breeding method for exploiting the heterosis. Keeping in view the above facts, the present investigation was conducted to estimate the magnitude of heterosis for various morphological and yield contributing traits in *desi* cotton.

The present investigation was conducted on twenty four hybrid combinations derived by crossing six *arboreum* lines (PA 720, PA 08, PA

528, PA 532, PA 255, PA 402) with four *arboreum* testers (AKA 7, GAM 162, Dwd-arb 10-1, JLA 802) including 2 checks (PKVDH 1 and NH 615) at Cotton Research Station, Mahboob Bagh farm, VNMKV, Parbhani during *kharif*, 2012-2013 in RBD design with 3 replications. The size of plot was 1.2 × 4.5 m^2 with spacing of 60 × 30 cm and each plot was with two rows/plot. Data were recorded on five randomly selected plants/ replication for all the twelve characters *viz.*, days to 50 per cent flowering, days to 50 per cent boll bursting, days to maturity, plant height, sympodia / plant, bolls / plant, seeds / boll, boll weight, seed index, seed oil content, seed cotton yield / plant and lint yield / plant. Per cent heterosis was estimated for all the characters under study over mid parent, superior parent and over standard checks.

The analysis of variance of parents and their hybrid for all the traits under study showed highly significant differences for lines, testers and hybrids for all the characters indicating the existence of sufficient variability.

Yield is the most important parameter and the highest mean performance for seed cotton yield was observed by the cross PA 528 × AKA 7 (58.80). The cross PA 528 × AKA 7 shown significantly high positive heterosis over mid, better parent and both standard check. Out of twenty four crosses, 15 exhibited significant positive heterosis over mid parent, 13 over better parent, 13 over standard check PKVDH 1 and NH 615 for seed cotton yield/plant (Table 1). These findings are in accordance with the results obtained by Patel *et al.,* (2010), Singh *et al.,* (2013) and Sonawane *et al.,* (2015).

Mean performance for days to 50 per cent flowering was ranged from 62.33 days (PA 402 × AKA 7) to 68.67 days (PA 528 × GAM 162). The crosses *viz.,* PA 402 × AKA 7 and PA 528 × Dwd-arb 10-1 shown significantly high negative heterosis over mid, better parent and both standard check. Out of twenty four crosses, 4 exhibited significant negative heterosis over mid parent, 5 over better parent, 9 over standard check PKVDH 1, while 7 crosses showed positive heterosis over standard check NH 615 for days to 50 per cent flowering (Table 1). Significant negative heterosis for earliness was also reported by Patel *et al.,* (2010) and Sharma *et al.,* (2016).

The crosses which were earlier and later for 50 per cent flowering were also found in same way for days to 50 per cent boll bursting. The days were ranged from 101.67 days to 110 days in boll bursting. The cross PA 255 × JLA 802 over mid parent, PA 402 × AKA 7 over better parent and both standard checks, shown highest significant negative heterosis in desirable direction. Out of 24 crosses two crosses over mid parent, three over better parent and one over standard check PKVDH 1, while six crosses exhibited positive significant heterosis over standard check NH 615 for days to 50 per cent boll bursting (Table 1).

The cross PA 532 × JLA 802 over mid and better parent and cross PA 720 × AKA 7 over both standard checks exhibited highest significant positive heterosis for sympodia / plant. Out of 24 crosses, 8 over mid, four over better parent, one over PKVDH 1 and all crosses over NH 615 showed desirable positive heterosis (Table 1). Heterosis for this trait was observed to the extent of 106.22 per cent in PA 720 × AKA 7. Heterosis for this trait was reported by the earlier workers Geddam *et al.,* (2011) and Guvercin (2011).

Out of 24 crosses, 9 crosses over mid, 6 over better parent, 9 over standard check PKVDH 1 and eleven over NH 615 showed desirable significant positive heterosis for bolls/plant. The cross PA 720 × JLA 802 exhibited maximum positive heterosis over mid parent, better parent and over both standard checks. Heterosis for this trait was observed to the extent of 43.27 per cent in PA 720 × JLA 802 over standard check NH 615 (Table 1). Heterosis for this trait was reported by the earlier workers Singh *et al.,* (2013) and Sonawane *et al.,* (2015).

None of the crosses showed significant heterosis over mid-parent, better parent and standard check PKVDH1 for seeds/boll. Three crosses showed negative heterosis over standard check NH 615 which is not desirable for this trait (Table 1).

