

Production, Fiber Quality, and Ginning Performance of Low and High Pubescent Pima Cotton¹

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ABSTRACT

A high pubescent Pima (*Gossypium barbadense* L.) cultivar that has high yield potential and adequate fiber properties was identified and evaluated. Performance testing and fiber quality evaluation were obtained while developing these cottons. The high pubescent cultivar was found to have greater amounts of trash in the seed cotton samples after normal cleaning than low pubescent commercial cultivars. A ginning study was conducted to determine the effectiveness of two seed cotton cleaning treatments for removal of trash from the high pubescent, experimental cultivar and a low pubescent, commercial cultivar. A moderate seed cotton cleaning system was adequate for cleaning the low pubescent Pima cotton, but an elaborate seed cotton cleaning system was required for obtaining acceptable grades of the high pubescent Pima cotton. —

Additional index words: Roller ginned, Micronaire, Yarn tenacity, Motes, *Gossypium barbadense* L.

INCREASED yield is a primary objective of most cotton breeding programs. In the mid-1960's, many of the high yielding and early maturing preliminary test entries in the USDA-ARS Pima (*Gossypium barbadense* L.) Breeding and Improvement Program at El Paso, Tex. were observed to have high pubescence on all plant parts — stems, leaves, petals, and fruiting bodies. In these tests, many of the high pubescent entries averaged 10 to 20% more lint than did 'Pima S-3' (3), a recommended Pima cultivar for high elevations (over 750 m). One or more of these high pubescent entries produced, under certain environments, over 50% more lint than did Pima S-3. The high level of pubescence of these productive entries, however, causes trash and waste problems in ginning and processing.

A ginning test was undertaken to examine the trash and waste problems associated with high pubescent Pima material and determine if a more elaborate seed cotton cleaning system would result in a commercially acceptable quality of lint for the high pubescent cultivar. The high pubescent material has been observed to have increased foreign matter in the lint fraction and increased milling (picker, card, and comb) waste for samples submitted for small scale spinning tests at the Clemson Spinning Laboratory.

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MATERIALS AND METHODS

Progenies with high yield and early maturity were selected from the Pima breeding nursery at El Paso, Tex. These progenies were evaluated for fiber properties, and those with acceptable levels were entered in preliminary performance tests, followed by advanced and regional tests. The cultivars were installed in randomized complete block designs with six replications. Boll and fiber quality properties were obtained from 100-boll hand-picked seed cotton samples and were ginned on a 203 cm roller gin. Yield data were obtained by machine spindle picking the individual plots. The 12 and 7 tex yarn tenacity and milling waste values were obtained from a bulked machine picked lint sample at selected locations. Locations and years were treated as replications for these characters. Duncan's multiple range test was applied when the F-test was significant.

A highly pubescent line, 'E-1097 63-1216' (later designated 'E-2') consistently produced high lint yields and had adequate fiber properties at the high elevations in Texas. It was increased in 1971 so its ginning performance could be compared with the principal cultivar, 'Pima S-4', which was produced on approximately 95% of the Pima acreage. The two cotton cultivars were roller ginned with two levels of cleaning: a moderate or typical seed cotton cleaning system and a more elaborate seed cotton cleaning system (1). The moderate ginning setup included: drier (104 C inlet), six cylinder cleaner, stick machine, six cylinder cleaner, feeder, rotary knife roller gin, and two stages of mill-type lint cleaning. The elaborate ginning setup included: drier (104 C inlet), six-cylinder cleaner, stick machine, six cylinder cleaner, two tandem stick machines, six cylinder cleaner, feeder, rotary knife roller gin, and two stages of mill-type lint cleaning. Each gin cleaning treatment was applied to three replications of each cultivar. Duncan's multiple range test was applied when the F-test was significant.

Seed cotton samples from machine spindle picked seed cotton were taken from the field trailer and gin feeder apron for foreign matter and moisture determination. Lint samples were taken at the bale press for moisture, classification, Shirley Analyzer nonlint fraction, and other quality determinations. Lot weights of seed cotton, seed cotton cleaning systems trash, lint cleaning system trash, seed, and lint were taken for each cultivar.

RESULTS AND DISCUSSION

Performance and Fiber Quality

The preliminary test entries that were early-maturing and high-yielding were usually very pubescent. Many of these entries were discarded because of low 27 tex (22's cotton counts) yarn tenacity. One highly pubescent entry that survived several stages of screening was E-2. E-2 was compared with Pima S-3 in 14 preliminary tests from 1965 through 1970. Pima S-3 is a low pubescent cultivar recommended for high elevations. E-2 averaged 31% more lint than Pima S-3, with a range of 16% less lint to 300% more lint than Pima S-3. E-2 yielded less than Pima S-3 in only one test. E-2, compared to Pima S-3, is similar for fiber length and 27 tex yarn tenacity, but has coarser and whiter fiber. Feaster and Turcotte (3) reported high yields associated with whiter fiber. E-2 had more foreign matter, soil particles, and plant parts in the lint than Pima S-3. The bolls were produced lower on the plant, permitting rain to splash soil particles on

Table 1. Summary of 17 Pima Regional Tests in 1971-72 for yield, boll, and plant data for three cultivars.

