Honeydew and Seed Coat Fragments: Identifying and Counting Two Major Cotton Fiber Contaminants

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ABSTRACT

Spinning techniques are constantly progressing. Equipment is getting faster and more automated. Spinners are less and less tolerant of fiber contaminants. Honeydew and seedcoat fragments (SCF) are a major problem that cannot be detected by HVI systems CIRAD developed techniques for honeydew and SCF detection and quantified them for use by researchers, producers and spinners. Thermodetection detects cotton entomological stickiness, results being expressed as the number of sticky spots in the specimen, providing a sample of stickiness potential. High Speed Stickiness Detector (H2SD) is fully automated and allows a bale by bale classification for stickiness at speeds comparable to HVI speed (30 seconds per sample). Results correlate well with the reference Stickiness Cotton Detector. Sticky spot size distribution is available. TRASHCAM image analysis on a card web detects seedcoat fragments. Results are expressed as an SCF total count in the specimen. Very small SCF are detected so the results can be considered as samples of SCF potential. TRASHCAM uses a scanning device and a specific algorithm. SCF size distribution is available. Yarn SCF assessment is possible without spinning any yarn. TRASHCAM can count SCF in yarn.

Introduction

In order to meet market requirements that are in part related to progress made in spinning techniques, it is essential to obtain more information on the quality of the raw material and a more precise description of the yarn quality. Rapid measurement techniques, (HVI), are employed to measure the technological characteristics of cotton fiber. These techniques are used for commercial classification purposes and in varietal improvement programmes, conditional, in this case, on certain precautions (Gourlot *et al.*, 1994). However, fiber classification criteria such as length, strength, micronaire and trash are insufficient to predict the quality of the finished product and are unable to guarantee the correct functioning of the spinning process since fiber contamination by foreign matters such as insect honeydew and seed coat fragments (SCF), may disrupt the process. These contaminants may reduce producer prices and have negative effects on yarn production and quality. CIRAD developed equipment and techniques for use in its research programs that are intended to reduce these effects, i.e. Trashcam used to evaluate SCFs and the SCT thermodetector and rapid H2SD detector to measure cotton stickiness.

Effects of contaminants on yarn quality

Currently, seed coat fragment neppiness is a major factor taken into account by CIRAD as they reduce the efficiency of fiber cleaning, increase fiber breakage during spinning (Price, 1987) and affect the yarn appearance. This character is more than 70% heritable (Gourlot *et al.*, 1995). Insect honeydew disrupts the spinning process by clogging equipment and results in poorer quality yarn. This yarn shows neps that contain honeydew, and fiber neps without honeydew, caused by the fiber rising upwards (Frydrych, 1996). These imperfections increase the total count determined by capacitive-sensor regularimeter. Figure 1 illustrates three cases of neppiness encountered in ring spinning (RS) detected on a capacitive-sensor regularimeter where only detailed analysis of the yarn is able to determine the different types:

- in case (A), the majority of the neps are SCF neps with a few fiber neps (mature cotton) and virtually no plant debris neps. Regularimeter total nep counting therefore corresponds to the number of SCF neps,
- in case (B), the percentage of fiber neps is higher as the cotton is insufficiently mature,
- in case (C), cottons have been contaminated by honeydew, and therefore sticky neps corresponds to a considerable proportion of the regularimeter total nep counting.

The high fiber nep count is largely due to stickiness, not to immaturity. The relationship between total neps and SCF neps is less pronounced in (C) than in case (A). In all cases, the foreign matter increases the number of yarn defects. They also decrease productivity and require special processing by spinners. It is therefore essential to identify and quantify this matter as early as possible, either during selection or processing.

Counting seed coat fragments in fiber and yarn

Trashcam, manufactured by CIRAD, capable of counting by image analysis (IA) captured by a scanning device, was developed to estimate potential neppiness caused by SCF at the earliest stages of varietal breeding programs (Gourlot *et al.*, 1995). Bachelier (1997) has clearly demonstrated the efficiency of Trashcam counts in card webs and to determine SCF content when used as an early selection method in breeding programs.

In addition to providing a SCF count in card webs, methodology has been developed to allow Trashcam to count seed coat neps in yarn.

