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Study on heterosis for fibre quality traits in intra specific crosses of desi cotton (*Gossypium arboreum* L.)

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Abstract
The Line x Tester method of analysis was followed involving eight female lines *viz*., PA 810, PA 785, PA 837, PA 873, PA 904, PA 906, PAIG 384, and PAIG 411 for study of heterosis for various fibre quality characters at three environments *viz*., Parbhani, Nanded & Badnapur. The F_1 and their parents were evaluated in randomized block design with three replications, observations were recorded on Fibre length (mm), Micronaire (µg/inch), Fibre strength (g/tex) and Uniformity ratio (%). The magnitude of heterosis was estimated in relation to better parent and standard checks. Results revealed that the cross combination PAIG 411 x AKA 7 showed the highest and desirable significant standard heterosis for UHML, PA 810 x PA 402 for micronaire value, whereas, PAIG 384 x PA 402 for fibre strength and the cross PA 810 x CNA 1054 for uniformity ratio and also exhibited high percentage of heterobeltiosis and high per se performance.

Keywords: Cotton, line x tester, heterosis, heterobeltiosis, standard heterosis and fibre properties

Introduction

Cotton is well known as the “white gold” and cultivated by about 80 countries in the world. Cotton belongs to the genus Gossypium under tribe Gossypiene of family Malvaceae. It comprises 50 species, four of which are cultivated, 44 are wild diploids and two are wild teraploids. Out of the four cultivated species; *G. hirsutum* and *G. barbadense* commonly called as new world cotton are tetrapoids (2n=4x=52), whereas, *G. arboreum* and *G. herbaceum* are diploids (2n=2x=26) are commonly called as old-world cottons. To overcome biotic and abiotic stresses, intra specific breeding in arboreum was carried out and varieties were released for commercial cultivation in the part of India.

Since India's independence, cotton research has been stepped up with the three main goals of increasing total production, increasing productivity per hectare, and producing enough long and extra-long staple cottons to meet the demands of the country's large textile industry and ever-growing population. The requirement of cotton is rising at a rapid pace than the population growth rate and hence increase in the yield per unit area is the need of the hour. To make the productivity of Indian cotton comparable to other leading countries like USA and China, there is a need to give more importance on the degree of heterosis, the mean performance and potency of genotypes. Heterosis breeding was used as a significant genetic approach to achieve these goals by developing hybrid cottons with great yield potential and high quality. In India, heterosis has been extensively used to increase yield. Geographical and genetic diversity, agronomic performance, adaptability, and parental genetic base are all factors to considered, which play an important role in the manifestation of heterosis in cotton. Utilization of hybrid vigour has become prospective tool for the improvement of this crop.

Materials and Methods

The investigation was undertaken during the winter 2022 in the research farm of Cotton Research Station, Mahboob Baugh Farm, Parbhani. The experimental material for present investigation consisted of fourteen diverse genotypes. These selected fourteen genotypes possess good amount of variation for fibre length, micronaire value, fibre strength & uniformity ratio.

Fourteen parents, among which eight lines *viz*., PA 810, PA 785, PA 837, PA 873, PA 904, PA 906, PAIG 384, and PAIG 411 and six testers *viz*., AKA 7, JLA 794, PA 740, PA 08, PA 402 and CNA 1054 were used for hybridization. Individual female lines were crossed with all the six male parents separately in a line x tester mating design (Kempthorne, 1957) [11] to generate fourty eight crosses during the *Rabi*, 2021. Thus the fourty eight intra-arboreum crosses were developed by hand emasculation and pollination method developed by Doak (1934).

The experiment was conducted under rainfed condition at three locations *viz*., Cotton Research Station, Mahboob Baugh Farm, Parbhani (L_1), Cotton Research Station, Nanded (L_2), and ARS, Badnapur (L_3) during *kharif*, 2022. The sowing of trials was done on 4th July, 9th July and 21st July, 2022 at L_1, L_2 and L_3 locations, respectively. Complete set of entries comprising of 48 F_1's, 8 lines, 6 testers and 3 standard checks (PKV Suvarna, PKV DH 1 & NACH 12) were raised in *rabi*, 2022 in two replications in a Randomized Block Design. Each genotype was raised in spacing of 60 x 30 cm. Recommended agronomic practices and need based plant protection measures were adopted. Five plants from each parents, F_1 s and check hybrids were selected randomly per replication and tagged with labels for recording. The data on four fibre quality properties *viz*., upper half mean length (mm), fibre fineness (µg/in), fibre strength (g tex^{-1}) and uniformity index (%) for each replication were recorded with High Volume Instrument (HVI) under HVI mode. The average values obtained from the observations was denoted as the mean of that genotype per replication. The recorded mean values were subjected to statistical analysis for getting the heterosis. The estimation of heterosis was done by calculating the superiority of the F_1 over standard check (PKV Suvarna, PKV DH 1 & NACH 12).

