RESEARCH ARTICLE

HETEROSIS FOR FIBRE QUALITY TRAITS IN UPLAND COTTON (*GOSSYPIUM HIRSUTUM* L.)

Shiva Kumar K.[1]*, J.M. Nidagundi[1] and A.C. Hosamani[2]

[1]Department of Genetics and Plant Breeding
[2] Department of Agricultural Entomology
University of Agricultural sciences, Raichur -584104
Email: kumar.shiva602@gmail.com

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Abstract: The present investigation was carried out with half diallel analysis involving 10 parents and their 45 F_1 hybrids to estimate the heterosis for fibre quality traits. The hybrid Pusa 9127 x BS 277 recorded highest heterobeltiosis (8.23) for 2.5% span length and hybrid BS 2170 x TCH 1728 exhibited positive significant relative heterosis (9.09%) for uniformity ratio. hybrid GSHV 99/ 307 x TSH 0250 (32.26%) showed significant positive heterobeltiosis for miconaire while hybrid CCH 510 x BS 2170 (18.25%) for strength to length ratio appears to be most superior hybrids.

Keywords: Heterobeltiosis, Relative heterosis, Miconaire, 2.5% span length, Half Diallel analysis

INTRODUCTION

India is second most leading country in production and utilization of cotton after the china at global level. By introduction of transgenic Bt (*Bacillus thuringiensis*) cotton with good management practices resulted in bumper harvest with minimum pesticide usage. However in the recent years demand for cotton fibers in markets dramatically increased (Zeng and Wu., 2012). Fiber quality is a complicated quantitative trait consists of several other traits such as fiber length, uniformity ratio, fiber strength, fiber elongation, micronaire *etc*., each were under control of many genes with variable effects (Song *et al*., 2014). Thus, improvement of cultivar with desirable fiber quality trait is most sustainable approach to meet the demands of textile industry and maintain profitability of cotton growers.

Heterosis breeding is most extensively used method for genetic improvement of both quantitative and qualitative traits and significantly contributed for development of large number of varieties, hybrids with desirable fiber quality traits. Previous studies of Ahuja (2003) suggested that to meet the requirement of present modern spinning mills there is urgent need for development of high fibre length and strength cultivars. By considering the importance of the use of heterosis for quality traits and its impact on future cotton production, present study is carried out with an objective of estimating manifestation of heterosis for fibre quality in F_1 hybrids in a 10x 10 half diallel mating design.

MATERIAL AND METHOD

Parental genotypes: Ten genetically distant upland cotton genotypes were selected from All India Coordinated Cotton Improvement Project (AICCIP) whose performance was found to be consistency in productivity and fiber quality traits. Forty-five F_1 hybrids were obtained by crossing the parental genotypes in half diallel mating design.

Field experiment

The F_1 seeds were hand dibbled to ensure uniform maintains of population size in a row having 20 plants spaced at 60 cm within plants and 90 cm between the rows in a randomized complete block design (RCBD) with two replications. All recommended cultural practices were carried out to establish good crop and maintained uniform agronomic practices to discourage environmental variability to the maximum possible extent. Observations were note done on the middle five competitive plants, Seed cotton sample of about 300g was collected from each treatment in each replication and these were ginned to 100g lint weight. Fiber quality properties *viz*, 2.5% Span length (mm), Fibre strength (g tex $^{-1}$), Fibre elongation (%), uniformity ratio, Fibre strength to length ratio were measured by using High Volume Instrument (HVI) at Central Institute for Research on Cotton Technology (CIRCOT), Main Station at Mumbai (India); data analysis carried out by using WINDOSTAT 8.0 software to estimate the magnititude of Heterosis and expressed as percentage increase (+) or decrease (-) respectively.

*Corresponding Author

RESULT AND DISCUSSION

Table 1. ANOVA for different fibre quality traits in 10 x 10 half diallel set of cross at ARS Siruguppa during *kharif* 2012-13

Source of variation	df	2.5% span length (mm)	Uniformity ratio (%)	Micronaire (µg/inch)	Fibre strength (g/tex)	Elongation (%)	Streng th to length ratio
		1	2	3	4	5	6
Replicates	1	0.25	28.50**	0.72**	6.19	1.12	102.15
Treatments	54	3.24*	2.97	0.20**	2.38	0.27	34.73
Parents	9	3.84*	3.76	0.21*	5.072**	0.18	50.76
Hybrids	44	3.19*	2.73	0.20**	1.88	0.30	32.16
Parent Vs Hybrids	1	0.06	6.34	0.07	0.25	0.10	3.91
Error	54	1.85	2.71	0.08	1.81	0.34	25.70
Total	109	2.53	3.07	0.14	2.14	0.31	30.88

The analysis of variance indicated (Table 3) significant differences between the treatments for 2.5% span length, Micronaire value suggesting the presence of wide variability for the traits. Parents were showed significant differences for 2.5% span length, Micronaire and Fibre strength while, crosses for 2.5% span length and Micronaire value respectively.

