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Heterosis Studies for Yield and Fibre Quality Traits in GMS based Asiatic Cotton (*Gossypium arboreum* L.) Hybrids

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ABSTRACT

Background: Cotton is a natural fibre grown in over 100 countries worldwide and is a key agricultural crop that provides raw material for various industries (Radhakrishnan, 2017). One effective strategy to address yield and productivity issues, as well as reduce cultivation costs, is to utilize the *Gossypium arboreum* species. This species has the ability to thrive in rainfed conditions, is resistant to sucking pests and requires fewer inputs compared to Bt cotton hybrids.

Methods: Twenty-nine genetic male sterility -based intra-arboreum cotton hybrids were evaluated for yield and fibre quality traits compared to the standard check AAH 1. The study was conducted in a randomized block design with three replications at the research area of the cotton section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar during the *Kharif* season of 2023.

Result: Analysis of variance showed significant differences for all traits. The standard heterosis for seed cotton yield varied from -47.1% (AAH 73) to 23.67% (AAH 59). Hybrid AAH 59 displayed the highest positive standard heterosis for lint yield (35.03%) and ginning outturn (9.22%), while the highest standard heterosis for seed index (29.14%) was observed in hybrid AAH 60. Based on standard heterosis, hybrids AAH 59, AAH 54, AAH 66 and AAH 58 showed promise for seed cotton yield and its related traits, while hybrids AAH 61, AAH 47, AAH 56 and AAH 55 performed well for seed cotton yield and fibre quality traits. These heterotic crosses can be utilized for enhancing seed cotton yield and improving fibre quality.

Key words: Fibre quality, Hybrid, Seed cotton yield, Significant, Standard heterosis.

INTRODUCTION

Cotton (*Gossypium arboreum*) is one of the natural fibres cultivated in more than100 countries of the world. It holds prominent position among the agricultural crops which supplies raw material forthe industries (Radhakrishnan, 2017). India possesses highest cotton acreage in the world *i.e.* around 40% of world area of 324.16 lakh hectares and one of the largest producers and consumers of cotton. Cotton plays a vital role in country's economy, which directly supports millions of farmers and forms the backbone of the textile industry. All the four cultivated species *i.e. G. arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense* have been commercially cultivated in India. In the beginning right from independence to 1972, cotton varieties belonging to *G. arboreum, G. herbaceum* and *G. hirsutum* were cultivated at large scale and the cotton productivity was just 152 kg lint/ha. After the development and introduction of hybrid cotton (1972-2002), the productivity was doubled. Further, with the introduction of *Bt* cotton hybrids in 2002; most of the area under cotton cultivation was occupied by *G. hirsutum* species and the productivity was increased 40 to 60%. It reached maximum of 565 kg lint/ha during 2013-14 and later started declining drastically due to the incidence of pests like pink bollworm, the sucking pests (jassid *Amrasca biguttula*, whitefly *Bemisia tabaci* and thrips *Thrips* sp.), diseases (root rot, leaf spot, boll rot, grey mildew, Tobacco streak virus and cotton leaf curl disease) (Khadi, 2021).

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One of the viable strategies to overcome yield and productivity challenges coupled with low cost of cultivation; is the use of *Gossypium arboreum* specieswith the inherent potential to sustain under rainfed conditions, resistant to sucking pests and requires low inputs as compared to *Bt* cotton hybrids. This species was being ignored after the introduction of *Bt* cotton, mainly due to its small boll size, short and coarse fibre which is chiefly used as surgical cotton in our country. Therefore, it is necessary to harness the full potential of this species by developing varieties and hybrids possessing high yield and fibre quality. To achieve this objective, appropriate breeding strategies are urgently required. Heterosis breeding programme which involves selection of superior crosses on the basis of heterosis is one of such strategies. Hence, in the present study genetic male sterility (GMS) based *desi* cotton hybrids

were evaluated for heterosis studies for yield and fibre quality traits.

