FINENESS, MATURITY, MICRONAIRE AND DYEABILITY OF TWO ACALA COTTONS

John W. Pellow, H. B. Cooper, Jr.,
John C. Palmer and Kelley E. McRae
J. G. Boswell Cottonseed Breeding
Corcoran, CA

Abstract

The basis for the 0.25 unit higher micronaire of El Dorado compared to Maxxa was investigated. Fiber samples from both replicated test plot samples and from bale lot sized tests were examined. Measurements of micronaire, fineness and maturity were made using the Spinlab 675, FMT III, Arealometer, AFIS L&D, AFIS F&M, HVI, NIRA, MANTIS and image analysis. All data showed El Dorado to have a higher micronaire resulting from a significantly higher maturity. Dispite the higher micronaire, El Dorado fiber had a smaller perimeter and therefore was a finer fiber. El Dorado fiber was finer at a 4.6 micronaire than Maxxa was at 4.1. Therefore, micronaire can not be generally used as a measure of coarseness. El Dorado also showed improved dyeability and fewer white specks than Maxxa which were likely ramifications of the higher fiber maturity.

Introduction

The release of a new cotton variety for commercial production in the San Joaquin Valley is regulated by the San Joaquin Valley Cotton Board (previously known as the Acala Cotton Board). An experimental variety must be tested for three years in the SJVCB tests and compared to the variety standard which is set by the Board. In order to be released for commercial production, the experimental variety must equal the performance of the standard variety and exceed it in at least one meaningful respect.

At the 1988 Beltwide Cotton Production Conferences, Cooper, et. al. (1) reported on an experimental variety (C-30) that was excluded from evaluation in the Acala Cotton Board testing program because of high micronaire. The concern was that micronaire is generally considered a measure of coarseness and that it might be difficult to sell the C-30 lint. The fiber and yarn traits of C-30 when compared to the standard variety did not support the hypothesis that it was a coarse fiber. Subsequent microscopic evaluations revealed that C-30 fiber had a smaller perimeter (finer) with a thicker cell wall and higher degree of circularity (more mature). Therefore, the high micronaire appeared to be result of high fiber maturity and not fiber coarseness.

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In 1991, we began testing strain B3991 and entered it into the SJVCB testing program in 1992 as PHY-27. It was released for commercial production in 1995 as El Dorado Acala. During the four years of testing we recognized many of the same fiber characteristics of C-30 in El Dorado. Particularly, the higher micronaire along with higher fiber and yarn strength than the standard variety. This along with the reduced level of manufacturing waste and improved yarn uniformity made us question whether the higher micronaire was a result of coarseness. The fiber, spinning and processing characteristics of this variety are being presented by Palmer, et. al. (2) and Cooper, et. al. (3) at this 1996 Beltwide Cotton Production Conference. The objectives of the work presented in this paper were to determine the basis of the higher micronaire in El Dorado Acala as compared to Acala Maxxa and to demonstrate some of the positive aspects of El Dorado Acala fiber that possibly result from higher micronaire.

Materials and Methods

In this study, Acala Maxxa was used as a comparison variety because it is the current variety standard set by the SJVCB to which all experimental varieties must be compared in order to be released for commercial production in the San Joaquin Valley of California. The data presented in Tables 1 through 4 were obtained from fiber samples of replicated test plots grown in the San Joaquin Valley between 1992 and 1994. All tests (locations) were in a randomized complete block design with 4 replications. Two or four determinations were made for each measurement on each sample. The data presented in Tables 5 through 9 and Figures 1 and 2 were obtained from fiber samples prepared in the following manner. Five bales of both Acala Maxxa and El Dorado Acala, produced in the Tulare Lake Basin of the San Joaquin Valley, were sent to Mr. Ken Bragg at USDA-ARS Clemson. He blended and sampled each bale and sent subsamples to the following labs where the indicated tests were performed:

1.) J. G. Boswell Cotton Seed Breeding: Spinlab 675 Micronaire, Shirley FMT III.
2.) USDA-AMS Cotton Division Laboratory-Memphis: HVI.
3.) USDA-Southern Regional Research Center-New Orleans: fiber cross sections, image analysis, MANTIS.
4.) USDA-ARS Cotton Quality Research Station-Clemson: white speck counts.
5.) Starlab-Knoxville: Arealometer.
6.) Parkdale Mills-Belmont, NC: HVI, NIRA, AFIS F&M, knitted fabric dyeing.

Results and Discussion

In the early stages of testing, El Dorado demonstrated very good basic fiber properties with length equal to Maxxa and length uniformity, stelometer T1, and elongation superior to Maxxa (2, 3). The micronaire of El Dorado was 0.25 units higher than Maxxa when averaged over three years and 17 locations as determined at the J. G. Boswell Breeding Lab (Table 1). The same difference was found in

a subset of 8 of these locations over the same three years and measured at the ITC Lab in Lubbock, Texas. The fiber was then spun into 50's count carded and combed yarns. The results showed El Dorado to be superior in all processing, single yarn and skein properties (2, 3). These spinning results would not be expected if the higher micronaire of El Dorado was a result of coarseness.

