SEED-COAT FRAGMENTS EFFECT ON CARDED COTTON YARN EVENNESS

M. Krifa[1, 2], V. Vydelingum[2],
J.-P. Gourlot[1] and R. Frydrych[1]
[1]Cirad-ca, T/COT
Montpellier, France
[2]ENSITM-LPMT
Mulhouse, France

Abstract

Since most yarn defects translate directly into fabric imperfections, high-quality yarn is a necessary prerequisite for high-quality fabrics. It is therefore essential to identify different sources of yarn defects and attempt to improve yarn quality.

This paper describes the highly significant contribution made by Seed Coat Fragments in all types of cotton yarn imperfections as detected by capacitive-sensor evenness tester. Different yarn quality parameters are shown to be significantly related to SCF.

Introduction

Seed Coat Fragments (SCF) are portions of a cotton seed that have been pulled or broken from either mature or immature seeds during ginning and mechanical processing. SCF are usually black or dark brown in color and may or may not have fibers or linters attached (ASTM, 1980).

SCF are known to be a major source of cotton yarn imperfections (Frydrych *et al.*, 1999). They are usually associated with thick and short irregularities detected by capacitive-sensor evenness tester as neps, +200% in Ring Spun (RS) yarn (Pearson, 1933; Bargeron and Garner, 1988; Baldwin *et al.*, 1995) and +280% in Open End (OE) Spun yarn. Only a few studies considered other types of yarn blemishes as related to SCF.

Gupta and Vijayshankar (1985) examined microscopically different types of yarn imperfections in samples cut from medium count (16-30 tex) RS yarn using the Uster Imperfection Selector. They concluded that a significant proportion (30-40 %) of thick places could be attributed to the presence of a SCF.

Frydrych *et al.* (1999) used image analysis (Trashcam) and Zellweger UT3 to count SCF in 20 tex RS yarn. They found that Trashcam detects and counts far more imperfections than UT3 (considering only 200 % neps). They concluded that a large number of SCF can be associated with other types of imperfection that may be detected by UT3 with other thresholds.

The present study was carried out to check the global effect of SCF on yarn evenness without focusing on a specific type of imperfection.

Materials and Method

Six upland cotton samples from various origins were selected for their moderate SCF content. Two samples of each cotton were constituted after blending and homogenizing the original mass by hand and on our laboratory opener. SCF were detected and removed by hand from one of the two samples using forceps and transparency lighting through the card web. This method (figure 1) therefore provided two samples of each cotton with the same fiber technological properties (length, maturity, strength, fineness) but with significantly different SCF contents.

Spinning settings (twist and draft) were optimized for each cotton according to the technological properties of the raw fibers measured on HVI (10 replications).

The two samples of each cotton were spun on Cirad's laboratory RS micro-spinning machine with exactly the same settings and under the same conditions of temperature and relative humidity. It may therefore be assumed that differences in yarn quality between the two samples of the same cotton are mainly due to the presence of SCF.

The yarn produced was tested for evenness on Zellweger Uster UT3 and for SCF count on Cirad's SCF counting device: Trashcam (Gourlot *et al.*, 1998).

Results and Discussion

As UT3 gives cumulated counts of different nep types, counts corresponding to +140% and +200% were recalculated to provide independent counts; i.e. between +140% and +200 % neps; between +200% and +280% neps and more than +280% neps.

It was assumed, for the statistical analysis, that the counting distributions followed Poisson's law.

1 - SCF Removal

The SCF counting and sizing results provided by Trashcam on yarn boards are presented in Table 1. These results show that a residual quantity of SCF (20-30 % of the initial amount) remains in cotton samples after SCF removal. A comparison of the apparent mean sizes of SCF as measured by Trashcam in each pair of cotton samples showed that residual SCF are small (0.1 mm²).

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Although some SCF remained in samples after removal, the two sets of samples will hereafter be referred to as "SCF-full samples" for the set spun without removing SCF and "SCF-free samples" for those spun after SCF removal.

2 - Yarn Non-Uniformity

Table 2 presents the values of non-uniformity or yarn unevenness as measured by UT3 (CV%) for the six pairs of cotton samples. The results show an improved yarn evenness for the SCF-free samples. A two factors variance analysis was performed on the non-uniformity two data sets. The two factors considered were cotton (with 6 levels) and SCF (2 levels i.e. SCF-full and SCF-free). The results of variance analysis reported in table 3 show a very highly significant influence of SCF on non-uniformity.

3 - Yarn Imperfections

Figures 2 to 6 show UT3 counts with confidence limits ($\propto$ = 0.05) for various types of yarn imperfections recalculated as described previously; respectively +200 % to +280%, +280 %, +140% to +200% neps, thick and thin places.