Results and Discussions

The experimental material for mating design proposed by Kempthorne (1957) [11] comprises of the mf (male x female) progeny families only. However many research workers are tempted to raise parental lines along with mf progeny families in a bid to get a single degree of freedom for the contrast 'parents vs. hybrids'. Significance of mean squares for parents vs. hybrids is taken to indicate presence of heterosis. Environment wise analysis of variance revealed significant genotype effects ($p< 0.01$) for all the characters studied in all the three environments. This indicates that genotypes studied were different for the characters studied over the environments (Table 1). Moreover, when there is significance, it is quite likely that many hybrids do not show heterosis but significance is caused by only a few highly heterotic hybrids; further the tests using F-ratio with one degree of freedom are known to be less efficient than those with large degrees of freedom (Dabholkar 1999) [6]. Hence, in this research the heterosis is mentioned in following pages irrespective of significance of parents vs. crosses for the particular trait. The pooled heterosis over better parent, check hybrid PKV Suvarna, PKV DH 1 and NACH 12 is tabulated in Table 2.

Upper Half Mean Length (mm)

The highest significant heterosis over better parent was expressed in the cross PAIG 411 x AKA 7 (22.77%) followed by PAIG 411 x PA 08 (14.69%) and PA 906 x AKA 7 (13.44%), only fifteen crosses followed significant positive heterobeltiosis. The range of heterobeltiosis was -5.52% (PA 906 x PA 402) to 22.77%. The difference among the environments for heterobeltiosis for this trait was very close as compared to other traits mentioned earlier.

Fourty eight, thirty three and four crosses showed significant standard heterosis over the checks PKV Suvarna, PKV DH 1 and NACH 12, respectively. The cross PAIG 411 x AKA 7 exhibited highest positive significant standard heterosis over check PKV Suvarna (40.08%), PKV DH 1 (19.48%) and NACH 12 (8.65%) followed by PA 873 x PA 402 (39.98%, 19.40% and 8.58%), respectively. The range of standard heterosis over PKV Suvarna, PKV DH 1 and NACH 12 was 17.26% to 40.08%, 0.01% to 19.48% and -9.05% to 8.65%, respectively.

Fiber quality parameters of cotton, fiber length and fineness have a vital influence on the yarn strength. The increasing fiber length results in improved yarn strength because a long fiber generates a greater frictional resistance to an external force. High fiber length and the tensile strength of the fibers becomes the controlling factor of yarn strength. The identification of cultivars or hybrids with high fiber length and strength is essential to current modernized spinning mills indicated that the most interesting crosses were those which exhibit heterosis or heterobeltiosis for seed cotton yield and for some fiber characters. In the present investigation some of the crosses exhibited significant heterosis for yield as well as for one or more fiber quality traits. The heterosis for fibre properties was less influenced by environment for this crosses and parents. Similar findings were also reported by Soomro *et al*., (2016) [18], Ashokkumar *et al*., (2013) [2], Srinivas and Bhadru (2015) [19], Munir *et al.*, (2016) [15] Shinde *et al.*, (2021) [17] and Deshmukh *et al*., (2022) [7].

Micron Aire (µg/ inch)

The lowest heterobeltiosis in desirable direction for fibre fineness was observed in PA 810 x PA 402 (-20.00%) followed by PA 810 x JLA 794 (-19.69%) Total twenty two crosses recorded significant negative heterobeltiosis. The heterobeltiosis pooled over the locations ranged from 7.74% (PA 873 x AKA 7) to – 20.00%.

