A recent report by the ITMF (International Textile Manufacturers Federation) entitled "Cotton Contamination Survey - 1993" studies "spinners' observations concerning the problem of contamination and foreign matter in cotton". The results of the survey indicate that contamination by "seed coat fragments" is significant. It must be stressed, however, that degrees of contamination are not dealt with in this survey, and that the survey was carried out on samples from origins which are not necessarily representative of production. Moreover, no subsequent validation control was carried out. Its results, therefore, serve merely as a general pointer.

Introduction

A method to differentiate cultivars depending on their SCF contents on yarn was developed in CIRAD CA using a GGP Uster Evenness Tester. Results indicate a high SCF heritability, but fabrication of yarn is too costly to be used for breeding programs. A new method, using image analysis, has been developed for counting and sizing up SCF on card web. SCF counts were made on card web and compared to those obtained by Uster Tester III on 20 tex, 27 tex, 37 tex yarns for 30 cultivars. Number of SCF on yarn can be predicted with R^2 as great as 80%.

Abstract

SEED COAT FRAGMENT COUNTING AND SIZING IN CARD WEB

J.-P. Gourlot, R. Frydrych, E. Hequet,
F. Thollard, O. Constantin, B. Bacheller.
Cotton technologists, Computer scientist and Cotton genetist respectively
CIRAD-CA
Montpellier, France
21UP
Montpellier, France
IUT
Montpellier, France
CIRAD-CA
Maroua, Cameroon

Measurements Conference
The "seed coat fragment" problem is on the increase because of changes that have occurred over the past few years:

* changes in ginning techniques: the number of devices for cleaning cotton seed and fiber has increased, as has their speed, making the process more aggressive,

* changes in spinning techniques: requiring batches of fiber that are ever more homogeneous and free of foreign matter.

These seed coat fragments make up a large part of yarn neppiness. Neppiness can be broken down into five categories and regrouped into fiber neps, seed coat fragments and miscellaneous fragments:

* three types of fiber neps can be identified:
  - "shiny neps" are lumps of unripe fiber; they cause uneven dying of the cloth
  - "process neps" are created during the various processing steps from seed cotton to yarn (ginning, cleaning, carding, etc.)
  - "sticky neps" are due to sugar on the fiber, the origin of which is either physiological or, more often, entomological (honeydew); this sugar is excreted by the aphid, Aphis gossypii and the white fly, Bemisia tabaci.

Contamination from insect honeydew can result in severe production losses.

* "seed coat fragments" arise from cleaning and ginning the seed cotton as these processes strip off part of the seed coat, to which the fibers remain attached. During spinning these seed coat fragments in the yarn cause breaks and deteriorate the yarn appearance and increase production costs related to their elimination.

* "other types of neps" are plant debris such as leaves, stems, etc. and various impurities; their presence is most often linked to the quality of the harvest and the cleaning processes employed (seed cotton and fiber).

Incidence of SCF in total yarn neppiness and heritability

The presence of SCF in the fiber causes numerous problems during spinning (J. D. Bargeron and T. H. Garner, 1988; G. J. Mangialardi Jr, 1988; L. Verschraegen, 1989). Consequently, cotton known to contain large quantities of SCF are liable to heavy downgrading on the market.

To try to contend with the problem, teams of breeders and CIRAD cotton technicians began studying the phenomenon in the late 1980's (B. Bacheller, 1992).

First, it was necessary to find a way to measure the number of SCF in the yarn. Second, the heritability of the character then remained to be determined.

Measuring the number of SCF in the yarn

At present, all quality control devices measure all neps in the yarn (fiber neps + shiny neps + sticky neps + SCF + plant debris); but although certain neps seem to result solely from the environment (plant debris and sticky neps), others are probably controlled genetically to a great extent (e.g. SCF). Yarn neppiness-measuring instruments available today do not evaluate this possible heredity factor. For this reason, CIRAD-CA in Montpellier created a method whereby it was possible to measure neps in yarn according to their type (R. Frydrych and I; Gutknecht, 1989; R. Frydrych, 1992).