Fifteen cottons representative of a broad range of SCF contents were ring spun (RS) and open-end spun (OE) to 20 tex yarn. The SCFs in the card web were counted by Trashcam (IAWeb) and in the yarn by three different methods:

- a capacitive-sensor regularimeter (UT3, Zellweger-Uster) based on a detailed analysis of neppiness (Frydrych, 1989). UT3 neps threshold was set to 200 % for RS, and 280 % for OE yarns.
- Trashcam on yarn plate (IAYarn),
- visual counting of the same yarn plate (Visual Yarn), with two repetitions.

Prediction of UT3 counts is more efficient for RS yarns (r = 0.87) than for OE yarns (r = 0.72) from Trashcam count on webs (Figures 2 and 3). This may be explained by the fact that UT3 do not detect small SCF which have been broken in smaller parts by the opening roller in the OE process. The comparison of Trashcam on yarn plate counts to the Trashcam on web counts give similar level of explanation for both RS and OE yarns.

The Trashcam SCF count in the card web gave a good prediction of the number of SCF in the yarn spun by RS and OE. This technique is therefore suitable for use in varietal improvement programs (Bachelier, 1997).

A very highly significant correlation was noted for the RS yarn between the results of the Trashcam count in the yarn plate and that provided by visual counting (Figure 4). If significance is set at 5%, the statistical analysis shows that the slope is not different from 1, the y-intercept at the origin is not different from 0 and the correlation coefficient is 0.99. Trashcam may therefore be considered as an efficient method for detecting and counting yarn SCFs by image analysis.

The correlation in OE yarn (Figure 5) was again highly significant (r=0.98). By contrast, the count provided by this technique was lower than the visual count (slope of 0.79). Thus, under the same imaging conditions, the Trashcam count is closer to the visual count in RS yarn than in OE yarn. This may be explained by the fact that the SCFs present in the OE yarn are smaller than those in the RS yarn and are therefore more difficult to detect.

The relationship between Trashcam and UT3 results on yarn plate were highly significant for both RS and OE yarn (Figures 6 and 7 respectively). However, the differences between the two counts showed that Trashcam counts far more imperfections than the UT3 widely used in the industry. This difference is due to the fact that the thresholds used by the UT3 prevent it from detecting the smaller SCFs.

Stickiness measured by the rapid H2SD detector

Cotton stickiness level has become a major selective criterion for spinners. Producers are sometimes therefore obliged to sell their cotton at a discount, and under these conditions, the entire production of a country with a reputation for supplying sticky cottons may be reduced in price, even though a large part of the crop is uncontaminated. Obviously the ability to characterize each bale for its degree of stickiness at the production stage is a considerable advantage as uncontaminated cotton can be sold at a higher price.

Micro-spinning sticky and non-sticky cottons has demonstrated that the number of sticky points determined on the SCT thermodetector correlates with the number of wraps during spinning and with the number of yarn defects (Hequet and Frydrych, 1992; Frydrych *et al.*, 1995). An ongoing study financed by the Common Fund for Commodities seeks to establish critical threshold for cotton contamination, beyond which problems arise that result in malfunctions and poor quality yarn. Spinners could reduce the effects of contaminated cottons by using appropriate means, such as mixing cottons with different degrees of stickiness and reducing relative humidity (Gutknecht *et al.*, 1986; Frydrych, 1996). They could also employ processing techniques, such as the use of additives (Perkins, 1992).

Establishing the stickiness of each bale requires a machine capable of rapidly measuring stickiness at speeds comparable to HVI lines measure other fiber properties. With this as its objective, CIRAD has developed a machine capable of measuring stickiness much more rapidly than the SCT thermodetector. This is the H2SD (High-speed Stickiness Detector) manufactured in partnership with Shirley-Developments Limited (SDL). The machine has the capacity to measure about 120 samples/h and has been optimized for use in industry. The different mechanical and electronic sections of the machine are easily accessible to facilitate maintenance.

Eighty-seven raw cottons of various geographical origins, were tested on the thermodetector and the H2SD with 3 repetitions per sample. Results provided by the thermodetector correlated well (0.92) with those from the H2SD (Figure 8). A good prediction of the relation H2SD counting to SCT counting can be proposed as follows

SQR(H2SD) = 7.26 * log[SQR (SCT) + 1] - 0.38 ;

r = 0.92

These cottons were tested a second time on the H2SD with the same number of repetitions. An excellent correlation was noted between the two tests with r= 0.94 (Figure 9).

The results of these tests almost equal. A statistical analysis showed that the 0.94 slope of the regression line was not different from 1 and that the y-intercept at the origin (0.15) was not different from 0. This shows the high reproducibility of the H2SD method.

