PERFORMANCE OF PIMA GERMPLASM LINES POSSESSING HIGH STRENGTH AND LONG LENGTH FIBER

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Abstract

Genetic variability available for the improvement of fiber strength and length within Pima cotton often occurs in genetic backgrounds that are unimproved or unadapted. The objectives of this project were to develop agronomically improved germplasm lines possessing high strength and long length fiber, and document the performance of these lines. Crossing was performed among germplasm lines possessing superior fiber strength or length in 1993 and 1994, followed by selection within the F_2, F_3, and F_4 generations. Ten selected progeny lines were evaluated for performance and fiber quality in replicated tests at Maricopa and Safford, AZ in 1999, and Shafter, CA in 2000. Among the five lines identified for germplasm release, four lines (93252, 94218, 94220, and 94217-19) produced yields not differing from the check cultivar Pima S-7 at Safford, AZ and Shafter, CA. Two of the five candidate lines (93252 and 94218) exceeded Pima S-7 in yield at Maricopa, AZ. Plant heights of candidate lines for release either did not differ from Pima S-7 or were slightly shorter than Pima S-7 at Maricopa, AZ (93252 and 93260-5). All lines tested produced greater fiber lengths than the Pima S-7 check at both the Maricopa and Safford, AZ locations. Across locations, fiber lengths of test lines ranged from 1.49 to 1.56 inches. All test lines had significantly stronger fiber than Pima S-7 at both Maricopa and Safford, AZ. Fiber strength improvement over Pima S-7 among lines identified for release ranged from 3.5 g/tex to 8.5 g/tex, depending upon line and location. All test lines produced lower lint percent and micronaire values than did Pima S-7 at both Maricopa and Safford, AZ. A release notice and formal release of 94220, 93252, 94218, 94217-19, and 93260-5 is scheduled for 2001.

Introduction

Genetic variability exists within the *Gossypium barbadense* L. species for fiber strengths and lengths in excess of values currently found in commercial American Pima cultivars. However, these sources of variability for improvement of fiber quality are often in genetic backgrounds that are agronomically unimproved or are not adapted to environmental conditions of the arid southwestern United States. The current project was begun with the objective of providing public and private breeders with heat-adapted, agronomically acceptable germplasm sources for improving fiber length and strength within Pima cotton. The performance and fiber characteristics of candidate lines for germplasm release are reported below.

Methods

In 1993 and 1994, crossing was performed among germplasm lines possessing superior fiber strength or length (Table 1). Genetic background of parents utilized in crosses varied from improved, elite Pima germplasm to an agronomically unimproved Sea Island cultivar and an environmentally unadapted Egyptian Giza cultivar (1,2,3). Pedigree breeding was practiced among progeny of crosses, with selection occurring in the F_2, F_3, and (sometimes) F_4 generations. The primary selection criterion was for plants possessing a high fiber strength - long fiber length combination. A strong secondary selection criterion was for plants possessing agronomic and performance traits such as yield, earliness, heat tolerance, and plant size. Putatively superior F_4 and F_5 progeny lines were identified for agronomic and fiber performance evaluation in replicated tests at Maricopa and Safford, AZ in 1999, and Shafter, CA in 2000. All tests were designed as randomized, complete blocks with four replicates. Plots within blocks consisted of four rows that varied in length between locations (14.6 m at Maricopa and Safford, 13.1 m at Shafter). All tests were managed using the standard farm practices of the three locations. The two center rows of each plot were mechanically harvested at season's end for fiber yield determination. Prior to harvest, 50- boll samples were hand harvested from each plot for determination of lint percent, boll weight, seed index, and fiber properties. Fiber properties were determined by STARLAB, Inc., using individual instrumentation (a stelometer was used for determining fiber strength). Fiber properties measured included 2.5% span length, fiber length uniformity, fiber bundle break strength, fiber elongation, and micronaire. Fiber data from the Shafter, CA were unavailable at the time of publication. Data were analyzed within and among tests using analysis of variance, general linear model.