Mean sum of squares due to parents were greater than hybrids for 2.5% span length, uniformity ratio, Micronaire and Fibre strength whereas, it was *Vice versa* for other traits. The mean sum of Squares due to Parent Vs Hybrids was non-significant for all the traits under study

Table 2. Ranges for mean performance of parents in fibre quality traits

SI No.	Traits	Minimum value	Maximum value	Mean	Lowest parents	Highest
1	2.5% span length	26.12	30.65	28.40	H 1462	TSH 0250
2	uniformity ratio	48.50	54.00	51.45	GSHV 99/ 307	Surabhi
3	micronaire	3.10	4.10	3.47	GSHV 99/ 307	BS 2170
4	fibre stregth	19.45	24.50	21.73	H 1462	TCH 1728
5	elongation %	5.00	6.10	5.68	GSHV 99/ 307	BS 2170
6	S/L ratio	0.65	0.87	0.77	GSHV 99/ 307	BS 2170

Table 3. Ranges for mean performance of hybrids in fibre quality traits

SI No.	Traits	Minimum value	Maximum value	Mean	Hybrids lowest	Highest
1	2.5% span length	25.8	31.59	29.11	CCH 510 x TSH 0250	BS 277 x TCH 1728
2	uniformity ratio	48.5	54.5	52.20	BS 277 x TCH 1728	Pusa 9127 x Surabhi
3	Micronaire	3.2	4.4	3.79	TSH 0250 x TCH 1728	GSHV 99/ 307 x Surabhi
4	fibre strength	20.05	23.85	21.77	Surabhi x CCH 510	ARB 904 x H 1462
5	elongation %	4.3	6.1	5.48	Pusa 9127 x Surabhi	ARB 904 x BS 2170
6	S/L ratio	0.69	0.88	0.74	Surabhi x TCH 1728	H 1462 x TCH 1728

Table 4. Heterosis for 2.5% span length, uniformity ratio and micronaire in 10 x 10 half diallel set of crosses

Crosses	2.5% span length		Uniformity ratio (%)		Micronaire	
	Hmp	Hbp	Hmp	Hbp	Hmp	Hbp
GSHV 99/ 307 x Pusa 9127	0.78	-4.13	-0.47	0.95	-4.4	12.86
GSHV 99/ 307 x ARB 904	-3.99	-4.09	-1.9	0.96	9.33	16.92*
GSHV 99/ 307 x Surabhi	2.84	-6.77	0	-4.63	11.54	26.15