MATERIALS AND METHODS

The experimental material comprised of thirty intra-specific hybrids of *G. arboreum* (29 hybrids and one standard check *i.e.* AAH 1). The material was generated by using genetic male sterile lines as female parents and elite genotypes as male parents. The experimental material was evaluated in a randomized block design (RBD) with three replications during *Kharif* 2023 at Research Area of Cotton Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The plot size was 16.2 m^2 for each hybrid; comprising four rows of 6 m length with a spacing of 67.5 × 60 cm. The standard package of practices was followed to raise the crop. Data were recorded on 13 different traits *viz.*, Days to 50% flowering, plant height (cm), number of sympods/plant, number of bolls/plant, boll weight (g), seed cotton yield (kg/ha), ginning outturn (%), seed index (g), lint yield (kg/ha), fibre length (mm), uniformity index, strength or tenacity (g/tex) and micronaire value (µg/inch). The plot yield was taken forseed cotton yield and lint yield which was converted into kg/ha for statistical analysis. Data on other traits were recorded on five randomly selected plants in each replication. The fibre quality parameters were measured by using the High Volume Instrument operated in the HVI Mode. The mean values of all the hybrids for all the traits were used for statistical analysis. Standard heterosis was estimated as suggested by Rai (1978).

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the hybrids for all the traits (Table 1). The mean performance and standard heterosis of different hybrids for all the traits were calculated and presented in Table 2, 3 and 4.

Days to 50% flowering ranged from 73 to 78 days among the hybrids. Nine hybrids showed significant positive standard heterosis and two hybrids showed significant negative standard heterosis (Table 2). The genotypes which take less time to flower are considered suitable as yield losses due to insect-pest and diseases get minimized in such genotypes (Khadi *et al.,* 2010). Venugopalan *et al.* (2014) also reported the advantages of such hybrids which take less time to flower and mature. Two hybrids *i.e.* AAH 56 and AAH 76 were found promising as depicted by the minimum days to 50% flowering (73 days) and significant negative standard heterosis in desirable direction (-4.37 and -3.93%). Similar findingshave been reported by Udaya *et al.* (2023); Vanapariya *et al.* (2022) and Hottigodar *et al.* (2023).

Very tall genotypes are not desirable in cotton as plant's energy gets utilized more towards vegetative growth than the reproductive growth. In this study, all hybrids were very tall. Among all hybrids, AAH 40 had minimum plant height (177 cm) and AAH 74 had maximum (236 cm), whereas

Table 1: Analysis of variance for seed cotton yield, its attributing and fibre quality traits in *desi* cotton (*G. arboreum*).

Source of variation	d.f.	Mean sum of squares											
		DFF	PH	NS	BN	BW	SCY	GOT	SI	LY	FL	UI	FS	MIC
Replications	2	4.68	266.4	0.56	2.67	0.004	30282	0.30	0.02	5327	0.08	1.90	0.15	0.00
Treatments	29	5.39**	778.8**	32.32**	81.95**	0.18**	2154982**	10.13**	0.49**	341263**	9.21**	3.46**	4.12**	0.27**
Error	58	1.05	147.7	3.41	9.75	0.01	192793	0.20	0.02	28657	0.16	1.54	0.10	0.02

** Indicates significant at 1% level of significance.

DFF- Days to 50% flowering; PH- Plant height; NS- Number of sympods; BN- Boll number; BW- Boll weight; SCY- Seed cotton yield; GOT- Ginning outturn; SI- Seed index; LY- Lint yield; FL- Fibre length; UI- Uniformity index; FS- Fibre strength; MIC- Micronaire.

Table 2: Mean values and estimates of standard heterosis for days to 50% flowering, plant height, number of sympods, boll number and boll weight in *desi* cotton (*G. arboreum*).