Cultivar	Lint kg/ha	Lint %	Boll size g	Seed index g/100 seed	Lint index	Seed/boll no.	Plant height cm
High elevation—above 750 m							
E-2	953 a*	36.1 b	3.01 bc	12.1 a	6.9 ab	16.2 cd	93 c
Pima S-3	748 b	35.4 bc	3.58 a	12.3 a	6.7 b	18.9 a	83 c
Pima S-4	772 b	37.2 a	3.60 a	12.1 a	7.2 a	18.7 a	71 d
Intermediate elevation—450 to 750 m							
E-2	552 cd	34.7 cd	2.48 e	11.2 a	5.9 c	15.0 e	124 b
Pima S-3	527 cd	35.6 bc	3.10 bc	11.1 a	6.0 c	18.0 b	119 b
Pima S-4	544 cd	37.1 a	3.20 b	11.2 a	6.6 b	18.0 b	90 c
Low elevation—below 450 m							
E-2	583 c	32.2 e	2.71 d	12.5 a	5.9 c	14.8 e	166 a
Pima S-3	460 d	32.2 e	2.96 c	12.4 a	5.9 c	15.8 d	169 a
Pima S-4	800 b	34.3 d	3.31 b	12.7 a	6.7 b	16.8 c	122 b

* Means followed by the same letter in each column are not significantly different at the 0.05 level of probability when using Duncan's multiple range test.

Table 2. Summary of 17 Pima Regional Tests in 1971-72 for fiber and spinning data for three cultivars.

Cultivars	2.5% span length	Uni- formity	Micro- naire	Strength (T ₁)	Yarn tenacity			Milling waste	Colorimeter	
					27 tex	12 tex	7 tex		Reflect- ance	Hunter's + b
mm	ratio	unit	mN/tex	mN/tex			%	unit		
High elevation—above 750 m										
E-2	35.3 cd*	51 ab	4.22 a	284 d	170 e	147 a	127 b	29.9 a	72.7 a	9.0 cd
Pima S-3	36.3 ab	49 c	3.58 de	277 e	171 de	157 a	138 a	27.8 a	67.0 de	11.0 a
Pima S-4	35.7 bcd	50 bc	3.72 cd	283 d	173 d	156 a	136 a	26.5 a	70.0 c	10.3 ab
Intermediate elevation—450 to 750 m										
E-2	36.3 ab	49 c	3.97 b	292 ab	182 a				72.0 ab	7.7 e
Pima S-3	37.1 a	49 c	3.56 e	296 ab	179 bc				67.5 d	8.6 cde
Pima S-4	36.1 bc	49 c	3.80 c	290 bc	180 ab				70.3 c	8.2 de
Low elevation—below 450 m										
E-2	35.1 d	52 a	4.19 a	295 a	178 bc	151 a	130 b	43.8 b	70.7 bc	8.6 cde
Pima S-3	35.9 bcd	49 c	3.57 de	286 cd	176 c	161 a	139 a	35.3 ab	66.2 e	10.2 ab
Pima S-4	35.8 bcd	50 bc	3.75 c	296 a	178 bc	163 a	139 a	27.2 a	68.7 c	9.7 bc

* Means followed by the same letter in each column are not significantly different at the 0.05 level of probability when using Duncan's multiple range test.

the seed cotton. Also, the trichomes cause many plant parts such as bracts, leaves, and stems to adhere tenaciously to the seed cotton.

Pima S-4 is the principal cultivar grown at high elevations and was included with Pima S-3 as a check in the 1971-72 Pima Regional tests. E-2 produced 23 and 1% more lint than Pima S-4, at high (above 750 m) and intermediate (450-750 m) elevations (Table 1), respectively, but produced 23% less lint at low (below 450 m) elevations (2, 4). E-2 produced significantly smaller bolls and fewer seed per boll than Pima S-4 at all locations. E-2 and Pima S-3 had similar plant heights at all elevations; both were significantly taller than Pima S-4. E-2 has a slightly shorter 2.5% fiber span length and a slightly higher fiber length uniformity than Pima S-3 and Pima S-4 (Table 2). The reflectance (whiteness) was consistently higher and Hunter's + b (yellowness) was lower for E-2 than Pima S-3 and Pima S-4. E-2 fiber averaged 0.6 and 0.4 Micronaire units higher than Pima S-3 and S-4, respectively. The flat bundle strength (T₁) and 27 tex yarn tenacity were the same for E-2 and Pima S-4 at each elevation, but 7 tex (80's cotton counts) yarn tenacity of E-2 were weaker than those of Pima S-4. E-2 had higher total milling waste than the other cultivars. At Phoenix, Ariz., where E-2 is poorly adapted, it had a processing waste of 51.5% in 1971.

Table 3. Percent of foreign matter in wagon and feeder samples.