Results and Discussion

Genotype by location interactions for lint yield were observed across the three locations of the evaluation. Among lines identified as candidates for release as germplasm, two lines (93252 and 94218) produced higher yields than the Pima S-7 check at Maricopa, AZ (Table 2). The other three candidate lines (94220, 94217-19, and 93260-5) did not differ in yield from Pima S-7. At the Safford, AZ and Shafter, CA locations, four of the five candidate lines (93252, 94218, 94220, and 94217-19) produced yields not differing from Pima S-7. Line 93260-5 produced yields substantially lower than the Pima S-7 check at both the above locations. Genotype by location interactions also occurred for the yield components lint percent, boll weight, and seed index. Averaged across locations, the lint percent of all test lines were lower than that of Pima S-7 (Table 3). Among the candidate lines for release, 94220 and 93252 produced the higher lint percentages. Boll weights of candidate lines varied from greater than Pima S-7 (93260-5), to equivalent to Pima S-7 (94220, 94218, and 94217-19), to lower than Pima S-7 (93252). Seed indices of seven of the ten test lines exceeded Pima S-7's seed index. Of the lines selected for release, 93252, 94218, and 93260-5 had greater seed indices than Pima S-7. The higher boll weights of 93260-5, 93260-6, and 94218 were surprising, since these lines appeared to have smaller bolls with "tight" fiber in the field. The discrepancy between observed boll size and measured boll weight may be due to the high seed indices of these three lines.

Plant heights at season's end at Maricopa, AZ and Shafter, CA were significantly impacted by fruit loss due to lygus damage and the resulting vegetative growth (Table 4). At the Maricopa location, two candidate lines for release, 93252 and 93260-5, were shorter than Pima S-7. The remaining candidate lines did not differ in height from Pima S-7. At the Safford, AZ location, all five candidate lines were equivalent to Pima S-7 in height. No plant height differences occurred among entries in the test at Shafter, CA.

All test lines produced greater fiber lengths than the Pima S-7 check at both the Maricopa and Safford, AZ locations (Tables 5 and 6). Fiber lengths among the candidate lines for release ranged from 1.50 in. for 94220 to 1.56 in. for 94218 at Maricopa, AZ. Fiber length among candidate lines ranged from 1.49 in. for 93252 to 1.54 in. for 93260-5 at Safford, AZ. None of the test lines differed from PS-7 in fiber length uniformity at Maricopa, AZ. At the Safford location, the candidate lines 93260-5 and 94218 possessed lower fiber length uniformities than the Pima S-7 check. All test lines had significantly stronger fiber than Pima S-7 at both Maricopa and Safford, AZ. Given that the historical stelometer strength average for Pima S-7 is 33.5 g/tex, there is evidence of negative environmental influences upon fiber strength in the Safford, AZ test. Regardless of the above, fiber strength improvement over Pima S-7 among candidate lines at Safford ranged from 3.5 g/tex for line 94218 to 7.7 g/tex for line 93252. At Maricopa, fiber strength improvement over Pima S-7 among candidate lines ranged from 3.5 g/tex for line 94218 to 8.5 g/tex for line 93252. Fiber elongation ranged from 6.4% in the candidate line 93252 to 7.3% in line

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94218 at Maricopa. Despite the broad range in elongation among lines selected for release, only one line, 93252, possessed a significantly lower fiber elongation than Pima S-7. At Safford, three candidate lines for release, 93252, 93260-5, and 94217-16, produced lower fiber elongation than Pima S-7. All test lines produced lower micronaire values than did Pima S-7 at both Maricopa and Safford, AZ. Among lines selected for release, 93252 had the highest micronaire at Maricopa and Safford (4.07 and 4.32, respectively), and line 93260-5 had the lowest (3.60 and 3.52, respectively). Given that high fiber strength and lower micronaire are often positively related in mature fiber, it is interesting to note that line 93252 had both the highest strength and the highest micronaire among the lines of the tests.