GSHV 99/ 307 x CCH 510	-4.67	-1.49	-1.44	1.9	5.41	22.54**
GSHV 99/ 307 x BS 277	2.03	-5.61	-0.95	1.98	-1.28	8.33
GSHV 99/ 307 x BS 2170	-6.32	-4.79	0.49	1.96	17.73 *	-6.1
GSHV 99/ 307 x H 1462	-1.74	-8.25	-1.44	-2.86	9.33	5.06
GSHV 99/ 307 x TSH 0250	5.71	-7.67*	-3.32	1.94	0	32.26**
GSHV 99/ 307 x TCH 1728	-0.34	-3.8	1.45	0.99	3.5	23.44**
Pusa 9127 x ARB 904	-1.54	0.34	-0.48	1.9	1.99	5.71
Pusa 9127 x Surabhi	5.03	-1.55	6.34 *	-2.78	-12.1	14.29
Pusa 9127 x CCH 510	2.1	-1.03	0.96	-0.95	10.07	8.45
Pusa 9127 x BS 277	0	8.23*	-1.44	3.81	4.46	-4.17
Pusa 9127 x BS 2170	-3.74	4.56	2.97	1.9	14.08 *	24.39**
Pusa 9127 x H 1462	10.06 *	-3.44	0	-1.9	-5.96	4.05
Pusa 9127 x TSH 0250	9.69 *	-7.5	-0.95	-0.95	-18.24 **	16.29*
Pusa 9127 x TCH 1728	1.46	6.79	0	-0.95	1.39	1.43
ARB 904 x Surabhi	-1.02	7.14*	2.94	-3.7	-12.16	30.77**
ARB 904 x CCH 510	-7.82 *	3.15	4.35	-0.96	1.43	2.82
ARB 904 x BS 277	1.22	6.43	0.96	1.92	5.41	-1.39
ARB 904 x BS 2170	1	3.93	3.48	0.96	0.75	-20.73**
ARB 904 x H 1462	-0.77	7.22*	-0.48	2.86	-7.04	-10.13
ARB 904 x TSH 0250	-7.69	-5.38	4.31	0.96	-8	20.00**
ARB 904 x TCH 1728	-0.59	3.06	0.49	0.96	15.56 *	3.08
Surabhi x CCH 510	-6.92	1.4	2.46	-0.81	0	-4.63
Surabhi x BS 277	7.08	-7.69	1.96	0.93	-9.09	-4.17
Surabhi x BS 2170	-3.37	7.01	6.60 *	-4.63	5.04	-4.88
Surabhi x H 1462	7.38	5.38	0.49	-7.41	-2.7	-2.53
Surabhi x TSH 0250	7.99	-8.97*	2.44	-3.7	0	12.31*
Surabhi x TCH 1728	0.43	0.03	0.5	2.72	14.89 *	7.69
CCH 510 x BS 277	-1.8	0.35	0.48	1.94	9.59	1.39
CCH 510 x BS 2170	-6.45	8.23*	8.00 **	-0.97	3.82	-12.20*
CCH 510 x H 1462	-0.84	4.2	-1.94	1.9	7.14	-1.27
CCH 510 x TSH 0250	10.78 *	-4.21	-6.73 *	-1.94	-12.16	14.08*
CCH 510 x TCH 1728	-10.43 **	5.09	3.92	3.88	27.82 **	-2.82
BS 277 x BS 2170	6.4	2.61	3.48	1.96	5.04	-2.44
BS 277 x H 1462	-5.08	2.52	5.31	2.86	5.41	-13.92
BS 277 x TSH 0250	11.01 *	-3.69	-0.48	-1.94	-10.26	19.05*
BS 277 x TCH 1728	2.9	7.27	-0.49	-3.96	-0.71	-9.72
BS 2170 x H 1462	-1.27	2.46	5	0.95	5.26	3.66
BS 2170 x TSH 0250	-0.71	-10.34*	2.97	0.97	-7.8	-6.1
BS 2170 x TCH 1728	-7.95 *	4.41	9.09 **	1.96	3.17	-10.98
H 1462 x TSH 0250	2.29	-2.94	-2.88	-0.95	-4	-11.39
H 1462 x TCH 1728	-8.97 *	1.02	0	-0.95	21.48 **	-11.39
TSH 0250 x TCH 1728	10.35 *	-4.4	0	-0.97	-11.89	9.37
Mean	0.32	0.32	1.25	-0.04	2.06	4.57
SEd	1.18	1.36	1.43	1.65	0.24	0.28

Hmp = Heterosis over mid-parent, Hbp = Heterosis over better parent * & ** Significant at 5% & 1% respectively

Table 5. *Per se* performance and heterosis for fibre strength, elongation and strength to length ratio in 10 x 10 half diallel set of crosses

	Fibre strength (g/tex)		**Elongation (%)**		**Strength to Length ratio**	
Crosses	**Hmp**	**Hbp**	**Hmp**	**Hbp**	**Hmp**	**Hbp**
GSHV 99/ 307 x Pusa 9127	-2.6	7.62	-1.82	1.87	-3.58	7.39

