AN INTER-LABORATORY TRIAL OF UPGRADED COTTONSCAN™ INSTRUMENTS FOR RAPID DETERMINATION OF AVERAGE FIBER LINEAR DENSITY (FIBER FINENESS).

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Abstract

The development of the Cottonscan™ instrument by CSIRO for the routine measurement of the average fiber linear density (fineness) of cotton lint samples has been reported at previous Beltwide meetings. Last year a Beltwide paper described an upgrade to the Cottonscan™ technology to significantly reduce the measurement time. This paper will present the results of an inter-laboratory trial comparing the performance of five upgraded Cottonscan™ instruments installed and operated in three different laboratories. Between instrument differences were mostly not statistically significant. Four instruments formed a cluster with giving statistically similar results and one instrument returned data with small (on average less than 4 mtex) statistically significant differences in average fiber linear density values compared to the other four instruments.

Introduction

Cotton fiber linear density or fineness is a key fiber quality parameter. For example fiber linear density determines the average number of fibers in a yarn cross-section and it is known that the average numbers of fibers in the yarn cross-section can have marked influence on yarn evenness particularly in the case of fine yarns (Martindale, 1945; Lamb and Yang, 1996; and Gordon and Naylor, 2008).

The development of the Cottonscan™ instrument by CSIRO for the routine measurement of the average fiber linear density of cotton lint samples has been reported at previous Beltwide meetings (Naylor, 2001; Gordon and Naylor, 2004; Naylor and Purmalis, 2005; and Naylor and Purmalis, 2006) and in more detail elsewhere (Higgerson et al, 2007; and Abbott et al, 2010). Figure 1 illustrates the instrument and principle of operation. It is based on the direct method of measuring the total length of a known mass of fibre snippets to calculate directly mass per unit length. The known mass of fiber snippets are suspended in an aqueous medium within the instrument and then the suspension passes through the measurement cell. The suspended snippets are then imaged as shown and using image analysis the total snippet length within the image is extracted.

Abbott et al (2009) described an upgrade to the instrument resulting in a significant reduction in the measurement time. A major design feature associated with the upgrade was a reduction of the volume of the aqueous medium within the instrument from approximately 4 liters to 1 liter. A consequence of this is that the cycle time for the measurement is reduced to approximately one minute.

This paper reports the results of an international inter-laboratory trial undertaken to examine the performance of the upgraded instruments.

Methods

The performance of five upgraded instruments was assessed. Three instruments were positioned at CSIRO, one at Texas Tech University and one at USDA ARS Clemson. A ‘reference’ cotton with an assigned average fiber fineness value of 168 mtex was used to initially calibrate/harmonise the output of the instruments, by applying a

single parameter scaling factor as previously described (Higgerson et al, 2007; and Abbott et al, 2010). A set of six well blended cottons covering a broad range of fiber linear density values was used in the trial. The trial was designed such that 10 replicate measurements of each of the six cottons were undertaken on one day by each machine. This protocol was repeated on four different days.

Results

The average fiber linear density of each sample obtained from each instrument is summarised in Figures 2 and 3. Table 1 lists the average between instrument differences in measured average linear density values. This table highlights that the differences between instruments are relatively small. Excluding the coarsest cotton (AM31) which is well outside the calibration range, the average differences between instruments is less than 4 mtex. A full statistical analysis of the data will be undertaken and the results will be published at a later date.

Figure 4 illustrates the day to day variation in the measurements for one of the instruments. Note that the day to day variation is also small (also typically less than 4 mtex).

