COMPARISON OF RESULTS PRODUCED BY TWO GENERATIONS OF HVI

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Summary

When using HVI equipment for characterizing samples from breeding program, specific operating methodology should be applied. This methodology may vary for every type or model of HVI. The cotton technology laboratory at Cirad-CA just acquired a Spectrum HVI model that has to meet the required confidence intervals for its measurements. The Spectrum model has been matched against the old model (ZUS 910B) length strength tester using 57 cottons covering a wide range of characteristics. Results show that the relationship between ZUS 910B and Spectrum is good for length parameters, medium for strength and poor for elongation.

Introduction

High Volume Instrument (HVI) measurement lines have been developed to improve the commercial classification of cottons. These instruments furnish an objective measurement of several fiber characteristics, some of which are of particular importance for fiber behavior during spinning. This advantage, associated with the rapidity and reliability of the measurements, corresponds to the requirements of the cotton industry. Since they first appeared in 1980, the number of HVI lines in use has continually progressed and an increasing segment of world fiber production is now classified in this way.

The production of high quality fiber is one of the major aims of breeding programs and over the last few years, researchers have been using HVI analysis of their vegetal material (Dever and Gannaway, 1987; Meredith, 1991) to:

- create true evaluation conditions. Some genotypes may be estimated differently on conventional equipment and on HVI lines (Brown and Taylor, 1988);
- rapidly produce results and reduce analysis costs. The HVI analysis method employed in the USA to classify commercial cottons (2 to 4 measurements per bale) gives precisions compatible with trading requirements (Sasser, 1992). By contrast, this precision is insufficient for breeders who need data of higher precision for cottons that are often less homogeneous (Cooper et al., 1988; Green and Culp, 1990).

The Cotton Technology Laboratory at Cirad-Ca analyses each year numerous cottons acquired from breeding programs. The HVI data it produces for these cottons must show the same precision despite the model of instrument used (Table 1). A preliminary study conducted by the laboratory on the Zellweger Uster/Spinlab (ZUS) length/strength 910B module showed that the precision required can be obtained when 10 measurements are taken for each cotton sample that has previously been opened manually (Gourlot and Héquet, 1994).

It has been demonstrated that the fiber sampler can interact at a high degree in the measurement precisions, affecting the number of replicates per sample to realize in order to meet the required confidence intervals (Gourlot et al., 1996 ; Chanselme et al, 1996).

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Recently a new HVI Spectrum model was installed in the Cirad-CA laboratory. One evolution between the two models of HVI is concerning the sampling device for length and strength measurements. As already seen, this sampling device can drastically affect the measurements precision, and we wanted to check this and/or change our operating method prior to using this equipment on a routine basis.

The study presented in this paper has the following objectives:

- to compare the two systems as regards their precision over a wide range of cottons;
- to evaluate the feasibility of using the Spectrum model without any change as far as the operating method we used for the 910B model is concerned.

Materials and Methods

For this study, a total of 57 cottons, making up a large variability of technological characteristics were selected from Cirad-Ca Fiber Bank:

- 31 roller-ginned (18 *Gossypium hirsutum*, 7 triple hybrids and 6 *G. barbadense*);
- 26 saw-ginned (25 *G. hirsutum* and 1 *G. barbadense*).

To be noted that none of these cottons was both roller- and saw-ginned, so these data do not allow any comparison of the type of ginning.
All the cottons were manually open, then divided into 2 samples (with a rest), one for each HVI line.

The Zellweger Uster system is composed of a length/strength 910B module (ZUS 910B) and a Fibrosampler 192. The Spectrum model is composed of all standard measuring devices including an automatic sampler for length/strength measurements. The two systems use micronaire value to determine strength. For each sample, the same micronaire value is used for the two systems, for all the specimens. This therefore eliminated any variation between strength results due to micronaire variations. The micronaire value was measured on the Spectrum system and the same value was keyed in the 910B model. The two HVI Cotton Calibration standards (short and long Upland), used for both HVI lines, covered the range of cottons analyzed. These standards were checked twice daily too on each system. The following characteristics were measured: mean length (ML) and upper half mean length (UHML), HVI strength and elongation. The maximum number of measurements authorized for each cotton was used systematically by the software, *i.e.* 10 for both systems. The cottons were manually open and prepared for 48 h, then analyzed under standard conditions of relative humidity (Relative Humidity = 65 % ± 2 %) and temperature (temperature = 21°C ± 0.5°C). Measurements of the 57 samples on each HVI line were carried out in a random order.