For boll weight mean rang varies from 2.46 to 2.84.The cross PA 08 × JLA 802 exhibited maximum positive heterosis over standard check PKVDH 1. Out of 24 crosses, 8 crosses over mid, 4 over better parent, 16 over standard check PKVDH 1 showed desirable positive heterosis (Table 1). Heterosis for this trait was also reported by Patel *et al.,* (2010), Singh *et al.,* (2013) and Sonawane *et al.,* (2015). While, fourteen crosses showed significant negative heterosis over standard check NH 615 which is undesirable for boll weight.

The cross PA 255 × Dwd-arb 10-1 showed the minimum (125.27 cm), while the cross (PA 532 × AKA 7 showed the maximum (166.47 cm) plant height. Out of 24 intra *arboreum* crosses, PA 532 × JLA 802 recorded highest significant positive heterosis over mid and better parent. Whereas, PA 532 × AKA 7 cross exhibited significant positive heterosis over both checks PKVDH 1 and NH 615 for plant height. Out of 24 crosses, 20 crosses over mid parent, 11 crosses over better parent, 23 crosses over standard check PKDVH 1 and all crosses over standard check NH 615 showed significant positive heterosis in desirable direction (Table 1). These findings are in accordance with the results obtained by Guvercin (2011), Khan (2011), and Sonawane *et al.,* (2015).

Mean value for days to maturity was ranged in between 142 days (PA 08 × AKA 7) to 154 days (PA 532 × JLA 802). The cross PA 402 × GAM 162 over mid, PA 255 × AKA 7 over better and PA 08 × AKA 7 over both standard checks PKVDH 1 and NH 615 had showed highest negative significant heterosis for day to maturity. Out of twenty four crosses, one, five, seven and one crosses were significantly earlier than their mid, better parents and standard check PKVDH1 and NH 615, respectively (Table 1). Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015) reported similar results for days to maturity.

None of the crosses showed desirable positive significant heterosis over mid-parent, better parent and both standard checks for lint yield. Most of the crosses showed negative significant heterosis over mid parent, better parent and both standard checks, which is not desirable for this trait (Table 1). Geddam *et al.,* (2011) and Guvercin (2011) found the similar results for lint yield.

Out of 24 crosses, 6 crosses over mid parent, 3 crosses over better parent and 4 over standard check PKVDH 1 and twenty over NH 615 showed desirable positive heterosis for seed index. The cross PA 08 × AKA 7 exhibited maximum positive heterosis over mid and PA 720 × JLA 802 over both standard checks.

Table 1. Mean performance and expression of heterosis for seed cotton yield and it's component traits

