Published March, 1968

Association of Color, Yield, and Quality of Lint in Pima Cotton[1]

Carl V. Feaster and E. L. Turcotte[2]

ABSTRACT

In 1965 and 1966, an evaluation of 30 lines comprising experimental 'Pima' cotton (*Gossypium barbadense* L.) strain P17 showed whitish fiber to be associated with higher yield, longer fiber, coarser fiber, stronger yarn, and possibly stronger and less elastic fiber.

Yield was not correlated with percent lint or its components (seed index and lint index), but it was highly significantly positively correlated with fiber length for 1 of 2 years. Percent lint was negatively correlated with fiber length for both years. Since the yield and percent lint relationship was independent, the negative association of percent lint and fiber length was no barrier in obtaining a combination of high yield and high quality.

The lint of the higher-yielding, higher-quality lines is whiter than that of present commercial varieties. Color appears to have no bearing on the utility of lint.

Additional index words: **lint color correlations, cotton improvement, *Gossypium barbadense* L.**

COMMERCIAL 'Pima' cotton (*Gossypium barbadense* L.), as compared with Upland cotton (*G. hirsutum* L.), has creamy lint. Pima cotton also has longer, stronger, and finer fiber than Upland cotton. This has led the cotton classer and merchant to associate creamy lint with superior quality. The creamy appearance thus has served as a mark of quality. Certain recently developed experimental Pima cotton strains have whitish lint, and their lint qualities are equal or superior to those of creamy-colored, commercial varieties. The whitish color apparently has no bearing on the utility of cotton lint, but the cotton trade has expressed concern that whitish Pima cotton would confuse classing and marketing.

Lint of various shades of brown is found in many cotton species. Several workers (3, 4, 5, 6, 7) have shown brown lint to be associated with shorter fiber, finer fiber, or both. Ware and Benedict (8) recognized these associations, but indicated that the creamy fiber of Pima was not associated with reduced fiber quality or yield.

P17 is one of several experimental Pima strains that have whitish lint. P17 originated as a mass cross of the 30 F_4 plants included in a progeny row from F_3 selection 5818-58-3. The lint from P17 has reflectance (R_d) and yellowness (Hunter's +b) values of 70 and 8.8, respectively, compared with 69 and 10.2 for 'Pima S-2', and 76 and 8.1 for the Upland variety 'Acala 4-42' (2). The reflectance for P17 is much less than for Acala 4-42, but the degree of yellowness is nearer to Acala 4-42 than to Pima S-2. The progenies from the 30 plants comprising P17 were observed to differ in lint color and productivity. This study is an evaluation of the range in lint color among the 30 lines, and the association of lint color with yield, components of yield, and components of lint quality.

MATERIALS AND METHODS

The lines from the 30 plants comprising an experimental strain of Pima cotton, P17, were evaluated for lint yield, components of lint yield, components of lint quality, and lint color. The following yield and quality factors were considered: seed index, lint index, percent lint, fiber length, fiber strength, fiber elongation, fiber fineness, and yarn strength.

Seed index is the weight of 100 seed, in grams. Lint index is the weight of lint, in grams, from 100 seed. Percent lint is the weight of lint ginned from a sample of seed cotton, expressed as a percentage of the weight of seed cotton. Fiber length was measured on the Digital Fibrograph,[3] and expressed as 2.5% span length and 50% span length. The former is the length in inches on the test sample that is spanned by 2.5% of the fibers scanned at the initial starting point. The latter is the length in inches on the test sample that is spanned by 50% of the fibers scanned at the initial starting point. Fiber strength was measured in terms of grams per tex on a stelometer with clamp jaws 1/8 inch apart. Elongation was recorded as the percentage elongation at break of the center 1/8 inch of the fiber bundle used for measuring the T_1 (1/8 inch) strength on the stelometer. Fiber fineness was measured on the micronaire, and reported in micronaire units. Higher readings indicate coarser fiber. The yarn strength was determined for 22's count yarn by a small scale test at the U. S. Department of Agriculture Spinning Laboratory, Knoxville, Tennessee. Fiber color was determined on the Nickerson-Hunter Colorimeter (Spinlab model)[3], and recorded as R_d (reflectance) and Hunter's +b (yellowness). R_d is a measure of the percentage of reflectance, with higher values indicating lighter color fiber. Hunter's +b value is a measure of yellowness of the fiber, with higher values indicating greater yellowness.

