Indian J. Genet., 49(3): 369–374 (1989)

HETEROSIS AND LINE–TESTER ANALYSIS IN *GOSSYPIUM BARBADENSE* L. COTTON. II. FIBRE QUALITY

S. N. KADAPA, R. M. PRAJAPATI AND E. S. ABRAHAM

University of Agricultural Sciences, Dharwad
A.R.S. Dharwad Farm 580007

(Received: February 17, 1988; accepted: January 9, 1989)

ABSTRACT

Eight intra-*Gossypium barbadense* hybrids producing 80–100% higher yield than the best fibre quality cv. Suvin were identified. The fibre quality characters like mean fibre length (MFL), 2.5% span length (SL), uniformity ratio (UR), micronaire value (MIC), per cent mature fibres (MF), fibre tensile strength at 0 (0-STR) and 3 mm guage (3-STR) and fibre elongation (E_1) of the hybrids, cv. Suvin and Chy. DCH-32 were assessed. Four hybrids possess nearly equal SL (36.4–37.0 mm) to that of cv. Suvin (37.3 mm). The same four hybrids depicted superior fibre characters to Suvin in UR (46–47), MIC (3.2–3.4), MF (83–91), 0-STR (10.21–10.36), 3-STR (32.20–35.06), and E_1 (10.6–12.1). Heterosis over respective midparent values of hybrids was nonsignificant, indicating additive gene control of SL, UR, MIC and 0-STR, in majority of hybrids but MFL, 3-STR and E_1 were determined by nonadditive gene action. It is suggested to exploit hybrid vigour shown by crosses of BCS 9-70 with TCS 30-6, TCS 3-5 and TCS 9-5 cotton strains for increasing productivity of superior quality *barbadense* cotton in India.

Key words: Heterosis, fibre quality, line-tester, cotton *Gossypium barbadense*.

Since cotton is mainly used for spinning yarns and making clothing and apparel, it should possess suitable fibre quality for spinning. This requirement is especially imperative in the case of *Gossypium barbadense* irrespective of productivity of a variety. As early as in 1939, Campbell [1] stressed the need for detailed study of fibre quality before a variety is recommended for cultivation in different regions. The superior fibre quality characters like fibre length, uniformity of fibre, fibre maturity, tensile strength and extensionability of *barbadense* cotton are outstanding as compared to fibre quality of the other cultivated species of cotton [2]. Fibre quality requirements for different uses of raw cotton were redefined in 1986 [3] and their suitability for the modern spinning machinery was stressed by Duession [4].Fibre quality of intra-*barbadense* hybrids that gave 46 to 81% more yield over cv. Suvin was assessed in comparison with those of cv. Suvin and Chy. DCH-32, *barbadense* variety, and interspecific hybrid.

MATERIALS AND METHODS

Seed-cotton (*kapas*) harvested from 54 plants of each hybrid and their parental varieties as a 3×11 line–tester experiment with 3 replications was bulked, hybrid or varietywise. The *kapas* was hand cleaned of bits of leaf and trash. Ginning was done on CTRL Laboratory Gin. Lint quality characters were assessed at CTRL Quality Evaluation Unit, Dharwad Farm, Dharwad, during 1986. Mean fibre length (MFL), 2.5% span length (2.5% SL) and Uster uniformity ratio were recorded using 430 Digital Fibrograph. Fibre fineness was recorded as MIC using micronaire apparatus. Stelometer readings were taken for tensile strength of fibre and extension (E_1). A small tuft of fibres were soaked in 18% caustic soda (NaOH) solution, placed on a slide, and separated from each other. The slide was mounted on stage of Euscope, the mature fibres counted and expressed in percentage.