Hybrid name	Pedigree	Days to 50% flowering		Plant height		Number of sympods/plant		Number of bolls/plant		Boll weight	
		Mean	Heterosis (%)	Mean (cm)	Heterosis (%)	Mean	Heterosis (%)	Mean	Heterosis (%)	Mean (g)	Heterosis (%)
AAH 39	GMS 1× GCD 22	76	-0.44	193	1.34	17	-21.57**	47	8.70	2.73	-0.61
AAH 40	GMS 1× P 541	75	-1.31	177	-7.13	17	-19.10**	50	9.72	2.66	-3.16
AAH 41	GMS 1 × HD 534	76	0.00	184	-3.33	16	-25.88**	51	16.35**	2.74	-0.12
AAH 43	GMS 1 × NP 15	78	2.62**	224	17.699**	23	7.31	42	-6.60	2.69	-1.94
AAH 46	RGMS 5 × GCD 91	77	0.87	216	13.318**	21	-1.68	40	-6.61	2.68	-2.43
AAH 47	GMS 1 × DMP 37	78	2.62**	198	3.97	16	-26.36**	53	14.20*	2.77	0.97
AAH 50	GMS 1 × HD 600	78	1.75*	231	21.20**	21	-1.11	43	-1.99	2.92	6.44**
AAH 54	GMS 1 × HD 594	78	2.18**	196	3.04	27	26.25**	55	25.21**	2.88	4.86*
AAH 55	GMS 1 × HD 578	78	1.75*	203	6.72	26	25.15**	56	25.14**	2.81	2.31
AAH 56	GMS 1× GCD 308	73	-4.37**	191	0.47	18	-15.36**	54	17.45**	2.75	0.37
AAH 58	RGMS 5 × HD 598	76	-0.87	221	16.00**	26	21.99**	49	14.16*	2.74	-0.24
AAH 59	GMS 16 × HD 615	77	0.87	189	-0.41	25	16.31**	58	29.36**	2.68	-2.43
AAH 60	GMS 16 × HD 596	76	-0.44	220	15.60**	24	13.62**	48	6.77	2.95	7.65**
AAH 61	GAK 50 × HD 535	76	-0.87	193	1.64	24	12.05**	53	15.45*	2.92	6.32**
AAH 62	GMS 1 × HD 548	75	-1.31	197	3.39	19	-7.94	46	1.13	2.78	1.22
AAH 63	GMS 1 × HD 596	75	-1.31	218	14.49**	27	26.25**	52	11.97	2.39	-12.76**
AAH 64	GMS 29 × HD 600	76	0.00	219	15.07**	25	20.41**	47	7.32	2.46	-10.45**
AAH 65	GMS 29 × HD 535	75	-1.31	210	10.34**	20	-4.79	45	2.27	2.83	3.16
AAH 66	RGMS 5 × HD 615	76	0.00	193	1.34	19	-10.63*	54	20.60**	2.64	-3.77*
AAH 67	GMS 1 × HD 618	76	0.00	211	10.92**	22	6.21	44	-3.59	2.45	-10.57**
AAH 68	GAK 50 × DMP 41	78	2.62**	215	12.97**	21	-2.68	39	-15.18*	2.82	2.80
AAH 69	GMS 1 × DMP 13	77	0.44	196	3.04	18	-13.68**	42	-7.92	2.47	-9.84**
AAH 70	GAK 50 × HD 598	76	-0.44	216	13.61**	24	11.47*	45	5.47	2.43	-11.54**
AAH 71	GAK 20 × HD 548	78	1.75*	209	9.81*	22	3.21	46	0.77	2.45	-10.81**
AAH 72	GMS 29 × HD 598	77	0.87	234	23.25**	19	-10.05*	43	-2.45	2.50	-8.99**
AAH 73	GAK 50 × HD 617	78	2.18**	192	0.76	19	-8.52	40	-10.91	1.73	-36.82**
AAH 74	GAK 50 × HD 614	78	1.75*	236	24.06**	22	3.58	43	-6.86	2.45	-10.57**
AAH 75	RGMS 6 × HD 614	75	-1.31	231	21.49**	24	11.99**	47	1.84	2.43	-11.30**
AAH 76	RGMS 6 × DMP 13	73	-3.93**	216	13.67**	19	-11.21*	41	-5.82	2.40	-12.51**
AAH 1	Standard check	76	-	190	-	21	-	44	-	2.74	-
SE ±		0.59		7.01		1.07		1.80		0.05	
CD@5%		1.67		19.86		3.02		5.10		0.15	
CD@1%		2.22		26.42		4.01		6.79		0.19	