Reflectance and yellowness were made on two sets of samples in 1965, and three sets in 1966. The measurements for 1965 were taken at Phoenix on blended fiber from 50-boll samples, and at Knoxville on samples for microspinning. The measurements for 1966 were taken at Phoenix on blended fiber from 50-boll samples, at Phoenix on samples for microspinning, and at Knoxville on samples for microspinning.

The 30 lines were grown with experimental strain P17 (a mass cross involving the 30 lines), and experimental strain P18. The test was a randomized block with four replications, and was grown near Safford, Arizona, in 1965 and 1966. Correlations involving yield were determined for the 30 lines from the mean values from the four replications. Correlations not

[1] Cooperative investigations of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the Arizona Agricultural Experiment Station, Tucson, Arizona. Journal paper No. 1259 of the Arizona Agricultural Experiment Station. Received August 31, 1967.

[2] Research Agronomist and Research Geneticist, Crops Research Division, ARS, USDA, University of Arizona Cotton Research Center, Phoenix, Ariz. 85040.

[3] The use of trade names does not imply their endorsement by the U. S. Department of Agriculture over similar products not mentioned.

involving yield were determined from the individual plot data. Mean values for correlations involving yield were employed because of the higher coefficient of variation for yield as compared with the coefficients of variation for other characters.

RESULTS AND DISCUSSION

The R_d values for fiber from the 30 lines comprising P17 ranged from 68 to 74, and the +b values ranged from 8.4 to 10.6. Thus, certain lines gave a reflectance which approached Acala 4-42 ($R_d = 76$), and other lines gave less reflectance than Pima S-2 ($R_d = 69$). Similarly, certain lines were almost as light yellow as Acala 4-42 (+b = 8.1), and other lines were more yellow than Pima S-2 (+b = 10.2).

The above color ranges were based on colorimeter readings made at Knoxville, so as to be comparable with data for Acala 4-42 and Pima S-2. Table 1 includes coefficients of variation for the two determinations in 1965 of R_d and +b for the 30 lines comprising P17, three determinations in 1966, and year-to-year correlations of these determinations. The low coefficients of variation, and the high year-to-year correlations for blended fiber from 50-boll samples indicate these samples to be most consistent. The blended samples gave slightly higher reflectance and greater yellowness.

The colorimeter values from the blended samples were employed in determining the correlations given in Table 2. In 1965, whitish fiber as indicated by greater reflectance (R_d) was highly significantly associated with higher yield, lower lint index, lower percent lint, longer fiber, stronger fiber, lower fiber elongation, stronger yarn, and was significantly associated with coarser fiber. R_d was not associated with seed index. Likewise in 1965, whitish fiber as indicated by lesser yellowness (+b) was highly significantly associated with higher yield, lower lint index, lower percent lint, longer fiber, stronger fiber, lower fiber elongation, coarser fiber, and stronger yarn. In 1966, the associations were generally lower, and the correlations of fiber color with fiber strength and fiber elongation failed to reach the level of significance. Again, no association was shown between fiber color and seed index. Correlations of R_d and +b were −0.878 and −0.897 in 1965 and 1966, respectively. The correlations for both years were highly significant.

Among these lines, whitish lint (high reflectance and lesser yellowness) was favorably associated with both yield and quality. This suggests a deviation from the generally accepted negative association between fiber quality and yield, since fiber yield, length and strength were positively correlated with a common character. Yield is usually positively correlated with lint index and percent lint, and these have been reported as negatively correlated with fiber quality — particularly fiber length (1, 4, 5). Among the 30 P17 lines, yield was not correlated with percent lint or its components (seed index and lint index), but it was highly significantly positively correlated with fiber length for 1 of the 2 years (Table 3). Percent lint was negatively correlated with fiber length for both years. Within this material, the higher yielding lines appear to be dependent on yield factors other than increased percent lint. Thus, the negative association of percent lint and lint quality is of no consequence in the yield-quality relationship.

The whitish lint observed among the P17 lines and other current Pima breeding strains is probably the result of *G. hirsutum* chromatin introgression into *G. barbadense*. Continued selection pressure for high yield, and high quality appears to have resulted in an accompanying selection for whitish lint. This is evidenced by an increasing proportion of high-yielding, high-quality strains with whitish lint now appearing in the Pima improvement program.

Table 1. Coefficients of variation for two determinations of R_d and Hunter's +b for fiber from 30 lines of Pima cotton strain P17 in 1965, three determinations in 1966, and year-to-year correlations for these determinations.