Conclusion

CIRAD Trashcam is used in varietal improvement programs to measure the number of SCFs in card webs. Recently, Trashcam has been shown to be suitable for counting the number of SCFs in yarn. The results in these tests were very similar to those provided by visual counts made on the same yarns.

As far as cotton contamination by insect honeydew is concerned, the improvements made to the commercial version of the rapid H2SD detector have optimized this machine for intensive use in an industrial environment and have enhanced its reliability. The results with the H2SD correlate well with those of the ITMF recommended SCT thermodetector. A bale-by-bale classification of fiber on the basis of its stickiness is now therefore possible.

References

Bachelier, B. (1997): Application en sélection des comptages de fragments de coques dans la fiber de coton (*Gossypium hirsutum* L.) par analyse d'image sur voile de carde. Actes des journées coton du Cirad. Pp.68-79.

Frydrych, R. and J. Gutknecht. (1989): Identification et comptage des diverses imperfections rencontrées sur le fil de coton. Coton et Fibers Tropicales, 44(1):59-65.

Frydrych, R., E. Hequet and and G. Cornuejols. (1994): A high speed instrument for stickiness measurement. 22th Intl. Cotton Conference of ITMF, Bremen, Germany. Pp.83-91.

Frydrych, R., E. Hequet and C. Brunissen. (1995): A high speed stickiness detector : relation with the spinning process. In: Proc. Beltwide Cotton Conf. D.Richter and J. Armour (Eds). Natl. Cotton Council, Memphis TN. Pp. 1185-1189.

Frydrych, R. (1996): Contribution à l’étude du collage des cotons au moyen de méthodes mécaniques et thermomécaniques. Université de Haute Alsace, France, thèse, 200 Pp.

Gourlot, J.P. and E. Hequet. (1994): Recherche cotonnière: comment utiliser les chaînes HVI en amélioration variétale?, Agriculture et Développement. 2:39-43.

Gourlot, J.P., R. Frydrych, E. Hequet, F. Thollard and O. Constantin. (1995): Seed coat fragments counting and sizing on card web. In: Proc. Beltwide Cotton Conf. D.Richter and J. Armour (Ed). Natl. Cotton Council, Memphis TN. Pp. 1245-1249.

Gutknecht, J., J. Fournier and R. Frydrych. (1986): Influence de la teneur en eau et de la température de l’air sur les tests de collage des cotons à la minicarde de laboratoire. Coton et Fibers Tropicales, 41(3):179-190.

Hequet, E. and R. Frydrych. (1992): Sticky cotton from plant to yarn. Proc. ITMF Intl. Conf. on Cotton Testing Methods. Bremen, Germany. Appendix 46:3-19.

Perkins, H.H., Jr., S. Hughs and W. Lalor. (1992): Preliminary results of gin additive research. The Cotton Gin and Oil Mill Press, June 27:6-9.

Price, J.B., (1987): The Suitability of Certain American Cottons for the Production of Fine Count Rotor-spun Yarn. Texas Tech University Lubbock , TX (USA). 25 Pp.

Figure 1. Imperfections counted with the Uster regulator equipped with the visualising device.

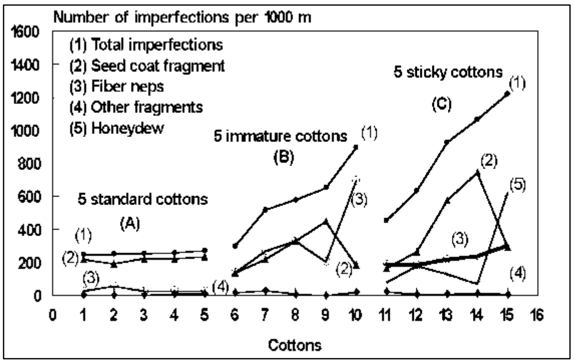

Figure 2. Yarn to web SCF count relation - Ring spun 20 tex yarn.

