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Development of recombinant inbred lines for fibre strength and other important traits in cotton (*Gossypium hirsutum*)

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ABSTRACT

Field experiment was conducted during 2004–09 at New Delhi to develop recombinant inbred lines for fibre strength and other important fibre quality traits in cotton (*Gossypium hirsutum* L.). Most of the presently developed *G. hirsutum* cottons have low fibre strength. There is an urgent need to breed for high fibre strength to meet the demands of modern textile industry. High fibre strength line 'Pusa 56-4' was crossed with low fibre strength variety 'RS 2013' during 2004. Wide variation was observed in F_2, F_3 and F_4 generations for fibre quality traits, especially fibre strength and also for seed cotton yield and important yield components. Transgressive segregation was observed for fibre strength, length and other traits. Ninety-three plants evaluated during 2008–09 in F_4 generation showed more than 26 g/tex fibre strength and 30 plants out of these showed high yield ranging from 204.1 to 459.2 g/plant. All the 297 plants in F_4 generation are being advanced to F_6 generation for developing recombinant inbred lines. The cross presents good scope for simultaneous improvement of yield and fibre quality traits, especially fibre strength.

Key words: Fibre quality, Ginning percentage, *Gossypium hirsutum*, Recombinant inbred line (RIL), Seed cotton yield, Transgressive segregation

Relative significance of fibre quality traits is determined by their end-use and the spinning technology used by the textile industry. Until recently research on improvement of fibre quality gave major emphasis on increasing fibre length and fineness to achieve higher spinning counts. The adoption of modern high speed ring/open-end spinning system by textile industry has increased demand for high fibre strength cottons. Most of the presently developed varieties have low fibre strength of 18 to 20 g/tex. Genetic variation available for the improvement of fibre quality is restricted in commercial *Gossypium hirsutum* cotton, which accounts for over 90% of total production. Research was therefore initiated at Indian Agricultural Research Institute, New Delhi to develop recombinant inbred lines for fibre strength and other important traits and to study genetic variation in segregating generations and their utility to develop lines combining high yield and superior fibre quality, especially high fibre strength.

MATERIALS AND METHODS

'Pusa 56-4' was identified for high fibre strength (Singh and Kaushik 2006; Singh *et al* 2007) at Indian Agricultural Research Institute, New Delhi. The mean fibre strength of 'Pusa 56-4' was found to be 27.8 g/tex against 23.1 g/tex of local check 'Pusa 8-6' during 5-year period from 2003 to 2008. Likewise, its mean 2.5% span length was 28.4 mm and micronaire was 3.9. It also showed good fibre uniformity (53.5%), good elongation (6.2%) and low short fibre index (5.0%). During the same period the mean 2.5% span length of local check 'Pusa 8-6' was 28.2 mm, mean micronaire value 4.6, mean uniformity ratio 51.7%, mean fibre elongation 5.8% and mean short fibre index 6.1%.

'RS 2013' variety was developed by Agricultural Research Station, Sriganganagar and was released for commercial cultivation in Rajasthan. It has medium staple fibre (24.5 mm) and low fibre strength of about 19 g/tex. It was therefore selected as a low fibre strength parent for making contrasting cross with high fibre strength parent 'P 56-4'. The strain 'P 56-4' was crossed with 'RS 2013' variety in 2004 to obtain F_1 generation. It was advanced to F_2 generation during 2005 which was evaluated during 2006. Two hundred and ninety seven single plants from F_2 generation were phenotyped for fibre strength and other fibre quality traits as well as seed cotton yield and important yield components. These single plants were advanced to F_3 and F_4 generations through

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selfing, following single seed descent method and were evaluated for fibre strength and other fibre quality traits during 2007–08 in F_3 generation and during 2008–09 in F_4 generation. Data were also recorded on seed cotton yield and important yield components.