Results

The information given in this paper is a first analysis on a part of the data. The results obtained for ML, UHML and UI were similar on ZUS 910B and Spectrum. For this reason, only those of UHML are presented for length parameters.

Variances

A Bartlett's test (Dagnélie, 1973) has been completed on the variances between cottons to assess their homogeneity (table 2). The probabilities obtained show that this homogeneity can only be accepted (*i.e.* probability > 0.05) for ML and UHML on Z 910B for roller-ginned cottons, for ML on Z 910B for all cottons and UI on Spectrum for saw-ginned cottons. In all the other cases, the variances are heterogeneous: two or more of them among the cottons studied are significantly different. This means that the precision of the measurements can differ from one cotton to another.

For each cotton, the variances on Z 910B and Spectrum have been drawn for UHML (figure 1), strength (figure 2) and elongation (figure 3). The ratio of the variances obtained on the two HVI lines has been tested by F-tests (figures 4 to 6). The results show that these variances significantly differ for 10 of the 57 cottons for UHML (mostly at a 95 % confidence level) and strength (mostly at a 99 % confidence level), and 13 for elongation (at a 99 or 99.9 % confidence level).

Averages

Although the conditions of linear regression (homogeneity of the variances) are not all fulfilled, we give here a comparison of the averages, as a result of preliminary investigations.

In these conditions, when considering the 57 cottons, the correlations between ZUS 910B and Spectrum results are very highly significant (*i.e.* at a 99.9% confidence level) for UHML (figure 7) and strength (figure 8), and highly significant (*i.e.* at a 99% confidence level) for elongation (figure 9).

When observing separately roller-ginned and saw-ginned cottons, these correlations remain very highly significant (figures 10 and 11), except for elongation on saw-ginned cottons (figure 12), where the correlation is not significant (at a 95% confidence level).

Confidence Intervals

Confidence intervals (at a 95 % confidence level) have been calculated for each of the 57 cottons and each characteristic on ZUS 910B and Spectrum. They overlap each other for 55 of the 57 cottons for UHML (figure 13), for 31 of them for strength (figure 14) and 9 for elongation (figure 15).

Discussion

The results obtained on Z 910B and Spectrum have been compared in terms of averages, variances and confidence intervals. These comparisons show that:

- for length parameters, the averages are very well correlated between the two HVI lines, on roller-ginned cottons as much as saw-ginned ones; most of the variances are not significantly different and the confidence intervals always close;
- for strength, the correlation between Z 910B and Spectrum averages is highly significant too; it seems however that the values are over-estimated for roller-ginned cottons on Spectrum (average of 30.9 g/tex) in relation to Z 910B (average of 29.2 g/tex), namely of 1.7 g/tex on the basis of the 31 roller-ginned cottons studied;
- for elongation, the correlation is at the limit of significance for roller-ginned cottons, and not significant for saw-ginned ones; several variances are very highly significantly different, and the confidence intervals almost all without overlap.

Some other parameters, established in CIRAD conditions, may be taken into account in this comparison, as:

- the time needed to evaluate one sample:
  - to measure 1 micronaire and 10 Length/Strength, 3 minutes are required on Z 900B (*i.e.* Z 910 + Z 920) and 5 minutes on Spectrum;
  - to measure 1 micronaire and 10 Length / Strength / Color / Trash, 4 minutes are required on Z 900B and 6 minutes on Spectrum;
- the minimum fiber mass required per sample:
  - 30 grams on ZUS 900B and 80 grams on Spectrum; the mass needed for Spectrum could be a limiting factor for the analysis of samples produced by a breeding program.

However, the Spectrum line has a higher level of automation, which may contribute to decrease the operator effect.

Conclusion

On the basis of the 57 cottons studied, the measurements made on Z 910B and Spectrum give similar results for length parameters, and the correlation is acceptable for strength. For elongation, it seems that there is no relationship between the values obtained on the two HVI lines, probably due to two different ways used to measure this characteristic. This was already observed in the past between the stelometer and the Z 910B.

Further investigations have to be led to study the effect of sample preparation (raw or manually open samples), the effect of ginning type, the effect of calibration type (short Upland/long Upland or short Upland/long Pima) and to determine the number of measurements needed per sample on Spectrum to get the precision needed for each characteristic.

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Table 1. Precisions sought by the Cotton Technology Laboratory at CIRAD.

Characteristic	Confidence interval (95% confidence level)
UHML	± 0.5 mm
Uniformity Index	± 1.5 %
HVI strength	± 1.0 g/tex
HVI elongation	± 0.6 %
Micronaire	± 0.1

Table 2. Homogeneity of variances (Bartlett's test): probability of overtaking χ^2observed.