GSHV 99/ 307 x ARB 904	-8.53	1.89	-4.98	-7.69	-4.23	-2.07
GSHV 99/ 307 x Surabhi	-0.9	-1.43	0.45	-1.87	-3.92	-4
GSHV 99/ 307 x CCH 510	-3.56	-6.4	0.46	-8.26	0.67	-10.7
GSHV 99/ 307 x BS 277	-1.84	-0.23	2.3	1.85	-3.58	-2.62
GSHV 99/ 307 x BS 2170	-1.18	-7.19	4.31	-9.02	4.9	-15.18**
GSHV 99/ 307 x H 1462	-7.49	7.2	-6.09	-3.54	-5.63	0.7
GSHV 99/ 307 x TSH 0250	-1.31	-5.54	-3.6	-10	-6.89	2.02
GSHV 99/ 307 x TCH 1728	-5.73	-15.31**	1.31	-10.83	-5.59	-14.45**
Pusa 9127 x ARB 904	3.62	4.96	-1.35	-0.85	5.3	0.58
Pusa 9127 x Surabhi	-2.65	3.1	-22.87 *	3.74	-6.98	-0.38
Pusa 9127 x CCH 510	2.62	-2.35	0.45	-9.09	1.02	-3
Pusa 9127 x BS 277	-2	-2.76	0.46	-20.37	-1.99	-10.31
Pusa 9127 x BS 2170	6.91	-1.74	4.27	-9.02	11.03	-14.79**
Pusa 9127 x H 1462	5.54	-0.95	-1.72	-2.65	-4.13	-0.16
Pusa 9127 x TSH 0250	3.65	-2.22	-4.46	-8.33	-5.33	5.58
Pusa 9127 x TCH 1728	-2.49	-2.86	-17.75 *	-5	-3.47	-9.05
ARB 904 x Surabhi	5.99	1.67	2.68	-8.55	6.98	-6.7
ARB 904 x CCH 510	-4.57	-4.05	-6.31	-21.49*	3.73	-6.77
ARB 904 x BS 277	-7.5	3.92	-4.55	-4.27	-7.95	-2.68
ARB 904 x BS 2170	6.29	2.18	14.15	-5.74	5.34	-7.54
ARB 904 x H 1462	3.7	1.18	1.29	-75.41**	4.76	0.9
ARB 904 x TSH 0250	1.9	-11.09	-3.11	-12.5	10	-8.73
ARB 904 x TCH 1728	-8.82	-8.57	-2.59	0.83	-8.52	-11.25*
Surabhi x CCH 510	-8.64	1.71	-8.11	-2.48	-2.04	0.49
Surabhi x BS 277	-0.47	-1.38	7.27	0.93	-6.98	0
Surabhi x BS 2170	0.24	-6.54	0	-7.38	3.57	-16.4
Surabhi x H 1462	3.65	3.58	-3	-0.88	-3.82	-1.46
Surabhi x TSH 0250	6.68	-10.86*	4.89	-15	-1.67	-5.32
Surabhi x TCH 1728	-12.99*	-13.67*	-3.45	-1.67	-13.29*	-16.00**
CCH 510 x BS 277	-0.46	-11.73*	4.59	-12.4	1.69	-12.14
CCH 510 x BS 2170	10.74	-0.21	-17.14	-7.38	18.25**	-13.11
CCH 510 x H 1462	-8.42	-6.4	-2.16	-2.48	-7.14	-10.46
CCH 510 x TSH 0250	7.78	-14.29*	-1.35	-7.44	-3.07	-16.28**
CCH 510 x TCH 1728	-10.68*	-8.98	-13.04	-9.09	-0.65	-13.39*
BS 277 x BS 2170	7.43	-6.54	12.5	-6.56	0.36	-14.21*
BS 277 x H 1462	0.79	6.91	6.55	-23.01	6.67	4.09
BS 277 x TSH 0250	12.05*	-7.1	2.26	-5.83	1.33	-8.62
BS 277 x TCH 1728	-4.19	-8.16	0	-8.33	-6.62	-14.39**
BS 2170 x H 1462	-2.44	-8.93	-3.17	-18.03	-1.36	-11.37**
BS 2170 x TSH 0250	8.32	-9.37	9.86	-11.48	8.24	-13.12*
BS 2170 x TCH 1728	-4.99	-11.43*	-2.73	-4.1	2.7	-19.03**
H 1462 x TSH 0250	1.17	0	-7.69	-5.83	-0.96	1.9
H 1462 x TCH 1728	-4.28	-7.96	1.24	-5.83	6.06	-8.76
TSH 0250 x TCH 1728	2.62	-11.43*	3	-5	-6.03	-10.95
Mean	-0.38	-3.82	-1.31	-8.57	-0.51	-6.93
SEd	1.17	1.35	0.5	0.58	4.39	5.07

Hmp = Heterosis over mid-parent, Hbp = Heterosis over better parent. * & ** Significant at 5% & 1% respectively

Mean performance

Mean performance of any genotype is estimated based on its performance under field conditions. Mean performance of parents and F_1 hybrids were represented in Table 2 and Table 3 respectively. mean performance of parents for 2.5% span length is varied from 26.12 mm to 30.65 mm and its expression is affected by environmental factors (Geddam *et al.*, 2011; Usha rani *et al.*, 2015) while, Cross shows variation from 25.8 mm to 31.59 mm. Among forty five hybrids twenty six hybrids were recorded significantly higher mean value than grand mean value.