As expected, the +200 % to +280% neps count (figure 2) decreased significantly after the SCF had been removed from cotton samples. Moreover, other types of imperfections detected by UT3 (+140% to +200%, 280% and thick places) decreased significantly for most samples (figure 3, 4 and 5). It may be concluded from these results that SCF can generate various types of RS yarn imperfections as detected by evenness tester.

Figure 6 shows that even thin places decreased significantly for some cottons. Since we can not establish a direct connection between SCF and thin places, this phenomenon can be explained by the close relationship usually observed between thin and thick places. Figure 7 shows a very highly significant correlation between these two types of yarn imperfections on more than 100 cottons spun for routine analysis in our laboratory (RS, 20 tex). We can therefore put forward the hypothesis that the decrease in the number of thin places is due to the decrease in the number of thick places. This subject is worth further investigation.

All the results were obtained on 20 tex yarns, but it is likely that yarn count may have an influence on the type of imperfections involved by SCF in yarn. Some experiments are in progress to study this effect.

SCF Contribution in Generating Yarn Imperfections

When considering these six samples, the contribution made by SCF in each type of yarn blemish can be calculated by the difference in the defect counts observed within each pair of samples, i.e. between SCF-full and SCF-free samples. The percentage decrease in each type of imperfection after SCF removal is reported in table 4.

The results in table 4 show that SCF contribute to different degrees in each type of yarn imperfection. The +280% and +200% to +280% neps are primarily due to SCF in most cotton samples. Meanwhile, +140% to +200% neps and thick places are significantly affected by SCF but to a lesser degree. If we consider cotton 6 as an example, SCF removal resulted in a decrease of 27% in +140% to +200% neps, 65% in +200% to 280% neps, 93% in +280% neps and 27% in thick places. It was also noted that the variation in the number of thin places was closely correlated to the decrease in the number of thick places. Figure 8 shows the highly significant correlation (r = 0.98) between thin and thick places variation due to SCF removal.

Moreover, the SCF contribution in generating yarn imperfections seems to be dependent on the cotton, with probable interaction between SCF content and fiber technological properties.

Effect of Raw Fiber Properties

Several studies have reported a close relationship between cotton yarn imperfections and some fiber technological properties.

As well as the significant proportion due to SCF, yarn imperfections may be related to fiber maturity (Pearson, 1933; Pearson, 1937), to maturity-fineness (Hebert *et al.*, 1986; Mangialardi and Meredith, 1990) and to stickiness (Frydrych *et al.*, 1999). On the other hand, some studies have reported that Short Fiber Content (SFC(w)) and standard fineness as measured by AFIS have a significant effect on yarn imperfections (Hequet, 1999). Therefore, many parameters may have an impact the Ring Spun yarn evenness.

Table 5 presents the correlation coefficients (r) between yarn evenness parameters (UT3) and both Trashcam SCF counts and fiber technological properties as measured on HVI. These relationships were established on an independent set of 15 cottons, representing a wide range of SCF contents.

Trashcam SCF counts are well correlated to all types of yarn blemishes as counted by UT3. These very highly significant relationships between SCF and yarn neps and thick places corroborate the results obtained by the removal of SCF.

On the other hand, yarn imperfections are also correlated to some fiber properties measured on raw cotton on HVI, which may explain the dependence between the contribution made by SCF in yarn imperfections and cotton samples.

Conclusion

SCF removal from cotton fiber resulted in a general improvement in RS 20 tex yarn evenness as UT3 counts for all types of imperfections decreased significantly. Even thin places decreased, probably due to the relationship observed between thick and thin places.

SCF contribute to different degrees in generating different types of 20 tex RS yarn imperfections as counted by UT3. The most affected defects were +200% to +280% and +280% neps. In addition, the proportion of each type of SCF-induced imperfections seems to be dependent on raw fiber technological properties.

Despite the large number of parameters affecting yarn quality, SCF remain one of the most important sources of imperfections. Cotton breeding seems to be an efficient method to avoid excessive SCF contamination (Bachelier, 1998; Bachelier and Lassus, 2000) and simple and efficient methods for varietal selection are available (Krifa *et al.*, 1998; Hequet *et al.*, 1999).

Literature Cited

ASTM (1980). Standard test method for seed coat fragments and funiculi in cotton fiber samples. Annual Book of ASTM Standards. American National Standard. ANSI/ASTM D 2496 - 80.

