APPLICATION OF THE AFIS MULTIDATA

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Abstract

On two sets of selected cotton samples the effect of the *fiber length distribution* (represented in this report by the AFIS short fiber content by weight) and the AFIS *standard fineness* on yarn strength and yarn uniformity was investigated. It is intuitively simple to understand that the fiber length distribution will have an effect on yarn geometry and, therefore, on yarn regularity. But it is not intuitively obvious why “standard fineness” would be a better predictor of yarn quality than “fineness.”

On these sets of samples, the AFIS standard fineness is highly and negatively correlated with both CSP and yarn tenacity. The AFIS short fiber content by weight is higly correlated with yarn non-uniformity, the number of thin places and thick places on the Saco Lowell ring spinning frame. After short fibers are removed by combing, yarn non-uniformity, the number of thin places and thick places are highly correlated with AFIS standard fineness.

Introduction

On two sets of selected cotton samples the effect of the *fiber length distribution* (represented in this report by the AFIS short fiber content by weight) and the AFIS *standard fineness* on yarn strength and yarn uniformity was investigated.

Material

Eighteen Upland cottons were selected for this project. They consisted of six varieties grown in three different locations. In addition, eighteen SJV type varieties grown in three locations (2 replications per location) were also selected.

On each cotton sample the following tests were done on the raw fiber:

- Zellweger Uster HVI 900A with 4 replications for micronaire, color and trash measurements and 10 replications for length and strength,
- Zellweger Uster AFIS multidata with 5 replications of 3,000 fibers,

The long-term and short-term stability of both instruments were tested before, during and after testing the samples.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:666-670 (1999)
National Cotton Council, Memphis TN

The upland type cottons were spun on both Zinser 330 HS and Saco Lowell SF-3H spinning frames, producing 30/1 Ne yarns. The SJV type cottons were spun only on the Saco Lowell SF-3H frame. Both carded and combed 50 Ne yarns were produced. Before spinning the cotton samples, a check test was done on the roving frame and the two ring spinning frames to control the spindle-to-spindle variations during the experiment.

The yarns obtained were tested as follows:

- Skein tester with 10 replications,
- Zellweger Uster Tensorapid with 10 replications of 20 breaks,
- Zellweger Uster UT3 with 10 replications of 400 yards.

The long-term and short-term stability of the measuring instruments was tested before, during and after testing the samples.

Results and Discussion

In this report we have decided to focus on two very important fiber properties estimated by the AFIS: the standard fineness and the short fiber content. In a previous communication D. Ethridge and E. Hequet (1998) reported very good correlations between the AFIS standard fineness and the fiber bundle strength, for both Stelometer and HVI strength, and the yarn strength. These results have been confirmed on the two new sets of samples tested in this project (tables 1 to 4).

A summary of major results follows:

- On the Upland type cottons, the AFIS standard fineness is highly and negatively correlated with both CSP and yarn tenacity (figures 1 and 2). The two regression lines are parallel; therefore a decrease in fiber standard fineness results in the same increase in yarn strength for both spinning frames. The Zinser frame produces a stronger yarn, probably due to a better yarn architecture.
- The same conclusions can be drawn for the SJV-type cottons for both carded and combed cottons as, shown in the figure 3 and 4.
- For yarns from the Saco Lowell spinning frame, the AFIS short fiber content by weight is higly correlated with yarn non-uniformity (figures 5 and 6). In each case, increased short fiber content results in increased levels of non-uniformity in the yarn. However, there are no significant relationships observed for the Zinser frame. Apparently the geometry of the Zinser frame effectively compensates for a disadvantageous fiber length distribution. As expected for the combed yarn spun on the Saco

Lowell frame, the correlation between yarn non-uniformity and short fiber content is not significant. It is noteworthy that, after short fibers are removed by combing, yarn non-uniformity is highly correlated (r = 0.94) with AFIS standard fineness (figure 7). The implication is that the coaser the fiber, the higher the yarn CV%. Thus, it appears that the effect of the short fiber content overwhelms the effect of fiber fineness, but removal of the shortest fibers reveals an important influence by the standard fineness.

