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STEPWISE IMPROVEMENT FOR FIBER QUALITY AND YIELD IN CULTIVAR DEVELOPMENT

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Abstract

Five Pee Dee lines selected for their superior fiber properties were crossed to five high yielding cultivars in an effort to improve fiber quality and yield. Lines were evaluated for yield and those lines with superior fiber properties were retained for a second cycle of selection. These selected lines were crossed to six high yielding cultivars. Populations from these crosses were advanced for several generations and lines were selected based on their superior fiber properties in tests in 2002. The selected lines were evaluated in replicated tests in 2003. Results indicated that fiber qualities were improved, especially fiber length, micronaire and fiber strength in many lines. Several lines showed no improvement in fiber quality, but improvements in lint yield. Two lines showed both improved fiber quality and yield. These lines will go through additional cycles of selection to continue improvements in fiber quality and yield in subsequent generations.

Introduction

Improvement in yield is the major objective of cotton breeding, especially in the area of commercial cultivar development. However, improvements in fiber quality are also essential to meet the demands of commercial ginning and textile production.

In many cases, attempts to improve yield have been shown to have negative effects on one or more fiber quality traits. However, directed attempts to improve fiber quality have often resulted in yield declines. In addition to these problems, selection for multiple traits is complex and may require many years of effort and multiple selection cycles to obtain positive results. Lastly, the initial material used in efforts to improve fiber quality and yield will have a major impact on the outcome.

Many commercial cultivars of cotton have high yield potential, but not superior fiber. Germplasm released from public breeding programs may have superior fiber qualities, but not provide sufficient yield and profitability returns. Germplasm released from the USDA Pee Dee (PD) breeding program in Florence, South Carolina is known for its long-fiber and high quality (Culp and Harrell, 1974). Combining this germplasm with higher yielding commercial cotton cultivars could potentially produce excellent products. However, making such combinations may require multiple selection cycles and long-term selection objectives. The objective of this study was to improve fiber quality in commercial cotton cultivars by introgressing long-fibered PD lines and to follow a stepwise, multi-cycle selection process for improved fiber among these lines.

Materials and Methods

Five PD lines selected for their superior fiber characteristics (Table 1) were crossed with five high yielding Deltapine (DP) cultivars or experimental lines in the summer of 1989. The cross combinations were PD 5286 x DP 5690, PD 5582 x DP 90, PD 5380 x DPX 28429-71, PD 5256 x DPX 3818-83. The F_1 seed of these crosses was harvested and advanced in bulk for three generations. In the summer of 1992, individual lines were selected visually and four lines with superior fiber were selected for testing against standard check varieties (Suregrow 501 and DP 5415) in replicated tests at five locations in 1993. These selected lines were designated as 91368-344, 92312-511, 92378-5150, and 92335-522 (Table 2).

Also in 1992, these four improved hybrids were crossed with other high-yielding Deltapine lines to make six new populations. The resulting F_1 seed from these crosses was advanced in bulk for three generations. Single plant selections were made and F_4 derived F_5 lines were visually selected from these populations in 2002. Fiber data were obtained on all lines from each population and lines with superior fiber were retained for yield testing. The cross combinations from which lines were selected based on superior fiber in 2002 were 91368-344 x DP 5690, 92312-511 x DPX 8C01, 92312-511 x DP 675, 92378-5150 x 8C01, 92335-522 x 8C09, 92335-522 x 8C36, and 92335-522 x DPX 9765. The lines with superior fiber were tested against standard check varieties (SG 105, DP 491, and Fibermax 958 (FM)) in replicated tests in summer 2003 in Hartsville, South Carolina. Yield and HVI fiber data were obtained on each line.

Results and Discussion

Several cycles of selection resulted in several lines with improvement in both fiber qualities and yield. After the initial cycle of selection, lines 91368-344, 92312-511, 92378-5150 and 92335-522 all showed improvement in fiber length and strength and lower micronaire relative to the check varieties (Table 2). Only line 92378-5150 showed an improvement in both fiber quality and yield. Fiber length improvements ranged from 1% to 13% better than SG 501 and between 1% and 12% better than DP 5415. Fiber strength improvements ranged between 1% and 6% better than SG 501 and between 4% and 12% better

than DP 5415. Micronaire showed a decline in all lines, ranging from 4% to 23% less than SG 501 and 10% to 21% less than DP 5415. Uniformity increases were small and inconsistent across the different lines in the test. None of the lines selected showed improvements in fiber elongation and only line 92378-5150 showed an increase in yield.