RESULTS AND DISCUSSION

Data on mean, range and standard deviation in respect of fibre quality traits, seed cotton yield and important yield components in F_2, F_3 and F_4 generations are given in Table 1. The data indicated wide variation for several fibre quality traits in 3 generations, especially in F_2. The fibre strength ranged from 18.1 to 33.1 g/tex in F_2; 18.8 to 27.9 g/tex in F_3 and 20.0 to 30.7 g/tex in F_4 generation. The mean fibre strength in F_2, F_3 and F_4 generations was 26.6, 23.1 and 25.1 g/tex, respectively. The 2.5% span length ranged from 22.7 to 30.6 mm in F_2; 22.6 to 30.6 mm in F_3 and 23.5 to 31.9 mm in F_4.The mean 2.5% span length was 26.8 mm in F_2, 26.6 mm in F_3 and 27.6 mm in F_4.The micronaire value varied from 3.6 to 4.9 in F_2, 3.2 to 5.7 in F_3 and 2.8 to 5.4 in F_4 with the respective average of 4.2, 4.4 and 3.9. Likewise, the fibre uniformity ranged from 47.6 to 61.3% in F_2, 46.6 to 58.5% in F_3 and 45.8 to 60.2% in F_4. The mean fibre uniformity ratio was 55.8, 52.4 and 53% in F_2, F_3 and F_4, respectively. The mean fibre elongation per cent was 6.3, 6.1 and 6.1, respectively in the 3 generations, with range of 5.4 to 6.7% in F_2, 5.5 to 6.6% in F_3 and 5.5 to 6.9% in F_4. All the plants in the 3 generations showed good fibre maturity ranging from 0.8 to 0.9. The short fibre content was found to be 3.5% to 8.8% in F_2, 3.5 to 11.2% in F_3 and 3.5 to 8.6% in F_4, with mean of 3.8, 4.8 and 4.1%, respectively in 3 generations. Wide variation was also observed for seed cotton yield per plant in all the 3 generations. It ranged from 22.0 to 196.3 g in F_2, 25.2 to 193.1 g in F_3 and 21.5 to 581.4 g in F_4 generation. The mean seed cotton yield was 43.2 g in F_2, 75.9 g in F_3 and 163.4 g in F_4. Likewise, boll weight was found to vary from 2.0 to 5.1 g in F_2, 2.1 to 5.7 g in F_3 and 2.1 to 5.8 g in F_4 generation. The ginning outturn varied from 25.6 to 41.4% in F_2, 25.6 to 39.3% in F_3 and 26.0 to 40.4% in F_4. The mean ginning outturn in the 3 generations was 30.6% in F_2, 31.7% in F_3 and 32.6% in F_4. Good variation was also observed for seed index and lint index in all the 3 generations.

Table 1 Seed cotton yield and fibre quality traits in F_2, F_3 and F_4 generations of the cross 'Pusa 56-4' × 'RS 2013'

Trait	Generation	Mean	SD	Minimum	Maximum
Yield / plant (g)	F_2	43.2	31.0	22.0	196.3
	F_3	75.9	33.1	25.2	193.1
	F_4	163.4	95.7	21.5	581.4
Boll weight (g)	F_2	3.5	0.7	2.0	5.1
	F_3	3.4	0.6	2.1	5.7
	F_4	3.9	0.7	2.1	5.8
Ginning outturn (%)	F_2	30.6	3.3	25.6	41.4
	F_3	31.7	2.4	25.6	39.3
	F_4	32.6	2.4	26.0	40.4
Seed index (g)	F_2	9.3	1.5	4.0	13.5
	F_3	8.1	1.0	5.6	11.6
	F_4	8.9	1.3	3.0	12.2
Lint index (g)	F_2	3.9	0.7	2.1	5.8
	F_3	3.8	0.5	2.5	6.0
	F_4	4.3	0.6	2.9	6.4
2.5% span length (mm)	F_2	26.8	1.5	22.7	30.6
	F_3	26.6	1.6	22.6	30.6
	F_4	27.6	1.7	23.5	31.9
Fibre uniformity (%)	F_2	55.8	2.3	47.6	61.3
	F_3	52.4	2.5	46.6	58.5
	F_4	53.0	2.6	45.8	60.2
Micronaire value	F_2	4.2	0.3	3.6	4.9
	F_3	4.4	0.5	3.2	5.7
	F_4	3.9	0.5	2.8	5.4
Fibre strength (g/tex)	F_2	26.6	2.3	18.1	33.1
	F_3	23.1	1.6	18.8	27.9
	F_4	25.1	2.0	20.0	30.7
Fibre elongation (%)	F_2	6.3	0.2	5.4	6.7
	F_3	6.1	0.2	5.5	6.6
	F_4	6.1	0.2	5.5	6.9
Fibre maturity	F_2	0.9	0.0	0.8	0.9
	F_3	0.8	0.0	0.8	0.9
	F_4	0.8	0.0	0.8	0.9
Short fibre index (%)	F_2	3.8	0.7	3.5	8.8
	F_3	4.8	1.6	3.5	11.2
	F_4	4.1	1.1	3.5	8.6