The lines selected for release, 94220, 93252, 94218, 94217-19, and 93260-5 possess superior fiber length and fiber strength. With the exception of 93260-5, the above lines possess yield potentials and plant heights that are within the range of a commercial Pima cultivar. All the release candidates display lower lint percents and micronaire values than the industry standard, Pima S-7. The presence of Sea Island and Giza cultivars in the pedigree of the lines make these lines a source for introducing or reintroducing genetic variability into Pima germplasm. A release notice and formal release of 94220, 93252, 94218, 94217-19, and 93260-5 is scheduled for 2001.

References

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Table 1. Parents used in crosses for fiber improvement in 1993 and 1994, and their origins.

Cross number	Female parent	Male parent
94217	**89590-7-8-7**[1]	**8810-51-4-1**
	(P62[2] X S .I. St. Vincent)	(P72 X P73)[3]
94220	**89590-7-12-2**	**8810-51-4-1**
	(P62 X S .I. St. Vincent)	(P72 X P73)
94222	**89590-7-8-7**	**8810-51-4-4**
	(P62 X S .I. St. Vincent)	(P72 X P73)
93253	**89590-7-8-5**	**8807-25-9-3**
	(P62 X S .I. St. Vincent)	(8006 X P73)
93260	**89590-7-8-4**	**89591-34-3-2**
	(P62 X S .I. St. Vincent)	(P62 X Giza 70)
93252	**89591-9-2-1**	**8807-25-9-3**
	(P62 X Giza 70)	(8006 X P73)
94218	**8915-13-7**	**8810-51-4-1**
	(P75 X P82)	(P72 XP73)

[1-3]References for origins and development of lines.

Table 2. Lint yield of improved fiber lines in tests at Maricopa, AZ and Safford, AZ in 1999 and in Shafter, CA in 2000.

	Lint Yield (lbs./acre)		
Entry	Maricopa 1999	Safford 1999	Shafter 2000
93252 *	1355 a†	814 bc	1305 abc
94217-16	1352 a	815 bc	1295 abc
94218 *	1303 ab	965 a	1401 ab
93253	1256 bc	729 cd	1388 ab
Pima S-7	1209 cd	883 ab	1360 ab
94217-19 *	1196 cd	838 b	1427 a
94220 *	1135 de	830 b	1289 abc
93260-5 *	1122 de	509 f	1154 c
93260-6	1094 e	615 e	1261 bc
93260-12	976 f	624 e	1267 bc
94222	913 f	698 de	947 d
Giza 70	222 g	359 g	-

* Lines proposed for release in 2001.

†Means in columns that are not followed by the same letter are significantly different at the 0.05 P level according to Waller-Duncan K-ratio t test.

Table 3. Lint percent, boll weight, and seed index of improved fiber lines averaged across the Maricopa, AZ, Safford, AZ, and Shafter, CA locations.

Entry	Lint percent	Boll weight	Seed index
	%	g/boll	g/100 seed
Pima S-7	37.8 a†	3.65 bc	13.0 ef
94220 *	36.3 b	3.43 cde	13.4 de
93252 *	36.0 b	3.34 de	14.8 ab
94217-16	35.6 b	3.33 de	13.6 d
94218 *	35.4 bc	3.63 bc	14.5 b
94217-19 *	34.5 cd	3.45 cd	13.1 def
93253	34.4 cd	3.45 cd	14.0 c
93260-5 *	34.0 de	3.95 a	14.6 b
93260-12	33.6 de	3.47 cd	12.9 fg
93260-6	33.4 de	3.80 ab	15.2 a
94222	33.3 e	3.39 de	14.9 ab

* Lines proposed for release in 2001.

†Means in columns that are not followed by the same letter are significantly different at the 0.05 P level according to Waller-Duncan K-ratio t test.

Table 4. Plant heights of improved fiber lines in tests at Maricopa, AZ and Safford, AZ in 1999 and in Shafter, CA in 2000.