Table 1. Mean values in respect of fibre quality characters of parental varieties and intra-*barbadense* hybrids

Parent/hybrid	Fibre quality characters							
	MFL (mm)	2.5% SL (mm)	UR (%)	MIC	mature fibres (%)	tenasity PSI 0 gauge	g/tex 3 mm gauge (g/tex)	extension (%)
Lines:								
S.I. Andrews	28.2	31.5	43	3.5	67	8.9	25.3	7.0
Suvin (CV_2)	33.0	37.3	42	2.8	70	10.1	31.6	9.9
BCS 9–70	32.7	35.6	46	3.6	79	9.9	31.1	10.0
Testers:								
PL–D6	30.0	34.0	45	3.4	64	9.7	29.0	6.3
TCS 30–6	30.5	34.2	47	3.6	72	9.5	29.6	7.3
BCS 12–125	28.2	31.3	45	3.4	65	9.3	28.5	7.3
TCS 9–5	28.2	32.1	44	3.0	74	9.7	29.8	7.7
TCS 3–5	30.2	33.6	46	2.8	63	10.0	28.4	7.5
PL–D2	31.2	34.8	43	2.7	58	9.7	26.9	6.8
BCS 9–45	29.2	32.5	46	3.6	76	9.9	29.6	7.8
BCS 14–48	31.0	34.4	46	2.9	63	9.6	28.3	7.5
BCS 171–2B	30.1	36.4	45	3.4	73	10.0	29.8	9.4
BCS 180–42	27.6	30.4	48	4.2	74	9.0	26.8	8.6
Giza–7	28.4	31.3	44	3.7	67	9.2	29.3	8.4
CD at 5%	3.2	2.5	1.4	0.3	16	0.8	1.2	0.7
Hybrids:								
BCS 9–70 × TCS 30–6	32.8	36.6	47	3.4	89	10.1	33.4	11.4
BCS 70 × TCS 3–5	31.5	35.4	46	3.3	83	10.2	34.6	11.8
BCS 70 × TCS 9–5	31.2	36.4	47	3.4	90	10.3	35.2	12.1
S.I. Andrews × Giza–7	33.5	36.8	46	3.2	64	10.2	32.2	10.6
BCS 9–70 × BCS 171–2B	32.9	37.0	47	3.4	91	10.3	35.0	11.6
S.I. Andrews × TCS 9–5	30.6	34.0	45	3.4	67	9.5	31.2	10.1
BCS 9–70 × BCS 12–125	27.0	31.8	47	4.0	74	9.8	29.7	7.8
Suvin × TCS 9–5	33.0	36.9	46	3.5	76	10.3	31.3	9.6
DCH–32 (interspecific hybrid check)	32.5	36.2	41	2.6	1.42	10.3	27.8	7.9
CD at 5%	2.9	3.3	1.1	0.9	0.1	0.8	2.2	0.8

RESULTS AND DISCUSSION

In cv. Suvin 2.5% SL of fibres was the longest (37.3 mm) but the same of BCS 9–70 and BCS 171–2B were statistically at par with Suvin (Table 1). The UR% of fibres of tester TCS 30-6 was highest (47) while those of check cv. Suvin (42) and Chy. DCH 32(41) were very low. Barkar [5] reported that fibre length uniformity is most important in determining spinnability of cotton. Fibre fineness determined as MIC was lowest in DCH-32 (2.6) and cv. Suvin (2.8) but those of lines and testers, except four, were between 3.4 and 4.2. Micronaire also is an indicator of fibre maturity and MIC values below 3 are considered to be poor in maturity [3]. But per cent mature fibres of cv. Suvin was 70 as compared to only 42 in DCH-32. BCS 9-70 showed highest per cent mature fibres (79). Fibre tensile strength both at 0 and 3 mm gauge was highest of Suvin fibres but those of BCS 9–70 were statistically at par with it. E_1 of BCS 9–70 fibres was also longest (10.3%). It is reported that more than 10% E_1 determines best fibre quality of *babadense* cottons [7].

When fibre quality characters of intra-*barbadense* cotton hybrids were considered, it was found that 2.5% SL of six hybrids was between 35.4 and 37.0 mm (BCS 9–70 × BCS 171–2B), almost equal to that of Suvin. Fibre length uniformity of all the hybrids was 45 to 47, being much superior to those of checks. The MIC ranged between 3.4 and 4.0, which is very suitable for high grade spinning [7]. With the exception of two hybrids, the per cent mature fibres of the hybrids was very high (74 to 91%). Such high percentage of long staple cottons has not been observed in any variety/hybrid so far in India [8]. Fibre tensile strength at 0 gauge 5 hybrids was higher than that of cv. Suvin, the values being 10.2 and 10.4 PSI and at 3 mm gauge showing g/tex values of 32.2 to 35.2. Such values of PSI give good spinnability [9]. Fibre elongation was very high (10.6 and 12.1% E_1). Thus, it was seen that two intra-*barbadense* hybrids possess fibre quality equal to or superior than that of the best quality cv. Suvin of India.