heterosis ranged from -7.13 to 24.06%. Sixteen hybrids showed significant positive standard heterosis for plant height (Table 2). However, none of the hybrid showed significant negative standard heterosis. Borgaonkar *et al.* (2024) also reported similar findings in *desi* cotton. Further, when significant standard heterotic (positive and negative) cross combinations for seed cotton yield were compared with respective heterosis for plant height; an inverse correlation for these traits was observed in most of the hybrids. Hence, heterosis in negative direction is desirable for plant height so as to get positive heterosis for seed cotton yield.

The sympodial branches bear fruits or bolls which contribute to the seed cotton yield. The number of sympods/ plant was minimum in AAH 41 and AAH 47 (16 sympods/plant) and maximum in AAH 54 and AAH 63 (27 sympods/plant). Ten hybrids showed significant positive standard heterosis in desirable direction, where the maximum heterosis *i.e.* 26.25% was exhibited by the hybrids AAH 54 and AAH 63 (Table 2). The boll number ranged from 39 bolls/plant (AAH 68) to 58 bolls/plant (AAH 59) and nine hybrids *i.e.* AAH 59 (29.36%), AAH 54 (25.21%), AAH 55 (25.14%), AAH 66 (20.60%), AAH 56 (17.45%), AAH 41 (16.35%), AAH 61 (15.45%), AAH 47 (14.20%) and AAH 58 (14.16%) showed significant positive standard heterosis for boll number (Table 2). These results were in agreement with the findings of Vavdiya *et al.* (2019); Richika *et al.* (2021), Keerthivarman *et al.* (2022) and Borgaonkar *et al.* (2024). The boll weight was observed minimum in AAH 73 (1.73 g) and maximum in AAH 60 (2.95 g). The significant standard positive

Table 3: Mean values and estimates of standard heterosis for seed cotton yield, ginning outturn, seed index and lint yield in *desi* cotton (*G. arboreum*).