As a first step, aUSTER GGP-IPI regularimeter was used fitted with an "imperfector selector" (USTER News 1965). Each yard underwent the routine global testing (total neps) then a detailed analysis of neps to identify the different types of imperfection: SCF, Illicellaneous neps such as honeydew, and fiber neps.

The method is broken down into two operations:

The yarn unrolls for a limited time at a speed of 25 m/min., with the normal sensitivity settings chosen, e.g. 30%, 50%, 200% for ring spinning. The yarn is retrieved on a separate drum. Total neps are counted.

Secondly, the yarn wound on the drum mounted on the upper part of the regularimeter introduced into the "imperfector selector", which stops it each ten seconds as it encounters an imperfection. Each is then examined carefully through a magnifying glass. Under intense light, placed in front of the yarn analyzer. The imperfections are counted by category: SCF, fiber neps, others.

Cotton Quality Measurements Conference
These results can be found in the table 1 according to main geographic areas.

The “seed coat fragment” problem is on the increase because of changes that have occurred over the past few years:

- changes in ginning techniques: the number of devices for cleaning cotton seed and fiber has increased, as has their speed, making the process more aggressive,
- changes in spinning techniques: requiring batches of fiber that are ever more homogeneous and free of foreign matter.

These seed coat fragments make up a large part of yarn neppiness. Neppiness can be broken down into five categories and regrouped into fiber neps, seed coat fragments and miscellaneous fragments:

- three types of fiber neps can be identified:
  - “shiny neps” are lumps of unripe fiber; they cause uneven dying of the cloth
  - “process neps” are created during the various processing steps from seed cotton to yarn (ginning, cleaning, carding, etc.)
  - “sticky neps” are due to sugar on the fiber, the origin of which is either physiological or, more often, entomological (honey dew); this sugar is excreted by the aphid, *Aphis gossypii* and the white fly, *Bemisia tabaci*.

Contamination from insect honeydew can result in severe production lasses.

- “seed coat fragments” arise from cleaning and ginning the seed cotton as these processes tear off part of the seed coat, to which the fibers remain attached. During spinning these seed coat fragments in the yarn cause breakages and deteriorate the yarn’s appearance and increase production costs related to their elimination.

- “other types of neps” group plant debris such as asleaves, stems, etc. and various impurities; their presence is most often linked to the quality of the harvest and the cleaning processes employed (seedcooon and fiber).

The presence of SCF in the fiber causes numerous problems during spinning (J. D. Bargeron and T. H. Gajjar, 1988; G. J. Mangialardi Jr, 1988; L. Verschraeghe, 1989). Consequently, cotonnes known to contain large quantities of SCF are liable to heavy downgrading on the market.

To try to contend with the problem, teams of breeders and CIRAD cotton technicians began studying the phenomenon in the late 1980’s (B. Bachelier, 1992).

First, it was necessary to find a way to inassure the number of SCF in the yarn. Second, the heritability of the character then remained to be determined.

### Measuring the nUmber of SCF in the yarn

At present, all quality control devices measure all neps in the yarn (fiber neps + shiny neps + sticky neps + SCF + plant debris); but although certain neps seem to result solely from the environment (plant debris and sticky neps), others are probably controlled genetically to a great extent (e.g. SCF). Yarn neppiness-measuring instruments available today do not evaluate this possible heredity factor. For this reason, CIRAD-CA in Mompellier created a method whereby it was possible to measure neps in yarn according to their type ([R. Frydrych and J. Gutknacht, 1988; R. Frydrych, 1992], Asi a first step, a USTER GGP-IP1 regularimeter was used fixed with an “imperfector selector” (USTER News 1965). Each yarn underwent the routine global testing (total neps) then a detailed analysis of neps to identify the different types of imperfect[al]: SCP, JIscellaneous neps suchs honeydew, and fiber neps.

The method is broken down into two operations:

**The yarun roll** for a limited time at a speed of 25 m/min, with the nonnal sensitivity settings chosen, e.g. -50%, 50%, 200% for ring spinning. The yarn is retrieved on a separate drum. Total neps are counted.

