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Heterobeltiosis for yield, its component traits and fibre properties in upland cotton (*Gossypium hirsutum* L.)

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ABSTRACT : In the present investigation, 24 parents and their 80 F_1 hybrids obtained by crossing 4 lines and 20 testers in line × tester mating system were grown at the Experimental Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University during 2011 to estimate heterobeltiosis. The analysis of variance indicated that the mean squares of parents and hybrids were significant for sympods/plant, bolls/plant, plant height, boll weight, seed cotton yield, 2.5 per cent span length, fibre strength and micronaire value indicating the presence of variability among the parents and their hybrids. Result indicated that the crosses having significant heterosis over better parent were, PIL 138 × IL 92 and PIL 138 × EC676023 for sympods/plant, bolls/plant and boll weight, and LH900 × RC 79 for plant height. For seed cotton yield the hybrid PIL 138 × PIL 136 exhibited highest heterosis over better parent and was also heterotic for yield contributing characters such as boll weight and sympods/plant. For fibre properties, the crosses, RS 875 × PIL 135 and LH 900 × PIL 8 were highly heterotic over better for 2.5 per cent span length and fibre fineness. While, maximum heterobeltiosis for fibre strength was exhibited by cross combination RS 875 × PIL 8H.

Key words: Cotton, heterobeltiosis, line × tester analysis

Cotton designated as "White Gold" is an important economic crop worldwide, which provides the most important natural fibre for the textile industry (Yu *et al.,* 2013). There are four cultivated cotton species including two diploids (*Gossypium herbaceum* L. and *G. arboreum* L.) and two tetraploids (*Gossypium hirsutum* L. and *Gossypium barbadense* L.). Approximately 95 per cent of the world cotton production is from *G. hirsutum* L. Although seed cotton yield is the main focus of cotton growers but improvement of cotton fibre quality has been extremely important because of changes in spinning technology. Industrial demand of cotton with superior fibre traits is also source of guide line for cotton breeders (Ashokkumar and Ravikesavan, 2013). All the recommended varieties/hybrids for Punjab state belong to medium fibre quality and no major progress has been made in this regards. Heterosis breeding is a tool in hands of plant breeders in which an adapted parent having high yield potential can be crossed with diverse germplasm lines having better quality to combine seed cotton yield and fibre quality in F_1 hybrids. Heterosis has substantially remained as one of the significant developments in cotton breeding programs. Several studies have been reported on yield and yield attributing traits, but little work has been reported on the genetics and heterosis of fibre quality traits in cotton breeding. Studies (Karademir *et al.,* 2011) have determined that cotton genotypes differ in fibre quality traits.

The value of heterosis for fibre properties were usually lower than for yield and its components. Significant heterosis for various fibre properties was detected by Bolek *et al.,* 2010. Keeping this in view exotic germplasm along with local genotypes were used to estimate heterosis and heterobeltiosis in F_1 crosses of *Gossypium hirsutum* L.

MATERIALS AND METHODS

The study was conducted at the experimental farm of Department of Plant Breeding and Genetics, Punjab Agricultural

University. Four female parents *viz.,* PIL 138, PIL 139, LH 900 and RS 875 were crossed with 20 testers including 12 local genotypes *viz.,* PIL 138, PIL 139, PIL 137, RC85, RC 8, PIL 8, PIL 8H, CIM240, RC 240, F 1040, IL 92, RC 79 and eight exotic accessions *viz.,* EC676023, EC676021, EC676015, EC676017, EC676018, EC676022, EC676014, EC676026 in line × tester pattern during *kharif* 2010. Eighty F_1 hybrids along with twenty four parents were field evaluated in randomised block design with three replications during 2011. The experiment was conducted with 67.5 cm row to row and 60 cm plant to plant distance. All the agronomical practices were maintained according the recommendations. The field observations on 5 plants from each genotype and replication were recorded for sympods/plant, bolls/plant, plant height (cm), boll weight (g), yield per plant (g) and fibre quality traits i.e. 2.5 per cent span length (mm), fibre strength (g/tex), fibre fineness (µg/inch). The mean values of the characters measured in 104 genotypes (crosses and parents) were statistically analysed for estimation of heterobeltiosis as suggested by Fehr (1987), which is per cent increase or decrease of hybrid over its better parent.