Bachelier B. (1998),"Contribution à l'étude de la variabilité et du déterminisme génétique de la teneur en fragments de coque de la fibre de coton. Premières applications pratiques en sélection chez *Gossypium hirsutum* L.". Thèse de Doctorat Biologie et Agronomie 98-32-C-50, Ecole Nationale Supérieure Agronomique, Rennes (FR), 271 p.

Bachelier B. and Lassus S. (2000), "Reducing the Seed Coat Fragment content of cotton fiber (*Gossypium hirsutum* L.) by varietal selection based on card web image analysis", Beltwide Cotton Conferences, San Antonio, TX (USA), National Cotton Council of America. Memphis, TN (USA), pp.

Baldwin J. C., Qaud M., and Schleth A. C. (1995), "AFIS Seed Coat Neps measurement", Beltwide Cotton Conferences, January 4-7, San Antonio, TX (USA), National Cotton Council of America. Memphis, TN (USA), pp. 1250-1253.

Bargeron J.D. and Garner T.H. (1988), "The role of seed-coat and mote-fragment neps in yarn and fabric imperfections : a survey", Beltwide Cotton Conferences, USA, National Cotton Council of America. Memphis, TN (USA), pp. 586-591.

Frydrych R., Krifa M., Tamime O., Giner M., and Gourlot J.-P. (1999), "Detection and counting of two cotton contaminants: Seed coat fragments and honeydew deposits", Beltwide Cotton Conferences, January 3-7, Orlando, FL (USA), National Cotton Council of America, Memphis, TN (USA), pp. 695-698.

Gourlot J.-P., Krifa M., Frydrych R., and Chanselme J.-L. (1998), "Honeydew and Seed Coat Fragments : Identifying and counting two major cotton fiber contaminants", 2ND World Cotton Research Conferences, September 1998, Greece, pp.

Gupta A. K. and Vijayshankar M. N. (1985), “Seed-Coat Fragments in Cotton as sources of Blemishes in Ring-spun yarns”, Journal of the Textile Institute 76(6): 393-401.

Hebert J. J., Mangialardi G. J., and Ramey H. H. (1986), “Neps in cotton processing”, Textile Research Journal 56(2): 108-111.

Hequet E. (1999), "Application of the AFIS Multidata", Beltwide Cotton Conferences, January 3-7, Orlando, FL (USA), National Cotton Council of America. Memphis, TN (USA), pp. 666-670.

Hequet E., Krifa M., and Gourlot J.-P. (1999), “Trashcam: a new instrument for cotton breeders”, Textile Topics (3: summer 1999): 2-8.

Krifa M., Bachelier B., Frydrych R., and Hofs J.-L. (1998), "Trashcam : counting Seed Coat Fragments for cotton breeding", Technical seminar of the International Cotton Advisory Committee, October 1998, Santa Cruz de la Sierra (Bolivia), pp. 30-32.

Mangialardi G. J. and Meredith W. R. (1990), “Relationship of fineness, maturity, and strength to neps and seed-coat fragments in ginned lint”, Transactions of the ASAE 33(4): 1075-1082.

Pearson N. L. (1933). "Neps and similar imperfections in cotton", USDA Technical Bulletin n° 396, Washington, D.C. (USA),18 p.

Pearson N. L. (1937). "Naps, neps, motes, and seed-coat fragments. A description of certain elements of cotton quality", USDA, Bureau of Agricultural Economics n° Washington, D.C. (USA),7 p.

Table 1. Trashcam SCF counts and mean size obtained on yarn plates (20 tex RS yarn).

	SCF-full sample (without SCF removal)		SCF-free samples (after SCF removal)	
Cotton	SCF/100m	Mean size(mm^2)	SCF/100m	Mean size(mm^2)
1	77	0,423	25	0,138
2	134	0,307	35	0,091
3	139	0,283	28	0,135
4	224	0,323	61	0,139
5	242	0,337	87	0,123
6	256	0,259	53	0,109

Table 2. RS 20 tex yarns non-uniformity (CV%) for the two sets of samples.

Samples	1	2	3	3	4	6
SCF-free samples	21.64	19.93	17.39	17.03	17.75	19.48
SCF-Full samples	21.72	21.31	18.09	18.30	18.93	20.33

Table 3. Effect test and variance analysis for yarn non-uniformity data sets.

Source	DF	Sum of Squares	F ratio	Prob.>F	Sign
Cotton	5	27.61	47.78	0.0003	***
SCF	1	2.47	21.39	0.0057	**
Error	5	0.58			
Total	11	30.67			

Table 4. Relative decrease (%) in the different types of 20 tex yarn UT3 imperfections due to SCF removal (SCF-full – SCF-free) / SCF-full.

