COMPARISONS OF COTTONSCOPE AND AFIS FIBER MATURITY DISTRIBUTIONS

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Abstract

Cotton fiber maturity and fineness are important fiber properties. The Cottonscope is a new instrument that provides rapid, precise, and accurate measurements of maturity ratio (MR) and fineness, and much interest has been expressed in its use by cotton breeders and geneticists. In addition to fiber MR, fineness, and ribbon width results, the Cottonscope also provides a MR distribution. In a preliminary program, the MR results and MR distributions from the Cottonscope and AFIS instruments were compared on pure and blended samples of known MR. Distinct differences in MR results and distributions were observed. AFIS response to maturity changes was less than observed from the Cottonscope.

Introduction

Maturity is a key quality property for cotton fiber, as it can impact the fiber's downstream processing and dye consistency/uniformity (Wakelyn et. al., 2007). Maturity, a measure of the fiber's degree of development (θ), is often difficult to measure directly, requiring slow, laborious techniques (e.g., image analysis of cross-sectional fibers, or IAM) and/or expensive techniques (e.g., Uster® AFIS). A common measure of fiber maturity is maturity ratio or MR, defined as

$$MR = \theta/0.577 \qquad (1)$$

A new instrument has been recently introduced which measures directly cotton fiber maturity (MR), fineness, and ribbon width—the Cottonscope (Cottonscope LLC, Australia). The Cottonscope measures these properties on weighed fiber snippets in water by use of image analysis and polarized light microscopy (Figure 1). Recent evaluations on routine lint, reference cottons, and breeder/genetic samples (e.g., days post-anthesis samples) have shown the Cottonscope to be a rapid, precise, and accurate measurement of fiber MR and fineness (Paudel et.al., 2013; Naylor et. al., 2011; Rodgers et.al., 2012; Rodgers et.al., 2013). Further, comparisons between the IAM reference method, Cottonscope, and AFIS yielded very good method agreement for MR between the IAM and Cottonscope methods. However, the AFIS was much less responsive to changes in MR compared to the IAM and Cottonscope methods, with slopes of approximately 0.5 (Paudel et.al., 2013; Rodgers et.al., 2013).

In addition to average values for fiber MR, the Cottonscope and AFIS also yield a fiber distribution histogram. Interest has been expressed by breeders and geneticists in the use of Cottonscope MR and MR distribution in place of the AFIS MR and MR distribution. Little comparative information is available on the distribution results for the two instruments. A preliminary program was implemented, on samples of known composition, to determine the similarities and differences between the Cottonscope and AFIS average MR values and MR distribution histograms. The samples were two pure samples (one low MR/A, one high MR/B) and 3 blends of the pure samples.

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

Material and Methods

Pure and blend samples were used in this evaluation. The 5 samples were pure samples A (low MR, ~0.6 MR) and B (high MR, ~1.0 MR) and 3 blend samples of A and B. The 3 hand prepared blends were 75% A/25% B, 50% A/50% B, 25% A/75% B. Each sample was measured on the Cottonscope and AFIS instruments, using standard procedures. Standard environmental conditions were used for all fiber measurements (21±1^{O}C and 65±2% relative humidity/RH). The Cottonscope MR, with its larger MR range, was used as the reference method for the comparison of the average MR values of each sample for each instrument.

Average MR values and MR distribution histograms were compared for both the Cottonscope and AFIS instruments. Comparison parameters included R^2, slope/linearity, and MR range.

Results and Discussion

A preliminary program was implemented to determine the similarities and differences between the Cottonscope and AFIS average MR values and MR distribution histograms. The samples were two pure samples (low MR "A" and high MR "B") and 3 blends of the pure samples. It is expected that as the percentage of high MR pure fiber B in the blend sample is increased, the average MR should increase. In addition, for the MR distribution histograms, it is expected that as the percentage of blend increases from pure low MR A to pure high MR B, the height of the MR distribution should decrease from a high for the pure MR histogram "peak" to the 50% A/50% B blend level, at which point the height of the MR distribution peak should increase. In addition, the 50% A/50% B MR distribution histogram should be noticeably wider than the pure samples' MR distribution.

The average MR results for the Cottonscope and AFIS measurements are presented in Table I and Figure 2. Very good method agreement was observed between the Cottonscope and AFIS instruments for the pure and blend samples, with $R^2 > 0.9$. The slope for the AFIS-Cottonscope agreement was low (approximately 0.4), and the range for the MR results for the AFIS was less than 50% the MR range observed for the Cottonscope. Thus, as observed in previous evaluations, the AFIS was much less responsive to changes in MR than observed with the Cottonscope.

The AFIS and Cottonscope MR distribution histograms for the 5 samples are presented in Figures 3 and 4. The Cottonscope MR distributions were much more representative of the known composition of the pure and blend samples compared to the AFIS. Only minor differences in MR distribution width and peak height were observed for the AFIS MR distributions. The Cottonscope MR distributions width and peak height were in line with the expected results for the pure and blend samples (MR distribution height decreases from a high for pure A to the 50% A/50% B blend level and then increases to pure B; the 50% A/50% B MR distribution was noticeably wider than for the pure A and B).