	Plant height (m)		
Entry	Maricopa 1999	Safford 1999	Shafter 2000
Giza 70	2.45 a†	1.79 a	-
93260-12	1.67 b	1.17 b	1.43 a
94217-16	1.64 bc	1.00 cd	1.46 a
Pima S-7	1.61 bcd	0.95 cd	1.42 a
94217-19 *	1.59 bcde	0.91 cd	1.50 a
93253	1.54 cdef	1.01 c	1.51 a
94220 *	1.54 cdef	1.01 c	1.47 a
94218 *	1.52 def	0.92 cd	1.47 a
94222	1.51 def	0.96 cd	1.51 a
93252 *	1.50 ef	0.92 cd	1.35 a
93260-5 *	1.44 fg	0.97 cd	1.45 a
93260-6	1.37 g	0.89 d	1.33 a

* Lines proposed for release in 2001.

†Means in columns that are not followed by the same letter are significantly different at the 0.05 P level according to Waller-Duncan K-ratio t test.

Table 5. Fiber traits of improved fiber lines at Maricopa, AZ in 1999.

Entry	Length 2.5%	Unif. %	Strength T_1	Elong. E_1	Micro.
94218 *	1.56 a†	43.5 ab	36.1 cde	7.3 ab	3.92 cd
93260-6	1.55 a	44.3 ab	35.3 de	6.6 cde	3.60 ef
93260-5 *	1.55 a	42.7 b	37.0 bcd	6.5 de	3.60 ef
94217-19 *	1.54 a	45.5 a	37.6 bc	7.1 a-d	3.85 d
93252 *	1.54 ab	45.7 a	41.0 a	6.4 e	4.07 b
94222	1.51 bc	46.0 a	38.3 b	6.9 b-e	4.00 bc
93260-12	1.51 c	45.8 a	34.8 e	7.6 a	3.50 f
94220 *	1.50 c	45.5 a	36.2 cde	6.9 b-e	3.67 e
94217-16	1.50 c	45.2 ab	36.0 cde	7.0 a-e	3.90 cd
93253	1.50 c	45.7 a	35.5 de	7.2 abc	3.70 e
Giza 70	1.42 d	44.9 ab	32.1 f	6.7 b-e	4.37 a
Pima S-7	1.42 d	45.4 ab	32.5 f	6.9 b-e	4.40 a

* Lines proposed for release in 2001.

†Means in columns that are not followed by the same letter are significantly different at the 0.05 P level according to Waller-Duncan K-ratio t test.

Table 6. Fiber traits of improved fiber lines at Safford, AZ in 1999.

Entry	Length 2.5%	Unif. %	Strength T_1	Elong. E_1	Micro.
93260-6	1.56 a	42.0 e	33.4 d	7.1 bcd	3.50 g
93260-5 *	1.54 ab	41.2 e	35.5 b	7.2 bc	3.52 g
94218 *	1.53 bc	42.6 de	33.5 d	8.1 a	3.95 e
93260-12	1.53 bc	42.6 de	33.7 cd	8.1 a	3.50 g
94220 *	1.52 bc	45.1 abc	35.7 b	8.1 a	3.75 f
94217-16	1.52 bc	44.1 bcd	33.4 d	7.6 ab	3.97 e
94217-19 *	1.52 bc	44.6 abc	35.1 bc	6.7 cd	4.05 de
94222	1.51 cd	45.5 ab	35.2 b	7.2 bc	4.17 cd
93252 *	1.49 de	45.3 abc	37.6 a	6.5 d	4.32 b
93253	1.47 e	42.6 de	33.5 d	7.2 bc	3.55 g
Pima S-7	1.37 f	45.8 a	29.9 e	8.0 a	4.52 a
Giza 70	1.36 f	43.7 cd	29.4 e	7.6 ab	4.25 bc

* Lines proposed for release in 2001.

†Means in columns that are not followed by the same letter are significantly different at the 0.05 P level according to Waller-Duncan K-ratio t test.