DETECTION AND COUNTING OF TWO COTTON CONTAMINANTS: SEED COAT FRAGMENTS AND HONEYDEW DEPOSITS

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Abstract

At present, many cottons are contaminated to varying degrees by Seed Coat Fragments (SCF) and insect honeydew. It is essential to obtain more information on the quality of the raw material and a more precise description of the yarn quality. This paper deals with two instruments developed by Cirad's Cotton Technology Laboratory for detecting and counting these two contaminants. The relationship of Trashcam (an image analysis method for counting SCF), and H2SD (High Speed Stickiness Detector) with reference methods is discussed.

Introduction

Today, 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, called HVI, are currently employed to measure the technological characteristics of cotton fiber. These techniques are used for commercial classification purposes and in varietal improvement programs, on condition in this case that certain precautions are taken (Gourlot et Hequet, 1994). However, these fiber classification criteria such as length, strength, micronaire, trash are insufficient to predict the quality of the finished product and are unable to guarantee that the spinning process will function correctly since fiber contamination by foreign matters, such as insect honeydew and seed coat fragments SCF, may disrupt the process.

These contaminants may push down prices for producers and have negative effects on yarn production and quality. Cirad has therefore developed equipment and techniques for use in its research programs that are intended to reduce these effects, i.e. Trashcam used to evaluate SCF, the SCT thermodetector and rapid H2SD detector to measure cotton stickiness.

Effects of Contaminants on Yarn Quality

At present, seed coat fragment neppiness is a major factor taken into account by Cirad as these fragments reduce the efficiency of fiber cleaning, increase breakage incidence during spinning (Price, 1987) and affect the appearance of the yarn. It has been shown that this character is heritable (Bachelier, 1998).

Insect honeydew disrupts the spinning process by clogging equipment and results in poorer quality yarn. This yarn shows fiber neps without honeydew B and caused by the fiber rising upwards B and neps that contain honeydew (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 and where only a detailed analysis of the yarn is able to determine the different types:

- in case (A), the majority of the neps are seed coat neps with a few fiber neps (mature cotton) and virtually no plant debris neps. Total neps number therefore corresponds to the number of seed coat fragment neps,
- in case (B), the percentage of fiber neps is higher as the cotton is insufficiently mature,
- in case (C), these cottons have been contaminated by honeydew which corresponds to a considerable proportion of the neps. The high fiber neps count is largely due to stickiness, not to immaturity. The relationship between total neps and Seed Coat Fragment neps is less pronounced than in case (A).

In all cases, these foreign matters increase the number of yarn defects. They also decrease productivity and require special processing by spinners. It is therefore essential to be able to identify and quantify this matter as early as possible, either during selection or processing.

Counting Seed Coat Fragments in Fiber and Yarn

Trashcam was developed by Cirad to estimate the potential neppiness caused by SCF at the earliest stages of varietal breeding programs (Gourlot *et al.*, 1995). This method is based on image analysis captured by a camera or a scanning device, and provides SCF count and size in card web.

Preliminary studies, have demonstrated the efficiency of Trashcam count on card web to estimate SCF neps count provided by UT3 (Zellweger-Uster) on yarn (Drean *et al.*,1998). These results allowed the use of Trashcam on card web as an early selection method in breeding programs to determine cultivar's SCF content without need of spinning (Bachelier, 1998).

In addition to providing a SCF count and size in card webs, methodology has also been developed to allow Trashcam to count seed coat neps in yarn. The yarn is wound around a white plate for an image acquisition. SCF are counted and

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sized by image analysis. Trashcam counts were very similar to those obtained visually on the same yarns. Figure 2 shows a very highly significant correlation between Trashcam counts on yarn plate (IAYarn) and that provided by visual counting (Visual Yarn). The slope is not different from 1 and the y-intercept at the origin not different from 0 at a 5% significance level.