Cotton	+140% to +200%	+200% to +280%	+280%	Thick places	Thin
1	11.03 NS	32.17*	65.71*	8.02 NS	-13.18 NS
2	9.40 NS	48.61***	82.00***	34.32***	37.94***
3	43.14***	68.93***	91.13***	30.30***	27.27 NS
4	41.01***	81.11***	90.23***	41.69***	50.53**
5	24.42*	73.43***	91.03***	47.48***	48.61*
6	27.65***	65.07***	93.58***	26.65***	23.74*

NS : Non Significant difference.
* : difference significant at = 0.05.
** : difference significant at = 0.01.
*** : difference significant at = 0.001.

Table 5. UT3 imperfections in 20 tex RS yarn vs. Trashcam SCF counts in fiber and yarn and fiber technological properties: correlation coefficients on 15 independent samples.

	+140% to +200%	+200% to +280%	280%	Thick places	Thin
Trashcam count in fiber	0.90***	0.93***	0.87***	0.87***	0.69**
Trashcam count on yarn	0.90***	0.95***	0.89***	0.84***	0.64*
ML (mm)	Ns	Ns	Ns	Ns	0.65**
Mic	Ns	0.56*	0.59*	0.66**	0.63*
H (mtex)	0.58*	0.67**	0.71**	0.80***	0.75**
MR	Ns	Ns	Ns	Ns	Ns

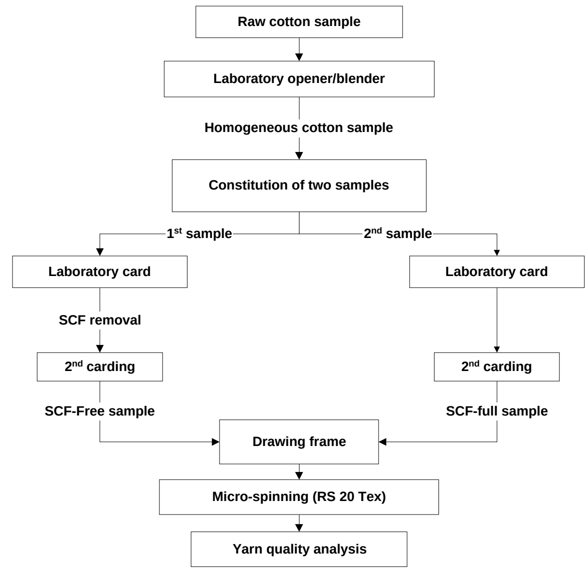

Figure 1. Experimental procedure (controlled conditions of temperature and humidity)

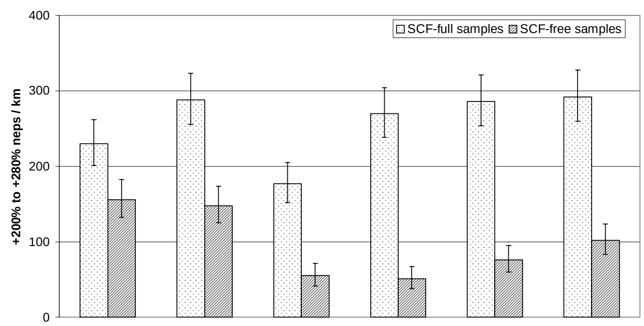

Figure 2. +200% to +280% neps as counted by UT3 for the two sets of samples (SCF-free and SCF-full RS 20 tex yarns).

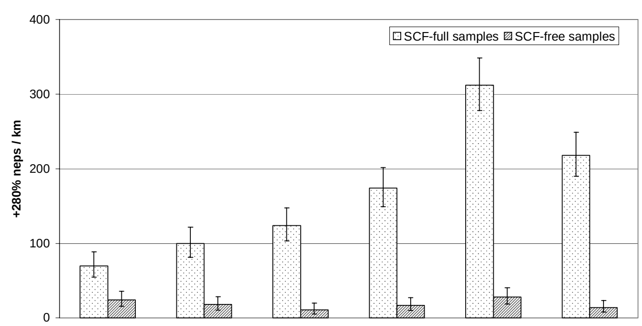

Figure 3. +280% neps as counted by UT3 for the two sets of samples (SCF-free and SCF-full RS 20 tex yarns).

