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Evaluation of heterosis and combining ability for yield and fibre quality traits in desi cotton (*Gossypium arboreum* L.) using half diallel.

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Abstract

The present investigation was undertaken at the Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, with the objective of evaluating heterosis and combining ability for yield and fibre quality attributes in Desi cotton. Twenty-eight F_1 hybrids generated from eight parents using a half-diallel mating system during *kharif* 2024 were assessed along with their parental lines and two standard checks in a randomized block design with three replications during *kharif* 2025. Analysis of variance revealed significant differences among the genotypes for all the characters studied, demonstrating the existence of considerable genetic variability. The hybrid JLA-1807 $\times$ JLA-1913 expressed the highest desirable standard heterosis for seed cotton yield per plant over both standard checks. Cross PA-810 $\times$ PA-740 exhibited superior performance for upper half mean length, whereas JLA-1807 $\times$ PA-810 showed favourable expression for fibre strength and fibre fineness. The cross JLA-1807 $\times$ PA-740 recorded the maximum positive heterosis for uniformity ratio. Combining ability analysis revealed that JLA-1807 was an efficient general combiner for seed cotton yield, fibre strength, uniformity ratio and fibre fineness, while PA-740 showed superior general combining ability for upper half mean length. Among the hybrids, JLA-1807 $\times$ JLA-1913, PA-810 $\times$ PA-740, PA-810 $\times$ PA-812 and JLA-1807 $\times$ PA-810 emerged as promising specific combinations for improving yield and fibre quality characteristics. The identified superior parents and hybrid combinations may therefore serve as valuable breeding material for the development of high-yielding Desi cotton genotypes with improved fibre quality.

Keywords: Desi cotton, Half Diallel, Heterosis, Combining Ability, Seed Cotton Yield, Fibre Quality, GCA, SCA.

Introduction

Desi cotton refers to the indigenous diploid cotton species native to the Indian subcontinent, primarily *Gossypium arboreum* L. and *Gossypium herbaceum* L., both possessing $2n = 26$ chromosomes. These species represent some of the earliest cottons domesticated by humans and are recognized for their high adaptability and resilience. Desi cotton is particularly suited to drought-prone and heat-stressed environments due to its tolerance to various abiotic and biotic stresses, making it well adapted to rainfed and low-input production systems commonly followed by small and marginal farmers. Unlike high-yielding tetraploid cotton hybrids such as *Gossypium hirsutum*, Desi cotton typically produces fibres that are shorter and coarser, but comparatively stronger.

The Indian cotton scenario remains highly dynamic and is shaped by both biotic and abiotic stresses as well as competition from other profitable crops. According to the Committee on Cotton Production and Consumption (COCPC), cotton production in India for 2025-26 is estimated at 292.15 lakh bales of 170 kg each from 110.86 lakh hectares, with average productivity of 448 kg lint/ha [Meeting dated 08.12.2025]. Compared to 2024-25, the area has declined by 3.47 percent and production by 1.72 percent.

Materials and Methods

The investigation was carried out at the experimental field of the Cotton Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, and Akola. Eight parents were crossed using a half-

diallel mating design during *kharif* 2024. The resulting 28 F₁ hybrids, together with their eight parents and two standard checks, were evaluated during *kharif* 2025 in a randomized block design with three replications. All recommended agronomic practices were followed throughout the experiment. Observations were recorded on five plants from each genotype in every replication for seed cotton yield per plant (g) and fibre quality attributes, namely upper half mean length (mm), fibre strength (g/tex), fibre fineness (µg/inch) and uniformity ratio. Analysis of variance was performed following the procedures described by Panse and Sukhatme (1967) ^[13]. Combining ability analysis was conducted according to Griffing's (1956b) Method 2, Model I.