MFL as well as 2.5% SL were found to be additive in six hybrids as heterosis over MP was statistically nonsignificant (Table 2). Hybrid BCS 9–70 × TCS 3–5, in particular, did not differ from MP value even slightly. The UR and MIC of this hybrid also showed similar trend of additivity. It is, therefore, suggested that this high yielding intra-*barbadense* hybrid combination is highly suitable for improvement of fibre length and its uniformity by pursuing the progenies in further segregating generations. Coupled with selection and inter se mating between selected plants for 3–4 cycles [10], it is possible to mop up additive gene complexes, determining fibre length and UR in a few individual plants of such hybrid derivatives.

In general, fibre strength at 0 gauge of hybrids did not deviate significantly from their respective MP values except in one case. But tensile strength at 3 mm gauge (g/tex) was highly heterotic and hence determined by nonadditive genes. Marani [11] also found that in *G. barbadense* hybrids, F_1 values of g/tex at 3 mm were close to the values of BP, indicating complete dominance, but Dark [12] did not find any definite trend in the inheritance of fibre strength in Sakel cottons. But it is clear from the present data that 3 mm tensile fibre strength is determined by dominance as well as epistatic gene actions as the F_1 values differed significantly and positively from BP vlaues.

Table 2. Heterosis (%) over midparent(MP), better parent(BP), and quality

Hybrid	MFL			2.5% S.L.			UR%			Micronaire		
	MP	BP	CV_2	MP	BP	CV_2	MP	BP	CV_2	MP	BP	CV_2
BCS 9–70 × TCS 30–6	5.8	2.5	−6.7	−0.3	2.8	−7.2	1.0	0.0	10.6*	−5.5	−5.5	21.4
BCS 9–7 × TCS 3–5	0.0	−3.7	−4.5	2.3	−0.6	−5.0	0.0	0.09	8.6	3.1	−8.3	17.8
BCS 9–70 × TCS 9–5	2.3	−4.6	−5.5	7.4	2.2	−2.4	64.4*	2.1*	10.6*	−3.0	−11.1	14.2
S.I. Andrews × Giza–7	18.4*	18.0*	1.5	15.7*	14.6*	−1.3	5.7*	4.5*	8.6*	−11.1	−13.5	14.2
BCS 9–70 × BCS 171–2B	4.8	0.6	−0.3	4.2	3.9	0.8	1.0	2.1	10.6	−2.8	−5.5	2.4
S.I. Andrews × TCS 9–5	8.5	8.5	−7.3	6.9	5.9	−8.8*	3.4*	4.5	6.6*	−3.0	−8.5	14.2
BCS 7–70 × BCS 12–125	−11.5*	−17.4*	−18.2*	−5.1	−0.1*	4.7*	3.2*	2.1	10.6	14.2	11.1	42.8*
Suvin × TCS 9–5	7.8	0.0	0.0	6.3	−1.0	−1.0	6.9*	4.5*	8.6*	20.6*	16.6*	25.0*

*Significant high/low or positive or negative heterosis.

While estimating heterosis in intra-*barbadense* F_1 hybrids, it was found that fibre length was equal to that of cv. Suvin in crosses BCS 9–70 × TCS 30–6, BCS 9–70 × TCS 9–5, and BCS 9–70 × TCS 3-5. The UR was nonheterotic, and so was MIC. In particular, per cent mature fibres, tensile strength of 3 mm, and elongation (E_1) showed positive and highly significant heterosis over cv. Suvin, the best quality *barbadense* variety of India, as also over respective BP values. General combining ability (gca) effects of parental types showed that line BCS 9–70 and testers TCS 30–6, TCS 3–5 and TCS 9–5 were positive and high in respect of MF, SL, UR, MIC, MF and 0 STR. Tabulated data of gca are not presented for the sake of brevity. These four *barbadense* genotypes, therefore, were best suited both for the exploitation of heterosis for seed cotton yield as well as for the main fibre quality characters. For cotton improvement by breeding and selection in succeeding generations also, the hybrid combinations provided good material.