- Relationships regarding thin places in the yarns are shown in figures 8 to 10. The higher the short fiber content (SFC), the higher the number of thin places for both yarn counts spun on the Saco Lowell frames (figure 8). On the Zinser frame, however, the number of thin places is much lower and the correlation with SFC is quite low. As expected, for combed yarn, the effect of the short fiber content is not significant (figure 9). But, after removal of the short fibers, the important influence of standard fineness again becomes clear (figure 10). While not revealed in figure 10, it is noteworthy that the correlation between standard fineness and thin places is nearly perfect except for one variety. When tested in different locations with replications, this variety always shows a high number of thin places that cannot be explained by the HVI or AFIS measurements. Perhaps its propensity to make thin places is due to a genetic component and/or an important fiber parameter is not currently measured.
- Relationships regarding thin places in the yarns are shown in figures 11 to 13. Most of the observations made about the thin places also apply for thick places. However, the "unknown fiber parameter" discussed for thin places does not seem to have any influence on the number of thick places.
- Regarding yarn neps, the only significant correlation between AFIS neps counts on the raw material and yarn neps counts was for the 36 Ne yarn spun on the Saco Lowell ring frame (figure 14). The SFC has a significant effect on Neps for both 36 Ne and 50 Ne when spun on the Saco Lowell frame—but no effect when spun on the Zinser frame (figures 15 and 16).
- Yarn hairiness appears to be highly related to the fiber length distribution (figure 17 and 18). The shortest fibers apparently tend to cause hairy protrusions from the yarns.
- As expected, the AFIS measure for SFC is highly correlated (r = 0.94) with the amount of combing noils generated (figure 19).

Conclusions

While the structure of ring-spun yarns is influenced by a large number of parameters, two seem to be of particular importance: the *fiber length distribution* (represented in this report by the short fiber content by weight) and the *standard fineness*. It is intuitively simple to understand that the fiber length distribution will have an effect on yarn geometry and, therefore, on yarn regularity. But it is not intuitively obvious why "standard fineness" would be a better predictor of yarn quality than "fineness."

Of course, the gravimetric fineness is expressed as the mass per unit length of a fiber. Supposedly, the AFIS fineness, expressed in millitex, is an estimate of the gravimetric fineness. The lower the fineness, the higher the number of fibers in the yarn cross section; therefore, fineness could be a logical candidate to predict yarn strength. Unfortunately, the AFIS fineness measure is not a good predictor of yarn strength.

Biological fineness is, by definition, related to the perimeter of the cross section of the fiber. Gravimetric fineness can be related to biological fineness if the wall thickness (or maturity) is known. This wall thickness cannot be objectively measured with AFIS technology, yet the ratio AFIS fineness/maturity ratio (or "standard fineness") is a very good predictor of yarn strength. Why? This question remains open, but it is clear than a research effort is needed to understand the exact meaning of the AFIS standard fineness.

Acknowledgment

The financial support given by the Texas Food and Fiber Commission to realize this project is gratefully acknowledged.

References

M. D. Ethridge, E. F. Hequet. Fineness/Maturity results for the latest generation of AFIS. International Textile Manufacturers Federation. Proceedings of the International Committee on Cotton testing Methods. Bremen, Germany, March 10 – 11, 1998. pp.73-76

Table 1. Relation fiber properties vs. yarn properties: Yarn 36Ne spun on Saco Lowell ring spinning frame

	Slope	Offset	R
CSP vs Std. Fineness	-26.6	7414	-0.84***
Yarn tenacity vs Std. Fineness	-0.174	47.6	-0.85***
Yarn CV% vs SFC (w)	0.309	17.0	0.75***
Thin places vs SFC (w)	37.2	90	0.74***
Thick places vs SFC(w)	65.2	254	0.77***
Yarn Neps vs SFC(w)	16.8	152	0.63**
Hairiness vs SFC(w)	0.126	3.43	0.86***
Yarn Neps vs AFIS Neps	0.622	187	0.66**

Table 2. Relation fiber properties vs. yarn properties: Yarn 36Ne spun on Zinser ring spinning frame

	Slope	Offset	R
CSP vs Std. Fineness	-29.2	8106	-0.91***
Yarn tenacity vs Std. Fineness	-0.165	46.9	-0.88***
Yarn CV% vs SFC (w)			NS
Thin places vs SFC (w)	8.8	5	0.56*
Thick places vs SFC(w)			NS
Yarn Neps vs SFC(w)			NS
Hairiness vs SFC(w)	0.130	3.16	0.79***
Yarn Neps vs AFIS Neps			NS

Table 3. Relation fiber properties vs. yarn properties: Yarn 50Ne spun on Saco Lowell ring spinning frame

	Slope	Offset	R
CSP vs Std. Fineness	-34.2	8762	-0.78***
Yarn tenacity vs Std. Fineness	-0.177	48.5	-0.74***
Yarn CV% vs SFC (w)	1.072	18.9	0.84***
Thin places vs SFC (w)	231.2	226	0.75***
Thick places vs SFC(w)	286.8	411	0.87***
Yarn Neps vs SFC(w)	162.0	546	0.63**
Hairiness vs SFC(w)	0.189	2.90	0.85***
Yarn Neps vs AFIS Neps			NS