The highest standard heterosis over PKV Suvarna, PKV DH 1 and NACH 12 was observed in PA 810 x PA 402 (-20.00%, -17.06% and -20.39%) followed by PA 810 x JLA 794 (-19.69%, -16.74% and -20.09%) and PA 810 x AKA 7 (-17.08%, -14.77% and -18.20%), respectively. Whereas, fifteen, eleven and seventeen crosses showed negative significant standard heterosis over PKV Suvarna, PKV DH 1 and NACH 12, respectively. The heterosis ranged from 5.5% to -20.00% over PKV Suvarna, 9.38% to -17.06% over PKV DH 1 and 4.99% to -20.39% over NACH 12.

The genotypes showed miscellaneous response over the environments for this trait. The above mentioned top three performers showed very little deviation from each other across the environments.

The fibre fineness value in particular range is desirable as it is one of the most important quality parameters. In hybrid group, mostly the negative heterosis is desirable. The lower micronaire may be due to inherent reduction in fibre diameter, inadequate cellulose deposition of the fibre wall or a combination of the diameter and wall thickness factors. Above results are in close agreements with Rajamani *et al.*, (2009) [16]. Deshmukh *et al.*, (2014) [6], Lodam *et al.*, (2017) [12], Monicashree *et al.*, (2017b) [13], Chinchane *et al.*, (2019) [4], Shinde *et al.*, (2021) [17] and Deshmukh *et al.*, (2022) [7].

Fibre strength (g/ tex): The cross PAIG 384 x AKA 7 (19.02%) possessed highest significant heterobeltiosis followed by PA 810 x CNA 1054 (17.56%). The observed range of heterobeltiosis was -7.87% (PA 906 x CNA 1054) to 19.02%. Over the environments, nineteen crosses showed significantly positive heterobeltiosis for fibre strength.

Thirty five, fourty five and twenty eight crosses succeeded to show significantly positive standard heterosis over PKV Suvarna, PKV DH 1 and NACH 12, respectively.

The highest standard heterosis over all the checks PKV Suvarna, PKV DH 1 and NACH 12 was observed in cross PAIG 384 x PA 402 (24.21%, 29.21% and 11.61%, respectively) followed by cross PAIG 411 x PA 402 (22.82%, 27.76% and 10.36%, respectively) and cross PAIG 411 x AKA 7 (21.76%, 26.66% and 9.41%, respectively).

In this case for above mentioned crosses and some other crosses the standard heterosis over the checks was higher in low yielding environments, moderate in moderate yielding environment while lower in high yielding environment. Same trend was found for heterobeltiosis in this trait. The range of standard heterosis was -0.96% to 24.21% over PKV Suvarna, -3.03% to 29.21% over PKV DH 1 and -11.01% to 11.61% over NACH 12.

Cotton textile sector demands better yield and high-quality cotton, for this reason improvement of yield and fiber quality is one of the important targets of all cotton breeders. The present study aimed to facilitate the selection in cotton breeding program and development of cotton with high yielding and better fiber quality. In respect of fibre strength, high fibre strength is most desirable trait of fibre quality character. In the present investigation some of the crosses exhibited significant heterosis for yield as well as for one or more fiber strength trait. The heterosis for fibre properties was less influenced by environment for this crosses and parents, similar finding were reported by Karademir *et al.*, (2009) [10], Deshmukh *et al.*, (2014) [6], Munir *et al.*, (2016) [15], Eswari *et al.*, (2016) [9], Sirisha *et al.*, (2019) [20] Udaya *et al.*, (2020) [21].

Uniformity ratio (%): The highest positively significant heterobeltiosis was observed in PA 810 x CNA 1054 (5.64%) for uniformity ratio followed by PAIG 384 x PA 08 (4.52%). The range of heterobeltiosis was -2.98% (PA 906 x PA 740) to 5.64%.