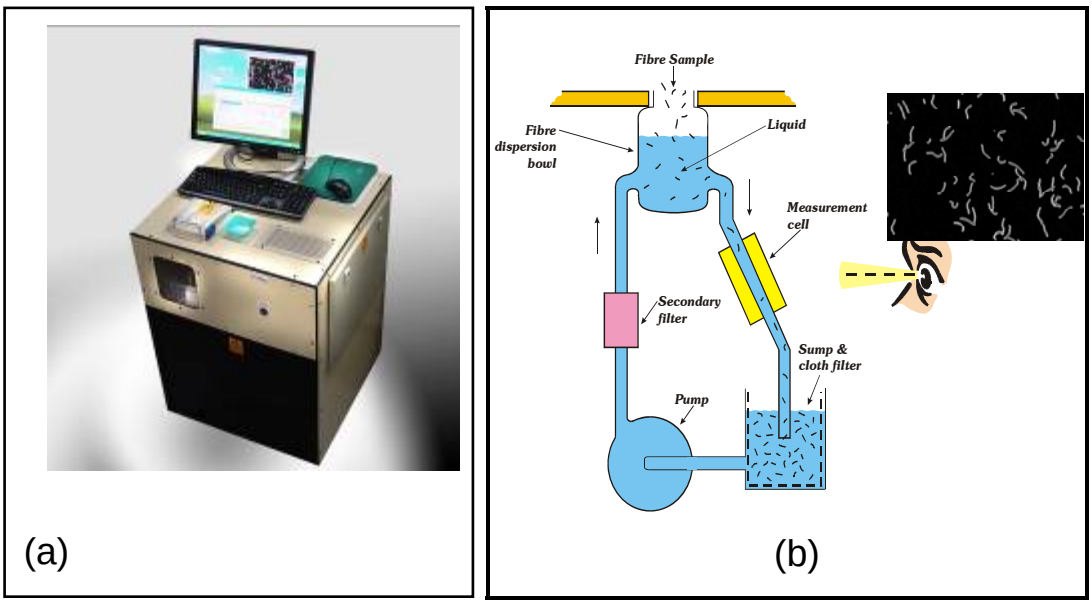

Figure 1. The 'CottonscanTM' instrument.

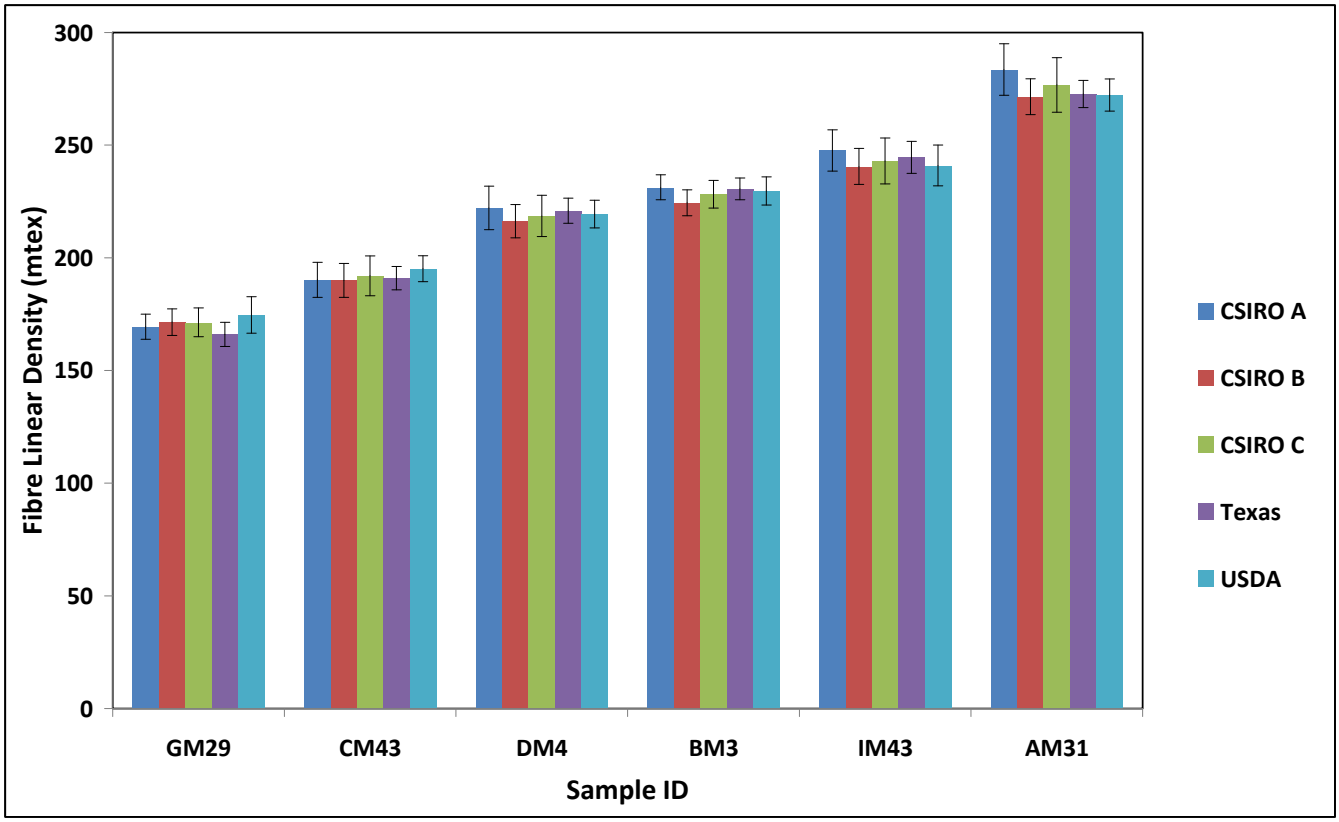

Figure 2. Summary of the results of the inter-instrument trial comparing three CottonscanTM™ systems. (The error bars represent the standard deviation of all replicate measurements per sample per machine.)