Table 4. Relation fiber properties vs. yarn properties: Yarn 50Ne combed spun on Saco Lowell ring spinning frame

	Slope	Offset	R
CSP vs Std. Fineness	-37.3	9643	-0.85***
Yarn tenacity vs Std. Fineness	-0.190	52.8	-0.77***
Yarn CV% vs Std. Fineness	0.096	0.4	0.94***
Thin places vs Std. Fineness	7.87	1231	0.63**
Thick places vs Std. Fineness	6.87	-974	0.88***
Yarn Neps vs SFC(w)			NS
Hairiness vs SFC(w)	0.111	2.72	0.69**
Yarn Neps vs AFIS Neps			NS
Combing Noils vs SFC (w)	2.085	6.45	0.94***

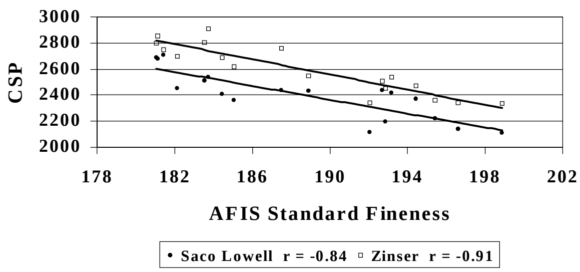

Figure 1. Count strength Product vs Standard Fineness on ring spun yarn 36 Ne

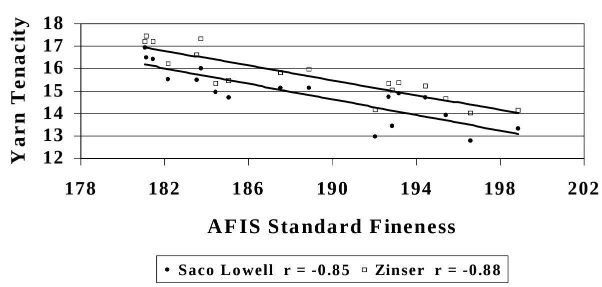

Figure 2. Yarn Tenacity vs Standard Fineness on ring spun yarn 36 Ne

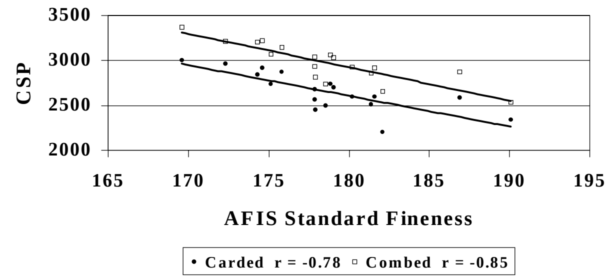

Figure 3. Count Strength Product vs Standard Fineness on ring spun yarn 50 Ne

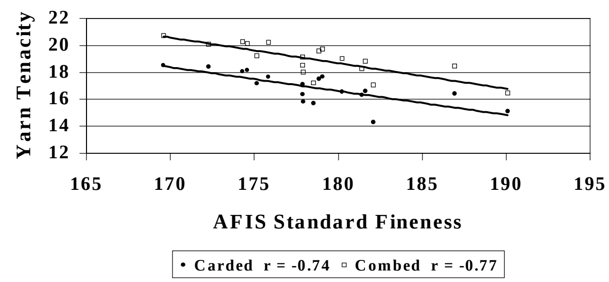

Figure 4. Yarn Tenacity vs Standard Fineness on ring spun yarn 50 Ne

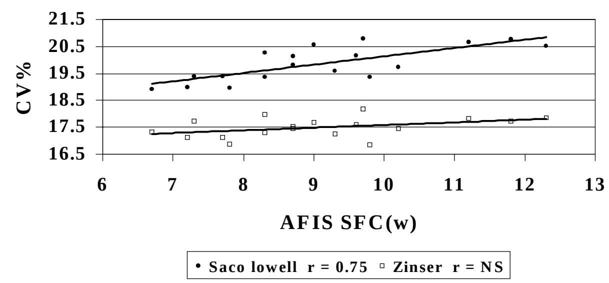

Figure 5. Yarn Non-Uniformity vs Standard Fineness on ring spun yarn 36 Ne

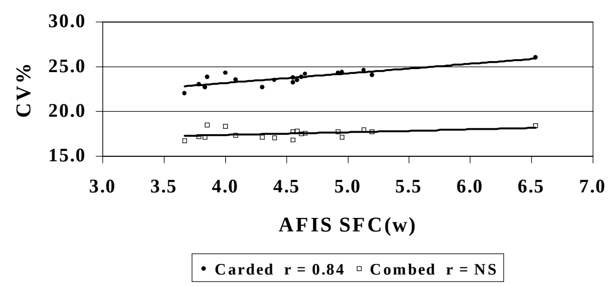

Figure 6. Yarn Non-Uniformity vs Short Fiber Content on ring spun yarn 50 Ne

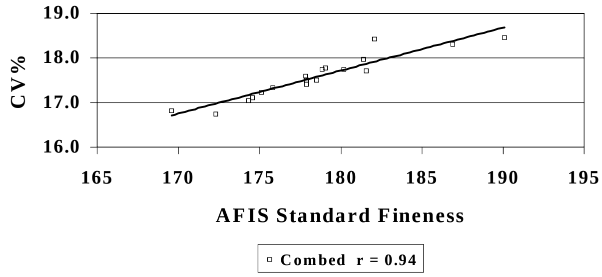

Figure 7. Yarn Non-Uniformity vs Standard fineness on ring spun yarn 50 Ne combed