Sr. No.	Hybrids	Mean	Days to 50 per cent flowering				Mean	Days to 50 per cent boll bursting			
			Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over			Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over	
					PKVDH 1	NH 615				PKVDH 1	NH 615
1	PA 720 × JLA 802	**66.33**	1.27	-1.00	-1.97	4.74	**106.33**	-0.78	-2.15	-0.62	3.57
2	PA 528 × AKA 7	**64.00**	-2.78	-4.48	-5.42*	1.05	**104.33**	-1.11	-3.99	-2.49	1.62
3	PA 08 × GAM 162	**65.67**	-2.48	-2.96	-2.96	3.68	**107.33**	0.00	-1.23	0.31	4.55
4	PA 532 × Dwd-arb 10-1	**68.33**	3.27	1.99	0.99	7.89**	**109.33**	3.80	0.61	2.18	6.49**
5	PA 255 × JLA 802	**62.67**	-4.81*	-7.39**	-7.39**	-1.05	**102.33**	-4.81*	-6.40**	-4.36	-0.32
6	PA 402 × AKA 7	**62.33**	-5.79**	-7.88**	-7.88**	-1.58	**101.67**	-3.94*	-7.01**	-4.98*	-0.97
7	PA 720 × GAM 162	**66.33**	-1.97	-1.97	-1.97	4.74	**107.00**	-0.62	-2.13	0.00	4.22
8	PA 528 × Dwd-arb 10-1	**62.67**	-5.76**	-7.39**	-7.39**	-1.05	**102.67**	-2.84	-6.10**	-4.05	0.00
9	PA 08 × JLA 802	**64.33**	-2.28	-4.93*	-4.93*	1.58	**104.00**	-2.35	-3.11	-2.80	1.30
10	PA 532 × AKA 7	**66.67**	0.76	-1.48	-1.48	5.26*	**107.00**	2.07	-0.31	0.00	4.22
11	PA 255 × GAM 162	**67.00**	-0.99	-0.99	-0.99	5.79*	**107.67**	0.94	0.31	0.62	4.87*
12	PA 402 × Dwd-arb 10-1	**63.33**	-4.76*	-6.40**	-6.40**	0.00	**103.00**	-1.59	-4.04	-3.64	0.32
13	PA 528 × JLA 802	**64.67**	-0.51	-2.02	-4.43	2.11	**104.67**	-0.79	-0.59	-2.18	1.95
14	PA 720 × AKA 7	**64.33**	-1.53	-2.53	-4.93*	1.58	**103.00**	-0.80	-2.22	-3.74	0.32
15	PA 528 × GAM 162	**68.67**	2.74	1.48	1.48	8.42**	**110.00**	4.10*	3.77	2.80	7.14**
16	PA 08 × Dwd-arb 10-1	**65.67**	0.000	-0.51	-2.96	3.68	**105.67**	1.93	0.32	-1.25	2.92
17	PA 532 × JLA 802	**67.00**	3.88	3.08	-0.99	5.79*	**109.00**	4.81*	3.15	1.87	6.17*
18	PA 255 × AKA 7	**62.67**	-3.34	-3.59	-7.39**	-1.09	**102.67**	0.33	0.33	-4.05	0.00
19	PA 402 × GAM 162	**66.00**	-0.50	-2.46	-2.46	4.21	**106.33**	2.80	0.31	-0.62	3.57
20	PA 720 × Dwd-arb 10-1	**67.00**	2.81	2.55	-0.99	5.79*	**108.00**	5.71**	5.54*	0.93	5.19*
21	PA 08 × AKA 7	**67.33**	3.86	2.54	-0.49	6.32*	**109.33**	3.80	3.47	2.18	6.49**
22	PA 532 × GAM 162	**64.33**	-1.28	-2.03	-4.93*	1.58	**104.00**	0.32	-0.95	-2.80	1.30
23	PA 255 × Dwd-arb 10-1	**65.33**	-2.00	-3.45	-3.45	3.16	**104.67**	-0.79	-1.26	-2.18	1.95
24	PA 402 × JLA 802	**65.33**	-0.25	-0.51	-3.45	3.16	**104.33**	0.81	-0.63	-2.49	1.62
	S.E.±	**1.0769**	1.338	1.545	1.545	1.545	**1.6456**	2.046	2.362	2.362	2.362