Counting SCF on yarn by Trashcam is a method developed to replace detailed analysis on capacitive-sensor evenness tester which requires visual examination of each neps on yarn and is therefore long and not economically acceptable. Today, the Cirad cotton technology laboratory uses Trashcam for routine analysis and research works concerning SCF.

The following paragraph shows the results obtained by Trashcam on 94 cottons that were ring-spun to 20 tex yarn. The 94 cottons were tested for SCF in fiber and in yarn using Trashcam and for evenness and neppiness using UT3 in usual global analysis.

Trashcam Validation in Routine Analysis

Figure 3 shows the relationship between SCF counts on yarn (IA Yarn) and in fiber (IA Fiber) provided by Trashcam. The correlation is very highly significant (r = 0.91***). These results confirm and validate those obtained on a limited number of cottons for the development of the method (Krifa *et al.*, 1998).

The relationship between Trashcam count on yarn plate (IA Yarn) and total neps (200%) counted by UT3 (figure 4) is also very highly significant (r = 0.86***). However, the differences between the two counts show that Trashcam, only by considering SCF, counts far more imperfections than the UT3 which is widely used in the industry and counts all nep classes (SCF, fiber neps ...). A slope of 1.5 is observed between the two counts (with a square root transformation of the data).

Trashcam measurements were taken with settings suitable for the detection of all SCF present in the yarn. The difference noted between Trashcam and UT3 counts can be explained by the fact that smaller SCF may not be detected by UT3 due to the thresholds applied in this method (200% neps).This information provided by Trashcam may well be of interest for cotton researchers and spinners.

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 fiber crop is uncontaminated. Obviously therefore, the ability to characterize each bale for its degree of stickiness at the production stage is a considerable advantage as the uncontaminated cotton can be sold at a higher price.

It has been demonstrated (Hequet and Frydrych, 1992; Frydrych *et al.*, 1995) by micro spinning sticky cottons and non-sticky cottons, that the number of sticky points determined on the SCT thermodetector and on the rapid H2SD detector correlates with the number of wraps during spinning and with the number of yarn defects. A study, financed by the Common Fund, is ongoing in industry to establish the critical threshold for cotton contamination, beyond which problems appear, resulting in malfunctions and poorer quality yarn. Spinners could thus reduce the negative effects of stickiness on machines and on yarn quality, using appropriate means such as mixing cottons or decreasing the relative humidity of the mill (Yao, 1990; Frydrych, 1996).

Establishing the stickiness of each bale required a machine capable of rapidly measuring stickiness. SCT thermodetector, ITMF reference method, is not rapid enough to work at the same speed the HVI lines measure other fiber characteristics. High speed stickiness detector (H2SD) has been developed to measure stickiness far more rapidly than the SCT thermodetector. This machine provides a result every 30 s and minimize operator effect.

Relationship Between H2SD and SCT

587 raw cottons from various geographical origins were tested on the thermodetector and the H2SD with 3 repetitions per sample. A large range of sticky cottons have been chosen, 0 to 150 sticky points determinated with SCT, and in addition we have included some rarely encountered very sticky cottons, more than 150 sticky points.

The results show (figure 5) that the H2SD-thermodetector relationship is excellent. For a large range of sticky cotton (0 to 200 SCT sticky points) the relation is not linear, the expression is given below:

$$SQR\,(H2SD) = -\,0.027\,(SCT) + 0.952\,SQR\,(SCT) + 0.442 \qquad r = 0.96$$

However, for a range of 0 to 150 SCT sticky points (also very sticky), figure 6 shows that the relationship is linear and may be expressed as:

$$SQR\,(H2SD) = 0.675 \times SQR\,(SCT) + 0.9 \qquad r = 0.92$$

Of these 587 cottons, 95 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 7). The results of the two tests were close to being equal. A statistical analysis showed that the 0.936 slope of the regression line was not different from 1 and that the y-intercept at the origin (0.17) was not different from 0. This clearly demonstrates that the H2SD method gives reproducible results.