Results and Discussion

The analysis of variance indicated significant differences among the genotypes for all the characters under investigation, confirming the existence of considerable genetic variability and demonstrating that the genotypes differed substantially in their performance for the traits studied. For seed cotton yield per plant, standard heterosis over PKV Suvarna ranged from -42.72 to 103.71 per cent. The hybrid JLA-1807 × JLA-1913 exhibited the maximum positive heterosis (103.71%), followed by JLA-1807 × PA-

740 (70.79%) and JLA-1807 × PA-810 (47.19%). With PDKV Dhawal as the standard check, the magnitude of standard heterosis ranged from -37.94 to 120.72 per cent. The cross JLA-1807 × JLA-1913 again recorded the highest positive heterosis (120.72%), followed by JLA-1807 × PA-740 (85.05%) and JLA-1807 × PA-810 (59.48%). For upper half mean length, the standard heterosis relative to PKV Suvarna ranged from -2.02 to 16.13 per cent. Among the hybrids, PA-810 × PA-740 showed the highest positive heterosis (16.13%), followed by JLA-1807 × PA-740 (11.29%) and AKA-8 × PA-812 (9.68%). Using PDKV Dhawal as the standard check, the heterosis estimates ranged from -3.20 to 15.20 per cent. The hybrid PA-810 × PA-740 recorded the maximum positive heterosis (15.20%), followed by JLA-1807 × PA-740 (10.40%) and AKA-8 × PA-812 (8.80%). For fibre strength, standard heterosis over PKV Suvarna varied from -4.90 to 24.08 per cent. The highest positive heterotic effect was expressed by JLA-1807 × PA-810 (24.08%), followed by PA-810 × PA-812 (19.18%) and AKA-7 × JLA-1807 (14.29%). With PDKV Dhawal as the reference check, heterosis estimates ranged from -13.06 to 13.43 per cent. JLA-1807 × PA-810 exhibited the highest positive standard heterosis (13.43%), followed by PA-810 × PA-812 (8.96%), AKA-7 × JLA-1807 (4.48%) and JLA-1807 × PA-740 (4.48%).

Table 1: Analysis of variance for seed cotton yield per plant yield and fibre properties.

Source of variation	DF	Seed cotton yield / plant (g)	Upper half mean length (mm)	Fibre strength (g/tex)	Fibre fineness (µg/inch)	Uniformity ratio (%)
Replication	2	26.77	0.15	0.22	0.001	0.28
Genotype	37	308.63**	3.66**	6.86**	0.30**	2.69**
Error	74	29.84	0.30	0.24	0.01	0.24

Note: * Significant at 5% level of significance ** Significant at 1% level of significance

Table 2: Estimation of average heterosis (H₁), heterobeltiosis (H₂) and standard heterosis (H₃) over checks PKV Suvarna and PDKV Dhawal

Sr. No.	Hybrids	Seed cotton yield per plant (g)		Upper half mean length (mm)		Fibre strength (g/tex)		Fibre fineness (µg/inch)		Uniformity ratio (%)	
		PKV suvarna	PDKV Dhawal	PKV suvarna	PDKV Dhawal	PKV suvarna	PDKV Dhawal	PKV suvarna	PDKV Dhawal	PKV suvarna	PDKV Dhawal
1	AKA-2016-3 × AKA-7	-13.61	-6.39	-0.40	-1.20	-4.90 **	-13.06 **	-6.90 **	-11.48 **	0.00	-1.23
2	AKA-2016-3 × AKA-8	-16.37	-9.38	4.03 *	3.20	0.82	-7.84 **	1.72	-3.28 *	3.75 **	2.47 *
3	AKA-2016-3 × JLA-1807	16.08	25.77	1.21	0.40	11.84 **	2.24	1.72	-3.28 *	1.25	0.00
4	AKA-2016-3 × JLA-1913	6.57	15.46	-2.42	-3.20	6.94 **	-2.24	0.00	-4.92 **	1.25	0.00
5	AKA-2016-3 × PA-810	29.40 *	40.21 **	2.42	1.60	10.61 **	1.12	3.45 *	-1.64	1.25	0.00
6	AKA-2016-3 × PA-812	-10.75	-3.30	3.23	2.40	6.53 **	-2.61	0.00	-4.92 **	1.25	0.00
7	AKA-2016-3 × PA-740	-6.57	1.24	6.45 **	5.60 **	5.71 **	-3.36 *	-1.72	-6.56 **	3.75 **	2.47 *
8	AKA-7 × AKA-8	-42.72 **	-37.94 **	-2.02	-2.80	2.86	-5.97 **	0.00	-4.92 **	2.50 *	1.23
9	AKA-7 × JLA-1807	2.66	11.24	5.65 **	4.80 *	14.29 **	4.48 **	-3.45 *	-8.20 **	1.25	0.00
10	AKA-7 × JLA-1913	12.75	22.16	3.23	2.40	4.90 **	-4.10 **	5.17 **	0.00	1.25	0.00
11	AKA-7 × PA-810	-22.84	-16.39	0.81	0.00	4.49 **	-4.48 **	-1.72	-6.56 **	1.25	0.00
12	AKA-7 × PA-812	19.89	29.90 *	7.66 **	6.80 **	6.53 **	-2.61	-6.90 **	-11.48 **	3.75 **	2.47 *
13	AKA-7 × PA-740	-5.04	2.89	3.23	2.40	8.57 **	-0.75	3.45 *	-1.64	1.25	0.00
14	AKA-8 × JLA-1807	-13.23	-5.98	4.84 *	4.00 *	4.49 **	-4.48 **	0.00	-4.92 **	2.50 *	1.23
15	AKA-8 × JLA-1913	-5.33	2.58	3.23	2.40	0.82	-7.84 **	-1.72	-6.56 **	1.25	0.00
16	AKA-8 × PA-810	30.07 *	40.93 **	7.26 **	6.40 **	8.16 **	-1.12	1.72	-3.28 *	2.50 *	1.23