Secondly, the yarn unwound round the drum mounted, on the upper part of the regularimeter is introduced into the “imperfector selector”, whichstopps each time it encounters an imperfection; Eachin then examined carefully througha magnifying glassunder intense lightplaced in front of the yarn analyzer. The imperfections are counted by category: SCP, fiber neps, others.

The results obtained by regularimetry on 94 non-sticky coUons, spun in jean and originating in several African and South American countries, confirmed a correlation between SCF and total USTER neps.

A statistical analysis revealed that the number of SCF in non-sticky xeps can be estimated fairly precisely by an equation which includes thick neps (TNX), total neps, counted by the USTER (fig. 1) (r = 0.984):

\[
\text{SCF} = -0.14 \times \text{THICK} + 0.96 \times \text{NEPS} + 14
\]

In the case of sticky coUons, the stickiness potential measured by the thermendodetector must be added to the equation. The equation is developed below.

\[
\text{SCF} = -0.17 \times \text{THICK} + 0.92 \times \text{NEPS} + 1.98 \times \text{SCT} + 62
\]

The technique has now been adapted and can be used on UT3.

### Evaluation of yarn SCF heritability

A preliminary trial using 5 varieties was performed at 6 different locations. The seed coUon produced was ginned and the fiber spun by ring spinning 21 times.

Total variance was broken down into varietal, location and residual variance.

Heritability was estimated using the ratio:

\[
\text{Heritability} = \frac{\text{Variatel variance}}{\text{Variatel variance} + \text{Location variance} + \text{Residual variance}}
\]

Heritability thus estimated was 73.2%.

At the same time, another trial in another country was performed using 6 varieties at 6 different locations. Estimated heritability was 76.1%.

It can be reasonably asserted, therefore, that the heritability of SCF in 20tex spinning yam is about 70%. This high level of heritability is compatible with CIRAD’s aim of setting up a genetic improvement program dealing with neppiness.

However, although the present technique for counting SCF in yam is autolomous, it is unable to meet the requirements of a strategy of varietal improvement designed to reduce neppiness, since thousands of yam analyses would be necessary. As the cost of a microspinning trial followed by quality control of the yarn is very high, this method would be incompatible with the usual biology at a breeder’s disposal.

### Setting up a quick method to count SCF on yarn

Ta solve this problem, CIRAD decided to evaluate the number of SCF in a card sample and to study the relation between this parameter and yarn neppiness due to SCF.

### Materials and methods

Two samples (500 g and 40 g) were taken from thirty coUons of various origins. Backcotton underwent the following processing and analyses:

- Spinning trials were performed on a Shirley-Platt microspinning machine comprising a colom opener, a card, anadrawing frame and a ring spinning frame using two drawing areas.
  - 500 g offillers were used in these tests to obtain about 13 km of yarn of 27 tex, 27 tex or 37 tex.
  - 500 g offillers were divided into 5 parts, each weighing 100 g.
  - Each 100 g sample was opened and mixed on our laboratory opener. The web was wound onto a drum 1.55 cm in circumference. Five webs were obtained for each cotton.
  - Each web was folded in the middle and inserted into the card feed roller. The stationary rollers were cleaned twice during each test. The cotton web produced was wound around a drum identical to that used on the opencard. Five webs were obtained for each cotton.
  - The first drawing, with a value of 10.5, converted the web into a silver. The sliver, which was 15.60m long, was collected in a can and all 5 slivers were obtained to be used for the second drawing.
  - The second drawing was used to homogenize and refine the sliver by doubling at 5. The 5 cans were placed at the back of the drawing frame.
The second drawing, with a value of 10.5, resulted in a sliver 170 m. long which was collected in a can, then divided into 10 cans. Each can contained 15.60 m. of sliver. The 10 cans were placed at the back of the drawing frame for the third drawing.

The third drawing homogenized and refined the sliver by doubling at 58°C to make 20 tex and 27 tex yarn, the drawing used is 10.5; then the sliver used to feed the 4 spindles of the ring spinning is about 2200 tex. To make 37 tex yarn, the drawing used is about 8.5; then the sliver used to feed the 4 spindles is 3000 tex.