Nine, eleven and five crosses each showed positively significant standard heterosis over PKV Suvarna, PKV DH 1 and NACH 12. The range of standard heterosis over PKV Suvarna was -2.61% (PA 785 x PA 08) to 3.09% (PA 810 x CNA 1054), over PKV DH 1 was -2.12% (PA 785 x PA 08) to 3.61%, while that of over NACH 12, it ranged from -3.26% (PA 785 x PA 08) to 2.41%. The highest standard heterosis was found in PA 810 x CNA 1054 over PKV Suvarna (3.09%), PKV DH 1 (3.61%) and NACH 12 (2.41%) followed by PA 873 x AKA 7 (3.04%, 3.56% and 2.36%) and PA 810 x PA 402 (2.94%, 3.46% and 2.26%).These results confirmed the findings of Baloch *et al.*, (2015), Muhammad *et al.*, (2015) [14], Monicashree *et al.*, (2017b) [13], Chinchane *et al.*, (2018a) [3] and Shinde *et al.*, (2021) [17]

In this case for above mentioned crosses and some other crosses the standard heterosis over the checks was higher in low yielding environments, moderate in moderate yielding environment while lower in high yielding environment. Same trend was found for heterobeltiosis in this trait.

Cotton textile sector demands better yield and high quality cotton, for this reason improvement of yield and fiber quality is one of the important targets of all cotton breeders. The present study aimed to facilitate the selection in cotton breeding program and development of cotton with high yielding and better fiber quality. In respect of fibre strength, high fibre strength is most desirable trait of fibre quality character. In the present investigation some of the crosses exhibited significant heterosis for yield as well as for one or more fiber strength trait. The heterosis for fibre properties was less influenced by environment for this crosses and parents, similar finding were reported by Karademir *et al.*, (2009) [10], Deshmukh *et al.*, (2014) [6], Munir *et al.*, (2016) [15], Eswari *et al.*, (2016) [9], Sirisha *et al.*, (2019) [20], Udaya *et al.*, (2020) [21] and Shinde *et al.*, (2021) [17].

Table 1: ANOVA for various characters studied in three environments

Location	Source of variation	d.f.	Mean sum of squares			
			UHML (mm)	Fibre fineness/micronaire (µg/in)	Fibre strength (g tex^{-1})	Uniformity ratio (%)
Parbhani (L_1)	Replication	1	0.011	0.006	0.964	1.340
	Treatment	64	5.033**	0.231**	5.926**	4.050**
	Error	64	0.834	0.078	0.819	1.382
Nanded (L_2)	Replication	1	3.003	0.006	2.334	0.780
	Treatment	64	5.271**	0.224**	5.361**	3.242**
	Error	64	2.562	0.100	2.673	1.449
Badnapur (L_3)	Replication	1	0.435	0.003	1.414	0.394
	Treatment	64	5.502**	0.214**	5.200**	3.150**
	Error	64	5.695	0.021	1.629	1.466

*,**- Significant at 5 per cent and 1 per cent level, respectively.

Table 2: Per cent heterosis pooled over environments over better parent (BPH), standard hybrid PKV Suvarna (SH 1), PKV DH1 (SH 2) and standard variety NACH 12 (SV 1)

Sr. No.	Crosses	UHML (mm)				Fibre fineness/ micronaire (µg/in)			
		BPH	SH 1	SH2	SV 1	BPH	SH 1	SH2	SV 1
1	PA 810 x AKA 7	6.1	33.59**	13.94**	3.61	-17.8**	-17.80**	-14.77**	-18.2**
2	PA 810 x JLA 794	0.86	26.99**	8.31*	-1.51	-19.69**	-19.69**	-16.74**	-20.09**
3	PA 810 x PA 740	-3.42	22.34**	4.35	-5.11	-4.46	-4.46	-0.95	-4.93*
4	PA 810 x PA 08	-4.26	20.54**	2.81	-6.51*	-0.18	2.14	5.90*	1.64
5	PA 810 x PA 402	10.85**	39.57**	19.05**	8.25**	-20**	-20.00**	-17.06**	-20.39**
6	PA 810 x CNA 1054	10.39**	38.98**	18.55**	7.80*	-12.17**	-12.17**	-8.94**	-12.6**
7	PA 785 x AKA 7	6.39	27.15**	8.46*	-1.38	-14.09**	-9.79**	-6.47*	-10.23**
8	PA 785 x JLA 794	1.77	21.63**	3.75	-5.66	-2.97	1.90	5.64*	1.40
9	PA 785 x PA 740	0.91	27.83**	9.04**	-0.85	-11.07**	-6.61**	-3.17	-7.06**