17	AKA-8 × PA-812	-28.73 *	-22.78	9.68 **	8.80 **	2.04	-6.72 **	0.00	-4.92 **	0.00	-1.23
18	AKA-8 × PA-740	-3.33	4.74	5.65 **	4.80 *	11.02 **	1.49	1.72	-3.28 *	1.25	0.00
19	JLA-1807 × JLA-1913	103.71 **	120.72 **	3.23	2.40	4.49 **	-4.48 **	0.00	-4.92 **	3.75 **	2.47 *
20	JLA-1807 × PA-810	47.19 **	59.48 **	6.45 **	5.60 **	24.08 **	13.43 **	-22.41 **	-26.23 **	2.50 *	1.23
21	JLA-1807×PA-812	37.58 **	49.07 **	5.65 **	4.80 *	11.84 **	2.24	-10.34 **	-14.75 **	1.25	0.00
22	JLA-1807×PA-740	70.79 **	85.05 **	11.29 **	10.40 **	14.29 **	4.48 **	-8.62 **	-13.11 **	5.00 **	3.70 **
23	JLA-1913×PA810	8.66	17.73	2.42	1.60	1.22	-7.46 **	0.00	-4.92 **	1.25	0.00
24	JLA-1913×PA-812	-14.94	-7.84	1.21	0.40	4.35 *	-4.60 **	1.72	-3.28 *	1.25	0.00
25	JLA-1913×PA-740	25.59	36.08 *	2.42	1.60	8.57 **	-0.75	3.45 *	-1.64	2.50 *	1.23
26	PA-810×PA-812	-16.46	-9.48	6.85 **	6.00 **	19.18 **	8.96 **	-6.90 **	-11.48 **	2.50 *	1.23
27	PA-810×PA-740	10.85	20.10	16.13 **	15.20 **	9.80 **	0.37	-12.07 **	-16.39 **	2.50 *	1.23
28	PA-812×PA-740	-4.47	3.51	6.85 **	6.00 **	5.31 **	-3.73 *	-1.72	-6.56 **	1.25	0.00

Note: * Significant at 5% level of significance ** Significant at 1% level of significance

For fibre fineness, standard heterosis with PKV Suvarna as the reference check ranged from -22.41 to 5.17 per cent. Since lower fibre fineness is desirable, JLA-1807 × PA-810 exhibited the most favourable negative heterosis (-22.41%), followed by PA-810 × PA-740 (-12.07%) and JLA-1807 × PA-812 (-10.34%). When PDKV Dhawal was used as the standard check, the heterosis estimates ranged from -26.23 to 0.00 per cent. The cross JLA-1807 × PA-810 recorded the highest desirable negative heterosis (-26.23%), followed by PA-810 × PA-740 (-16.39%) and JLA-1807 × PA-812 (-14.75%). For uniformity ratio, standard heterosis over PKV Suvarna ranged from 0.00 to 5.00 per cent. The hybrid JLA-1807 × PA-740 exhibited the maximum positive heterosis of 5.00 per cent. The crosses AKA-2016-3 × AKA-8, AKA-2016-3 × PA-740, AKA-7 × PA-812 and