Similar results were obtained in the second cycle of selection. Almost all of the lines selected on superior fiber properties in 2002, (Dawn this sentence is unclear to me) have improved fiber length, ranging from 1% to 12% improvement over SG 105 and between 1% and 9% over FM 958. Two lines, 05Z824 and 05Z529, showed no improvement in fiber length, but had lower micronaire than either of the standard checks. Micronaire showed a decline in all lines except 05Z750, 05Z557 and 05Z749. Micronaire of lines 05Z625, 05Z529 and 05Z800 was lower than FM 958, but not lower than SG 105. The decrease in micronaire ranged from 1% to 13% less than SG 105 and 2% to 22% less than FM 958. Many lines showed improvements in fiber strength ranging from 2% to 17% better than SG 105 and 1% to 14% better than FM 958. All lines except 05Z670 showed improvement in elongation over FM 958, ranging from 1% to 37%, however, improvements in elongation relative to SG 105 were inconsistent. Few lines showed improvements in lint percent and fiber uniformity and improvements were small relative to the check varieties.

Improvements in fiber properties were more prevalent than improvements in lint yield. Several lines including 05Z867, 05Z529, had increases in yield of 9% and 14% over SG 105 and 19% to 37% better than FM 958, respectively (Table 4). However, the fiber properties of these lines were not improved relative to either of the standard checks. Only two lines showed major improvements in both yield and fiber quality. Line 05Z865 yielded 2% over SG 105 and 10% over FM 958 with improvements in fiber length, elongation and micronaire. Line 05Z715 showed the greatest improvement of all of the lines tested. Lint yield was 33% better than SG 105 and 21% better than FM 958, with improvements in fiber length, strength, elongation and micronaire (Table 4).

References

Culp, T. W., and D. C. Harrell. 1974. Breeding Quality Cotton at the Pee Dee Experiment Station Florence, SC. USDA-ARS Publication ARS-S30.

Table 1. Fiber qualities and yield of initial parental lines used in 1st cycle of selection in tests conducted at the Pee Dee Research and Education Center from 1987-1989.

Line	Length	Uniformity	Strength	Elongation	Micronaire	Yield
DP 5690	1.15	85.0	28.1	7.6	4.9	982
DP 90	1.16	84.7	26.7	7.8	4.5	1088
DPX 28429-71	1.17	84.8	27.63	7.5	5.0	1338
DPX 3818-83	1.17	85.6	29.45	7.6	4.8	1291
DP 5415 Check	1.16	85.0	26.63	8.1	5.2	1322

Table 2. Fiber qualities and yield for lines selected after first cycle of selection for improved fiber and yield as a percentage of the check means (SG 501 and DP 5415) in tests at Hartsville, SC in 1992.

	Lint %		Length		Uniformity		Strength		Elongation		Micronaire		Yield	
Line	SG 501	DP 5415	SG 501	DP 5415	SG 501	DP 5415	SG 501	DP 5415	SG 501	DP 5415	SG 501	DP 5415	SG 501	DP 5415
91368-344[1]	0.92[2]	0.94	1.03	1.01	1.00	0.99	1.01	1.05	0.94	0.90	0.88	0.88	0.84	0.83
92312-511	0.86	0.92	1.13	1.12	1.02	1.03	1.06	1.06	0.92	0.86	0.77	0.79	0.82	0.91
92378-5150	0.98	1.00	1.03	1.00	1.01	1.01	1.01	1.04	0.93	0.91	0.96	0.98	1.09	1.08
92335-522	0.91	0.93	1.09	1.09	1.00	1.01	1.02	1.12	0.85	0.78	0.89	0.90	0.89	0.91

[1] Pedigrees are 91368-344 (PD 5582 x DP 5690); 92312-511 (PD 5286 x DP 90); 92378-5150 (PD 5380 x DPX 28429-71); 92335-522 (PD 5472 x DPX 3818-83)

[2] Values reported as a percent of the check value (SG 501 or DP 5414) for each measurement

Table 3. Fiber qualities and yield for lines selected after the second cycle of selection for improved fiber and yield as a percentage of the check means (SG 105 and FM 958) in tests at Hartsville in 2003.