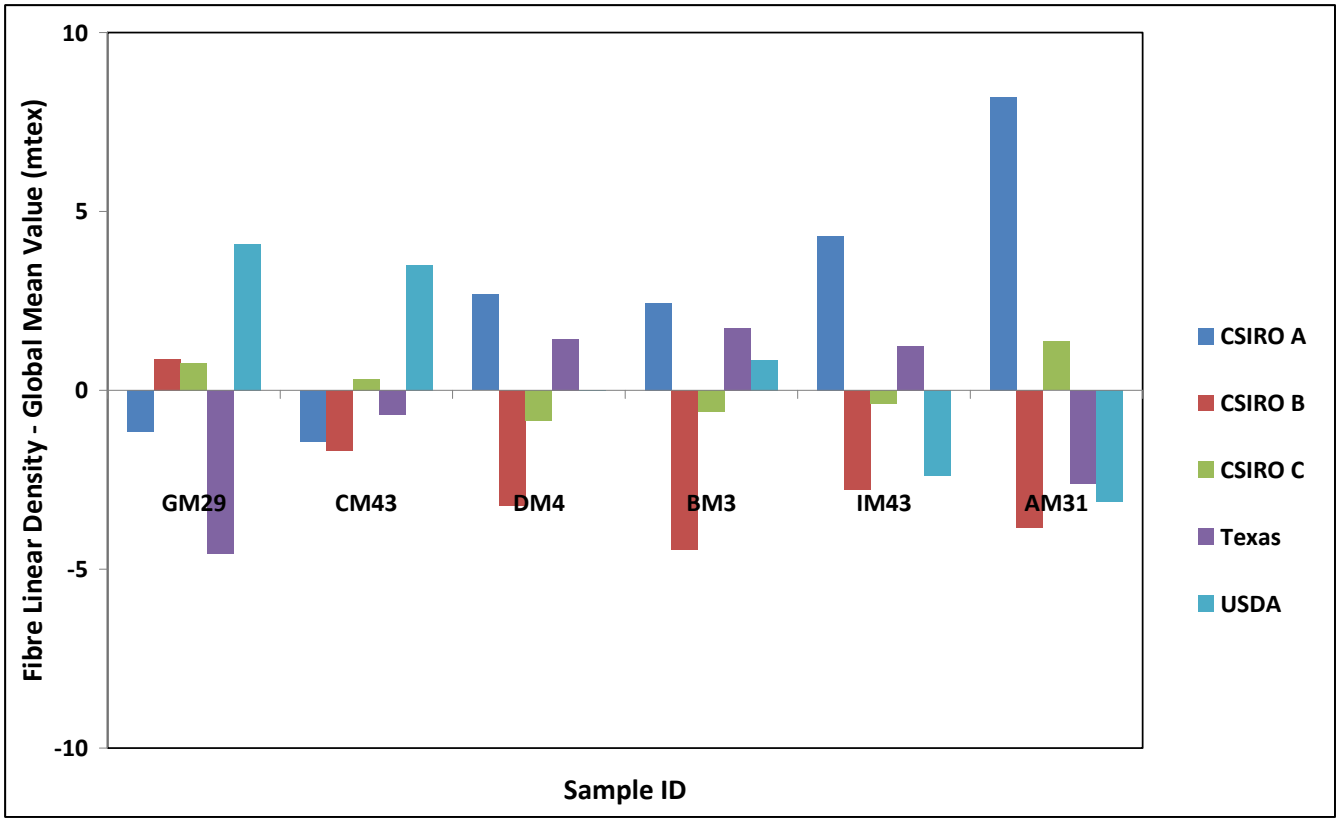

Figure 3. Summary of the differences between measurements on a single instrument relative to the mean fiber linear density value averaged over all instruments.