Hybrid name	Pedigree	Seed cotton yield		Ginning outturn		Seed index		Lint yield	
		Mean (kg/ha)	Heterosis (%)	Mean (%)	Heterosis (%)	Mean (g)	Heterosis (%)	Mean (kg/ha)	Heterosis (%)
AAH 39	GMS 1 × GCD 22	4403	3.38	34.6	-9.83**	5.6	10.60**	1522	-6.79
AAH 40	GMS 1 × P 541	4506	5.80	38.1	-0.70	5.6	11.26**	1716	5.09
AAH 41	GMS 1 × HD 534	4650	9.18	38.3	0.00	5.5	8.61**	1783	9.20
AAH 43	GMS 1 × NP 15	3909	-8.21	38.2	-0.35	5.4	7.95**	1494	-8.50
AAH 46	RGMS 5 × GCD 91	4424	3.87	39.2	2.35**	5.5	8.61**	1461	-10.50
AAH 47	GMS 1 × DMP 37	4979	16.91**	40.1	4.52**	4.9	-1.99	1995	22.22**
AAH 50	GMS 1 × HD 600	4609	8.21	38.3	-0.17	5.4	7.95**	1764	8.03
AAH 54	GMS 1 × HD 594	4954	16.31*	38.2	-0.44	5.6	10.60**	2026	24.12**
AAH 55	GMS 1 × HD 578	4900	15.04*	35.7	-6.78**	5.9	16.56**	1875	14.83*
AAH 56	GMS 1 × GCD 308	4959	16.43*	40.8	6.52**	5.3	5.30**	2024	23.99**
AAH 58	RGMS 5 × HD 598	4794	12.56*	38.6	0.70	5.5	9.93**	1852	13.42*
AAH 59	GMS 16 × HD 615	5267	23.67**	41.9	9.22**	5.8	14.57**	2205	35.03**
AAH 60	GMS 16 × HD 596	4444	4.35	39.6	3.22**	6.5	29.14**	1758	7.65
AAH 61	GAK 50 × HD 535	4990	17.15**	39.9	4.09**	6.0	18.54**	1990	21.88**
AAH 62	GMS 1 × HD 548	4342	1.93	40.6	5.83**	5.5	8.61**	1762	7.91
AAH 63	GMS 1 × HD 596	4362	2.42	37.5	-2.09**	5.9	16.56**	1636	0.20
AAH 64	GMS 29 × HD 600	4115	-3.38	34.6	-9.74**	6.4	26.49**	1424	-12.76*
AAH 65	GMS 29 × HD 535	4424	3.87	38.7	0.87	5.5	8.61**	1711	4.77
AAH 66	RGMS 5 × HD 615	4877	14.49*	37.4	-2.44**	5.7	12.58**	1825	11.79
AAH 67	GMS 1 × HD 618	3621	-14.98*	36.0	-6.00**	6.2	23.84**	1305	-20.09**
AAH 68	GAK 50 × DMP 41	2984	-29.95**	37.6	-1.83**	5.2	3.97*	1122	-31.28**
AAH 69	GMS 1 × DMP 13	3740	-12.19*	40.9	6.70**	4.6	-8.61**	1120	-31.38**
AAH 70	GAK 50 × HD 598	3539	-16.91**	40.4	5.48**	5.7	12.58**	1431	-12.35*
AAH 71	GAK 20 × HD 548	2798	-34.30**	40.5	5.65**	5.3	5.96**	1134	-30.54**
AAH 72	GMS 29 × HD 598	3695	-13.25*	39.7	3.47**	5.9	16.56**	1346	-17.58**
AAH 73	GAK 50 × HD 617	2257	-47.01**	39.9	4.09**	5.2	3.31*	901	-44.83**
AAH 74	GAK 50 × HD 614	2984	-29.95**	36.6	-4.61**	5.3	5.30**	1089	-33.28**
AAH 75	RGMS 6 × HD 614	3848	-9.66	37.1	-3.13**	5.5	8.61**	1430	-12.42*
AAH 76	RGMS 6 × DMP 13	3622	-14.96*	37.9	-1.13	5.2	2.65	1108	-32.16**
AAH 1	Standard check	4259	-	38.3	-	5.0	-	1633	-
SE ±		253.5		0.26		0.08		97.7	
CD@5%		717.6		0.73		0.24		276.7	
CD@1%		954.8		0.97		0.31		368.1	

heterosis for boll weight was observed in four hybrids *i.e.* AAH 60 (7.65%), AAH 50 (6.44%), AAH 61 (6.32%) and AAH 54 (4.86%). Similar results were reported by Richika *et al.* (2021).

The mean seed cotton yield ranged from 2257 kg/ha (AAH 73) to 5267 kg/ha (AAH 59). The significant standard heterosis ranged from -47.01 to 23.67% for seed cotton yield. Eight hybrids namely, AAH 59 (23.67%), AAH 61 (17.15%), AAH 47 (16.91%), AAH 56 (16.42), AAH 54 (16.31%), AAH 55 (15.04%), AAH 66 (14.93%) and AAH 58 (12.56%) showed significant standard positive heterosis for seed cotton yield (Table 3). Giri *et al.* (2021) and Jattan *et al.* (2022) also observed similar results.

The ginning outturn was recorded minimum in AAH 39 (34.6%) and maximum in the hybrid AAH 59 (41.9%). The significant positive standard heterosis for ginning outturn was exhibited by 12 hybrids *i.e.*AAH 59 (9.22%),AAH 69 (6.70%), AAH 56 (6.52%), AAH 62 (5.83%), AAH 71 (5.65%), AAH 70 (5.48%), AAH 47 (4.52%), AAH 61 and AAH 73 (4.09%), AAH 72 (3.47%), AAH 60 (3.22%) and AAH 46 (2.35%) as depicted in Table 3. The seed index ranged from 4.6 to 6.5 g among the hybrids. Twenty six hybrids displayed significant positive standard heterosis for seed index. The highest seed index was shown by the hybrid AAH 60 (29.14%) followed by AAH 64 (26.49%) and AAH 67 (23.84%). Pavitra *et al.* (2019), Chakholoma *et al.* (2021), Keerthivarman *et al.* (2022) and Borgaonkar *et al.* (2024) also reported similar results. The lint yield among the hybrids ranged from 901 kg/ha (AAH 73) to 2205 kg/ha (AAH 59). Seven hybrids showed significant positive