RESULTS AND DISCUSSION

The analysis of variance of parents and their hybrids for the traits under study indicated highly significant differences for lines, testers and hybrids for all the characters except for plant height in case of lines and hybrids.

In parents, highest number of sympods/plant and lowest number of sympods/plant were produced by female parents RS875 (15.00) and PIL 139 (7.00), respectively. Values for sympodial branches in testers ranged from 4.67 (RC85) to 21.00 (EC676014). In hybrids, the lowest value of 10.22 (RS 875 × EC676026) and the greatest value of 20.33 (PIL 138 × F 1040) were recorded. The highest heterotic effect for sympodial branches was recorded in cross PIL 139 × RC85 and PIL 138 × F 1040 which surpassed its better parent by 183.12 per cent and 154.17 per cent, respectively (Table 1). Heterosis values were significantly positive over better parent in 41 cross combinations out of total 80 hybrids. This is similar with earlier finding of Ashokkumar and Ravikesavan (2013).

The seed parent, LH900 (35.67) and pollen parent RC8 (41.00) possessed the highest bolls/plant, while the remaining lines as well as tester displayed lesser bolls/plant. The hybrid PIL 138 × IL 92 (38.19%) with highest significant positive heterobeltiosis proved to be promising and the best for bolls/plant. This cross combination manifested maximum *per se* performance (38.23) whereas the least by PIL 139 × EC676021 (2.44). Other three crosses *viz.,* PIL 138 × EC676023 (10.84%), PIL 138 × F 1040 (6.39%), PIL 139 × EC676026 (2.41%) exhibited next higher bolls/plant with respect to better parent heterosis. Therefore, bolls/plant being the most important and direct yield contributing trait can be exploited from the above cross combinations (Abro *et al.,* 2014).

For plant height results revealed that RS875 (110 cm) as seed parents and CIM240 as pollen parent proved to be the tallest. Results on heterosis showed that the heterobeltiosis for plant height ranged from 85 per cent in cross, PIL 139 × EC676015 in positive direction to hybrid, LH 900 × RC 79 (-25.15%) in significant negative direction. Out of 80 hybrids, significant positive better parent heterosis for plant height was observed in 39 hybrids. A varying degree of difference was seen for plant height (Abro *et al.*, 2014). The hybrid PIL 139 × EC676015 being the top ranker with a value of 85.00 per cent. Whereas the highest significant negative values was shown by LH 900 × RC 79 (-25.15%).

For boll weight the lowest values among the parents was in EC676023 (2.97 g) and highest in F 1040 (4.60 g), however, in hybrids these values varied from 3.45 g in LH 900 × EC676015

Table 1. Mean performance and expression of heterosis in selected hybrids for yield, its components and fibre quality traits