JLA-1807 × JLA-1913 each recorded 3.75 per cent heterosis. With PDKV Dhawal as the standard check, heterosis estimates ranged from -1.23 to 3.70 per cent. The highest positive heterosis was observed in JLA-1807 × PA-740 (3.70%), whereas AKA-2016-3 × AKA-8, AKA-2016-3 × PA-740, AKA-7×PA-812 and JLA-1807×JLA-1913 each registered 2.47 per cent heterosis. Similar finding for standard heterosis for these characters in cotton was also reported earlier by several researchers viz., Pole *et al.* (2008), Dheva *et al.* (2009), Chaudhary *et al.* (2016), Munir *et al.* (2016), Vaid *et al.* (2022), Anandan *et al.* (2010) and Bolek *et al.* (2010), Geddam *et al.* (2011), Babu *et al.* (2018), sharma *et al.* (2024) and Shinde *et al.* (2021) [1, 3, 4, 7, 8, 11, 17, 19, 20, 23].

Table 3: Estimation of general combining ability effects of parents

Sr. No.	Parents	Seed cotton yield / plant (g)	Upper half mean length (mm)	Fibre strength (g/tex)	Fibre fineness (ug/inch)	Uniformity ratio (%)
1	AKA-2016-3	-2.400	-0.719**	-0.333*	0.116**	-0.219
2	AKA-7	-4.558**	-0.706**	-0.596**	0.028	-0.344
3	AKA-8	-6.721**	0.144	-0.521**	0.153**	-0.094
4	JLA-1807	10.463**	0.256	1.254**	-0.222**	0.531
5	JLA-1913	3.067	-0.719**	-1.025**	0.216**	-0.219
6	PA-810	1.683	0.531**	1.042**	-0.184**	0.156
7	PA-812	-2.908	0.356	-0.012	-0.122**	-0.219
8	PA-740	1.375	0.856**	0.192	0.016	0.406

General Combining Ability Effect

For seed cotton yield per plant, JLA-1807 exhibited the highest positive and significant GCA effect (10.463), establishing it as the most promising general combiner for yield improvement. In contrast, AKA-8 recorded the highest significant negative GCA effect (-6.721). Regarding upper half mean length, PA-740 showed the maximum positive and significant GCA effect (0.856), thereby emerging as the best general combiner for this trait. For fibre strength, the highest positive and significant GCA effect was observed in JLA-1807 (1.254), followed by PA-810 (1.042). In the case of fibre fineness, negative GCA effects were considered favourable, and significant desirable effects were recorded for PA-810 (-0.184) and PA-812 (-0.122). For uniformity ratio, JLA-1807 registered the highest positive GCA effect (0.531), followed by PA-740 (0.406), indicating their potential for improving fibre uniformity.

Specific Combining Ability Effect

Among the crosses, JLA-1807 × JLA-1913 (20.658) showed the highest significant positive SCA effect for seed cotton yield per plant. For upper half mean length, PA-810 × PA-740 (1.448) exhibited the highest significant positive SCA effect. The cross PA-810 × PA-812 (1.875) showed the highest significant positive SCA effect for fibre strength. None of the crosses exhibited a significant positive SCA effect for uniformity ratio. For fibre fineness, where a negative effect is desirable, JLA-1807 × PA-810 (-0.766) exhibited the highest significant negative SCA effect. Similar type of result for combining ability reported by Patel and chaoudhary (2015), Shinde *et al.* (2018), Nand *et al.* (2019), Mudhalvan *et al.* (2021), Shinde *et al.* (2022), Deosarkar *et al.* (2014), Reddy and Reddy (2011), Manonmani *et al.* (2020), Ranganath *et al.* (2013a), Patil *et al.* (2017) and Thiyagu *et al.* (2019) [6, 9, 10, 12, 13, 15, 18, 21, 22].