For each spindle, a length of sliver was collected in a can and placed at the back of the ring spinning frame.

Ring spinning was composed of two drawings; the back draught was fixed at about 6.5, the front draught fluctuated depending on the incoming scoured yarn. Four spindles were used. For each tex, the length of sliver used was divided to obtain:

- 1500 m. of yarn for the regularimetry test (first replication). The length was wound onto four cops.
- 1500 m. of yarn to identify and count the various imperfections found in cotton yarn. The length was wound onto four cops.

Temperature and hygroscopic conditions in the course of the study were 22°C and 65% relative humidity during spinning.

Each yarn was analyzed on USTER devices as follows:
- Regularimetry: performed on a USTER UT3 regularimeter. The settings chosen were as follows: speed 10 mm/min., thickness (-50%), twist (50%), and non-twist (200%).
- These settings were used for both regularimeter tests, i.e. non-twist and detailed analysis.
- Normal test: two replications were made, each replication using 250 m. of yarn per cap x 4 cops to obtain 1000 m. The mean was calculated.
- Detailed analysis: performing a method developed at CIRED for identifying the different neps observed. Each imperfection was examined in detail using a magnifying glass and intense lighting. The yarn was stopped for a given period of time (20 seconds); then loosened to obtain stabilization for 5 seconds before reading. Imperfections were classified as seed coat fragments, fiber neps (entangled fibers and sticky neps) fragments such as leaves. Percentages obtained for each type of imperfection were adjusted to total neps on 1000 m to obtain the number of neps per type of imperfection in 1000 m.

Counting of imperfections on card web.

A rapid counting method for estimating cotton SCF comprises:
- A microscope
- A video camera
- A PC 486 computer with video card
- Software created especially for the purpose.

The 40x fiber sample is put through the following steps:
- The sample is opened by hand to obtain a web of about 26 cm x 21 cm.
- The web is folded in four, and is carded with a smooth aluminium plaque in place of flat.
- The fiber web thus obtained is wound around a drum.
- The web is then divided into three equal paraslitethread parcels or pieces and is carded a second time, this time with a non-nai card flat.
- Once a regular web has been obtained, 4 layers of the web are wound around a drum.

Results

Number of imperfections

A statistical analysis of the number of fibers observed by Trascam in relation to the intra-cotton variance distribution is given in Table 6. The number of imperfections observed in each cotton card web was significant at 1 in 1000.

Surface area of imperfections

Imperfections were distributed into 6 categories, and the number of imperfections observed was reclassified according to their type and number of lint pieces, fiber neps, seed coat fragments, and sticky neps. The different neps observed were classified as:

- Type of harvest (manual or mechanical)
- Type and number of lint pieces
- Type and number of fiber neps
- Type and number of seed coat fragments
- Variety

A precise study would be necessary to determine the number and size of the objects present in the SCF.

Subsequently, research was conducted on the SCF on 20, 27 and 37 tex yarn in five different countries.

- A second drum is placed on the web of each made up of 4 layers of SCF.
- The first web is placed on the second drum using 3 video images are taken. Each gives the result (number of object) file.

To obtain high quality images, the video camera is placed on an equipment with a zoom lens that produces a uniform background.

The software reads the image line by line and identifies objects. The area of an object is estimated by the area distribution of the image by contrast. The software identifies objects by contours and is affected by the anti-reflection effect produced by the surface of the card web.

For this reason, surface areas will be expressed as

The size distribution of the imperfection area classifications, from 1 to 30 pixels, is given in Table 7. The coefficient of variation for the SCF diameter is 10%.

Temperature and hygroscopic conditions during the study were 22°C and 65% relative humidity during spinning.

The web is folded in four, and is carded with a smooth aluminium plaque.

The software reads the image line by line and identifies objects. The area of an object is estimated by the area distribution of the image by contrast. The software identifies objects by contours and is affected by the anti-reflection effect produced by the surface of the card web.

For this reason, surface areas will be expressed as

The size distribution of the imperfection area classifications, from 1 to 30 pixels, is given in Table 7. The coefficient of variation for the SCF diameter is 10%.