Sr. No.	Trait	Total	Better parent heterosis (%): Hybrid with significant + heterosis: Hybrids	per cent heterosis	Mean	Total	Hybrids with significant - heterosis: Hybrids	per cent heterosis	Mean
1	Sympods/plant	**41**	PIL 139 × RC85	183.12**	15.10	**34**	RS 875 × EC676026	-40.96**	**10.22**
			PIL 138 × F 1040	154.17**	20.33		RS 875 × EC676022	-38.33**	**11.11**
			PIL 139 × IL 92	143.68**	15.44		LH 900 × EC676014	-38.10**	**13.00**
			PIL 138 × IL 92	124.76**	15.74		LH 900 × EC676022	-36.48**	**11.44**
			PIL 138 × RC 79	123.81**	15.64		PIL 139 × EC676014	-34.92**	**13.67**
			PIL 139 × PIL 135	84.07**	16.56		PIL 138 × EC676014	-30.00**	**14.72**
2	Bolls/plant	**4**	PIL 138 × IL 92	38.19**	38.22	**75**	PIL 139 × EC676021	-91.20**	**2.44**
			PIL 138 × EC676023	10.84**	30.66		LH 900 × EC676017	-84.11**	**5.67**
			PIL 138 ×F 1040	6.39**	29.44		RS 875 × EC676017	-80.00**	**6.00**
			PIL 139× EC676026	2.41**	28.34		LH 900 × EC676022	-74.49**	**9.12**
							PIL 139 × EC676014	-74.34**	**7.09**
							LH 900 × EC676014	-73.55**	**9.44**
3	Plant height (cm)	**39**	PIL 139 × EC676015	85.00**	111.0	**1**	LH 900 × RC 79	-25.15**	**76.11**
			PIL 138 × PIL 135	69.77**	121.67				
			PIL 138 × F 1040	63.83**	161.11				
			PIL 139 × PIL 137	62.35**	124.45				
			PIL 139 × PIL 135	58.93**	113.89				
			PIL 138 × EC676015	56.50**	93.89				
4	Boll weight (g)	**63**	PIL 138 × EC676018	37.78**	4.87	**16**	RS 875 × RC 240	-10.48**	**3.70**
			PIL 138 × PIL 135	37.26**	4.76		RS 875 × EC676021	-8.43**	**3.79**
			PIL 139 × PIL 137	37.11**	4.66		LH 900 × RC 8	-7.44**	**3.86**
			PIL 138× EC676023	36.11**	4.27		RS 875 × PIL 135	-7.06**	**3.84**
			PIL 139 × EC676018	34.20**	4.74		LH 900 ×PIL 8	-6.35**	**4.18**
			PIL 139 × PIL 135	34.09**	28.01		RS 875 × EC676022	-5.99**	**3.89**
5	Seed cotton yield/plant (g)	**7**	PIL 138 × PIL 136	108.15**	117.95	**43**	LH 900 × EC676015	-79.97**	**19.23**
			PIL 138 × PIL 137	85.93**	105.36		RS 875 × EC676023	-78.32**	**54.83**
			PIL 138 × EC676023	66.7**	94.47		LH 900 × EC676021	-77.39**	**21.71**
			PIL 138 × PIL 135	62.78**	92.24		RS 875 × EC676014	-75.33**	**24.10**
			RS 875 × RC85	56.83**	153.17		LH 900 × RC 79	-73.79**	**27.52**
			PIL 138 × EC676015	42.87**	80.96		LH 900 × EC676017	-73.78**	**25.17**
6	2.5 per cent span length (mm)	**19**	PIL 139 × PIL 8	6.10**	27.69	**48**	PIL 138 × EC676017	-14.20**	**23.65**
			PIL 138 × EC676026	5.00**	28.28		RS 875 × EC676018	-13.81**	**24.19**
			RS 875 × EC676026	4.81**	28.23		PIL 139 × EC676022	-12.78**	**25.66**
			PIL 138 × PIL 8	4.60**	27.30		PIL 139 × PIL 136	-12.68**	**24.74**
			LH 900 × PIL 8	4.50**	27.27		PIL 139 × IL 92	-10.75**	**24.66**
			RS 875 × PIL 135	3.09**	27.56		LH 900 × RC 8	-10.69**	**24.50**
7	Fibre strength (g/tex)	**24**	RS 875 × PIL 8H	21.23**	24.37	**54**	LH 900 × EC676026	-41.92**	**16.90**
			LH 900 × RC 79	16.83**	23.83		LH 900 × RC 8	-33.71**	**19.60**
			PIL 138 × F 1040	16.07**	24.80		RS 875 × RC 8	-30.44**	**20.57**
			PIL 139 × RC 240	15.80**	25.17		PIL 139 × RC 8	-28.07**	**21.27**
			PIL 139 × F 1040	14.04**	24.37		PIL 138 × PIL 8	-25.47**	**21.17**
			PIL 139 × IL 92	13.62**	24.20		PIL 138 × RC 8	-24.80**	**22.23**
8	Fibre fineness (µg/inch)	**63**	PIL 139 × EC676018	61.25**	4.73	**17**	RS 875 × EC676015	-13.47**	**4.15**
			PIL 139 × EC676023	55.57**	4.56		RS 875 × CIM240	-10.14**	**4.22**
			PIL 138 × EC676023	54.81**	5.47		RS 875 × EC676022	-9.72**	**4.33**
			PIL 139 × CIM240	52.73**	4.48		RS 875 × RC 79	-8.93**	**4.25**
			LH 900 × F 1040	9.84**	4.58		RS 875 × PIL 135	-8.75**	**4.38**
			LH 900 × PIL 137	9.04**	4.54		RS 875 X PIL 136	-8.33**	**4.40**

*, ** significant at 5 per cent and 1 per cent level, respectively

to 4.90 g in PIL 138 × CIM240. A total of 63 crosses exhibited significant positive better parent heterosis. The cross, PIL 138 × EC676018 ranked at the top (37.78 %) for bolls/plant having 4.87 *per se* performance. While the lowest heterosis for boll weight was exhibited by RS 875 × RC 240 (-10.48 %). The results are in accordance with the findings of Saha *et al.,* (2015).