Table 4: Mean values and estimates of standard heterosis for fibre quality traits in *desi* cotton (*G. arboreum*).

Hybrid name	Pedigree	Fibre length		Uniformity index		Fibre strength		Micronaire	
		Mean (mm)	Heterosis (%)	Mean	Heterosis (%)	Mean (g/tex)	Heterosis (%)	Mean (µg/inch)	Heterosis (%)
AAH 39	GMS 1 × GCD 22	22.1	12.75**	80.0	2.61**	20.9	8.10**	6.4	-5.88**
AAH 40	GMS 1 × P 541	21.8	11.22**	80.0	2.56**	21.2	9.65**	6.5	-3.92**
AAH 41	GMS 1 × HD 534	22.1	12.92**	80.0	2.56**	20.7	7.07**	6.4	-5.39**
AAH 43	GMS 1 × NP 15	20.9	6.63*	79.0	1.28	20.0	3.45**	6.4	-5.88**
AAH 46	RGMS 5 × GCD 91	20.0	2.04	78.0	-0.04	19.7	1.90	6.7	-1.47
AAH 47	GMS 1 × DMP 37	21.0	7.14**	79.0	1.28	19.8	2.41*	6.2	-8.82**
AAH 50	GMS 1 × HD 600	22.7	15.99**	80.0	2.56**	21.6	11.72**	6.3	-6.86**
AAH 54	GMS 1 × HD 594	18.1	-7.65**	77.0	-1.28	18.6	-3.79**	7.1	4.40**
AAH 55	GMS 1 × HD 578	21.7	10.71**	79.0	1.28	20.8	7.59**	6.1	-10.29**
AAH 56	GMS 1 × GCD 308	21.3	8.67**	79.0	1.28	20.4	5.34**	6.3	-7.35**
AAH 58	RGMS 5 × HD 598	20.2	3.06*	79.0	1.28	19.7	1.90	6.9	1.47
AAH 59	GMS 16 × HD 615	20.0	2.04	78.0	0.00	19.7	1.90	6.8	-0.49
AAH 60	GMS 16 × HD 596	23.1	17.86**	80.0	2.61**	21.8	12.76**	6.2	-9.31**
AAH 61	GAK 50 × HD 535	20.7	5.61**	79.0	1.33	20.3	5.00**	6.2	-8.82**
AAH 62	GMS 1 × HD 548	20.0	2.04	78.0	0.00	19.5	0.86	6.6	-2.94*
AAH 63	GMS 1 × HD 596	23.3	18.88**	80.0	2.56**	22.5	16.55**	6.6	-2.94*
AAH 64	GMS 29 × HD 600	24.6	25.51**	81.0	3.85**	23.1	19.48**	6.1	-10.78**
AAH 65	GMS 29 × HD 535	22.4	14.29**	80.0	2.56**	21.2	9.83**	6.4	-5.88**
AAH 66	RGMS 5 × HD 615	19.0	-3.06*	78.0	0.00	19.1	-1.21	6.9	1.50
AAH 67	GMS 1 × HD 618	22.6	15.31**	80.0	2.56**	22.3	15.34**	6.5	-4.41**
AAH 68	GAK 50 × DMP 41	22.1	12.75**	80.0	2.56**	20.4	5.52**	6.1	-10.78**
AAH 69	GMS 1 × DMP 13	23.2	18.20**	80.0	2.56**	21.3	10.17**	6.2	-8.82**
AAH 70	GAK 50 × HD 598	23.6	20.24**	80.0	2.56**	20.0	3.45**	6.8	0.00
AAH 71	GAK 20 × HD 548	24.2	23.47**	81.0	3.80**	21.9	13.10**	6.2	-8.82**
AAH 72	GMS 29 × HD 598	24.2	23.47**	81.0	3.85**	21.5	11.21**	6.4	-6.37**
AAH 73	GAK 50 × HD 617	19.2	-2.04	78.0	0.00	18.9	-2.24*	6.3	-7.35**
AAH 74	GAK 50 × HD 614	23.7	20.92**	80.0	2.56**	22.0	13.79**	5.8	-14.71**
AAH 75	RGMS 6 × HD 614	24.2	23.64**	81.0	3.85**	21.9	13.28**	6.4	-5.88**
AAH 76	RGMS 6 × DMP 13	22.6	15.48**	80.0	2.56**	21.9	13.28**	6.2	-8.82**
AAH 1	Standard Check	19.6	-	78.0	-	19.3	-	6.8	-
SE ±		0.23		0.72		0.19		0.09	
CD@5%		0.65		2.03		0.53		0.24	
CD@1%		0.87		2.70		0.70		0.32	