Temperature and hygroscopic conditions during the study were 22°C and 65% relative humidity during spinning.

The web is folded in four, and is carded with a smooth aluminium plaque.

The software reads the image line by line and identifies objects. The area of an object is estimated by the area distribution of the image by contrast. The software identifies objects by contours and is affected by the anti-reflection effect produced by the surface of the card web.

For this reason, surface areas will be expressed as

The size distribution of the imperfection area classifications, from 1 to 30 pixels, is given in Table 7. The coefficient of variation for the SCF diameter is 10%.
The second drawing, with a value of 10.5, resulted in a sliver 170 m long, which was collected in a can, then divided into 10 cans. Each can contained 15.6 m of sliver. The 10 cans were placed at the back of the drawing frame for the third drawing.

The third drawing homogenized and refined the sliver by doubling the twist. To make 20 tex and 27 tex yarn, the drawing used is 10.5; then the sliver used to feed the 4 spindles of the ring spinning is about 2200 tex. To make 37 tex yarn, the drawing used is about 8.5; then the sliver used to feed the 4 spindles is 3000 tex.

For each spindle, a length of sliver was collected in a can and placed at the back of the ring spinning frame.

Ring spinning was composed of two drawings; the back draught was fixed at about 0.5, the front draught fluctuated depending on the incoming yarn. Four spindles were used. For each tex, the length of sliver used was divided to obtain:

- 1500 m, of yarn for the regularimetry test (first replication). The length was wound onto four cops;
- 1500 III of yarn to identify and count the various imperfections found on cotton in yarn. The length was wound onto four cops;
- 1500 m, of yarn for the regularimetry test (second replication).

Local humidity and hygrometric conditions in the course of the study were 22°C and 65% relative humidity during spinning.

Yarn was analyzed on USTER devices as follows:

- Regularimetry: performed on a USTER UT3 regularimeter. The settings chosen were as follows: speed 50 cm/min., thin (-50%), thick (+50%), type (200%).
- These settings were used for bath regularimeter tests, i.e. normal test and detailed analysis.

Normal test: two replications were made, each replication using 250 m of yarn per cop x 4 cops to obtain 1000 m. The mean was calculated.

Detailed analysis: performed using a method developed at CIRAD to quantify the different types of imperfections observed. Each imperfection was examined in detail using a magnifying glass and intense lighting. The yarn was stopped for a given period of time (20 seconds), then loosened to obtain stabilization for 5 seconds before reading. Imperfections were classified as seed coat fragments, fiber neps (entangled fibers and sticky neps), fragments such as stains. Percentages obtained for each type of imperfection were adjusted to totals on 1000 m to obtain the number of neps per type of imperfection on 1000 m.

An analysis of imperfections on card web:

The counting method for estimating cotton SCF comprises:

- Guidelines for image acquisition:
  - Support for the card web
  - Light source
  - Video camera
  - A PC 486 computer with video card
  - Software created especially for the purpose.

A fiber sample is put through the following steps:

- The sample is opened by hand to obtain a web of about 26 cm x 21 cm.
- The web is folded in four, and is carded with a smooth aluminium plate and a felt burl.
- The fiber web thus obtained is wound round a drum.
- The web is then divided into three equal parts that are placed one on top of the other and are carded a second time, this time with a normal card flat.
- A regular web has been obtained, 4 layers of the web are wound around a drum.

Quality Measurements Conference

To obtain high quality images, the fiber web is pressed against the examination plate. The side of the pressing instrument in contact with the fiber web is covered with a uniform white background.

The software reads the image line by line and imperfections are revealed by localized contrasts. Contiguous lines are then analyzed to describe the contours of the objects. The area of an object is overestimated because of the slight magnifying effect produced by the anti-reflection plate onto which the fiber web is pressed. For this reason, surface areas will be described in pixels rather than in mm².

The size distribution of the imperfections is established according to 30 surface area classifications, from 1 to 30 pixels.

Temperature and hygrometric conditions in the, course of the study were were 22°C and 65% relative humidity during resistance and regularimetry testing.