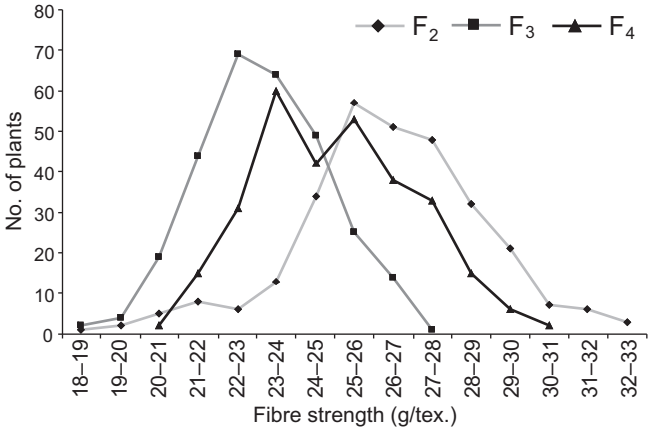

Fig 1 Ditribution of fibre strength in F_2, F_3 and F_4 generations

The distribution of fibre strength in 3 generations is given in Fig 1. The distribution in F_2 was little skewed as 76.5% plants out of 297 showed high fibre strength (above 25 g/tex). Furthermore, 21 plants (7.0%) in F_2 showed above 28 g/tex fibre strength which was higher than that of the better parent, suggesting transgressive segregation for the trait. The range observed for fibre strength in F_3 and F_4 generations was relatively less as compared to F_2 generation as is evident from Fig 1. The distribution of fibre strength in F_3 was normal and ranged from 18.8 to 27.9 g/tex. Several plants in F_4 generation also showed more than 25 g/tex fibre strength

Table 2 Variation among 93 high fibre strength plants for important yield and fibre quality traits in F_4 generation of the cross 'Pusa 56-4' × 'RS 2013' during 2008

Trait	Mean	SD	Minimum	Maximum
Yield/plant (g)	165.4	96.8	32.3	459.2
Boll weight (g)	3.9	0.7	2.3	5.2
2.5% span length (mm)	28.6	1.4	25.1	31.9
Micronaire value	3.8	0.4	2.9	4.7
Fibre strength (g/tex)	27.5	1.1	26.1	30.7

with 2.7% plants showing higher fibre strength than the better parent.