10	PA 785 x PA 08	1.94	21.84**	3.92	-5.50	-8.97**	-4.40	-0.89	-4.87*
11	PA 785 x PA 402	9.72**	36.16**	16.14**	5.61	-10.08**	-5.57*	-2.09	-6.03*
12	PA 785 x CNA 1054	10.89**	32.54**	13.05**	2.80	-18.11**	-14.01**	-10.84**	-14.42**
13	PA 837 x AKA 7	1.46	27.8**	9.01**	-0.87	0.66	3.24	7.04**	2.74
14	PA 837 x JLA 794	-3.62	21.4**	3.55	-5.84	-1.55	0.98	4.69	0.49
15	PA 837 x PA 740	1.89	29.07**	10.09**	0.11	-2.15	0.37	4.06	-0.12
16	PA 837 x PA 08	4.93	32.18**	12.74**	2.52	-0.24	2.32	6.09*	1.83
17	PA 837 x PA 402	-0.24	25.66**	7.18*	-2.54	-5.37*	-2.94	0.63	-3.41
18	PA 837 x CNA 1054	-0.71	25.07**	6.68*	-2.99	-4.71*	-2.26	1.33	-2.74
19	PA 873 x AKA 7	7.00*	35.45**	15.53**	5.06	7.74**	4.71	8.56**	4.20
20	PA 873 x JLA 794	-1.56	24.61**	6.29	-3.35	-0.25	-2.32	1.27	-2.80
21	PA 873 x PA 740	1.98	29.19**	10.19**	0.20	-2.09	-2.81	0.76	-3.29
22	PA 873 x PA 08	-3.85	21.71**	3.81	-5.60	-2.39	-0.12	3.55	-0.61
23	PA 873 x PA 402	10.59**	39.98**	19.4**	8.58**	-8.79**	-11.19**	-7.93**	-11.63**
24	PA 873 x CNA 1054	-3.31	22.39**	4.39	-5.07	3.27	2.45	6.21*	1.95
25	PA 904 x AKA 7	3.36	28.42**	9.54**	-0.39	-0.59	2.32	6.09*	1.83

Sr. No.	Crosses	UHML (mm)				Fibre fineness/ micronaire (µg/in)			
		BPH	SH 1	SH2	SV 1	BPH	SH 1	SH2	SV 1
26	PA 904 x JLA 794	-1.43	22.47**	4.46	-5.01	-5.41*	-2.63	0.95	-3.10
27	PA 904 x PA 740	1.39	28.43**	9.55**	-0.38	-3.74	-0.92	2.73	-1.40
28	PA 904 x PA 08	6.53*	32.35**	12.89**	2.66	-2.67	0.18	3.87	-0.30
29	PA 904 x PA 402	-5.41	17.52**	0.24	-8.85**	-5.41*	-2.63	0.95	-3.10
30	PA 904 x CNA 1054	-4.77	18.32 **	0.92	-8.23**	1.90	4.89*	8.75**	4.38
31	PA 906 x AKA 7	13.44**	30.70 **	11.48**	1.38	-10.25**	-6.79**	-3.36	-7.24**
32	PA 906 x JLA 794	4.35	23.89 **	5.67	-3.91	-2.89	0.86	4.57	0.37
33	PA 906 x PA 740	-1.94	24.23 **	5.96	-3.65	-8.95**	-5.44*	-1.97	-5.90*
34	PA 906 x PA 08	12.17**	29.30 **	10.29**	0.29	-2.47	1.28	5.01*	0.79
35	PA 906 x PA 402	-5.52	17.26 **	0.01	-9.05**	-6.07**	-2.45	1.14	-2.92
36	PA 906 x CNA 1054	0.86	19.38 **	1.83	-7.40*	-6.18**	-2.57	1.01	-3.04
37	PAIG 384 x AKA 7	4.85	27.69 **	8.92**	-0.96	7.11**	4.10	7.93**	3.59
38	PAIG 384 x JLA 794	10.93**	35.10 **	15.23**	4.78	3.06	0.92	4.63	0.43
39	PAIG 384 x PA 740	3.43	31.03 **	11.76**	1.63	3.45	2.69	6.47*	2.19
40	PAIG 384 x PA 08	5	27.88 **	9.08**	-0.81	3.11	5.50*	9.38**	4.99*
41	PAIG 384 x PA 402	6.92*	32.69 **	13.18**	2.92	-6.09*	-8.56**	-5.2*	-9.01**
42	PAIG 384 x CNA 1054	2.86	25.27 **	6.85*	-2.83	-6.41**	-7.16**	-3.74	-7.61**
43	PAIG 411 x AKA 7	22.77**	40.08 **	19.48**	8.65**	-11.39**	-13.39**	-10.21**	-13.82**
44	PAIG 411 x JLA 794	7.69*	27.85 **	9.05**	-0.84	1.31	-0.80	2.85	-1.28
45	PAIG 411 x PA 740	2.05	29.27 **	10.26**	0.26	1.66	0.92	4.63	0.43
46	PAIG 411 x PA 08	14.69**	32.20 **	12.76**	2.54	1.32	3.67	7.48**	3.16
47	PAIG 411 x PA 402	3.35	28.27 **	9.40**	-0.51	3.38	1.04	4.76	0.55
48	PAIG 411 x CNA 1054	9.51**	29.62 **	10.56**	0.54	-14.18**	-14.86**	-11.73**	-15.28**
	S.E.±	0.98	0.98	0.98	0.98	0.69	0.69	0.69	0.69
	C.D. @ 5%	1.91	1.91	1.91	1.91	1.35	1.35	1.35	1.35