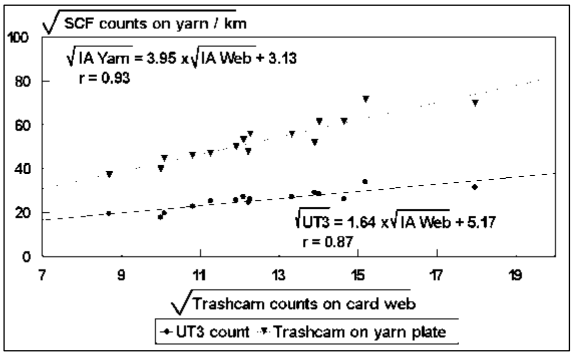

Figure 3. Yarn to web SCF count relation - Open end 20 tex yarn.

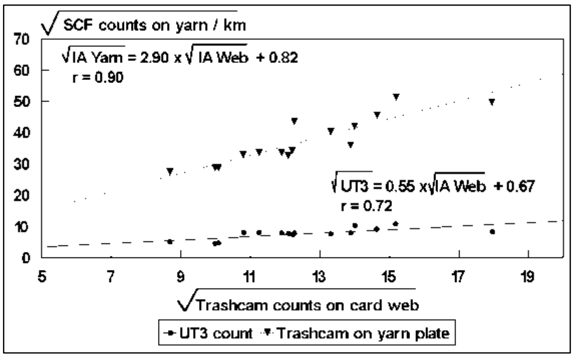

Figure 4. Trashcam on yarn plate vs visual count on yarn plate ring spun 20 tex yarn.

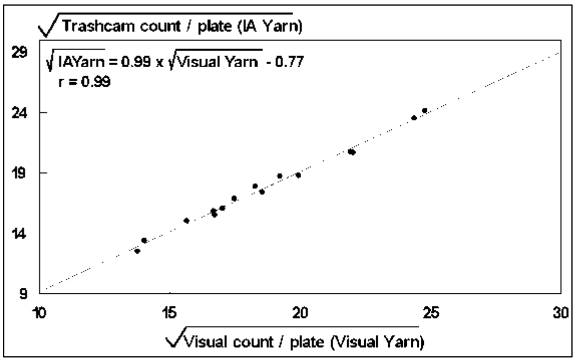

Figure 5. Trashcam on yarn plate vs visual count on yarn plate; Open end spun 20 tex yarn.

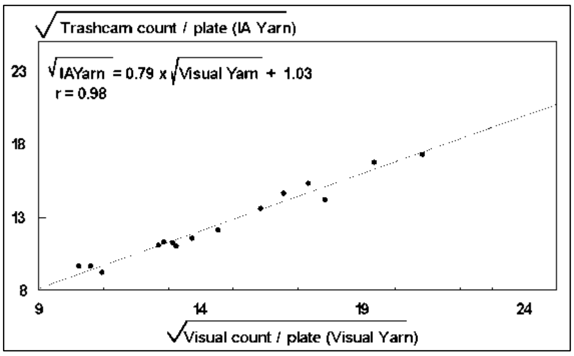

Figure 6. Trashcam on yarn plate vs UT3 count ring spun 20 tex yarn.

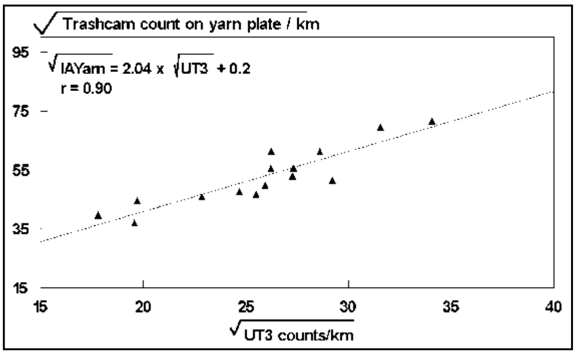

Figure 7. Trashcam on yarn plate vs UT3 count open end spun 20 tex yarn.

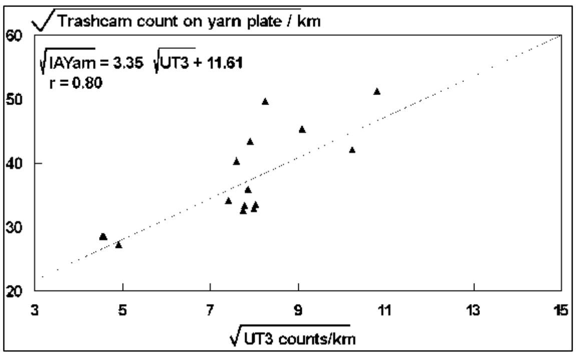

Figure 8. Thermodetector SCT vs H2SD on 87 cottons from different countries (3 repetitions).