Table 4: Estimation of specific combining ability effects of crosses.

Sr. No.	Hybrids	Seed cotton yield (g)	Upper half mean length (mm)	Fibre strength (g/tex)	Fibre fineness (ug/inch)	Uniformity ratio (%)
1	AKA-2016-3 × AKA-7	0.046	0.156	-2.067**	-0.416**	-1.031
2	AKA-2016-3 × AKA-8	1.242	0.406	-0.742	-0.041	1.719
3	AKA-2016-3 × JLA-1807	-4.575	-0.406	0.183	0.334**	-0.906
4	AKA-2016-3 × JLA-1913	-0.512	-0.331	1.263**	-0.203*	-0.156
5	AKA-2016-3 × PA-810	8.871	-0.381	0.096	0.397**	-0.531
6	AKA-2016-3 × PA-812	-0.604	-0.006	0.150	0.134	-0.156
7	AKA-2016-3 × PA-740	-3.421	0.294	-0.254	-0.103	1.219
8	AKA-7 × AKA-8	-5.833	-1.106*	0.021	-0.053	0.844
9	AKA-7 × JLA-1807	-7.117	0.681	1.046*	0.122	-0.781
10	AKA-7 × JLA-1913	3.812	1.056*	1.025*	0.184*	-0.031
11	AKA-7 × PA-810	-7.271	-0.794	-1.142**	0.184*	-0.406
12	AKA-7 × PA-812	12.287**	1.081*	0.412	-0.178	1.969
13	AKA-7 × PA-740	-0.729	-0.519	0.708	0.284**	-0.656
14	AKA-8 × JLA-1807	-10.521*	-0.369	-1.429**	0.197*	-0.031
15	AKA-8 × JLA-1913	-0.358	0.206	-0.050	-0.341**	-0.281
16	AKA-8 × PA-810	13.425**	-0.044	-0.317	0.259**	0.344
17	AKA-8 × PA-812	-2.583	0.731	-0.763	0.097	-1.281
18	AKA-8 × PA-740	2.033	-0.769	1.233**	0.059	-0.906
19	JLA-1807 × JLA-1913	20.658**	0.094	-0.925*	0.134	1.094
20	JLA-1807 × PA-810	2.242	-0.356	1.808**	-0.766**	-0.281
21	JLA-1807×PA-812	3.467	-0.381	-0.137	-0.128	-0.906
22	JLA-1807×PA-740	10.817*	0.519	0.258	-0.166	1.469
23	JLA-1913×PA810	-3.862	-0.381	-1.513**	0.097	-0.531
24	JLA-1913×PA-812	-7.537	-0.506	0.308	0.134	-0.156
25	JLA-1913×PA-740	2.379	-0.706	1.138**	0.097	0.219
26	PA-810×PA-812	-6.688	-0.356	1.875**	0.034	0.469
27	PA-810×PA-740	-1.404	1.444**	-0.629	-0.403**	-0.156
28	PA-812×PA-740	-2.179	-0.681	-0.675	0.134	-0.781

Conclusion

The findings demonstrated the presence of considerable genetic diversity among the genotypes for all the characters evaluated. Among the hybrids, JLA-1807 × JLA-1913 emerged as the most promising combination for seed cotton yield, whereas PA-810 × PA-740 showed superior performance for upper half mean length. The hybrid JLA-1807 × PA-810 exhibited desirable potential for improving fibre strength and fibre fineness, while JLA-1807 × PA-740 performed best for uniformity ratio. JLA-1807 and PA-740 were identified as valuable general combiners for important yield and fibre quality attributes. Furthermore, JLA-1807 × JLA-1913, PA-810 × PA-740, PA-810 × PA-812 and JLA-1807 × PA-810 emerged as promising specific cross combinations with potential for simultaneous improvement of seed cotton yield and fibre quality. The superior parental lines and identified cross combinations may therefore be effectively exploited in future breeding programmes aimed at developing high-yielding Desi cotton genotypes with improved fibre characteristics.

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