Results and discussion

Number of imperfections

A statistical analysis of the number of imperfections was carried out according to Fisher with 30 varieties and 4 repetitions. We corrected the number of SCF observed by Trashcam in relation to the weight of the web analyzed (0.5 gr).

Intra-cottn variance distribution is not normal. A square root transformation of the number of imperfections observed per 500 g of fiber stabilized the variances. The coefficient of variation for the transformed trial data was 8.3%, and the F test was significant at 1 in 1000.

Figure 3 shows that the range of COUs chosen was very wide.

Surface area of imperfections

Impurities were distributed into 6 classes for each cotton. The 30 classes of imperfections observed were reclassified into 6 classes of surface area.

Distribution homogeneity of the surface areas for the 30 cottons was tested using Pearson's χ² test. The χ² = 238.2 for 145 degrees of freedom was highly significant. This revealed that the mean distribution observed for the 30 cottons (fig. 4) was not representative of all cases observed. Figures 5, 6 and 7 show the different possible types of distribution. These variations in distribution forms depending on the COU may be related to several causes (non-exhaustive list):

- Type of harvest (manual or mechanical) leading to variations in the amount of plant fragments in the fiber.
- Type and number of seed cotton cleaners in the ginning mill
- Type and number of lint cleaners in the ginning mill
- Variety

A precise study would be necessary to determine the impact of these different factors on the number and size of the objects revealed by image analysis.

Subsequently, research was conducted on the type of object which could represent SCF on 20, 27 and 37 tex yarn in ring spinning:

- Objects smaller than 15 pixels are too small to be of significance on the yarn.
- Objects larger than 0.0020 pixels are not generally SCF; they are often plant debris or are not categorized as neps by the UT3.

It was therefore decided to study the relation between objects between 15 and 19 pixels and the number of SCF on the yarn.

Relation between SCF on the fiber web and SCF on the yarn

Figures 8, 9 and 10 show the relationship between the number of SeF on the card web and the number of SCF on the yarn.

1247
1995 Belwide Cotton Conferences
The correlation coefficient between the card web and 20 tex yam is 0.916.
The correlation coefficient between the card web and 27 tex yam is 0.912.
The correlation coefficient between the card web and 37 tex yam is 0.888.

Conclusion

The correlation between the number of SCF on the card web and the number of SCF on ring spinning yam is satisfactory throughout. The process is currently being computerized to obtain direct reading of the card web as it unravels. This method can be used in varietal improvement. However, investigations must continue to establish the impact of types of ginning processes on the number of SCF and their size distribution.

Bibliography


ITMF. 1993. "Cotton contamination survey".


Table 1. Seed Coat Fragment contamination (from Cotton Contamination Survey - 1993 - ITMF).

<table>
<thead>
<tr>
<th>Geographie area</th>
<th>Positives answers</th>
<th>Number of answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>South America</td>
<td>32.0</td>
<td>129</td>
</tr>
<tr>
<td>North America</td>
<td>34.0</td>
<td>446</td>
</tr>
<tr>
<td>Africa</td>
<td>38.5</td>
<td>385</td>
</tr>
<tr>
<td>Europa</td>
<td>39.7</td>
<td>225</td>
</tr>
<tr>
<td>Asia</td>
<td>49.0</td>
<td>390</td>
</tr>
<tr>
<td>World</td>
<td>36.2</td>
<td>1575</td>
</tr>
</tbody>
</table>

The correlation coefficient between the card web and 20 tex yam is 0.916.

The correlation coefficient between the card web and 27 tex yam is 0.912.

The correlation coefficient between the card web and 37 tex yam is 0.888.

SCF = -0.14 * Thick + 0.96 * Neps + 14

r = 0.984
Figure 5. An example of trashcam count distribution.

Figure 6. An example of trashcam count distribution.

Figure 7. An example of trashcam count distribution.

Figure 8. Seed Coat Fragments on 20 tex yam' vs Trashcam count on the web (5 grams web).

Figure 9. Seed Coat Fragments on 27 tex yam' vs Trashcam count on the web (5 grams web).

Figure 10. Seed Coat Fragments on 37 tex yam vs Trashcam count on the web (5 grams web).