Sr. No.	Hybrids	Seed index					Oil content (%)				
		Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over		**Mean**	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over	
					PKVDH-1	NH-615				PKVDH-1	NH-615
1	PA 720 × JLA 802	**6.99**	11.37*	-5.54	4.90	27.34**	**17.12**	-4.84	-8.28**	-16.49**	-16.49**
2	PA 528 × AKA 7	**7.60**	7.98	2.79	14.16**	38.58**	**17.85**	6.06*	3.00	-12.93**	-12.93**
3	PA 08 × GAM 162	**6.96**	-3.73	-5.86	4.55	26.91**	**17.83**	2.27	1.65	-13.00**	-13.00**
4	PA 532 × Dwd-arb 10-1	**6.48**	-2.90	-12.39**	-2.70	18.10**	**16.33**	-9.18**	-12.35**	-20.34**	-20.34**
5	PA 255 × JLA 802	**6.58**	4.20	12.03**	-1.20	19.93**	**16.20**	-12.79**	-13.14**	-20.98**	-20.98**
6	PA 402 × AKA 7	**7.11**	0.33	-4.99	6.71	29.53**	**17.12**	-1.69	-7.46**	-16.49**	-16.49**
7	PA 720 × GAM 162	**5.55**	23.71**	-25.80**	-16.67**	1.15	**17.35**	-3.72	-6.22*	-15.37**	-15.37**
8	PA 528 × Dwd-arb 10-1	**6.81**	1.41	-8.96*	2.25	24.12**	**18.53**	-0.19	-0.54	-9.61**	-9.61**
9	PA 08 × JLA 802	**6.08**	0.11	-13.07**	-8.76	10.75	**18.91**	10.10**	1.39	-7.76**	-7.76**
10	PA 532 × AKA 7	**7.11**	3.92	1.67	6.71	29.53**	**17.00**	6.15*	4.10	-17.07**	-17.07**
11	PA 255 × GAM 162	**6.65**	-5.45	-5.99	-0.20	21.14**	**16.23**	-2.35	-7.47*	-20.83**	-20.83**
12	PA 402 × Dwd-arb 10-1	**7.13**	10.25*	2.05	7.11	30.01**	**18.11**	5.51*	-2.79	-11.66**	-11.66**
13	PA 528 × JLA 802	**7.64**	21.05**	2.23	14.71**	39.25**	**18.52**	2.46	-0.70	-9.66**	-9.66**
14	PA 720 × AKA 7	**6.41**	-9.46*	14.23**	-3.75	16.83**	**17.33**	2.45	0.97	-15.46**	-15.46**
15	PA 528 × GAM 162	**6.49**	-10.9*	13.16**	-2.55	18.29**	**17.00**	-2.97	-3.08	-17.07**	-17.07**
16	PA 08 × Dwd-arb 10-1	**6.92**	3.10	-7.40	3.90	26.12**	**18.91**	4.68	10.50	-7.76**	-7.76**
17	PA 532 × JLA 802	**5.30**	-17.74**	-31.51**	-20.37**	-3.34	**16.59**	-4.79	-11.05**	-19.07**	-19.07**
18	PA 255 × AKA 7	**7.15**	-0.85	-7.62	7.41	30.38**	**17.50**	7.59**	7.16*	-14.63**	-14.63**
19	PA 402 × GAM 162	**6.70**	-9.59*	-13.52**	0.55	22.05**	**17.93**	6.28*	2.22	-12.54**	-12.54**
20	PA 720 × Dwd-arb 10-1	**6.79**	-0.83	-12.31**	1.95	23.75**	**18.23**	4.68	-2.15	-11.07**	-11.07**
21	PA 08 × AKA 7	**7.43**	23.56**	8.05	11.56*	35.42**	**17.26**	-5.03*	-7.45**	-15.80**	-15.80**
22	PA 532 × GAM 162	**7.44**	9.71*	8.19	11.71*	35.60**	**17.56**	3.20	-0.97	-14.34**	-14.34**
23	PA 255 × Dwd-arb 10-1	**6.84**	-1.86	-3.21	2.75	24.73**	**18.40**	4.43	3.95	-10.24**	-10.24**
24	PA 402 × JLA 802	**5.94**	-7.43	-13.67**	-10.86*	8.20	**19.33**	6.41*	3.76	-5.71*	-5.71*
	S.E.±	**0.2294**	0.286	0.331	0.331	0.331	**1.5124**	0.439	0.507	0.507	0.507

