RELATIONSHIP BETWEEN SEED COAT FRAGMENT CONTENT AND YARN STRENGTH DEPENDING ON THE RANGE OF FIBER QUALITY

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Abstract

The hypothesis that fiber quality and the presence of seed coat fragments are related is put forward to explain the variability noted in yarn strength and was tested by selecting cottons from a population and evaluating their technological characteristics. Two cotton groups could be differentiated (so-called "good" and "poor" qualities) for ring-spun 20 text yarn. The results obtained show that the higher the quality of the fibers, the more pronounced the negative impact of SCF on yarn structure.

Introduction

The market for textiles, and particularly that for cotton, is becoming increasingly competitive. In this context, the balance between product quality and profitable productivity constitutes an economic imperative. Spinners are aware of the problems caused by contaminants and are increasingly strict as concerns the cleanliness of their raw material. Thus, discounts of varying magnitudes are applied to cotton contaminated by foreign matter (Chen *et al.*, 1991).

The problem posed by cotton contamination has been exacerbated by the technical advances made in the cotton industry. The increasingly widespread use of mechanical methods at every step in cotton processing, particularly during harvesting, has had a negative impact on fiber cleanliness. This has required the introduction of new cotton cleaning steps, leading to higher fiber production costs without entirely solving the problem. In fact, the value of these operations is often limited by the negative effect they may have on the intrinsic properties of the cotton fibers, particularly on length which may be affected by excessively brutal mechanical processing (Gutknecht, 1960; Gutknecht and Roerich, 1963; Newton *et al.*, 1966; Chanselme and Lançon, 1988; Hughs and Bragg, 1991; Anthony, 1998).

Seed-coat fragments (SCF) are among the principal contaminants of cotton fiber, but although they correspond to a major source of yarn imperfections (Krifa *et al.*, 1999; 2000a) few studies have been conducted to investigate the effect of SCF on other yarn quality parameters such as strength.

According to several authors (Ramey *et al.*, 1977; Frydrych, 1992; May and Taylor, 1998), yarn strength is primarily dependent upon the technological properties of the fiber (strength, length, fineness, etc.).

Sawich-Towler and Rogers (Sawich-Towler and Rogers, 1997) compared the dynamometric properties of portions of rotor spun (OE) yarn, some of which contained fiber or SCF neps in the center. They noted that yarn breakages occurred frequently close to the neps and therefore concluded that the presence of such yarn defects contributed to the creation of weak points. However, they noted that this effect did not cause a significant decrease in the specific breakage load.

In the course of previous studies, (Krifa, 1997) conducted on a range of 15 cottons spun using rotor spinning (OE) and ring spinning (RS) for 20 tex yarn, the author noted a very highly significant relationship between yarn strength and the Trashcam count of coat fragments in the fiber (R^2: 0.76*** for RS yarn and 0.78*** for OE yarn). The Trashcam (Gourlot *et al.*, 1998; Frydrych *et al.*, 1999) is an image analysis tool developed to count and size SCF. The explanation of yarn strength as a function of various fiber characteristics is growing significantly clearer when including a count of the seed coat fragments present in the fiber. Matusiak *et al.* (Matusiak *et al.*, 2000), also observed the same trend in OE yarn (27 tex) in a separate correlation study.

The results of an experimental study conducted led us to put forward the following hypothesis: the effect of SCF on yarn strength is dependent upon the presence or absence of other weak points in the yarn structure which may show lower strength than that of the point associated with the SCF (Krifa *et al*, 2000b). This effect is therefore dependent upon the general quality of the yarn structure, which itself is partly dependent upon the characteristics of the fiber.

Materials and methods

To support this hypothesis, we analyzed the data produced by 105 spinning tests for 20 tex yarn conducted over the last 3 campaigns and for which all the corresponding data were available, i.e. fiber characteristics, yarn characteristics and Trashcam analyses on yarn plates.

The data used were drawn from the SISTER database (Gourlot *et al.*, 1995) developed by the Cotton Technology Laboratory. Built around a database concept, SISTER allows users to input their information in a routine manner while authorizing general use of the data, e.g. extraction of the results of analyses performed on samples or the determination of analytical conditions and the calibration of measuring equipment.