A more detailed study on micronaire, maturity and fineness was conducted on fiber samples of El Dorado and Maxxa from three locations in each of two years. The higher micronaire of El Dorado in this subset of six locations (Table 2) is statistically significant and similar in magnitude to the larger comparison in Table 1. Fiber maturity is compared in Table 3 and shows that El Dorado had a significantly more mature fiber irrespective of the instrument used or the type of measurement taken. Fiber fineness is compared in Table 4. Gravimetric fineness (linear density) was measured by the FMT III and the Arealometer. Perimeter was calculated based on the respective data. Diameter was determined by the AFIS L&D and perimeter was calculated for comparison to the other instruments. All instruments indicated that El Dorado had a finer fiber. Furthermore, all differences were statistically significant except for the linear density measurement on the FMT III. This combination of high micronaire, with a highly mature yet fine fiber along with superior yarn strength and processing characteristics showed great potential.

To further study the performance of the El Dorado fiber-type, five bales from each of El Dorado and Maxxa were sampled as described in the Methods and Materials. The average micronaire of the five bales of El Dorado was significantly higher by 0.5 to 0.6 units (Table 5). A difference this large is not typical when the two varieties are grown in replicated tests (Table 1 & 2). The f value which is a micronaire equivalent from the AFIS F&M also shows El Dorado to have a significantly higher micronaire but with a smaller difference. Fiber maturity of the bale lot samples is compared in Table 6. All measurements from all of the instruments showed El Dorado to have a significantly higher maturity and the AFIS F&M and Arealometer showed it to have a thicker cell wall. Fiber fineness measurements on the same samples are shown in Table 7. Indirect determinations of biological fineness using the FMT III, Arealometer, and MANTIS again showed El Dorado to have a significantly smaller perimeter. The measurements of gravimetric fineness were less discrete. The Arealometer showed El Dorado to have a significantly lower linear density than Maxxa. The FMT III measured the two varieties to be equal and the AFIS F&M showed El Dorado to have a significantly higher linear density than Maxxa. We do not understand the differences between these three instruments with respect to the linear density measurements. We would have to question whether the instrument calibration procedures and the standard cottons that were used were equivalent.

To ultimately determine the structure of the El Dorado fiber, cross sections were made from the bale lot samples. A photomicrograph of the comparison to Maxxa is shown in Figure 1. More thin-walled flattened fibers can be seen in the Maxxa sample whereas more of the El Dorado fibers have thicker cell walls and more circular. These interpretations are supported by the image analysis data from these samples (Table 8). Three hundred cross sections from each of two samples for both El Dorado and Maxxa were measured. These results confirm the previous fineness and maturity data. These data show that in samples where the micronaire of El Dorado is 4.6 and Maxxa is 4.1 the fibers of El Dorado are finer (smaller perimeter) and more mature (greater circularity).

Figure 2 shows knitted fabric made at Parkdale Mills from the bale lot samples. The fabric has alternating sections of El Dorado, Maxxa and SJ2. The fabric was dyed according to the red/green differential dye uptake test for maturity (4). Maxxa has dyed slightly less green than SJ2 whereas El Dorado clearly stands out as being more red and therefore containing more mature fibers. Other pieces of the same fabric were dyed with blue dye. These swatches show that fabric from El Dorado has a "richer" blue color to the trained eye. Digitally scanned images of these fabrics did not readily show these differences and are not shown here. The dyed fabric is available. White specks are another aspect of dye uptake that is related to fiber maturity. White specks (immature fiber neps) were counted in dyed fabric produced from carded 40's and combed 50's count yarns (Table 9). In these data El Dorado has fewer white specks than Maxxa and significantly less in the fabric from the carded 40's count yarn. The lack of statistical significance in the fabric from the combed 50's yarn is likely due to the small number of samples that were counted.

Summary

El Dorado is a cotton variety for the San Joaquin Valley that has a higher micronaire than Maxxa, the SJV variety standard. The higher micronaire is a reflection of the higher fiber maturity and does not indicate coarseness. El Dorado fiber at a micronaire of 4.3 or 4.6 is finer than Maxxa at a micronaire of 4.1. This is evidence that micronaire is not a ready measure of coarseness as it is quite often used. This data also indicates that high micronaire can be a beneficial characteristic if the fineness of the fiber is known. Furthermore, the information presented in this paper demonstrates the immediate need for the development of instrumentation and its incorporation into the classing system that will provide reliable measures of fineness and maturity so that superior fiber such as that from El Dorado can be recognized rather than rejected based on micronaire.

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Table 1. Comparison of micronaire: Over years - Maxxa vs. El Dorado.