Sr. No.	Hybrids	No. of seed/boll					Boll weight (g)				
		Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over		**Mean**	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over	
					PKVDH-1	NH-615				PKVDH-1	NH-615
1	PA 720 × JLA 802	**24.47**	0.14	-1.61	-0.81	-5.41	**2.72**	11.17**	9.24**	11.93**	-3.89
2	PA 528 × AKA 7	**23.53**	-4.08	-5.36	-4.59	-9.02	**2.75**	11.26**	10.44**	13.17**	-2.83
3	PA 08 × GAM 162	**23.07**	-4.16	-7.24	-6.49	-10.82	**2.68**	6.36*	5.24	10.15**	-5.42
4	PA 532 × Dwd-arb 10-1	**24.20**	-0.27	-2.68	-1.89	-6.44	**2.61**	2.42	0.26	7.27*	-7.89*
5	PA 255 × JLA 802	**22.80**	-5.79	-6.56	-7.57	-11.86*	**2.84**	9.24**	1.67	16.74**	0.24
6	PA 402 × AKA 7	**23.60**	-2.88	-3.28	-4.32	-8.76	**2.47**	-5.91*	-11.59**	1.51	-12.84**
7	PA 720 × GAM 162	**24.73**	3.78	1.37	0.27	-4.38	**2.46**	-7.87**	-11.95**	1.10	-13.19**
8	PA 528 × Dwd-arb 10-1	**24.67**	2.64	1.09	0.00	-4.64	**2.67**	-0.80	-4.18	10.01**	-5.54
9	PA 08 × JLA 802	**22.67**	-7.23	-8.85	-8.11	-12.37*	**2.81**	8.91**	1.93	15.64**	-0.71
10	PA 532 × AKA 7	**24.07**	-1.90	-3.22	-2.43	-6.96	**2.54**	-2.62	-7.98*	4.39	-10.37**
11	PA 255 × GAM 162	**24.73**	2.77	-0.54	0.27	-4.38	**2.65**	-0.13	-3.99	8.92*	-6.48**
12	PA 402 × Dwd-arb 10-1	**23.33**	-3.85	-6.17	-5.41	-9.79	**2.53**	-5.41	-8.10*	4.25	-10.48**
13	PA 528 × JLA 802	**23.40**	-1.13	-2.50	-5.14	-9.54	**2.81**	12.79**	9.07**	15.50**	-0.82
14	PA 720 × AKA 7	**24.07**	1.26	-0.55	-2.43	-6.96	**2.63**	4.64	2.02	8.23*	-7.07*
15	PA 528 × GAM 162	**23.67**	1.57	1.43	-4.05	-8.51	**2.81**	9.49**	9.33**	15.78**	-0.59
16	PA 08 × Dwd-arb 10-1	**23.87**	1.56	0.85	-3.24	-7.73	**2.74**	5.93*	5.38	12.76**	-3.18
17	PA 532 × JLA 802	**24.60**	2.07	1.65	-0.27	-4.90	**2.62**	5.43	1.94	7.96*	-7.30*
18	PA 255 × AKA 7	**25.27**	4.41	4.41	2.43	-2.32	**2.538**	0.80	-1.55	4.25	*10.48**
19	PA 402 × GAM 162	**24.73**	4.21	2.20	0.27	-4.38	**2.62**	2.28	1.68	7.68*	-7.54*
20	PA 720 × Dwd-arb 10-1	**23.47**	-1.95	-3.03	-4.86	-9.28	**2.47**	-4.51	-5.00	1.65	-12.72**
21	PA 08 × AKA 7	**25.53**	8.96	6.39	3.51	-1.29	**2.53**	-1.17	-6.98*	4.25	-10.48**
22	PA 532 × GAM 162	**25.33**	7.65	4.68	2.70	-2.06	**2.50**	-3.28	-8.08*	3.02	-11.54**
23	PA 255 × Dwd-arb 10-1	**23.60**	2.31	1.43	-4.32	-8.76	**2.64**	0.25	-3.06	8.64*	-6.71*
24	PA 402 × JLA 802	**22.73**	-2.29	-3.94	-7.84	-12.11*	**2.74**	2.94	0.61	12.76**	-3.18
	S.E.±	**1.0000**	1.207	1.394	1.394	1.394	**0.0588**	0.072	0.083	0.083	0.083

