COMPARISONS OF COTTON MATURITY AND FINENESS MEASUREMENTS (COTTONSCOPE, AFIS, HVI™) J. E. Rodgers C. D. Delhom X. Cui USDA-ARS-SRRC New Orleans, LA

<u>Abstract</u>

The Cottonscope, a new instrument for fiber maturity (MR) and fineness, utilizes polarized light microscopy and image analysis to measure longitudinal, weighted fiber snippets in water. Interest has been expressed by the Commercial Standardization of Instrument Testing of Cotton (CSITC) on the potential of using the Cottonscope in CSITC Round Trials. Preliminary CSITC comparative analyses were performed on a set of diverse cotton samples. The AFIS maturity and fineness, HVI[™] maturity, and Cottonscope maturity (MR) and fineness results were compared. In addition, MR and fineness results were inserted into the Lord equation to obtain calculated micronaire results for each instrument, and the calculated micronaire was compared to HVI[™] micronaire for each sample. Overall, good instrument trend agreement was observed between the MR and fineness results. For calculated micronaire, the best method agreement to HVI[™] micronaire was obtained with the Cottonscope instrument. As observed in previous evaluations, the AFIS results were less responsive to changes in MR, fineness, and calculated micronaire compared to the Cottonscope.

Introduction

Maturity is a measure of the fiber's degree of development (often expressed as maturity ratio or MR), and fineness is a measure of the fiber's diameter or size (e.g., linear density) (Wakelyn et. al., 2007). Although maturity and fineness are important cotton fiber properties, they are normally very difficult to measure directly. Thus, the fiber's micronaire is often used to indicate the fiber's maturity and fineness. The relationship between micronaire and maturity and fineness is quadratic (Lord et. al., 1956), as shown in equation 1.

 $M^{*}H = 3.86^{*}Mic + 18.16^{*}Mic + 13$, where M = maturity ratio or MR, H = fineness, and Mic = micronaire.

Much interest has been expressed internationally in fast, precise, and accurate <u>direct</u> measurements of cotton fiber maturity (MR) and fineness. The Cottonscope is a new commercial instrument that meets these needs (Figure 1). The Cottonscope utilizes polarized light microscopy and image analysis to measure longitudinal, weighted fiber snippets in water. The Cottonscope measures cotton fiber maturity, fineness, and ribbon width rapidly, accurately, and precisely. Previous evaluations have shown that the Cottonscope exhibits very good agreement with the image-analysis of cross-sectional fiber (IAM) reference method for MR and fineness (Paudel et.al., 2013; Naylor et. al., 2011; Rodgers, 2012; Rodgers et.al., 2013).

Interest has been expressed by the Commercial Standardization of Instrument Testing of Cotton (CSITC) of the International Committee on Cotton Testing Methods (ICCTM) of the International Textile Manufacturers Federation (ITMF) on the potential of using the Cottonscope in CSITC Round Trials for MR and fineness. A program was implemented to compare various MR and fineness measurements using the Uster[®] HVITM (MR), Uster[®] AFIS (MR and fineness), and Cottonscope (MR and fineness) instruments. In addition, micronaire was calculated from the AFIS and Cottonscope MR and fineness results for each sample, and the calculated micronaire compared to the HVITM micronaire.

(1)



Figure 1. Cottonscope system (image analysis module, knife cutter, computer).

Material and Methods

The cotton fiber samples used in this evaluation consisted of 39 lint cottons with a wide MR and fineness range (0.59-1.05 MR, 76.8-237.2 mtex fineness). Fifteen of the samples were CSITC Round Trial samples (5 each from 2009, 2010, and 2012), and 6 samples were ICA Round Trial samples (1 U.S. and 5 international samples). Each sample was measured on the HVI^M, AFIS, and Cottonscope instruments, using standard HVI^M, AFIS, and Cottonscope procedures. The Cottonscope MR and fineness results were used as the comparative reference values for this evaluation (largest range of MR and fineness for the 3 methods evaluated). The following measurements were performed:

- HVI[™]: MR and micronaire
- AFIS: MR and fineness
- Cottonscope: MR and fineness

All measurements were made under standard environmental conditions (21±1°C and 65±2% relative humidity/RH).

Direct comparisons were performed between the HVI^{TM} , AFIS, and Cottonscope MRs and the AFIS and Cottonscope fineness values. For the Cottonscope and AFIS results, the fiber micronaire for each sample was calculated from the MR and fineness results using the Lord equation (equation 1), and the calculated micronaires compared to the HVI micronaire results.

The comparison parameters included R^2 , slope/linearity, Standard Deviation of Differences residual analysis (SDD, the standard deviation of the differences between the reference and measured maturity/fineness value for each sample), and micronaire outliers (% of samples whose difference between the HVITM micronaire and AFIS and Cottonscope calculated micronaire were $\geq \pm 0.3$ micronaire units).