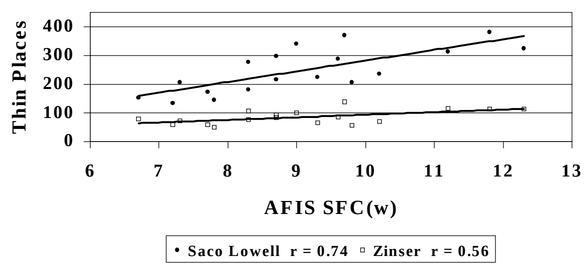

Figure 8. Thin places vs Short Fiber Content on ring spun yarn 36 Ne

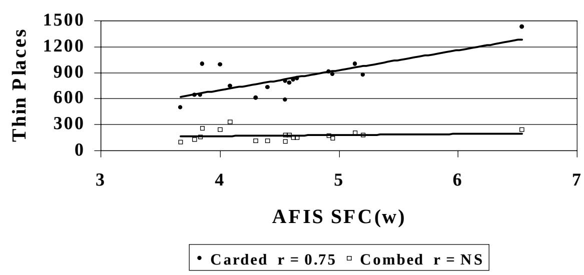

Figure 9. Thin places vs Short Fiber Content on ring spun yarn 50 Ne

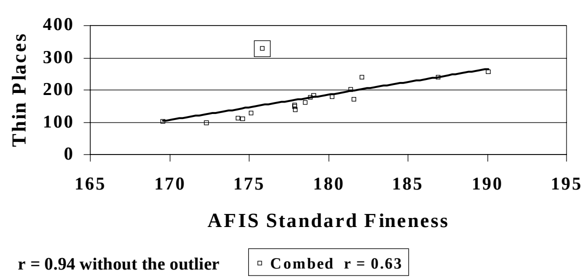

Figure 10. Thin places vs Standard Fineness on ring spun yarn 50 Ne

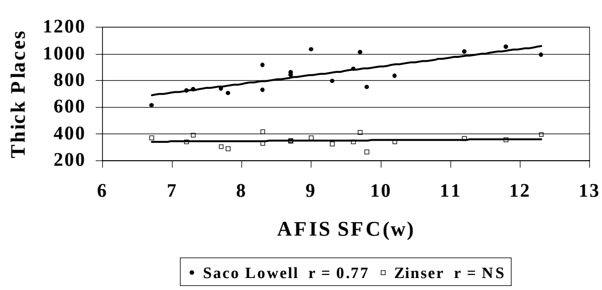

Figure 11. Thick places vs Short Fiber Content on ring spun yarn 36 Ne

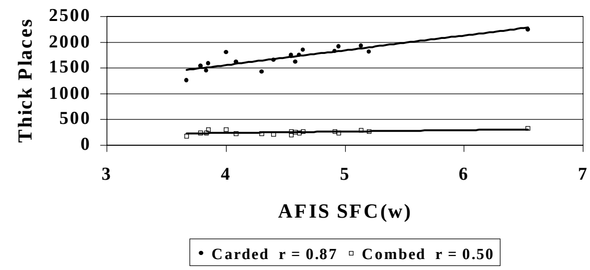

Figure 12. Thick places vs Short Fiber Content on ring spun yarn 36 Ne

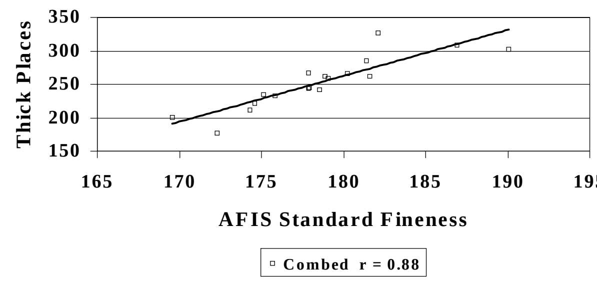

Figure 13. Thick places vs. Standard Fineness on ring spun yarn 50 Ne combed