Sr. No.	Hybrids	Hybrids Sympodia/plant					Bolls/plant				
		Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over		Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over	
					PKVDH 1	NH 615				PKVDH 1	NH 615
1	PA 720 × JLA 802	**26.20**	31.0**	7.38	11.65	88.04**	**19.87**	38.93**	39.91**	35.45**	43.27**
2	PA 528 × AKA 7	**23.33**	-5.28	-6.17	-0.57	67.46**	**20.13**	36.96**	34.22**	37.27**	45.19**
3	PA 08 × GAM 162	**21.67**	-8.06	-11.20	-7.67	55.50**	**18.80**	36.23**	42.42**	28.18**	35.58**
4	PA 532 × Dwd-arb 10-1	**19.47**	-18.09*	-20.22*	-17.05	39.71*	**15.60**	4.23	0.43	6.36	12.50
5	PA 255 × JLA 802	**25.47**	52.50**	43.07**	8.52	82.78**	**20.07**	23.36	41.31**	36.82**	44.71**
6	PA 402 × AKA 7	**22.40**	5.00	-9.92	-4.55	60.77**	**17.73**	6.40	18.22	20.91*	27.88**
7	PA 720 × GAM 162	**24.93**	23.03*	9.68	6.25	78.95**	**18.87**	19.66**	42.93**	28.64**	36.06**
8	PA 528 × Dwd-arb 10-1	**28.00**	36.81**	21.04*	19.32	100.96**	**17.00**	0.39	9.44	15.91	22.60*
9	PA 08 × JLA 802	**26.60**	47.50**	29.97*	13.35	90.91**	**17.07**	6.22	20.19*	16.36	23.08*
10	PA 532 × AKA 7	**24.27**	7.06	-2.41	3.41	74.61**	**14.53**	-11.47	-3.11	-0.91	4.81
11	PA 255 × GAM 162	**22.13**	2.47	-2.64	-5.68	58.85**	**16.07**	3.21	21.72*	9.55	15.87
12	PA 402 × Dwd-arb 10-1	**21.07**	-3.36	-8.93	-10.23	51.20**	**15.53**	-7.17	0.00	5.91	12.02
13	PA 528 × JLA 802	**27.47**	36.88**	11.96	17.05	97.13**	**19.67**	34.09**	38.50**	34.09**	41.83**
14	PA 720 × AKA 7	**28.73**	16.33*	15.55	22.44*	106.22**	**14.93**	-0.88	-0.44	1.82	7.69
15	PA 528 × GAM 162	**25.87**	9.45	5.43	10.23	85.65**	**19.33**	36.47**	46.46**	31.82**	39.42**
16	PA 08 × Dwd-arb 10-1	**21.13**	-11.33	-13.86	-9.94	51.67**	**15.33**	0.00	-1.29	4.55	10.58
17	PA 532 × JLA 802	**25.00**	54.00**	48.22**	6.53	79.43**	**13.00**	-15.22*	-8.45	-11.36	-6.25
18	PA 255 × AKA 7	**24.33**	16.61	-2.14	3.69	74.64**	**14.33**	-8.90	-4.44	-2.27	3.37
19	PA 402 × GAM 162	**21.87**	10.44	-3.81	-6.82	56.94**	**16.00**	7.87	21.21*	9.09	15.38
20	PA 720 × Dwd-arb 10-1	**22.40**	12.00	-3.17	-4.55	60.77**	**13.27**	-17.08*	-14.59	-9.55	-4.33
21	PA-08 × AKA-7	**21.33**	19.63	6.31	-9.09	53.11**	**15.80**	8.47	11.27	7.73	13.94
22	PA 532 × GAM 162	**23.07**	2.67	-7.24	-1.70	65.55**	**14.27**	-4.68	-4.89	-2.73	2.88
23	PA 255 × Dwd-arb 10-1	**20.40**	-4.67	-10.26	-13.07	46.41**	**16.20**	15.71*	22.73*	10.45	16.83
24	PA 402 × JLA 802	**24.07**	11.42	4.03	2.56	72.73**	**19.47**	27.79**	25.32**	32.73**	40.38**
	S.E.±	**1.5981**	1.989	2.297	2.297	2.297	**0.8279**	1.037	1.197	1.197	1.197