Alternation of Very Sticky / Non Sticky Cotton Samples on H2SD

138 samples from a very sticky cotton (cotton A) and the same number of samples from a non-sticky cotton (B) were tested alternatively on H2SD.

The results of this test (figure 8) show that the automatic cleaning operation of H2SD after every test is sufficiently efficient to guarantee non-contamination of the machine from one sample to the next.

Conclusion

Today, many cottons are contaminated to varying degrees by Seed Coat fragment and insect honeydew. Cirad's cotton technology laboratory has developed techniques for use in its research programs that are intended to reduce these effects.

The Trashcam can be used to count SCF on yarn in practical applications. The results obtained in routine analysis demonstrate the efficiency of this method.

The H2SD is now used in the commercial version, the correlation with thermodetector is highly significant. The automatic cleaning operation after every test is sufficiently efficient to guarantee non-contamination of the machine from one sample to the next and consequently gives reproducible results. A bale-by-bale classification of fiber on the basis of its stickiness is now therefore possible.

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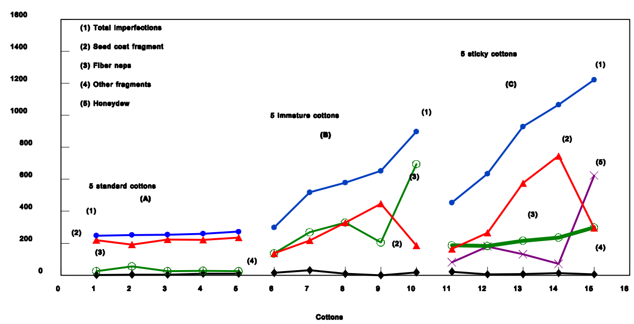

Figure 1. Various imperfections counted with the Uster regulator equipped with the visualizing device

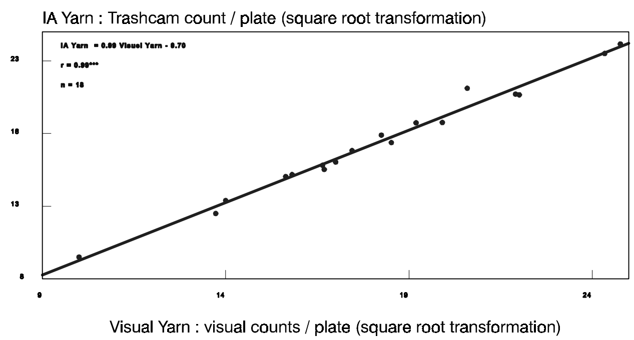

Figure 2. Trashcam count vs visual count on yarn plate Ring Spun 20 tex yarn

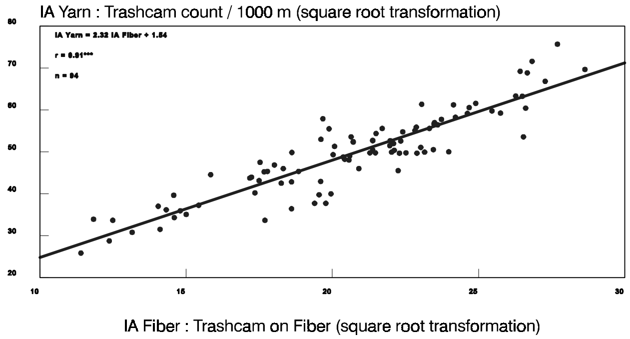

Figure 3. Trashcam on RS 20 tex yarn vs Trashcam on fiber

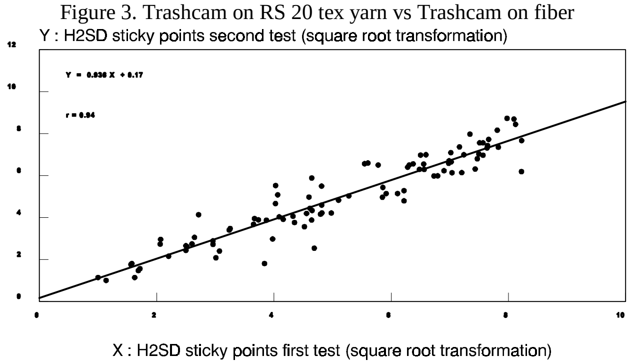

Figure 4. Trashcam count on yarn plate vs UT3 neps (200%) count Ring Spun 20 tex yarn