Therefore, from overall fibre quality point of view the top hybrids listed were equal to or superior than the fibre quality of cv. Suvin. That these three hybrids

check (CV_2) in respect of fibre quality characters in intra-*barbadense* crosses

Mature fibres % %			Tenasity (g/tex) 0 gauge			g/tex 3 mm gauge			Extension %		
MP	BP	CV_2	MP	BP	CV_2	MP	BP	CV_2	MP	BP	CV_2
17.1	12.6*	27.1*	4.4	2.4	0.1	10.0*	7.3*	16.5*	39.0*	26.6*	44.3*
16.9	5.0	18.5	2.5	2.2	3.6	16.2*	11.2*	20.7*	42.1*	31.1*	49.3*
16.8*	13.9*	28.5*	5.3	4.5	2.1	15.6*	13.1*	22.8*	44.0*	34.4*	53.1*
−4.4	−10.4	−8.5	12.3	10.5	0.6*	22.2*	15.0*	12.3*	37.6*	26.1*	34.1*
18.0	15.1	30.0	4.0	3.5	2.2	15.0*	12.0*	22.3*	20.6*	23.4*	46.8*
−9.8	−9.4	−4.2	2.5	−1.1	−5.8	13.5*	5.1	9.1*	36.4*	31.1*	27.8*
−6.9	−6.3	5.7	2.3	−0.7	−2.5	−0.3	−4.4	3.8	−4.8	−13.3	−1.2
2.7	2.7	8.5	4.4	1.9	1.9	7.3	5.3	9.3	23.0	21.5	21.4

have produced 80–100% higher yield of seed cotton over Suvin in large multilocation trials has already been reported and fibre quality of the hybrids is comparable to that of Suvin. Therefore, these three intra-*barbadense* hybrids can be exploited to increase the production of superior quality *barbadense* cottons in India and promote export.

REFERENCES

1. M. E. Campbell. 1939. Preliminary report of cotton spinning and related fibre studies in connection with regional variety series of 1935 and 1936. Address before The American Society of Agronomy 23rd November, 1939.
2. E. Lord. 1967. Trends in cotton quality requirements. Cott. Gr. Rev., **44:** 51–68.
3. V. Sundaram, S. B. P. Rao and M. S. Parthasarathy. 1986. Cotton improvement research and production. Practices in India in relation to fibre quality and end use requirements. Part IV. ICMF Journal. Bombay, India. July: 20–28.
4. Halmut Duession. 1986. Rethinking of breeding and marketing methods. Cott. International, **53:** 32–36.

5. H. F. Barkar and O. A. Pope. 1948. Fibres and spinning properties of cotton: correlation stuay of variety and environment. USDA Tech. Bull. 970 (cited from Emp. Cot. Gr. Rev., **27**: 73, 1950).

6. H. A. Abdel-Nabi. 1965. Inheritance of fibre strength and fibre elongation in F_3 of a cross between two varieties of upland cotton. Diss. Abstr., **26**: No. 65–11–382 of N. C. Univ. USA: 1843 (Pl. Breed. Abstr. 1967, **37**: 120).

7. Arie Pulvermachor. 1986. Quality is imperative. Cott. International, **53**: 221.

8. Anonymous. 1986. The Indian Cotton Annual. East India Cott. Assoc. Marwari Bazar, Bombay.

9. E. Lord and C. Underwood. 1958 The interpretation of spinning test reports. Emp. Cott. Gr. Rev., **35**: 26–32.

10. S. N. Kadapa. 1987. Development of giant boll *Gossypium hirsutum* L. cotton variety, BAR-JK 97 GB. I. Breeding procedure and selection, ICMF. J., May: 14–18.

11. A. Marani. 1968. Inheritance of lint quality characteristics in intra-specific crosses among varieties of *Gossypium hirsutum* L. and *G. barbadense* L. Crop Sci., **8**: 36–38.

12. S. O. S. Dark. 1962. Breeding increased fibre strength in Sakel type cotton. Emp. Cott. Gr. Rev., **39**: 161–168.