Gin cleaning treatment	Cultivar	Burs	Sticks	Fine trash	Motes	Total trash
Wagon foreign matter						
	E-2	2.5 a*	0.3 a	3.8 b	2.2 a	8.8 a
	Pima S-4	2.8 a	0.4 a	4.6 a	1.1 b	8.9 a
Feeder foreign matter						
Moderate	E-2	2.6 a*	0.5 a	1.9 a	1.5 a	6.5 a
	Pima S-4	1.2 b	0.4 a	0.8 c	0.6 b	3.0 b
Elaborate	E-2	0.9 b	0.3 a	1.3 b	0.8 ab	3.3 b
	Pima S-4	0.6 b	0.4 a	0.6 c	0.4 b	2.0 b

* Means followed by the same letter in each column for wagon or feeder foreign matter are not significantly different at the 0.05 level of probability when using Duncan's multiple range test.

Ginning Performance

The foreign matter contents of the machine-picked cottons are shown in Table 3. Seed cotton samples from the wagon showed significant differences between cottons for fine trash and motes. Fractionation data for the feeder samples are also shown in Table 3. These data along with seed cotton cleaning system performance data, (Table 4) show that less trash was removed from E-2 per unit of seed cotton input, and that E-2 had a lower seed cotton cleaning system efficiency than Pima S-4. Thus, the elaborate seed cotton

Table 4. Seed cotton cleaning system performance.

Gin cleaning treatment	Cultivar	Grams of trash removed per kg of seed cotton	Percentage of seed cotton cleaning efficiency based on total trash removed†
Moderate	E-2	53 c*	44.8 d
	Pima S-4	61 bc	59.3 c
Elaborate	E-2	73 b	64.9 b
	Pima S-4	98 a	75.4 a

* Means followed by the same letter in each column are not significantly different at the 0.05 level of probability when using Duncan's multiple range test.

† Efficiency computations based on collected trash weights from the seed cotton cleaning systems and lint trash measurements before lint cleaning.

cleaning system would be required to clean E-2 to a trash level similar to that obtained with the moderate system for Pima S-4.

The pubescent character of E-2 was expected to make fine trash removal difficult in seed cotton cleaning machines. The moderate seed cotton cleaning system removed 45% of the fine trash and motes present in the E-2 cotton compared to 73% removal from Pima S-4, based on the wagon and feeder fractionations data. The elaborate system removed 66% of the fine trash and motes from E-2 compared to 73% for Pima S-4 with the moderate seed cotton cleaning system. Even with elaborate seed cotton cleaning, E-2 had a 2 unit lower classer's grade than Pima S-4 with moderate cleaning. Most mills require Pima lint with a grade of 5 or better.

Classer's grade data (Table 5), show that E-2 was improved one full grade from the elaborate system, compared with the moderate system, whereas Pima S-4 was 0.7 of a grade lower with the elaborate system than with the moderate system. Shirley Analyzer data support the classer's grading and show the same trends for the desirability of moderate cleaning for Pima S-4 and elaborate cleaning for E-2. No differences were observed in classer's staple length from cleaning treatments of the two cottons.

Moisture contents were consistent between cultivars and gin treatments with averages of 8.6, 8.0, 4.8, and 9.6% for wagon seed cotton, feeder seed cotton, bale

Table 5. Classer's grade and Shirley Analyzer data from bale press lint samples.

Gin cleaning treatment	Cultivars	Classer's grade†	Shirley Analyzer total nonlint
Moderate	E-2	5.7 a*	4.7 a
	Pima S-4	3.0 b	1.6 c
Elaborate	E-2	4.7 a	3.3 b
	Pima S-4	3.7 b	1.8 c

* Means followed by the same letter in each column are not significantly different at the 0.05 level of probability when using Duncan's multiple range test.

† Pima lint grades range from 1 to 9, with 1 being the superior grade.

press lint, and ginned seed, respectively.

There were no differences in lint turnout attributable to the two cultivars or seed cotton cleaning systems. Average lint percentage was 32%.

The high pubescent E-2 responded to elaborate seed cotton cleaning more favorably than Pima S-4. Our results indicate that the moderate seed cotton cleaning system is adequate for processing low pubescence cottons like Pima S-4, but an elaborate seed cotton cleaning system would be required to satisfactorily process high pubescent cottons such as E-2. Lint from a high pubescent strain likely will be two to three grades lower than lint from a low pubescent strain if a moderate cleaning system is used, and from one to two grades lower if an elaborate cleaning system is used. The pubescent cotton would be acceptable in the trade only if the elaborate seed cotton cleaning system is used in ginning.

REFERENCES

1. Alberson, D. M., and V. L. Stedronsky. 1964. Roller ginning American-Egyptian cotton in the Southwest. Agric. Handb. No. 257. p. 45.
2. Feaster, C. V., and E. L. Turcotte. 1965. Fruiting height response: a consideration in varietal improvement of Pima cotton, *Gossypium barbadense* L. Crop Sci. 5:460-464.
3. ———, and ———. 1968. Association of color, yield, and quality of lint in Pima cotton. Crop Sci. 8:199-201.
4. ———, ———, and E. F. Young, Jr. 1967. Pima cotton varieties for low and high elevations. Crops Res., ARS 34-90, p. 11.