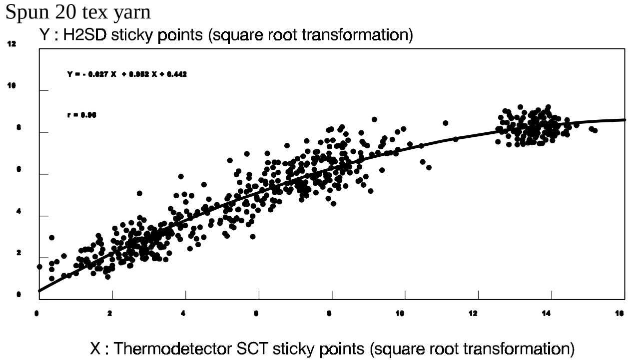

Figure 5. H2SD vs Thermodetector SCT on 587 samples from different countries, (mean of 3 replications)

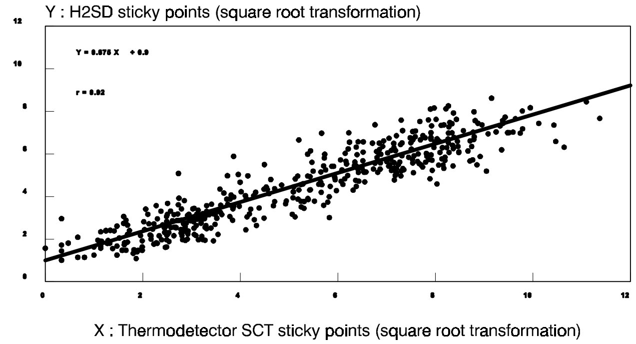

Figure 6. H2SD vs Thermodetector SCT on 455 samples from 0 to 150 sticky points (mean on 3 replications)

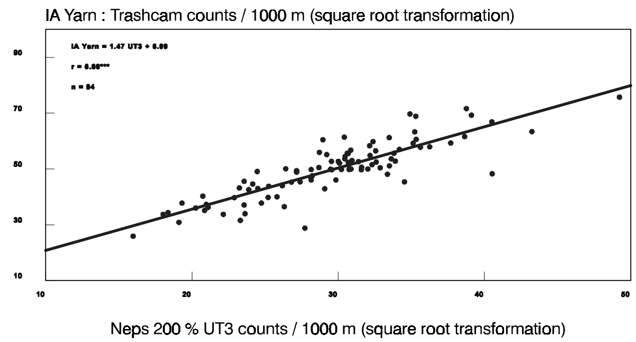

Figure 7.

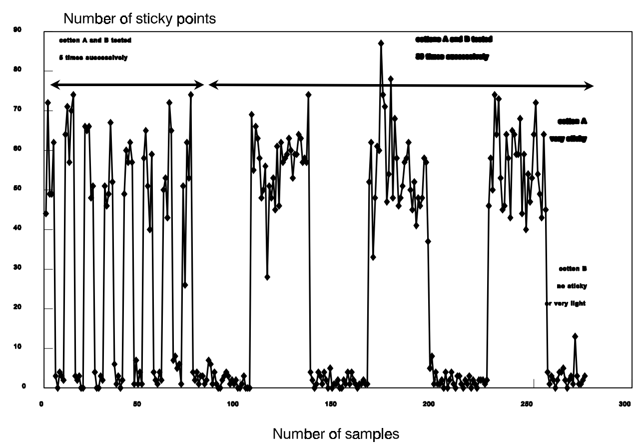

Figure 8. Alternation of very sticky / non sticky cotton samples on H2SD