Results and Discussion

MR and Fineness Comparisons

Preliminary CSITC comparative analyses were performed on a series of 39 diverse cotton samples as described above. MR comparisons were made between the HVI[™], AFIS, and Cottonscope instruments, and fineness comparisons were made between the AFIS and Cottonscope. For MR, overall good linear agreement was observed between the 3 instruments for the 39 samples (Figure 2). However, it was readily observed that the AFIS' and

 HVI^{TM} 's response to changes in MR were different from the Cottonscope's response, with low R² and low slopes, especially for the HVI^{TM} MR. In general, the HVI^{TM} and AFIS MR measurements were not as responsive to changes in MR between samples compared to the MR obtained with the Cottonscope. The low AFIS response to changing MR, compared to the Cottonscope and IAM methods, was observed previously (Paudel et.al., 2013; Rodgers et. al., 2013), and these comparative MR results on the HVI^{TM} and AFIS were in good agreement with the previous observations.

For fineness, overall very good linear agreement was observed between the Cottonscope and AFIS instruments (Figure 3). The AFIS-Cottonscope method agreement for fineness was much better than the agreement observed for MR. However, the AFIS fineness measurements were also not as responsive to changes in fineness between samples compared those for the Cottonscope (lower slope/gain), with a slope of ~ 0.5 . The fineness results for the AFIS and Cottonscope were in very good agreement with those observed previously.

Micronaire Comparisons

Micronaire comparisons were performed by inserting the Cottonscope and AFIS MR and fineness results into the Lord equation (equation 1), bias adjusting the average calculated micronaire for each instrument to the average HVI^{TM} micronaire for the samples, and comparing the resulting calculated micronaires to the HVI^{TM} micronaires for each sample (Table I). For calculated micronaire, the best method agreement (for R², slope, SDD, and outliers) to HVI^{TM} micronaire was obtained with the Cottonscope instrument. Although the AFIS had good overall linear agreement to the HVI (based on R²), its slope was only 0.54 and it had a high number of outliers. Thus, the AFIS results were less responsive (lower slope) to changes in micronaire as well as to changes in MR and fineness compared to the Cottonscope.



Figure 2. Comparison of MR results, HVI[™], Cottonscope (CS), and AFIS measurements for MR (n=39).



Figure 3. Comparison of fineness results, HVI[™], Cottonscope (CS), and AFIS measurements for MR (n=39).

Table I.	Comparison of micronaire,	measured HVI [™]	vs. calculated	micronaires fi	rom Cottonscope	e and AFIS		
(bias adjusted; n=39).								

PARAMETER	MEASU	MEASURED/CALCULATED MICRONAIRE				
	TM HVI	COTTONSCOPE	AFIS			
AVERAGE	4.26	4.30	4.30			
SD	0.77	0.79	0.44			
R ²	NA	0.91	0.89			
SDD	NA	0.24	0.41			
SLOPE	NA	0.91	0.54			
% > ±0.30	NA	15.4%	30.8%			

Summary

At the request of CSITC, the Cottonscope was evaluated for its potential for use to obtain MR and fineness results for the CSITC Round Trials. Comparative analyses were performed on a set of diverse cotton samples on the HVITM (MR), AFIS (MR and fineness), and Cottonscope (MR and fineness). Overall, good instrument trend agreement was observed between the MR and fineness results between the 3 instruments. In general, the AFIS and HVITM measurements were not as responsive to changes in maturity (HVITM and AFIS) and fineness (AFIS) as observed for the Cottonscope (lower slope/gain). The AFIS-Cottonscope agreement for fineness was superior to the agreement obtained for MR. These results agreed with previous evaluations between the Cottonscope and AFIS. In addition, MR and fineness results were inserted into the Lord equation to obtain calculated micronaire results for each instrument, and the calculated micronaire was compared to HVITM micronaire for each sample. For calculated micronaire, the best method agreement to HVITM micronaire was obtained with the Cottonscope instrument, and the AFIS results were less responsive to changes in micronaire compared to the Cottonscope.

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References

Lord, E. 1956. Air flow through plugs of textile fibres. Part II. The micronaire test for cotton. Journal of the Textile Institute, 47 (1), T16-T47.

Naylor, G., Gordon, S., Hwang, H., Brims, M. 2011. Cottonscope—rapid, independent and simultaneous measurement of both cotton fiber linear density (fineness) and maturity. Proceedings of the 2011 Beltwide Cotton Conference, pp.1278-1281.

Paudel, D., Hequet, E., Abidi, N. 2013. Evaluation of cotton fiber maturity measurements. Industrial Crops and Products, 45:435-441.

Rodgers, J., Delhom, C., Fortier, C., Thibodeaux, D. 2012. Rapid measurement of cotton fiber maturity and fineness by image analysis microscopy using the Cottonscope[®]. Textile Research Journal, 82 (3), 259-271.

Rodgers, J., Delhom, C., Hinchliffe, D., Kim, H.J., Cui, X. 2013. A rapid measurement for cotton breeders of maturity and fineness from developing and mature fibers. Textile Research Journal, 83(14), 1439-1451.

Wakelyn, P., Bertoniere, N., Edwards, J., French, A., Gamble, G., et. al. 2007. Chapter 7: Physical properties of cotton. Cotton Fiber Chemistry and Technology. CRC Press, Boca Raton, FL, pp. 107-109.