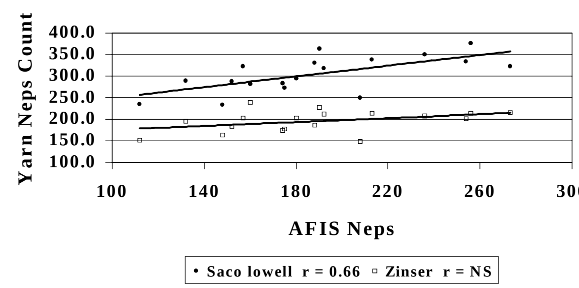

Figure 14. Yarn Neps Count vs. AFIS Neps Count on ring spun yarn 36 Ne

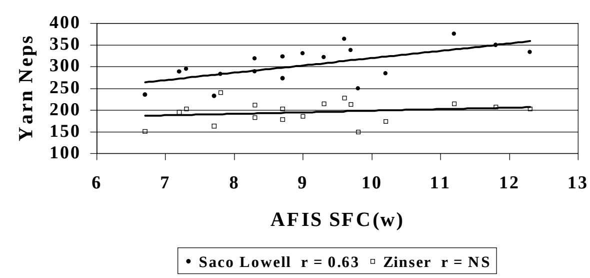

Figure 15. Yarn Neps Count vs. Short Fiber Content on ring spun yarn 36 Ne

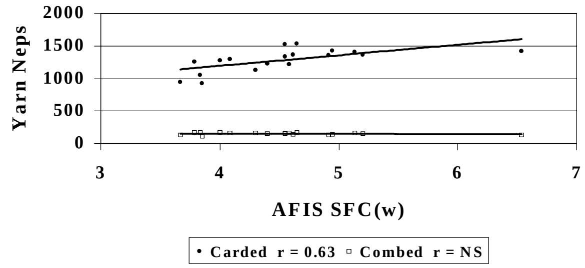

Figure 16. Yarn Neps Count vs. Short Fiber Content on ring spun yarn 50 Ne

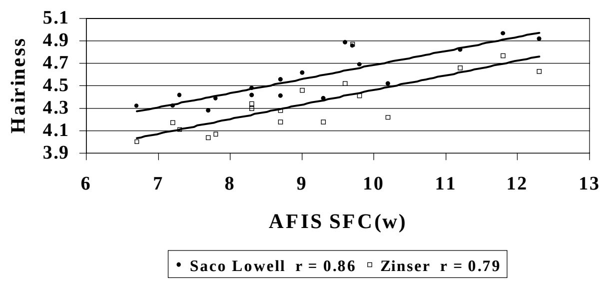

Figure 17. Yarn Hairiness vs. Short Fiber Content on ring spun yarn 36 Ne

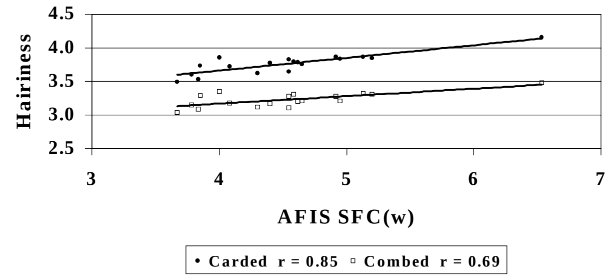

Figure 18. Yarn Hairiness vs. Short Fiber Content on ring spun yarn 50 Ne

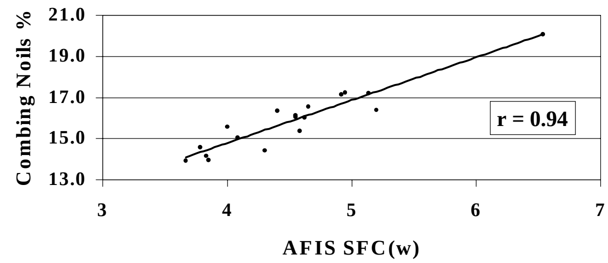

Figure 19. Combing Noils vs. Short Fiber Content