	Coefficient of variation		1965-66 correlation
	1965	1966	
R_d from blended, Phoenix	0.75%	0.97%	.790*
R_d from microspin, Phoenix		1.67%	
R_d from microspin, Knoxville	2.02%	1.84%	.655*
Hunter's +b from blended, Phoenix	1.43%	2.45%	.871*
Hunter's +b from microspin, Phoenix		4.42%	
Hunter's +b from microspin, Knoxville	4.19%	3.74%	.776*

* Significant at 1% level.

Table 2. Correlations of R_d and Hunter's +b fiber color values with yield, components of yield, components of fiber quality, and yarn strength for 30 lines of experimental Pima cotton strain P17.

	1965		1966	
	R_d	Hunter's +b	R_d	Hunter's +b
Lint yield	.689**	−.755**	.364*	−.381*
Seed index	.016	−.118	.022	−.110
Lint index	−.517**	.446**	−.327**	.279**
Percent lint	−.502**	.529**	−.403**	.432**
Fiber length (2.5% span)	.700**	−.807**	.653**	−.703**
Fiber length (50% span)	.445**	−.588**	.457**	−.410**
Fiber strength (T_1)	.333**	−.384**	.139	−.162
Fiber elongation (E_1)	−.244**	.273**	−.134	.128
Fiber fineness (Micronaire)	.204*	−.240**	.221*	−.231*
Yarn strength (22's count)	.328**	−.397**	.232*	−.330**

* Significant at 5% level. ** Significant at 1% level.

The longer, stronger, and finer fiber of commercial Pima relative to Upland cotton is marked by its creamy color. Traditionally, creamy fiber has been associated with high fiber quality; although color, per se, has no bearing on spinning performance. Among Pima strains, the association of creamy color with high quality does not necessarily apply. In this study, many of the higher-quality, higher-yielding strains have whitish lint. The positive correlations of whitish lint with both high productivity and high quality explain the fact that certain of the most desirable experimental strains of Pima have whiter lint than present commercial varieties.

Classing standards for Pima cotton discriminate against whitish cotton. Therefore, the release of a commercial Pima variety with whitish lint would require changes in classing standards.

Table 3. Correlations of yield, and percent lint with components of yield, components of percent lint, components of fiber quality, and yarn strength for 30 lines of experimental Pima cotton strain P17.

	Yield		Percent lint	
	1965	1966	1965	1966
Seed index	.131	.323	−.505**	−.266**
Lint index	−.124	.205	.569**	.625**
Percent lint	−.174	−.072		
Fiber length (2.5% span)	.656**	.295	−.585**	−.485**
Fiber length (50% span)	.468**	.259	−.565**	−.339**
Fiber strength (T_1)	.353	.143	−.409**	−.170
Fiber elongation (E_1)	−.284	−.050	.323**	.041
Fiber fineness (Micronaire)	.284	.368*	−.242**	−.007
Yarn strength (22's count)	.433*	.319	−.528**	−.170

* Significant at 5% level. ** Significant at 1% level.

LITERATURE CITED

1. AL-JIBOURI, H. A., P. A. MILLER, and H. F. ROBINSON. 1958. Genotypic and environmental variances and covariances in an Upland cotton cross of interspecific origin. Agron. J. 50:633-636.
2. ANONYMOUS. 1966. Results of 1965 regional cotton variety tests. Crops Research, ARS 34-82.
3. HARLAND, S. C. 1935. The genetics of cotton. XIV. The inheritance of brown lint in New World cottons. J. Genet. 31:27-37.
4. KEARNEY, T. H. 1926. Correlations of seed, fiber, and boll characters in cotton. J. Agr. Res. 33:781-796.
5. KOTTUR, G. L. 1923. Studies in inheritance in cotton. I. History of a cross between *Gossypium herbaceum* and *Gossypium neglectum*. Mem. Dep. Agric. India, Bot. 12:71-133.
6. RICHMOND, T. R. 1943. Inheritance of green and brown lint in Upland cotton. J. Amer. Soc. Agron. 35:967-975.
7. SILOW, R. A. 1944. The inheritance of lint colour in Asiatic cottons. J. Genet. 46:78-115.
8. WARE, J. O., and L. I. BENEDICT. 1962. Colored cottons and their economic value. J. Heredit. 53:57-65.