Results

Table 1 presents the lowest and highest values for the characteristics of the 105 cottons tested.

Figure 1 illustrates the relationship between yarn strength and the SCF content of the 105 cottons.

The relationship between the two variables was seen to be non significant. As already mentioned, the hypothesis states that the higher the quality of the fibers, the more pronounced the impact of SCF on yarn strength. It was noted that the results for these 105 cottons could be divided into two clusters of points representing two different fiber property classes:

1- The first cluster (figure 2) corresponded to cottons where the values for one or two quality parameters were lower than the value corresponding to the 10% quantile of this parameter's distribution. The corresponding thresholds obtained for this cluster corresponded to HVI strength < 27.2 g/tex, H > 192 mtex, HS > 220 mtex, ML < 23 mm, UHML < 27.3 mm, UI < 82.2 %.

This cluster was composed of 35 cottons for which no relationship could be found between yarn strength and SCF content. It may therefore be stated that, for these samples of rather poor quality, SCF did not seem to have any effect on yarn strength.

2- Figure 3 shows the relationship for cottons with good fiber characteristics (the 70 remaining cottons), i.e. with thresholds corresponding to HVI strength > 27.2 g/tex, H < 192 mtex, HS < 220 mtex, ML > 23 mm, UHML > 27.3 mm, UI > 82.2 %. A very highly significant negative trend was observed here which is expressed for this group of cottons as a significant effect of SCF on yarn strength.

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Discussion

The results produced by micro-spinning tests (RS 20 tex) conducted on a broad range of cotton samples were analyzed. When considering all 105 samples, the relationship between SCF content determined by Trashcam and yarn strength was not significant.

By contrast, different trends were observed when two groups were isolated on the basis of the technological properties of their fibers. Here, although the SCF count did not appear to be related to yarn strength in cottons with rather poor fiber quality characteristics, the relationship between SCF and yarn strength was very highly significant for the cottons showing better quality fibers (strength, fineness, length, etc.).

In addition, the various models used to predict yarn strength generally show that strength is increased when fibers are selected for their favorable technological characteristics. This in fact signifies that choosing good quality fibers results in yarn with less weak points.

According to our hypothesis, the presence of SCF in the yarn predisposes to the creation of other weak zones in addition to those due to the intrinsic quality of the fibers. The relationships described in this paper show that weak areas indeed appeared when SCF were present in the yarn. These weak areas are all the more problematic since only a few are present in the yarn, particularly when good quality fiber is used and where yarn of a very regular structure is expected. In this case, the probability of the SCF being the weakest point in the yarn is increased. Thus, the higher the SCF count in yarn spun from good quality fibers, the greater their impact on yarn strength (Krifa *et al*, 2000b).

Conclusion

These results support the hypothesis that the strength of yarn produced from high quality fiber is dependent upon the presence of seed coat fragments (Krifa *et al*, 2000b).

This conclusion also supports the theory that the presence of SCF leads to the creation of points that are even weaker that the weakest points naturally occurring in the structure of the yarn. The higher the quality of the fibers used, the greater the impact of the weak points caused by SCF.

The results obtained also demonstrate the importance of choosing a broad range of samples for experimental studies where interactions exist between several factors.

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Table 1. Fiber characteristics of the cottons analyzed: lowest and highest values.

	Parameter	Min	Max
Fibers	HVI strength (g / tex)	24.4	34.1
	H (mtex): linear fineness	135	204
	HS (mtex): standard fineness	154	245
	ML (mm): Mean length	21.5	27.5
	UHML (mm) Upper Half ML	25.9	32.2
	UI (%): Uniformity Index	81.5	85.9
	MR: Maturity Ratio	0.73	0.97
	IM: Micronaire Index	3.18	4.71
Yarn	Strength (cN/tex)	10.81	16.26
	Trashcam SCF (SCF/km)	1100	6840
	Total neps UT3/km	276	2423
	Thick UT3/km	484	2071
	Thin UT3/km	67	933