Charac-teristic	Roller-ginned cottons		Saw-ginned cottons		All cottons	
	Z910B	Spectrum	Z910B	Spectrum	Z910B	Spectzrum
ML	0.4980 ns	0.0153 *	0.0040 **	<0.0001 ***	0.0008 ***	<0.0001 ***
UHML	0.3687 ns	0.0070 **	0.0374 *	<0.0001 ***	0.0658 ns	<0.0001 ***
UI	0.0045 *	0.0081 **	0.0004 ***	0.1623 ns	<0.0001 ***	0.0044 **
Strength	0.0239 *	0.0017 **	<0.0001 ***	0.0016 **	<0.0001 ***	<0.0001 ***
Elongation	0.0104 *	0.0085 **	<0.0001 ***	0.0204 *	<0.0001 ***	0.0009 ***

ns : non significant at a 5 % confidence level
*, **, *** : significant at a 5 %, 1 % or 0.1 % confidence level

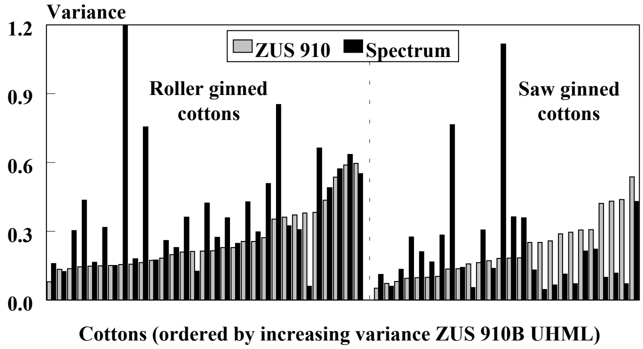

Figure 1. Comparison of ZUS 910B and Spectrum variances for Upper Half Mean Length on the 57 cottons studied.

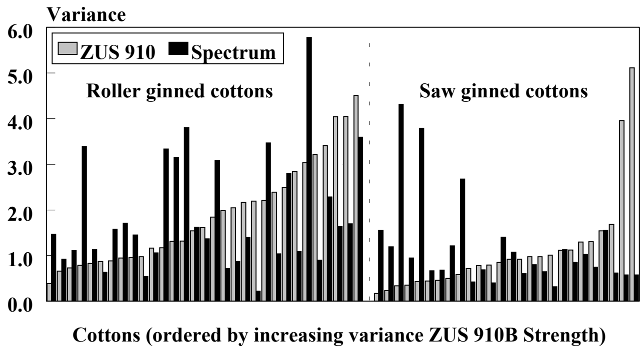

Figure 2. Comparison of ZUS 910B and Spectrum variances for Strength on the 57 cottons studied.

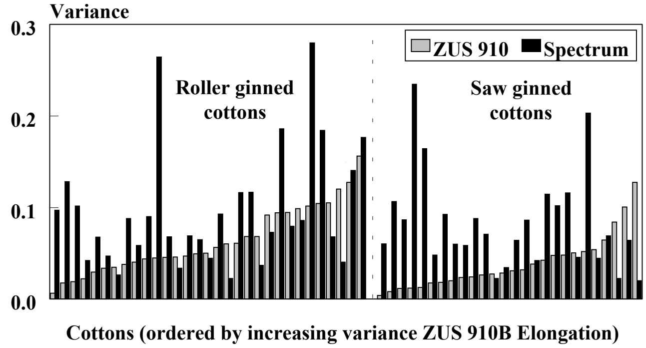

Figure 3. Comparison of ZUS 910B and Spectrum variances for Elongation on the 57 cottons studied.

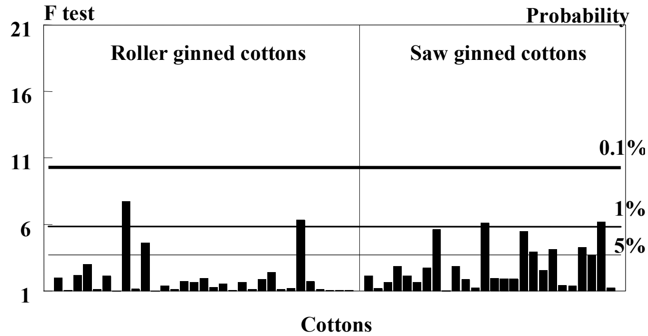

Figure 4. F test of the ZUS 910B and Spectrum variance ratio of Upper Half Mean Length on the 57 cottons studied.

Figure 5. F test of the ZUS 910B and Spectrum variance ratio of Strength on the 57 cottons studied.