*,**- Significant at 5 per cent and 1 per cent level, respectively.

Table 2: Contd……

Sr. No.	Crosses	Fibre strength (g tex^{-1})				Uniformity ratio (%)			
		BPH	SH 1	SH2	SV 1	BPH	SH 1	SH2	SV 1
1	PA 810 x AKA 7	15.48**	16.4**	21.09**	4.60	0.82	0.32	0.83	-0.34
2	PA 810 x JLA 794	0.69	8.54**	12.91**	-2.47	-1.65	-1.21	-0.71	-1.86*
3	PA 810 x PA 740	-5.10	4.91	9.14**	-5.73*	-1.10	-0.60	-0.10	-1.26
4	PA 810 x PA 08	6.90*	7.75*	12.09**	-3.17	-0.13	-1.79*	-1.29	-2.44**
5	PA 810 x PA 402	9.36**	21.25**	26.13**	8.95**	3.00**	2.94**	3.46**	2.26**
6	PA 810 x CNA 1054	17.56**	19.96**	24.79**	7.80**	5.64**	3.09**	3.61**	2.41**
7	PA 785 x AKA 7	12.53**	14.83**	19.46**	3.19	-1.99*	-2.44**	-1.95*	-3.09**
8	PA 785 x JLA 794	-2.86	4.71	8.93**	-5.91*	-2.39**	-1.95*	-1.45	-2.60**
9	PA 785 x PA 740	-6.32*	3.57	7.74*	-6.93*	0.75	1.26	1.77*	0.59
10	PA 785 x PA 08	6.01	8.17**	12.53**	-2.80	-2.16*	-2.61**	-2.12*	-3.26**
11	PA 785 x PA 402	7.21*	18.87**	23.65**	6.81*	0.14	0.08	0.58	-0.58
12	PA 785 x CNA 1054	4.22	6.35*	10.63**	-4.44	-1.94*	-2.39**	-1.90*	-3.04**
13	PA 837 x AKA 7	1.25	11.86**	16.36**	0.51	-2.22*	-1.72*	-1.22	-2.37**
14	PA 837 x JLA 794	-2.94	7.23*	11.54**	-3.65	2.07*	2.6**	3.12**	1.92*
15	PA 837 x PA 740	-7.10*	2.71	6.84*	-7.71**	-1.78*	-1.28	-0.78	-1.93*
16	PA 837 x PA 08	-3.59	6.51*	10.80**	-4.29	0.64	1.16	1.67	0.49
17	PA 837 x PA 402	0.85	11.81**	16.32**	0.47	-0.46	0.06	0.56	-0.60
18	PA 837 x CNA 1054	3.71	14.58**	19.19**	2.96	2.17*	2.69**	3.21**	2.01*