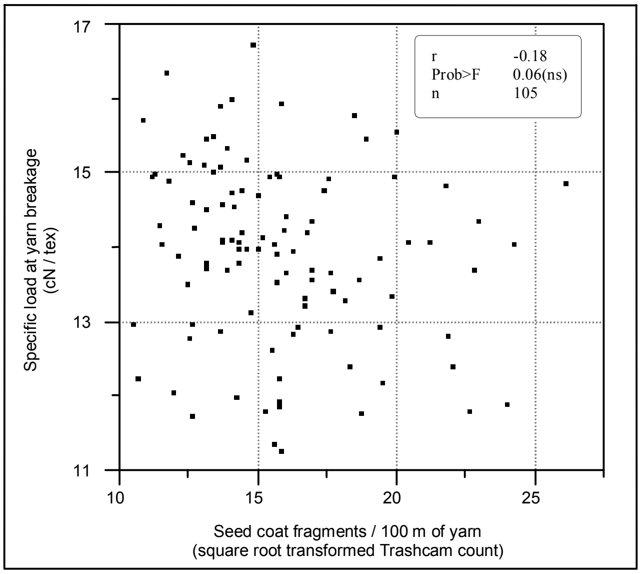

Figure 1. Relationship between yarn strength (RS 20 tex) and Trashcam SCF count (range of 105 cottons).

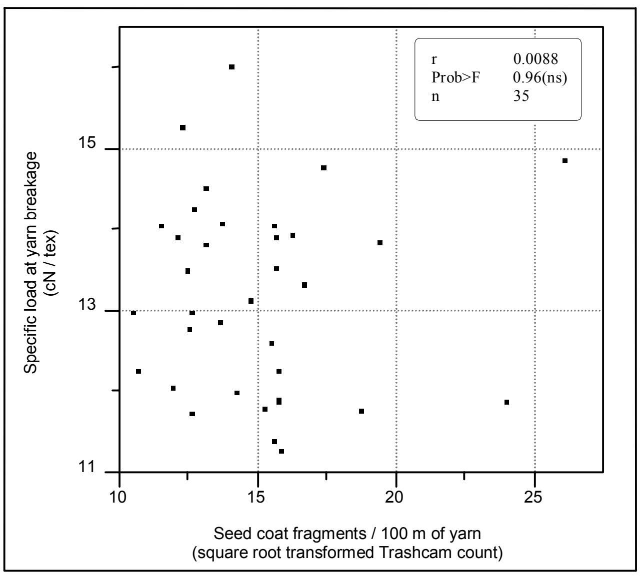

Figure 2. Relationship between yarn strength (RS 20 tex) and Trashcam SCF count (range of 35 "poor quality" cottons).

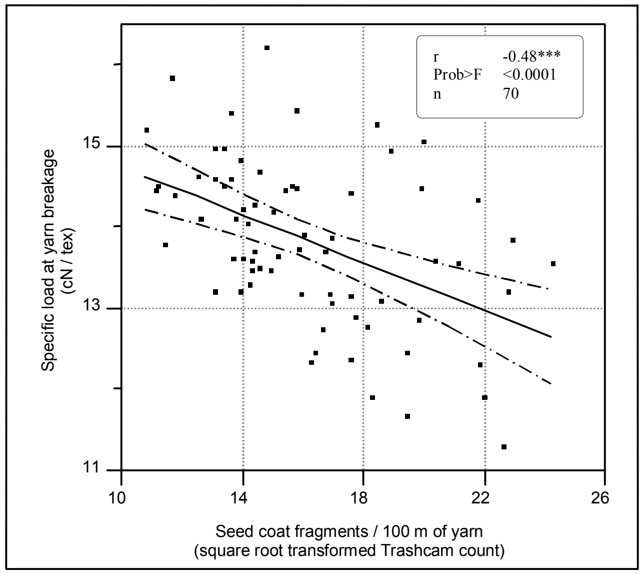

Figure 3. Relationship between yarn strength (RS 20 tex) and Trashcam SCF count (range of 70 "good quality" cottons).