Line pedigrees	Lint %		Length		Uniformity		Strength		Elongation		Micronaire		Yield	
	SG 105	FM 958	SG 105	FM 958	SG 105	FM 958	SG 105	FM 958	SG 105	FM 958	SG 105	FM 958	SG 105	FM 958
05Z878														
91368-344 x DP 5690	0.89	0.82	1.04	1.01	0.98	0.99	1.02	0.99	0.97	1.17	0.87	0.78	0.82	0.90
05Z670														
92312-511 x DP 675	1.03	0.99	1.05	1.04	1.00	1.00	1.12	1.04	0.86	0.97	0.99	0.89	0.80	0.79
05Z529														
92312-511 x DP 675	1.00	0.98	0.95	0.95	0.99	1.00	0.98	0.98	0.92	1.15	1.04	0.98	1.14	1.37
05Z625														
92312-511 x DP 675	0.95	0.93	1.04	1.03	1.00	1.00	1.02	1.00	0.95	1.21	1.04	0.94	1.11	1.00
05Z766														
92312-511 x DP 675	0.99	0.96	1.03	1.01	0.98	0.98	0.94	0.92	0.98	1.09	0.93	0.94	1.06	0.89
05Z833														
92312-511 x DP 675	1.05	0.91	1.01	1.03	0.98	0.99	0.90	0.94	0.91	1.18	0.99	0.83	0.98	0.87
05Z867														
92312-511 x DP 675	0.97	0.90	0.99	0.96	0.99	1.00	0.95	0.92	0.97	1.18	0.90	0.80	1.09	1.19
05Z667														
92312-511 x DPX 8C01	0.95	0.92	1.03	1.02	1.00	0.99	1.15	1.07	1.00	1.13	1.13	1.01	0.77	0.76
05Z824														
92312-511 x DPX 8C01	1.01	0.87	0.96	0.98	0.99	1.00	0.97	1.00	0.93	1.20	0.97	0.80	0.74	0.65
05Z865														
92312-511 x DPX 8C01	0.95	0.88	1.04	1.01	0.99	1.01	0.93	0.90	1.05	1.27	0.93	0.83	1.02	1.10
05Z851														
92335-522 x DP 9765	0.91	0.84	1.05	1.02	0.99	1.00	0.94	0.92	1.02	1.23	0.85	0.76	0.84	0.90
05Z864														
92335-522 x DP 9765	0.95	0.88	1.03	1.00	0.99	1.00	1.00	0.97	1.04	1.26	0.82	0.73	0.75	0.82
05Z715														
92335-522 x DPX 8C36	1.01	0.99	1.08	1.05	0.99	1.00	1.06	1.07	0.91	1.08	0.91	0.82	1.33	1.21
05Z841														
92335-522 x DPX 8C36	1.01	0.87	1.01	1.03	1.00	1.01	0.93	0.97	0.82	1.07	0.99	0.83	0.80	0.71
05Z847														
92335-522 x DPX 8C36	0.96	0.89	1.04	1.01	1.00	1.01	1.04	1.01	0.95	1.15	0.93	0.93	0.56	0.61
05Z714														
92335-522 x DPX 8C09	0.94	0.92	1.03	1.01	0.99	1.00	1.03	1.04	0.85	1.01	0.86	0.78	0.88	0.80
05Z749														
92335-522 x DPX 8C09	1.00	0.97	1.03	1.01	1.02	1.02	1.04	1.02	1.07	1.19	1.03	1.04	0.98	0.82
05Z800														
92335-522 x DPX 8C09	0.99	0.96	1.03	1.05	1.00	1.01	1.03	1.07	0.90	1.04	1.03	0.97	0.82	0.87
05Z823														
92335-522 x DPX 8C09	0.98	0.85	1.03	1.05	1.01	1.02	1.10	1.14	0.90	1.17	0.99	0.83	1.00	0.88
05Z850														
92335-522 x DPX 8C09	0.95	0.88	1.11	1.08	1.00	1.01	1.08	1.05	0.87	1.06	0.93	0.83	0.68	0.74
05Z863														
92335-522 x DPX 8C09	0.90	0.84	1.06	1.03	1.00	1.01	1.01	0.98	0.97	1.18	0.87	0.78	0.68	0.74
05Z873														
92335-522 x DPX 8C09	0.94	0.87	1.12	1.09	0.99	1.00	0.97	0.94	1.05	1.27	0.82	0.73	0.86	0.94
05Z874														
92335-522 x DPX 8C09	0.92	0.85	1.08	1.05	1.00	1.01	1.01	0.98	1.13	1.37	0.90	0.80	0.80	0.87
05Z875														
92335-522 x DPX 8C09	0.86	0.80	1.09	1.06	0.99	1.00	0.96	0.94	0.92	1.12	0.87	0.78	0.82	0.89
05Z750														
92376-520 x DP 675	0.93	0.91	1.03	1.01	1.01	1.01	1.07	1.05	0.98	1.09	1.06	1.07	0.87	0.73
05Z668														
92378-5150 x DPX 8C09	0.99	0.95	1.01	1.01	1.00	1.00	1.17	1.09	0.89	1.01	0.99	0.89	0.78	0.78

Table 4. Fiber characteristics and yield of improved lines after two cycles of selection in tests at Hartsville in 2003.

Line	Lint %	Micronaire	Length (inches)	Uniformity	Strength (g/tex)	Elongation (%)	Yield lbs/ac
05Z867							
92312-511 x DP 675	35.27	3.30	1.19	83.80	31.90	13.5	1420
05Z529							
92312-511 x DP 675	37.30	4.00	1.14	83.80	32.40	12.5	1489
05Z865							
92312-511 x DPX 8C01	34.28	3.40	1.15	83.10	34.20	13.5	1010
05Z715							
92335-522 x DPX 8C36	37.36	3.80	1.23	83.50	32.80	13.5	1316
FM 958	37.87	4.63	1.17	83.23	30.70	12.5	1087
SG 105	37.01	4.17	1.14	83.93	31.03	14.8	987