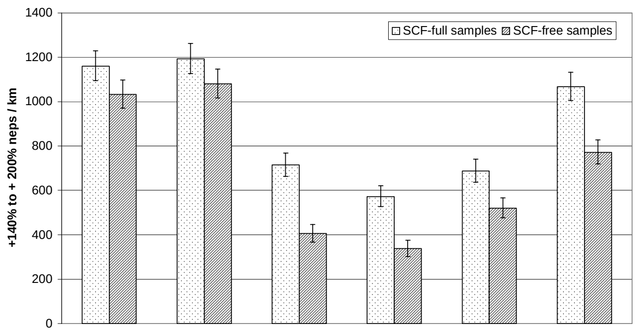

Figure 4. +140% to +200% neps as counted by UT3 for the two sets of samples (SCF-free and SCF-full RS 20 tex yarns).

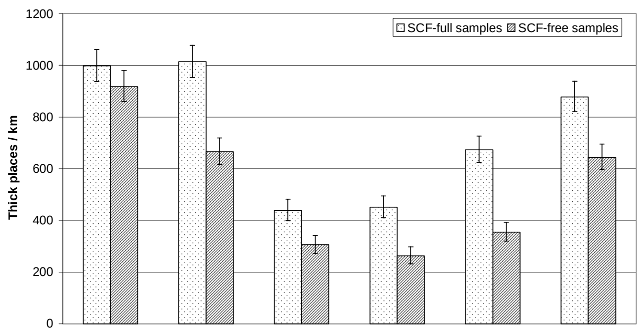

Figure 5. Thick places as counted by UT3 for the two sets of samples (SCF-free and SCF-full RS 20 tex yarns).

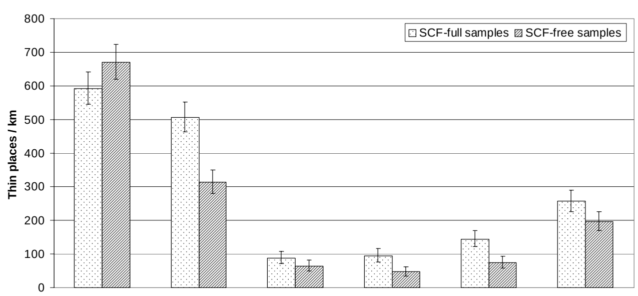

Figure 6. Thin places as counted by UT3 for the two sets of samples (SCF-free and SCF-full RS 20 tex yarns).

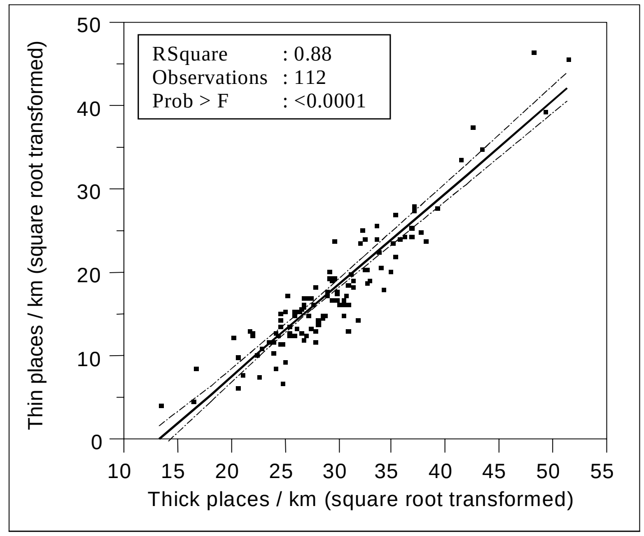

Figure 7. UT3 Thin places vs. Thick places on a independent set of 112 samples (RS 20 tex yarns).

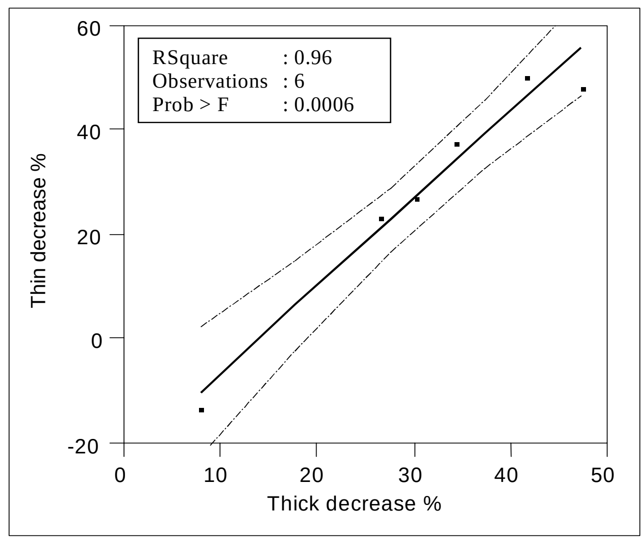

Figure 8. Decrease in UT3 Thin places vs. decrease in Thick places due to SCF removal (RS 20 tex yarns).