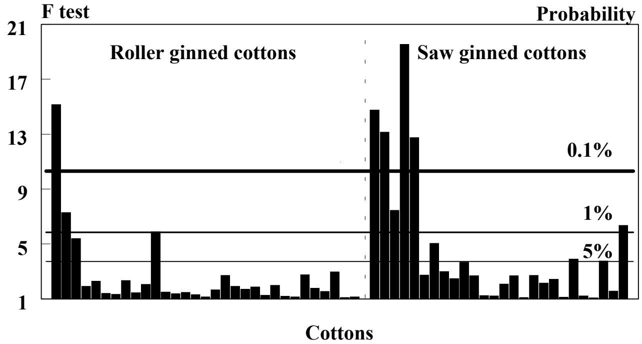

Figure 6. F test of the ZUS 910B and Spectrum variance ratio of Elongation on the 57 cottons studied.

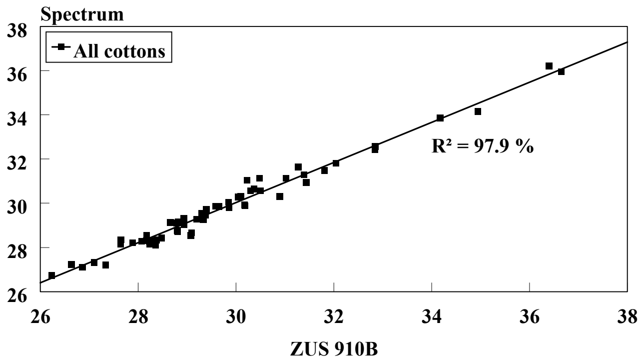

Figure 7. Comparison of ZUS 910B and Spectrum averages for Upper Half Mean Length (mm) on the 57 cottons studied.

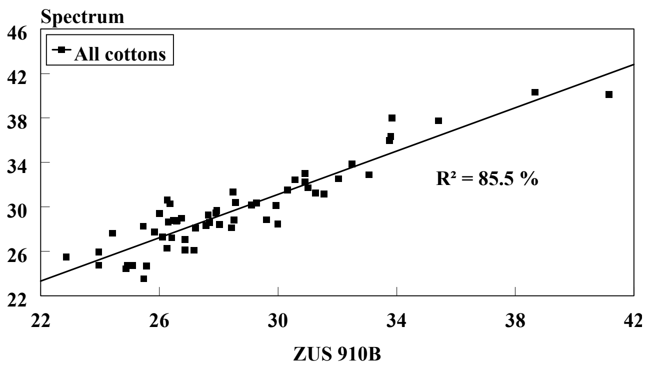

Figure 8. Comparison of ZUS 910B and Spectrum averages for Strength (g/tex) on the 57 cottons studied.

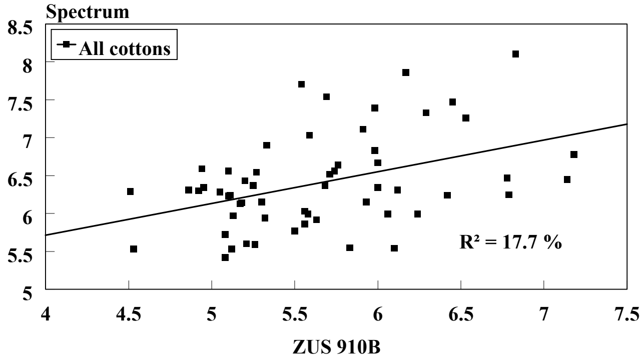

Figure 9. Comparison of ZUS 910B and Spectrum averages for Elongation (%) on the 57 cottons studied.

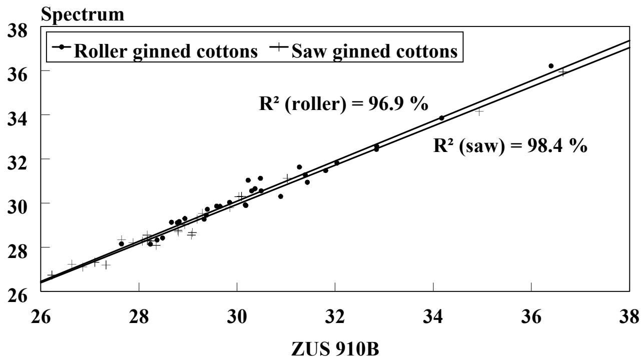

Figure 10. Comparison of ZUS 910B and Spectrum averages for Upper Half Mean Length (mm) on roller- and saw-ginned cottons.

