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Microscopic Confirmation of Cotton Fiber Maturity Measurements

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Fast, accurate and cost effective methods for measuring wall thickness, or maturity, of cotton fibers are in continuing development. Some of these methods are direct and are based on microscopic measurements of actual fiber diameters. Some are indirect methods based on measurements or observations of some related secondary characteristics. Although the intent of all these methods is to measure the amount of development of the fiber secondary wall, they do not all report data in the same format, nor do all measured data between the systems correlate. When maturity data taken on a set of samples using several methods for measuring were compared, obvious differences in results could be seen. Data on a set of two cotton varieties grown in three locations is shown in Table I. Differences in maturities of samples grown in Georgia, Mississippi, and Texas are shown by all methods. Exact values cannot be compared since all values are not reported in the same terms. However, it is possible to compare maturity values of cottons from the three locations within each method. In most of the data sets it can be seen that maturity of the Texas samples is lower than that of either of the other two. However, in both the Image Analysis (IA) and AFIS Pro data, this difference is not shown. Image analysis is a computerized microscopic method, and AFIS Pro is an updated AFIS instrument, and data from these methods would be expected to accurately show these variations. This report provides some examination of procedures used by the various methods to determine whether it is possible to find reasons for these differences. To better understand the samples, they were dyed using the differential dye technique of Goldthwait [1]. In this two-dye system immature fibers dye green, and mature fibers red. For the initial dye experiment, samples directly from the bale were used. Because fibers have not been combed or blended, bundles of green fibers remain clumped in all samples. Although the Georgia and Mississippi grown samples are predominantly red or mature, the bundles of green fibers indicate that seed containing all immature fibers were harvested with the sample. Fiber bundles taken from all of the samples were sectioned using the Hardy hand sectioning device [2]. Dyed bundles for one fiber variety, and resultant cross sections are shown in Fig. 1. The sections showed more red fibers in the Georgia and Mississippi samples, and more green fibers in the Texas samples. Even the more mature samples contain inseparable clumps of extremely immature green fibers that affect maturity measurements if they are present during testing. Therefore, a preparation procedure before maturity measurement must consider whether these fibers will be removed. All of the dyed samples contained undyed, white-appearing materials. These were removed and examined using scanning electron microscopy. Figure 2 is an illustration of such a bundle. At low magnification (left) composition of the bundle cannot be determined, but at higher magnification extremely thin fibers without secondary wall development can be identified. These fibers cannot be dyed and form defects in the final textile product. When bale samples are hand-combed to remove clumped fibers, a greater amount of the sample from very immature samples is removed than from more mature samples. There is, however, no set protocol for amount of combing used in the various measurement methods. Therefore, combing can improve maturity data for immature samples more than for mature samples. The combed samples show more homogeneity, but almost half the sample was lost. Methods of selecting fibers for measuring are important factors in the maturity value determined.

References

[1.] Goldthwait, C. F. et al., Textile World, July, 1947, p106-110, ASTM D 1464-90

[2.] Hardy, J. I., U. S. Department Agricultural Circular 378, 1935

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TABLE 1.

Maturity Data Table

ID	State	Mic[3]	Mic[4]	Micron[1]	Theta[1]	Theta[2]	Mat Ratio[4]	400-2500 nm[5]	1100-2500 nm[5]	Mat Ratio[6]
		HVI	FMT	AFIS V2	AFIS V2	IA	FMT	NIR Mat	NIR Mat	AFIS Pro
FM832	GA	4.03	3.97	3.718	0.471	0.48	0.79	0.787	0.806	0.92
FM832	MS	3.97	3.89	3.605	0.460	0.59	0.81	0.821	0.806	0.90
FM832	TX	2.89	2.79	3.042	0.415	0.44	0.65	0.647	0.642	0.85
FM966	GA	4.34	4.28	3.940	0.473	0.48	0.82	0.813	0.827	0.92
FM966	MS	4.53	4.49	4.253	0.493	0.50	0.85	0.855	0.849	0.91
FM966	TX	3.19	3.18	3.279	0.432	0.53	0.70	0.687	0.690	0.87

1 AFIS V2 — G Davidonis/K Pusateri/G Richard
2 Image Analysis — D Thibodeaux/ J Moraitis
3 HVI — D McAllister/ L Cui
4 FMT — J Montalvo/ T Von Hoven
5 NIR — J Montalvo/ T Von Hoven
6 AFIS Pro — J Campbell/ K Blakes

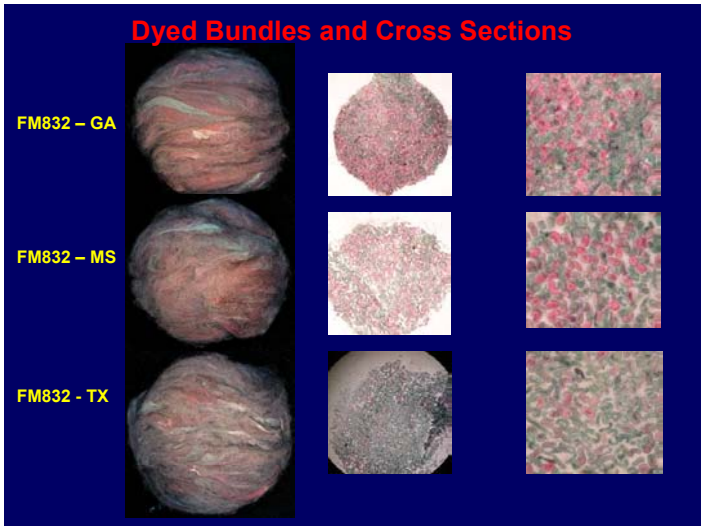

FIGURE 1.

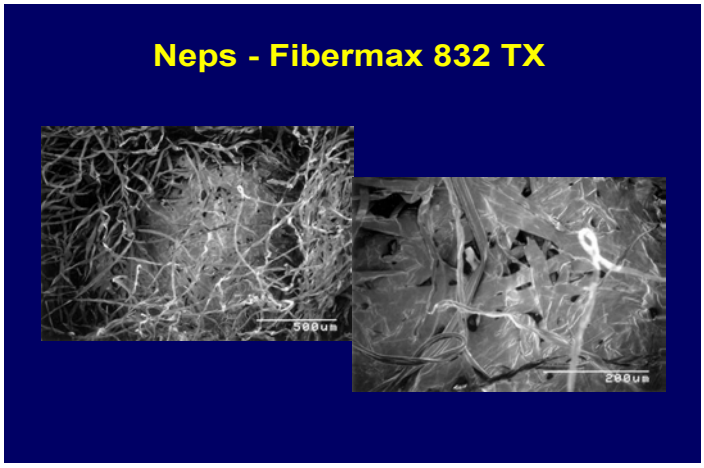

FIGURE 2.

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