Sr. No.	Hybrids	Plant height (cm) Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over PKVDH 1	Per cent standard heterosis over NH 615	Days to maturity Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over PKVDH 1	Per cent standard heterosis over NH 615
1	PA 720 × JLA 802	**138.80**	10.60**	-12.59**	21.83**	81.68**	**151.00**	1.80	1.34	-3.82	0.44
2	PA 528 × AKA 7	**136.13**	-6.09	-14.27**	19.49**	78.18**	**144.00**	-3.25	-4.00	-8.28**	-4.21
3	PA 08 × GAM 162	**151.50**	7.73*	-4.60	32.97**	98.30**	**147.33**	-3.60	-6.75**	-6.16*	-2.00
4	PA 532 × Dwd-arb 10-1	**151.00**	10.09**	-4.91	32.53**	97.64**	**152.33**	0.44	-2.14	-2.97	1.33
5	PA 255 × JLA 802	**153.00**	44.70**	28.28**	34.29**	100.26**	**148.00**	-1.22	-1.77	-5.73*	-1.55
6	PA 402 × AKA 7	**136.67**	9.16*	4.22	19.95**	78.88**	**147.00**	-2.22	-2.43	-6.37*	-2.22
7	PA 720 × GAM 162	**150.47**	24.49**	22.86**	32.07**	96.95**	**150.33**	-2.59	-4.85	-4.25	0.00
8	PA 528 × Dwd-arb 10-1	**147.67**	25.78**	23.81**	29.61**	93.28**	**150.00**	-2.07	-3.64	-4.46	-0.22
9	PA 08 × JLA 802	**144.33**	40.95**	28.18**	26.68**	88.92**	**146.67**	-4.14	-6.58*	-6.58*	-2.44
10	PA 532 × AKA 7	**166.47**	36.60**	26.94**	46.11**	117.89**	**150.67**	-1.85	-4.03	-4.03-	0.22
11	PA 255 × GAM 162	**132.20**	12.48**	7.95	16.03**	73.04**	**153.00**	-2.86	-3.16	2.55	1.77
12	PA 402 × Dwd-arb 10-1	**133.00**	16.60**	15.12**	16.73**	74.08**	**151.33**	-3.20	-3.691	-3.61	0.67
13	PA 528 × JLA 802	**163.40**	38.71**	13.95**	43.42**	113.87**	**152.00**	1.33	0.66	-3.18	1.22
14	PA 720 × AKA 7	**149.00**	8.55*	3.91	30.78**	95.03**	**149.33**	-0.78	-1.10	-4.88	-0.67
15	PA 528 × GAM 162	**148.73**	11.89**	3.72	30.54**	94.68**	**153.00**	-0.97	-3.16	-2.55	1.77
16	PA 08 × Dwd-arb 10-1	**127.40**	-1.60	-11.16**	11.82*	66.75**	**148.00**	-3.48	-4.93	-5.73*	-1.55
17	PA 532 × JLA 802	**155.40**	50.73**	63.32**	36.40**	103.40**	**154.00**	0.11	-2.94	-1.91	2.44
18	PA 255 × AKA 7	**139.33**	13.68**	6.25	22.29**	82.37**	**147.67**	-4.32	-6.93**	-5.94*	-1.77
19	PA 402 × GAM 162	**135.07**	14.24**	10.29*	18.55**	76.79**	**150.33**	-5.05*	-5.25	-4.25	0.00
20	PA 720 × Dwd-arb 10-1	**142.47**	24.14**	23.31**	25.04**	86.47**	**153.67**	-2.23	-3.15	-2.12	2.22
21	PA 08 × AKA 7	**130.27**	23.16**	9.16	14.34**	70.51**	**142.00**	-2.85	-4.70	-9.55**	-5.54*
22	PA 532 × GAM 162	**134.87**	7.69	2.85	18.37**	76.53**	**150.00**	2.27	0.00	-4.46	-0.22
23	PA 255 × Dwd-arb 10-1	**125.27**	3.16	2.29	9.95	63.96**	**149.67**	-0.66	-5.27*	-4.67	-0.44
24	PA 402 × JLA 802	**136.53**	16.26**	14.41**	19.84**	78.71**	**152.33**	1.90	-2.14	-2.97	1.33
	S.E.±	**4.0628**	4.904	5.663	5.663	5.663	**2.7437**	3.396	3.922	3.922	3.922