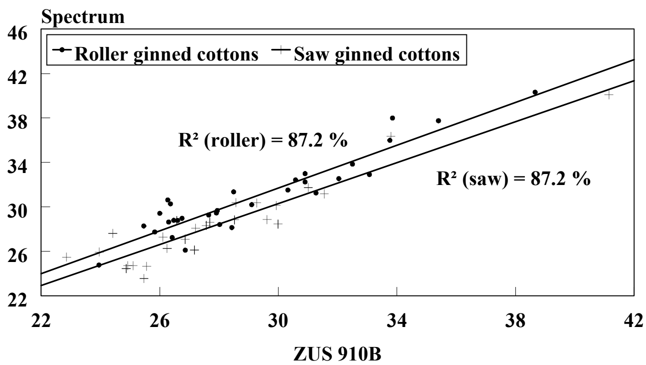

Figure 11. Comparison of ZUS 910B and Spectrum averages for Strength (g/tex) on roller- and saw-ginned cottons.

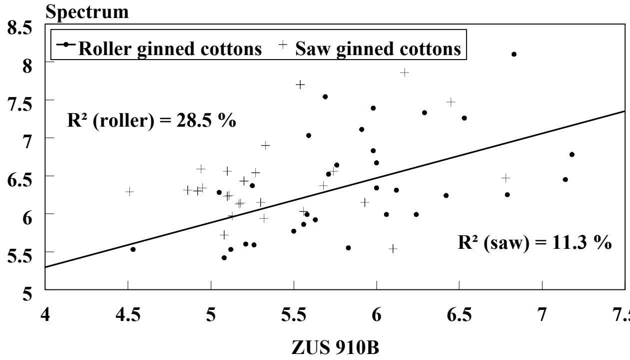

Figure 12. Comparison of ZUS 910B and Spectrum averages for Elongation (%) on roller- and saw-ginned cottons.

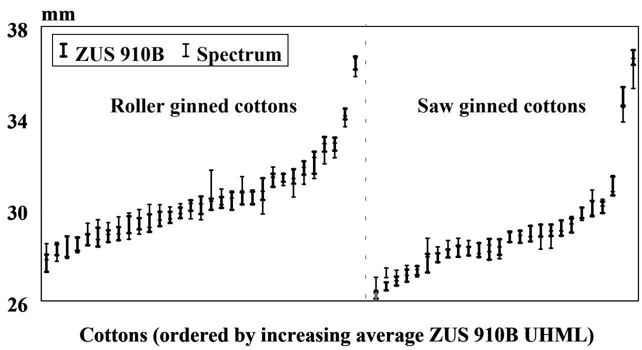

Figure 13. Confidence intervals of the averages of Upper Half Mean Length on ZUS 910B and Spectrum for the 57 cottons studied.

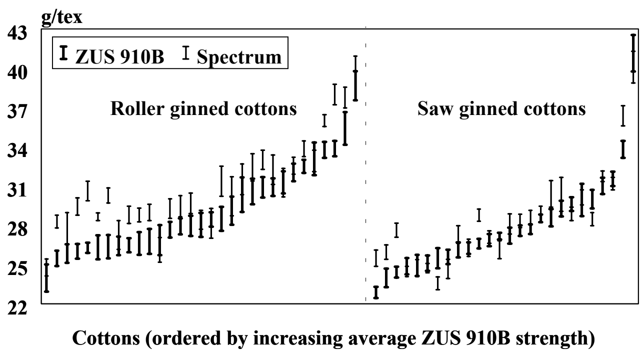

Figure 14. Confidence intervals of the averages of Strength on ZUS 910B and Spectrum for the 57 cottons studied.

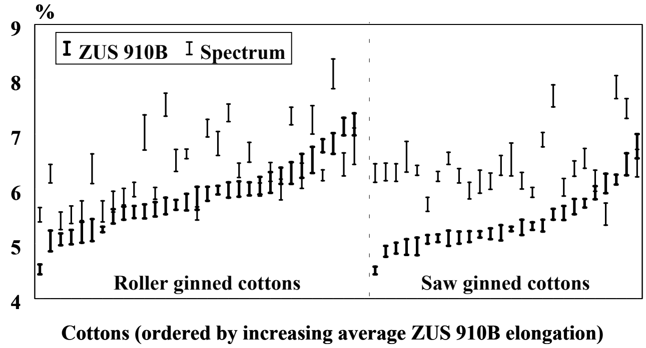

Figure 15. Confidence intervals of the averages of Elongation on ZUS 910B and Spectrum for the 57 cottons studied.