19	PA 873 x AKA 7	15.65**	16.11**	20.78**	4.33	3.55**	3.04**	3.56**	2.36**
20	PA 873 x JLA 794	3.74	11.83**	16.33**	0.49	0.13	0.58	1.09	-0.08
21	PA 873 x PA 740	1.79	12.53**	17.06**	1.12	0.31	0.83	1.34	0.16
22	PA 873 x PA 08	12.66**	13.1**	17.65**	1.63	1.98*	0.29	0.80	-0.37
23	PA 873 x PA 402	6.71*	18.31**	23.07**	6.31*	1.73*	1.67	2.19*	1.00
24	PA 873 x CNA 1054	8.83**	11.06**	15.53**	-0.21	1.31	-0.75	-0.25	-1.41
25	PA 904 x AKA 7	12.1**	14.63**	19.25**	3.00	2.34**	2.30**	2.82**	1.63

Sr. No.	Crosses	Fibre strength (g tex^{-1})				Uniformity ratio (%)			
		BPH	SH 1	SH2	SV 1	BPH	SH 1	SH2	SV 1
26	PA 904 x JLA 794	-1.18	6.52*	10.81**	-4.28	-0.67	-0.22	0.28	-0.88
27	PA 904 x PA 740	-0.34	10.18**	14.61**	-1.00	-1.95*	-1.45	-0.95	-2.10*
28	PA 904 x PA 08	12.29**	14.83**	19.46**	3.19	-1.72*	-1.75*	-1.26	-2.40**
29	PA 904 x PA 402	-2.84	7.71*	12.05**	-3.21	-1.11	-1.14	-0.65	-1.80*
30	PA 904 x CNA 1054	3.93	6.28*	10.56**	-4.50	0.17	0.13	0.64	-0.53
31	PA 906 x AKA 7	8.91**	17.08**	21.79**	5.20	0.46	1.00	1.51	0.33
32	PA 906 x JLA 794	-3.40	4.13	8.32*	-6.43*	1.52	2.06*	2.58**	1.39
33	PA 906 x PA 740	-4.74	5.32	9.56**	-5.36	-2.98**	-2.46**	-1.97*	-3.10**
34	PA 906 x PA 08	-1.01	6.41*	10.7**	-4.38	-1.94*	-1.41	-0.91	-2.06*
35	PA 906 x PA 402	-6.62*	3.53	7.70*	-6.97*	-1.88*	-1.35	-0.86	-2.01*
36	PA 906 x CNA 1054	-7.87**	-0.96	3.03	-11.01**	-0.51	0.02	0.53	-0.64
37	PAIG 384 x AKA 7	19.02**	18.2**	22.96**	6.21*	-0.54	-1.03	-0.53	-1.68
38	PAIG 384 x JLA 794	-5.34	2.04	6.15	-8.31**	0.09	0.55	1.05	-0.12
39	PAIG 384 x PA 740	-6.44*	3.44	7.60*	-7.05*	-0.66	-0.14	0.36	-0.81
40	PAIG 384 x PA 08	6.85*	6.14	10.42**	-4.62	4.52**	2.85**	3.37**	2.17*
41	PAIG 384 x PA 402	12.04**	24.21**	29.21**	11.61**	0.00	-0.06	0.44	-0.72
42	PAIG 384 x CNA 1054	-0.37	1.66	5.76	-8.65**	0.83	-0.77	-0.27	-1.43
43	PAIG 411 x AKA 7	13.01**	21.76**	26.66**	9.41**	1.82*	1.32	1.83*	0.65
44	PAIG 411 x JLA 794	0.33	8.15**	12.5**	-2.82	-1.93*	-1.49	-0.99	-2.14*
45	PAIG 411 x PA 740	-1.07	9.38**	13.78**	-1.71	-0.68	-0.17	0.34	-0.83
46	PAIG 411 x PA 08	7.62**	15.96**	20.63**	4.20	3.63**	1.91*	2.43**	1.24
47	PAIG 411 x PA 402	10.78**	22.82**	27.76**	10.36**	-0.06	-0.12	0.38	-0.78
48	PAIG 411 x CNA 1054	3.10	11.08**	15.56**	-0.18	3.23**	0.72	1.23	0.06
	S.E.±	0.89	0.89	0.89	0.89	0.83	0.83	0.83	0.83
	C.D. @ 5%	1.74	1.74	1.74	1.74	1.62	1.62	1.62	1.62

*,**- Significant at 5 per cent and 1 per cent level, respectively.

Conclusion

Cross combinations *viz*, PA 810 x PA 402 and PAIG 411 x AKA 7 should be exploited for fibre quality improvement.

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