Table I. Comparison of MR for pure and blend samples, Cottonscope vs. AFIS (n = 5).

SAMPLE	% COMPONENTS		MR	
	A	B	COTTONSCOPE	AFIS
1	100	0	0.58	0.76
2	75	25	0.65	0.77
3	50	50	0.72	0.81
4	25	75	0.86	0.84
5	0	100	0.97	0.92
AVERAGE	NA	NA	0.76	0.82
SD	NA	NA	0.16	0.06
RANGE	NA	NA	0.39	0.16
SLOPE	NA	NA	NA	0.40
R^2	NA	NA	NA	0.95

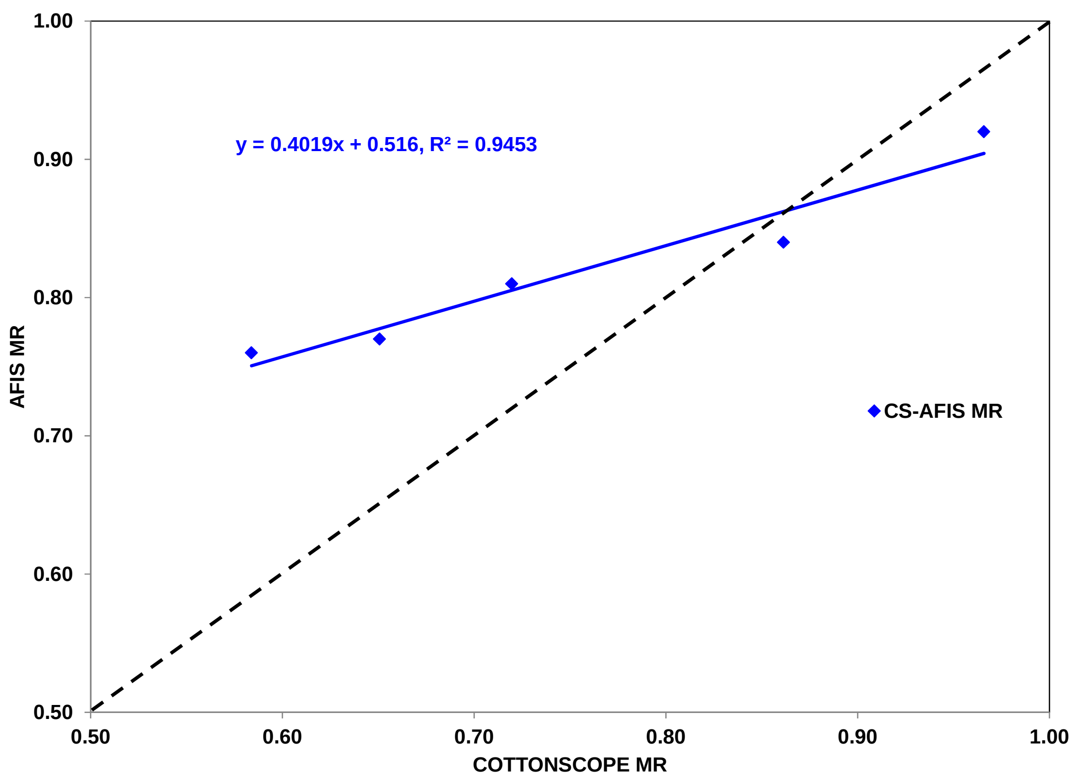

Figure 2. Comparison of MR results, HVI™, Cottonscope (CS), and AFIS measurements for MR (n=39).