	Maxxa	El Dorado
J. G. Boswell Lab (17 Locations, 1992-94)	3.89	4.14*
ITC Lab (8 Locations, 1992-94)	4.00	4.25*

* significantly different at a = .05

Table 2. Comparison of micronaire: Test plots - 6 locations - 1992-93.

	Maxxa	El Dorado
Spinlab 675	4.04	4.27*
FMT III	4.15	4.33*

* significantly different at a = .05

Table 3. Comparison of fiber maturity: Test plots-6 locations - 1992-93.

	Maxxa	El Dorado
Maturity Ratio (FMT III)	1.02	1.11*
Immaturity Ratio (Area.)	1.79	1.53*
% Maturity (FMT III)	89.1	94.9*
% Maturity (Area.)	82.0	91.7*
Wall Thickness (Area.)	2.58	2.80*

* significantly different at a = .05

Table 4. Comparison of fiber fineness: Test plots-6 locations - 1992-93

	Maxxa	El Dorado
Biological Fineness		
Perimeter (FMT III)	46.86	44.61*
Perimeter (Area.)	48.07	42.55*
Diameter (AFIS)	13.30	13.10*
Perimeter (AFIS)	41.70	41.02*
Gravimetric Fineness		
Fineness (FMT III)	156	153
Weight Fineness (Area.)	3.98	3.64*

* significantly different at a = .05

Table 5. Comparison of micronaire: Bale lots - 1993.

	Maxxa	El Dorado
Spinlab 675 (JGB)	3.78	4.46*
HVI (USDA-Memphis)	4.10	4.60*
HVI (Parkdale)	3.9	4.5*
HVI (Cotton Inc.)	4.14	4.66*
FMT III (JGB)	4.11	4.64*
f (AFIS-Parkdale)	4.50	4.63*

* significantly different at a = .05

Table 6. Comparison of fiber maturity: Bale lots - 1993.

	Maxxa	El Dorado
Maturity Ratio (FMT III)	0.91	1.08*
Maturity Ratio (AFIS)	0.83	0.95*
% Maturity (FMT III)	80.9	93.2*
% Maturity (Area.)	79.0	97.2*
% Maturity (AFIS)	74.8	84.2*
Maturity (NIRA)	73.3	76.6*
Theta-Circularity (AFIS)	0.459	0.530*
Wall Thickness (Area.)	2.46	3.02*

* significantly different at a = .05

Table 7. Comparison of fiber fineness: Bale lots - 1993.

	Maxxa	El Dorado
Biological Fineness		
Perimeter (FMT III)	51.88	47.70*
Perimeter (Area.) 48.51	40.02*	
Ribbon Width (Mantis)	13.92	13.37*
Gravimetric Fineness		
Weight Fineness (Area.)	3.87	3.55*
Fineness (FMT III)	171	171
Fineness (AFIS) 158	170*	

* significantly different at a = .05

Table 8. Comparison of image analysis data from fiber cross sections.

	Maxxa	El Dorado
Perimeter (um)	59.3	51.5
Std. dev.	9.7	8.1
Area (um^2)	155	143
Std. dev.	52	38
Circularity	0.56	0.68
Std. dev.	0.15	0.14

Table 9. Comparison of White Specks in knitted fabric.

	Maxxa	El Dorado
Carded 40's	63	19*
Combed 50's	33	9

* significantly different at a = .05

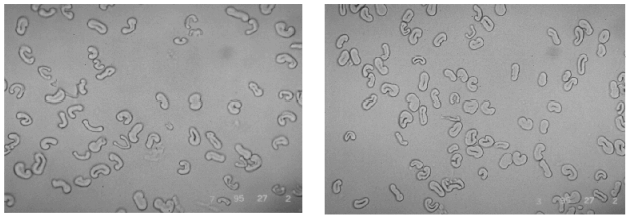

Figure 1. Comparison of fiber cross sections between Maxxa and El Dorado.

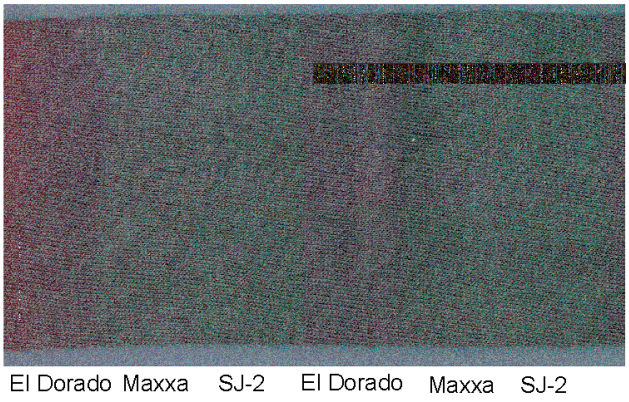

Figure 2. Red/Green differential dye uptake of El Dorado, Vaxxa and SJ-2.