standard heterosis for lint yield. The hybrid AAH 59 (35.03%) followed by AAH 54 (24.12%), AAH 56 (23.99%), AAH 47 (22.22%) and AAH 61 (21.88%) showed highly significant heterosis for lint yield (Table 3). These results are in agreement withthe findings of Rani *et al.* (2020).

Fibre length is an important fibre quality parameter which determines the utility of cotton fibre in textile industry or for some other purpose. The fibre length was short to medium long among the hybrids. The fiber length was maximum in the hybrid AAH 64 (24.6 mm) and minimum in AAH 54 (18.1 mm). Twenty three hybrids exhibited significant positive standard heterosis in desirable direction (Table 4). Abro *et al.*(2014) and Chinchane *et al.* (2018) also obtained similar results. The uniformity index (UI) was low to average and it ranged from 77 (AAH 54) to 81 (AAH 64, AAH 71, AAH 72 and AAH 75). Seventeen hybrids showed significant positive standard heterosis in desirable direction and none of the hybrid showed significant negative standard heterosis for uniformity index (Table 4). Hamed and Said (2021) and Hottigodar*et al.* (2023) also reported similar results for uniformity of fibre lengths in terms of uniformity ratio (UR).

Fibre strength or tenacity was found to be maximum (23.1 g/tex) in the hybrid AAH 64, whereas minimum (18.6 g/tex) in AAH 54 (Table 4). Twenty two hybrids showed significant positive standard heterosis in desirable direction. It was maximum in the hybrid AAH 64 (19.48%) followed by AAH 63 (16.55%) and AAH 67 (15.34%). Similar findings were reported by Shinde *et al.* (2021) and Hottigodar *et al.* (2023). The micronaire value determines whether the fibre is fine or coarse. A low micronaire value is desirable for the fine quality of the fibre and hence heterosis in negative direction is desirable for micronaire. The micronaire value ranged from 5.8 (AAH 74) to 7.1 µg/ inch (AAH 54) and standard heterosis ranged from -14.71 (AAH 74) to 4.4% (AAH 54). Twenty three hybrids showed significant negative standard heterosis in desirable direction (Table 4). Borgaonkar *et al.* (2024) also observed similar results in *G. arboreum*.

CONCLUSION

The current analysis revealed significant amount of standard heterosis for various traits. This implies the potential for cotton improvement through heterosis breeding. In most of the hybrids fibre quality was compromised for seed cotton yield or vice-versa. However, four hybrids *i.e.* AAH 61, AAH 47, AAH 56 and AAH 55; showed significant standard heterosis in desirable direction for both seed cotton yield and fibre quality traits. Four hybrids *viz.*, AAH 59, AAH 54, AAH 66 andAAH 58 showed significant standard heterosis in desirable direction only for seed cotton yield and its attributing traits.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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