Transgressive segregation was also observed for 2.5% span length as 18.7% plants in F_2 showed higher fibre length than 28.4 mm of better parent 'P 56-4'. Only 1.3% plants in F_2 showed lower micronaire value (finer fibre) as compared to 3.9 micronaire value of better parent 'P 56-4' and 6.3% plants showed higher short fibre index than better parent 'P 56-4'. Boll weight was found to be higher than 4.5 g of 'P 56-4' in 21% plants. Transgressive segregation was also observed for low as well as high ginning percentage. The variation and transgressive segregation observed for fibre length and strength and other traits has practical implication for combining high yield and superior fibre quality in *G. hirsutum* cottons. Percy *et al.* (2006) also reported transgressive segregation for high and low lint percentage, with about 5% of lines exceeding high ginning outturn parent. Similarly, about 25% lines exceeded the height of the taller parent. They further reported that 20% lines possessed fibre strength equivalent to high fibre strength parent while 4% exceeded high strength parent. Fibre length and uniformity were reported to be normally distributed, while 14% lines showed transgressive segregation for lower micronaire value (Percy *et al.* 2006). They also reported shifted distribution among recombinant inbred lines towards smaller boll size. Reinisch *et al.* (1994) reported strongly distorted segregation of molecular markers in early generations and Jiang *et al.* (2000) reported skewed transmission in advanced generations of inter-specific hybrids. In the present study also transgressive segregation was observed for several important traits.

During 2008–09 crop season 93 plants out of 297 evaluated in F_4 generation showed high fibre strength above 26.0 g/tex. Data on important traits in respect of these high fibre strength plants showing mean, standard deviation and range is summarized in Table 2. The fibre strength of these 93 plants ranged from 26.1 to 30.7 g/tex with mean fibre strength of 27.5 g/tex. These plants also showed good fibre length with mean 2.5% span length of 28.6 mm and range of 25.1 to 31.9 mm. The micronaire value varied from 2.9 to 4.7, the mean being 3.8. Likewise, the boll weight ranged from 2.3 to 5.2 g with mean of 3.9 g. The seed cotton yield showed wide variation from 32.3 to 459.2 g, the mean being 165.4 g. Percy *et al.* (2006) also observed genetic variation among recombinant inbred lines for all the traits. They observed more variation for 2.5% span length, 50% span length and micronaire value, whereas lowest variation was reported for uniformity ratio and fibre elongation.

Out of 93 high fibre strength plants 11 showed high yield ranging from 204.1 to 246.6 g. The fibre strength in these plants varied from 26.2 to 28.6 g/tex., 2.5% span length from 25.1 to 30.9 mm and micronaire value from 3.1 to 4.3. Another set of 19 plants showed above 250 g seed cotton yield/plant. The range for different characters was 252.0 to 459.2 g for yield, 3.4 to 5.1 g for boll weight, 26.1 to 30.1 g/tex for fibre strength, 26.8 to 31.0 mm for 2.5% span length and 3.3 to 4.6 for micronaire value. Thus, none of above mentioned 30 plants had fibre strength below 26 g/tex and their seed cotton yield was high ranging from 204.1 to 459.2 g/plant. Thus, the F_4 plants derived from the cross '56-4' × 'RS 2013' showed valuable genetic variation for simultaneous improvement of yield and fibre quality, especially fibre strength in *G. hirsutum* cottons. These will be carried forward and will be evaluated as recombinant inbred lines in 2010–11 in F_6 generation.

REFERENCES

Jiang C, Wright R J, El-Zik K M and Paterson A H. 2000. QTL analysis of leaf morphology in tetraploid *Gossypium*. *Theoretical and Applied Genetics* **100**: 409–18.

Percy R G, Cantrell, R G and Jinfa Zhang. 2006. Genetic variation for agronomic and fibre properties in an introgressed recombinant inbred population of cotton. *Crop Science* **46**: 1311–7.

Reinisch M J, Dong J, Brubaker C L, Stelly D M, Wendel J F and Paterson A H. 1994. A diallel RFLP map of cotton, *Gossypium hirsutum* × *Gossypium barbadense*: chromosome organization and evolution in disomic polyploidy genome. *Genetics* **138**: 829–47.

Singh J and Kaushik S K. 2006. High fibre strength strains of American cotton suitable for rotor spinning. *ICAR News* **12** (2): 15–6.

Singh J, Kaushik S K and Chaudhary Babita. 2007. Seed cotton yield and fibre quality analysis in American cotton. *Journal of the Indian Society for Cotton Improvement* **32** (3): 188–92.