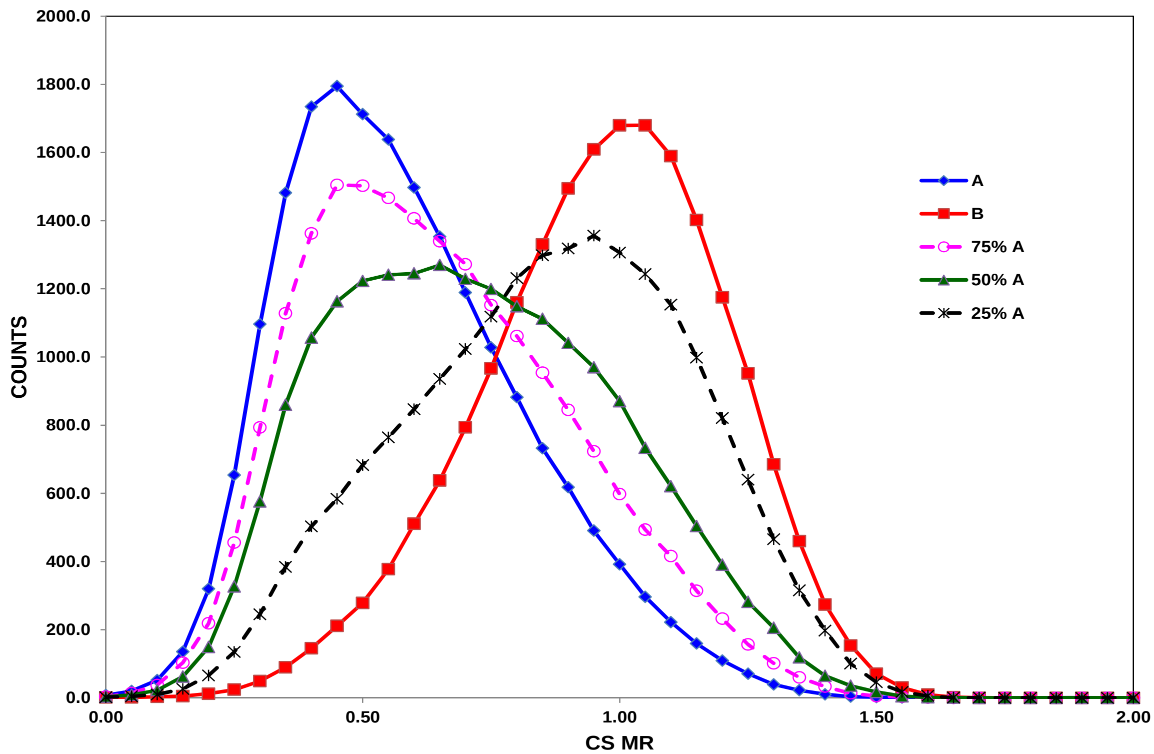

Figure 3. Cottonscope (CS) MR distribution, pure and blend samples.

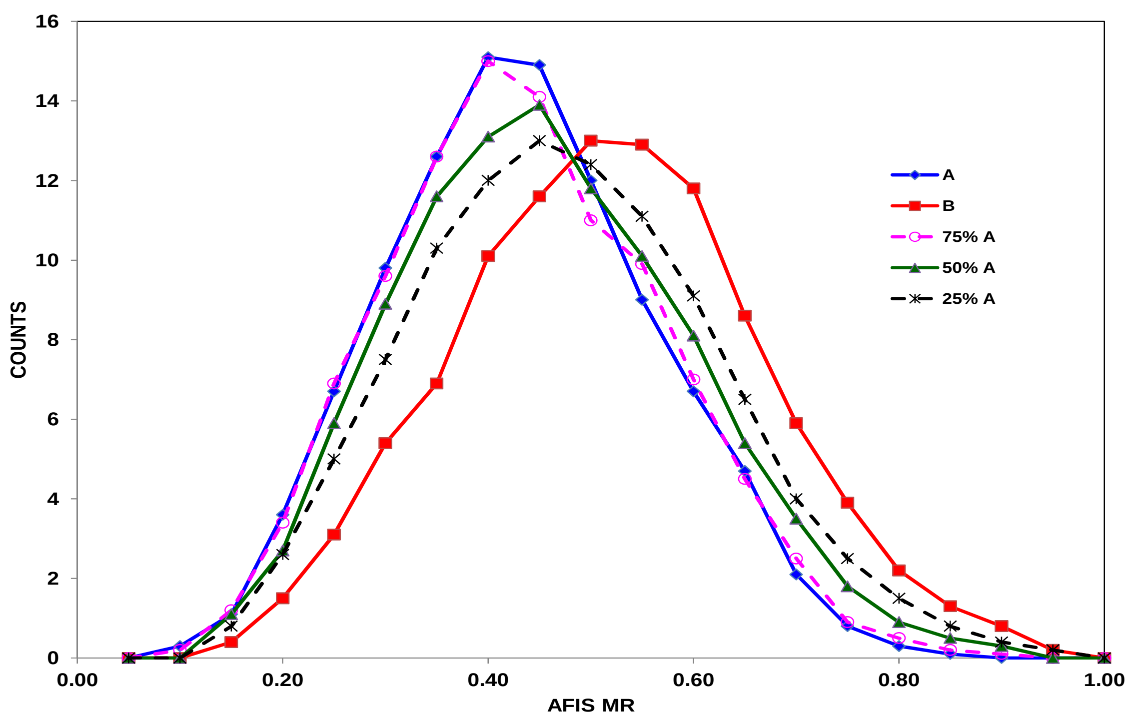

Figure 4. AFIS MR distribution, pure and blend samples.

Summary

A preliminary program was implemented to determine the similarities and differences between the Cottonscope and AFIS average MR values and MR distribution histograms, using pure samples A (low MR) and B (high MR) and 3 blend samples. Very good method agreement was observed for the average MR values between the Cottonscope and AFIS instruments for the pure and blend samples. However, as observed previously, the AFIS instrument was much less responsive to changes in MR than observed with the Cottonscope. The Cottonscope MR distribution was much more representative of the known composition of the pure and blend samples compared to the AFIS and in line with the expected MR distributions. Therefore, the Cottonscope average MR values and MR distribution is more representative of the actual MR values and MR distributions than those obtained from the AFIS.

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Disclaimer

The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.

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