Sr. No.	Hybrids	Seed cotton yield/plant (g)					Lind yield/plant				
		Mean	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over		**Mean**	Mid parent heterosis	Better parent heterosis	Per cent standard heterosis over	
					PKVDH 1	NH 615				PKVDH 1	NH 615
1	PA 720 × JLA 802	**46.73**	23.09**	21.28**	14.92**	13.43*	**21.73**	-58.60**	-60.10**	-65.84**	-65.88**
2	PA 528 × AKA 7	**58.80**	65.32**	57.22**	44.59**	42.72**	**31.25**	-50.33**	-58.50**	-50.89**	-50.94**
3	PA 08 × GAM 162	**58.73**	53.22**	49.58**	44.43**	42.56**	**28.10**	-52.42**	-58.42**	-55.83**	-55.88**
4	PA 532 × Dwd-arb 10-1	**38.60**	-4.46	-11.06*	-5.08	-6.31	**24.05**	-64.88**	-72.18**	-62.20**	-62.24**
5	PA 255 × JLA 802	**54.60**	27.57**	16.01**	34.26**	32.52**	**45.69**	4.42	-16.10	-28.19**	-28.26**
6	PA 402 × AKA 7	**39.20**	-2.97	-16.71**	-3.61	-4.85	**44.38**	-18.07*	-41.05**	-30.24**	-30.32**
7	PA 720 × GAM 162	**49.13**	13.82**	6.39	20.82**	19.26**	**50.61**	0.57	-25.12**	-20.45**	-20.54**
8	PA 528 × Dwd-arb 10-1	**39.80**	-12.01**	-15.44**	-2.13	-3.40	**27.75**	-53.56**	-67.90**	-56.49**	-56.43**
9	PA 08 × JLA 802	**52.67**	19.97**	6.90	29.51**	27.83**	**45.79**	24.17*	-15.93	-28.03**	-28.11**
10	PA 532 × AKA 7	**38.73**	-6.67	-21.38**	-4.75	-5.99	**30.50**	-35.50**	-59.48**	-52.06**	-52.11**
11	PA 255 × GAM 162	**56.07**	26.66**	13.80**	37.87**	36.08**	**37.45**	-13.79	-44.59**	-41.14**	-41.20**
12	PA 402 × Dwd-arb 10-1	**42.33**	-8.63*	-14.07**	4.10	2.75	**36.55**	-30.87**	-57.72**	-42.56**	-42.62**
13	PA 528 × JLA 802	**58.40**	55.60**	51.56**	43.61**	41.75**	**29.57**	-47.40**	-49.00**	-53.52**	-53.57**
14	PA 720 × AKA 7	**42.20**	20.11**	15.51*	3.77	2.43	**34.05**	-48.90**	-54.77**	-46.48**	-46.54**
15	PA 528 × GAM 162	**53.13**	40.19**	35.31**	30.66**	28.96**	**24.56**	-60.89**	-63.67**	-61.41**	-61.45**
16	PA 08 × Dwd-arb 10-1	**48.13**	20.43**	10.91*	18.36**	16.83**	**28.54**	-60.48**	-6.99**	-55.14**	-55.19**
17	PA 532 × JLA 802	**40.60**	-4.92	13.37**	-0.16	-1.46	**38.43**	-13.87	-22.44**	-39.61**	-39.67**
18	PA 255 × AKA 7	**52.40**	30.02**	11.81*	28.85**	27.18**	**30.64**	-44.31**	-59.30**	-51.84**	-51.89**
19	PA 402 × GAM 162	**53.07**	23.22**	13.23**	30.49**	28.80**	**27.11**	-47.04**	-59.90**	-57.40**	-57.44**
20	PA 720 × Dwd-arb 10-1	**42.73**	-5.32	-8.82	5.08	3.72	**29.38**	-51.53**	-66.02**	-53.83**	-53.88**
21	PA 08 × AKA 7	**43.87**	33.55**	27.85**	32.46**	30.74**	**27.92**	-35.51**	-48.74**	-56.12**	-56.17**
22	PA 532 × GAM 162	**42.27**	11.42*	0.32	3.93	2.59	**21.79**	-59.42**	-71.06**	-65.75**	-65.79**
23	PA 255 × Dwd-arb 10-1	**38.53**	-5.32	-8.54	-5.25	-6.47	**33.63**	-32.55**	-50.25**	-47.14**	-47.20**
24	PA 402 × JLA 802	**41.67**	-2.57	-3.99	2.46	1.13	**31.18**	-47.41**	-63.94**	-51.00**	-51.05**
	S.E.±	**1.5124**	1.873	2.163	2.163	2.163	**3.2626**	3.844	4.439	4.439	4.439

Heterosis for seed index was observed to the extent of 23.56 per cent in PA 08 × AKA 7 over mid parent (Table 1). Similar results were reported by the earlier workers Khan *et al.,* (2010) and Tuteja *et al.,* (2014).

The cross PA 255 × JLA 802 was found with lowest (16.20) oil content, while the cross PA 402 × JLA 802 was found with highest (19.33) seed oil content. Seven crosses exhibited desired positive significant heterosis over mid parent. The cross PA 255 × AKA 7 recorded significant positive heterosis over better. All crosses showed negative significant over both standard check PKVDH 1 and NH 615 (Table 1). Similar results on heterosis were observed by Khan *et al.,* (2010).

CONCLUSION

The cross PA 528 × AKA 7 for seed cotton yield and PA 720 × JLA 802 was found superior for bolls/plant, so can be promoted in further yield targeted breeding programmes. The crosses *viz.,* PA 402 × AKA 7 and PA 528 × Dwd-arb 10-1 were earlier for days to 50 per cent flowering and the crosses *viz.,* PA 402 × GAM 162, PA 255 × AKA 7 and PA 08 × AKA 7 were found earlier for days to maturity. These crosses might be used for earliness.

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