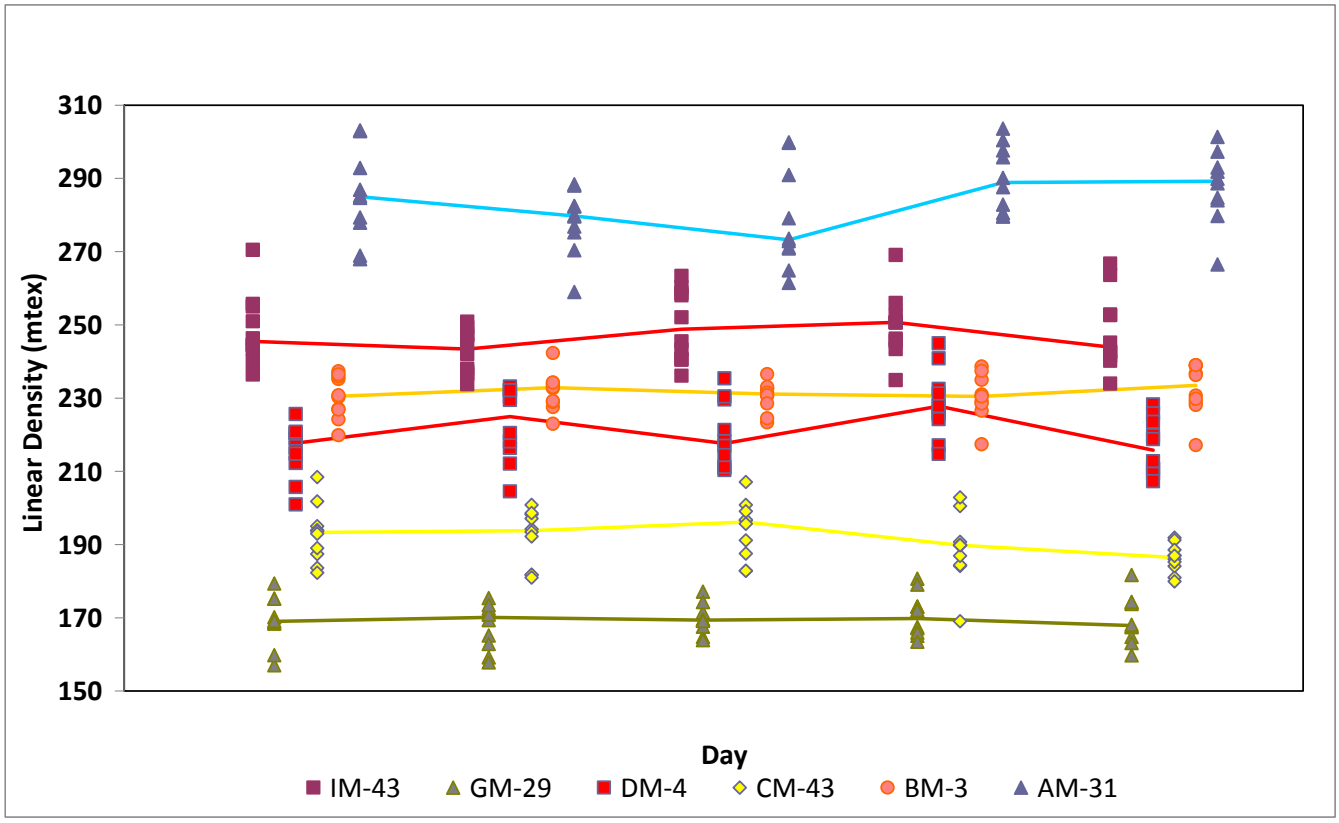

Figure 4. Summary of the typical day to day variation in measured fiber linear density for one instrument.

Table 1. Summary of the Differences in Measured Fiber Linear Density Values (mtex) between Instruments/Laboratories averaged over all samples.

	All Data	Excluding AM31
CSIRO A – CSIRO B	5.03	3.63
CSIRO A – CSIRO C	2.40	1.52
CSIRO A – Texas	3.08	1.53
CSIRO A – USDA	2.02	0.16
CSIRO B – CSIRO C	-2.62	-2.11
CSIRO B – Texas	-1.95	-2.09
CSIRO B – USDA	-3.01	-3.47
CSIRO C – Texas	0.68	0.02
CSIRO C – USDA	-0.38	-1.36
Texas – USDA	-1.06	-1.37

Conclusion

The performance of five faster upgraded Cottonscan™ instruments has been evaluated in a number of laboratories in a structured inter-laboratory trial. This demonstrated that the instrument is robust. The observed differences between instruments are relatively small. Excluding the coarsest cotton which is well outside the calibration range, the average differences between instruments is less than 4 mtex.

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