The range of mean values for seed cotton yield varied from 8.93 g/plant (F 1040) to 108.33 g/plant (PIL 137) in parents and from 18.54 g/ plant (PIL 139 × EC676023) to 153.17 g/plant (RS 875 × RC85) in cross combinations. A total of seven crosses exhibited significant positive heterosis for seed cotton yield. The heterosis ranged from -79.97 per cent to 108.15 per cent recorded by hybrids LH 900 × EC676015 and PIL 138 × PIL 136, respectively. The top ranking cross combination, PIL 138 × PIL 136 (108.15%) expressed highest significant positive better parent heterosis (Table 1). This hybrid also displayed significant heterosis for yield component traits like boll weight and number of sympods/plant. The top promising hybrid was followed by the cross, PIL 138 × EC676023 with a value of 66.70 per cent significant positive heterosis and was also heterotic for bolls/plant, boll weight and sympods/plant. This suggested that these cross combinations can be used in future hybridization programme for the exploitation of heterosis (Abro *et al.,* 2014 and Patil *et al.,* 2014). The hybrid RS 875 × RC85 had highest *per se* performance of 153.17 g seed cotton yield/plant and also expressed considerable amount significant positive better parent (56.83%) heterosis.

For parents, 2.5 per cent span length had a minimum expression of 22.00 mm (PIL 138) and maximum value of 28.33 mm (PIL 136). The hybrids, PIL 138 × EC676017 and PIL 138 × PIL 136 registered minimum (23.65 mm) and maximum (28.57 mm) 2.5 per cent span length Significant positive heterosis over better parental value was discernible in 19 hybrids. The heterobeltiosis ranged from -14.20 per cent in cross PIL 138 × EC676017 to 6.10 per cent in cross PIL 139 × PIL 8 (Table 1). The present findings was substantiate with Ashokkumar *et al.,* (2013).

Regarding the fibre strength, pollen parent, RC 8 had highest fibre strength (29.57 g/tex) and seed parent PIL 138 (16.90 g/tex) gave least fibre strength. While among the hybrids, PIL 138 × EC676018 and LH 900 × EC676026 produced high and low fibre strength (28.03 g/ tex and 16.90 g/tex, respectively). The expression of better parent heterosis for fibre strength was significant and positive for 24 hybrids. This ranged from -41.92 per cent in LH 900 × EC676026 to 21.23 per cent in RS 875 × PIL 8H. Hybrid vigour was also observed by Karademir *et al.*, (2011).

In parents, the lowest mean for fibre fineness *i.e.* finer fibre was observed in PIL 139 (2.93 µg/inch) and highest (coarse fibre) in EC676023 (5.53 µg/inch). Among cross combinations, lowest value was observed in cross PIL 139 × PIL 8 (3.31 µg/inch) and highest in PIL 138 × EC676023 (5.47 µg/inch). A total of 17 hybrids expressed significant negative whereas, 63 hybrids showed significant positive heterosis over better parent for fibre fineness. The hybrid, RS 875 × EC676015 (-13.47%) gave maximum significant negative better parent heterosis having 4.15 µg/inch *per se* performance. These results are in the agreement with earlier research findings of Ashokkumar *et al.,* (2013).

Based on heterobeltiosis, the best crosses identified was PIL 139 × PIL 8 (6.10 %) for 2.5 per cent span length, while RS 875 × PIL 8H (21.23 %) for fibre strength and RS 875 × EC676015 (-13.47%) for fibre fineness. When both 2.5 per cent span length and fibre fineness were taken into consideration, the crosses RS 875 × PIL 135 and LH 900 × PIL 8 were found superior.

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