The range of mean value varied from 48.5% (CCH 510 x TSH 0250) to 54.5% (Pusa 9127 x Surabhi)) for uniformity ratio between the hybrids. Twenty five

out of forty five hybrids exhibited significantly higher means value than grand mean value. Highest values (54.5%) were observed for four cross combinations (Pusa 9127 x Surabhi, BS 277 x H 1462, ARB 904 x TSH 0250, BS 277 x H 1462). These findings were in accordance with the previous reports of Sekhar *et al*., (2012) in male sterile diploid cotton hybrids.

For micronaire mean value of parent's ranges from 3.1 to 4.1µg/inch while, in hybrids it represents from 3.2µg/inch (TSH 0250 x TCH 1728) to 4.4µg/inch (GSHV 99/ 307 x Surabhi). 29/45 hybrids manifested significantly higher mean values than the grand mean values (Ashokkumar *et al*., 2013) and greater difference among the cultivars were extensively observed by Bolek *et al*., (2010) for the trait. Among the hybrids mean value of variation represents from 20.1g/tex (Surabhi x CCH 510) to 23.9g/tex (ARB 904 x H 1462) while in parents from 19.45 g/tex to 23.85 g/tex for fiber strength (Karademir *et al*., 2011).

Mean performance of parents were slightly higher than the hybrids and it ranges in hybrids from 4.3% (Pusa 9127 x Surabhi) to (ARB 904 x BS 2170) 6.1%. Twenty seven out of forty five hybrids were manifested significantly higher mean values than the grand mean value. Between cross combinations mean range of variation arises from 0.69 (Surabhi x TCH 1728) to (H 1462 x TCH 1728) 0.88 for Strength to Length ratio while, parents represents from 0.65 to 0.87 respectively. 24 out of 45 hybrids were recorded higher mean value the grand mean value.

Estimation of Heterosis

Heterosis refers to superiority of progeny in performance over their parents either in positive or negative direction. Calculated Heterosis values were presented in Table 4 and Table 5 respectively. Three hybrids viz., BS 277 x TSH 0250 (11.01), CCH 510 x TSH 0250 (10.78), TSH 0250 x TCH 1728 (10.35) were manifested significant positive heterosis over mid-parent and four (Pusa 9127 x BS 277, CCH 510 x BS 2170, ARB 904 x H 1462, ARB 904 x Surabhi) over better parent respectively for 2.5% span length. These findings were in accordance with previous studies of Patel *et al*., (2014). For uniformity ratio four hybrids expressed significant positive heterosis over mid parent and one in negative direction (Jyotiba *et al*., 2010). However, none of the hybrid was manifested significant positive heterosis over better parent. Six out of 45 hybrids recorded significant mid parent Heterosis in positive direction and one in negative direction for micornaire value. The magnitude of percent heterosis over better parent was found to be the highest for the cross GSHV 99/ 307 x TSH 0250 (32.26%). One hybrid (BS 277 x TSH 0250) exhibited significant positive heterosis over mid parent (Abro *et al*., 2014) while other two in negative direction *viz*., Surabhi x TCH 1728 (-12.99) and CCH 510 x TCH 1728 (-10.68) for fibre strength.

For Elongation percent none of the hybrids manifest themselves over better parent in positive but seven hybrids expressed in negative direction. Heterosis over the mid parent among the hybrids ranged from -22.87 (PUSA 9127 x Surabhi) to 14.15 (ARB 904 x BS 2170) per cent. None of the hybrids expressed significant mid parent in positive direction. Two out of 45 hybrids [PUSA 9127 x Surabhi (-22.87) and PUSA 9127 x TCH 1728 (-17.75)] showed significant mid parent heterosis in negative direction.

Heterosis over mid parent among the hybrids ranged from -13.29 (Surabhi x TCH 1728) to 18.25 (CCH 510 x BS 2170) percent. While one of the cross (CCH 510 x BS 2170) expressed significant mid-parent heterosis in positive direction, the cross Surabhi x TCH 1728 showed significant heterosis in negative direction. However, none of the hybrid manifests significant positive heterosis over better parent for strength to length ratio. Thus the present study concludes that even though much Heterosis is not manifest in large number of hybrids, mean performance can be used as one of the criteria for selection of hybrids and provides a future way for crossing negative x negative hybrids or intermitting may probably expected to produce desirable combination.

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